A REVIEW OF THE LEGAL FRAMEWORK GOVERNING ENVIRONMENTAL IMPACTS OF FUEL STATIONS ON GROUNDWATER IN CAPE TOWN, SOUTH AFRICA

By

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DECLARATION

I, **Eden Alexandre Nsimba**, declare that the contents of this dissertation represent my own unaided work and that the dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinion and not necessarily those of the Cape Peninsula University of Technology.

Signature: **Date:**

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ABSTRACT

Since the year 2014, decreasing water levels in dams have become a serious concern in the City of Cape Town. The city's authorities have had to implement strict restrictions to curb the consumption of water and diversification strategies which lead to an increased reliance on alternative sources of water supply. As a result, many residents of Cape Town opted for private boreholes to maintain their access to sufficient water for various purposes. However, using groundwater can be associated with risks, such as contamination. For example, it is well documented that leaking underground storage tanks often in fuel stations are among the major sources of groundwater contamination, especially in urban areas. In the City of Cape Town, fuel stations are widespread, and many of them are located inside residential areas where many private properties have groundwater abstraction points. Despite this observation, little is known in the public domain about the effectiveness of the legal frameworks governing the impacts of fuel stations on groundwater. This study aimed to review the legal frameworks governing the impacts of fuel stations on groundwater and to shed light on the risk approach adopted for the prevention and mitigation of the impacts fuel stations pose on groundwater in Cape Town. The research adopted an exploratory qualitative design. Thus, a desktop study was conducted to investigate the legal requirements for the development of fuel stations, the control of their impacts on groundwater, and the risk approach applicable to the management of fuel station risks. In addition, semi-structured interviews were conducted to supplement the document analysis. The selection of interview participants was structured to accommodate relevant parties, with key participants from the government, academic institutions, environmental consulting firms, and fuel stations. The findings revealed some gaps in the legal framework governing the impacts of fuel stations on groundwater, such as (1) the lack of precautionary requirements that consider land uses around fuel station developments and (2) the fragmentation of legal instruments regulating the control of impacts of fuel stations on groundwater. It is recommended that authorities must establish additional precautionary measures in terms of land use and equipment. To reduce the fragmentation of legal instruments, an integrated regulatory instrument must be adopted to regulate fuel stations' environmental aspects.

Keywords: Groundwater, fuel station, impacts, contamination, land use, legal framework, regulation, risk approach

DEDICATION

This dissertation is dedicated to God for the grace, my family for the love and support, and to my all-time mentor Dr David O. Oyedepo, Chancellor of Covenant University, whose life is a beacon spreading the light of faith to many of us.

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LIST OF ABBREVIATIONS

Acronym	Description
BAR	Basic Assessment Report
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CoCT	City of Cape Town
ECA	Environmental Conservation Act
EIA	Environmental Impact Assessment
GDACELA	Gauteng Department of Agriculture, Conservation, Environment and Land Affairs
LNAPL	Light Non-Aqueous Phase Liquid
MHI	Major Hazard Installation
NAPL	Non-Aqueous Phase Liquid
NEMA	National Environmental Management: Waste Act
NEMWA	National Environmental Management Act
NRGI	Natural Resource Governance Institute
NWA	National Water Act
OHS Act	Occupational Health and Safety Act
SABS	South African Bureau of Standards
SPLUMA	Spatial Planning and Land Use Management Act
UST	Underground Storage Tank

GLOSSARY

Term	Explanation/Definition
Aquifer	An aquifer is a saturated rock or other geologic material such as sand or gravel that can store sufficient water underground and can allow water to move through (Easton and Bock, 2015).
BTEX compounds	A group of organic compounds of concern for public health as they are carcinogenic, often released into soil and groundwater by leaking tanks of gasoline and petrol storage (Mitra and Roy, 2011).
Groundwater abstraction	The process of taking groundwater from an aquifer or ground source such as through boreholes or wells (Thomsen, Søndergaard and Sørensen, 2004).
Environmental impact	An environmental impact is generally defined as any change whether beneficial or adverse caused by natural or man-made activity or as the materialisation of predicted risk (Hern, 2011; Gilissen *et al.*, 2021).
Legal framework	A set of rules governing the rights and responsibilities of government, companies, and citizens, includes the laws and regulations of a country (Natural Resources Governance Institute, 2015).
Fuel stations	Petroleum fuel retail facilities (also called petrol stations) that store and sell petroleum products; also called garages, petrol stations, filling stations or gas stations, etc. depending on countries (Qonono, 2019).
Risk approach	A specific method or strategy of dealing with risk (Rothstein *et al.*, 2006).

Sensitive land-use	Land-use that is particularly vulnerable to environmental risks, for example, residential properties, schools, hospitals, etc. (Environmental Authority West Australia, 2005).
Separation distance	Distance or buffer zone separating a source of contamination to potential receptors (California State Water Resources Control Board, 2004).
Underground storage tank	A type of tank that is buried at fuel stations to store liquid petroleum fuels (Pfotenhauer, 2011).

CHAPTER ONE: GENERAL INTRODUCTION

1.1. Introduction

Global water resources are coming under severe strain due to many factors such as climate change and population growth, especially in urban agglomerations (Malaza and Mabuda, 2019). In addition, contamination of water resources by anthropogenic activities is also a big concern worldwide (Khatri and Tyagi, 2015; Rasheed *et al.*, 2019). These challenges are reducing the available water resources humans can use.

Water resources are threatened by several kinds and sources of anthropogenic contamination. A few decades ago, policy-makers started deploying laws, regulations, and policies to safeguard the environment in general and more particularly water resources (Solanes, 2009; Grönwall and Danert, 2020). However, the effectiveness of a legal framework governing environmental aspects may be inexpedient if certain theoretical and practical parameters are not properly considered (Maljean-dubois, 2017). Such parameters include among others, incorporating an appropriate risk approach in the management of environmental impacts and risks. According to Abubakar (2019), the effectiveness f the legal and regulatory frameworks depends among others on the clarity of the components and approaches used to govern the environmental issues.

Hence, it is important to critically analyse the legal frameworks developed at all levels of governance (Abubakar, 2019). This research reviewed the environmental legal framework governing environmental impacts and risks posed by fuel stations on groundwater in the City of Cape Town (CoCT). Groundwater is a precious source of fresh water, which serves as the main source of water in many regions across the globe and South Africa (Grönwall and Danert, 2020). Therefore, it is crucial to bolster the legal measures intended to protect groundwater and its users.

1.2. Background

Fuel stations are associated with several environmental impacts despite their socio-economic importance (Ahmed *et al.*, 2011; Olapeju, 2017). Several sources indicate that leaking underground storage tanks are a major cause of groundwater contamination, especially in urban areas (see for instance Day, *et al.,* 2001; Fiedler and Quander, 2004). Gomo (2009) and Gosling (2011) reported the events of groundwater contamination in

Beaufort West, Western Cape; an area located in the Central Karoo and where many residents rely solely on groundwater for domestic water supply. According to Johnston (2014), fuel leakages at fuel stations located in the town of Beaufort West caused groundwater contamination which in turn affected more than 100 boreholes.

In Cape Town and many other municipalities in the Western Cape, the availability of water supply depends largely on water stored in dams during rainfall seasons (Malaza and Mabuda, 2019). However, with severe droughts that afflicted Cape Town, particularly between the years 2015 and 2018, the annual precipitation in the Western Cape Province decreased, affecting municipal water supplies (Visser, 2018; Omar, 2020). Subsequently, stricter water restrictions on the use of water were imposed to curb water consumption (Omar, 2020). Following these events, since groundwater was the most immediate avenue compared to other sophisticated alternatives, reliance on groundwater through private boreholes became a “new normal” (Ziervogel, 2019). Jordan (2019) states that between 2016 and 2019 registered boreholes by the CoCT increased from 1500 to 26 000 (Jordan, 2019).

In light of the above events, one can predict that if water challenges continue to unfold, the CoCT may continue to experience increases in boreholes. Given the affluence of people to groundwater in times of restrictions, it is important to be cautious about the potential environmental and health impacts associated with groundwater and how these challenges are regulated. Adelana and Jovanovic (2006); Adelana (2010); Seyler, Witthüser and Sunaitis (2019) recognise fuel stations and problematic underground storage tanks (USTs) as one of the major activities threatening groundwater quality in Cape Town, especially in aquifers underlying popular suburbs.

1.3. Problem statement

Fuel stations are widespread in Cape Town, especially in populated areas, where the number of boreholes has increased (Jordan, 2019). On the other hand, fuel stations are also known for the potential to cause incidents susceptible to contaminating soil and groundwater (Solecki and Stop, 2016). However, although fuel stations can be problematic for groundwater, it appears that in Cape Town environmental protection measures concerning fuel stations' impacts on groundwater are not readily discussed. Furthermore,

little is known about the effectiveness of the current legal framework governing these risks posed by fuel stations.

Therefore, to suggest improvements to the legal framework for the protection of groundwater and public health, it is important to investigate the current legal provisions that govern the development of fuel stations, measures for control of impacts, and the approach used to manage the risks and impacts petrol stations pose on groundwater. Thus, this study seeks to review the legal framework governing the impacts of fuel stations on groundwater.

1.4. Research questions

The following questions are addressed regarding the research:

- What regulatory conditions are in place for the development of fuel stations and control of their impacts on groundwater?
- What requirements are in place for the protection of boreholes in areas adjacent to fuel stations?
- What risk approach is recommended in the legal framework governing fuel stations' impacts on groundwater?

1.5. Research aim

This study was to review the legal framework governing the impacts of fuel stations on groundwater in Cape Town and shed light on the risk approach adopted for the prevention and mitigation of fuel stations' impacts.

1.6. Objectives

The following objectives were pursued:

- To review pieces of legislation that govern the development and control of fuel stations' impacts on groundwater.
- To evaluate the effectiveness of the requirements set in place for the protection of groundwater and boreholes in areas adjacent to fuel stations.
- To identify the risk approach recommended in the legal framework governing fuel stations' impact on groundwater.

1.7. Delineation and significance of this study

The scope of this study is limited to the review of the legal framework of environmental management applicable to fuel stations' impacts on groundwater in Cape Town. The findings of this study would enable practical recommendations for future environmental policies and further research to strengthen the effectiveness of the legal framework regulating the environmental aspects of fuel stations.

1.8. The study area

Cape Town is located at the Southwestern tip of the African continent, approximately between the latitude 33.55 °S and longitude 18.25°E, in an ecologically sensitive region. The CoCT falls under the Mediterranean climate, characterised by an unreliable and sometimes unpredictable rainfall pattern which makes it prone to water scarcity (Omar, 2020). The highest rainfall averages, up to 2000 mm per annum and above are often recorded in mountainous areas such as the Heidelberg basin, Steenbras, and Franschhoek (Malaza and Mabuda, 2019).

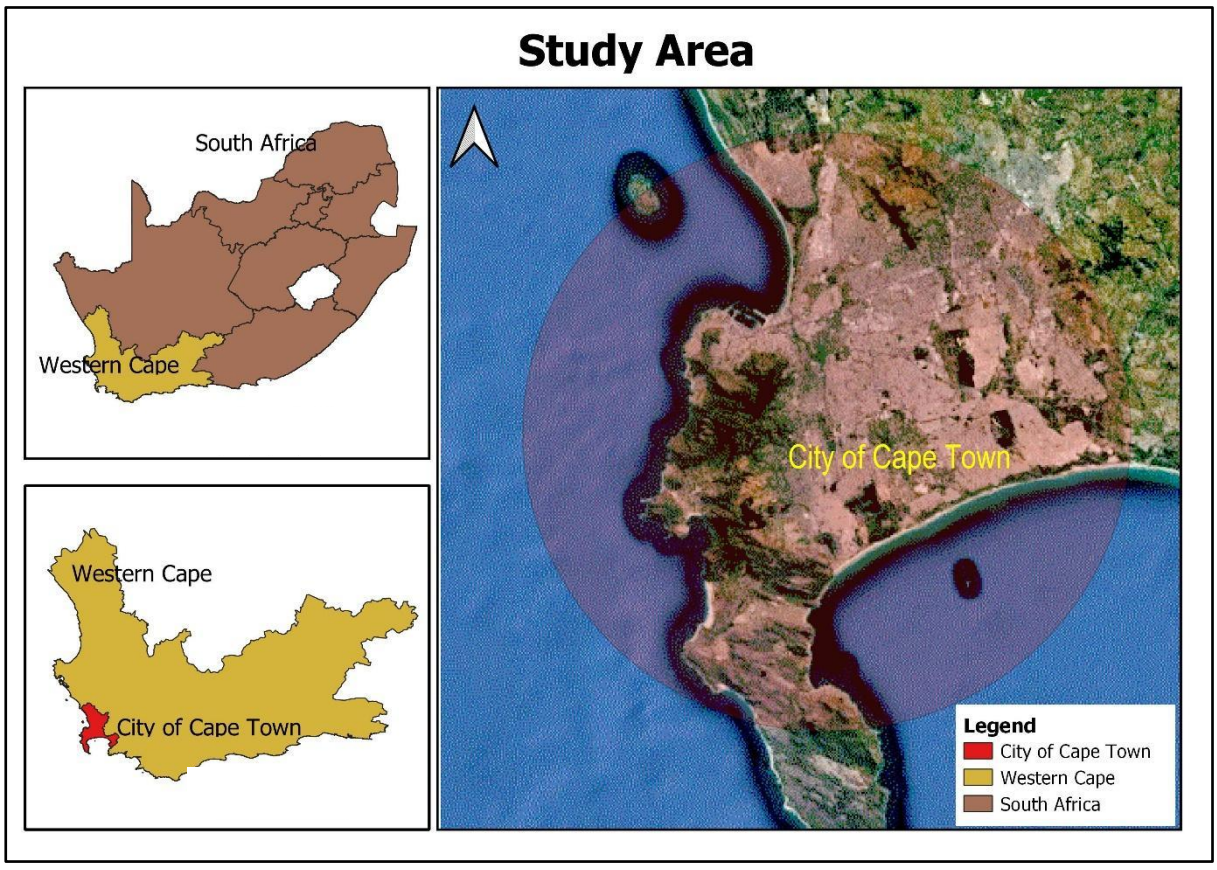

Figure 1.1: Cape Town location in South Africa.

The geology of Cape Town falls within the Cape Supergroup, with five groups among which the Malmesbury group constitutes the oldest group of rocks, underlying most of the city (Dippenaar, 2016; Marazula, 2018). The geological formations of Cape Town are mostly made up of sedimentary rock deposited through wind and water erosion in the geologic time scale. This geological characteristic provides the CoCT with many aquifers such as the Table Mountain Group (TMG), Cape Flats aquifer, Atlantis aquifer, and the Malmesbury aquifer, from which residents of the CoCT can abstract groundwater as an alternative to water municipal supply, especially during periods of water penury (Dippenaar, 2016; Mauck, 2017; Visser, 2018).

Currently, only a small fraction of groundwater contributes to the bulk water supply distributed in Cape Town. Groundwater represents around 2 % of the total bulk municipal supply (Mauck, 2017; Oliver and Xu, 2018). Nevertheless, the experience of the past drought events and water shortages have prompted the increase of privately owned boreholes in the CoCT (Jordan, 2019).

1.9. Project Outline

This project is organised into five chapters. Chapter one introduces this report and contains among others the background, problem statement, research questions, and the research aim and objectives of this study. Chapter Two presents the review of literature relevant to the research topic while chapter three gives the details of the methodology employed for data collection and analysis. Chapter four focuses on the result and discussion and lastly, chapter five presents the conclusion and recommendations.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

This chapter provides insights from the literature regarding environmental regulations and management of fuel stations vis-à-vis groundwater contamination. According to Feris (2010); Hern (2011); Aven and Renn (2018) and Gilissen *et al.*, (2021), there is a close tie between environmental governance, regulation and the environmental principles applied in the regulation of environmental risks and impacts. Therefore, the first section of this chapter discussed the basic concepts relating to the study.

2.2. Defining basic concepts

2.2.1. Environmental risk and impact

The concept of risk is often interpreted differently in different walks of life (Bialostok, 2015). In natural sciences and engineering, the term risk is often measured in terms of the probability of a negative outcome (Kunreuther, Meyer and Michel-Kerjan, 2019). The concept of risk is often related to impact, especially in environmental contexts such as climate change or pollution (Aven and Renn, 2018). Gilissen *et al.* (2021) explain that an "impact" is the materialisation of a risk. Thus, an environmental impact is described in simple terms as any change that occurs in the environment as a result of natural phenomena or man-made actions (Kosyakova *et al.*, 2019).

2.2.2. Environmental governance

Numerous scholarly writings have been dedicated to the concept of environmental governance (see for example Feris, 2010; Erhun, 2015; Aven and Renn, 2018). The term governance covers many fields including corporate governance, welfare governance, economic governance, and environmental governance (Erhun, 2015). Nowadays, governance stands as the leading concept in the management of social, political, economic, and socio-ecological problems. Braithwaite *et al.* (2007) argued that regulation and governance have become popular phenomena of study by social scientists. Particularly, environmental governance and regulation gained prominence between 1960 and 1970 following landmark environmental incidents (Braithwaite *et al.,* 2007).

Feris (2010) describes governance as a function of public administration or the use of managerial, political, and legal theories for the provision of regulatory functions to society.

The concept of governance can denote also the processes, organisations, and individuals; acting in an official capacity to implement laws and other binding measures (Renn, Klinke and Van Asselt, 2011; Fukuyama, 2013; Cosens *et al.*, 2017). In the same vein, Hern (2011) highlights the participatory aspects of governance, with an emphasis on environmental governance, which should involve actors from all levels, and interaction between different stakeholders.

Environmental governance, however, became more prominent in the 21st century, an era characterised by the increasing need for sustainable management of socio-ecological systems which require strong regulatory measures (Delgado and Marín, 2019). Thus, Feris (2010) highlights the need for innovative research to analyse options to govern sustainable development in consideration of political effectiveness, efficiency, justice and equity.

2.2.3. Legal framework

According to the Natural Resource Governance Institute (2015) (NRGI), a legal framework is a set of rules that govern the rights and responsibilities of governments, organisations, and citizens. The NRGI (2015) adds that the components of a legal framework include a country's constitution, legislation, regulations, policy, etc. However, it is important to keep in mind the hierarchy of legal instruments in a legal framework as it influences the implementation of the rule of law (Clegg *et al.*, 2016) (Figure 2.1). In countries where there is the rule of law, the order commences by the constitution as the supreme law, statutes enacted by legislative bodies followed by other instruments developed by authorised bodies. Such instruments include regulations, guidelines, codes, etc. (Lowe and Potter, 2018).

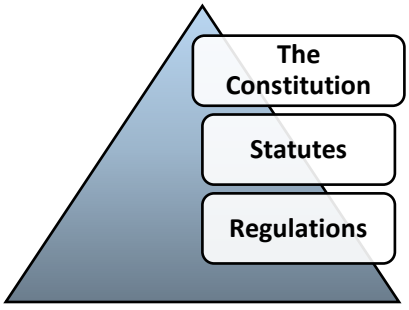

Figure 2.1: The hierarchy of laws (adapted from Clegg *et al.*, 2016).

As mentioned above, statutes or legislation are enacted by a legislative body of the government and are the regulations that provide specific details for the implementation of

statutes. (Clegg *et al.*, 2016). Legislation is often broad, providing principles and rules that give effect to a public policy. Regulations differ from legislation as they provide specific directions to implement and enforce legislation (Koop and Lodge, 2015). Therefore, the environmental legal framework entails provisions for the governance of the environment. However, Holley (2017) explains that ever since the inception of modern environmental regulations in the early 1970s, the development and implementation of effective and efficient regulations remained a considerable challenge for governments and society. These challenges are often created by regulatory and governance crises (Holley, 2017).

2.2.4. Risk approach

The effectiveness of regulation of environmental risks depends on the available legal provisions, but also the risk approach implemented in the regulation (Hern, 2011). Several risk management approaches are applied in the governance of risk (Aven and Renn, 2018). However, there are two main approaches applied in engineering, environmental and legal sciences: the precautionary and risk-based approaches (Gouldson, Morton and Pollard, 2009; Hern, 2011; Aven and Renn, 2018).

The precautionary approach is based on the precautionary principle. Ahteensuu and Sandin (2012) note that the precautionary approach gave rise to the development of policy for sensitive environmental problems such as pollution, nuclear power production, and other possible situations. The precautionary approach promotes proactivity in taking measures to avoid environmental impacts in the presence of uncertainties (Ahteensuu and Sandin, 2012). Hence, in environmental governance and regulation, the precautionary approach implies the need to take caution in advance to prevent negative impacts (Rogers, 2001). In the same vein, Renn and Klinke (2015) advocate for a "precaution-based" approach that finds an adequate and fair balance between being overcautious and not being adequately cautious.

The risk-based approach is widely applied in environmental regulation in many countries. Risk assessment and monitoring are foundational elements of this approach (Gouldson, Morton and Pollard, 2009). Hern (2011) highlights the fact that in the agenda for better regulation, the risk-based approach is commonly used as it ameliorates the regulatory process, and contributes to the effectiveness and efficiency of decision-making. In addition to the fact that the risk-based approach facilitates a more transparent process, it also

promotes inclusiveness which is an essential requirement for good governance (Rothstein *et al.*, 2006). However, the risk-based approach is suitable for situations where uncertainty and ambiguity are minimal (Hern, 2011).

Moreover, some literature describes the risk approach to management as proactive and reactive approaches (Vastola and Saracino, 2006; Gilissen *et al.*, 2021). Proactive and reactive paradigms are well-grounded in various disciplines where they are both aimed at controlling and preventing the potential occurrence of negative impacts (Vastola and Saracino, 2006; Hern, 2011; Van Staveren, 2018). In Van Staveren (2018), the reactive approach is described as fatalistic, and proactive as holistic. The author further states that the reactive approach focuses on the retention or acceptance of risk and argues that this approach can be difficult and dangerous because the forecasting of risk can be limited by inherent uncertainties. On the other hand, the proactive approach focuses on avoidance, prevention, and reduction of risk (Van Staveren, 2018). Nevertheless, integrative strategies that combine both approaches are encouraged, to help maximise the effectiveness and efficiency of risk management (Lenssen, Dentchev and Roger, 2014; Aven and Renn, 2018).

2.3. Environmental impacts of fuel stations on groundwater

2.3.1. An overview of the importance of groundwater

Water on the planet earth is mostly saline, residing in the earth's oceans (96.5%) (Han, 2010). Only 2.5% of the water on earth is fresh water and of which 69.6% is in the form of icecaps and glaciers, groundwater (30.1%), and the remaining portion is found in lakes, marshes, and rivers (Easton and Bock, 2015). Like many other natural resources, freshwater is not evenly distributed. Thus, many water-stressed areas around the globe use sophisticated technologies like desalination plants as an alternative to convert seawater to freshwater (Liehr *et al.*, 2018; Williams, 2018).

According to Grönwall and Danert (2020), about 2.5 billion people across the globe solely depend on groundwater for their daily water needs. A case study found in Seyler, Witthüser and Sunaitis (2019) reveals that in Denmark the water supply including for drinking purposes comes almost exclusively from groundwater. As a consequence, the reliance on groundwater has led to the extensive development of legal measures for the protection of groundwater in Denmark (Thomsen, Søndergaard and Sørensen, 2004).

In South Africa, a report by Green Cape (2019) revealed that 13% of the total bulk water supply is sourced from groundwater, of which 27% is distributed to various urban areas. In Cape Town, for example, the commissioning of boreholes especially in residential areas is often drought-driven as restrictions increase during such dry seasons (Wright and Jacobs, 2016). Thus, the use of groundwater, especially for outside activities like garden watering increases during drought periods (Wright and Jacobs, 2016; Visser, 2018; Omar, 2020).

However, using groundwater also has some risks. For instance, Adelana and Jovanovic (2006); Adelana (2010); Seyler, Witthüser and Sunaitis (2019) cite leaking USTs as potential threats to groundwater quality in Cape Town. Leaking USTs are also cited by many authors as threats to groundwater, especially in urban areas where petroleum hydrocarbons are often found in soil and groundwater at fuel stations (Solecki and Stopa, 2016; Logeshwaran *et al*., 2018).

2.3.2. Description of underground storage tank (UST)

A UST system consists of a steel tank with a single wall or double-walled, connected to a network of pipes and pumps. Today, USTs are equipped with protective coating or glass-reinforced polyester (GRP) to prevent corrosion and spillage (Pfotenhauer, 2011). Nevertheless, some USTs can be sources of pollution due to leaks that can result from corrosion and structural problems in the equipment (Pfotenhauer, 2011).

2.3.3. Impacts of leaking USTs onto groundwater

Fuel stations can refer to any facility where petroleum fuels like petrol and diesel are stored and sold to motorists, especially in big urban agglomerations (Ahmed *et al.*, 2011). Fuel stations are crucial for the urban transport system, facilitating the supply of fuel across cities and vital parts of the economy (Ihsan, Mustafa and Akeel, 2020). Notwithstanding their socio-economic relevance, fuel stations are also known to be fire hazards (Qonono, 2019; Kehinde, 2020), and a source of contamination of soil and groundwater mostly due to leaking USTs (Day*, et al.,* 2001; Mitra and Roy, 2011; Ossai *et al.*, 2019).

Substances released from leaking USTs can remain unnoticed for some time while impacting groundwater (Fiorenza, Suarez and Rifai, 2002; López, Schuhmacher and Domingo, 2008). This can result in pervasive substances such as benzene, toluene ethylbenzene and xylene (BTEX), methyl tert-butyl ether (MTBE), polycyclic aromatic hydrocarbons (PAHs), etc. contained in petroleum fuel being released in groundwater and

detected in private boreholes (Figure 2.2), thereby causing public health issues (Wu, Zhang and Zhang, 2017).

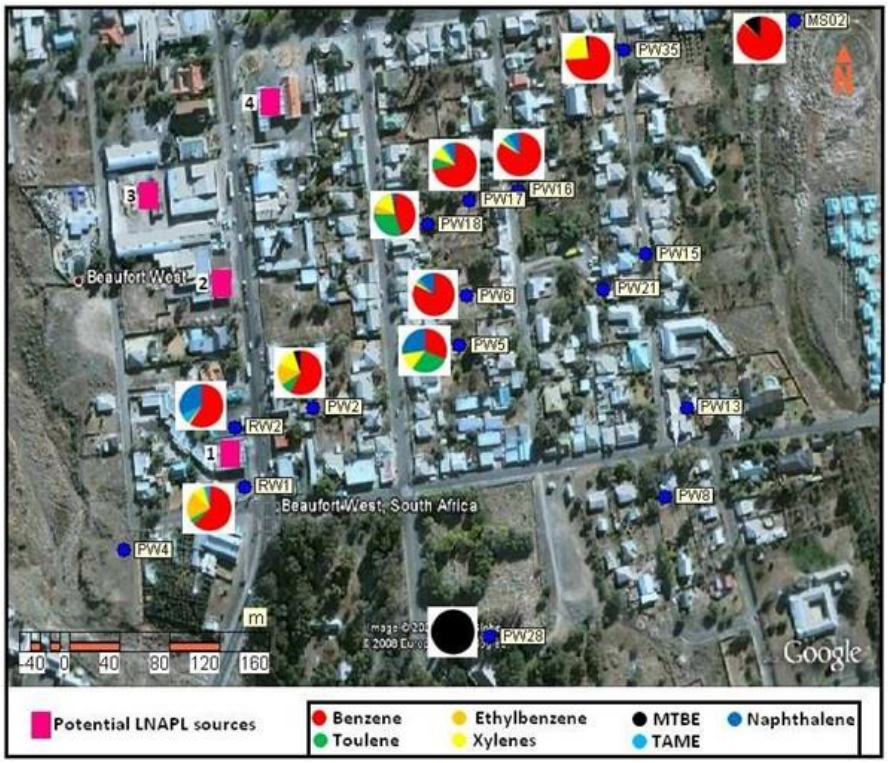

Figure 2.2: Contaminated boreholes near fuel stations in Beaufort West (Gomo, 2009).

Pfotenhauer (2011) argues that the prolonged use of USTs for the storage of petroleum products will always present a risk of groundwater contamination. According to Wu, Zhang and Zhang (2017), the secondary containment measures for the oil storage tanks, such as double-layer tanks or containment ponds have proven to be effective to control the contamination of groundwater resulting from USTs. Furthermore, Ching sheng *et al.* (2009) stress the importance of appropriate monitoring practices to minimise the spread of impacts caused by leaking USTs. This is very important, particularly for concerns posed by the exposure to petroleum fuel around fuel stations in urban areas. Many countries have adopted a series of proactive moves aiming to tighten regulations as countermeasures in preventing and minimising contaminations, especially in ageing UST systems (Ching sheng *et al.*, 2009).

2.3.4. Fate and health effects of petroleum fuel in groundwater

The earth subsurface that extends to groundwater can be subdivided into three parts: the unsaturated zone (the vadose zone), the capillary fringe, and a saturated zone (Han, 2010;

M. Easton and Bock, 2015). The vadose zone is the uppermost layer located between the earth's atmosphere and the water table (piezometric surface), playing a critical role in filtering the water which percolates through before reaching the saturated zone. Below the vadose zone, is the capillary fringe, where groundwater seeps upward from the water table due to capillary force (Newell *et al.*, 1995). Lastly, the saturated zone is located below the water table where water fills the aquifers (Han, 2010).

When liquid fuels are released into the groundwater, an immiscible light non-aqueous phase (LNAPL) (free phase) is formed. (Azimi *et al.*, 2020). LNAPLs are causes of concern for groundwater as they can migrate through and contaminate groundwater (Newell *et al.*, 1995), as depicted in Figure 2.3. It is well established that a very small amount of petroleum fuel can cause the contamination of large aquifers (Gomo, 2009; Azimi *et al.*, 2020; Marić *et al.*, 2020).

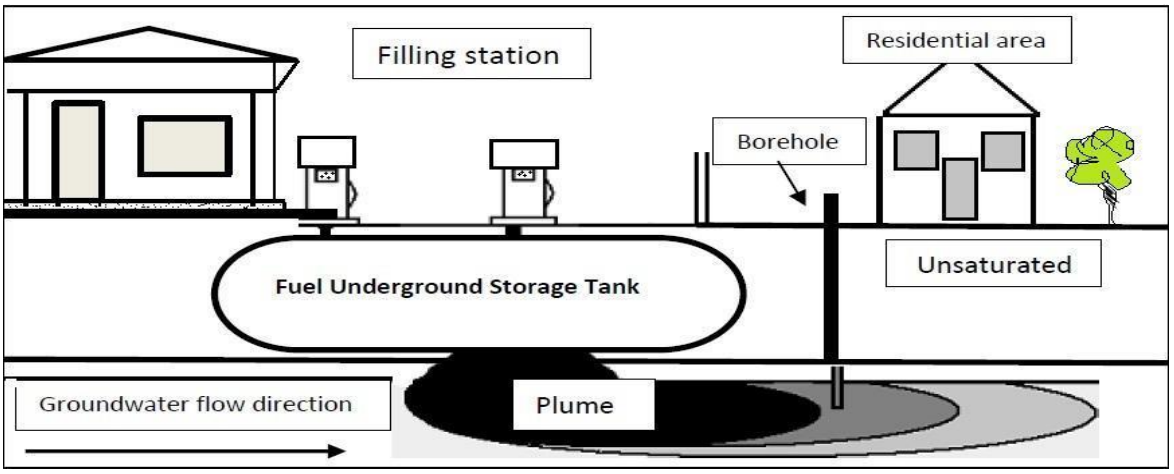

Figure 2.3: A conceptual model of leaking fuel tank (Adapted from California State Water Resources Control, 2012).

LNAPL plumes can spread in soil and reach groundwater, the remediation can require complex techniques with high financial implications (Wang *et al.*, 2017). Studies by Powers *et al.* (2001); Fiorenza, Suarez, and Rifai (2002) and California State Water Resources Control Board (2004) revealed that the lengths and stability of contaminant plumes can spread beyond 50 metres from the contamination source.

2.3.4.1. Health impact

Consuming contaminated groundwater can have repercussions on human health (Michaels, 2019; Gibson *et al.*, 2020). Humans can be exposed to petroleum fuel through inhalation of fumes from contaminated soil, vapour-intrusion in a building or ingestion of soil containing petroleum hydrocarbons by children. While the severity of the effects may depend on exposure pathways and the timing of exposure, the greatest risk to human health can be expected when drinking contaminated water supply (Kponee *et al.*, 2015). In general, exposure to petroleum hydrocarbons can lead to acute health effects such as flu-like symptoms, cough, headache, dizziness, eyes and skin irritation, and memory loss. Over time, chronic exposure to petroleum hydrocarbons can cause more severe and permanent effects such as cancer, leukaemia, cardiotoxicity, endocrine toxicity, teratogenicity, etc. (Sierra Club, 2005; Kponee *et al.*, 2015; Bai *et al.*, 2019).

Considering that petroleum substances may cause severe health impacts, potential sources of groundwater contamination such as leaking USTs must be well regulated to avoid mishaps (Wu, Zhang and Zhand, 2017). Ching sheng *et al*. (2019) argue that because of the unpredictability of UST leakages, both in terms of occurrence and severity of damages, more stringent measures have been proposed and implemented by governments worldwide.

2.3.5. Regulation of fuel stations and USTs around the world

Regulations are important to prevent and mitigate the impacts of USTs. In 1988, the United States Congress issued the UST regulations (Subtitle I) under the Resource Conservation and Recovery Act (RCRA) (Rogers, 2019). The RCRA UST regulations govern the storage of petroleum or hazardous substances, covering three aspects: technical requirements, financial responsibility and state programme approval objectives. By issuing the UST Regulations, the American policymakers aimed to minimise the releases due to overfills, spills and corrosion of tanks resulting from UST facilities such as fuel stations. Thanks to the UST regulations, the Environmental Protection Agency (EPA) launched the UST programme which was carried out by the Office of Underground Storage Tanks (OUST) to eliminate the threats posed by leaking USTs (Rogers, 2019). As a result, the EPA successfully remediated 500 000 UST petroleum releases that were posing a threat to soil and groundwater (Fiedler and Quander, 2004; US EPA, 2019; Horinko *et al.*, 2020).

In the United Kingdom (UK), the development of fuel stations and installation of USTs is regulated under the Codes of Practice and the Environmental Permitting Regulations (2016/No 1154). Interestingly, the UK's approach to the protection of groundwater focus on specific risk activities such as fuel stations rather than providing general requirements (Christopher, 2011). Regulation 21 of the UK's Groundwater Regulations (1998/No 2746) allows the minister in charge of the environment to approve codes of practices for activities that may contaminate groundwater. Thus, the UK Department of Environment, Food and Rural Affairs approved for the first time in 2002, the Groundwater Protection Code: Petrol stations and other fuel dispensing facilities involving underground storage tanks. The Code of Practice provide specifications for USTs and ancillary equipment to prevent groundwater contamination (Christopher, 2011).

Concerning land use regulation, fuel stations are considered hazard sources (Qonono, 2019). As such, land-use regulations address land factors such as proximity to sensitive land uses (Harrison *et al.*, 1999; Brender, Maantay and Chakraborty, 2011; Cox *et al.*, 2013; García-Pérez *et al.*, 2016; Yang, Song and Choi, 2016). In many countries, specific legal requirements are in place to regulate land use and proximity to fuel stations. For instance, the "groundwater protection codes for USTs" in Wale require that a proponent must provide a risk assessment and information relating to the proximity of the tanks to a local watercourse, sensitive groundwater location, and public and private groundwater abstraction points before the installation of a UST (Welsh Government, 2017).

Similarly, in Nigeria and Ghana precautionary measures are required to avoid land-use conflicts. In both countries, regulations do not forbid fuel stations within a minimum of at least 100 metres from residential properties, hospitals, schools, health centres, etc. (Olapeju, 2017).

2.4. Regulation of impact of fuel stations on groundwater in South Africa

According to Holley (2017), the development of modern environmental legislation started in the United States in the 1970s, in response to increased public awareness of sustainability issues after high-profile environmental incidents. As a consequence, countries including South Africa, have developed and improved their environmental legislation to face issues of declining environmental quality in the past fifty years (Holley, 2017).

South Africa is a constitutional democracy, with a three-tier government (Johnston, 2014). The country has a rich constitution with extraordinary rights and an environmental regulatory framework (van der Linde and Feris, 2010), governing the country's environmental affairs. The following paragraphs will discuss selected legal instruments to demonstrate awareness of the objectives and relevance of the legal instruments that were selected for the review in this dissertation.

2.4.1. South African Constitution

The South African Constitution is the foundation of democracy in the country; upon which all the laws, regulations and policies must be built (van der Linde and Feris, 2010). One of the most important provisions of the constitution is the Bill of Rights, which list the basic rights that must be enjoyed by all citizens. Interestingly, the right to an environment that is not harmful is guaranteed for everyone in the constitution. Further, to ensure that this right is fully protected, several legislative and regulatory instruments are passed by authorised bodies to regulate various aspects of the environment (van der Linde and Feris, 2010; Beech and Veltman, 2017).

2.4.2. Environmental Conservation Act (Act 73 of 1989)

The Environmental Conservation Act (Act 73 of 1989) was the main framework for environmental governance in South Africa before 1998. The first Environmental Impact Assessment (EIA) regulations that require an impact assessment for listed activities were developed under this act (van der Linde and Feris, 2010). Part IV "Control of Environmental Pollution" and Part V "Control of Activities Which May have Detrimental Effect on the Environment" of this gave effect to the implementation of measures such as waste management under which USTs were regulated (Johnston, 2014). However, in 1998 the National Environmental Management Act (Act 107 of 1998) was promulgated, becoming, therefore, the main legal framework for environmental governance and management in South Africa.

2.4.3. National Environmental Management Act (Act 107 of 1998) (NEMA)

The National Environmental Management Act (Act 107 of 1998) (NEMA) is the main legislative framework for environmental management in South Africa. The NEMA aims at establishing principles for cooperative governance, decision-making, and procedures for

the coordination of environmental functions of organs of states, among others. These functions of organs of states include protection of ecological functioning and prevention of environmental degradation (Glazewski and Du Toit, 2013; Beech and Veltman, 2017). Thus, the NEMA recognises that the negative effects of the introduction of extraneous materials into the environment may result in significant health and therefore establishes rules for the prevention of such occurrences (van der Linde and Feris, 2010).

2.4.4. National Environmental Management: Waste Act (Act 59 of 2008)

The National Environmental Management: Waste Act (Act 59 of 2008) (NEMWA) governs the waste sector in South Africa. The NEMWA regulates the generation, handling, and disposal of waste and gives provisions for the management of contaminated land (Beech and Veltman, 2017). Moreover, in a bid to standardise the management of contaminated land remediation, the governmental department in charge of environmental affairs introduced the Framework for the Management of Contaminated Land (2010), which is used as a guideline for risk assessment and remediation of contaminated land (Department of Environmental Affairs, 2010).

2.4.5. National Water Act (Act 36 of 1998)

The National Water Act (Act 36 of 1998) is the main framework for the governance of water resources in South Africa. The act came into effect in 1998, replacing the National Water Act of 1956 which was previously the main framework for the regulation of water resources (Schreiner, 2013). The National Water Act (Act 36 of 1998) aims to ensure that South Africa's water resources are "protected, used, developed, conserved, managed and controlled". The National Water Act (Act 36 of 1998) states that "protection of the quality of water resources is necessary to ensure the sustainability of the nation's water resource in the interest of all users. Hence, the protection of water quality is an essential element of sustainable development.

2.4.6. Occupational Health and Safety Act (Act 85 of 1993)

The Occupational Health and Safety Act (Act 85 of 1993) (OHS Act) is an important piece of the regulatory framework as far as fuel station risks are concerned (Qonono, 2019). The objective of the OHS Act is to safeguard the health and safety of persons at work workplace and the surrounding public (Niemand, Jordaan and Minnaar, 2016). Furthermore, Section

43 of the OHS Act gives effect to the promulgation of the Major Hazard Installation (MHI) Regulations (Government Notice No. 22506) to address the management of facilities considered MHI (Niemand, Jordaan and Minnaar, 2016). MHI is defined in the terms of the OHS act, as "an installation where any substance is produced, processed, used, handled or stored in such a form or quantity that it has a potential to cause a major incident" (Government Notice No. 22506). Niemand, Jordaan and Minnaar (2016) argue that the land use planning in South Africa does not adequately consider the safety of people living near MHI and suggest an appropriate integration of safety considerations in the land use planning to improve the safety of communities living near MHI in South Africa.

2.4.7. Regulation of land use at the local level

Land use management plays an important role in the prevention of environmental impacts (Snyman, 2017). In South Africa, land use management is governed by the Spatial Land Use Management Act (Act 13 of 2016) (SPLUMA). The SPLUMA requires that mechanisms for development control be developed by local authorities, among which are land-use schemes. The SPLUMA state that land-use schemes "must take cognisance of any environmental management instrument adopted by relevant environmental management authority and comply with environmental legislation". Thus, the Development Management Schemes are developed at local levels in line with responsibilities devoted to local governments in terms of the constitution, the SPLUMA and the Municipal Systems Act, 2000 (Act 32 of 2000).

However, provincial legislative bodies are also allowed to develop planning legislation that is applicable within their jurisdiction (Glazewski and Du Toit, 2013). In the CoCT for example, the Western Cape Land Use Planning Act, 2014 (Act 3 of 2014), Western Cape Land Use Planning Act Regulations, 2015 and Municipal Planning By-Law, 2015 are local instruments that constitute the land use regulatory framework. Thus, local authorities issue the Development Management Scheme; which defines the rules for land use development conditions in terms of the abovementioned legislative and regulatory frameworks (City of Cape Town, 2015).

(Cox *et al.*, 2013) assert that land use plays an important role in the reduction of environmental impacts. Concerning the land use aspect of fuel stations, Kruger (2012) argues that the Gauteng Province has a guideline that covers the best practices approach

in South Africa. The EIA Administrative Guideline for Installation and Upgrade of Underground Storage Tank and Associated Equipment established by the GDACELA is a unique document of this kind throughout the country. It provides specific measures for the construction and upgrade of fuel stations and considerations of land use and specifies conditions where fuel stations may be situated near sensitive land use (Kruger, 2012). The Gauteng Province's EIA Administrative Guideline for Installation and Upgrade of Underground Storage Tank and Associated Equipment (2002) stipulates that new fuel stations will not be approved if they are located:

a) within 100 metres of residential properties, schools, or hospitals unless it can be clearly demonstrated that there will be no significant noise, visual intrusion, safety concerns or fumes and smells.

b) within three kilometres of an existing filling station in an urban, built-up or residential area (and within 25 kilometres driving distance of an existing filling station in other instances, such as in rural areas, and along highways and national roads); or

c) within a sensitive area such as wetlands, alongside rivers, etc.

In addition to the conditions mentioned above, proponents are required to provide information on the location of boreholes on the site and adjacent properties, with an indication of the public reliance on groundwater. Such a guideline is not available in the Western Cape Province and the CoCT (Qonono, 2019).

2.5. Summary

Fuel stations' impacts on groundwater are extensively mentioned in literature. From the literature review, it became evident that groundwater contamination caused particularly by petroleum leaking USTs and auxiliary equipment in fuel stations is a prominent issue worldwide (Mitra and Roy, 2011; Johnston, 2014; Olapeju, 2017; etc.). However, very few studies are dedicated to the legal framework for the protection of groundwater from fuel stations' contamination in South Africa**.** Therefore, the present study has set to review the legal framework governing the impacts of fuel stations on groundwater in Cape Town.

Table 2.1: Selected instruments applicable in environmental regulation of fuel stations.

Act/Regulation/Policy	Provisions	Government
Constitution of South Africa (1996)	Section 24 & Section 27	National
Environmental Conservation Act, 1989 (Act 73 of 1989	Part IV & Part V	National
National Environmental Management Act, 1998 (Act 107 of 1998)	Section 24, Section 28, Section 30 & Section 34	National
National Environmental Management: Waste Act, 2008 (Act 59 of 2008)	Part 8	National
Environmental Impact Assessment Regulations	Listing Notice 1, Listing Notice 2 & Listing Notice 3	National
National Water Act, 1998 (Act 36 of 1998)	Part 1, Part 2, Part 3, Part 6, Part 7, & Schedule 1	National
Water Service Act, 108 (Act of 1997)	Section 34	National
Occupational Health and Safety Act, 1993 (Act 85 of 1993)	Section 43	National
EIA Administrative Guideline for Construction and Upgrade of Filling Station and Associated Tank Installations (Gauteng Province)	-	Provincial
Western Cape Land Use Planning Act, 2014 (Act of 2014)	Section 22, Section 23 & Section 24	Provincial
Cape Town Water Amendment By-Law, 2018	Section 33, Section 34 & Section 35	Municipal
Municipal Planning By-Law, 2015 (Cape Town)	Schedule 3	Municipal

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

The chapter discusses the research design and methodology used to conduct this study and to gather the necessary data. The chapter unpacks the methods and techniques used for data collection and analysis and the steps taken throughout this study.

3.2. Research design

Research design is considered the blueprint of research and defines the approach adopted to conduct research (Melnikovas, 2018). This research was carried out using a research design based on the pragmatic paradigm. Kaushik and Walsh (2019) argue that pragmatism is not restricted to choices of a single research approach or method but rather focuses on “what works”, thereby granting the researcher methodological flexibility.

Generally, three main approaches are used in research: quantitative, qualitative, and mixed methods (Saunders, Lewis and Thornhill, 2019). Kanazawa (2017) explains that qualitative research deals mainly with the collection, interpretation, and analysis of non-numerical data. Considering the context, aim and objectives of the research, the exploratory qualitative design was suitable given the exploratory nature of the study. The study involved a combination of desktop and fieldwork (interviews), thereby overcoming the weakness of a single data collection method (Saunders, Lewis and Thornhill, 2019).

Furthermore, the case study strategy was adopted to allow an in-depth and context-bound investigation (Zainal, 2007). The data was first obtained from a desktop study involving a literature review and review of legal documents. Supplementary data were collected using semi-structured interviews with key informants from the government, a research institution, environmental consulting firms and fuel stations.

3.3. Research methods

3.3.1. Data collection methods and sources

The collection of data started with a desktop study during which several documents were reviewed. Following this, the researcher conducted semi-structured interviews with key informants from different sectors. Moreover, concerning data sources, primary data was obtained from the statutes, regulations and semi-structured interviews. On the other hand, secondary data was obtained from the literature review.

3.3.1.1. Sampling technique

Purposive sampling was used to select legal documents reviewed in this research and key informants for the interviews. Purposive sampling is a non-probabilistic technique, which confers the researcher with the "power" to decide certain criteria for the selection of a sample from a population. Taherdoost (2018) argues that although purposive sampling has limitations such as vulnerability to the judgement of the researcher and the inability to generalizable findings, this technique is ideal for exploratory study. In this study, purposive sampling conferred to the researcher the ability to set selection criteria for interview participants.

3.3.1.2. Desktop study and Literature review

Snyder (2019) states that the best way to produce useful research is by identifying first what others in the field have discovered. This is done through a review of published literature to critically evaluate published resources on a topic (Snyder, 2019). Thus, the purpose of the literature review was to evaluate the existing research against the aim and objectives of the present study. The major contribution of the literature review for this study is that it helped the researcher identify what other researchers have already found, particularly concerning the regulation of USTs and further facilitated the selection of legal documents relevant to this study.

The context of this study required reviewing legal documents. Thus, a systematic approach of documentary analysis was employed (Dalglish and Mcmahon, 2020), to extract the required data to answer research questions**.** The following legal documents were reviewed, among others:

- The Constitution of the Republic of South Africa Act 108 of 1996
- National Environmental Management Act 107 of 1998
- EIA Regulations of 2014
- National Environmental Management Act: Waste Act 59 of 2008
- National Water Act 36 of 1998
- National Water Service Act 108 of 1997
- Municipal Planning By-Laws, 2015
- Water By-Laws, 2018
- Framework for the Management of Contaminated Land (2014)
- South African National Standards
- Cape Town Water Strategy (2019)
- Guidelines for the Installation of Alternative Water Systems

In addition to the review of the above documents, semi-structured interviews were conducted with relevant key informants to gather supplementary information and details the researchers could not get directly from the legal documents.

3.3.1.3. Semi-structured interviews

Interviews are research techniques grounded both in qualitative and quantitative research (Cassell, 2015). In this study, semi-structured interviews were conducted (Appendix F) with key informants (participants) who have expertise in the field of environmental management and regulation in South Africa. Two criteria were used for the selection of participants: (1) participants with the expertise and in-depth knowledge of environmental governance and regulation. This criterion was verified by reviewing the professional background of the targeted participants. (2) the accessibility condition. Concerning the population size, Boddy (2016) argues that qualitative studies do not necessitate a large sample size like positivist-oriented studies. The sample size in in-depth studies is contextual and dependent on the research paradigm, as the aim is not to

generate generalisation but a clear understanding of the subject under investigation (Boddy, 2016).

Interview requests were sent to 15 potential participants purposively selected in different sectors. This number was estimated with consideration of the availability of potential participants and the time for the completion of the data collection phase. However, only 7 out of 15 participants confirmed participation and provided consent letters for the interviews (Table 3.1). Nevertheless, further interviews were not deemed necessary as participants provided sufficient information in line with the objectives of this study. Due to COVID-19 restrictions, only 3 interviews were conducted briefly face-to-face, 2 interviews were conducted remotely via online platforms and 2 participants requested to respond to interview questions in writing. However, subsequent follow-up questions were sent where necessary.

Table 3.1: Key informants who participated in this study.

Participant	**Sector**	**Function**
Participant 1	Government	Environmental Officer
Participant 2	Government	Environmental Officer
Participant 3	Research institution	Researcher/Land use planning
Participant 4	Environmental consulting	Consultant
Participant 5	Fuel station	Manager
Participant 6	Fuel station	Manager
Participant 7	Fuel station	Attendant

During the semi-structured interviews, a script containing questions (Appendix F) prepared by the researcher was used to guide discussions. After the interviews, transcription software was used for transcriptions of audio files of participants who allowed the recording. Subsequently, the transcripts were read integrally to ascertain the integrity of the interview data. The transcription process allowed the researcher to spend time with the data and gain an in-depth understanding before data analysis.

3.3.2. Data analysis

Qualitative content analysis was adopted as a framework for analysing the data. One of the advantages of this data analysis technique is a rigorous approach to deriving meaningful

information from the data while minimising the risk of researcher biases (Erlingsson and Brysiewicz, 2017). The process was not as complex as in other studies involving a high volume of data. The analysis in the study involved breaking down the data into codes and assigning groups of similar codes under specific themes that were pre-developed. The data was then presented under the specific themes in the result and discussion chapter. For semi-structured interviews, however, the data is presented per interview question to facilitate the presentation. It is important to mention that interview questions were linked to the research questions.

3.3.3. Pilot study

Pilot studies are often conducted before the data collection to identify inconsistencies (Saunders, Lewis and Thornhill, 2019). To ensure the validity and reliability of the research, a pilot study was conducted to identify potential issues and to pre-test the interview questions. The pre-test enabled the researcher to elucidate inconsistencies and refine interview questions. In addition, the pilot study helped the researcher ascertain the minimum time to conduct the interviews. The feedback provided by the two participants in the pilot interview contributed to the amelioration of the interview process.

3.4. Ethical considerations

Ethical considerations are extremely important when in research activities (Bell and Bryman, 2007). In order to comply with the University's research ethics requirements, research permission from the CoCT (Appendix A), consent forms from potential interview participants (Appendix D) and other relevant documentation were submitted alongside the research proposal to the Faculty Research Ethics Committee for the ethics approval (Appendix B). As for the participation in this study, it was indicated to all potential participants that their contribution to this study is voluntary. Participants were free to avoid certain questions and withdraw from the study at any stage. Further, interview proceedings were recorded only where participants had granted permission. The study complied with the requirements of the Protection of Personal Information, 2013 (Act 3 of 2013) regarding personal information. Thus, to ensure confidentiality and anonymity, the identities of participants were removed from the datasets and the names were replaced by pseudonyms (e.g. Participant 1, Participant 2, Participant 3, etc.).

3.5. Research dissemination

The research report will be made available in electronic format on the CPUT's online repository at the CPUT library in line with the university's Open Access Policy. Furthermore, the researcher aims to disseminate the research results to environmental authorities in the Western Cape Province. Academic journals may also be published in accredited journals for large dissemination.

3.6. Summary

This chapter sketched the design and methodology applied in the present study (figure 3.1). The study adopted an exploratory qualitative design. This design provided the researcher with a flexible framework to integrate desktop study and semi-structured interviews as data collection methods. The chapter concluded with information about ethical considerations and the dissemination of the findings. Particular attention was given to the university's research ethics requirements.

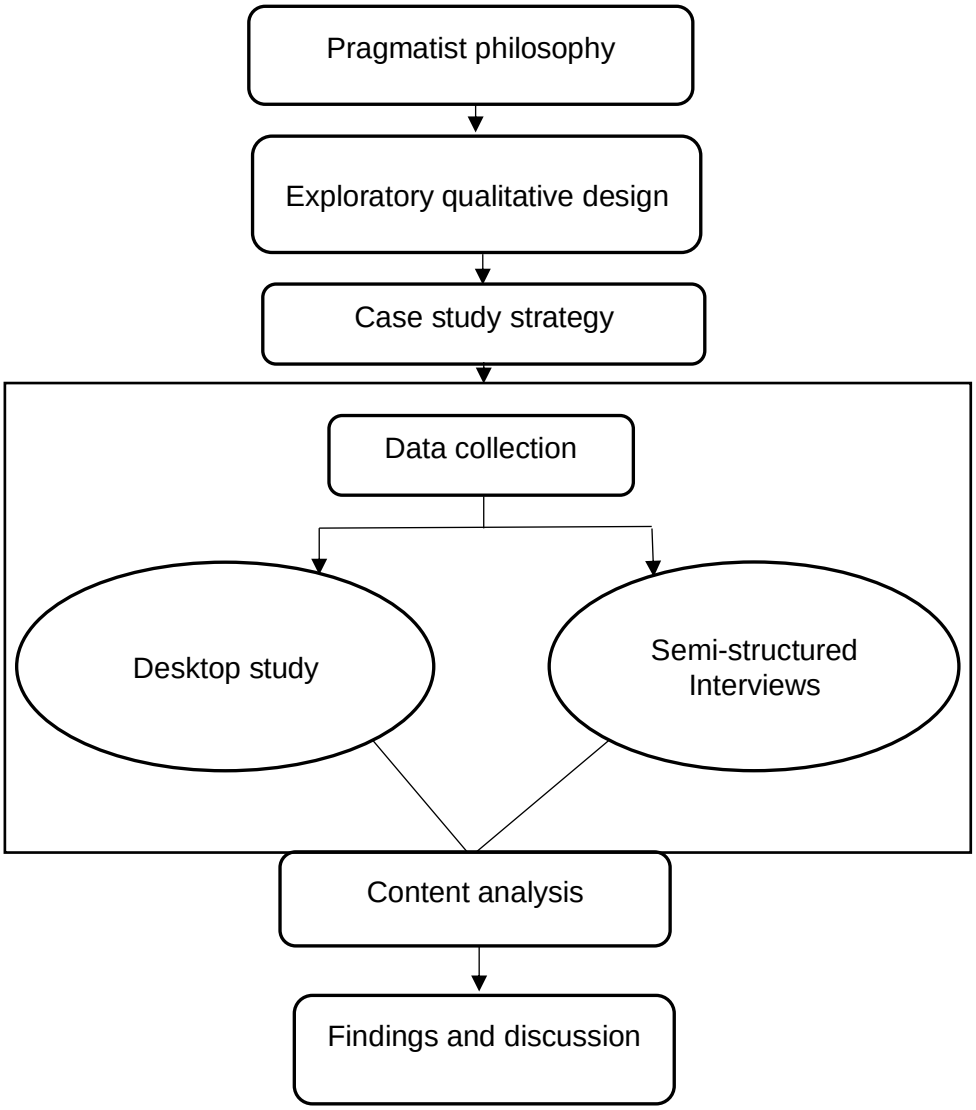

Figure 3.1: Research design and methodology adopted in the study.

CHAPTER FOUR: FINDINGS AND DISCUSSION

4.1. Introduction

This chapter reports findings from the desktop review of this study which consisted mainly of the analysis of the legal framework and the data collected through semi-structured interviews. The study aimed to examine the legal framework governing fuel station impacts on groundwater in the CoCT. The study anticipated improving the current legislative approach adopted for the mitigation of potential groundwater impacts from fuel stations. In South Africa, environmental aspects of fuel stations are governed by the Constitutions, statutes such as NEMA, Environmental Management Acts (SEMAs), regulations and norms and standards.

The findings are presented in two sections; the first part (section 4.2.) presents the desktop research findings which consist of the analysis of the legal documents governing the impacts of fuel stations on groundwater. The desktop study included legal frameworks such as the Constitution of South Africa, Act 108 of 1996, the NEMA, and SEMAs. For this study, the South African National Standards (SANS) that focus on the petroleum industry and specifically on the installation of USTs and associated equipment were reviewed to gather data on technical recommendations for USTs. In addition, to expand data collection on specific issues such as strategies and policy proposals for groundwater protection in the Cape Town region, the Cape Town Water Strategy (2019) was also reviewed.

The second part (section 4.3) of the chapter presents the result of the semi-structured interviews. Six semi-structured interviews were conducted with a variety of participants including two government officials, a researcher, an environmental consultant, two fuel station site managers and one fuel station attendant. Five main questions were developed previously and asked during the interviews (Appendix F).

4.2. Part 1: Desktop study

Legal documents were reviewed to extract data on legal requirements for the development of fuel stations, protection of boreholes and the protection of groundwater from impacts associated with fuel stations. The risk approach to the governance of impacts of fuel stations has been reviewed. The findings in this section are organised under the following themes: constitutional

rights, development and control of impacts of fuel stations on groundwater, protection of groundwater and boreholes, and risk management approach.

4.2.1. Constitutional rights

The South African constitution gives everyone a right, both the present and future generations, to a sustainable development which integrates environmental, social and economic aspects. These aspects include the rights to an environment that is protected from harm, and access to sufficient water, which are inalienable rights that require the duty of care from the government and every person who conduct an activity likely to affect these rights.

Section 24 of the Constitution gives provision for the protection of the environment. Section 24 (a) states that “Everyone has the right to an environment that is not harmful to their health or well-being”. In the same vein, Section 27(b) provides the right to have access to a sufficient amount of water, which implies that the state is constitutionally obliged to provide sufficient water to the general public, subject to the availability of water resources. The means to realise this right can also be achieved through alternative sources such as private domestic boreholes. However, environmental pollution can negatively affect both private and public water sources. Hence the state and individuals have a constitutional mandate to ensure the environmental protection of all environmental resources.

To realise the right to access sufficient water, the constitution requires the state’s responsibility in section 27(2) of the Constitution where it says, the state is required to take reasonable legislative and other measures, within its available resources, to achieve the progressive realisation of these rights. By the same token, the state can be expected to take reasonable legislative measures to deal with matters related to groundwater impacts from underground storage tanks and other potential point sources. This is especially in accordance with Section 24(b) of the constitution which also requires that “reasonable legislative and other measures” must be adopted by the state for the protection of the environment. The provisions of Section 28 of the NEMA, become more relevant in this context especially when it comes to enforcing the duty of care, as the section advocates for taking necessary measures to avoid the occurrence of negative impacts. Therefore, the legal measures that ensure implementation of the provisions

of the abovementioned constitutional mandates include framework laws, regulations and policies developed across all the government spheres.

4.2.2. Development and control of impacts of fuel stations on groundwater

The regulatory conditions for the development and control of fuel stations' environmental impacts are similar throughout the Republic of South Africa. In the Western Cape Province, the following regulatory environmental frameworks are used:

- National legislation such as the NEMA, NEMWA and NWA;
- Provincial Acts such as Western Cape Land Use Planning Act of 2014; and
- Local by-laws such as municipal Planning By-law, 2015 (for the CoCT).

The environmental frameworks regulate different environmental aspects of the development and control of impacts of fuel stations on groundwater. The NEMA gives the requirements for development applications which include environmental authorisation and EIA's that should be conducted for listed activities such as USTs installation. NEMWA specifically deals with issues of contaminated land by high-risk activities. The local land use planning laws, on the other hand, establish land use requirements for developments such as fuel stations. These legal requirements cover the necessary aspects of the control and mitigation of fuel stations' impacts on groundwater including in the development, operational, and decommissioning/closure phases.

As can be noted above, the requirements guiding the development of fuel stations and control of the impacts they pose on groundwater are not encapsulated in a single piece of the legislative framework. Rather than being contained in a single framework document, these requirements and conditions draw from several separate pieces of legislation within the broader environmental governance framework in South Africa. The following sections present different requirements and aspects that are taken into consideration in the development of fuel stations and the control of impacts from fuel stations into groundwater:

4.2.2.1. Environmental authorisation

The foremost condition for the development of activities that have the potential to cause significant environmental impacts is found in section 24(1) of the NEMA:

> “In order to give effects to the general objectives of the integrated environmental management laid down in this chapter, the potential consequences for or impacts on the environment of listed activities or specified activities must be considered, investigated, assessed and reported on to the competent authority or the Minister responsible for mineral resources, as the case may be, except in respect of those activities that may commence without having to obtain an environmental authorisation in terms of this Act”.

The lists of activities referred to in section 24 (1) of NEMA are published under the NEMA EIA Regulations (Listing notices 1, 2 and 3) (Table 4.1). Depending on the magnitude and capacity of the USTs, fuel stations will qualify for one of the EIA listing notices.

Table 4.1: Selected listed activities triggered by fuel station developments (EIA Regulations, 2014**).**

Listing & Activity N˚	Activity	Process
Listing 1 (GNR 983) Activity 14	The construction of facility for storage, or for storage and handling of dangerous goods, where storage occurs in containers with combined capacity of 80 but not exceeding 500 cubic metres.	Basic Assessment Report (BAR)
Listing 1 (GNR 983) Activity 51	The expansion of facility for storage, or for storage and handling of dangerous goods, where the capacity of such facility will be expanded by 80 cubic metres or more.	
Listing 1 (GNR 983) Activity 31	The decommissioning of existing facility or infrastructure, for: (v) storage, or storage and handling, of dangerous goods of more than 80 cubic metres.	
Listing 2 (GNR 984): Activity 4	The construction of facility or infrastructure for storage, or for storage and handling of dangerous goods, where such storage occurs in containers with combine capacity of 80 exceeding 500 cubic metres	Scoping/full EIA
Listing 3 (GNR 985) Activity 10 (Western Cape Province)	The construction of facility or infrastructure for storage, or for storage and handling of dangerous goods, where such storage occurs in containers with combine capacity of 30 but not exceeding 80 cubic metres	BAR

A requirement to get an environmental authorisation implies that an EIA in the form of the Basic Assessment Report (BAR) or full EIA must be conducted. The EIA considers social, economic and environmental risks and benefits associated with the proposed development.

The “Guideline for involving Hydrologists in the EIA Process”, developed by the Western Cape DEA&DP places fuel stations as Development Category 1 (Table 4.2), which constitute activities with the potential to cause a change in groundwater quality (Saayman, 2005). Thus, the EIA for fuel stations must take into consideration factors such as the sensitivity of the receiving environment which include the geohydrological characteristics of the proposed site for development. Aquifers are sensitive environmental features particularly when surrounding communities that may rely on them for groundwater abstraction. Hence groundwater specialist studies are an important part of the impact assessment and can influence the outcome of an environmental authorisation for fuel station developments. A summary of steps involved in an EIA process is outlined in figure 4.1 and a decision to approve or not approve the EIA for development is key.

Table 4.2: Categories of issues to be addressed by a hydrologist in the EIA process (Saayman, 2005).

Type of environment	Development category 1: change in groundwater quality, e.g.: Petrol station	Development category 2a: change in quantity of groundwater, e.g. wellfield development.	Development category 2b: Change in groundwater recharge		Development category 3: Change groundwater flow regime, e.g. deep excavations
			Decreased	Increased	
(A) Shallow water table	Pollution of the water resource.	Impact on groundwater dependent ecosystems.	Decline in water level and discharge, with impact on ecosystems services	Inundation of low-lying areas.	Lowering of the water table
(B) Rapid water infiltration and flow	Pollution of the water resource.	n/a	n/a	Increased discharge.	Lowering of the water table
(C) Groundwater abstraction within 1 km of development	Health, aesthetic and/or use versatility impact on resources users.	Reduced yield and increased abstraction costs.	n/a	Use recharged water; possible health, aesthetic and/or use impacts.	Lowering of the water table
(D) Wetland or groundwater dependent ecosystem occurs within 1 km of development	Loss of ecological functioning and associated ecosystem services.	Drying out wetland and diminished ecosystem services.	Decline in water level and discharge, with impact on ecosystems	Increased discharged and change in character of the discharge environment with possible impacts on ecosystems and ecosystem services	Change in discharge and impact on ecosystems and ecosystem services
(E) Aquifer is particularly vulnerable to	Pollution of the water resource.	n/a	n/a	Introduction of contaminants in the	n/a

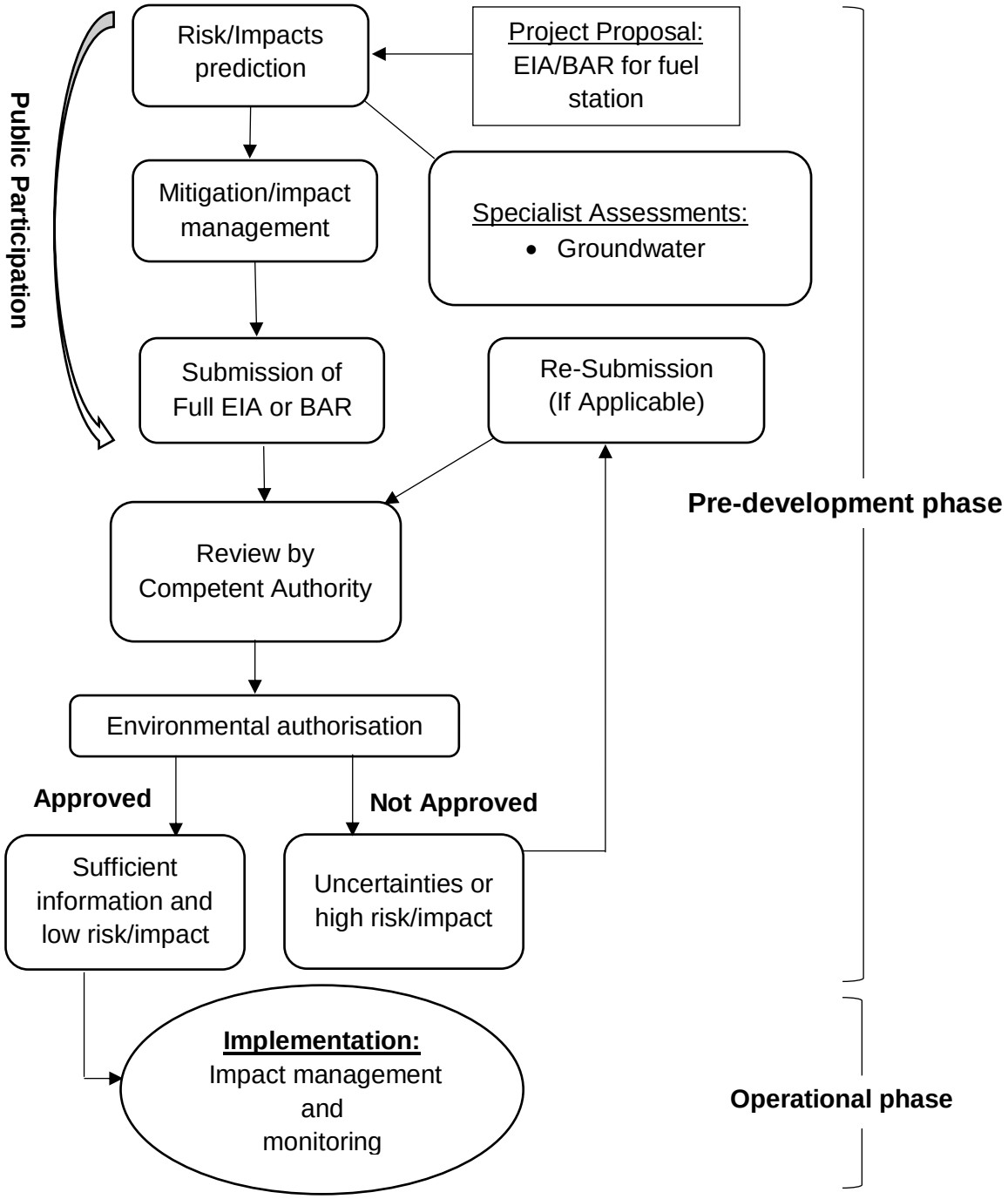

Figure 4.1: A conceptual summary of steps in the EIA process adapted for fuel stations (developed and modified from Saayman, 2005).

The competent authority's approval or rejection of development applications is guided by Section 24O of the NEMA, which addresses the "Criteria to be taken into account by competent authorities when considering applications". Section 24O (1) (b) (i) and (ii) of the NEMA state that:

If the Minister, the Minister responsible for mineral resources or an MEC considers an application for an environmental authorisation, the Minister responsible for mineral resources or MEC must:

(b) take into account all relevant factors, which may include-

(i) Any pollution, environmental impacts or environmental degradation likely to be caused if the application is approved or refused"

(ii) Measures that may be taken–

(aa) to protect the environment from harm as a result of activity which is subjected to the application;

While it is the responsibility of environmental authorities to consider potential impacts likely to arise from the development, proponents must draft and provide authorities with environmental management measures that will be implemented to prevent or minimise impacts such as contamination. In line with the above, the submission of an environmental management programme (EMPr) is required by competent authorities.

Furthermore, for the development of an underground storage tank, another important aspect to be considered is the Environmental Management Programme (EMPr) in terms of section 24N of the NEMA. The EMPr entails details of proposed management, mitigation, protection, and remedial measures that will be undertaken to address the environmental impacts of the proposed project. The EMPr allows competent authorities to assess the effectiveness of mitigation strategies against the potential impacts that have been identified in all phases of the development. Section 24N (1) states that:

the Minister responsible for mineral resources, an MEC or identified competent authority must require the submission of an environmental management programme before considering an application.

As a management tool required by law, the EMPr contains a monitoring plan for regulatory compliance and contingency actions for incidents. Section 24N (2) requires that an EMPr must satisfy the following condition:

The environmental management programme must contain:

(a) Information of any proposed management, mitigation, protection or remedial measures that will be undertaken to address the environmental impacts that have been identified in a report contemplated in subsection 24(1), including environmental impacts or objectives in respect of –

(i) Planning and design;
(ii) Pre-construction and construction activities
(iii)The operation or undertaking of the activity in question;
(iv) Closure, if applicable

(g) A description of the manner in which it intends to-
(iii) Comply with any prescribed environmental management standards or practices.

Therefore, the EMPr gives effect to provisions of environmental care and management as required in Section 28(1) of the NEMA. Such a document would be significant in the development of fuel stations as it will provide a detailed plan of specific measures that would be implemented for the prevention of groundwater contamination and due diligence procedures.

4.2.2.1.1. South African National Standards (SANS)

While considering applications for environmental authorisation, the NEMA requires the competent authority to take into consideration critical measures that should be implemented for the protection of the environment. As stated in section 4.2.2.1, fuel stations are listed activities based on the USTs capacity. The NEMA as primary legislation does not cover detailed obligations for activities such as fuel stations and specific USTs regulations have not been developed yet in South Africa. However, for the development of fuel stations and associated infrastructures such as tanks and pipes, codes of practice are for guidance with matters relating to preventive measures for environmental protection. South African National Standards (SANS) are codes of practice issued by the South African Bureau of Standard (SABS) in terms of the Standards Act, Act 29 of 1993. There are SANS developed for petroleum oil industries (Table 4.4) and adopted as environmental protection measures in line with the requirements of Section 24O(1)(b)(ii) of the NEMA.

Table 4.3: SANS applicable for the prevention of UST corrosion and leaks.

SANS Codes	Year	Description
SANS 1830	2006	Flexible piping for underground use at services and consumer installations.
SANS 10089	2010	The Petroleum Industry Part 3: the installation, modification, and decommissioning of underground storage tanks, pumps/dispensers, and pipework at service stations and consumer installations.
SANS 1535	2018	Steel tanks for the underground storage of hydrocarbons and oxygenated solvent.

With regard to groundwater protection, SANS 10089 Part 3 clause 4, clause 5, clause 11 and clause 12 are particularly crucial. These clauses comprise specific requirements for current groundwater protection features for the prevention of corrosion, leaks, and spillage control equipment. Importantly, clause 12 requires a full system integrity test per approved method to be carried out on tanks after the installation as a mandatory requirement. Furthermore, the SANS 1830 recommends “flexible piping for underground use at service stations and consumer installations”, to minimise the risk of leakage and release of fuel into the groundwater (Appendix G). As for the protection of steel tanks specifically, which is the main culprit for groundwater contamination, the SANS 1535 recommends a secondary wall (“secondary containment” such as Glass-reinforced polyester (GRP) additionally coated on steel USTs (primary containment) of hydrocarbons and oxygenated solvent (clause 3.4). Furthermore, clause 4.2.4 of SANS 1535 recommends that “a tank shall be so designed as to withstand any pressure resulting from the upward thrust of surrounding water after the tank has been installed while taking due cognisance of any point loading imposed by tank’s hold-down’s system”.

In line with Section 24N and Section 24O of the NEMA, the above measures are examples of environmental management and industry-standard specifications that may be adopted as measures to protect the groundwater from harm that could result from a proposed fuel station. However, the implementation of these codes of practices is largely voluntarily and

the SABS Standards emphasise that “compliance with this document cannot confer immunity from legal obligations”, which implies that unless officially gazetted by the government, application of these standards may not have an effective impact in the protection of the environment. Moreover, many fuel stations were built before the development of these standards and as a consequence, owners of fuel stations that are already operating may be reluctant to upgrade the infrastructures to current SANS voluntarily considering the financial costs. An attempt to adopt the SANS 10089 and other SANS standards relating to the petroleum industry, as mandatory environmental management specifications, was made by the government in 2016.

The government adopted the Dangerous Goods Standard (Government Gazette Volume 614, No.40188 of 5 August 2016) in terms of the NEMA Section 24 (2) for listed activities that may be excluded from the obligation of environmental authorisation but must comply with conditions set in the adopted standard (Appendix H). The Dangerous Good Standard covers listed activities relating to the operation or expansion of facilities or infrastructure and handling of dangerous substances. The implementation of this standard would render mandatory the SANS 10089 and other standards which would increase the protection of groundwater and boreholes in proximity to fuel stations. However, the Dangerous Goods Standard is not effective yet presently.

4.2.2.2. The duty of care

The duty of care is a legal obligation imposed on every person undertaking activities that are risky for the environment. The constitution of South Africa in section 24 establishes the right to “an environment that is not harmful to health and well-being” as a basic right for everyone. This is a positive right that imposes the “duty of care” governed by Section 28 of the NEMA, to every physical and legal person undertaking any sort of activities. Section 28 (1) states:

> Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing, or recurring, or, in so far as such harm in the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

Section 28(2) further specifies that the “duty of care” of NEMA is imposed on persons having a level of responsibility concerning a potentially detrimental activity which includes the land or premises owner, a person in charge of the land or premises and a person having the right to use that land where risky activities are undertaken. This implies that those who have boreholes affected by the contamination from fuel stations have the right to hold any person having a level of responsibility on the land where a fuel station is located irrespective of the time this contamination occurred. The duty of care obliges these persons to take reasonable measures (i.e., to investigate, assess and evaluate the impacts on the environment; cease, modify or control the action causing pollution or degradation; and remedy the effects of the pollution or degradation).

Moreover, other preventive measures are provided in terms of liabilities for unplanned events or actions arising out of the negligence of those undertaking activities with the potential to affect the environment and public health negatively. Liability is an important legal aspect associated with fuel station operations, as it presents risks to the environment and groundwater particularly. It is also important to highlight that schedule 3 of the NEMA provides a list of offences that one may be convicted for the pollution of the environment especially if it is proven that there has been negligence of the duty of care.

4.2.2.3. Control of emergency incidents

Section 30 of the NEMA provides a standard procedure for control and administration of emergency incidents (i.e incidents that may result unexpectedly and that involve hazardous substances). By their nature, petroleum fuels and their chemical components such as BTEX compounds) are recognised as hazardous in terms of the Hazardous Substance Act, 15 of 1973.

In view of the fact that petroleum fuels are considered hazardous substances, incidents involving fuel at fuel stations would fall within the scope of Section 30 (1) of the NEMA and must be reported to designated authorities. The administration of emergency incidents as regulated by Section 30 of the NEMA facilitate the enforcement of “duty of care” obligations and ensures that public health is protected from detrimental effects. In terms of Section 30(4) of the NEMA, the person responsible for an emergency incident (or where the incident occurred in the course of that person’s employment, his or her employer) is obliged to “Take all reasonable measures to contain and minimise the effects of incidents, including its effects on the environment and any risks posed by the incident to health, safety and property

of persons". Responsible persons are required by the NEMA to report emergency incidents directly after becoming aware of their occurrences. It is important to note that according to Section 30 (1)(b) of the NEMA, a responsible person includes one who:

(i) is responsible for the incident;
(ii) owns any hazardous substance involved in the incident; or
(iii) was in control of any hazardous substance involved in the incident at the time of the incident;

In light of the above, fuel stations are subject to the conditions of Section 30 of the NEMA due to the likelihood of incidents involving petroleum fuels from fuel station premises. However, Section 30 of NEMA does not give sufficient details regarding the volume of hazardous substances that should be reported incidents as an "emergency incident" in terms of the NEMA. Thus, in the case of fuel stations unreported relatively small incidents may cause cumulative contamination of soil and groundwater.

4.2.2.4. Contaminated land management

Contaminated land management is specifically governed in Part 8 of the NEMWA 59 of 2008. In terms of the NEMWA, "contaminated" means "the presence under the land, site, building or structure of a substance or micro-organisms above the concentration normally present in or under the land". Therefore, in light of this description, contaminated land provisions (Part 8 of the NEMWA) are legally applicable to fuel stations especially where land contamination may have occurred due to the release of fuel in soil and groundwater. The NEMWA provides two legal mechanisms in terms of Section 36 of Part 8, to discover contaminated land: identification and notification. These mechanisms are established to allow timely implementation of remedial actions to protect the environment and the public from negative outcomes such as contamination of water sources in areas surrounding the contaminated land.

The first mechanism is the identification of investigation areas by the Minister or MEC in consultation with the Minister of Water Affairs and other state organs [Section 36 (1)]. Identification of an investigation area as stipulated in Section 36(1) can be triggered by authorities if they suspect "on reasonable ground" the occurrence of contamination. The reasons that can be considered reasonable grounds are for example the presence of high-

risk activities (such as the underground storage of petroleum products) taking place on land. Section 36(1) of NEMWA states that:

The Minister, or the MEC in respect of an area that affects the relevant province, may, after consultation with the Minister of Water Affairs and Forestry and other organs of the state concerned, by notice in the Gazette, identify as investigation area-

(a) Land on which high-risk activities have taken place or taking place that are likely to result in land contamination.
(b) Land that the Minister or MEC, as the case may be, on reasonable grounds believes to be contaminated.

The second mechanism is the notification mechanism. This mechanism is in section 36 (5) of the NEMWA is triggered when a land owner or any person undertaking an activity that may cause land contamination notifies authorities that the land is significantly contaminated. Section 36(5) of the NEMWA states that:

An owner of land that is significantly contaminated, or a person who undertakes an activity that caused the land contamination, must notify the Minister and the MEC of that contamination as soon as that person becomes aware of that contamination.

The consequences of identifyingand notifying contaminated land as an investigation area (as contemplated in Section 36) are set out in Section 37 of the NEMWA. Section 37(1) of the NEMWA states that the Minister or MEC in consultation with relevant stakeholders can request a site assessment to be conducted by an independent person to provide details on the extent and severity of contamination. The Minister is mandated in Section 41 of the NEMWA to maintain a National Register of Contaminated Land, with a minimum of information to be captured. The register must contain the name of the land owner or user of the land, the location, the nature and origin of the contamination and the status and timeframe for remediation among others. In the Western Cape, fuel stations represented the majority (88%) of contaminated land registered in 2018 (figure 4.2) (Contaminated Land Register, no date).

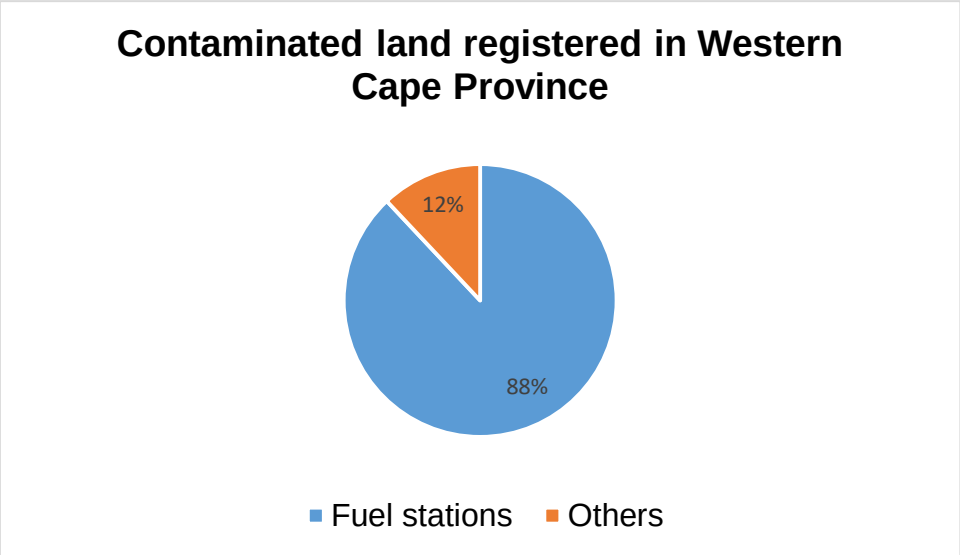

Figure 4.2: Graph showing the proportion of fuel stations registered in the National Contaminated Land Register in the Western Cape Province.

In the management of contaminated land, the Framework for the Management of Contaminated Land (2010) (hereafter referred to as "the framework" in this section) also plays an important role, as a consistent guideline for risks posed by contaminated land. The framework also serves "norms and standards" for contaminated land assessment, thereby establishing regulatory conditions, technical/environmental considerations for site assessment and remediation and a system of Soil Screening Values (SSVs). The SSVs are given for different receptors and land-use scenarios (such as informal residential, standards residential, commercial/industrial or protection of ecosystem health, etc.). The framework also provides a "Protocol for Site Risk Assessment" (chapter 2 of the Framework) with specific considerations for "Water Resource Sensitivity and Protection" (section 2.2), which include the attention that must be given to the protection of groundwater resources from land-based contamination sources (such as fuel stations for example).

Among the key questions that need to be addressed for evaluation of the impacts of contaminated land, one question draws the attention as it considers specifically groundwater users: "Is there current or potential groundwater use on the contaminated site or within the likely groundwater migration pathway?" (This question can be viewed in section 2.2 of the Framework). The Framework recommends, therefore, that the assessment associated with groundwater contamination should identify the presence of exposure pathways through which human or ecological receptors can be affected. The risk-based approach adopted in the management of contaminated land requires that only

contaminated sites where there is a link between source, pathway and receptors be classified as remediation sites.

The contaminated land management measures provided in Part 8 of NEMWA apply virtually to all land-based activities with the potential to contaminate the land. However, they are also particularly relevant for the prevention and remediation of contamination risks associated with fuel stations.

4.2.2.5. Land use considerations for fuel stations

South Africa has a rich land use regulatory framework that covers various aspects, including sustainable development of land, and control of activities. Land use management in the City of Cape Town is governed by the Spatial Planning and Land Use Management Act (Act 13 of 2013) and the Municipal Planning By-law, 2015. Moreover, land-use management is one of the competencies devoted to local governments. Therefore, municipalities establish rules for development management. The CoCT has a Development Management Scheme that is in line with its socio-economic and development priorities (Municipal Planning By-Laws, 2015).

The development of fuel stations in Cape Town must comply with requirements of the Municipal Planning By-law, 2015 in terms of zonings (Table 4.4). Each zoning corresponds to a set of criteria such as the height and thickness of walls, carriageway crossings, roads and erection of base for fuel pumps.

Table 4.4: Zonings that are compatible with fuel station development (Municipal Planning By-Law, 2015).

Zoning/Subzoning	Brief description	Item
Local Business zoning 2 (LB2)	Provides for low intensity commercial and mixed-use development which serves local needs for convenience goods and personal service.	57
General Business subzoning (GB)	Provide for general business activity and mixed-use development of a medium to high intensity.	61
Mixed Use subzoning (MU)	Accommodate a mixture of business, appropriate industrial and residential development.	65
General industry subzoning (GI)	GI accommodates all forms of industry except noxious trade and risk activity in order to promote manufacturing sector of economy.	75
Risk Industry (RI)	Provides for noxious industries or which carry high risk in the event of fire or accident.	77

However, the land use and zoning policy in the CoCT does not provide specific requirements for the location of fuel stations and setback distances with sensitive land uses such as residential properties as precautionary measures. Furthermore, no reference is made to the protection of groundwater abstraction points such as boreholes which may be located in land uses adjacent to fuel stations.

4.2.3. Protection of groundwater resources and boreholes

Protection of groundwater resources is in two folds: preservation of groundwater quantity and groundwater quality. The protection of the quality and quantity of groundwater is intertwined particularly as seen in the National Water Act (Ac 36 of 1998) (NWA), the condition relating to water protection, in general, depends on the category of “water use”. The following sections present the relevant legal aspects relating to groundwater protection with an emphasis on the protection of boreholes.

4.2.3.1. Water use

In terms of Section 21 of the NWA, water use includes among others:

(a) taking water from a water resource;

(b) Storing water;

(c) Impeding or diverting the flow of water in a watercourse;

(d) Engaging in stream flow reduction activity contemplated in section 36;

(e) Engaging in a controlled activity identified as such in section 37 (1) or declared under section 38(1); and

(f) Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or conduit.

Furthermore, Section 21 (j) of the NWA specifically lists the abstraction of groundwater as water use. Thus, to control the use of water resources, the NWA establishes four types of water uses that are deemed permissible use: Schedule 1, General Authorisation, Existing lawful use and Licensed water use [Section 22 (1)] (Table 4.5). Domestic boreholes do not require a permit, as long as water abstraction will not exceed the schedule 1 water use.

Table 4.5: type of water use allowed in the National Water Act, 36 (Act 36 of 1998).

Water Use	Description
Schedule 1 water use	Schedule 1 allows a person to take water for reasonable domestic purposes, such as gardening for non-commercial purposes, watering for animals grazing on the land, or firefighting and recreational use.
General Authorisation water use	The General Authorisation issued under Section 39 of the NWA (Part 6) applies to water use and amounts prescribed in table 1.2 of the General Authorisation published in Government Notice 399
Licensed use	Licenced use applies where no other entitlements are applicable. i.e., all other types of water use and amounts which are not included in schedule 1 and General Authorisation water use must apply for a license in terms of Section 40 of NWA (Part 7).
Existing lawful water use	This use allows water users to continue use of water that was lawful two years before the NWA came into effect and remains subjected to the pre-existing conditions under which it was lawfully authorised (Part 3).

However, Section 26 of the NWA requires that every water use such as groundwater abstraction must be registered to allow the Department of Water Affairs, the trustee of water resources in terms of Section 3(1), to control the national water use. The NWA provisions, only cover the requirements for the protection of water quantity and quality as a scarce commodity.

4.2.3.2. Protection of groundwater quality and boreholes

The preamble of the NWA recognises that water is a scarce commodity in South Africa and that the protection of water quality is necessary to ensure the sustainability of water. The protection of groundwater quality ensures that the health of groundwater users is not negatively impacted. Cape Town has seen an increase in boreholes in the last few years, as residents opt for alternative systems for water supply. According to Section 1(1)(ii) of the NWA, a borehole includes "a well, excavation or artificially constructed or improved underground cavity which can be used for the purpose of- (a) intercepting, collecting, storing or removing water from an aquifer". While there are codes of practice such as SANS 10229 which guides the construction and drilling of boreholes, the protection of the quality of groundwater abstracted from boreholes may be a difficult task considering various land use risks such as leaking USTs which are common in urban areas (Solecki and Stopa, 2016).

Most boreholes that are installed for domestic water use fall under the Schedule 1 category. However, under the schedule 1 category, there seems to be a lack of legal provisions and adequate requirements for the protection of water users from potential threats emanating from land-based activities such as fuel stations. In contrast, under the General Authorisation and licensed use category, the NWA sets out more stringent requirements. Section 29 of the NWA empowers the "responsible authority" to specify conditions for every general authorisation or licence. These conditions can cover various aspects of the protection and management of water resources. For example, in the case of abstraction of water under the General Authorisations, Section 29 states the following conditions for the protection of water quantity and quality:

(d) In the case of controlled activity-

(ii) specifying the management practices to be followed to prevent pollution of any water resources

(e) In case of taking or storing water-

(i) Setting out the specific quantity of water or percentage of flow to which may be taken

(ii) Setting out the rate of abstraction

(iii) Specifying the method of construction of borehole and the method of abstraction from the borehole

Nevertheless, the above conditions apply to the abstraction of a water quantity above the schedule 1 permissible use and may not apply to most boreholes in residential areas. Generally, private boreholes commissioned by private owners in urban areas are under schedule 1 for basic domestic activities which do not require an authorisation. Furthermore, the conditions set out in Section 29 of the NWA give only the responsibilities of water users generally with regards to water resources protection and focus more on monitoring the abstraction. While the above legal dispositions emphasise more on the protection of water quantity, the compelling obligations to prevent water resources pollution is found in Section 151 of the NWA. This Section establishes offences in terms of the NWA. Section 151 (1) of the NWA indicates that:

No person may –

(i) unlawfully and intentionally or negligently commit any act or omission which pollutes or is likely to pollute a water resource and

(ii) unlawfully and intentionally or negligently commit any act or omission which detrimentally affects or is likely to affect water resources

The above provisions are broad enough to cover groundwater contamination risks posed by fuel stations. Furthermore, more responsibilities are imposed on those who undertake activities that may affect water and water users in general, and therefore, can be seen as dissuasive legal dispositions constraining those who undertake activities to prevent possible impacts. Considering the impacts leaking USTs at fuel stations may have on groundwater and boreholes located near fuel stations, fuel station operators are expected to comply with Section 151 of the NWA. Section 151(2) of the NWA makes it clear that the non-compliance to obligations set out in Section 151(1) shall result in legal liabilities.

Moreover, Section 54 of Cape Town Water By-law, 2010 imposes a duty to owners of alternative water infrastructure to maintain preventive measures to avoid intrusion of harmful substances into the drinking water systems (i.e., potable water supply provided

through municipal services). This provision aims to protect the quality of potable drinking water that the CoCT provides. Meanwhile, Section 11(3) of the Water Service Act (Act 108 of 1997) (WSA) states that: “In ensuring the water service, a water service authority must take into account, among other factors- alternative ways of providing water service”. In the light of the above, the CoCT has a duty to consumers and potential consumers of water resources. Although private boreholes are not under the scope of the water service authority, the CoCT as the local authority can, in terms of Section 11(3) of WSA, Section 24(a) and 24(b) of the Constitution, assist with the growing part of the local population that uses alternative water systems such private boreholes to ensure that there is no risk to their health.

4.2.3.2.1. Regulation of boreholes in Cape Town

As a response to water crises in Cape Town, the CoCT had planned to “continue to promote the responsible use of rainwater, greywater, groundwater from private boreholes and well points for non-drinking purposes” (Cape Town Water Strategy, 2019). Currently, the CoCT has no local legal instrument that solely regulates the protection of boreholes from surrounding land-based activities, let alone fuel stations. The CoCT has published the “Guidelines for the installation of alternative water systems”, which guide the installation and management of alternative water infrastructure, albeit the guidelines have no legal status as a standalone document (Appendix I). However, together with the Water By-law, 2010 and SANS codes of practices, the guidelines for the installation of alternative water systems assist the CoCT’s Department of Water and Sanitation which runs an inspection programme for private boreholes (Appendix J). The main objective of the inspections of boreholes by the CoCT is to ensure that boreholes are not installed in a way that may cause contamination of drinking water quality and to ensure the sustainable use of groundwater.

The inspections help further to raise awareness about the installation of alternative water systems and health risks associated with the consumption of untreated groundwater from private boreholes which have become increasingly popular in the CoCT. For matters pertaining to the governance of groundwater, except for boreholes registrations, the CoCT advises its citizens to refer to the national DWS as the custodian of water resources in terms of Section 3(1). It is important to note that Cape Town’s Water By-law, 2010, refers to the nuisance boreholes may cause and the contamination risks that may be posed to boreholes

from adjacent properties. Section 57 of the Cape Town Water By-Law, 2010 as amended in 2018 states that:

> Every owner of premises must ensure that any well, borehole, or well-point, installation relating to alternative water or any excavation relating thereto located in his or her premises
>
> (a) is adequately safeguarded from creating a health nuisance
>
> (b) is not filled with materials that may cause an adjacent well, borehole or underground source of water to become polluted or contaminated

Specifically, the above dispositions of the Water By-law, 2010 provide recommendations for the protection of boreholes, although in very specific scenarios which do not take into consideration impacts that can arise from potential threats such as fuel stations. This is probably because most aspects relating to environmental impacts are regulated by the NEMA and other frameworks. Nevertheless, according to commitment 2 of Cape Town Water Strategy (2019), the CoCT plans "revising by-laws and planning requirements as well as using other incentives to support water efficiency and water treatment and reuse" (Appendix K), which would be beneficial if these planned revisions by the CoCT would consider adding more stringent dispositions to improve the regulation of boreholes and to provide better protection of boreholes from potential threats such as leaking USTs.

4.2.3.3. Monitoring of groundwater

Environmental monitoring is a legal requirement both in terms of Section 137 of the NWA which gives effects to the national monitoring systems and Section 24E of the NEMA which entails the minimum conditions attached to environmental authorisations.

4.2.3.3.1. National and regional groundwater quality monitoring

Section 137 of the NWA states that:

> (1) The Minister must establish a national monitoring system on water resources as soon as reasonably practicable.
> (2) The systems must provide collection of appropriate data and information necessary to assess, among other matters-
>
> (a) The quantity of water in the various water resources;

(b) The quality of water resources; and

(c) The use of water resources.

Generally, the monitoring of water quality as required in Section 137(2) is primarily undertaken by the DWS. However, the national monitoring programmes mostly monitor raw surface and groundwater quality to produce long-term trend reports. Based on the data provided by the DWS (2020), the monitoring programme covers the national territory with 378 monitoring points sampled routinely twice a year (Appendix L). However, the monitoring programmes do not include monitoring of activities-based such as groundwater contamination at fuel stations. The monitoring of groundwater for activities such as fuel stations is conducted following the conditions of environmental authorisation and the approved EMPr (Section 24E and Section 24N of the NEMA).

4.2.3.3.2. Monitoring boreholes at fuel stations

Activities such as fuel stations that require an environmental authorisation are approved based on a set of requirements that must be maintained throughout their life cycle. Section 24E of the NEMA stipulates that:

> Every environmental authorisation must as a minimum ensure that-
>
> (a) adequate provision is made for the ongoing management and monitoring of impacts of the activity on the environment throughout the life cycle of the activity

Section 24N (1A) of the NEMA stipulates that:

> Where environmental impact assessment has been identified as the instrument to be utilised in informing an application, or where such application relates to prospecting, mining, exploration or production area, the Minister, the Minister responsible for mineral resources, a MEC or identified competent authority must require the submission of environmental management programme before considering an application for an environmental authorisation.

In line with the above legal disposition, an environmental monitoring plan is designed as part of the EMPr for environmental authorisation application. In the case of fuel station development, once the environmental authorisation and EMPr are approved, the fuel station operations throughout its life cycle must comply with regulatory requirements contained in

the EMPr, including groundwater monitoring. Monitoring wells are installed at certain locations within the fuel station premises for monitoring hydrocarbons in groundwater. Generally, technical recommendations from codes of practices are followed to construct and conduct monitoring of groundwater. Below are national standards and guidelines that provide the best practices for groundwater monitoring:

- The Department of Water and Sanitation (2006) Best Practice Guideline – G3: Water Monitoring Systems Series G: General Guidelines
- The SANS 10299-2:2003 Development, maintenance, and management of groundwater Part 2: The design, construction and drilling of boreholes
- The SANS 5667-11: 2009 / ISO 5667-11Water quality – sampling- Part 11: Guidance on sampling of groundwater
- Framework for the Management of Contaminated Land (2010)

As the EMPr is specific to a site, the monitoring of the groundwater takes into consideration such description of the site, groundwater characteristics and surrounding areas. Generally, a minimum of two groundwater quality monitoring points (monitoring wells) should be installed to monitor the presence of hydrocarbons underground in the fuel stations. Furthermore, details such as the frequency of sample collection depend on environmental standards and codes of practice.

As concluding remarks in the review of legislative frameworks and policy documents relating to water resources protection, it appeared that the protection of groundwater quality and more particularly boreholes are governed by primary legislation and to some extent assisted by codes of practices (SANS). There's an absence of subordinates' legislation such as regulations that comprise detailed provisions for specific aspects of groundwater protection in relation to fuel station impacts and that specifically dictates obligations for protecting boreholes near fuel stations. Moreover, the existing provisions that were found to be applicable for the protection of boreholes in areas adjacent to fuel stations are fragmented in different pieces of the legislation governing the protection of water resources, principally the NWA and the NEMA.

4.2.4. The risk management approach

The environmental management principles in Section 2 of the NEMA cover all aspects of environmental protection and give guidance on how environmental risks should be approached. Section 2(4)(a) highlights the factors required for sustainable development, from which two main risk approaches applicable in environmental governance of socio-economic activities were distilled. The two main approaches include the:

- Risk-averse and cautious approach
- Risk-based approach.

4.2.4.1. Risk-averse and cautious approach

The risk-averse and cautious approach is entrenched in section 2(4) (a) (vii) of NEMA and states that:

> A risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions

The “risk-averse and cautious approach” relates to the precautionary approach and is best applied where evidence for risk is insufficient or uncertain. This approach can be seen in the EIA as a regulatory condition for the development of listed activities. The EIA is evaluated by authorities by taking into account precautionary considerations which can be demonstrated by the fact that environmental authorisations are subjected to a minimum of precautionary requirements before approval. Furthermore, to ensure that developments will not pose significant environmental impacts, conclusive information and data must be presented to competent authorities without any uncertainty to allow them to reach a risk-informed decision.

While the EIA process is the same for all activities, for developments that may contaminate groundwater resources such as fuel stations, the NEMA places precautionary requirements such as (1) provision of sufficient and comprehensive information about the receiving environment and potential impacts of the proposed development [Section 24 (1A) and Section 24(4)(a)], (2) Adequate mitigation measures to ensure groundwater contamination will be prevented through effective technology based on current standards. It is important to note that the EIA as a precautionary process, does not allow uncertainties about environmental impacts and other aspects of the EIA [Section 24(4)(b)].

4.2.4.2. Risk-based approach

NEMA Section 2(4) (a) (viii) stipulates: “That negative impacts on the environment and people’s environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied”.

This legal provision shows a level of risk tolerance for certain activities as it is stated that “where they (negative impacts, *own emphasis*) cannot be altogether prevented, are minimised and remedied”. This can be considered a “risk-based approach” as the focus is on the management of potential risks rather than total avoidance before their occurrences. The risk-based approach to environmental impacts of activities is mostly applied as a reactive approach with an emphasis on minimisation and remediation of impacts. In the case of petrol fuel stations, this approach can be implemented in cases such as land contamination and emergency incidents which occur in the operational phases of fuel station activities. The management of emergency incidents (NEMA Section 30) follows a risk-based approach which consists of a set of measures to be taken in response to an emergency incident. This requires assessment of risk in the short and long-term, and remediation of effect in response to an emergency incident on the environment and public health [NEMA Section 30 (4)]. The legal directives provide for the allocation of resources for the prevention of further consequences based on the risk that the incident represents. In the case of land contamination, Part 8 of the NEMWA provides essential regulatory requirements for the management of contaminated land. The approach to contaminated land, in general, follows a risk-based approach, focusing on assessment and remediation rather than prevention**.**

Therefore, it can be argued that the risk approach for the management of fuel station risks is a dual approach, consisting of both precautionary and risk-based management, albeit not specifically written as such in any legal framework. The implementation of this dual approach enables the protection of the environment that is adapted to the life cycle of fuel stations. At the strategic or pre-development phase, the precautionary approach is applied through the EIA and consideration of environmental authorisation applications. However, the monitoring and management of impacts arising or likely to arise in the operational phase of fuel stations are governed by a risk-based approach which requires environmental risk monitoring, risk assessment and remediation.

4.3. Part 2: Semi-structured interviews

Semi-structured interviews were conducted with key informants (participants) from the government, local environmental consulting firms, research institutions, and fuel stations. To avoid redundancy, data reported in this section has been filtered to retain mainly new information that did not emerge in the review of legal instruments. This consists mainly of data that supports the findings of the document analysis. It is worth noting that, only questions relating to the EIA, impacts of fuel stations on groundwater and boreholes, land use and risk management were asked. Hence, the information presented here may not be valid for other types of environmental impacts that fuel stations can pose on the environment.

4.3.1. Interview question 1

Generally, what is the criteria guiding the review of an EIA report with regards to fuel station development applications?

The answers to the first interview question were provided by Participant 2, a senior government official. The question sought to understand if there are specific review criteria for fuel station development and how the review authorities use these criteria to evaluate EIA reports. Participant 2 explained that all applications for environmental authorisations are submitted to the competent authorities designated in the EIA regulations. In the case of fuel station development applications in the Western Cape Province, the Western Cape Government is the authority designated to review and make decisions. The reviewers are officials from the Department of Environmental Affairs and Development Planning (DEA&DP). Their role as reviewers is to ensure that EIA reports address environmental and socio-economic issues identified during the screening and scoping phases of the assessment. Following screening and scoping, the Terms of Reference (TOR) are produced, setting a guideline for the entire EIA study. The TOR outlines the purpose of the project, the nature and extent of the EIA, specialists' studies and consultation of Interested and Affected Parties (I&APs). The review process, therefore, serves as quality assurance for the decision-making.

Participant 2, explained further that all types of development applications, including those of fuel stations, follow the same review process and criteria as indicated in Section 24 of NEMA and the EIA regulations, 2014. Unlike in the Gauteng Province where the

government has developed the EIA administrative Guideline with specific criteria for fuel stations, in the Western Cape, the evaluation of EIA for fuel station development is guided solely by the conditions set in the NEMA, EIA regulations and local Planning By-laws.

Furthermore, Participant 2 indicated that, although the Western Cape Province does not have a specific EIA guideline for fuel stations like in the Gauteng province, there are legal mechanisms set in terms of the NEMA, as a part of EIA, to inform decision-making for an environmental authorisation. Two relevant mechanisms: (1) specialist studies (particularly groundwater assessment for fuel station developments) to inform on the vulnerability of groundwater and (2) public participation which allows integration of the community's views and concerns about risks associated with a proposed development. Thus, during the review of EIAs, reviewers use the information provided by specialists and the outcome of public participation as a basis for decision-making. Participant 2 further emphasised that the views of the community near a proposed development may affect the decision of the competent authority for approval or rejection of an application. Finally, Participant 2 argued that "generally the idea is not to allow fuel station development close to a residential area or where it may pose a significant risk".

4.3.2. Interview question 2

Do fuel stations pose risks to groundwater and boreholes in Cape Town?

This question assessed how key informants perceive the risks fuel stations pose to groundwater. All participants considered fuel stations as a major source of contamination to groundwater in Cape Town and major cities. Although not all of them referred specifically to boreholes, most answers were substantiated with example cases of incidents involving the risk of contamination of soil and groundwater and impacts on surrounding boreholes.

Participant 1 explained that environmental incidents do happen at fuel stations often as a result of leaking pipes, USTs and/or dispensers most of the time in small quantities but their cumulative impacts can become significant with time. Moreover, incidents involving large volumes on the surface do also occur as a result of fuel spillage during fuel truck offloading into USTs. Although the occurrence of such incidents is rare, fuel station construction standards provide recommendations for fuel release prevention systems, spill containment manholes and separators that must be installed to prevent and contain spillage and overflows which may endanger the surrounding of fuel station facilities.

All fuel station operators interviewed in this study acknowledged the risk posed by fuel stations, albeit they referred primarily to the risk of fire at fuel station facilities, therefore with no likelihood to directly impact groundwater resources. Participant 7, a fuel station attendant, stated that they are aware of the requirements relating to the safety of customers, and personnel on-site and closest residential properties. It was also indicated that safety behaviour that must be respected by everyone entering the fuel station's premises is closely monitored daily. Participant 7 mentioned also that the company provides induction training and toolbox meetings, in compliance with the OHS, which informs the staff about all types of risks in fuel station premises and the surrounding areas. The site managers acknowledged that fuel stations may be viewed as hazardous installations considering that fire risk is high within the perimeters of these facilities and there is potential for groundwater contamination when there is an underground leakage.

Furthermore, Participant 5 and Participant 6 stated that they have consideration for environmental legislation concerning groundwater contamination and that groundwater contamination risk is monitored on-site. Participant 5 explained that fuel releases in soil and groundwater can be detected sometimes when the stock reconciliation is being conducted, using the traditional tank dips or electronic monitoring. Participant 5 was asked to clarify if such loss is reported to environmental authorities' emergency incident cases in terms of Section 30 of the NEMA or as contaminated land in terms of Section 36(1) of the NEMWA. It was indicated that the primary objective of stock reconciliation is for tank inventories and the planning for new stocks. However, in case of significant losses of fuel that are above acceptable fuel evaporation values, the stock reconciliation data can serve as evidence of leaks in USTs. When such fuel loss incidents persist, reports are escalated to technical teams for corrective actions which may include remediation and preventive measures against future occurrences of similar incidents. Nevertheless, all the participants from fuel stations highlighted that the primary objective of stock reconciliation as part of daily management is to inventory the stocks to ascertain the need for fuel refill, rather than for environmental reporting.

Participant 1 explained further that fuel stations pose a serious risk, especially in highly populated suburbs of Cape Town. It was stated that many cases of soil and groundwater contamination occurred at old fuel stations. Such cases often involve "failure in infrastructures such as pumps or pipelines resulting in fuel spillage into soil and

groundwater causing contamination problems that need to be addressed" (Participant 1). Participant 1 argued that many of such issues which the DEA&DP have dealt with included also incidents occurring in residential areas, as quoted below:

> "Some couple of years ago, there was an incident of a fuel leak. There was a filling station that was close to a residential property that had a huge leak. The concern is that, when you have people living nearby the filling station and there is nothing protecting people from the leak, there might be chronic and acute exposure to human health due to substances that might cause diseases like cancer which may only become visible after many years"

However, it was confirmed during the interview that pollution caused by such incidents represents a danger to groundwater and boreholes. Participant 1 argued that "ideally, such incidents are dealt with in line with the legal provisions of duty of care in the NEMA Section 28, but the reality is different". The comments made by Participant 1 left the impression that there is a need to focus on old fuel stations, especially in urban areas.

4.3.3. Interview question 3

Do you consider fuel stations as a significant cause of contaminated land and how does contaminated land relate to groundwater contamination?

This question aimed to gather experts' opinions on the significance of contaminated land resulting from fuel stations. Secondly, the question aimed to understand how experts relate contaminated land issues to groundwater. Participants acknowledged that fuel stations are a possible significant cause of land contamination. Participants 1 and 4 stated that many cases of contaminated land in Cape Town involve fuel stations with old fuel stations being the main contributors. Participant 4 stated that:

> "Fuel service stations do significantly contribute to the contamination of land in Cape Town. Petrochemical contaminants often migrate off-site into adjacent properties after spills. This is escalated when service stations are older with more worn-out USTs. Site owners are reluctant to replace tanks in some cases due to costs and extended periods of closure during the refurbishments. These older tanks are more prone to leakages and account for most cases of soil and groundwater contamination."

Participant 1 also added that cases of contaminated land are often recorded at old fuel stations as can be seen in the national register of contaminated land. However, according to Participant 1, the process for identification and notification of fuel stations as provided by Section 36 of the NEMWA remains ineffective as it appears to be a reactive rather than proactive approach. This is because the NEMWA leaves the onus of notification on the land user or owner while detailed mechanisms for proactive actions that would allow easy identification of fuel stations that may be contaminated land are not provided. Participant 1 explained further that in many cases, fuel stations do not report the contaminations to authorities as required in Section 36 of NEMWA. In some cases, the notification is only done when there is an imminent land transfer.

Furthermore, Participant 1 explained how the notification of contaminated land during the process of an imminent land transfer. It was stated for example "when a purchaser wants to acquire a land property that has been a fuel station and after conducting at least the phase one of the environmental site assessment to get an idea of the site's suitability or if there is historical contamination", only then owners become compelled to notify authorities of the findings if they reveal contamination. However, Participant 1 believed that considering fuel stations as high-risk activities, developing a proactive policy in terms of Section 36(1) of NEMWA specifically for fuel stations is a necessity. According to Participant 1, it will allow local authorities to act proactively to identify land potentially contaminated land by fuel stations. Moreover, such a policy would improve the mechanism of investigation of fuel stations by integrating risk criteria such as the age of underground tanks, among others.

4.3.4. Interview question 4

Do you see any potential for land use conflict between fuel stations and sensitive land-uses in Western Cape?

Most participants explained how land use management how works in the Western Cape and particularly in Cape Town before giving their views on the potential land-use conflicts. Participant 4 stated that fuel stations can potentially affect surrounding land uses:

> "Fuel service stations are integral parts of residential, commercial and agricultural areas of Cape Town. However, they do impact groundwater below the site when a spillage occurs thus potentially affecting surrounding land users. If Contamination

remains within the service station property and the amount of product spilt is not that significant – there may not be a sense of urgency"

Similarly, Participant 1, acknowledged the environmental concerns posed by the proximity of fuel stations to residential properties in Western Cape province. To substantiate this view, Participant 1 related cases of incidents involving the release of fuel in a fuel station located close to a residential property.

In the same vein, Participant 3 argued that land use aspects of fuel stations in Cape Town are not properly regulated. Participant 3 indicated that "In South Africa, the legislation guiding land-use management is informed by the broader principles in South Africa's Constitution. Land use management is regulated by legislation at all three spheres of government". However, the Participant mentioned that the problem at the local level (in Cape Town) is the lack of land-use guidelines to dictate the location of fuel stations.

Participant 3 argued that "it appears to me that the Western Cape does not have clear guidelines as to sitting of fuel stations in the protection of sensitive land use." Nonetheless, Participant 3 acknowledged that this is "proven to be a global trend where land-use guidelines for sitting of fuel stations is either not in place or when they are in place, they are not adhered to. Western Cape is no exception". Participant 4 explained that the impacts of fuel stations on groundwater may, however, lead to land use conflict scenarios in cases where surrounding land users are negatively affected.

"They (*fuel stations*, added emphasis) do impact groundwater below the site when a spillage occurs thus potentially affecting surrounding land users… once petrochemical contaminants (free phase product or dissolved components) migrate off-site – this is where remediation becomes more urgent. It also depends on the 'sensitive receptors" – for example- if the surrounding land user is using groundwater for domestic purpose…" (Participant 4)

Participant 3 expressed concerns about the proliferation of fuel stations in big cities such as Cape Town. According to Participant 3, the absence of a land-use policy in the Western Cape province that is specific for fuel station installation and protection of sensitive land uses creates a conducive environment for land-use conflicts. Participant 3 added that there is an urgent need to adopt policies similar to the Gauteng Province EIA administrative

guideline to minimise potential land-use conflicts between fuel stations and adjacent land users in Cape Town.

4.3.5. Interview question 5

How would you describe the risk management approach in reference to the management of risk posed by fuel stations in Cape Town?

Participant 2 indicated that the EIA process follows a precautionary approach as multiple precautionary conditions precede the development. The idea is that all the risks must be scoped out before deciding to approve or reject a project proposal. Most participants indicated that the approach in the management of risks of fuel stations is largely risk-tolerant and concentrates on remediation of impacts rather than prevention.

Participant 1 and Participant 3 considered that the risk management approach in Western Cape province is reactive rather than proactive. This is because the focus of the law is more "on fixing the effect of incidents" (Participant 3). About contaminated land management, Participant 1 explained that "our legal experts (legal division) would call this risk approach a reactive approach. Because we would normally get either somebody who notify us as the responsible party, or we would get a complaint from the community… and then we would react to that" Furthermore, reflecting on the provisions of Part 8 of the NEMWA, Participant 1 stated that Section 36 (1) grants the authority power to act proactively but generally whether, in the case of contaminated land or emergency incidents, authorities react to "something that has happened already". According to Participant 1, the reactive approach in dealing with contaminated land for example is supported by some legal dispositions which allow reactiveness: "When we bring it to what NEMA says, prevention is preferred but where something cannot be prevented, we need to look at measures to minimise the impacts".

Similarly, Participant 3 views the regulatory approach to risk management for fuel stations as reactive rather than proactive and preventive. Participant 3 explained: "by this (reactive, *own emphasis*) I mean, it appears that an incident should first occur regardless of its magnitude and effect then reactionary measures will be put in place to respond". Thus, according to Participant 3, there is inadequate consideration of the Disaster Risk Reduction approach in the development of fuel stations in the Western Cape in general.

Moreover, Participant 4's perspectives on the fuel station risk regulation are largely based on technical aspects. Participant 4 described the risk approach as being strict as the regulations set strict conditions for the elimination of risk posed by the contamination. "I think the regulations are quite strict as a site can only move from a remediation status to a monitoring status once the soil and groundwater screening values for soil and groundwater are met" (Participant 4). On the other hand, Participant 5, Participant 6 and Participant 7 did not provide informed responses to the question relating to the risk approach as their focus was mainly on the business aspect of fuel stations.

4.4. Discussion of the findings

In recent decades, regulation and governance have become popular phenomena of study for social scientists and interdisciplinary scientists, especially concerning sustainability (Braithwaite et al., 2007). Kotze (2006) argue the concept of sustainability can be understood as the ability to maintain desired conditions over time without depleting the natural, social, and financial resources, through a process of continual improvement in the form of sustainable development. To maintain this ability, and the continual improvement of the environmental condition, various considerations must be integrated. These considerations include environmental governance, public and industry involvement, and principles of sustainability (Kotze 2006). The present study is aligned with the concept of sustainable development while focusing on the governance of fuel stations' impacts on groundwater and more specifically on boreholes.

According to Visser (2018) and Ziervogel (2019), drought events that afflicted Cape Town in the last decade with the looming "Day Zero" in 2018, have provoked a change in water consumption behaviour. Many people now rely on alternative sources for water supply as they become more aware of the fragility of surface water systems that provide the bulk supply for Cape Town. (Jordan, 2019) reported that the number of boreholes rapidly increased in Cape Town and this trend may continue. Considering that groundwater consumption may continue to increase especially as an alternative source of water in residential areas, the question arises to know what legal measures are in place to ensure the protection of boreholes, given that they are often at the receiving end of groundwater contamination (Gosling, 2011; Mitra and Roy, 2011; Ossai *et al.*, 2019). This study used the exploratory strategy to explore the legal framework governing the environmental impacts of fuel stations on groundwater.

The findings of the study revealed fragments in the framework governing the environmental aspects of fuel stations. It was discovered that there is inadequate consideration of sensitive land uses surrounding fuel station developments in the legislation governing the impact of fuel stations. The study further revealed that there are no conspicuous provisions that dictate the installation or upgrade of up-to-date USTs and pipes that have groundwater protection equipment in fuel stations. Thirdly, the legal framework governing the impacts of petrol stations on groundwater is largely fragmented making, therefore, the implementation more complex. The results of this study may initiate policy dialogues for the development of additional legal measures for the protection of groundwater and borehole users who might be exposed to groundwater contamination risks from fuel stations in Cape Town.

4.4.1. Revisiting research objectives

This thesis aimed to review the legal framework applicable in the regulation of the environmental impacts of fuel stations on groundwater in Cape Town. The rationale of this was to shed light on the risk approach adopted for the prevention and mitigation of fuel stations' impacts on groundwater. Three objectives were set at the inception of this study: the first objective was to review legislation and policies regulating fuel stations' impacts on groundwater. Concerning the first objective, the findings show that environmental authorisation and EIA are required in terms of Section 24 of the NEMA as the main condition for the development of fuel stations. Thus, a fuel station development cannot be approved without undergoing an environmental assessment and obtaining an environmental authorisation from the competent authority. However, there is no specific legal requirement or guideline, that dictates the location of fuel stations in relation to other land uses.

As for the control of fuel stations' impacts on groundwater, the findings drew from different fragments of legislative frameworks and SANS standards applicable to fuel stations and show that legal provisions for the protection of the environment, such as the duty of care, management of emergency incidents and the contaminated land management have direct implication in the management of fuel stations' impacts. However, some gaps exist in terms of specific requirements for the protection of groundwater. These gaps can be attended to if the government develop a specific regulation for USTs or adopt petroleum industry codes of practice (such as SANS 10089) as mandatory standards to compel fuel stations' compliance with best practice for groundwater protection.

The second objective was to evaluate the effectiveness of the requirements set in place for the protection of groundwater and borehole users near fuel stations. With respect to the second objective, the findings have shown that the legal framework for the protection of groundwater does not dictate specific requirements for borehole protection such as a safety distance or buffer in relation to fuel stations. The lack of requirements for safety distance between fuel stations and other land uses might undermine the safety of boreholes adjacent to fuel stations. Thus, this is viewed as an impediment to the effectiveness of the legal framework for the protection of groundwater.

The third objective was to identify the approach of risk management in the legal framework governing fuel stations' risks and impacts. Albeit not specifically written in any pieces of the legal framework, the analysis of legal texts and information gathered from the interviews with experts suggest that the management of risks of fuel stations consists of two approaches that vary based on the phases of the fuel station lifecycle. Precautionary risk management is applied in the environmental authorisation and EIA process whereby precautionary conditions must be satisfied before the proposed fuel station development is approved. On the other hand, the risk-based approach is implemented in the operational phase of activities. However, the findings indicate that there is a lack of specific precautionary measures concerning land-use surrounding fuel stations. Furthermore, the fragmented state of laws regulating risks of fuel stations may complicate the implementation of an effective risk approach.

4.4.2. Development of fuel stations and control of their impacts on groundwater

According to Ahmed *et al.* (2011), fuel stations are any facility where petroleum-based fuels like petrol, diesel, and other types of refined products are stored in large quantities for sale. Despite their socio-economic importance, especially in urban agglomerations, fuel stations are also sources of groundwater contamination, mostly as a result of fuel that seeps into the underground (Solecki and Stopa, 2016)**.** Groundwater represents an important strategic water resource in South Africa despite its relatively small contribution presently (Johnston, 2014; Grönwall and Danert, 2020). So, in line with the first objective of this study, a review of the legislation that governs the environmental impacts of fuel stations on groundwater particularly in Cape Town was conducted. It is important to note that it was not in the ambit of this paper to discuss specific petroleum products sold at fuel stations. However, it is

common knowledge and well-documented fact in literature, that petroleum fuels have pervasive effects on groundwater (Logeshwaran, 2018).

4.4.2.1. Conditions for development of fuel stations

Fuel stations on their own are not specifically a listed activity in terms of EIA Regulations, but, they fall under the description of “the construction of facility for storage and handling of dangerous goods”. As a consequence, the development of fuel stations is conditioned by an environmental authorisation of the installation of tanks and associated equipment. Based on the findings, a conclusion can be drawn that the NEMA Section 24 environmental authorisation requirement is an effective precautionary mechanism to control the development of fuel stations. However, as mentioned in the literature (Kruger, 2012; Qonono, 2019), the environmental authorisation process in the Gauteng Province consider the potential severity of risks of petrol stations on groundwater more seriously, thereby adopting additional measures in terms of the EIA guideline in support to the requirements of Section 24 of the NEMA. This augments the protection of boreholes from the potential impacts that may result from petrol stations. However, in the Western Cape, the environmental authorisation for fuel stations is solely regulated by the requirements of the national legislation. Participant 2, a role player in the evaluation of applications for environmental authorisation in Western Cape, stated that although currently there are no other regulatory or policy requirements similar to the Gauteng Administrative Guideline for fuel stations generally when reviewing an application for a fuel station, “the idea is not to allow *or to grant environmental authorisation* (added emphasis), for a fuel station too close to a residential area”. This key informant added that the public participation which is undertaken during the EIA process also allows the public to express their concerns against a proposed development and consequently, can lead to the rejection of the proposed development. However, the researcher notes that it is not evident that all members of the public may have the same level of environmental health literacy to understand the risk they might face or the cumulative impacts if a fuel station is permitted in proximity to their residential properties.

Drawing from the example of the EIA Administrative: Guideline for Construction of Filling Stations and Installation of Associated Tanks developed by the Gauteng Province, it would be necessary to establish a guideline in the Western Cape that defines clear land-use criteria for the installation of fuel stations. Such guidelines should take into consideration

land-use characteristics in the surroundings of proposed fuel station developments to minimise land-use conflicts. The benefit of having such guidelines as in the Gauteng Province is that it provides additional and specific requirements to be considered during the evaluation of environmental authorisation. Furthermore, such guidelines would strengthen the existing precautionary requirements by separating fuel stations from sensitive land uses thereby decreasing the potential for land-use conflicts. Qonono (2019) argues that the lack of specific criteria for the siting or location of fuel stations may pose a serious risk to the surrounding environment. Considering the pervasiveness of petroleum fuels in groundwater (Logeshwaran *et al*., 2019), specifying the criteria for the location of fuel stations is critical to a safe distance between fuel stations and groundwater users.

Furthermore, Section 24 of NEMA which gives effects to the environmental authorisation and the EIA requirements is too broad. An integrated environmental regulation system for fuel stations would be the best alternative to consider as it would provide detailed requirements that are specific to fuel stations thereby reducing the effect of fragmentation. Kotze (2006) argues that the fragmentation of environmental regulation has many disadvantages which include, among others: duplication of governance effort, with all organs of states focusing on environmental authorisation without having enough resources for follow-up after authorisation, inefficient arrangements between organs of states that control similar activities and significant gaps in control arrangements. Perhaps this is one of the reasons that motivated the adoption of the Dangerous Good Standard, 2016 in terms of NEMA 24(2), although the government of South Africa has never specified the date for the commencement of this standard.

Finally, one question vividly emerged through the analysis of findings, about fuel stations that are still operating today that were approved before the commencement of NEMA in 1998 under EIA regulation of the ECA regime, implying that they might pose a greater risk since they did not undergo the same scrutiny as required in Section 24 of NEMA. With regards to the risk that fuel stations approved under the former dispensation of the ECA, the risk can be greater because many of these fuel stations consist of old technology which did not have effective pollution prevention mechanisms such as double-walls, protective coating or glass reinforced polyester (GRP). Pfotenhauer (2011) explained that in South Africa most fuel stations installed before 1994 are not equipped with appropriate anti-corrosion and spill-prevention equipment. This can be the reason for the large incident of

contamination of boreholes that occurred in Beaufort West involving three fuel stations in the town of a groundwater-relying city and similar incidents can still occur wherever proper measures are not implemented. Therefore, legal measures should be established for up-to-date equipment with improved leak prevention technology, particularly for fuel stations approved before the NEMA.

4.4.2.2. Control of fuel station impacts on groundwater

As discussed in Section 4.4.2.1, the construction of fuel station facilities is subjected to the requirements of Section 24 of the NEMA which require that all listed activities must undergo impact assessment before obtaining an environmental authorisation. This implies that fuel station development, as a listed activity, can only be allowed after obtaining an environmental authorisation from the competent authority. Consequently, an EIA must be conducted to unveil the potential impacts that could be associated with the installation of a fuel station. Moreover, the NEMA provides further obligations for the measures that must be implemented to prevent, minimise, and remediate the degradation that might be caused by an approved listed activity as in the case of this study, a fuel station. The control of environmental impacts that may result from a fuel station is an obligation. The law imposes a “duty of care”, to activities like fuel stations owing to the risks posed to the environment. The duty of care is provided statutorily by the legislative requirements found in Section 28 of the NEMA. Furthermore, specific environmental management acts such as the NEMWA and NWA also give effect to some specific aspects relating to the control of pollution that may result from risky activities albeit not specifically mentioning fuel stations. The philosophy of the duty of care places the onus on every person who has caused or may cause the deterioration of environmental quality to take the responsibility for the prevention, minimisation, and remediation of such degradation.

The findings of this study highlighted two specific legal aspects of environmental management, relating to duty care, with implications for fuel stations’ impacts on groundwater: (1) the management of emergency incidents as regulated by NEMA Section 30 (also in Part 5 of Chapter 3 of the Water) and (2) the management of contaminated land regulated by the Part 8 of the Waste Act. Both aspects closely concern the context of fuel stations as fuel may be emitted during an emergency incident or as historical contamination which may lead to cumulative impacts on groundwater, thereby affecting people’s ability to use water from boreholes. Therefore, the release of petroleum substances in groundwater

whether as the result of what the NEMA describes as an “emergency incident” or historical contamination is a source of concern in terms of water resources protection. The Framework for the Management of Contaminated Land (2010) uses the “Source-Pathway-Receptor” model of risk assessment to conceptualise this concern. Leaking USTs represent a major source of contamination that can spread through groundwater (Sierra Club, 2005), affecting groundwater users such as it occurred in the semi-desert town of Beaufort West, Western Cape (Gosling, 2011). Hence, the effective management of emergency incidents and contaminated land is a relevant obligation for the control of potential groundwater contamination risks posed by fuel stations.

Although there are requirements for groundwater protection that apply to fuel stations, some participants in the interviews highlighted gaps in the legal framework governing fuel stations' impacts. Participant 1 argued that there are several reports of incidents where the failure in fuel station infrastructures has led to spillage causing soil and groundwater. However, despite these observations, currently, no provision adequately provides mandatory specifications and standards for the installation or upgrading of modern fuel station infrastructures that are equipped with groundwater preventive devices.

As mentioned in section 4.2.2.1.1 of this report, the SABS has developed several standards that apply to the petroleum industry and of which three are particularly relevant for groundwater protection, namely the SANS10089, SANS 1830 and the SANS 1535. These standards provide up-to-date recommendations and best practices for fuel station equipment designed for the prevention of corrosion, leaks and structural failure that may result in groundwater contamination. However, legal mechanisms to enforce these standards are lacking as these SABS-developed specifications are not legally binding like legislation and regulations (Johnston, 2014). This challenge can be overcome if these SANS standards are formulated as norms and standards in terms of Section 24(2) of the NEMA such as proposed in the “Dangerous Goods Standard, 2016”.

4.4.2.3. Land use consideration with regard to fuel stations

Qonono (2019) observed that in Stellenbosch, many fuel stations do not comply with land-use best practices as the location of some fuel stations was not guided by risk principles regarding the proximity to residential areas. Concerns about land use conflict were also raised in this study, especially about public exposure to potential incidents that may lead to groundwater contamination. Participant 1 narrated a case where a “filling station was next

door to a residential property, and they had a very large leak and it was a big problem". Such remarks by a government official highlight the necessity to instate a safe distance between fuel stations and other developments as a legal obligation, to avoid or minimise the risk of exposure to fuel station impacts.

Land use planning and management is the responsibility of municipal governments. Cape Town Municipal Planning By-Laws, 2015 provides land-use zoning conditions and there are specific zonings under which fuel stations can be built. The zoning criteria provided in Cape Town's Planning By-law describe conditions relating to land-based structures in fuel stations such as buildings, roads, walls, etc. (Table 4.2), but no specification is given for groundwater aspects nor the conditions for a safe distance with surrounding land users. Land-use considerations play an important role in the evaluation of EIA and therefore, integrating protective land-use conditions in local policies for fuel stations would be an additional element of consideration. The Gauteng Province took this approach with the development of the EIA 2002 with the EIA administrative guidelines: Guideline for the Construction and Upgrade of Filling Station and Associated Tank Installation.

The considerations for fuel stations as imposed in the Guideline for the Construction and Upgrade of Filling Station and Associated Tank Installation demonstrates clear precautionary thinking that should be adopted in other provinces. For instance, no fuel station development can be allowed within a minimum distance of 100 metres from sensitive land uses. Furthermore, in terms of the Guideline for the Construction and Upgrade of Filling Station and Associated Tank Installation, it is required that proponents of fuel stations must provide information relating to the degree of reliance on groundwater abstraction and the location of boreholes around the proposed site for fuel station development. The aforementioned requirements implemented in Gauteng Province demonstrate that the lack of legal measures for safe distance may exacerbate the severity of groundwater contamination risks arising from fuel stations, particularly where groundwater is abstracted. Groundwater abstraction enhances the migration of contaminant plumes toward the abstraction points, therefore, without a protection zone for groundwater, groundwater users may be exposed to the intake of petroleum substances (California State Water Resources Control Board, 2004).

4.4.3. Protection of boreholes in areas adjacent to fuel stations in Cape Town

One of the objectives of this study was to evaluate the effectiveness of the requirements that are in place for the protection of boreholes located in areas adjacent to fuel stations. Protection of boreholes from contamination resulting from surrounding activities is important, especially considering the increased borehole registration observed in Cape Town in the past few years. The Constitution of South Africa gives the right to everyone to have access to sufficient water. As stated above, alternative sources of water supply such as boreholes are one of the ways people may decide to access sufficient water.

According to Seyler, Witthüser and Sunaitis, (2019) pollution risk is the most notable impediment to the use of groundwater. In addition, the lack of appropriate policy for the protection and monitoring of groundwater quality prevents extensive access to groundwater (Seyler, Witthüser, and Sunaitis, 2019). Drawing from the example of Denmark, measures for the protection of groundwater abstraction include policies that set special protection zones aimed at creating a buffer to exclude certain activities nearby groundwater abstraction points (Thomsen, Søndergaard and Sørensen, 2004). In Wales, for example, the “Underground Storage Tanks: Groundwater Codes for Wales" provides details of requirements for the protection of groundwater resources and groundwater abstraction points (Welsh Government, 2017), with information specifically designed for fuel stations.

The findings of the study have shown that in the CoCT, as in South Africa generally, the relevant legal provisions ensuring the protection of boreholes from the risks posed by fuel stations are entailed primarily in the NWA, NEMA and NEMWA. However, some aspects of water and sanitation that are specific to the mission of the local government as the water service authority are regulated by the Water By-law, 2010. Moreover, while the NEMA provides environmental principles for environmental protection in general, the NWA deals specifically with water use requirements and the protection of water resources. As for the NEMWA, Part 8 of this act gives effect to the management of contaminated land, which englobes soil and groundwater assessment and remediation, with the Framework for the Management of Contaminated Land (2010) being a guideline providing acceptable levels of contamination (SSVs) for various land-use types.

While the three pieces of legislation mentioned above contain legal provisions relating to the protection of the groundwater and human receptors from pollution; there are no specific obligations or preventive protection measures stipulated especially for boreholes located in

the vicinity of fuel stations. Provisions such as Section 28 of the NEMA and Section 19 of the NWA are broad enough to compel the prevention of pollution, but, the fact there is no clarity about how the proximity to fuel stations to potential boreholes should be regulated may lead fuel station operators to pay less consideration to this regard. Interviews with participants from the fuel retail industry revealed that, save for fire hazards, personnel of fuel stations seemed to pay less attention to potential contamination in the surrounding residential land use. The proximity of fuel stations and groundwater users is especially adverse when water is abstracted for domestic purposes as this may lead to chronic exposure and consequently increased cancer incidence (Kponee *et al.,* 2015).

Monitoring is an essential mechanism for groundwater protection (Seyler, Witthüser, and Sunaitis, 2019). South African water legislation provides mechanisms for monitoring water resources, particularly, Chapter 14 of the NWA gives effect to the “National Monitoring systems”, albeit for centralised water management (Appendix L). The decentralised or small-scale water monitoring, such as groundwater monitoring for fuel stations is governed in terms of Section 24(4) of the NEMA which gives provisions for monitoring and management of impacts under environmental authorisation conditions. This suggests that the monitoring of the potential impacts on the surrounding groundwater users is solely under the responsibility of those who carry out the authorised activity. However, anti-leakage monitoring and precise implementation regulations for fuel stations seem to be unavailable in the South African regulatory framework.

Seyler, Witthüser, and Sunaitis (2019) noted that the governance of groundwater in South Africa is characterised by insufficient groundwater monitoring measures. Hence, the lack of sufficient monitoring around fuel stations can be detrimental to the public, especially with the growing access to groundwater. Groundwater is a valuable water resource, therefore, stringent measures should be imposed. The above can lead to the conclusion that in South Africa, the environment regulation lacks reliable legal, mandatory and guiding regulatory standards that compel fuel stations adequately to take measures for the protection of boreholes and potential groundwater users in their surroundings. Similar observations have been also made in China by Wu, Zhang and Zhand (2017), which suggests that this problem is not exclusive to Cape Town and South Africa in general.

4.4.4. Risk approach to governing risk of fuel stations on groundwater

Two risk approaches were identified in line with NEMA principles. As mentioned in section 4.2.4 of this thesis, Section 2(4)(a)(vii) of the NEMA recommends first a “risk-averse and cautious approach is applied, which takes into account the limits of current knowledge”, connoting that the precautionary approach should be applied under circumstances of limited knowledge. In addition, Section 2(4)(a)(viii) of the NEMA requires that the negative environmental impacts are “anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied” which implies that risk-based actions need to be considered where there cannot be prevented (Figure 4.4.)

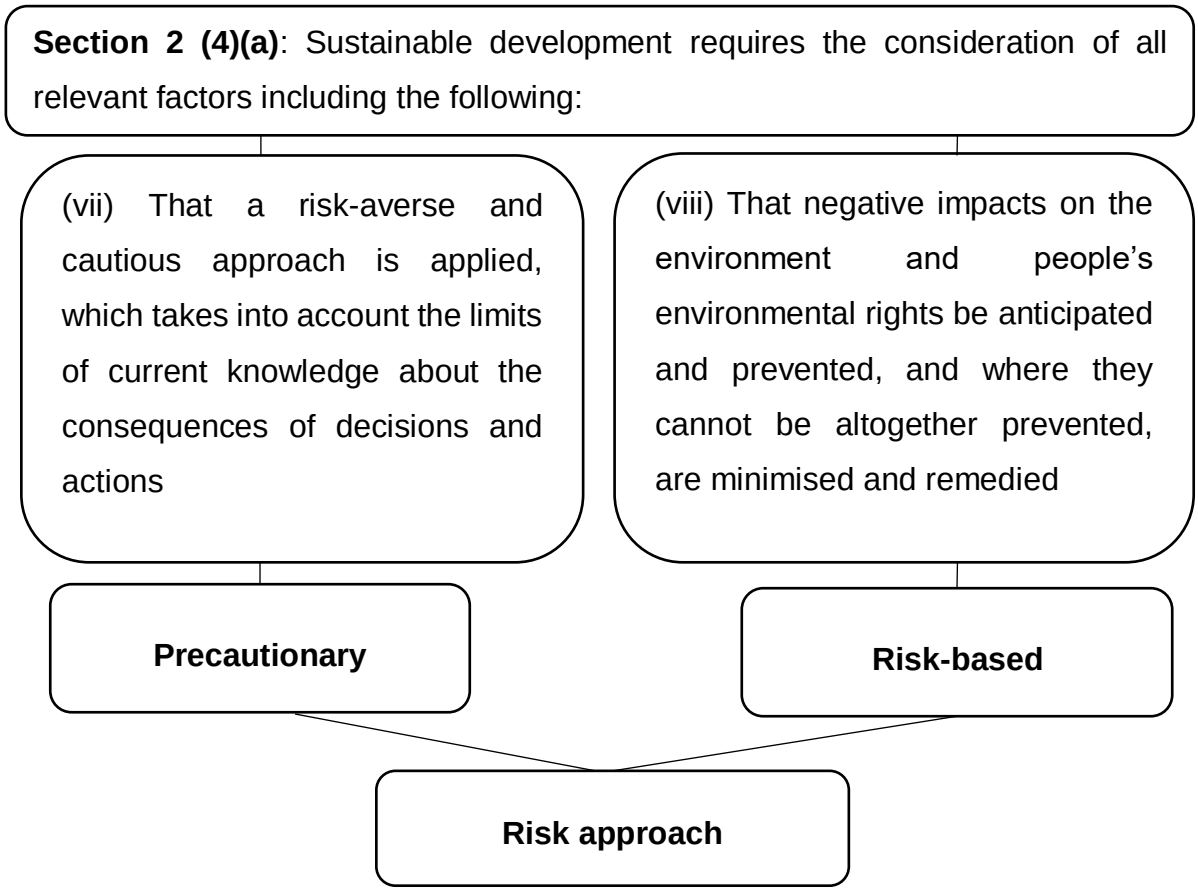

Figure 4.3: The NEMA principles relating to the risk approach in environmental management (NEMA 107 of 1998).

Aven and Renn (2018) note that in certain circumstances, the combination of risk approaches is a common practice allowing the implementation of different strategies. This is what transpired from the analysis of the legal framework, as it appeared that the precautionary and risk-based approaches are implemented in consideration of potential

impacts. Concerning the impacts of fuel stations, the risk approaches vary depending on the phases in the lifecycle of the fuel station. For instance, the EIA and environmental authorisation process as provided in the NEMA demonstrate the features of a precautionary approach. However, after approval of a fuel station development, the focus shift to the management of risks that emerge in the operational phase throughout the life cycle of the fuel station (Ahmed *et al.*, 2011). In the context of fuel stations, the risk-based approach as implemented in terms of Section 2(4)(a)(viii) of the NEMA, correlates with the management of emergency incidents and the management of contaminated land.

According to (Rothstein *et al.*, 2006) risk-based regulations relate to the assessment and management of issues. This description relates to the management of contaminated land as established in Part 8 of the NEMWA and the management of emergency incidents (Section 30 of NEMA). During the interview Participant 1 mentioned that when a contaminant land has been identified, the urgency for remediation action depends on the surrounding receptors. Similarly, the approach to emergency incidents focuses on remedying the risks. This suggests in both emergency incidents and contaminated land management; the significance of risk determines the urgency of actions after an incident.

However, considering the nature of groundwater contamination, the risk-based approach may be less effective to some extent in the case of a fuel station. Groundwater contamination may occur unnoticeably for a long period, but, its cumulative effects can be devastating for health (Sierra Club, 2005; Michaels, 2019; Gibson *et al.*, 2020). Therefore, it is important to place precautionary measures such as in terms of a minimum distance between fuel stations and sensitive land uses where boreholes may be used (California State Water Resources Control Board, 2004).

4.4.5. The fragmentation of the legal framework

The review of the array of legislative frameworks, regulations and other relevant documents applicable to the regulation of fuel stations' impacts on groundwater revealed that the legal framework governing fuel station impacts is extensively fragmented. This fragmentation may have an impact on the effectiveness of the regulation of fuel stations' environmental aspects. Furthermore, the fragmented nature of the laws governing fuel stations' impacts on groundwater may render implementation and compliance to legal measures aimed at the protection of the groundwater complex. Johnston (2014) concluded also that the fragmentation of legal frameworks applicable to UST may pose compliance problems

because legal requirements are contained in several pieces of legislation rather than being contained in a single comprehensive document. The fragmentation of the legal frameworks affects also the designation of the implementing authorities who should handle mater relating to fuel stations' impacts on groundwater. For example, the department in charge of environmental affairs is the lead authority of the NEMA and NEMWA whilst the DWS is the lead authority for water-related matters in terms of the NWA.

The issue of fragmentation seems to be a general problem with the South African environmental governance framework. More than a decade ago Kotze (2006) also noted that the fragmentation of the components of environmental governance and decision-making frameworks (i.e., statutes, regulations, policy and, institutions) is the most notorious challenge bedevilling sustainable environmental governance in South Africa. According to Kotze (2007), it is imperative to consider the integration of some components of the governance framework at different levels of government to improve the effectiveness of pollution regulation in South Africa.

Thus, to minimise the effect of fragmentation, Johnston (2014) recommended the establishment of a UST regulatory authority to focus on the regulation of underground storage in South Africa. This recommendation is not fully supported in this study, given that in the short term, such proposals may encounter opposition from the government due to financial and legal constraints that may be associated with this proposal. However, in this study, the researcher is of the view that the development and harmonisation of legal conditions and requirements applicable to fuel stations into an integrated and cohesive document to facilitate the regulation of fuel stations' environmental aspects and compliance would be a more effective and efficient approach. The implementation of a harmonised framework can be easily overseen by the provincial government who is the competent authority for the environmental authorisation of fuel stations in terms of the EIA regulation, 2014.

4.4.6. Implications of the study

The findings of the study have implications for the regulation of environmental aspects of fuel stations in Cape Town. It was found that there are insufficient precautionary regulatory measures such as minimum safety distances around fuel stations. Thus, it is not clear what land use criteria are used for the evaluation of EIA and environmental authorisation applications before allowing fuel stations in residential areas. In addition, there are no

mandatory legal requirements for the installation and upgrade of up-to-date fuel tanks and associated pipes that are equipped with anti-leaks and corrosion prevention systems. As a consequence, many USTs especially old ones may be contaminating the groundwater, resulting in cumulative impacts on the public surrounding fuel stations. Therefore, the findings of the study underline the necessity to increase the precautionary measures to minimise fuel stations' potential impacts on groundwater and health risks to private boreholes users.

Moreover, the study identified that the legal framework governing the environmental impacts of fuel stations is extensively fragmented. The fragmented nature of laws governing the environmental aspects of fuel stations may impede effective risk regulation. Accordingly, the present study suggests the integration of the components of the legal framework governing the impacts of fuel stations on groundwater (figure 4.5).

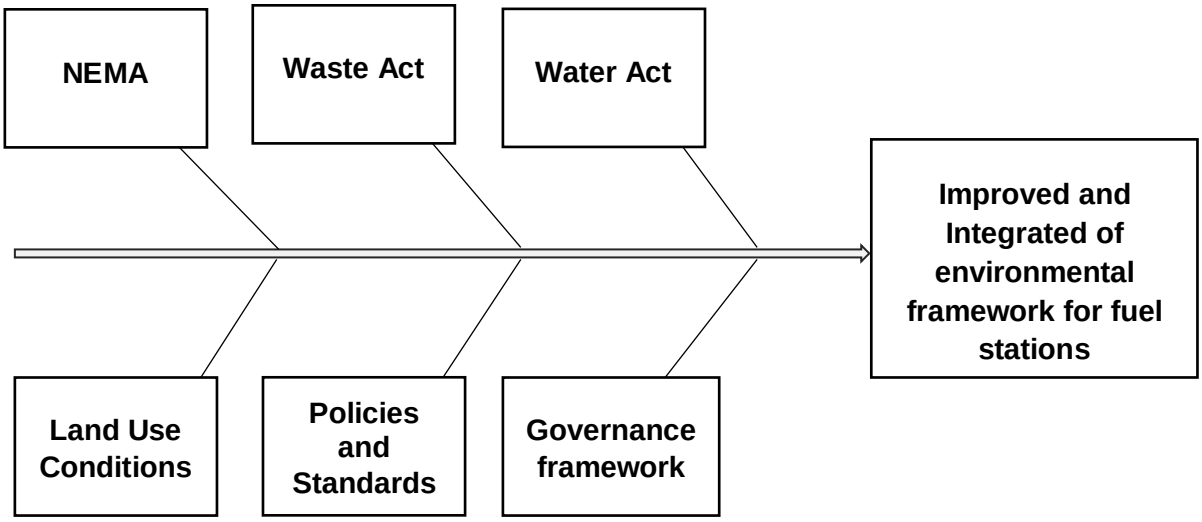

Figure 4.4: Suggested integration of the components of the legal framework governing fuel stations' impacts on groundwater.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

Groundwater is an important freshwater source for many people. In Cape Town, for example, the number of people using boreholes as an alternative source of municipal water has increased in the past few years. This trend may continue as water dams that are the main sources of municipal water supply experience several challenges (Ziervogel, 2019). Considering the importance of groundwater, it is imperative to take preventive measures against groundwater contamination and its effects on public health. To achieve this, an evaluation of the effectiveness of current groundwater protection measures is necessary (Martin, Boer and Slobodian, 2016), to identify areas of improvement. Therefore, considering fuel stations represent a potential source of contamination of groundwater, especially in urban areas, this research reviewed the legal framework governing fuel stations' impacts on groundwater in Cape Town.

An exploratory qualitative research design was employed to conduct this research, using a combination of desktop study and semi-structured interviews. While in the desktop study the review of legal instruments governing fuel stations' environmental aspects yielded insightful data on the requirements for the development of fuel stations and the control of groundwater impacts resulting from fuel station operations, the interviews provided further insights that supplemented the data from the legal and regulatory framework. The findings of the study showed that the requirements for the development of fuel stations and the control of their impacts are mainly dictated by national environmental legislation such as the NEMA, NEMWA and NWA. However, for requirements relating to the local development management, the CoCT as the local authority has a specific management framework which gives land use specifications for fuel stations.

It was established that the development of fuel stations is subject primarily to Section 24 of the NEMA which requires an environmental authorisation and EIA for activities that are categorised as "listed activity". The environmental authorisation and EIA serve as a precautionary process to unravel the potential impacts, such as groundwater contamination. However, the researcher noted that there is a lack of specific legal provisions at the national, provincial, and local levels that dictate a safe distance between fuel stations and other land uses. The lack of legal provisions for a minimum safety distance may constitute a legal vacuum in the evaluation of environmental authorisation and

attached EIA for fuel station developments in Cape Town. This may have facilitated the proliferation of fuel stations close to residential properties. Therefore, it would be necessary to integrate specific land use conditions for the location of fuel stations and a minimum safety distance to be observed around sensitive land uses. This will help minimise the vulnerability of residents who use or may potentially use boreholes around fuel station sites.

Concerning the protection of boreholes in areas adjacent to fuel stations, it was found that this aspect is covered by general environmental protection principles in the NEMA, NEMWA and NWA. However, it was noted that no provision addresses specifically the protection of boreholes in areas adjacent to fuel stations. It is important to mention that the literature highlighted that in some countries, USTs are governed by specific UST regulations providing legal measures for the protection of groundwater and borehole users. In contrast, in South Africa, such regulations are not currently in place.

The research intended also to identify the risk approach in the management of risks arising from fuel stations. In this regard, the NEMA recommends first that “a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions”, which begs the application of a precautionary approach to environmental risk in general. In the case of the regulatory process of fuel station development, the precautionary approach is applied in the environmental authorisation and EIA evaluation process. On the other hand, the NEMA provides that where environmental impacts “cannot be altogether prevented, are minimised and remedied”. Hence this calls for a risk-based approach which has more significance in the operational phases of fuel stations. Nevertheless, it is important to define a specific risk approach which establishes specific precautionary measures, particularly in terms of land use control as a shield of protection to minimise the potential for fuel station impacts in adjacent areas.

It is therefore concluded that the legal framework governing fuel stations' impacts on groundwater may have limited effectiveness due to several factors. This is mainly because specific regulations governing groundwater contamination risks arising specifically from fuel stations are not in place. The absence of specific and compelling provisions can lead to insignificant and inadequate considerations of potential groundwater and borehole contamination around fuel stations. In addition, the fragmented nature of the legal

instruments governing fuel stations' impacts on groundwater may impact negatively the effective implementation of existing environmental protection measures.

5.2. Limitations and challenges

Some limitations and challenges were encountered while conducting this study. One of the most challenging steps was the process of obtaining research permission from the local authority. The process took longer than expected thereby affecting the research schedule. The delay caused by this process has had an impact on the implementation of the research plan as the remaining time was tight for the re-adjustment of all research activities. A significant limitation was encountered with the selection of participants for the semi-structured interviews as it was initially planned that 15 participants would be selected for interviews. However, this challenge was overcome by conducting in-depth interviews with available participants given their extensive experience and knowledge of the subject under study. Lastly, although the CoCT was the study area, there was no interview with municipal authorities due to the unavailability of officials.

5.3. Recommendations from the study

Abstraction of groundwater for domestic needs has the potential to alleviate considerably the pressure on the municipal drinking water supply. However, groundwater contamination leaking USTs at fuel stations may cause detrimental health effects on groundwater users. To ensure that residential communities using private boreholes in Cape Town will not be exposed to hydrocarbon-contaminated groundwater resulting from fuel station operations, stringent precautionary measures need to be in place. The recommendations and suggestions for further studies are made to improve the regulation of fuel stations' impacts on groundwater and private borehole users:

- Authorities responsible for land use planning in Cape Town should establish a specific minimum safe distance (buffer) between fuel stations and sensitive land. This requirement will constitute an additional land use control measure that should be considered during the review of EIA reports for fuel station developments.
- Local governments should consider developing policies that aim at providing environmental health literacy assistance to borehole owners in proximity to potential sources of groundwater contamination such as fuel stations.

- National, provincial, and local governments must cooperatively work to develop specific regulations and strategies for the control and monitoring of fuel stations' impacts on groundwater and private boreholes in Cape Town.
- SANS codes of practices that provide recommendations for anti-leak, anti-corrosion and other spill control equipment designated for USTs and ancillary equipment should be made mandatory to compel non-compliant fuel stations to abide.
- The study recommends that the legal instruments governing the fuel stations' impacts on groundwater must be integrated into one comprehensive document to facilitate regulation, enforcement and compliance.

5.4. Recommendations for further research

- The study recommends further research to investigate the contamination status of fuel stations in residential areas in Cape Town, to provide an understanding of contamination risk on boreholes around fuel stations. Specific considerations must be given to the following variables: age of USTs and proximity to residential properties.
- The study recommends also further research adopting mixed-methods (qualitative and quantitative) with larger samples of local environmental authorities, members of the fuel retail industry in Cape Town and residents of properties located near fuel stations. This will allow gaining an understanding of different realities and perceptions about groundwater contamination risk, legal frameworks and factors that may impede compliance with the requirements of groundwater protection.

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APPENDICES

Appendix A: Research permission

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Date	: 4 November 2021
To	: Director: Policy & Strategy
Reference	: PSRR- 0345

Research Approval Request

In terms of the City of Cape Town System of Delegations (June 2019) - Part 29, No 8 Subsection 4, 5 and 6

"Research:

(4) To consider any request for the commissioning of an organizational wide research report in the City and to approve or refuse such a request.

(5) To grant authority to external parties that wish to conduct research within the City of Cape Town and/or publish the results thereof.

(6) To after consultation with the relevant Executive Director: grant permission to employees of the City of Cape Town to conduct research, surveys etc. related to their studies, within the relevant directorate

The Director: Policy & Strategy is hereby requested to consider, in terms of sub-section 5, the request received from:

Name	: Eden Nsimba
Designation	: Masters candidate, Environmental Management
Affiliation	: Cape Peninsula University of Technology
Research Title	: "A review of the legal framework governing environmental impacts of petrol stations on groundwater in Cape Town, South Africa."

Taking into account the recommendations below (see Annexure for detailed review):

Recommendations

The CCT via the Director: Policy & Strategy grants permission to Eden Nsimba, in his capacity as a candidate for Master of Environmental Management, Cape Peninsula University of Technology, in order to conduct this research in the CCT, the applicant is advised to:

- National, Provincial and City COVID-19 protocols and regulations to be adhered to for all engagements;
- Face to face engagements to be limited and online platforms to be used for interviews;
- Contact with the identified interviewees from Water & Sanitation to occur via Meagan Donnelly on Meagan.Donnelly@capetown.gov.za ;
- The willingness and/or availability of individual CCT staff members to participate in the research study, in a voluntary capacity;
- Only questions pertaining to registration of boreholes as a conservation practice can be answered by the identified officials;
- Questions related to Ground Water should be directed to National Government in line with their regulation mandate;
- The research report to explicitly acknowledge that City of Cape Town responses are limited to registration of boreholes in Cape Town.
- Signed permission to record interviewees must be obtained from interviewees.

- The use of direct quotations in the report to be agreed in advance and in writing by the respondent concerned, and any text for direct quotation/s must be verified and signed off individually, ahead of any publication of the case study, policy briefing and/or report;
- Clear acknowledgement in the research report that the views of the participants and the analysis of the research findings are not regarded as official CCT policy;
- City officials and their inputs to be anonymised;
- The City branding and logo not being used in the research report;
- Researcher to provide feedback to the Water & Sanitation Directorate: Technical Services, including all research findings, either in a presentation or upload the analysis on an agreed platform by the Water & Sanitation management team;
- Submission of the completed research report to the Director: Policy & Strategy, the Director: Technical Services, Water & Sanitation Directorate and the Manager: Research Branch - Policy & Strategy, within 3 months of completion of the research report.

Delegated authority:	**Acceptance by Applicant:**
Approved ☒ Comment: per above conditions	I, **Eden Alexandre Nsimba**, confirm that I agree to abide by the conditions as stipulated above.
Not Approved ☐ Comment:	
Hugh Cole: Dir: Policy & Strategy: acting	**Applicant**:
Date: Daniel Sullivan Digitally signed by Daniel Sullivan Date: 2021.11.12 09:42:58 +02'00'	**Date**: **12-12-2021**
CCT departments: No interviews or data to be provided without proof of acceptance of the conditions under which the research permission is granted.	***Kindly return signed copy to sivuyilevuyo.rilityana@capetown.gov.za***

Appendix B: Ethics and data approval

Cape Peninsula University of Technology

Statement of Permission

A site permit is not required for this study.

Reference no.	216008107/02/2022
Surname & name	Nsimba EA
Student Number	216008107
Degree	Master of Environmental Management
Title	A review of the legal framework governing environmental impacts of petrol stations on groundwater in Cape Town, South Africa
Supervisor(s)	Dr. Malaza Ntokozo
FRC Signature	
Date	28 Feb 2022

Cape Peninsula University of Technology

P.O. Box 1906 · Bellville 7535 South Africa ·Tel: +27 21 953 8677 (Bellville), +27 21 460 4213 (Cape Town)

Ethics Approval Letter **Reference no: 216008107/02/2022**

Office of the Chairperson **Research Ethics Committee**	**Faculty of Applied Sciences**

On 28 February 2022, the Faculty Research Ethics Committee of the Faculty of Applied Sciences granted ethics approval to Nsimba EA for research activities related to a project to be undertaken for a degree (Master of Environmental Management) at the Cape Peninsula University of Technology.

Title of project:	A review of the legal framework governing environmental impacts of petrol stations on groundwater in Cape Town, South Africa

Comments (Add any further comments deemed necessary, e.g. permission required)

1. Humans are involved in the study.
2. This permission is granted for the duration of the study.
3. Research activities are restricted to those detailed in the research proposal.
4. The research team must comply with conditions outlined in AppSci/ASFREC/2015/1.1 v1, CODE OF ETHICS, ETHICAL VALUES AND GUIDELINES FOR RESEARCHERS.

	28/02/2022
Signed: Chairperson: Faculty Research Ethics Committee	**Date**

Appendix C: Request permission sent to the Department of Water and Sanitation

Cape Peninsula University of Technology

Cape Peninsula University of Technology
Faculty of Applied Sciences
Department of Environmental and Occupational Studies
P.O. Box 652
Cape Town
8000

06 April 2021

The Director
Department of Water and
Sanitation
Private Bag X16,
Sanlamhof
52 Vootrekker Rd, Spectrum Building
Cape Town

Dear Sir/ Madam

RE: Request for Permission to Conduct Research in Cape Town- Mr Eden Alexandre Nsimba -216008107

This is to confirm that the above student Mr Eden Alexandre Nsimba (216008107) is a student at Cape Peninsula University of Technology (CPUT). He is conducting a research project in fulfilment of a qualification in Master of Environmental Management; and his study area is Cape Town, South Africa. The title of the research project is *"A review of the legal framework governing environmental impacts of petrol stations on groundwater in Cape Town, South Africa"*. It is an academic requirement that students be granted permission to conduct research by the competent authority in their area of study before they start data collection. We therefore, request your good office to assist Mr Nsimba in acquiring such a permission letter.

Please let me know if you need further information.

Yours Faithfully

Dr N. Malaza (Supervisor & Head of Department)

Email: malazan@cput.ac.za

Tel: +2721 460 9040

Appendix D: Interview Consent Form

Cape Peninsula
University of Technology

INTERVIEW CONSENT FORM

Research title: A review of the legal framework governing environmental impacts of petrol stations on groundwater in Cape Town, South Africa

Student Name:

Student Number:

Interviewee name and affiliation: _____

This interview forms part of the research required to review the legal framework governing environmental impacts of petrol stations on groundwater in Cape Town. The research is conducted in partial fulfilment of the requirements for the Masters degree in Environmental Management (MGEVMC): Environmental and Occupational Studies, presented by the Faculty of Applied Sciences at the Cape Peninsula University of Technology.

The interview will take approximately one hour. We do not anticipate any risks associated with your participation, but you have the right to stop or withdraw from the interview at any time.

Thank you for agreeing to be interviewed as part of the above-mentioned research project. The Cape Peninsula University of Technology requires that all interviewees give consent to being interviewed and to how the interview information is used. This consent form is therefore designed to make sure that you understand the reason for your participation and to prove that you agree to the conditions of participating in the interview. Please carefully read through the following conditions and sign at the bottom of this consent form if you agree / approve of the following:

- This interview will be recorded, and a transcript will be produced;
- You will be sent the transcript and given the opportunity to correct any factual errors;
- The transcript of the interview will be analysed by Eden Alexandre Nsimba (student number 216008107) for inclusion in the above dissertation;

_____

Interviewee initial: _____

Date of interview: ____/___/_____

Page 1 of 3

- The interview transcript will be limited to Eden Alexandre Nsimba, his supervisor and academic colleagues with whom he might collaborate as part of the research process;
- Interview content, summaries and quotations used as part of the academic publication will be anonymous in order to protect the identity of the interviewee;
- The recording of the interview will be deleted after the transcript has been reviewed / verified by the interviewee;
- None of these conditions will be varied without the prior approval of the interviewee.

All or part of the content / information gathered from this interview may be published in academic papers, on our website and in other media that we may produce, such as written or spoken presentations or during feedback sessions.

CONTACT INFORMATION

This research has been reviewed and approved by the Cape Peninsula University of Technology. If you have any additional questions or concerns about this research, please contact:
Eden Alexandre Nsimba
Student no.:
E-mail:
Telephone:

You can also contact the research supervisor:
Dr Ntokozo Malaza
Faculty of Applied Sciences
Cape Peninsula University of Technology
E-mail:
Telephone:

_____

Interviewee initial: _____

Date of interview: ____/___/_____

By signing this interview consent form, I, the interviewee, agree that:

- My participation in this interview, and therefore this project, is voluntary. I understand that I don't have to take part, and I can stop the interview at any time.
- The transcribed interview or extracts from it may be used as described above.
- I acknowledge that I have read and understand the Information sheet.
- I have no expectation to receive any benefit or payment for my participation in this interview / project.
- On review of the interview transcript I may make edits as I feel necessary to ensure that all the facts are captured correctly.
- I was able to ask questions and I understand that I am free to contact the researcher or her supervisor with any further questions I may have in the future.

Interviewee Signature: _____

Interviewee Name: _____

Date of interview: _____/_____/_____

Interviewer Signature: _____

Appendix E: List of laws and policies reviewed

Act/Regulation/Policy	Developed by
Constitution of South Africa (1996)	Republic of South Africa
National Environmental Management Act, 1998 (Act 107 of 1998)	Republic of South Africa
National Environmental Management: Waste Act, 2008 (Act 59 of 2008)	Republic of South Africa
National Water Act, 1998 (Act 36 of 1998)	Republic of South Africa
Water Service Act, 108 (Act of 1997)	Republic of South Africa
Environmental Impact Assessment Regulations	Republic of South Africa
EIA Administrative Guideline for Construction and Upgrade of Filling Station and Associated Tank Installations	Gauteng Province
Western Cape Land Use Planning Act, 2014 (Act of 2014)	Western Cape Province
Cape Town Water t By-Law, 2018	City of Cape Town
Municipal Planning By-Law, 2015 (Cape Town)	City of Cape Town
Framework for the Management of Contaminated Land (2010)	South Africa

Appendix F: Semi-structured Interview questions

Question 1: Generally, what is the criteria guiding the review of an EIA report with regards to fuel station development applications?
A/
Question 2: Do fuel stations pose risks to groundwater and boreholes in Cape Town?
A/
Question 3: Do you consider fuel stations as a significant cause of contaminated land and how does contaminated land relate to groundwater contamination?
A/
Question 4: Do you see any potential for land use conflict between fuel stations and sensitive land-uses in Western Cape?
A/
Question 5: How would you describe the risk management approach in reference to the management of risk posed by fuel stations in Cape Town?
A/

Appendix G: Petroleum industry codes of practice: SANS 10089 & SANS 1830

ISBN 978-0-626-24858-1

SANS 10089-3:2010
Edition 4

SOUTH AFRICAN NATIONAL STANDARD

The petroleum industry

Part 3: The installation, modification, and decommissioning of underground storage tanks, pumps/dispensers and pipework at service stations and consumer installations

Published by SABS Standards Division
1 Dr Lategan Road Groenkloof ✉ Private Bag X191 Pretoria 0001
Tel: +27 12 428 7911 Fax: +27 12 344 1568
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SABS

SANS 10089-3:2010
Edition 4

Table of changes

Change No.	Date	Scope

Acknowledgement

The SABS Standards Division wishes to acknowledge the valuable assistance derived from publications of the following organizations:

American Petroleum Institute

Deutsches Institut für Normung

Foreword

This South African standard was approved by National Committee SABS TC 28, *The Petroleum industry – Equipment and systems*, in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This document was published in November 2010.

This document supersedes SABS 089-3:1999 (third edition).

Reference is made in 3.3(a), 4.2.2.1, 4.4.3, 9.1 and 13.1 to "safety legislation". In South Africa this means the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) (as amended from time to time).

Reference is made in 3.3(b) to "relevant legislation". In South Africa this means the Mine Health and Safety Act, 1996 (Act No. 29 of 1996).

Reference is made in 3.3(c) and 9.2 to "relevant legislation". In South Africa this means the Trade Metrology Act, 1973 (Act No. 77 of 1973).

Reference is made in 3.3(d) to "relevant legislation". In South Africa this means the National Environmental Management Act, 1998 (Act No. 107 of 1998).

Reference is made in 3.3(e) and annex A to "relevant legislation". In South Africa this means the Petroleum Products Act, 1977 (Act No. 120 of 1977).

Reference is made in 3.9 to "relevant legislation". In South Africa this means the Engineering Profession Act, 2000 (Act No. 46 of 2000).

Reference is made in clause 10 and annex A to "legislation". In South Africa this means the National Water Act, 1998 (Act No. 36 of 1998).

SANS 10089 consists of the following parts under the general title *The petroleum industry*:

Part 1: Storage and distribution of petroleum products in above-ground bulk installations.

Part 2: Electrical and other installations in the distribution and marketing sector.

Part 3: The installation, modification, and decommissioning of underground storage tanks, pumps/dispensers and pipework at service stations and consumer installations.

Annexes A and B form an integral part of the document. Annex C is for information only.

Introduction

In terms of the regulations promulgated under chapter 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (Government Notice 385 of 21 April 2006), the construction of service stations may not commence without environmental authorization from the provincial authority responsible for environmental management. The environmental authorization requires that an environmental impact assessment be undertaken which identifies all the potential environmental implications of constructing and operating a service station.

The environmental authorization may contain certain specific conditions for the construction of the facility. These conditions may take precedence over the requirements of this document.

Contents

The petroleum industry

Part 3:
The installation, modification, and decommissioning of underground storage tanks, pumps/dispensers and pipework at service stations and consumer installations

1 Scope

1.1 This part of SANS 10089 covers provisions for the installation of underground storage tanks of individual capacity not exceeding 85 000 m^3, pumps/dispensers and pipework at service stations and consumer installations.

1.2 This part of SANS 10089 does not cover the installation of pressurized underground storage tanks such as liquefied petroleum gas (LPG) and compressed natural gas (CNG) storage vessels.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

APEA/IP, *Design, construction, modification, maintenance and decommissioning of filling stations ("Blue Book")*.

API RP 1604, *Closure of underground petroleum storage tanks*.

EN 12954, *Cathodic protection of buried or immersed metallic structures – General principles and application for pipelines*.

EN 13617-3, *Petrol filling stations – Part 3: Safety requirements for construction and performance of shear valves*.

EN 14125, *Thermoplastic and flexible metal pipework for underground installation at petrol filling stations*.

IP method 34, *Determination of flash point – Pensky-Martens closed cup method*.

IP 1, *Institute of Petroleum performance specification for underground pipework systems at petrol filling stations, November 1995*.

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SANS 1830:2013

Edition 1.2

SOUTH AFRICAN NATIONAL STANDARD

Flexible piping for underground use at service stations and consumer installations

Published by SABS Standards Division
1 Dr Lategan Road Groenkloof ✉ Private Bag X191 Pretoria 0001
Tel: +27 12 428 7911 Fax: +27 12 344 1568
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SANS 1830:2013
Edition 1.2

Table of changes

Change No.	Date	Scope
Amdt 1	2006	Amended to change the designation of SABS standards to SANS standards, with no technical changes.
Amdt 2	2013	Amended to update referenced standards, and to modify the requirements for fuel 3.

Foreword

This South African standard was approved by National Committee SABS SC 138H, *Water and sanitation – Equipment and systems – Plastics pipes and fittings,* in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This document was published in March 2013.

This document supersedes SANS 1830:2006 (edition 1.1).

A vertical line in the margin shows where the text has been technically modified by amendment No. 2.

Annexes A, B and C form an integral part of this document. Annexes D and E are for information only.

Contents

Contents (*concluded*)

Flexible piping for underground use at service stations and consumer installations

1 Scope

This standard specifies the requirements for flexible and semi-flexible pipework used underground in service station forecourts and consumer installations. This covers pipework used to convey liquid motor fuels and their hydrocarbon vapours to and from underground storage.

All pipework is expected to be suitable for use with diesel, leaded and unleaded petrol, and their associated additives.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

ASTM D 471, *Standard test method for rubber property – Effect of liquids*.

ASTM D 2143, *Standard test method for cyclic pressure strength of reinforced, thermosetting plastic pipe*.

ASTM D 2412, *Standard test method for determination of external loading characteristics of plastic pipe by parallel-plate loading*.

ISO 7233, *Rubber and plastics hoses and hose assemblies – Determination of resistance to vacuum*.

ISO 13954, *Plastics pipes and fittings – Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm*.

~~SANS 299 (SABS 299), *Leaded petrol.*~~ **Amdt 2** |

SANS 1598, *Unleaded petrol*.

3 Definitions

For the purposes of this standard, the following definitions apply.

3.1
flexible piping
pipes which can be laid out to a desired shape or configuration without permanent deformation

ISBN 978-0-626-35764-1

SANS 1535:2018

Edition 3

SOUTH AFRICAN NATIONAL STANDARD

Steel tanks for the underground storage of hydrocarbons and oxygenated solvents

WARNING
This document references other documents normatively.

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SANS 1535:2018
Edition 3

Table of changes

Change No.	Date	Scope

Foreword

This South African standard was prepared by National Committee SABS/TC 280, *The petroleum industry – Equipment and systems*, in accordance with procedures of the South African Bureau of Standards, in compliance with annex 3 of the WTO/TBT agreement.

This document was approved for publication in May 2018.

This document supersedes SANS 1535:2005 (edition 2.3).

Reference is made in 6.2.3 to the "minimum required qualification". In South Africa this means a qualification of the South African Qualification and Certification Committee (SAQCC – Radiographics) (level 2), or the American Society for Non-Destructive Testing (ASNT)/TC/1A.

Annex A forms an integral part of this document. Annex B is for information only.

Compliance with this document cannot confer immunity from legal obligations.

Introduction

This standard is for use by manufacturers of steel tanks intended for the underground storage of hydrocarbons and oxygenated solvents.

Contents

Appendix H: Dangerours Goods Standards

SCHEDULE

NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 of 1998)

DRAFT STANDARD FOR THE DEVELOPMENT AND RELATED OPERATION OR EXPANSION AND RELATED OPERATION OF FACILITIES OR INFRASTRUCTURE FOR THE STORAGE OR STORAGE AND HANDLING OF DANGEROUS GOODS

TABLE OF CONTENTS

CHAPTER 1

INTERPRETATION, PURPOSE AND SCOPE

Interpretation

1. In this Notice, any word or expression to which a meaning has been assigned in the Act and in the SANS standards adopted in this Schedule shall have the meaning so assigned, and unless the context otherwise indicates—

"competent authority" refers to the organ of state that would have been charged by section 24C of the Act with evaluating the environmental impact of the activities contemplated in section 3(1) of this Standard and, where appropriate, with granting or refusing an environmental authorisation in respect of that activity or activities;

"current Environmental Impact Assessment Regulations" means the regulations published in terms of section 24(5) of the Act, under Government Notice R 982 in Government Gazette 38282 of 4 December 2014 (as amended), or any similar regulations repealing said 2014 Regulations

"days" means calendar days, excluding public holidays and the period of 15 December to 5 January;

"**dangerous goods**" means goods containing any of the substances as contemplated in South African National Standard No. 10234, supplement 2008 1.00: designated "List of classification and labelling of chemicals in accordance with the Globally Harmonized Systems (GHS)" published by Standards South Africa, and where the presence of such goods, regardless of quantity, in a blend or mixture, causes such blend or mixture to have one or more of the characteristics listed in the Hazard Statements in section 4.2.3, namely physical hazards, health hazards or environmental hazards;

"ECA Regulations" means the regulations published in terms of section 26 and 28 of the Environment Conservation Act, 1989 (Act No 73) of 1989, under Government Notice R. 1183 in Government Gazette18261 of 5 September 1997;

"phased activities" means, for purposes of section 3(1)(c), an activity for the development and related operation or expansion and related operation of facilities for the storage, or storage and handling of dangerous goods that is developed or expanded in phases over time on the same or adjacent properties or sites to create a single or linked entity through interconnected internal vehicular or pedestrian circulation, sharing of infrastructure, or the continuum of design, style or concept by the same proponent or his or her successors, where such storage occurs in containers with a combined capacity of 80 cubic metres or more, but not exceeding 500 cubic metres;

"previous NEMA Regulations" means the previous Environmental Impact Assessment Regulations published in terms of the Act (Government Notice No. R. 385 in the Government *Gazette* of 21 April 2006 or Government Notice No. R. 543 in the Government *Gazette* of 18 June 2010);

"proponent" refers to the person that intends to undertake an activity contemplated in the scope of this Standard;

"**SANS**" means the South African National Standards contemplated in Chapter 3 of the Standards Act, 1993 (Act No. 29 of 1993), and SANS followed by any number means a reference to a SANS code of practice, specification or standard of the corresponding number referred to in Appendix 2 of this Standard and includes any amendments thereto; and

"**the Act**" means the National Environmental Management Act, 1998 (Act No. 107 of 1998).

Purpose

2. The purpose of this Standard is to regulate the development and related operation and expansion and related operation of facilities or infrastructure for the storage, or storage and handling, of a dangerous good, as contemplated in section 3(1), in order to facilitate and enable exclusion of such facilities or infrastructure from the requirement to obtain an environmental authorisation in terms of the Act.

Scope

3. (1) The provisions of this Standard are applicable to the—

(a) development and related operation of facilities or infrastructure for the storage, or storage and handling, of a dangerous good, where such storage occurs in containers with a combined capacity of 80 cubic metres or more but not exceeding 500 cubic metres; and

(b) expansion and related operation of facilities or infrastructure for the storage, or storage and handling, of a dangerous good, where the capacity of such storage facility will be expanded by more than 80 cubic metres but where the combined capacity of such storage facility will not exceed 500 cubic metres; and

(c) phased activities.

(2) The provisions of this Standard are not applicable to the—

(a) development and related operation or expansion and related operation of facilities or infrastructure for the storage, or storage and handling, of a dangerous good, where such storage occurs in containers with a combined capacity exceeding 500 cubic metres;

(b) decommissioning of facilities contemplated in subsection (1); or

(c) phased activities where the combined capacity of the facility or infrastructure exceeds 500 cubic metres;

in which case environmental authorisation in terms of the Act must be obtained, unless excluded from such requirement.

CHAPTER 2

ADMINISTRATIVE REQUIREMENTS

Notification, registration and commencement

4. (1) A proponent must submit to the competent authority—

(a) a request to be registered, notification of intent to comply with this Standard and declaration, as set out in Appendix 1;

(b) a report generated by the national web-based environmental screening tool, once the tool is operational; and

(c) proof of written consent of the landowner or person in control of the land if the proponent is not the landowner.

(2) The competent authority must, within 30 days, acknowledge receipt of the information contemplated in sub-section (1) and—

(a) if satisfied with the information provided, issue a registration number to the proponent; or

(b) if not satisfied with the information provided, request additional information from the proponent within a period determined by the competent authority or advise on any matter that may prejudice the success of the registration request.

(3) The proponent may commence with the development and related operation or expansion and related operation of facilities or infrastructure for the storage, or storage and handling, of a dangerous good within 2 years of receipt of the registration number contemplated in sub-section (2)(a), and must notify the competent authority, in writing, 30 days prior to such commencement.

(4) Registration lapses if commencement does not occur within 2 years of receipt of the registration number and subsections (1), (2) and (3) will apply afresh in such instances.

(5) The competent authority must keep a register of all registered developments and expansions of facilities or infrastructure, including as a minimum the —

(a) name of the proponent;

(b) project name and description;

(c) registration number;

(d) erf number, where development or expansion occurs; and

(e) date on which the registration number was issued.

(6) Proof of registration must be made available—

(a) on site at all times;

(b) on request;

(c) where the proponent or owner has a website, on such publicly accessible website; and

(d) where the proponent or owner is a member of a formally established industry organisation, to such organisation.

(7) Where change of ownership of a facility or infrastructure registered in terms of subsection (2)(a) occurs, the new owner must submit the relevant declaration and details contemplated in Appendix 1 within 30 days upon finalisation of such change.

CHAPTER 3

ENVIRONMENTAL MANAGEMENT SPECIFICATIONS

Specifications and applicability of SANS

5. The proponent or new owner must ensure compliance with the specifications as indicated in Appendix 2, insofar as these specifications are applicable to the facilities or infrastructure contemplated in section 3(1).

CHAPTER 4

AUDIT REQUIREMENTS

Audit requirements

6. (1) The proponent must ensure that an environmental audit —

(a) is undertaken by an external independent person with the relevant expertise, which provides verifiable findings, in a structured and systematic manner;

(b) includes an assessment of compliance with the requirements of this Standard;

(c) determines the level of compliance with this Standard and whether that level of compliance sufficiently provides for the avoidance, management and mitigation of environmental impacts associated with the undertaking of the activity that falls within the scope of this Standard; and

(d) is undertaken within 3 months of commencement of the development and related operation or expansion and related operation of the facility or infrastructure falling within the scope of this Standard, and every 3 years thereafter for as long as the facility or infrastructure remains operational; and

(e) is summarised in an environmental audit report.

(2) A proponent and new owner must report any non-compliance with this Standard to the competent authority within 5 days of its occurrence.

(3) Where change of ownership of a facility or infrastructure registered in terms of section 4(2)(a) occurs, the new owner must assume the auditing schedule undertaken by the previous owner as contemplated in subsection (1) and comply with subsections 1(a), (b), (c) and (e), and subsection (1)(d) where relevant, for as long as the facility or infrastructure remains operational.

(4) An environmental audit report must be made available—

(a) on site at all times;

(b) on request;

(c) where the proponent or owner has a website, on such publicly accessible website; and

(d) to the competent authority and, where the proponent or owner is a member of a formally established industry organisation, to such organisation, within 5 working days in the case that non-compliance to this Standard is indicated in such environmental audit report.

CHAPTER 5

GENERAL MATTERS

Competent authority inspections

7. The proponent or new owner must provide the competent authority and any environmental management inspector with access to the facility, for the purposes of compliance monitoring, without prior notification.

Offences

8. (1) A proponent commits an offence if such proponent commences with the development and related operation or expansion and related operation of facilities or infrastructure for the storage, or storage and handling, of a dangerous good without a registration number as contemplated in section 4(2)(a) or if such proponent contravenes or fails to comply with sections 4(1) or 6 of this Standard.

(2) A new owner of a facility—

(a) contemplated in this Standard commits an offence if such new owner commences with the development and related operation or expansion and related operation of facilities or infrastructure for the storage, or storage and handling, of a dangerous good without a registration number; or

(b) registered in terms of section 4(2)(a) commits an offence if such owner contravenes or fails to comply with sections 4(7) or 6 of this Standard.

Penalties

9. A proponent or new owner convicted of an offence in terms of section 8 of this Standard is liable to a fine not exceeding R10 million or to imprisonment for a period not exceeding 10 years, or to both such fine or such imprisonment.

CHAPTER 6

TRANSITIONAL ARRANGEMENTS AND COMMENCEMENT

Transitional arrangements

10.(1) Where the holder of an environmental authorisation for facilities or infrastructure contemplated in section 3(1) of this Standard, which environmental authorisation was issued in terms of the Act prior to the coming into effect of this Standard—

(a) can comply with the provisions of this Standard insofar it relates to facilities or infrastructure contemplated in section 3(1) authorised in such environmental authorisation, such holder must submit the relevant declaration and details contemplated in Appendix 1 within 30 days of the coming into effect of this Standard;

(b) cannot comply with the provisions of this Standard insofar it relates to facilities or infrastructure contemplated in section 3(1) authorised in such environmental authorisation, that environmental authorisation will remain valid as indicated in the content of such environmental authorisation and this Standard will apply to facilities or infrastructure contemplated in section 3(1) not covered by such environmental authorisation and which commences after the coming into effect of this Standard.

(2) The competent authority must, within 30 days of receipt of the information contemplated in sub-section (1)(a), acknowledge receipt thereof and issue a registration number to the proponent.

(3) On issuance of a registration number contemplated in in subsection (2), the environmental authorisation will be deemed to be superseded by this Standard insofar as the environmental authorisation relates to the development and related operation and expansion and related operation of facilities or infrastructure for the storage, or storage and handling, of a dangerous good, as contemplated in section 3(1).

(4) An application for environmental authorisation submitted in terms of the previous NEMA Regulations or the current Environmental Impact Assessment Regulations for facilities or infrastructure contemplated in section 3(1) of this Standard and which application is pending when this Standard takes effect, may be dispensed with in terms of such Regulations, whereafter subsection (1) will apply, provided that the reference in subsection (1)(a) to 30 days is read as within 30 days of the date of the environmental authorisation.

(5) If a holder of an environmental authorisation contemplated in subsection (1)(a) or (4) does not submit the relevant declaration and details contemplated in Appendix 1 within the prescribed timeframe, subsection (1)(b) will be deemed to apply.

(6) Where change of ownership occurs of a facility or infrastructure contemplated in subsection (1)(a) , the new owner must-

(a) submit the relevant declaration and details contemplated in Appendix 1 within 30 days upon finalisation of such change; and

(b) assume the auditing schedule undertaken by the previous owner and comply with sections 6 (1)(a), (b), (c) and (e), and section 6(1)(d) where relevant, for as long as the facility or infrastructure remains operational;

and failure to comply constitutes an offence.

Short title and commencement

11. These standards are called the Dangerous Goods Standard, 2016 and come into operation on the date of publication in the *Gazette*.

APPENDIX 1

For official use:

Reference Number	
Date received	

REQUEST FOR REGISTRATION, NOTIFICATION OF INTENT TO COMPLY WITH THE DANGEROUS GOODS STANDARD, 2016 AND DECLARATION

General

1. Please note that the information contained in this notification form must be accurate as it can be used for the purposes of compliance monitoring.

2. All information in this Appendix must be submitted to the relevant section responsible for enforcement and compliance monitoring-

Contact Person	
Address	

Definitions

3. For the purpose of this document a word or expression defined in the Dangerous Goods Standard, 2016 has the same meaning.

PART A: Request for registration

I, _____ hereby request registration for
(**full names of proponent**)
the development and related operation or expansion and related operation of a facility or infrastructure as detailed below for the storage or storage and handling of dangerous goods.

1. REQUEST FOR REGISTRATION (tick where applicable)	
New development	
Existing development	

PART B: Project Information

2. PROPONENT DETAILS	
Name of individual/ company	
Contact Person	
Passport/ Identity Document (ID) Number	
Company Registration Number	
Physical Address	
Postal address	
Email Address	
Phone No.	
Fax No.	

3. PROPERTY DETAILS			
Erf number			
Zoning			
Physical Address			
Municipal jurisdiction of activity			
SG21 Code			
GPS Coordinates			
Latitude (S)	°	'	"
Longitude (E)	°	'	"
Locality Map			
A locality map must be attached to this notification. The **scale** of the locality map must be at least **1:50 000** and **must be indicated** on the map.			

The map must indicate the following: – an accurate location of the proposed facility applied for at an appropriate scale ; – a description of the location of the facility, including • the 21 digit Surveyor General code of each cadastral land parcel; and • where available, the physical address or farm name – road names or numbers of all the major roads as well as the roads that provide access to the site; – a north arrow; – a legend explaining the symbols used in the map; – the prevailing wind direction; and – GPS co-ordinates (Indicate the position of the proposed activity using the latitude and longitude of the centre point of the site. The co-ordinates should be in degrees and decimal minutes. The minutes should have at least three decimals to ensure adequate accuracy. The projection that must be used in all cases is the WGS-84 spheroid in a national or local projection)
Screening Report
A Screening Report generated by the national web-based environmental screening tool, once the tool is operational must be attached to this notification.

4. DETAILS OF LAND OWNER OR PERSON IN CONTROL OF THE LAND (if the proponent is not the owner or person in control of the land)	
Name of individual / company	
Contact	
Passport/ Identity Document (ID)	
Company Registration Number	
Postal address	
Email Address	
Phone No.	
Fax No.	

5. PROJECT DESCRIPTION					
Name of Project					
Tick applicable boxes below					
Petroleum based		Non-Petroleum based		Liquefied Petroleum Gas (LPG)	
Above ground		Below ground			
Tick SANS applicable to facility					
SANS 310 (2011)		SANS 10089 Part 1 (2008)			
SANS 10131 (2004)		SANS 10089 Part 2 (2007)			
SANS 1535 (2007)		SANS 10089 Part 3 (2010)			
SANS 10087 Part 2 (2011)		SANS 10087 Part 3 (2008)			
SANS 10087 Part 4 (2011)		SANS 10087 Part 7 (2011)			
Combined storage capacity of new or expanded tanks/installations(in m^3)					
Combined storage capacity of existing tanks/installations(in m^3)					
Is it a phased activity?			Yes		
			No		
Details of Project:(To be completed only for additional information not covered above)					

The notification of intent to comply has the purpose to clarify whether a proposed project is likely to comply with the Dangerous Goods Standard, 2016 and thus does not include all provisions that the proponent must comply with. It is the proponent's responsibility to ensure that this Standard is complied with in its entirety.

PART C: DECLARATION

This Part consists of the following:

Part C1:	Declaration by proponent
Part C2:	Declaration by new owner and details
Part C3:	Declaration by holder of environmental authorisation superseded by this Standard and details

Note: Please complete only the relevant Part

APPENDIX 2

APPLICABILITY OF SANS TO THIS STANDARD

SANS (including amendments hereto)	SANS TITLE	SCOPE AND RELEVANCE OF SANS FOR THIS STANDARD	FEATURES NOT INCLUDED IN THE SCOPE OF SANS
310 (2011)	Storage Tank facilities for hazardous chemicals – Above ground storage tank facilities for flammable, combustible and non-flammable chemicals	– Above ground facilities; – 80 – 500 cubic metres; – expansion by more than 80 cubic metres but not exceeding 500 cubic metres combined capacity for the facility	Underground facilities
10089 Part 1 (2008)	The Petroleum industry Part 1 (2008): Storage and distribution of petroleum products in above-ground bulk installations	– Above-ground facilities; – 80 – 500 cubic metres; – expansion by more than 80 cubic metres but not exceeding 500 cubic metres combined capacity for the facility; – petroleum products	– Underground facilities – Non-petroleum products – Refineries or exploration facilities
10089 Part 2 (2007)	The Petroleum Industry Part 2 (2007) Electrical and other installations in the distribution and marketing sector	– 80 – 500 cubic metres; – expansion by more than 80 cubic metres but not exceeding 500 cubic metres combined capacity for the facility; – petroleum products	Non petroleum products
10089 Part 3 (2010)	The Petroleum Industry Part 3 (2010): The installation, modification and decommissioning of underground storage tanks, pumps/dispensers and pipework at service stations and consumer installations;	– Underground facilities; – 80-500 cubic metres; – expansion by more than 80 cubic metres but not exceeding 500 cubic metres combined capacity for the facility; – petroleum products (but refer to exclusions)	– Above-ground facilities – non-petroleum products

Appendix I: Extracts of the Guidelines for installation of alternative water systems

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GUIDELINES FOR THE INSTALLATION OF ALTERNATIVE WATER SYSTEMS

Making progress possible. Together.

Groundwater: boreholes, wellpoints and springs

Groundwater comes from below the earth's surface. It is stored in spaces within sub-surface sand/soil and rock formations known as aquifers. DWS defines an aquifer as "a geological formation that has structures or textures that hold water or permit appreciable water movement through them". An aquifer is generally regarded as such when its underground water deposit can yield a usable quantity of water. Aquifers have inert (built-in) storage, which usually stays below the surface.[3]

Springs are groundwater that flows up onto the surface, either throughout the year or for part of the year only. Springs can form an independent watercourse (e.g. a stream) or can flow into an existing watercourse.

Boreholes and wellpoints are holes drilled into the ground to extract groundwater from an aquifer below. A wellpoint provides access to shallow groundwater, while boreholes are drilled at a depth of more than 20 m to extract deeper groundwater.

The quality of groundwater is affected by the geology and land use in the catchment area from where it is fed. Groundwater often contains corrosive minerals that can damage plumbing equipment, and may also cause discolouration if not treated e.g. a rust colour if not de-ionised. In urban areas such as Cape Town, groundwater can also contain pollutants and chemicals from human, commercial and industrial processes and waste, including factory waste, graveyards, informal settlements without plumbed sewage, illegal dumping and sewer pipe leaks. These contaminants may infiltrate and pollute the groundwater below.

If the feeder area is not contaminated, groundwater can be a relatively 'low-risk' source. Yet it is unpredictable, as underground sewer spills or other factors that may not be obvious from above the ground can also affect the quality of groundwater. Treatment of groundwater varies, but often includes deionising or similar methods to remove any metal content.

If managed poorly, groundwater can become contaminated and be depleted by over-extraction. Over-extraction of groundwater can result in the lowering of groundwater levels, which will affect supply to other users, reduce water levels in streams and rivers, and cause other environmental harm such as reducing the functioning of ecosystems and the services they provide.

Groundwater use is subject to licensing under the National Water Act and approval by DWS, being the custodian of groundwater in South Africa. The National Water Act stipulates the licensing needs, which depend on the intended use and quantities abstracted and stored.

[3] If the groundwater level rises sufficiently during the wet season aquifers may however also drain into watercourses above ground.

11

12. CHECKLIST FOR GROUNDWATER SYSTEMS

12.1. Pre-installation

Choosing the right system for your needs.

To create a wellpoint, a high-pressure jet is used to pump water through a steel pipe, pushing it down into the ground. A perforated pipe is placed inside the steel pipe, and the steel pipe is removed. Wellpoints may consist of multiple holes connected to the common suction pipe just below ground level. Wellpoints are smaller, shallower and more economical installations than boreholes and take approximately two to four hours to install. These are suitable for small to medium gardens, in sedimentary sand conditions, and where the groundwater table is relatively close to the surface (not deeper than 10 m if the pump is surface-mounted).

A borehole, on the other hand, is usually a single, larger-diameter hole (100 mm to 250 mm) drilled into the ground at a depth ranging between 15 m and 130 m. Boreholes are drilled by an auger, which sinks a cylindrical hole vertically into the ground through all geological layers, including hard rock and granite, which of course makes it significantly more expensive. Boreholes cost roughly R1 000 for every metre in depth, depending on the depth and extent of hard rock conditions. Installation takes approximately three to five days. The drilling procedure generates excess material that needs to be used elsewhere or be disposed of at a landfill site.

All groundwater installations will vary depending on factors such as your property's location, geology, soil conditions, depth to groundwater, and the nature of your water needs. Springs do not require deep drilling, but will require pumping.

Request a geo-hydrologist, installer or related specialist to assess the property.

They will help determine whether groundwater is present and feasibly available to be drawn from, and whether a wellpoint or borehole will be best. To this end, they will consider the soil conditions and underlying geology, as well as whether wellpoints or boreholes are predominantly being used at other properties in the area.

Estimate the volume of groundwater to be abstracted, and test its quality.

Estimate the total volume of groundwater to be withdrawn every day judging by the type of lawn, trees, plants and crops to be irrigated and/or the scope of indoor use. A water sample must also be taken for testing to determine whether the groundwater has a high iron content and whether the water quality is sufficient for the intended purpose.

Get quotes and appoint a driller.

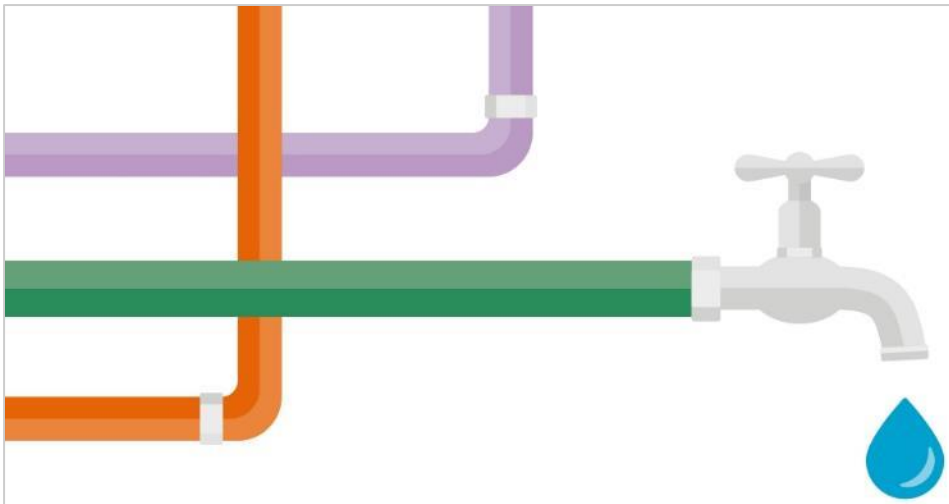
Select your service providers based on factors such as their qualifications, experience, cost estimates and availability. Together with the drilling company, consult the building plans of your house to ensure that the drilling and installation does not take place where underground electrical cables, sewer drainage pipes and water plumbing pipes are situated.

Submit applications to the City and DWS, if necessary (see section 6.2 and 6.3).

Submit a building plan to the City for the authorisation of a water tank, where applicable (see section 6.4).

12.2. Installation

The outdoor and indoor use of groundwater is illustrated on page 53. All the principles and requirements contained in the illustration and the numbered explanatory notes are in line with the City's Water By-law (amended in 2018) and current policy context for the lawful use of groundwater systems.



Additional guidelines

- Ensure that the appropriate colour-coding for alternative water pipes is used (see section 7).
- Ensure that the official signage for the use of alternative systems is displayed on your property (see section 8).
- DWS gazetted a notice on limitations and related matters around borehole, wellpoint and surface water (rivers and streams). This took effect on 12 January 2018 and includes the following requirements:
  - All water sector groups and individuals who abstract surface or groundwater must install electronic water-recording, monitoring or measuring devices. The volumes of water abstracted must be reported to **metering@dws.gov.za** every Monday.
  - Existing groundwater users in the Cape Town catchment area (domestic and industrial) must now abstract 45% less than their average use in the five years from 2010 to 2015.
  - DWS's permission is required to sell or buy borehole or wellpoint water.

12.3. Post-installation

Registration of borehole or wellpoint (see section 6.2).

Borehole or wellpoint signage to be displayed at all times.

Following registration, the City will make available a sign indicating the use of non-drinking wellpoint or borehole water as well as a unique registration number. This must be clearly displayed at all times in the main thoroughfare of your property and at any extraction points such as taps.

Prevention of over-extraction and pollution

Use groundwater sparingly/efficiently. This means using it for only priority essential purposes (e.g. toilet flushing) in times of drought, and in accordance with the restrictions in place at the time. Also comply with DWS's gazetted notice on 12 January 2018 which includes limitations and related matters around borehole, wellpoint and surface water (rivers and streams), which requires that existing groundwater users (domestic and industrial) should abstract 45% less than their average use in the five years from 2010 to 2015. In addition, measures should be taken to prevent any pollution of groundwater.

Regular maintenance of your groundwater system. Cover the pump to protect it from the sun, rain, wind and adverse weather conditions. Ensure that the power supply and components to the borehole or wellpoint pump are kept dry and are not exposed to rain, water, wet conditions or moisture. The non-return valve must be checked frequently to ensure that no solids or sand grains are trapped inside, preventing it from closing fully. During the winter months, when boreholes and wellpoints are used less frequently due to winter rains, the pump must be switched on at least once every one to two weeks and left to run for one to two minutes. Clean nozzles and filters of irrigation sprinklers frequently to prevent clogging.

Note that the national standard SANS 10299 Parts 1 to 9 apply to the maintenance and management of groundwater resources. If tanks are involved, regular disinfection of the storage tank(s) must comply with SANS 10252:1 (as amended).

Appendix J: City of Cape Town's media release on registration and inspection of alternative water systems

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Making progress possible. Together.

CITY OF CAPE TOWN

24 MARCH 2021

MEDIA RELEASE

What residents need to know about registration and inspections of alternative water systems

The City of Cape Town's Water and Sanitation Department is currently running a programme inspecting boreholes and well-points that will continue until the end of June 2021. Compliance requirements are in place to safeguard drinking water quality in the general network, and ensure sustainable use of groundwater. Read more below:

High resolution photos available here: https://bit.ly/3vkspEM

Private boreholes and well-points have become much more common in recent years due to our experience with drought. While groundwater is a useful resource that can be used for a range of purposes, offsetting demand on the drinking water supply, it is important that alternative water supply systems are safely installed. If these water sources are incorrectly connected

to the shared water supply system, it could lead to a negative impact on human health.

'The City thanks residents who tapped into groundwater resources as part of the broader effort to offset reliance on the potable supply during the extreme scarcity during the drought. It is, however, critical that alternative water installations do not contaminate the drinking water supply, and that this finite resource does not become depleted.

'The City is supporting these objectives by conducting city-wide inspections at properties with registered well-points and boreholes, to ensure that alternative water supply systems have been safely installed in accordance with the City's Water By-Laws, SANS codes of practice and the City's guidelines for the installation of alternative water systems. If these installations are not compliant, and/or the correct backflow prevention device has not been installed, it can result in untreated water contaminating the municipal drinking water supply, resulting in water quality incidents and related health risks,' said the City's Mayoral Committee Member for Water and Waste, Alderman Xanthea Limberg.

The National Department of Water and Sanitation (NDWS) is the custodian of groundwater resources, and residents who wish to take water from an underground water resource are advised that National Legislation (the National Water Act) applies. If they are unclear on these regulations, we recommend that they please contact the regional office of the National Department of Water and Sanitation (NDWS) for guidance on applicable authorisations.

The NDWS has gazetted a notice requiring that all borehole and well-point water use is to be metered, and for this information to be submitted to the National Department of Water and Sanitation via metering@dws.gov.za on a regular basis. This will assist DWS in ensuring this water source is used sustainably. The City is not the custodian of the resource and does not have authority to enforce the requirements, but supports regulations that protect this finite resource and the health and safety of residents.
Inspections in terms of City by-laws started in October 2018 and should be completed by the end of June 2021.

'Once the installation has been verified to be compliant by the Water Inspector, he or she will issue the owner with a Certificate of Approval (COA) which is signed by both parties. The original copy will be handed to the homeowner,' said Alderman Limberg.

Homeowners can verify the water inspector's identification and request that the inspector produce his or her City ID card, which includes their contact details as well as the contact details of the Supervisor and/or Manager.

Residents who would like more information on alternative water sources and the rules and regulations which apply are advised to consult the following documents:

- Water By-law at www.capetown.gov.za/waterregulations
- Guidelines for the Installations of Alternative Water Systems
- Summary Guide to Alternative Water Installations
- Risks of Groundwater Quality Pamphlet

End

Issued by: Media Office, City of Cape Town

Media enquiries: Alderman Xanthea Limberg, Mayoral Committee Member for Water and Waste, City of Cape Town, Tel: 021 400 1299 or Cell: 073 271 2054, Email: Xanthea.Limberg@capetown.gov.za (please always copy media.account@capetown.gov.za)

Appendix K: Cape Town's Water Strategy (2019)

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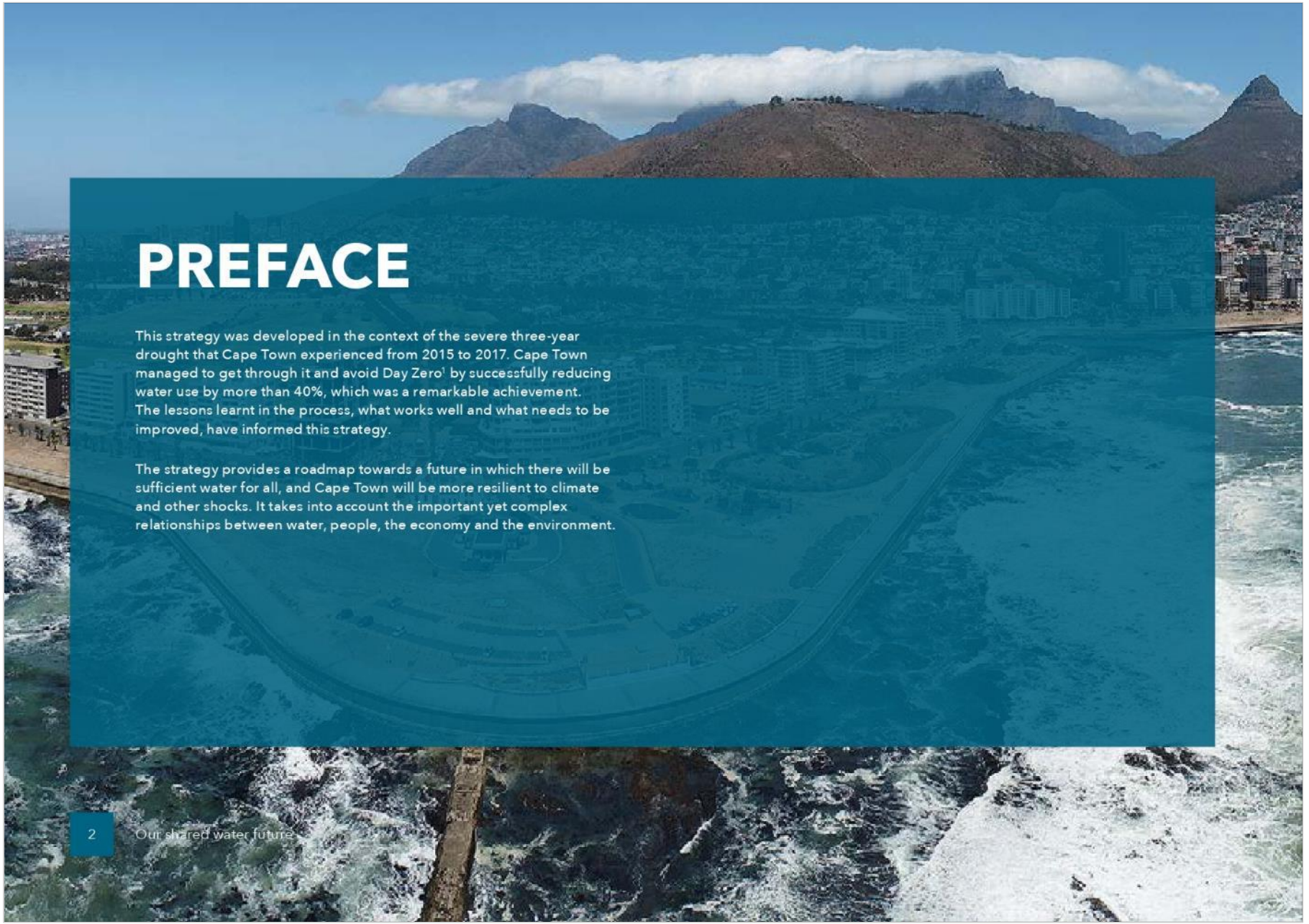


PREFACE

This strategy was developed in the context of the severe three-year drought that Cape Town experienced from 2015 to 2017. Cape Town managed to get through it and avoid Day Zero[1] by successfully reducing water use by more than 40%, which was a remarkable achievement. The lessons learnt in the process, what works well and what needs to be improved, have informed this strategy.

The strategy provides a roadmap towards a future in which there will be sufficient water for all, and Cape Town will be more resilient to climate and other shocks. It takes into account the important yet complex relationships between water, people, the economy and the environment.

SUPPORTING THE LIFE OF THE CITY

Cape Town residents were reminded during the recent drought that water is life and having enough of it makes the city's life possible. Without it, everyone's quality of life is at risk. The City understands that it has a central role to play in ensuring that this fundamental need is met. This strategy puts quality of life for everyone in the city as the first priority. Poverty and poor living conditions are a daily reality for many households in Cape Town. So this strategy also supports poverty reduction and improved living conditions by outlining practical steps to improve the quantity and quality of water and sanitation services provided to all people, particularly those living in informal settlements. Better management of stormwater, rivers and waterways in the city will reduce flood risk. Cost-effective, secure water provision provides an essential foundation for economic growth and job creation.

The effective implementation of the water strategy is necessary to achieve Cape Town's other development goals – undoing the spatial legacy of apartheid, eradicating crime and violence, improving living conditions, and enabling work opportunities.

This strategy can therefore be regarded as both a foundational and enabling strategy for Cape Town and its people.

CLIMATE UNCERTAINTY

Cape Town and surrounds have always experienced a high degree of climate variability and uncertainty. Rainfall patterns are highly variable from one year and one place to the next, and droughts and localised floods are common. Changes in temperature and wind also affect water availability. The development and management of surface water schemes in South Africa take these uncertainties into account. Planning was based on the probability of low rainfall years. Dams and the related systems supplying water to urban areas in South Africa are generally designed to achieve a 98% level of supply assurance. This means that, for any given year, there is a 98% probability that there will be sufficient water to meet demand. This does not mean that water restrictions will be imposed only once in every 50 years, though. The normal operating rules developed for drought conditions are based on the principle that light restrictions should be applied more frequently, and more severe restrictions less frequently. Applying increasingly more severe restrictions enables maximum sustainable abstraction from the system while ensuring that the dams never run empty.

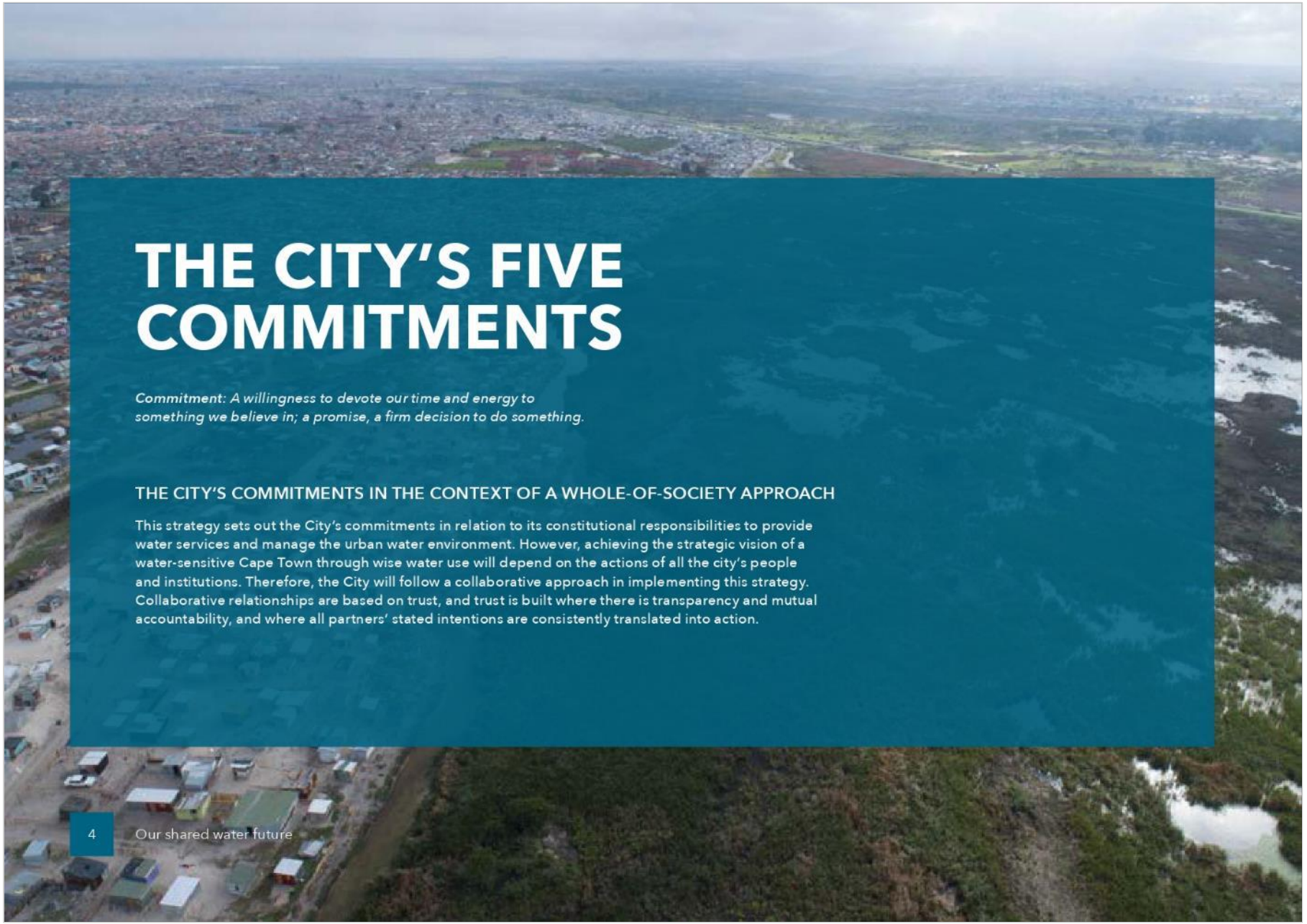
The three-year drought in Cape Town was a 1-in-590-year event based on historical rainfall records. The additional uncertainties associated with climate change now need to be included in future planning, including changes in rainfall, temperature and wind, and a likely increase in the intensity and frequency of extreme weather events. Nobody is able to accurately predict the future climate and water availability, so Cape Town needs to make plans that are robust in the context of this uncertainty.

VISION, PRINCIPLES, COMMITMENTS AND ACTION

This strategy, which is informed by a long-term vision and set of principles, is centred on five core commitments made by the City to the citizens of Cape Town. The fulfilment of these five commitments will result in citizens' needs being met, support being given for improved living conditions and protection of the environment, and will ultimately enable and support a growing economy. The steps necessary to translate the strategy into action are set out in the last section of this document and include the strengthening of institutions, financial resourcing and building trust.

A STRATEGY, NOT A DETAILED PLAN

Many of the comments received on the draft strategy, which was published for public comment in March 2019, requested more details on the City's plans. The City makes use of a number of detailed planning instruments, including its Integrated Development Plan and Water Services Development Plan. Many of these plans are required by law and include the appropriate level of detail on planned investments in terms of the City's budget cycle. This document is not a plan. Instead, it is a high-level strategy document that sets out the City's approach to water, identifies key priorities and articulates a set of core commitments.



THE CITY'S FIVE COMMITMENTS

***Commitment**: A willingness to devote our time and energy to something we believe in; a promise, a firm decision to do something.*

THE CITY'S COMMITMENTS IN THE CONTEXT OF A WHOLE-OF-SOCIETY APPROACH

This strategy sets out the City's commitments in relation to its constitutional responsibilities to provide water services and manage the urban water environment. However, achieving the strategic vision of a water-sensitive Cape Town through wise water use will depend on the actions of all the city's people and institutions. Therefore, the City will follow a collaborative approach in implementing this strategy. Collaborative relationships are based on trust, and trust is built where there is transparency and mutual accountability, and where all partners' stated intentions are consistently translated into action.

1

SAFE ACCESS TO WATER AND SANITATION

The City of Cape Town metropolitan municipality[2] will work hard to provide and facilitate safe access to water and sanitation for all of its residents in terms of well-defined minimum standards. In particular, the City will work with communities in informal settlements and with other stakeholders to improve the daily experience of access to water and sanitation, with an emphasis on building trust and increasing safety within these communities through this process.

2

WISE USE

The City will promote the wise use of water by all water users. This will include promoting water conservation behaviour through (a) pricing water with reference to the cost of providing additional supply, while retaining the commitment to provide a basic amount of water for free for those not able to afford this; (b) revising by-laws and planning requirements, and using other incentives to support water efficiency and the treatment and reuse of water; (c) supporting active citizenship by substantially improving customer management and engagement; and (d) managing the water network effectively to reduce losses and non-revenue water.

3

SUFFICIENT, RELIABLE WATER FROM DIVERSE SOURCES

The City will develop new, diverse supplies of water including groundwater, water reuse and desalinated water, cost effectively and timeously to increase resilience[3] and substantially reduce the likelihood of severe water restrictions in future. The City is committed to increasing supply by building affordable new capacity of approximately 300 million litres per day over the next ten years, and in suitable increments thereafter, in a way that is adaptable and robust to changes in circumstances.

4

SHARED BENEFITS FROM REGIONAL WATER RESOURCES

The City will work with key stakeholders and partners, including other urban and agriculture water users and other spheres of government, to make the most of the opportunities to optimise the economic, social and ecological benefits of regional[4] water resources, and to reduce the risks. The City will do this through collaborative processes.

5

A WATER-SENSITIVE CITY[5]

The City will actively facilitate the transition of Cape Town over time into a water-sensitive city with diverse water resources, diversified infrastructure and one that makes optimal use of stormwater and urban waterways for the purposes of flood control, aquifer recharge, water reuse and recreation, and is based on sound ecological principles. This will be done through new incentives and regulatory mechanisms as well as through the way the City invests in new infrastructure.

COMMITMENT 2:

WISE USE

The City will promote wise water use by all consumers.[16] This will include promoting water conservation by (a) pricing water with reference to the cost of providing additional supply, while retaining the commitment to provide a basic amount of water for free to those who cannot afford to pay; (b) revising by-laws and planning requirements as well as using other incentives to support water efficiency and water treatment and reuse; (c) supporting active citizenship by substantially improving customer management and engagement; and (d) managing the water network effectively to reduce losses and non-revenue water.

When reviewing and implementing regulations and incentives, the City will draw on international best practice and aim for stability and predictability. (See annexure E, "Water conservation and demand management".)

ALTERNATIVE WATER FOR NON-DRINKING PURPOSES

The City will continue to promote the responsible use of rainwater, greywater and groundwater from private borehole and well points for non-drinking purposes. The City will work with relevant authorities and partners to provide guidelines and supportive regulations for this purpose.[24]

SUPPORTING ACTIVE CITIZENSHIP THROUGH CUSTOMER ENGAGEMENT

The City will support active citizenship by substantially improving customer management and engagement.

During the drought, many households were inconvenienced by low pressures and various matters associated with meter reading and water management devices. To assist with water management, and to avoid unaffordable water bills, about 220 000 water management devices have been installed by the City. These devices automatically cut off the water after the daily allocation has been reached. The installation of these devices was accelerated during the drought to households who contravened the water use limits for households – initially 20 kℓ/month and later 10,5 kℓ/month. This, together with a lack of understanding of how the devices worked, and high bills (due to the implementation of drought tariffs), contributed to a high number of complaints to the City. Aggressive pressure management also contributed to no water being available in a few areas, sometimes for several hours, increasing the number of complaints. Response times were therefore slow due to the increased number of complaints.

The City will continue to improve the services it provides and will significantly enhance the customer management function within Cape Town Water, including call response times and the time to resolve complaints and will adhere to a core set of service levels and response times. Changes will be made in the way services are provided and paid for to increase the level of responsibility taken by citizens and to increase citizen engagement. (See "Translating the strategy into action".)

The City will engage with citizens to promote water conservation awareness and develop water-use norms appropriate for a water scarce region. Education programmes at schools are important to ensure that the high level of conservation awareness gained during the drought is maintained and passed on to younger citizens.

Prior to the drought, much drinking water was used inefficiently for swimming pools and watering gardens. The City will work with researchers and specialists to explore new water-efficient technologies and establish guidelines for water-wise irrigation and swimming pools.

EFFECTIVE WATER NETWORK MANAGEMENT

The City will continue to manage and reduce water demand through improved network management, including the establishment of pressure management zones, night-flow monitoring, water leak detection and reducing non-revenue water.

The administration complies with the norms and standards published in terms of sections 9 and 10 of the Water Services Act of 1997, which state that pressure may not exceed 9 bars and that the flow rate must be at least 10 litres per second. The minimum pressure for firefighting must be implemented as prescribed in the National Building Regulations of 1977, or as amended. The onus is on the user to adjust accordingly for higher pressures, as required based on their needs.

Cape Town has a well-managed water network. Before the drought, water losses (a component of non-revenue water[25]) were just 15%, which was much lower than in other South African cities.[26] This was

WHERE DOES CAPE TOWN GET ITS WATER FROM, AND HOW WILL THIS CHANGE?

Cape Town gets almost all of its water from the Western Cape Water Supply System (WCWSS). This is an integrated system providing water for both urban and agricultural use. In a "normal" year, Cape Town uses about 60% of the available water, and agriculture uses about 30%.

Supply to Cape Town is dominated by surface water sources. The bulk of the water supplied in the supply area is from surface water sources, which rely on winter rains. Rainfall varies significantly across the area and between years.

The surface water system comprises six large dams and a number of smaller ones. The City owns three of the six large dams. The other dams are owned by National Government. Total storage of the six large dams is approximately 900 million kilolitres.

The WCWSS is managed by the national Department of Water and Sanitation (DWS) in partnership with the City. DWS is responsible for water resources regulation (making allocations and monitoring abstraction) as well as for water resources planning. DWS and the City jointly manage the operation of the complex, interconnected system of dams, pipelines, tunnels and related infrastructure.

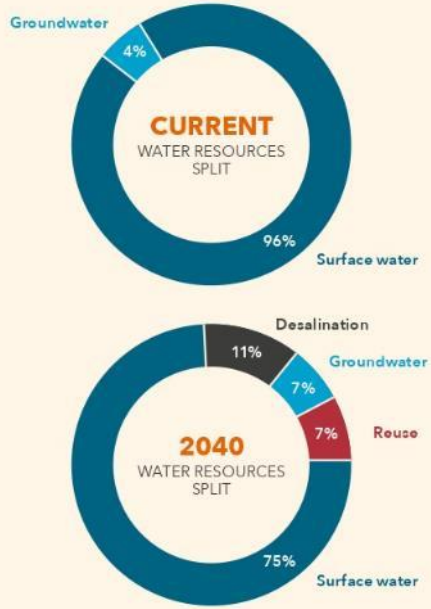
A WCWSS water resource reconciliation study was completed in 2007. The study explored future water demand and supply, and proposed interventions to ensure that supply exceeds demand. DWS produces regular status updates, of which the most recent was in 2016. (The 2018 update is in progress.)

An annual operating analysis informs operating rules and restrictions. The hydrological year ends on 30 October, when DWS, in consultation with water users, makes a decision on operating rules for the system for the hydrological year ahead.

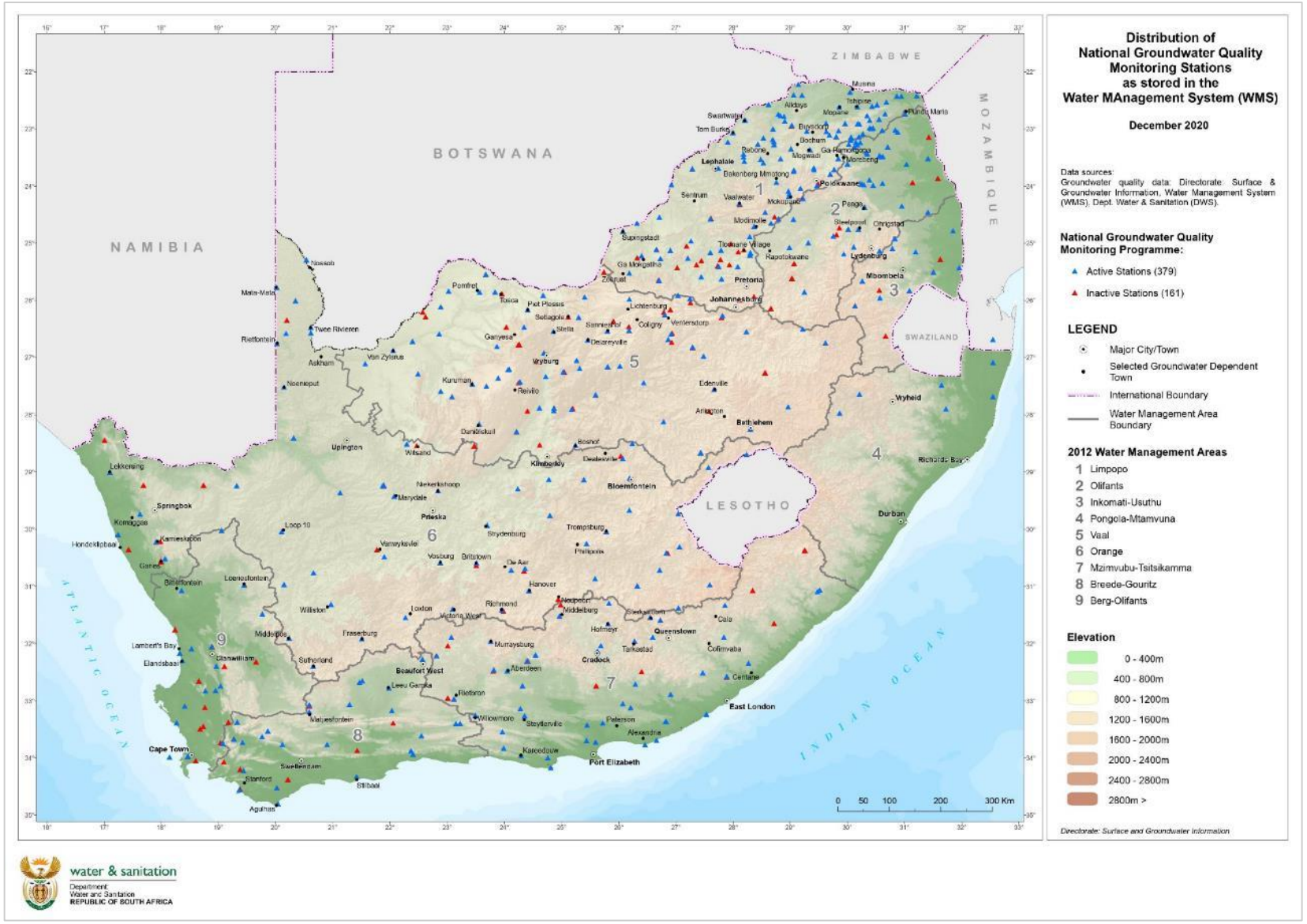
The WCWSS steering committee makes recommendations. The committee, which comprises water users, meets annually to review the status (and other) reports submitted and make recommendations on interventions, including new supply schemes.

Additional supply was planned for 2022. At the time of drafting this strategy, the next water augmentation scheme was the Lower Berg River augmentation scheme. The scheme would add 23 million cubic metres per year into the WCWSS and was due for completion in 2022 (Status Report May 2016).

FIGURE 6: HOW CAPE TOWN'S WATER SUPPLY SYSTEM WILL CHANGE



Appendix L: National Groundwater Quality Monitoring Project (2020)



Appendix M: Worksheet developed for document analysis

Research question 1		
What regulatory conditions are in place for the development of fuel stations and the control of their environmental impacts on groundwater?		
DOCUMENT SELECTED	**PART/CHAPTER/SECTION**	**DATA ANALYSED**
Constitution		
NEMA		
EIA Regulations, 2014		
NEMWA		
National Water Act		
National Water Service		
Cape Town Water By-Laws, 2018		
Western Cape Land Use Planning Act, 2014		
Municipal Planning By-Laws, 2015		
SANS Codes		

Research question 2		
What requirements are in place for the protection of boreholes in areas adjacent to petrol stations?		
DOCUMENT SELECTED	**PART/CHAPTER/SECTION**	**DATA ANALYSED**
Constitution		
NEMA		
EIA Regulations, 2014		
NEMWA		
National Water Act		
National Water Service		
Cape Town Water By-Laws, 2018		
Western Cape Land Use Planning Act, 2014		
Municipal Planning By-Laws, 2015		
SANS Codes		

Research question 2		
What approach is applied in the legal framework regulating the risks and impact of groundwater contamination posed by fuel stations?		
DOCUMENT SELECTED	**PART/CHAPTER/SECTION**	**DATA ANALYSED**
Constitution		
NEMA		
EIA Regulations, 2014		
NEMWA		
National Water Act		
National Water Service		
Cape Town Water By-Laws, 2018		
Western Cape Land Use Planning Act, 2014		
Municipal Planning By-Laws, 2015		
SANS Codes		