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A Critical Assessment of the Causes and Impacts of Water Pollution- the case of the Vaal River in Emfuleni Local Municipality

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A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Masters of Science Development Planning.

April 2020

Declaration

I, Kholiswa Xaba, declare that this research report is my own unaided work except where acknowledged. It is submitted for the degree of Master of Science Development Planning at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.



Signature of candidate

On the 4th day of December 2020

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Abstract

South Africa is confronted with the challenge of increasing pollution levels and deterioration of its surface water resources, especially rivers, due to anthropogenic activities associated with rapid population growth and urbanisation. The Vaal River is one of the most polluted rivers in South Africa as a result of, *inter alia*, inadequately treated industrial effluent, wastewater from dysfunctional sanitation infrastructure, acid mine drainage and agricultural activities. This is of grave concern because of South Africa's semi- arid nature and water scarcity. Although the impacts are evidently detrimental to the ecology, economic development and social aspects such as human health and quality of life, the pollution crisis remains unsolved. This study is a critical assessment of the causes and impacts of water pollution of the Vaal River in Emfuleni Local Municipality. Data was collected using secondary resources such as academic literature and government publications, among other sources. Additionally, semi- structured interviews with Officials involved in the water and sanitation sector, as well as environmental management in Emfuleni were conducted with the aim of understanding the causes and impacts of the Vaal River pollution. The findings of this study suggest that sewage spillage from dilapidated sanitation infrastructure is the main cause of the Vaal River pollution in Emfuleni Local Municipality. Additionally, the study suggests that institutional challenges such as, *inter alia*, capacity constraints, poor leadership and noncompliance to regulatory requirements underlie the on-going sewage pollution in the Vaal River in Emfuleni.

Keywords: Water pollution, Vaal River, Emfuleni Local Municipality, sewage spillage, institutional capacity, SANDF, sustainability

List of abbreviations and acronyms

Colony Forming Units (CFU)

Construction Industry Development Board (CIDB)

Council for Scientific and Industrial Research (CSIR)

Department of Planning, Monitoring and Evaluation (DPME)

Department of Water Affairs (DWA)

Department of Water and Sanitation (DWS)

Emfuleni Local Municipality (ELM)

Ekurhuleni Wastewater Treatment Works (ERWAT)

Integrated Development Planning (IDP)

Integrated Water Resources Management (IWRM)

Gauteng Department of Agriculture and Rural Development (GDARD)

National Qualifications Framework (NQF)

Primary Settling Tank (PST).

Save the Vaal Environment (SAVE)

South African Human Rights Commission (SAHRC)

South African National Defence Force (SANDF)

Spatial Development Framework (SDF)

Sustainable Development Goals

United Nations (UN)

Wastewater Quality Management Regulation (WQMR)

Water Services Provider (WSP)/Water Services Authority (WSA)

World Health Organisation (WHO)

World Wide Fund of South Africa (WWF-SA)

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CHAPTER ONE

Introduction and background to the study

1. Introduction

1.1. Background

Water is an essential resource on which all life depends. Not only is water a basic need for survival, its availability and quality are fundamental in the production of food, energy, support of economic activities, developmental and other societal needs (van der Merwe-Botha, 2009, Halder and Islam, 2015). However, the overexploitation of water for socio-economic activities such as, *inter alia*, industrial production, energy, agriculture and urban development has resulted in increasing pollution of surface water resources (Delpla, et al., 2009). Likewise, Gauteng Department of Agriculture and Rural Development (2017) in the Gauteng State of the Environmental Report (SOER), argues that there is growing concern about the deteriorating quality of surface water resources in Gauteng, especially rivers, due to rapid population growth, commercial activity and urbanisation pressure. The pollution of water resources has negative impacts on socio-economic development and human health, as well as serious implications for water security (WWF-SA, 2016; Nkonya (2008).

The Department of Water Affairs and Forestry (2004) and Gauteng Department of Agriculture and Rural Development (GDARD) (2017) state that the Vaal River is a water resource in South Africa whose function is fundamental for natural ecosystems and socio-economic activities in the five provinces through which it runs. The continuous pollution and deteriorating state of the Vaal River is course for concern. Therefore, it is pivotal that relevant institutions and all affected parties collaborate to ensure that the Vaal River and other surface water resources are protected from pollution and any kind of degradation. Similarly, Nkonya (2008) emphasises the need to manage water resources sustainably in order to address water scarcity in Sub- Saharan Africa. The right to access safe water and the requirement to protect, conserve, manage and sustainably use water is stipulated in the Constitution of South Africa (Act 108 of 1996) and relevant legislation such as the National Environmental Management Act (Act 107 of 1998) and National Water Act (Act 36 of 1998).

This report critically assesses the causes and impacts of the Vaal River pollution in Emfuleni Local Municipality.

1.2. Problem statement

Water is a scarce resource in South Africa due to erratic rainfall patterns and overexploitation of water resources for development needs (CSIR, 2010; GDARD, 2017; DWS, 2018). The continuous deteriorating water quality of the Vaal River due to pollution threatens the sustainability of the river's ecosystem. Additionally, it carries serious implications for socio-economic development in Emfuleni, Gauteng and South Africa. Water pollution in the Vaal River has reached crisis. This environmental disaster has become a health risk to human and aquatic life as eutrophication and E. coli levels increase (Halder and Islam, 2015; South African Human Rights Council, 2018). Additionally, the deterioration of the quality of the river presents detrimental impacts on Emfuleni's economy and resident's quality of life.

1.3. Research aim

The main aim of this research is to identify the main causes and impacts of the ongoing water pollution problem of the Vaal River in Emfuleni Local Municipality.

1.4. Rationale

The deterioration of water quality in the Vaal River is of grave concern. This study is informed by concerns of the increasing levels of pollution in the Vaal River in the Emfuleni Local Municipality. While there has been great focus on the causes and impacts of water pollution, little evidence exists on the critical assessment of water pollution beyond the known natural and anthropogenic factors such as population climate change and growth and urbanisation pressure, respectively. Thus, this research also interrogates the institutional challenges as contributing factors to the continuous of the Vaal River pollution in Emfuleni Local Municipality.

1.5. Objectives

- To determine the main causes of the pollution of the Vaal River in Emfuleni Local Municipality and associated impacts

- To investigate the institutional response to the water pollution crisis

- To create awareness of the implications of the deteriorating water quality for the Vaal River and Emfuleni
- To emphasise the need for protection and sustainable use of the Vaal River
- To explore the efficacy of relevant legislation

1.6. Research questions

This study is intended to answer the following questions:

What are the main causes and impacts of the Vaal River water pollution in Emfuleni Local Municipality?

1.6.1. Sub-questions

- What are the underlying issues for the persistent pollution of affecting the Vaal River in Emfuleni?
- How has the pollution of the Vaal River affected the Emfuleni's environment?
- What is the legislative framework for guarding water resources and the environment in Emfuleni?
- What are the measures taken by relevant institutions to address the pollution crisis?

1.7. Conceptual framework

Having reviewed the literature relevant to the study, key concepts have been identified as the theoretical framework of the study.

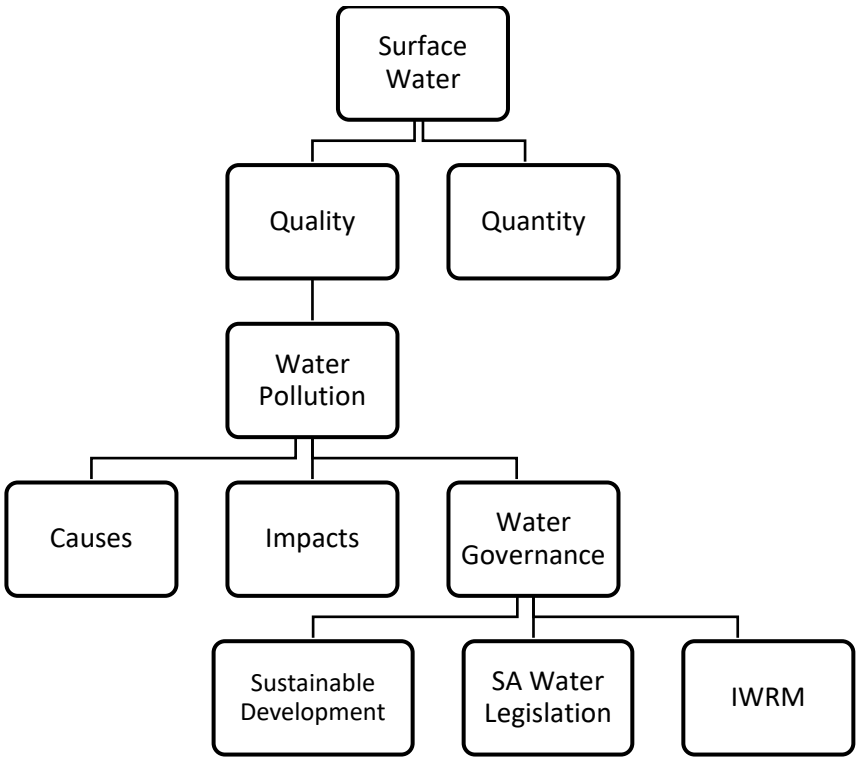


Figure 1.1: Research conceptual framework

1.7.1. Conceptual framework outline

This diagram (Figure 1.1.) highlights the key concepts of this study. Although these concepts are explained in chapter 2, it is important to provide a brief outline of the conceptual framework. Surface water is freshwater that is in liquid phase and found above the earth's surface. It is stored in rivers and lakes among other water bodies (Du Plessis, 2017). Surface water quantity is the amount of water available in a specific geographic area while water quality is concerned with the condition of the available water and its suitability for consumption. Water pollution is the contamination of water which results in the water being unfit or unsafe for consumption and use. Water pollution causes are factors that contribute to the pollution which could be anthropogenic or natural. Impacts, on the other hand, are the resultant conditions or changes in the environment, whether positive or negative, due to pollution. Water governance includes systems, structures and laws that govern water use, protection or management. Sustainable development in this case is about the management, protection and preservation of water resources for the benefit of present and future generations. The South African water legislation comprises among others the Constitution of South Africa (Act 108 of 1996) and the National Water Act (Act 36 of 1998). Integrated Water Resources Management is a holistic approach used for the coordination, development and management water, land and natural resources so that an equitable and sustainable environment comprising natural, economic and social welfare is achieved (Mitchell, 2005).1.8. Methodology

The research method best fitting this study is the qualitative research method. Creswell (2009) identifies features that should underlie qualitative studies. First, he asserts that the

researcher is required to gather data by studying various literature sources and interview relevant participants amongst other activities, and ultimately analyse and interpret the data (ibid). This statement applies to this study since I collected secondary data in the form of academic literature, government and independent sector reports as well as media reports. I conducted face-to-face interviews with identified experts in the water and environmental sectors in Emfuleni Local Municipality. Additionally, a Non- governmental organisation (NGO) was selected for an interview in order to get an independent source's perspective on the Vaal River pollution crisis. Second, Creswell (2009) emphasises the need for the researcher to conduct the study or interviews in a setting to which the participant is familiar and has the first-hand experience on the issue they are interviewed. This statement supports the decision to interview experts based or involved in the water sector in Emfuleni Local Municipality in terms of water provision, water use and protection as they understand better the causes and implications of the pollution crisis in the area. To understand the research problem and context, the study employs the explanatory case study approach. Yin (1994:13) posits that a case study is an "empirical inquiry that investigates contemporary phenomenon within its real-life context". The case study for this research is the Vaal River within Emfuleni Local Municipality.

1.9. Data collection

Researchers doing a qualitative study ought to engage multiple sources of data in order to analyse and produce integrated information (Creswell, 2009). I engaged both primary and secondary data sources for this study. Primary data was sourced from Officials or Experts from water institutions and the ELM Environmental Management Department. Creswell (2009:178) contends that qualitative research methods promote the 'careful and intentional selection of the study area and participants with the aim to understand the problem and research question'. In agreement with this statement, I selected a purposive sample since the study seeks to understand the role and involvement of the Officials in the case study (Vaal River within Emfuleni Local Municipality) as key stakeholders. I selected these Officials because I was looking for first-hand information and for informed discussion with participants that understood the depth of the problem, causes and impacts, as well as relevant institutional structures among other aspects.

The data collection method from primary sources was through semi- structured interviews. The semi-structured interviews allowed for flexibility and in-depth engagement. I interviewed three Officials from Rand Water (Anonymous Official 1), Metsi-a-Lekoa under Emfuleni Local Municipality (Anonymous Official 2) and Emfuleni Local Municipality's Environmental Management Department (Anonymous Official 3). Due to time constraints, I only managed to conduct two face-to-face interviews with Anonymous Official 1 and Anonymous Official 2 by verbally asking questions compiled in the semi- structured questionnaire. Anonymous Official 3 was sent the questionnaire by email due to their delayed response to the invite and busy schedule. Prior to the interview, I ensured that Officials understood the ethics consideration of the study, read and understood participant information sheet and Participant Consent Forms. I had also identified and selected a local Non- governmental organisationSave the Vaal Environment (SAVE) based on its role and knowledge of local environmental issues particularly the Vaal River pollution and its advocacy of environmental protection. Unfortunately, I could not secure an interview with the NGO after numerous attempts of contacting the organisation. Consequently, I used data found in the NGO's website, published articles and media interviews to answer the questions I had drafted. Therefore, this became a limitation as some of the questions were not answered to my satisfaction.

Additionally, I engaged secondary data sources namely academic literature and grey literature. The literature comprised books and journal articles, as well as government publications and media reports, respectively. Secondary data sources contributed greatly to the discussion of key concepts, debates and as evidence of the pollution problem. Lastly, although this was not planned, Anonymous Official 2 afforded me the opportunity to visit three pump stations which are owned by Emfuleni Local Municipality and managed by Emfuleni's water and sanitation unit; Metsi- a- Lekoa. The visits provided me with first-hand experience of the state of the Emfuleni's water and sanitation infrastructure and its contribution to the water pollution crisis. I took photographs as evidence and to strengthen my research findings and analysis.

1.10. Research limitations

The limitations of this study include the inadequacy of available data relating to the Vaal River pollution within the area of Emfuleni, especially during interviews with Officials. There

might have been withholding of fundamental information due to the Officials' fear of implicating themselves or revealing confidential information. Getting a hold of and securing interview appointments with identified Officials was another challenge encountered during data collection. For example, I could not conduct a face-to-face interview with Official 3 because they responded in December 2019. Likewise, I could not reach the NGO which resulted in the interview not happening. As a result, this limited the desired outcome and findings of this research. Another limitation was identifying fewer Officials. Perhaps selecting more Officials to interview from other ELM departments such as Local Economic Development (LED) and experts in property valuation to understand impacts on riverfront properties for example, would have improved my study's findings. Additionally, the study does not provide a measurement method of impacts and consequently lacks in-depth discussion on the impacts of water pollution of the Vaal River in Emfuleni.

1.11. Ethical considerations

Ethical issues are a crucial part of research. The researcher has an obligation to ensure that they do not infringe a participant's privacy, culture and social norms (Simon, 2006). Therefore, I will ensure the confidentiality of the information collected through interviews. Keeping the participants anonymous is of paramount importance because the study intends to understand the problem through the participants' perspective. This will be done by using pseudo names to identify participants, not sharing data with other parties, as well as keeping the data safe where no one else but the researcher can access. I have completed and signed the Ethics form binding me to adhere to the University's Ethics protocols.

1.12. Conclusion

This chapter provided the background of the research report. It gave an outline of the problem, objectives, research methodology and conceptual framework among other important components. The following chapter and focuses on the fundamental concepts and debates relating to surface water pollution.

CHAPTER TWO: Literature review

Understanding surface water pollution

2. 1. Introduction

Pollution is an environmental phenomenon which has resulted in the destruction of water resources. This is of great concern because of the life-sustaining and socio-economic roles water resources play. First, this chapter explores secondary data sources in order to determine the state of water resources in terms of quantity and quality in both the international and local contexts. Second, it focuses on the causes and impacts of water pollution. Lastly, the statutory institutions, the legislative framework of water resources management and pollution are discussed.

2.2. Surface water from the international context

Water is an essential resource on which all life depends. Du Plessis (2017) argues that water covers nearly 75% of the Earth. Of this 75%, only 0.3 percent is surface water (Du Plessis, 2017) (see figure 2.1). According to the World Wide Fund of South Africa (WWF-SA) (2016) and Nkonya (2008), surface water consists of rivers, lakes, natural ponds and artificial reservoirs. Of the 0.3 per cent surface water, only 2.8 percent is available for human consumption (Igwe et al., 2017). This indicates the insufficiency of freshwater for human consumption.

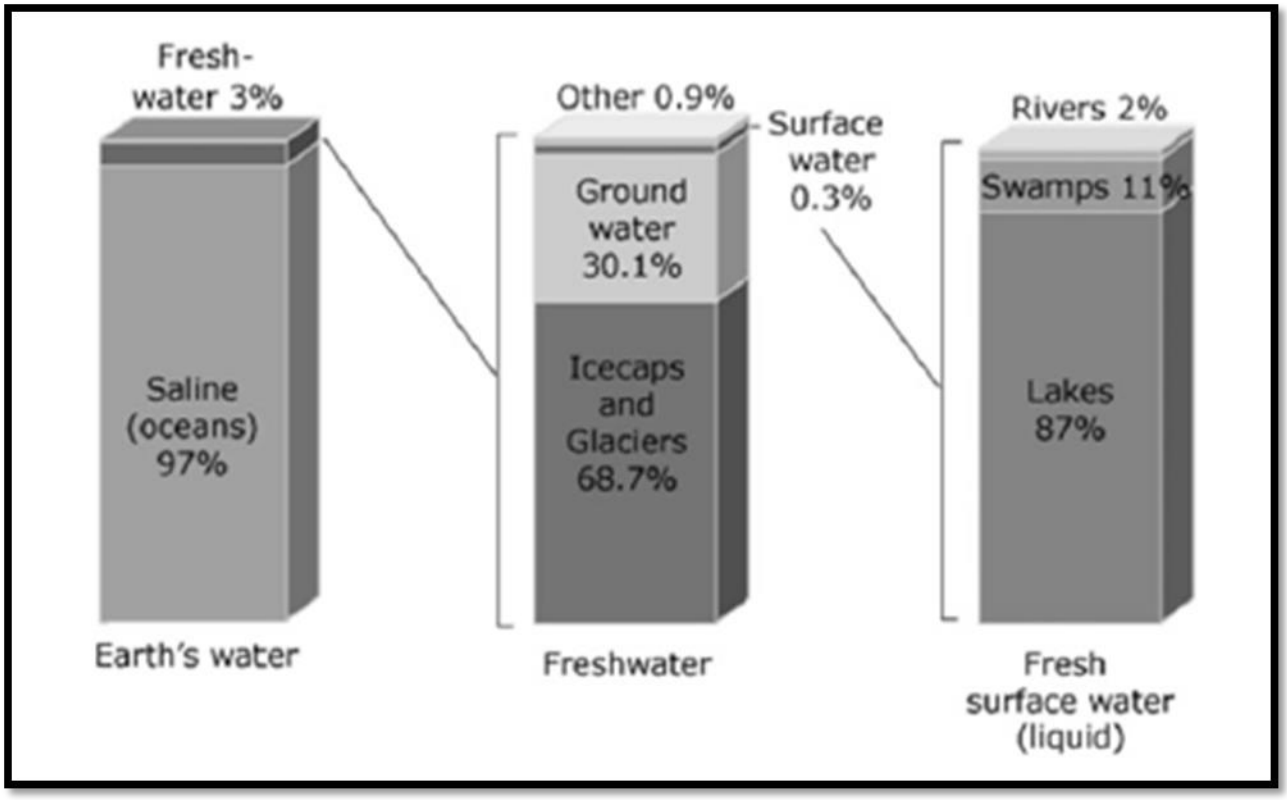


Figure 2.1 Global water availability (source: Du Plessis, 2018)

The lack of surface water availability for human consumption is also evident in its uneven distribution across the globe. Du Plessis (2017) and Igwe et al (2017) posit that the North American region has adequate surface water, while the Middle East and Africa are water-scarce regions. The distribution of water is influenced by natural processes such as climate change and anthropogenic factors such as water-intensive economic activities. Climate change processes and anthropogenic factors alter ecosystems and, as a result, negatively affect the hydrological cycle (Du Plessis, 2017) (see figure 2.2). This is exacerbated by the demand for water which exceeds supply due to rapid urbanization, especially in developing countries (ibid). According to Igwe et al. (2017) freshwater resources demand increased six fold between 1900 and 1995. This statement emphasises the interrelation between urbanization and water demand.

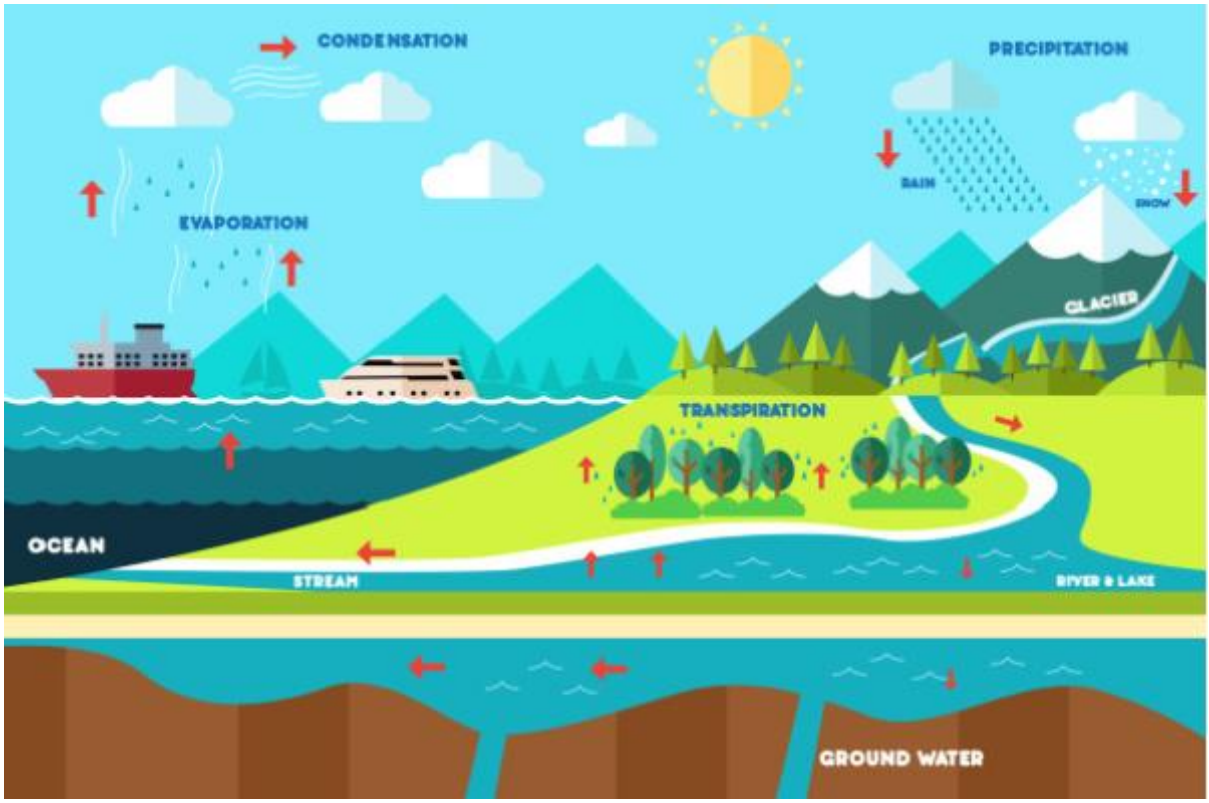


Figure 2.2: The hydrological cycle (source: Inglezakis et al., 2016)

Surface freshwater is essential for a number of uses which can be grouped into ecological, economic and social uses (Chen, 2017). In terms of ecological use, surface water supports the functioning of ecosystems (Du Plessis, 2017). Surface freshwater essentially absorbs wastes disposed of in these resources (DWSb, 2016). Most importantly, poor communities, mainly in developing countries rely on surface water such as rivers for domestic use. For example, more than three-quarters of the Sudanese population and 40 percent of the Nigerian population directly source domestic water from surface watercourses such as rivers (Igwe et al., 2017). Surface water also supports socio-economic activities such as agriculture, industry including energy generation, as well as recreation (ibid; Du Plessis, 2017). All these uses can have detrimental impacts on water quality, availability and human health, if they are not regulated and monitored (Igwe et al., 2017; Du Plessis, 2017). Du Plessis (2017) writes that water use for economic activities or development is often in conflict with the role of water as a life supporter and for health human. First, the conflict emerges when the already scarce resource is prioritized for economic activities or becomes inaccessible due to high costs. Second, overexploitation of surface water sources may result in the deterioration of water quality or depletion of the resource (Du Plessis, 2017).

Pollution is one of the most common environmental challenges facing both developed and developing countries. According to the national environmental quality standards of China, pollution levels in Chinese rivers are below the acceptable standard of surface water quality (Chen, 2017). Consequently, most rivers in Guangzhou have reached a point of dysfunction and are no longer fit for human consumption (ibid). The main causes of water pollution in China are, *inter alia*, effluent from industries and domestic waste from homes located next to the rivers (Bhuiyan et al., 2013).

2.3. Surface water from the South African context

South Africa (hereunder referred to as 'the country') is a water-scarce country due to erratic rainfall patterns and overexploitation of water resources for development needs (CSIR, 2010; GDARD, 2017; DWS, 2018). The Department of Water and Sanitation (DWS) (2016b) and Gauteng Department of Agriculture and Rural Development (GDARD) (2017) state South Africa's surface water quality, especially in rivers, is deteriorating as a result of pollution and poor water management. A number of factors contribute to this challenge. These factors encompass acid mine drainage (AMD), inefficient and poorly managed sewage systems, dysfunctional infrastructure and untreated waste discharged into the nearest surface watercourses specifically rivers (CSIR, 2010; DWS, 2016b; GDARD, 2017). O'Keeffe (1989) argues that in order to maintain good health and well-being of humans and ecosystems, there must be sufficient supply of water and quality that is suitable and of acceptable standards for human use and socio-economic development. Therefore, the following section discusses the quantity and quality of water resources in order to determine the state of water in South Africa.

2.3.1. Water availability in South Africa

Water availability is of great concern in South Africa due to its scarcity. The semi-arid nature of the country is attributed to the amount of rainfall it receives annually (497mm) which is just under 60 percent below the global average of 860mm (Du Plessis, 2017). This situation is exacerbated by numerous factors including climate change, alterations of the environment primarily due to the need for development, as well as inefficient water management (GDARD, 2017; Inyinbor et al., 2018). Furthermore, there is a growing concern of increasing water demand in water-scarce areas such as Gauteng (GDARD, 2017). It is

projected that water issues will worsen in the coming decade as a result of rapid population growth in areas of water stress (Inyinbor et al., 2018).

2.3.2. Water quality in South Africa

Water quality describes the 'physical, chemical, biological and aesthetic properties of water that determine its fitness for a variety of uses and for the protection of the health and integrity of aquatic ecosystems' (DWS, 2016a:2). The normal composition of water resources consists of living organisms, natural physical and chemical substances which sustain biogeochemical cycles (Du Plessis, 2017). Even though naturally occurring, these substances may contribute to the deterioration of water quality (ibid). Degradation of the quality of the water compromises its availability in that specific area (O'Keeffe, 1989). This shows the interrelation between water quality and availability. Degraded surface water cannot serve its life and economic support function since it requires clean water (Du Plessis, 2017). The following section discusses water pollution, its causes and impacts.

2.4. Water pollution in South African rivers

Water pollution is the undesirable presence of hazardous chemicals and other biological substances which surpass the acceptable natural properties of a watercourse (Du Plessis, 2017; Bhuiyan, 2013; Owa, 2014). These substances have detrimental effects on the functioning of ecological systems, human health and the socio-economic aspects of life (ibid). The following points discuss the two types of water pollution causes consisting of point source pollution and non- point source pollution, as well as the water pollution impacts.

2.4.1. Point source pollution

Point source pollution comes from a single source which can be identified when it enters the watercourse (Du Plessis, 2017; Kumar et al., 2012). The easy identification of a point source enables the relevant water institutions to effectively manage the pollution by controlling water use and granting licenses to industries and other for permissible water use (Du Plessis, 2017). However, the increasing pollution levels and deteriorating water quality is indicative of the failure of relevant institutions to manage the pollution. The main point sources of pollution include acid mine drainage, raw sewage and other industrial wastes intentionally discharged into surface water resources (DWS, 2016a; Owa, 2014). The latter

sources carry chemicals such as metals which are harmful for aquatic health, especially fish (Owa, 2014). Additionally, Mishra et al. (2017) argue that the increasing amount of wastewater found in rivers in the Global South is a result of the burden of urban population growth and industrialisation.

2.4.2. Non- point source pollution

Non- point or diffuse source pollution is rather intricate because it enters the water from unidentified sources (Kumar et al., 2012; GDARD, 2017). Non- point source pollution is not easily identified, planned or controlled (Du Plessis, 2017). This is evident by the high level of nutrients and hydrocarbons from fertilisers and wastewater leaching from agricultural land and overflowing municipal treatment plants present in rivers (GDARD, 2017; Kumar et al., 2012). Furthermore, non-point sources may not have an immediate impact on a water source but the impact becomes greater in the long-term as pollution accumulates. In addition to point source pollution and non- point source pollution, Mishra et al. (2017) argue that water pollution causes include, among others, dilapidated wastewater infrastructure, non- compliance with legal requirements for management of surface water resources as well as inadequate regulations and control. These water pollution causes need urgent attention because they may become the biggest threat to the quality of surface water resources if they are not acknowledged or addressed.

2.5. Impacts of water pollution in surface water

The impacts of water pollution are grouped into three interlinked categories namely ecological impacts, economic impacts and social/health impacts (Frost and Sullivan, 2010) (see figure 2.3).

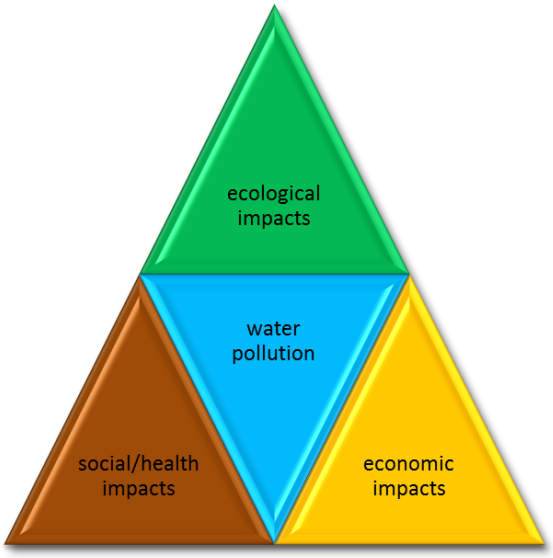


Figure 2.3: Interlinked relationship between water pollution impacts (source: adapted from Frost and Sullivan, 2010).

2.5.1. Ecological impacts of water pollution

The degradation of water quality, especially through processes such as eutrophication, negatively affects the natural ecological composition, its function, biodiversity, as well as the aesthetic and recreational value (Du Plessis, 2017; DWS, 2016a). The destruction of the ecosystems affects the ability of the water to maintain its life-supporting role and its role as an economic resource (DWS, 2016). Ecological impacts are inextricably linked to economic and social impacts. For example, the presence of microscopic algae coupled with odour-causing compounds in surface water, especially rivers, negatively affects the social and economic aspects of recreation and water sports (DWS, 2016a). Water pollution impacts associated with climate change include, *inter alia*, increased volume of sediments and contaminants (Grobler et al., 1987; DWS, 2016a). These contaminants are introduced to surface water resources as a result of increased runoff due to frequent rainfall which may cause changes in water transparency. Moreover, heavy rainfall corrodes catchments which enable effluents from agricultural land, industries, and municipal sewage treatment plants to easily enter water courses (DWS, 2016a). The bacteriological impact associated with solid waste is also important to note, especially bacteria and viruses found in disposable nappies, medical wastes, animal carcasses that are present as solid waste in surface water resources (ibid).

Organic pollutants and decomposed solid waste result in reduced oxygen content of aquatic ecosystem affect the solubility of trace metals and nutrients and consequently kill aquatic life (DWS, 2016; Du Plessis, 2017). Acid mine drainage is also of grave concern in South Africa's surface water resources because it lowers the pH which triggers the distribution of elements such as sulphate and mercury (Du Plessis, 2016). This poses a threat to aquatic life, human health and economic sectors, especially those dependent on water resources (ibid). Additionally, litter and solid waste contribute to reduced aesthetic value of water resources (Tempelhoff, 2009b; DWS, 2016).

2.5.2. Social/health impacts of water pollution

Pollution infringes on the basic human right of access to adequate and clean water (DWS, 2016; RSA, 1996). Contaminated water is a health risk to human life, contributes to poverty and threatens economic development at different scales (Nkonya, 2008; Igwe et al., 2017). These impacts may occur directly when a surface water resource is the main source of drinking water and indirectly when aquatic species are consumed (ibid). Communities who are exposed to feacal pollution due to, for instance, presence of untreated sewage in surface water are vulnerable to waterborne diseases such as cholera and typhoid fever and, reproductive health problems (DWAF, 1996; CSIR, 2010; Owa, 2014; Igwe et al., 2017; UNEP, 2016). A UNICEF report cited in (UNEP, 2016) states that the world records approximately 3.4 million water-borne related mortalities annually. Similarly, DWS (2016) writes that diarrhea is responsible for about 10 percent of child mortality of children under the age of five in the country.

These figures reflect a serious implication of the water pollution for society. Negative impacts on human health have serious implications for economic development. For example, the 2008 cholera outbreak in Limpopo resulted in approximately R3.5 billion spent by the government to fight the spread of waterborne diseases (DWS, 2016). While some impacts of water pollution are easily identified, some impacts are not obvious and may take a long time to be identified. These impacts accumulate and eventually result in the degradation of the environment particularly surface water resources (Mishra et al., 2017; DWS, 2016a). Additionally, pollution of water used for recreational purposes is detrimental to local the economy as users might seek alternative venues for leisure and water sports to avoid exposure to waterborne diseases from polluted water (Tempelhoff, 2009a).

2.5.3. Economic impacts of water pollution

The degradation of surface water ecosystems has undesirable impacts on economic development. Water pollution has direct and indirect impacts on water-intensive economic sectors including, among others, agriculture and manufacturing (DWS, 2016b). One of the serious economic impacts of degraded surface water resources is the high cost of water treatment to ensure that water is safe for human consumption (Mishra et al., 2017). Likewise, the clearing of unwanted waste or overgrown aquatic biota such as macrophyte biomass can amount to millions of Rands (DWS, 2016b). This is not ideal for South Africa's developing economy. For example, in 2010, the United Association of South Africa (UASA) conducted an economic impact study of water pollution in South Africa. The study found that the deteriorating 'quality of water and consequently its usability may result in the loss of 200,000 jobs and an increase of R18, 1 billion in government spending' (DWS, 2016b:4). Moreover, the burden of water treatment for domestic purposes by water service providers and local government may cause services rate hikes which could negatively impact local communities that are already faced with numerous socio-economic challenges such as the high unemployment rate and low average household income (ibid). Consequently, this affects the ability of local government to provide basic services if communities are not paying for services.

Pollution decreases the aesthetic value of water to be used for recreational activities such as water sports, fishing and general leisure which has a negative impact on the tourism sector (DWS, 2016a). Eventually, these economic impacts usually at micro-level scale accumulate and have a serious impact on the macro level especially on the Gross Domestic Product (GDP) of the country (ibid). Having discussed the impacts of surface water pollution, it is important to assess applicable governance for water and environmental management to determine if it is adequate to address the pollution problem.

2.6. Governance and institutional aspect

Governance in this context is about water governance. According to Hoekstra (2006:9) water governance encompasses 'political, social, economic and administrative systems that are in place to manage water resources and the delivery of water services at different levels of South Africa'. There are three dimensions of governance namely environmental, economic and socio-political dimensions Agnew and Woodhouse (2011) (see figure 2.4).

This section will provide a brief background of the international political agenda with regard to water and environmental management. It also explores the South African legislative framework applicable to water resources and environmental management as a measure to guard and control the development and use of water resources.

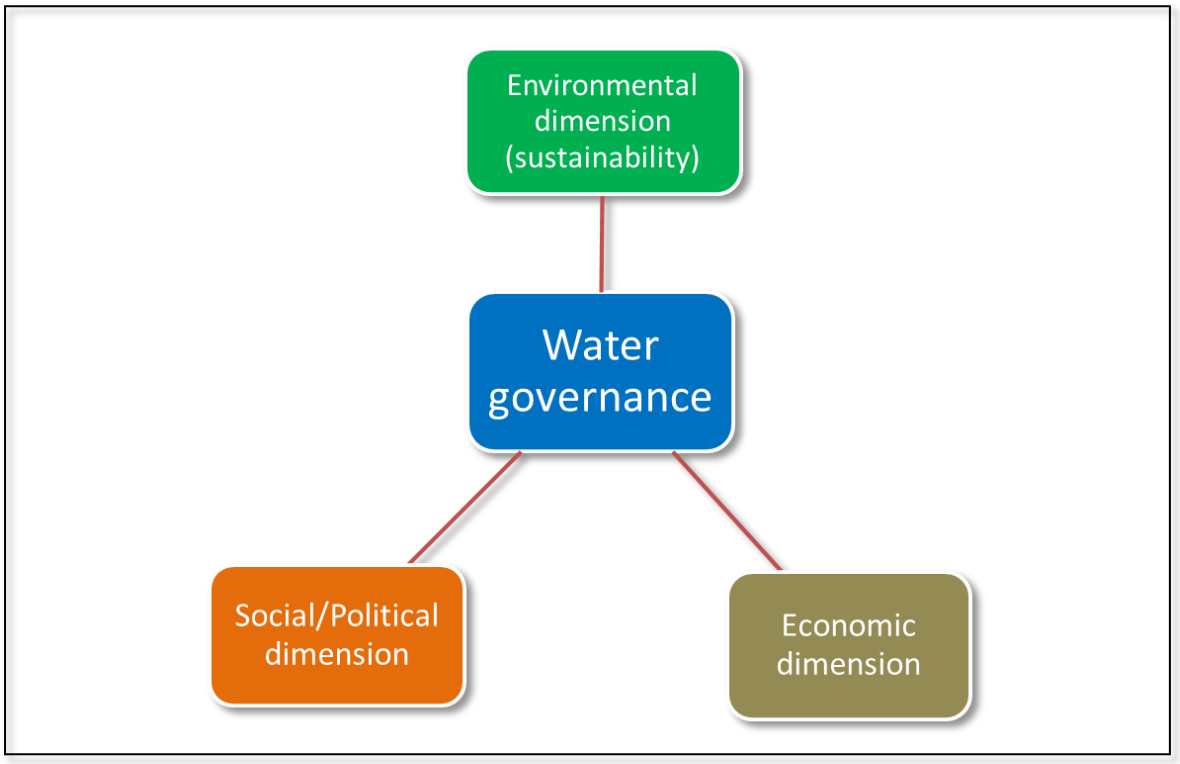


Figure 2.4: Dimensions of water governance (adapted from Agnew and Woodhouse, 2011).

2.6.1. Background

Environmental concerns and the sustainability concept gained formal international recognition at the United Nations Conference on Human Environment in Stockholm in 1972 (Agnew and Woodhouse, 2011). Principle two of the twenty six principles included in the Stockholm Declaration is about the management of natural resources. It states that the natural resources must be safeguarded for the benefit of present and future generations through careful planning or management (Sohn, 1973). However, the 1987 United Nation's World Commission on Environment and Development (WCED) which produced the 'Our Common Future' Report may have been the most impactful event in the promotion of sustainable development. The WCED (1987) posits that it is humanity's responsibility to ensure that development meets the needs of the present without compromising the ability of future generations to meet their own needs. Carden (2013) posits that sustainable

development is based on the concepts of 'needs' and 'limitations'. The concept of needs calls for prioritization of poor communities' needs, while the notion of 'limitations' highlights the imposition of technology and social organization on environmental resources and their ability to meet current and future needs (ibid: WCED, 1987).

In 1992, the United Nations convened the Conference on Environment and Development in Rio de Janeiro which resulted in the adoption of Agenda 21 by state leaders. Chapter 18 of the Agenda 21 is essential for this research as it deals with the protection and management of freshwater resources (Agnew and Woodhouse, 2011). Furthermore, the importance of water resources management was emphasized at the International Conference on Water and the Environment (ICWE) held in Dublin in 1992. The conference highlighted guiding principles which formed the basis of water resource management (ibid). Lastly, World Summit on Sustainable Development held in Johannesburg was about promoting environmental norms and standards to be adopted and implemented as good practice (Kumar et al. (2012). It can be deduced that the aforementioned conferences on sustainable development influenced the existing environmental and water legislation, policies as well as norms and standards for governments and industries. Recently adopted in the global agenda are the Sustainable Development Goals (SDGs) for 2030. Noting that the SDGs are interlinked and focus on a wide- range of issues, Goal 6 particularly promotes the protection of water resources (see box 2.1) (United Nations, 2015).

Box 2.1 Sustainable Development Goals 2030

Goal 6 - 'Ensure availability and sustainable management of water and sanitation for all'

- Target 6.3 by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemical and materials halving the proportion of untreated wastewater and sustainability increasing recycling and safe reuse globally
- Target 6.6 by 2030, protect and restore water- relates ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.

2.6.2. Water management challenges

Implementation of legislation, policies and strategies related to water management has proven difficult in both government and the private sector. Goldin (2010) writes that poor governance and institutional capacity are the main reasons for the ineffective water

management and fundamentally the persistent water pollution problem in South Africa. Similarly, DWS (2016c:77) attribute water management challenges to 'inadequate cooperative governance, overlapping mandates and discontinuous regulatory interfaces between the departments', including other spheres of government. Furthermore, Inyinbor et al. (2018) state that the inefficient implementation of water legislation is caused by the leniency the government has towards the industries that are the key sectors in terms of contributing to the country's economy. It is significant that environmental issues, particularly water issues, are integrated into policies regarding socio-economic development (ibid).

2.6.3. Integrated Water Resources Management

Originally, water resources management in South Africa focused on balancing water supply and demand (Braune and Rogers, 1987). However, water management is essential due to the scarcity of water resources in the country and increasing levels of pollution, especially in rivers (ibid). According to Agnew and Woodhouse (2011), Integrated Water Resources Management emphasises the significance of water as a natural resource in the ecosystem, a social and economic good. Additionally, Integrated Water Resources Management ensures the objectives of sustainability, equity and efficiency are achieved (DWF, 2004). The quantity and quality of a water resource control how the resource is used (Agnew and Woodhouse, 2011). It is, therefore, crucial that water resources are protected so that they can meet the current and future human consumption needs. The National Water Resource Strategy (NWRS) was promulgated in 2002 as an implementation framework for managing water resources in accordance with the National Water Act and National Water policy. Its objectives consist of, *inter alia*, establishing and identifying development opportunities and constraints (DWF, 2004). The management of water resources needs to be approached in an integrated manner which takes into account the socio-economic, environmental, political and technical factors (Pollard and du Toit, 2011).

2.7. Conclusion

The scarcity of water resources in South Africa cannot be contested. This chapter suggests that the quality of water resources is deteriorating due to increasing pollution. Although water pollution can be caused by factors such as climate change, anthropogenic factors including, among others, AMD, poorly managed and dysfunctional sewage infrastructure

and inadequately treated industrial effluent are major contributors to the pollution of water resources, especially rivers. Not only is pollution detrimental to aquatic ecosystems, it also has negative impacts on socio- economic activities and human health. Noting that water pollution is an internationally recognized environmental challenge which has prompted the promotion of sustainable development, the South African Constitution, NEMA and National Water Act are aligned with the requirements of sustainable development which include the promotion of water resources protection and sustainable use. This chapter indicates that the legislation is conceptually sound, yet, its implementation is evidently a challenge because water pollution persists. Many factors attribute to this problem including, inter alia, poor water and cooperative governance, as well as inadequate institutional capacity.

CHAPTER THREE

Contextualizing water pollution: the case of the Vaal River in Emfuleni Local Municipality

3.1. Introduction

The previous chapter argues that raw sewage, inadequately treated industrial effluent and institutional factors such as poor governance are some of the major causes of the pollution of surface water resources, particularly rivers. This chapter provides brief profiles of the Vaal River including its quality and Emfuleni Local Municipality with respect to ecological, socio-political and economic aspects.

3.2. The Vaal River – 'South Africa's hardest working river'

The Vaal River is a tributary of the Orange River which flows from the Drakensberg in the eastern interior of South Africa to the west on the border between South Africa and Namibia into the Atlantic Ocean (Tempelhoff, Munnik, and Viljoen, 2007). While it is a medium-sized river, according to international standards, the Vaal River is the second largest river in South Africa (ibid). It is 1300km long and runs through the Free State, Gauteng, Mpumalanga, North West and the Northern Cape Provinces (Wepener et al., 2011; Tempelhoff et al., 2007) (see Figure 3.1).

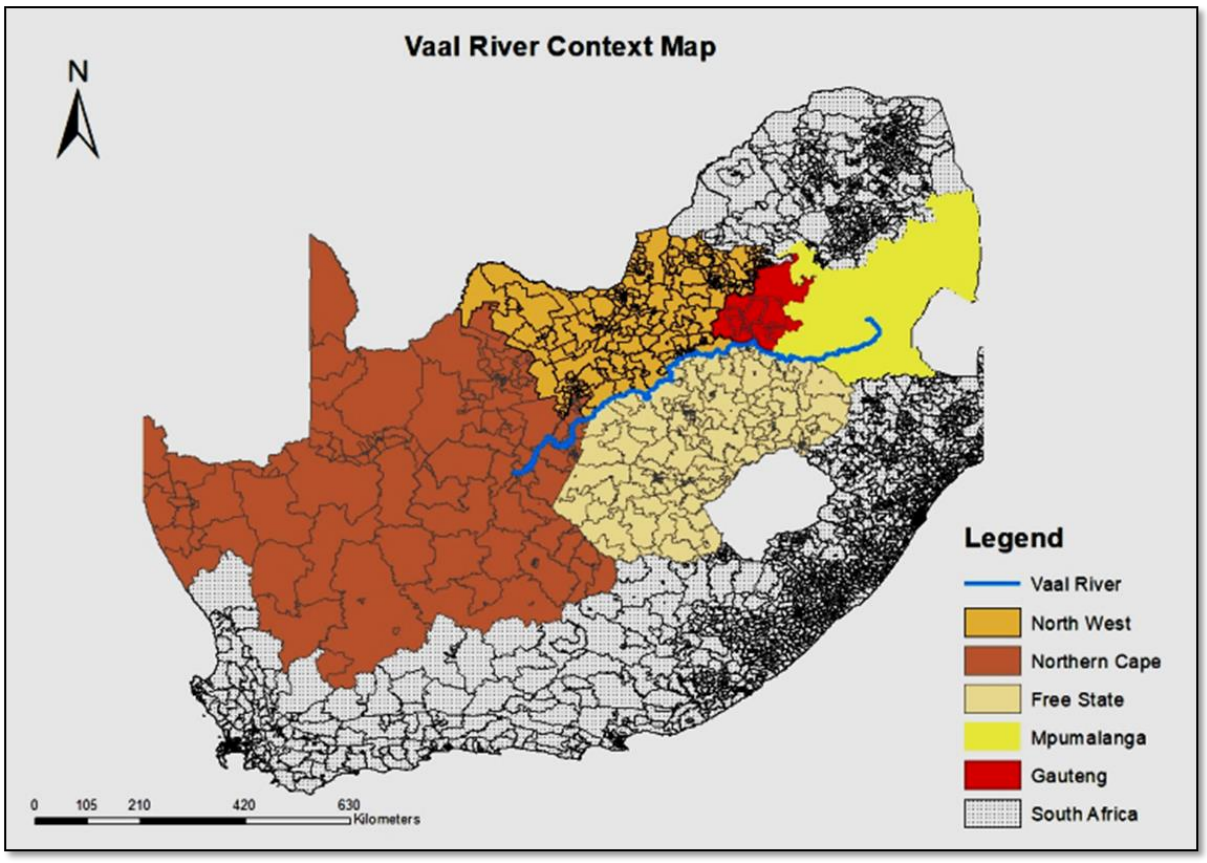


Figure 3.1: Vaal River context map (source: SoAP ArcGIS, 2019).

According to Braune and Rogers (1987), the Vaal River Catchment has an area of 192 000 km². It is also responsible for the production of eight percent of the mean annual runoff of the country (ibid). The Vaal River has been termed "the hardest-working river" due to the essential socio-economic role it plays by supporting economic sectors and millions of people in the Pretoria-Witwatersrand-Vereeniging (PWV) complex (Braune and Rogers, 1987; Tempelhoff, et al., 2007). The PWV complex has the highest concentration of urban, industrial, mining and power generation development in SA (ibid). The Vaal River is divided into three water management areas, namely the Lower Vaal, Middle Vaal and Upper Vaal (see figure 3.2) (DWS, 2018). The case study for this research focuses on the Upper Vaal management area in which lies Emfuleni Local Municipality.

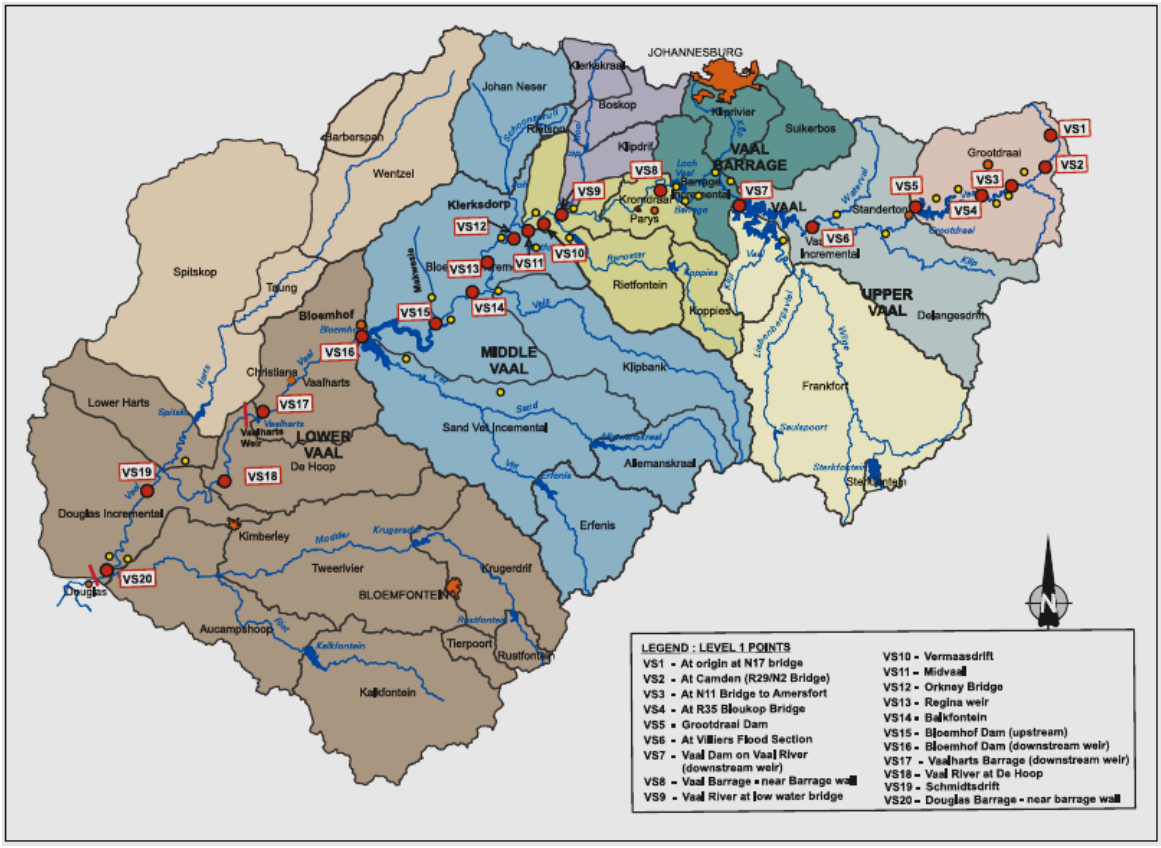


Figure 3.2: Vaal River Water Management Areas (source: van der Merwe- Botha, 2009)

3.2.1. Water quality in the Vaal River

Salinization, eutrophication and microbiological pollution are the leading causes of deteriorating water quality in South African rivers (Jordaan and Bezuidenhout, 2013; van der Merwe- Botha, 2009; DWS, 2018). The Vaal River water quality is, therefore, assessed based on these three occurrences since they currently affect the river. Salinization is a major water quality problem in the Vaal River. It is caused by the presence of salts in water as a result of increasing volumes of effluent from industries in the Vanderbijlpark and Vereeniging areas, acid mine drainage, wastewater plants and irrigation activities (van der Merwe- Botha, 2009; Grobler et al., 1987). However, acid mine drainage, is currently not a significant contributing factor to the increased levels of salinisation in the Vaal since mining is not a major sector in Emfuleni. Another problem affecting water quality in the Vaal River is eutrophication which occurs when water is enriched by nutrients that produce cyanobacteria or blue- green algae bloom (Matthews and Bernard, 2015). Van der Merwe-Botha (2009) attributes increasing eutrophication levels to sewage spills from wastewater

treatments works and agricultural fertilisers runoff. Lastly, the microbiological characteristic of water quality is indicated by total coliform bacteria (DWS, 1996). The most important indicator used to determine the presence of these coliforms, especially faecal pollution, is *Escherichia coli* (E. coli) (DWS, 1996; Jordaan and Bezuidenhout, 2013). The Department Of Water and Sanitation (2016c) specifies that for the Upper Vaal management area, E. coli must not exceed 130 (Colony Forming Units) cfu/100 ml. On the other hand, the Rand Water's raw water quality guidelines stipulate that the acceptable limit of E. coli in raw water is 126 cfu/100 ml (Steynberg, Heath and Viljoen, 1996), while DWAF (1996) specifies E. coli of 400 cfu/100 ml or more as a health risk in terms of the South African Water Quality Guidelines for Recreational Use. Nonetheless, recent water quality reports of the Vaal indicate that E. coli is over 1 million cfu/100 ml and far exceed the abovementioned acceptable limits. As a result, the water in the Vaal has become a health risk to the ecosystem and community of Emfuleni (Mabuza, 2019).

3.2.2. The socio-economic significance of the Vaal River situation

The Vaal River plays an important socio-economic role in South Africa (Grobler et al., 1987). First, it is responsible for the supply of water to the areas within the country's economic heartland, the PWV complex, where almost 40% of the total population is located (ibid). Second, the economic significance of the Upper Vaal is evident through its significant contribution to the Gross National Product (GNP) (Jordaan and Bezuidenhout, 2013). Third, the Vaal River is widely used for recreational purposes (Grobler et al., 1987). However, it has been established that the river is overexploited which compromises its ability to maintain its function. Consequently, water is sourced from other rivers to meet current water demands (ibid). Water demand is increasing due to population growth and the land use which is characterized by the extensive agricultural and industrial activities such as steel manufacturing in the western and northern parts of the Emfuleni, respectively (E mfuleni Local Municipality, 2018; Jordaan and Bezuidenhout, 2013). This explains the large volumes of industrial and agricultural effluent being discharged into the Vaal River, causing high levels of salinization and eutrophication.

3.3. Emfuleni Local Municipality (ELM) contextual setting

Emfuleni's context presents the historical background of the municipality's establishment and its existing profile.

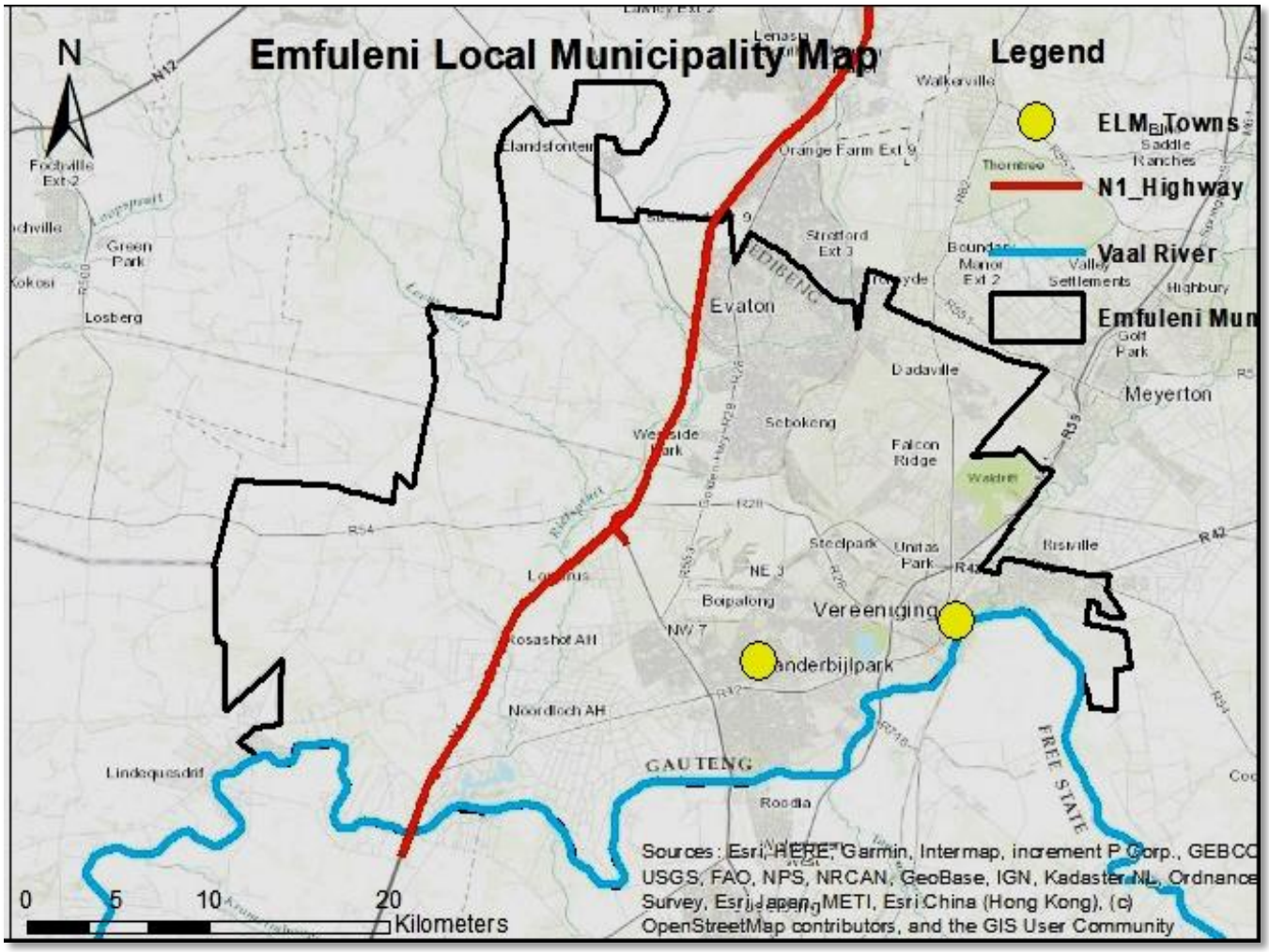


Figure 3.3: Vaal River and Emfuleni Local Municipality locality map (Source: SoAP ArcGIS, 2019).

3.3.1. Emfuleni's historical background

The development of Emfuleni began in 1892 with the establishment of Vereeniging whose growth was characterized by the presence of a coal mine and steel manufacturing companies (Marais et al., 2016). It was after the establishment of a Union Steel Corporation in 1913 and the government-owned Iscor in 1929 that Vereeniging became an important iron and steel industry hub (ibid). The industries presented an opportunity for job creation in the area and the PWV region (ibid). However, the new jobs benefitted the White minority

who had control over the iron and steel industry. Nonetheless, the economic impact of the steel industry was of great benefit to the country's economy. Vanderbijlpark town was founded after the development of Iscor's steelmaking plant which was meant to provide steel for the war industry in 1943 (Marais, et al., 2016). The establishment of Iscor is linked to the availability of land, easy access to water and the Vaal River which allowed for industries to easily release effluent into the Vaal River and coal mines for energy production (Marais, et al., 2016). Similarly, the South African Cities Network (SACN) (2014:24) argues that there is a 'historical inter-relationship between the steel manufacturing sector and the availability of energy and water'. The economic importance of Emfuleni dates back to the 1950s when Sasol was established due to high demand for steel and 1960s when Iscor became the largest state-owned enterprise in South Africa (Marais et al., 2016). Iscor was responsible for the employment of just over 60,000 people and the rapid population growth in the area (ibid; SACN, 2014). Consequently, Vanderbijlpark and Vereeniging experienced significant increases in their economy (Marais, et al., 2016).

Emfuleni Local Municipality is the southernmost municipality in the Gauteng Province and one of the three local municipalities under Sedibeng District Municipality (Emfuleni Local Municipality, 2017; SACN, 2014). The Municipality covers an area of 987.45 km² (ibid). Emfuleni is surrounded by Midvaal and Lesedi Local Municipalities to the east, Westonaria Local Municipality to the west Free State to the south and the City of Johannesburg Metropolitan to the north (SACN, 2014). This type of spatial positioning has significant implications for the development of ELM. In terms of connectivity, ELM is easily accessible via the N1 road network which links it to the cities of Johannesburg and Bloemfontein (ibid). The Vaal River is found on the southern boundary of the area (Emfuleni Local Municipality, 2017). There are six large peri-urban townships in Emfuleni, namely, Evaton, Sebokeng, Sharpville, Boipatong, Bophelong, and Tshepiso (Emfuleni Local Municipality, 2018).

3.3.2. Emfuleni's Physical profile

3.3.2.1. Topography

The topography of Emfuleni is fairly gentle and undulating in some parts (Emfuleni Local Municipality, 2018). The multiple watersheds in the area the prominent features of this type

of topography (ibid). Emfuleni local municipality's Spatial Development Framework (SDF) (2018) suggests that the hydrological system drains from these watersheds into the rivers, which then flow into the Vaal River. The most important watershed is located between Sebokeng and Vereeniging, which affects urban development, particularly the provision of water and sanitation (ibid). Apart from the Vaal River, 3 rivers are of importance within Emfuleni, namely the Klip River, Rietspruit, and Leeuspruit (ibid).

3.3.2.2. Spatial Form

The land- use in Emfuleni is diverse (see figure 3.4). Vanderbijlpark and Vereeniging are the main Central Business Districts (CBD) (Emfuleni Local Municipality, 2018). Emfuleni's economic activities are concentrated in the eastern part of the municipality where the two CBDs are located. These economic activities consist of five regional business nodes as well as ten industrial and commercial nodes (Emfuleni Local Municipality, 2018). Mittal Steel (former Iscor) takes up the largest portion of the industrial space between Vanderbijlpark and Sebokeng (ibid).

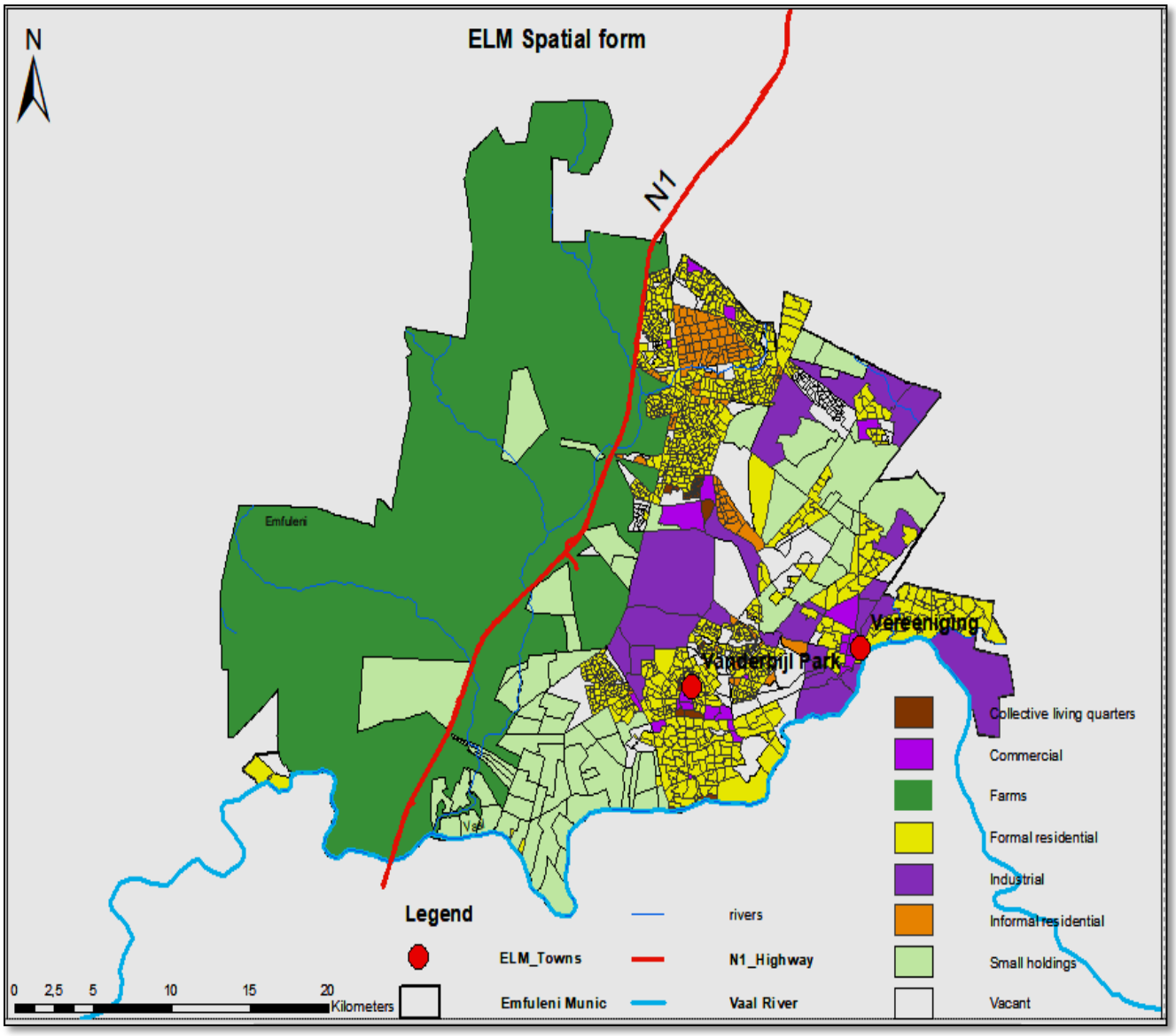


Figure 3.4: ELM Land- use map (Source: SoAP ArcGIS, 2019)

The largest portion of the western part of the land in Emfuleni is used for agriculture which corresponds to its rural character even though the area is categorized as urban (Emfuleni Local Municipality, 2018). The farms and agricultural activities are strategically located near the Vaal River and its tributaries (ibid). Over 80% of Emfuleni's population resides in the eastern urban part of the town (ibid). The resultant spatial form is that of high-density residential areas, particularly Sebokeng, Evaton and Sharpeville (ibid). On the other hand, the main towns in ELM, Vanderbijlpark and Vereeniging are characterized by lower-density residential areas (ibid). This is due to Apartheid spatial planning policies which strategically

placed the black population group in the peripheries of the towns while the minority settled in or closer to the CBDs.

3.3.3. Emfuleni's socio-political situation

The socio-political profile of ELM looks into the population of ELM, its demands, governance including the political aspect and other social issues. According to the Emfuleni Local Municipality's Integrated Development Planning (IDP) (2017), Emfuleni's population is 733 444, 60% of which is unemployed (ibid). The high unemployment rate is indicative of not only a growing unemployment crisis but it also shows the current economic situation of Emfuleni and South Africa. The unemployment crisis calls for integrated effort from both the public and private sectors to create sustainable job opportunities for the community of Emfuleni. Emfuleni's delivery of basic services such as water and sanitation is quite notable. While Emfuleni Local Municipality's IDP (2017) argues that there is 100 percent water supply coverage in the municipality, the Emfuleni Local Municipality's SDF (2018) shows that 96% of ELM's population has access to running water. Only four percent of the population depends on natural resources such as boreholes (represented as "Other") (see figure 3.5). In terms of sanitation, 92 percent of Emfuleni population has access to sanitation, while the remaining 8 percent uses pit latrines (ELM Spatial Development Framework, 2018). These figures show that in terms development planning, Emfuleni is ensuring that it delivers the most basic services to the community.

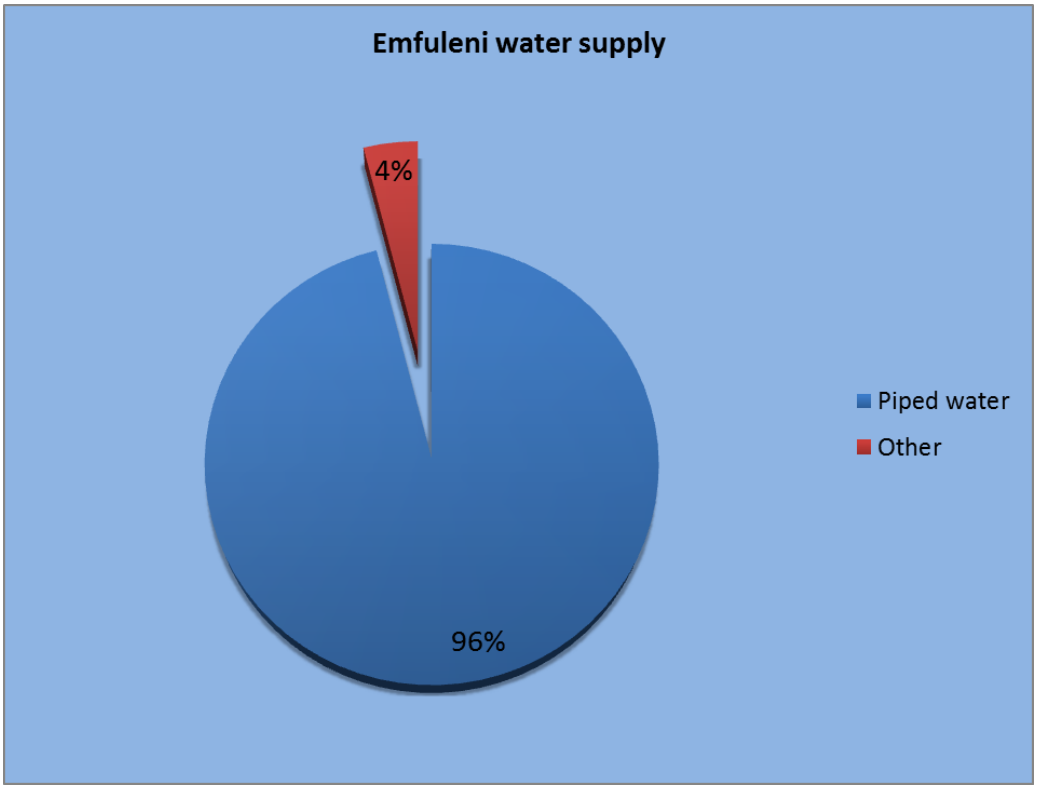


Figure 3.5: Households with piped water (adapted from Emfuleni Local Municipality, 2018)

In terms of governance, Emfuleni Local Municipality is an African National Congress led municipality (Emfuleni Local Municipality, 2017) (see figure 3.6).

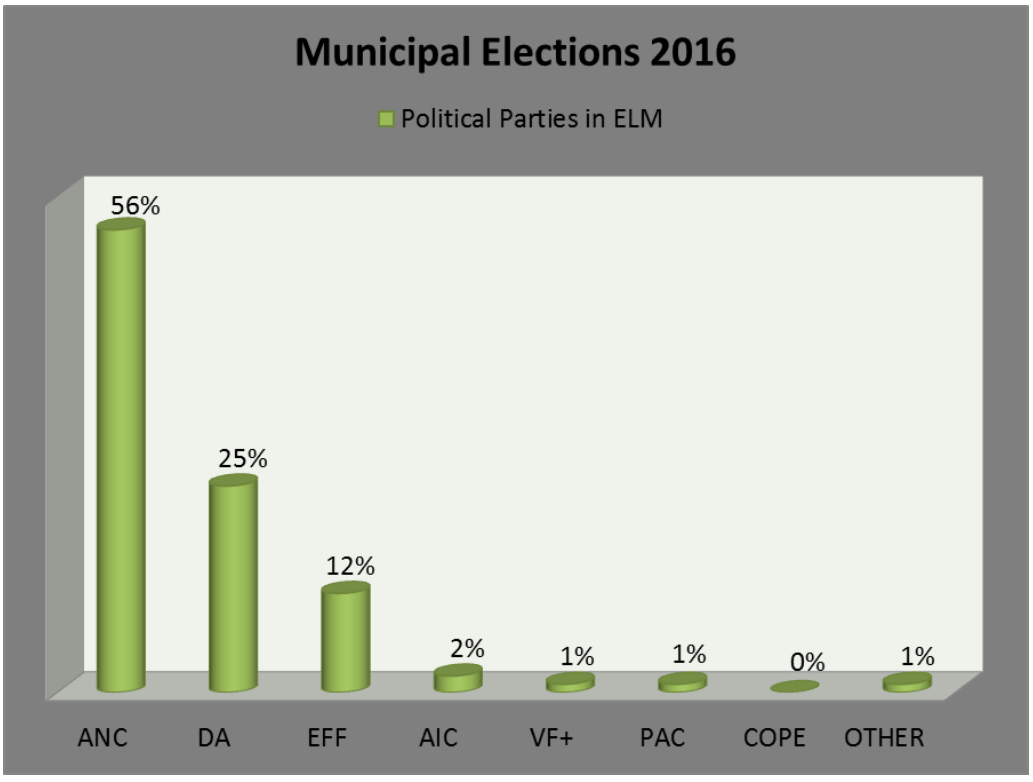


Figure 3.6: Political parties in Emfuleni Local Municipality (Source: Emfuleni Local Municipality, 2017).

Emfuleni is confronted with many governance challenges including, among others, irregular expenditures of approximately R872m in the 2017/2018 financial year, infighting within the leading political party and corruption (SAHRC, 2018; Marais et al, 2016; SACN, 2014). According to Olver (2016) these challenges emerge when politics becomes transactional, where 'political entrepreneurs' at municipalities fight over positions which afford them the opportunity to have access to resources and power. This has a negative impact on service delivery which has led to community service delivery protests (Marais et al, 2016). Likewise, AGSA (2018) highlights the correlation between increased corruption and a decline in service delivery. Consequently, in 2018, the Gauteng Premier placed Emfuleni under administration due to these challenges which is in accordance with Section 139 of the Constitution (SAHRC, 2018). Section 139(1) (b) stipulates that the provincial government may intervene in municipal matters when a municipality cannot fulfill its executive obligation including 'assuming responsibility for the relevant obligation in that municipality to the extent necessary' (RSA, 1996:41). ELM is also home to the Sharpeville Monument, a significant heritage site commemorating the Sharpeville massacre and also symbolizes the liberation struggle against the Apartheid regime (Emfuleni Local Municipality, 2017).

3.3.4. Emfuleni's Economic profile

Recent reports suggest that the Emfuleni Local Municipality's economy is contracting. SACN (2014) suggests that Emfuleni's annual economic growth rate of 1.4 percent between 1996 and 2011 fell below Gauteng's metropolitan municipalities. This decline is attributed to the restructuring of the steel industry upon which the municipality's economic development largely depended since the establishment of Vereeniging and Vanderbijlpark (ibid). As stated in Emfuleni Local Municipality (2017), the best performing economic sectors in terms of Local Economic Development (LED) are manufacturing at 26.2%, followed by the finance & business services at 22.2% and government, social & personal 21.8% (see figure 3.7). Conversely, the agriculture, forestry, and fishing contribute 0.7 percent combined to Emfuleni's LED which is very low (ibid).

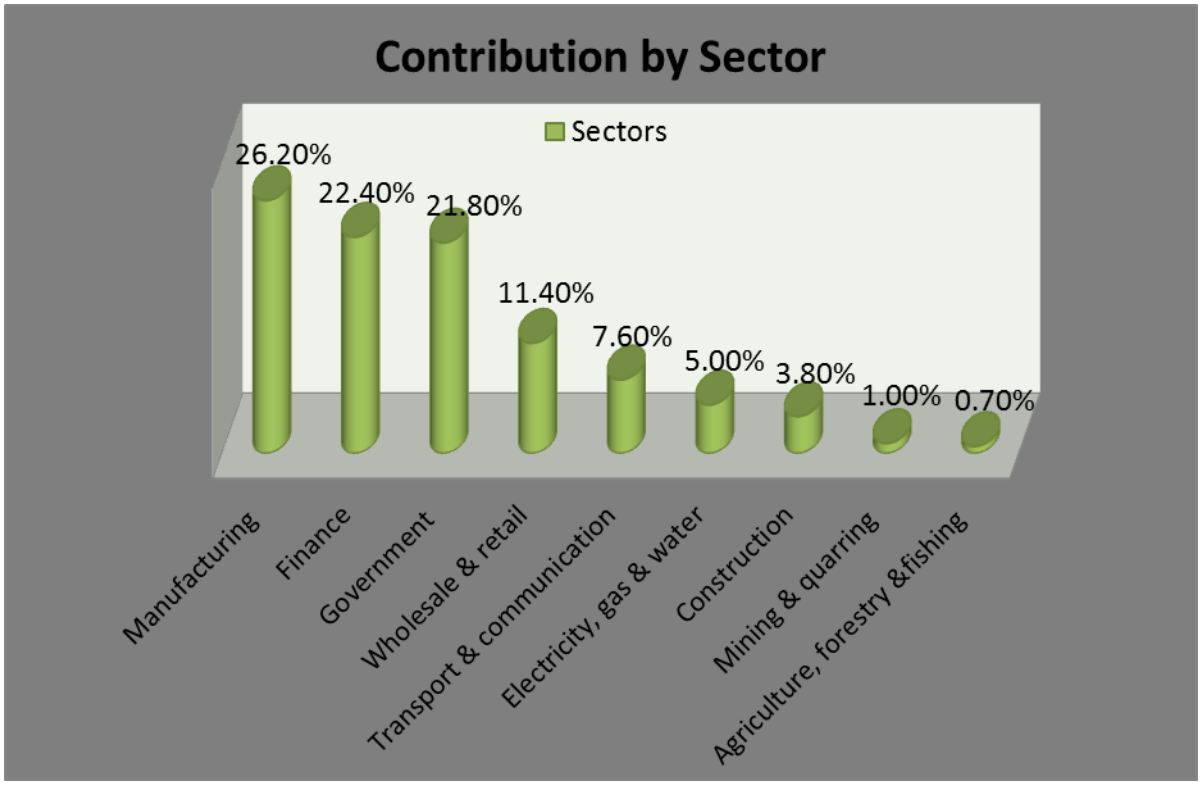


Figure 3.7: Economic contributions by sector (Emfuleni Local Municipality, 2018).

Although the manufacturing sector is still prominent, it has been on a steady decline since 1996 (SACN, 2014). Nonetheless, this decline should be considered an opportunity to diversify Emfuleni's economy. Table 3.1 represents employment by sector which indicates that manufacturing is still the leading employer in Emfuleni regardless of its decline in terms of revenue.

Table 3.1: Economic sector by employment in ELM (source: Emfuleni Local Municipality Spatial Development Framework 2018-2019).

Employment by Sector	Percentage
Manufacturing	27%
Community	24%
Retail	21%
Financial	11%
Construction	6%
Transport	6%
Electricity	n/a
Agriculture	n/a
Mining	n/a

3.3.5. Emfuleni Environmental condition

Emfuleni, also known as 'The 'River City', encompasses several ecologically sensitive sites classified as 'irreplaceable sites' and 'important sites' such as the Sharpeville Dam that is also used for recreational purposes (Emfuleni Local Municipality, 2018). The previous chapter highlights the role of anthropogenic factors in shaping Emfuleni's current environmental condition. According to Emfuleni Local Municipality (2017), Emfuleni is faced with high levels of water and pollution. Water pollution challenges are discussed below.

3.3.5.1 Water pollution challenges in Emfuleni

Marais et al. (2016) identify three activities that threaten water resources in Emfuleni. First, they note that the steel industry's use of water to cool steel products, particularly in the Vanderbijlpark and Vereeniging areas, requires the industry to discharge waste water back into the Vaal River (Marais et al., 2016; Emfuleni Local Municipality, 2018; SACN, 2014). Often, the waste water is inadequately treated. The second threat to water resources, especially the Vaal River, is Emfuleni's dysfunctional sanitation infrastructure which currently operates above capacity and causes sewage spills (SACN, 2014). The third threat is effluent from abandoned mines which discharge directly to water resources and ultimately the Vaal River (GDARD, 2017; Marais et al., 2016). The aforementioned threats indicate a

persistent culture of non- compliance with regulatory requirements of water management by industries, as well as infrastructure asset management by the local municipality. Furthermore, these activities threaten the ecological biodiversity of the Vaal River, economic activities such as agriculture and tourism, human health (Marais, et al., 2016; Emfuleni Local Municipality, 2017). The following section discusses the legislative framework for water management in South Africa which could be implemented to address the water pollution challenge in Emfuleni.

3.4. South African water legislative framework

According to Awoke et al. (2016), the government's legal framework comprising legislation, policies, norms and standards should aim to control and monitor water pollution at all levels of government. The South African water legislation is founded upon the Constitution's Bill of Rights. Section 24 of the Constitution (RSA, 1996:8) states that 'everybody has the right:

(a) to an environment that is not harmful anybody's health and wellbeing and

(b) to have the environment protected for the benefit of present and future generations…'.

Section 24 requires the enacting of legislation and measures to ensure, *inter alia*, the prevention of pollution and ecological degradation, promotion of conservation and the sustainable use natural resources (RSA, 1996). However, the Constitution does not provide specific measures on how to achieve this right. Therefore, to realise the right to a healthy environment, the South African government promulgated the National Environmental Management Act (Act 107 of 1998) (NEMA) which contains a set of principles guiding the protection and management of the environment while centering people (RSA, 1998a). The act also seeks to promote co-operative environmental governance, sustainable development, and environmental justice (RSA, 1998a).

The National Water Act (Act 36 1998) (NWA) is the main legislation that guards the development and use of water resources which encompass surface water and groundwater (RSA, 1998b). The main aim of the Act is to 'ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled sustainably'(RSA, 1998b: unpaginated). The NWA is an implementation tool of the National Water Policy which is founded upon the objectives of equitable access to water, sustainable use of water and

efficient and effective water use (Lange and Hasaan, 2006). Ensuring equitable water access is based on the need to address the injustices of the Apartheid government which, under the Water Act of 1956, permitted private ownership of water resources and deprived the majority of the population the same right (Lange and Hasaan, 2006). It is important to note that South African developmental issues cannot be addressed without considering existing socio-economic dynamics which are often consequences of Apartheid policies. Additionally, Goldin (2010:196) argues that the National Water Act identifies the need to establish suitable water management institutions so that social and economic development can be achieved through water use. NWA bestows the right to guard the country's water resources to the National Department of Water and Sanitation (DWS) (former Department of Water Affairs and Forestry). DWS is responsible for enacting and implementing regulations, policies and water management strategies (Goldin, 2010).

Another important Act is the Water Services Act (Act 108 of 1997) which provides for the delivery of water and sanitation services to the community (RSA, 1997). The Act stipulates that municipalities are water service authorities (WSA) and they have a legislative obligation to supply adequate water and sanitation according to national norms and standards (RSA, 1997). This obligation is also emphasized by the Department of Water and Sanitation's slogan which states that 'water is life, sanitation is dignity'. These acts indicate that the South African water legislation is a conceptually sound legislation. Despite this comprehensive legislative framework, the pollution of water resources persists. The water legislation cannot be effectively implemented without sound and adequate governance as well efficient institutions dedicated to managing water resources. The relevant water institutions in Emfuleni are discussed below.

3.5. Institutional arrangements for water governance in Emfuleni

This section focuses on the institutions or stakeholders involved in the water sector in terms of its management, protection and provision in Emfuleni (see figure 3.8). DWS falls under the National sphere of government as the custodian of water resources South Africa (RSA, 1998b). A Catchment Management Agency has the powers to, among others, 'manage and monitor water use as well as conserve and protect the water resources and water quality within its water management area (RSA, 1998b). Emfuleni Local Municipality is one of the twelve Water Service Authorities in Gauteng whose responsibility is to implement the

policies and strategies of water supply, provision of sanitation and storm water management put in place by the Department of Water and Sanitation (GDARD, 2017). Water Boards, such as Rand Water, are responsible for abstracting, purifying and distributing about (205Ml/day) potable water (Emfuleni Local Municipality, 2017). With respect to environmental management, municipalities may implement their own environmental management processes consisting of policies, by-laws and environmental management systems or plans (DWS, 2016a). Additionally, the Save the Vaal Environment (SAVE) NGO is the most active and prominent NGO in terms of ensuring environmental justice in Emfuleni. I interviewed Officials from the institutions at local level namely, Metsi-a-lekoa, ELM's environmental department, and Rand Water. The NGO could not be reached.

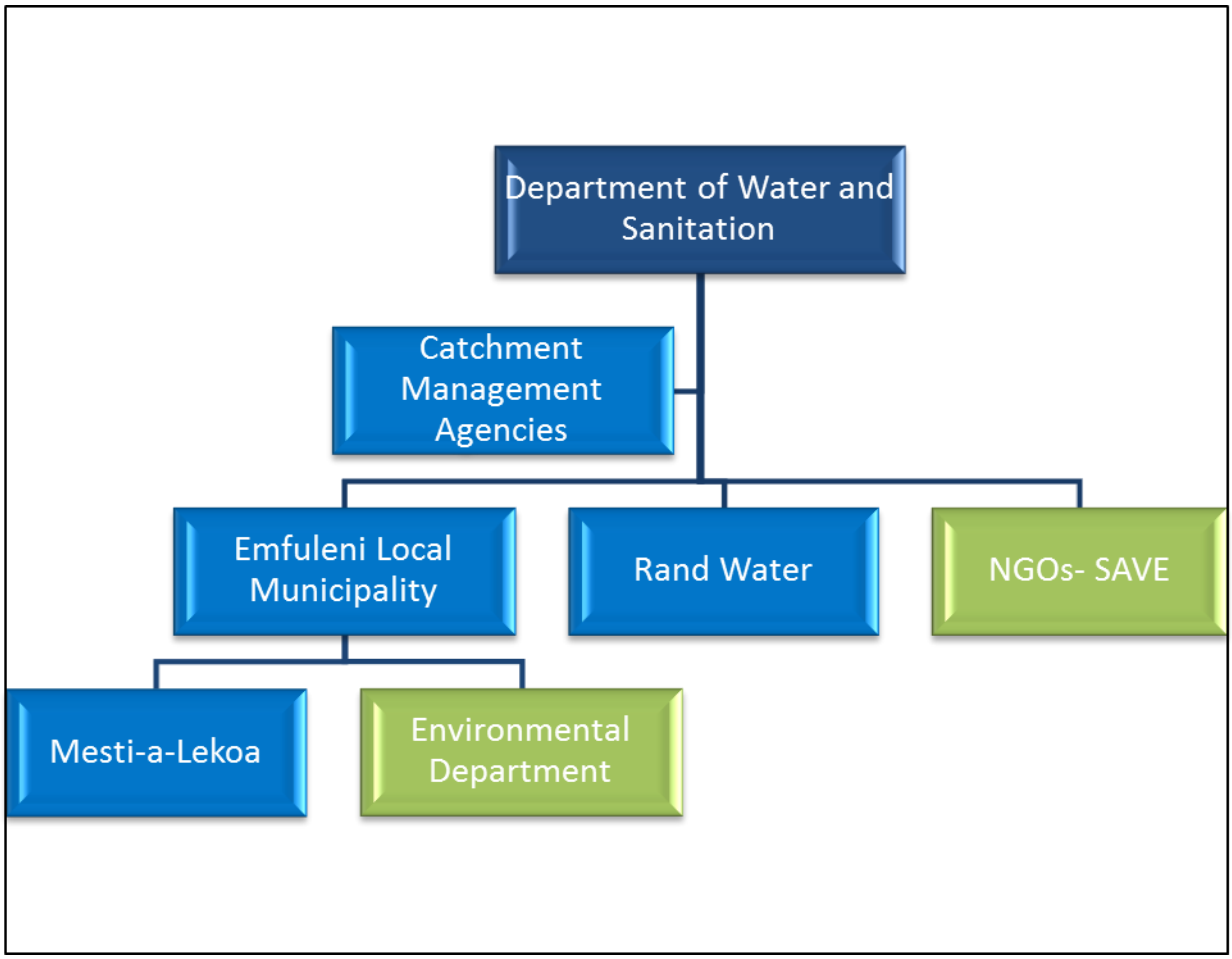


Figure 3.8: Emfuleni's water sector and environmental management institutions (source: author).

3.6. Green Drop Report in Emfuleni

The Green Drop Programme is a Department of Water and Sanitation's (former DWA) incentive-risk based regulatory measure introduced to ensure compliance and performance improvement of Water Services Authorities (WSA) in terms of Wastewater Quality Management Regulation (WQMR) (DWA, 2011). Municipalities are rewarded or penalized depending on their performance on meeting the minimum required standards for wastewater management (DWA, 2011). According to the 2011 Green Drop Report (see table 3.2), Emfuleni scored a total of 66.9% which falls within the 'average performance' indicator. The table is shows that although Emfuleni wastewater treatment works (WWTWs) scored high in performance areas such as 'process control, maintenance & management skills', it scored very low in for 'wastewater quality compliance' in two of their three WWTWs. This indicates non-compliance with wastewater quality regulatory requirements according to the Green Drop programme. It should be noted that this was the last Green Drop Report with results for municipalities. The report also exposes the early stages of a collapsing sanitation system that has led to the Vaal River pollution in Emfuleni.

Table 3.2: Green Drop score for Emfuleni (source: DWA, 2011)

Performance Area	Emfuleni Local Municipality wastewater treatment works		
	Rietspruit	Leeukuil	Sebokeng
Process Control, Maintenance & Management skills	100	100	100
Monitoring Programme	40	40	50
Credibility of Sample Analyses	85	100	100
Submission of Results	100	100	100
Wastewater Quality Compliance	20	72	20
Failure Response Management	100	45	100
Bylaws	100	100	100
Treatment & Collector Capacity	55	70	50
Asset Management	62.5	57.5	85
Bonus Scores	20	20	28.8
Penalties	0	0	0

Green Drop Score (2011)	**61.1%**	**72.7%**	**66.6%**
Green Drop Score (2009)	NA – 0%	NA – 0%	NA – 0%
Treatment Capacity (Ml/d)	36	41	100
Operational % i.t.o. Capacity	81%	61%	128%
Cumulative Risk Rating (CRR)	15	11	21
% i.t.o. Maximum Risk Rating	53.6%	39.3%	63.6%

3.7. Blue Drop Report

Noting that the standards for safe drinking water are stipulated by the DWS, municipalities and WSAs have an obligation to ensure that water they treat and distribute as potable water meets these standards (DWS, 2016a). To monitor municipalities' or WSA's compliance with the regulatory requirements of tap water quality management, the Blue Drop Certification Programme was designed. The Blue Drop Report for 2012 indicates that Emfuleni's performance was excellent with an overall score of 96.80% which meets the requirements of the Blue Drop Certification (DWA, 2012). Although this has been a consistent trend, there is growing concern of future potable water quality due to the increasing levels of pollution in the Vaal River.

3.8. Conclusion

This chapter highlights the significance of the Vaal River in the development of Emfuleni which is evident by the strategic location of Vanderbijlpark and Vereening near the river, the socio- economic role it plays in the PWV complex and in South Africa. The deteriorating quality of the river cannot be contested as it experiences increasing levels of microbiological pollution, eutrophication and salinization due to anthropogenic activities. It should be noted that the declining quality of the Vaal River presents multiple challenges for the natural ecosystem and socio-economic environment because it threatens ecosystem biodiversity, water availability and potential water use for different socio-economic needs. Emfuleni Local Municipality faces challenges encompassing, among others, declining economy, political in- fighting, corruption, capacity constraints and collapsing bulk infrastructure.

These challenges manifest in the decline of service delivery which has triggered service delivery protests from disgruntled community members. Since service delivery is a key executive mandate of municipalities, it is important that Emfuleni addresses these challenges to ensure it delivers sustainable services to the community.

CHAPTER FOUR

Findings of the Vaal River pollution assessment

4.1. Introduction

Chapter 3 paints a clear picture of the water pollution challenge facing Emfuleni. Although the causes of water pollution vary, the common factor is that of human actions such as inadequately treated effluent from industries, acid mine drainage and illegal dumping of waste (GDARD, 2017; Emfuleni Local Municipality 2017; Anonymous Official 3, interview, 12 December 2019). The Officials that I interviewed in the course of my fieldwork acknowledge that even though these are some of the causes of pollution in the area, they are not currently the main water pollution causes. They argue that sewage spillage, from non- point sources namely wastewater treatment plants and pump stations, is the main cause of water pollution of the Vaal River in Emfuleni. The following section discusses the causes of the sewage spillages.

4.2. The main causes of water pollution in the Vaal River within Emfuleni Local Municipality

4.2.1. Ageing bulk infrastructure

Various academic and government reports suggest that there is increasing concern of sewage spills from pump stations and wastewater treatment plants due to the malfunction of ageing bulk infrastructure (Sedibeng District Municipality, 2019; Tempelhoff, 2009b; CSIR, 2010; confirmed by Anonymous Official 1, interview, 17 October 2019). Ageing infrastructure is a major problem that is facing many South African municipalities including Emfuleni Local Municipality (CSIR and CIDB, 2007; Emfuleni Local Municipality, 2017). Emfuleni's water and sanitation infrastructure was constructed over 60 years ago (Sedibeng District Municipality, 2019). Consequently, the infrastructure has reached its design lifespan resulting in its malfunction (ibid). Emfuleni's infrastructure consists of 44 pump stations and 3 wastewater treatment works (Emfuleni Local Municipality, 2017; confirmed by Anonymous Official 2, interview, 18 October 2019). Ageing infrastructure coupled with the demand for services such as water and sanitation due to population growth and urbanisation pressure has resulted in pump stations and wastewater treatment plants

operating above capacity and ultimately causing spillages (CSIR, 2010; Anonymous Official 1, interview, 17 October 2019; Anonymous Official 2, interview, 18 October 2019).

Photo (4.1) demonstrates old and dilapidated infrastructure at Metsi- a- Lekoa's pump station 8. This pump station is not operational. Consequently, all the sewage meant to be pumped in this station from the communities connected to this network spills into the pump station's emergency dam (Anonymous Official 2, interview, 18 October 2019).



Photo 4.1: Dilapidated infrastructure at pump station 8 (source: author's photograph, 18 October, 2019)

Sebokeng Wastewater Treatment Works has a capacity of 119 Ml/ day and normally receives up to 100 Ml/ day of wastewater (Tempelhoff, 2009a; Emfuleni Local Municipality, 2018b; Anonymous Official 1, interview, 17 October 2019). However, the plant currently receives between 19 Ml/d and 20 Ml/d due to breakdown of sanitation infrastructure and blockage of pipes (Emfuleni Local Municipality, 2018b; Anonymous Official 1, interview, 17

October 2019). According to Anonymous Official 2 (interview, 18 October 2019), the excess wastewater that does not reach Sebokeng WWTW is discharged directly into water resources and ultimately ends up in the Vaal River. Old infrastructure challenges include the use of old asbestos pipes that no longer meet the minimum safety standards (Anonymous Official 1, interview, 17 October 2019). Furthermore, ageing infrastructure causes water losses which increases cases of non- revenue water for the Municipality (Anonymous Official 1, interview, 17 October 2019). Non- revenue water (NRW) encompasses billed and unbilled authorised consumption, apparent water losses and real losses (Seago and Mckenzie, 2007; Carden, 2013). Emfuleni subsequently partnered with Rand Water to develop a training programme that saw Emfuleni's unemployed youth being trained in basic plumbing skills and fixed leaking and broken water taps that were causing water loss in Emfuleni (Anonymous Official 1, interview, 17 October 2019).

4.2.2. Lack of infrastructure maintenance

Not only is bulk infrastructure in ELM ageing and malfunctioning, it is also not maintained. According to CSIR (2010) the challenge of operating and maintaining infrastructure faces all spheres of government. Maintenance of infrastructure is significant for ensuring the longevity of its use. Emfuleni's failure to maintain its bulk infrastructure is attributed to limited financial and technical capacity for operating and maintaining infrastructure (CSIR and CIDB, 2007; CSIR, 2010; Anonymous Official 1, interview, 17 October 2019). However, the problem is often lack of priority in respect of funding maintenance of infrastructure. Furthermore, the maintenance budget is more often than not the most ransacked when funds are needed for other services in the financial year (CSIR and CIDB, 2007). The CSIR and CIDB (2007:11) attribute this action to 'insufficient understanding by elected municipal representatives of the importance of infrastructure maintenance'.

During my visit to pump station 8 (see photo 4.2), I found that lack of maintenance of technical equipment led to its breakdown. The state of the equipment shows that it has not been functioning for a long time.



Photo 4.2: Unmaintained equipment inside pump station 8 (source: author's photograph, 18 October, 2019).

4.2.3. The complex issue of capacity

The assessment of capacity takes into account the design capacity of existing pump stations and wastewater treatment works, financial capacity and capacity in terms of human resources.

4.2.3.1. Infrastructure design capacity

Wastewater treatment plants are overloaded and operating above capacity (CSIR, 2010, DWS, 2018). Consequently, sewage is discharged into the nearest water resources and ultimately pollutes the Vaal River (CSIR, 2010; Anonymous Official 1, interview, 17 October 2019; Anonymous Official 2, interview, 18 October 2019). The existing infrastructure (see figure 4.1) has become inadequate to handle the current sanitation needs of Emfuleni, both in the number and size of pump stations and water treatment plants due to the

amalgamation of municipalities (The Department of Planning, Monitoring and Evaluation,2004).

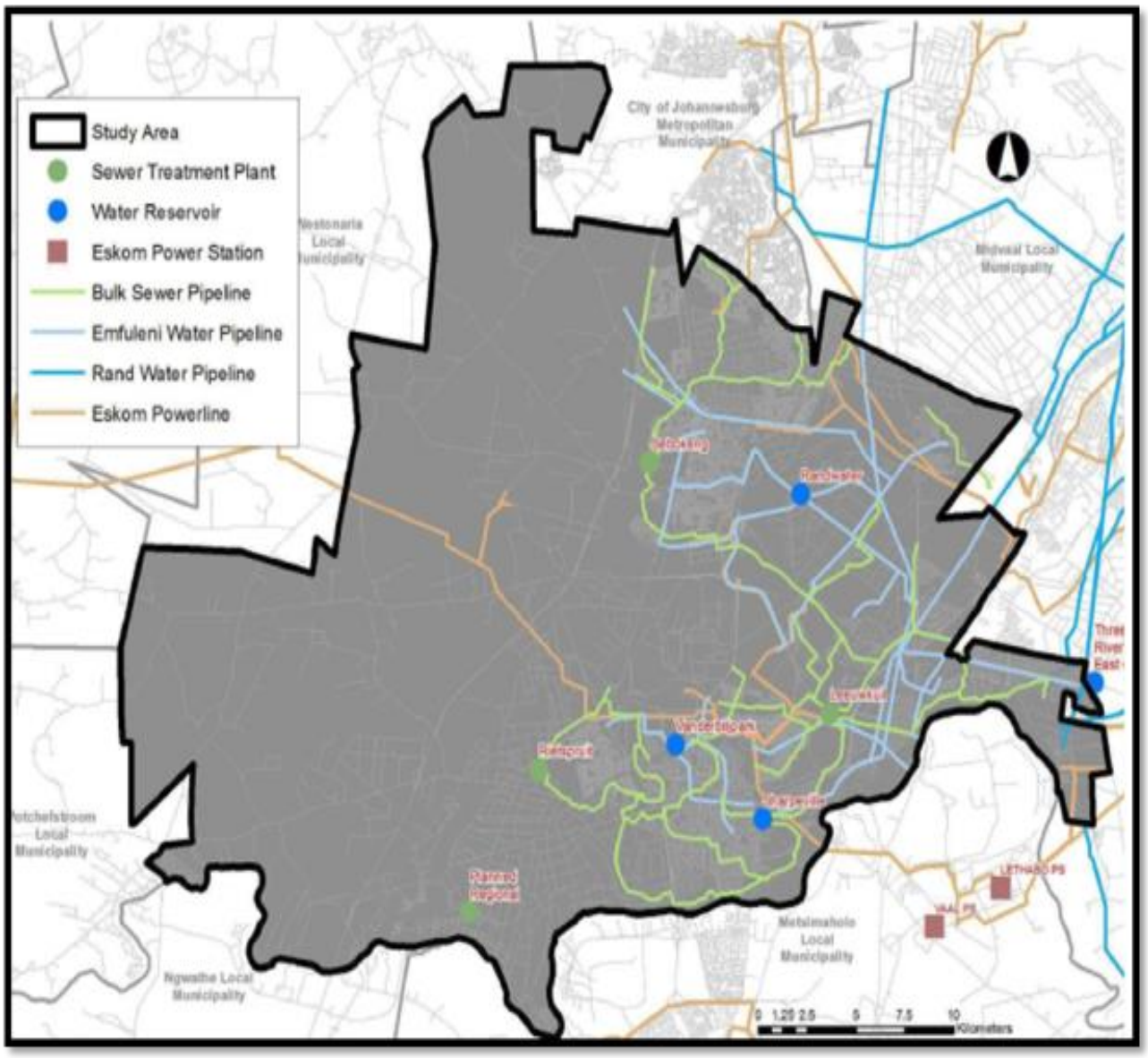


Figure 4.1: Existing bulk services infrastructure (Source: Emfuleni Local Municipality, 2018b)

This fact signifies the underlying risk of shortsighted and ineffective planning which is one of the challenges facing the ELM administration (to be discussed later in this chapter).

Photo 4.3 shows an overflowing emergency dam[1] at pump station 8 where the infrastructure is not operational. This emergency dam is effectively utilized for its purpose

[1] An emergency dam is used to store excess sewage flows during peak flows, heavy rains and unforeseen plant breakdowns (Anonymous Official 2, interview, 18 October 2019).

as a storage area of sewage flow since the pump station is not operational. However, the dam is has reached its capacity and can no longer contain the wastewater.



Photo 4.3: Overflowing emergency dam at pump station 8 (source: author's photograph, 18 October, 2019).

4.2.2.2 Financial capacity challenges in Emfuleni

Inadequate financial capacity is among the major challenges facing SA's municipalities (CSIR, 2010; Madumo, 2015). Consequently, this negatively affects service delivery (ibid). The issue of financial capacity is quite complex. All the Officials that I interviewed agree that water and sanitation are essential services, as they are both basic human rights and fundamental for other socio- economic needs. Nevertheless, sufficient funds are scarcely allocated for municipalities to ensure that basic human rights are realized and needs are met. When funds are available, the municipality has to deal with the challenge of financial mismanagement (Anonymous Official 1, interview, 17 October 2019; Anonymous Official 2, interview, 18 October, 2019). The issues of inadequate budget, delays in allocation of funds

and inadequate investment affect the delivery of services including , *inter alia*, construction of new wastewater treatment works and refurbishing of old infrastructure (CSIR and CIDB, 2007; Anonymous Official 1, interview, 17 October 2019). Complexities underlying financial challenges can be associated with the lack of human resources with appropriate qualifications and skills to efficiently and effectively plan, allocate and use funds (CSIR and CIDB, 2007).

4.2.2.3. Inadequate and incompetent human resources

The challenge with human capacity has to do with the number of technically- skilled personnel with suitable qualifications, skills and experience in the water and sanitation sector and local government in order to ensure sustainable service delivery (DWS, 2018). According to CSIR and CIDB (2007), most municipal vacancies are filled by personnel without the appropriate qualifications and experience to perform their duties. This is exacerbated by political appointments which have become a transaction in the political market (Olver, 2016). The operation of wastewater treatment works and pump stations is complex and it requires highly trained and experienced professionals, specifically engineers and technicians (DWS, 2018; Anonymous Official 2, interview, 18 October, 2019). CSIR and CIDB (2007) attribute inadequate human capacity to the exodus of qualified and experienced personnel at the advent demarcation changes in the year 2000. Demarcation changes coupled with rapid urbanization, presented a new challenge of securing financial and human resources to meet the demands of the newly amalgamated municipalities (Ashley and Cashman, 2006). Furthermore, this meant that the existing inadequate municipal staff was 'required to deliver, operate and maintain services over far larger areas than before, with population having increased from two to ten times in some cases instances' (CSIR and CIDB, 2007: 12). While this statement may be true, it is also pivotal to examine the profile of the staff that left local government. Many experienced staff left the public sector due to political changes in government, better opportunities in the private sector and abroad, as well as because of retirement (DWS, 2018).

Regarding the incompetence of staff, the problem is with the appointment of unqualified or unskilled staff in crucial positions such as engineering and finance. However, it is irresponsible to assume that all unqualified personnel are incompetent or lack necessary skills. The Officials that I interviewed argue that Metsi-a-Lekoa's staff includes many people

who, although not necessarily qualified in terms of the required National Qualifications Framework (NQF), were trained by highly qualified and skilled engineers at the advent of the democratic South Africa (Anonymous Official 1, interview, 17 October 2019; Anonymous Official 2, interview, 18 October, 2019). However, they further note that the unqualified yet skilled personnel cannot be promoted to senior positions as these positions require relevant qualifications (ibid). Figure 4.5 shows the educational level of ELM staff in terms of the NQF. The highest category,NQF 4, represents staff with FET certificates, followed by NQF 3 representing staff with a grade 12 certificate and NQF 1 which equates to grade 4 to grade 9 level of education (Emfuleni Local Municipality, 2019). It is evident from this graph that ELM has a skills shortage problem which could be another reason behind its failure to address the ongoing Vaal River water pollution crisis.

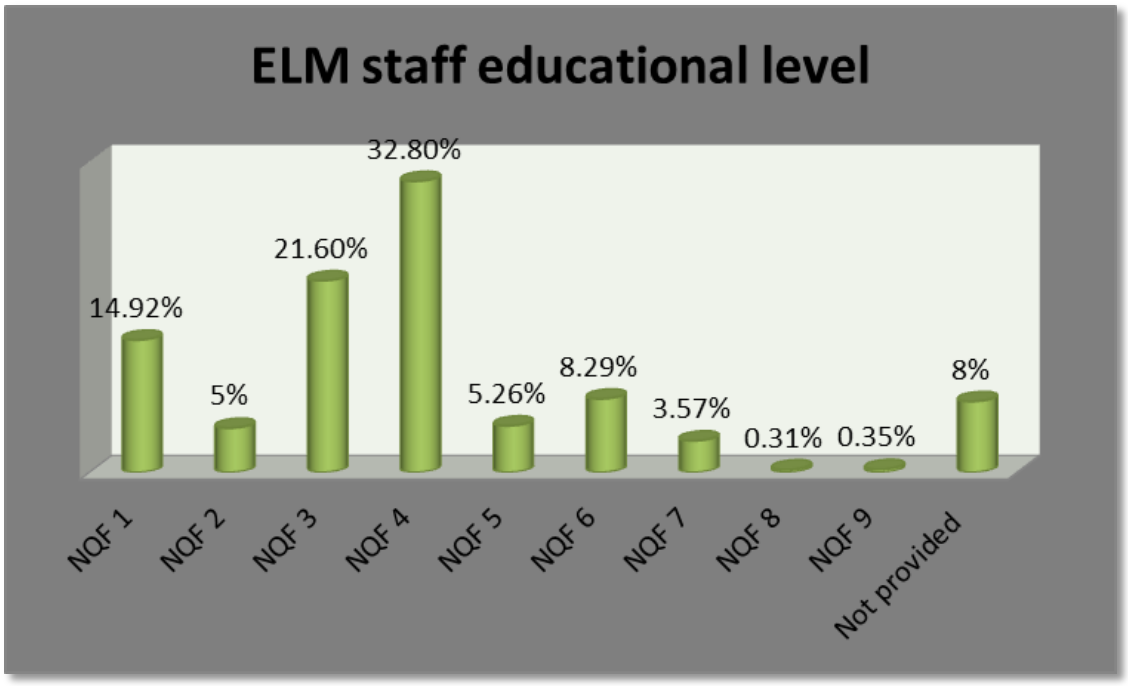


Figure 4.2. Emfuleni'sstaff educational level (Adapted from Emfuleni Local Municipality, 2019)

4.2.4. Noncompliance with regulatory requirements

The ongoing sewage spills into the Vaal River indicate the municipality's non- compliance with regulatory requirements relevant to water resources management. Madumo (2015) identifies noncompliance with regulations as one of the challenges confronting municipalities. The regulatory requirements for water resources management and

protection are contained in, *inter alia*, National Water Act (Act 36 of 1998) Water Services Act (Act 108 of 1997), National Water Resources Strategy (2004) and Emfuleni Local Municipality Wastewater By-Laws. The operation of pump stations and wastewater treatment plants is regulated and must be done within the parameters specified in the legislation (DPME, 2014; Anonymous Official 1, interview, 17 October 2019). The operation of infrastructure by unqualified personnel indicates Emfuleni's noncompliance with water and sanitation standards. Furthermore, inadequately skilled wastewater treatment works operators contribute to the ongoing sewage spills due to the inability to respond to complex policy requirements (ibid). The problem also lies with lack of *implementation* of legislation which could be motivated by lack of compliance monitoring and enforcement by authorities (CSIR and CIDB, 2007). Furthermore, compliance monitoring and enforcement requires human capacity with suitable knowledge and skills to monitor and enforce the law (Anonymous Official 1, interview, 17 October 2019).

4.2.5. Inefficient and ineffective administration, planning and management

Inefficient and ineffective administration, planning and management are directly linked to the challenges of both financial capacity and human capacity. Without suitable capacity, municipalities cannot efficiently and effectively *plan* for and manage their affairs (DSW, 2018). For example, increasing the capacity of pump stations and wastewater plants in order to efficiently service current and future populations should be planned and implemented by suitably qualified personnel (Anonymous Official 1, interview, 17 October 2019). Poor leadership[2] and political interference affect the ability of municipalities to deliver sustainable services (DPME, 2014). Likewise, Anonymous Official 1 (interview, 17 October 2019) confirms this assertion and states that the Sebokeng WWTW project is 98% complete. The refurbishment project is expected to solve a large part of the sewage spillage problem since it is malfunctioning and responsible for a significant amount of sewage spills (Sedibeng District Municipality, 2019). However, the project has been put on hold due to protests following the interference of ANC's national leaders. The ANC leaders promised community members that the project would provide employment opportunities for the youth and other qualifying members. Although this was true to some extent, the politicians failed to explain the requirements of jobs related to the local beneficiation programme

[2] Leadership refers to the administration of an institution, its political office and strategic sector coordination (DWS, 2018).

(Anonymous Official 1, interview, 17 October 2019). This is in line with the Preferential Procurement Regulations (2017) which stipulates that tenderers awarded contracts of at least R30 million must, if feasible, sub-contract 30% of the contract value to local Small Medium and Micro Enterprises (SMMEs) (RSA, 2017). This incident reflects the existing lack of transparency between political leaders and their constituents, as well as lack of effective participation of the community in local governance issue (DPME, 2014).

4.3. Understanding the Vaal River pollution impacts

The persistent challenge of the Vaal River pollution due to sewage spillages results in various impacts encompassing ecological, economic and social impacts. The negative impacts of water pollution are starting to have a knock-on effect on the development of ELM. The sewage pollution impacts in the Vaal River and Emfuleni are discussed below.

4.3.1. The detrimental impacts of sewage pollution on the natural ecosystem of the Vaal River and Emfuleni

Escherichia coli (E. coli)[3] level in the Vaal River due to sewage spills is of grave concern. E. coli has a detrimental impact on the ecosystem of the Vaal River particularly aquatic life and the health of Emfuleni residents (Mabuza (2019; Anonymous Official 3, interview, 12 December 2019). Additionally, the presence of sewage in the Vaal River increases phosphate which causes algae blooms Tempelhoff (2009b; Matthews and Bernard, 2015). Consequently, as the algae blooms decompose, they reduce the much needed oxygen for the survival of aquatic life, mainly fish (Tempelhoff , 2009b; Anonymous Official 3, interview, 12 December 2019). In 2006, thousands of protected indigenous yellowfish died in the Vaal River Barrage due to sewage spillages into freshwater resources (Tempelhoff, 2009b). This is indicative of the severity of the impacts of sewage pollution.

4.3.2. The negative impacts of sewage pollution on the local economy of ELM

The pollution of the Vaal River due to sewage spillages has negative impacts on Emfuleni's Local Economic Development (LED). The challenge of failing bulk infrastructure has serious implications for service delivery and economic development (Ashley and Cashman, 2006; Anonymous Official 3, interview, 12 December 2019). These impacts are evident mostly on businesses located along the banks of the River. For example, the Riviera Hotel is located on the banks of Vaal River and has a sewage pipe from pump station 10 running through the

[3] Escherichia coli (E. coli) is a microbial indicator of faecal pollution by warm-blooded animals or humans, usually indicating sewage or treated effluents in water (WHO, 1996; DWAF, 1996).

hotel's property. Due to dysfunctional infrastructure at pump station 10, sewage is spilling onto Riviera's property, affecting operations of the business (Anonymous Official 2, interview, 18 October 2019. During fieldwork, however, I learned that the sewage pipe running through Riviera hotel had been diverted into a nearby stream to prevent sewage from spilling onto the hotel's property (see Photo 4.4). Metsi-a-Lekoa may have diverted the sewage pipe to stop further spills into the Riviera Hotel, however, diverting the sewage flow into stream does not solve the problem but contributes to the pollution of the Vaal River.



Photo 4.4: Sewage pipe diverted into a stream (source: author's photograph, 18 October, 2019).

Property owners in the hospitality industry have also raised concerns about the sewage spilling into their properties which negatively affects the value of the properties and businesses (Tempelhoff, 2009b). Moreover, the stench coming from sewage has a negative impact on the quality of life of riverfront residents (ibid). More negative impacts of pollution are evident as the Vaal loses its attraction as a tourist destination and fishing venue

(Tempelhoff, 2009a). The aforementioned arguments suggest that the tourism sector is one of the most affected sectors. As a result, this affects its contribution to Emfuleni's LED.

4.3.3. Increased operational costs

The level of sewage pollution in the Vaal River has serious implications for the operations of water institutions such as Rand Water. The purification process of water containing untreated wastewater, especially raw sewage, is complex and includes high treatments costs to ensure the distributed potable water meets the required standards (CSIR, 2010; SAICE, 2017; Anonymous Official 1, interview, 17 October 2019). Consequently, increased operational costs directly affect potable water costs for consumers (Rand Water, 2011). Electricity is the main form of energy used in the water and sanitation system in South Africa (Rand Water, 2011; Anonymous Official 1, interview, 17 October 2019). Rand Water's water purification processes are threatened by increasing electricity costs (ibid). Another challenge associated with electricity is the implementation of power cuts by Eskom. Power cuts threaten the effective functioning of the water and sanitation system. During the course of my fieldwork, I visited the Emerald pump station where none of the equipment was working due to power outage which halted operations. This shows that the sanitation system is solely dependent on electricity to operate and there are no alternative plans in place for when electricity is cut. This may also cause sewage spills because non-functional equipment cannot process sewage (Anonymous Official 2, interview, 18 October 2019).

4.3.4. The social implications of water pollution in Emfuleni

The social implications of sewage pollution in the Vaal River have to do with the residents' quality of life and human health. First, E.coli levels are unacceptably high at the point where Rietspruit enters the Vaal River. Mabuza (2019) and Tempelhoff (2009) argue that E. coli Vaal River has been recorded at over 1 million cfu/100 ml clearly indicating a health risk for the ecosystem and Emfuleni residents. Second, the quality of life of Emfuleni residents is compromised as sewage runoff flows into large parts of the agricultural hub located south-west of Emfuleni are dependent on the Vaal River for irrigation water (Emfuleni Local Municipality, 2018). Consequently, there could be increasing risk on agricultural produce which in turn could have a negative impact on Emfuleni's LED and health of the consumers (CSIR, 2010). The killing of fish due to sewage pollution in the Vaal River compromises the livelihoods of many local small- scale fishermen who fish in the river to sell in the informal

sector or for sustenance purposes (van Riet and Tempelhoff, 2009; Anonymous Official 3, interview, 12 December 2019).

4.4. Institutional response to the Vaal River pollution crisis

4.4.1. Cooperative Governance

Institutional measures such as strengthening cooperative governance between Emfuleni and relevant institutions gained importance as attempts to address the Vaal River pollution began. Newly established partnerships are worth noting. First, the deployment of the South African National Defence Force (SANDF) to help eradicate the Vaal River pollution crisis is a widely discussed intervention by government. This is a partnership formed by the National Department of Water and Sanitation, SANDF and ELM, among other stakeholders. According to Mabuza (2019), the South African National Treasury (NT) announced the allocation of approximately R800m to address the Vaal River pollution crisis. National Treasury is responsible for, inter alia, financial management comprising budgeting and expenditure of institutions from all spheres of government (DWS, 2018). The deployment of the SANDF has raised questions concerning the actual mandate given to the Army and exact budget allocated for the project. First, there are varying budget figures of the project ranging between R176m to R800m (ibid). Second, the exact mandate given to the SANDF is not clearly communicated and seems to be constantly changing. It was initially stated that the SANDF would be rehabilitating the River (ibid). However, the mandate shifted to refurbishment of water and sanitation infrastructure (Emfuleni Local Municipality, 2019; Mahapa, 2019).

The Officials that I interviewed state that the rehabilitation of the Vaal River has not yet begun. Nevertheless, it is important to note that the SANDF has successfully delivered on its mandate to refurbish and maintain infrastructure at ELM pump stations and WWTWs. According to Mahapa (2019), the SANDF successfully installed, refurbished and recommissioned two of the three Primary Settling Tanks (PSTs) and unblocked 10km of sewer lines in Sebokeng. The refurbishment of dysfunctional infrastructure resulted in the drop of E. coli in the Vaal River (ibid). Additionally, two of the three pump stations I visited during fieldwork were guarded by the Army. The role to guard the pump stations and WWTWs was due to increased equipment theft incidents in these plants (ibid; confirmed by Anonymous Official 2, interview, 18 October 2019). As a result, vandalism and theft of

pumping instruments and electrical equipment declined (Mahapa, 2019). Noting SANDF's success in fixing some of the infrastructure in the Sebokeng WWTW, capacity challenges including limited equipment and financial constraints led to SANDF's failure to complete the project (ibid). The SANDF did not have the financial capacity required to complete the project and adequate wastewater equipment to be installed in these plants (ibid). As a result, the SANDF terminated their services.

Following SANDF's termination of services, DWS and relevant stakeholders procured the services of sanitation specialists, Ekurhuleni Wastewater Treatment Works (ERWAT). ERWAT services include refurbishment of the dysfunctional sanitation infrastructure which is responsible for sewage spillages into the Vaal River (SAHRC, 2018). ERWAT will install new pumps and pipe, as well as refurbish the Sebokeng Wastewater Treatment Works which has been dysfunctional for more than 10 years and continually spills high amounts of sewage (Mabuza, 2019; Tempelhoff, 2009b). Moreover, there is an internal intervention the local government argues will solve the ongoing sewage pollution crisis. This is the Sedibeng Regional Sanitation Scheme (SRSS) project which contains several components such as a new wastewater treatment plant and a new pump station (Sedibeng Dictrict Municipality, 2019).The proposed SRSS will service major settlements in the Sedibeng district namely Sebokeng, Vanderbijlpark, Vereeniging, and Meyerton, meeting the current and growing population demand for sustainable water and sanitation services(ibid).

4.4.2. Local NGO involvement

Few environmental NGOs exist within the jurisdiction of Emfuleni. Save the Vaal Environment (SAVE) is the most active and successful NGO in the fight for environmental justice in this area. The SAVE NGO was established by the Vaal River front property owners in the 1990s (Tempelhoff, 2009b). SAVE has gained prominence throughout the years as they advocate for environmental protection and ensuring that ELM takes responsibility for the ongoing pollution of the Vaal River. Their main currency is professional services provided by its members who are educated and experienced in different fields, including science and environmental management, as well as external services. The NGO has exposed Emfuleni in the media for their failure to address the pollution crisis. SAVE has gone to the extent of taking several entities such as Sasol to court for polluting the Vaal River (ibid). Tempelhoff (2009b) states that following SAVE's court action in November 2008, the

Johannesburg High Court ordered Emfuleni Local Municipality to repair the dilapidated sanitation infrastructure which was spilling sewage. Similarly, in February 2018, SAVE was granted an interdict against Emfuleni for the sewage spills which had been ongoing for over a decade (SAHRC, 2018). It is safe to say that some of the responses to the pollution of the Vaal can be accredited to the consistent work of SAVE as it continues to put pressure on the government to address the pollution crisis.

4.6. Conclusion

Data collected for this research shows that although the causes of water pollution vary, sewage spillage is currently the main cause of pollution of the Vaal River in Emfuleni. This chapter discussed the causes of ongoing sewage pollution and deteriorating water quality of the Vaal River. These causes encompass malfunction of ageing infrastructure, lack of infrastructure maintenance, lack of capacity, non- compliance with water and sanitation regulatory requirements as well as inefficient and ineffective administration and management. The resultant impacts are evidently detrimental and pose serious implications for the Emfuleni's environment comprising the ecology, economy and society. The intervention by DWS to deploy the SANDF to refurbish dysfunctional infrastructure is indicative of Emfuleni's failure to address the pollution crisis on its own. Similarly, SANDF's failure to complete the refurbishment project due to limited wastewater equipment and budget constraints also suggests that capacity challenges exist in all spheres of government and organs of state. These challenges hinder service delivery.

CHAPTER FIVE: ANALYSIS

A critical assessment of the causes and impacts of water pollution of the Vaal River in Emfuleni

5.1. Introduction

The previous chapter suggests that sewage spillage is the main cause of the Vaal River pollution in Emfuleni. It is of great concern that this problem persists although the national government has intervened to address the crisis. This chapter provides a critical assessment of the findings discussed in chapter 4, regarding the causes and impacts of the Vaal River pollution in Emfuleni. It also assesses the institutional response to the pollution crisis.

5.2. The causes and impacts of water pollution of the Vaal River in Emfuleni

5.2.1. Dysfunctional and inadequately maintained bulk infrastructure

Having been built over 60 years ago, the water and sanitation infrastructure in Emfuleni has reached its design lifespan. Therefore, the infrastructure is no longer effectively and efficiently functional (Sedibeng District Municipality, 2019). The last pump station that was constructed in Emfuleni is 32 years old. This reveals that the post- apartheid local government has not adequately invested in the development of new infrastructure to meet the demands of the growing population and development. The challenge of old and dilapidated infrastructure demonstrates a multilayered institutional challenge. This is apparent in Emfuleni's inability to adequately *plan* for infrastructure maintenance, *manage* finances as well as *retain* qualified and skilled staff. Besides capacity challenges, the issue of maintenance or the lack thereof reflects the common challenge in many municipalities failure to develop effective infrastructure maintenance policy (AGSA, 2017).Even when policy is developed, it is inadequately implemented (ibid). These issues underlie the sewage pollution crisis.

The *Independent Online* in Sedibeng District Municipality (2019) points out that only 30% of the pump stations are functional. This means 13 pump stations are fully functional while the other 31 pump stations are dysfunctional, limited in capacity or non- operational. Likewise, the three wastewater treatment works servicing Emfuleni are dysfunctional. These figures suggest that the sanitation system is in a critical state. The Water Services Act (RSA, 1997) stipulates that municipalities are responsible for the operation and maintenance of water

and sanitation infrastructure. The wastewater treatment works infrastructure needs to be refurbished and its capacity upgraded as soon as possible. This will reduce the ongoing sewage spillage that has been polluting the Vaal River. Since Emfuleni failed to maintain infrastructure on its own, it is plausible that the other spheres of government assisted Emfuleni to fulfill its executive obligation. For example, DWS, National Treasury, SANDF and ERWAT among other stakeholders, cooperated to address the pollution crisis by providing funding and technical expertise in order to refurbish old and dysfunctional infrastructure. The national government's response is in line with section 41 of the Constitution and the Intergovernmental Relations Framework Act (RSA, 1996; RSA, 2005) as they encourage cooperative governance between spheres of government with the aim to fulfill their executive mandate and deliver services.

5.2.2. The complex issue of capacity (design, financial, human resources)

Ashley and Cashman (2006) argue that functional urban infrastructure is essential for economic development, as it is both an investment[4] and a foundation for basic service delivery. Although this assertion is true, urban infrastructure has proven difficult to *plan* or maintain for different reasons. For example, the challenge of maintaining water and sanitation infrastructure is attributed to capacity inadequacies of institutions and existing infrastructure. The South African Cities Network (2014) reveals that Emfuleni's wastewater treatment plants are operating 150% above capacity due to the demand presented by rapid population growth. This point reveals that the institutions responsible for development planning lack effective strategies to deal with development challenges. The obvious risk of plants operating above capacity is sewage spillage which has been the main source of pollution in Emfuleni for more than a decade. Additionally, there is a safety factor that needs to be considered when operating dysfunctional or overloaded wastewater treatment infrastructure.

Lack of financial capacity coupled with administration capacity is the foundation of the capacity challenge facing many municipalities in South Africa. A municipality must have sufficient financial capacity to build new infrastructure and maintain existing infrastructure in order to cater for the growing population and development needs (DWS, 2018). It must

[4] Infrastructure is a long-term investment as a public asset created for the benefit of the community (SAICE, 2017).

also be in a position to employ new staff needed to plan, manage and operate infrastructure (Van der Waldt, 2002). Up skilling the existing human resources is important. Maintaining infrastructure should be one of Emfuleni's municipality's priorities because of the role it plays in ensuring efficient service delivery and to also reduce sewage spills from dysfunctional infrastructure. Although the national government provides funding for infrastructure projects through programmes such as Municipal Infrastructure Grant (MIG), the prioritization of infrastructure maintenance and service delivery is lacking (CSIR, 2010, DWS, 2018). This argument shows the issues of the budget lies with the lack of capacity to effectively and efficiently spend and not with its availability DWS (2018). Furthermore, CSIR and CIDB (2007) argue that in some cases, municipal administration might lack will to address service delivery challenges.

The lack of political will of Emfuleni's administration to deliver sustainable services reflects the incompetence of the current staff that holds significant positions. Incompetent staff often lacks foresight of the risks associated with the sewage spills and pollution of the Vaal River. When addressing pollution through interventions such as rehabilitation or infrastructure upgrade, the responsible stakeholder needs to have comprehensive financial management expertise. The impact of poor financial management[5] is evident in the SANDF's termination of their services in the middle of project due to financial constraints. The SANDF argues that it estimated the bulk infrastructure upgrade project would cost R1.1 billion although the National Treasury has allocated a budget of R800 million for the project (Mahapa, 2019). This challenge demonstrates the existent lack of effective financial management of the involved stakeholders. Additionally, it highlights the lack of transparency between the spheres of government with respect to the available and required budget (Van der Waldt, 2002). Transparency would have enabled the SANDF to properly plan or decide whether or not it had the capacity to deliver on this project prior to its deployment. This resulted in SANDF stepping down from its duties which delayed progress of the project.in the wastewater infrastructure upgrade project (ibid). The challenge of inadequate human resources confronting Emfuleni is confirmed by all. Chapter 4 revealed that Emfuleni has a low number of staff with tertiary education. This means that

[5] Financial management is defined as 'appropriate budgeting for all and operational expenditure within the available funding and implementation capacity of the organisations (DWS, 2018: 12-22).

the critical positions whose minimum requirement is a tertiary qualification are either not filled or filled by unqualified staff. This challenge is highlighted in government reports including, among others, the Emfuleni Local Municipality's IDP and Statistics South Africa (StatsSA). Table 5.2 and Table 5.3 demonstrate municipalities with the highest staff vacancy rates and highest staff vacancy rates in the water and wastewater department, respectively.

Table 5.2 Municipalities with the highest staff vacancy rates (Adapted from StatsSA Community Survey, 2016).

Municipality	Vacant posts (%)
Emfuleni Local Municipality	59 %
Msunduzi Local Municipality	53 %
Rustenburg Local Municipality	51 %
Mangaung Metropolitan Municipality	50 %
Nkonkobe Local Municipality	49 %

Table 5.3 (b) Municipalities with the highest staff vacancy rates in the water and wastewater department (Adapted from StatsSA Community Survey, 2016).

Municipality	Vacant posts (%)
Rustenburg Local Municipality	69 %
Mogale City Local Municipality	60 %
Ba- Phalaborwa Local Municipality	60 %
Emfuleni Local Municipality	54 %
Ubuntu Local Municipality	52 %

Nearly 60 % of vacancies in Emfuleni are not filled, while more than 50% of essential water and wastewater posts are also vacant. Both these tables indicate that Emfuleni has a

shortage of human capacity needed to deliver services and, particularly, eradicate the Vaal River pollution crisis. Since the Statistics SA Community Survey is from 2016, it is alarming that Emfuleni Local Municipality's 2019- 2020 IDP review suggests that many critical posts in the municipality are still not filled (see Figure 5.4). These posts are the most critical posts that can ensure sustainable services are delivered to the community of Emfuleni.

Table 5.4: Emfuleni's Human Resources (adapted from Emfuleni Local Municipality, 2019)

Cluster	Department	No. approved posts	Filled posts	Vacant posts	Vacancy rate %	Critical vacancies
Chief Directorate: utilities & strategic projects (Metsi-a-Lekoa)	Office of the Chief Director	21	5	16	76.19	1
	Operations	617	267	350	56.73	254
	Projects & Planning	21	4	17	80.95	6
Chief Financial Officer	Office of the CFO	10	5	5	50.00	3
	Budget	14	5	9	64.29	5
	Expenditure	48	29	19	39.58	8
	Financial control	28	14	14	50.00	4
	Assets management	12	2	10	83.33	1
	Credit control & debt management	44	14	30	68.18	11
Public works	Environmental management & planning	508	335	173	34.06	169
Infrastructure planning & development	Office of the Executive Director	4	2	2	50.00	0
	Programme & administration	19	10	9	47.37	2

	PMU	19	9	10	52.63	13

On the other hand, it is important to be cognisant of Emfuleni's limited financial capacity which contributes to the municipality high rate of vacant positions. Most municipal challenges are associated with finances or the lack thereof. For municipalities to attract and retain highly skilled staff, they need to have a sufficient budget to remunerate the required staff accordingly. Likewise, DWS (2018) argues that municipalities often lack competitive salaries and suitable working environment which enable municipalities to attract qualified staff. Having noted the challenge of vacant posts, the departure of qualified, skilled and experienced staff is also a major threat to municipal service delivery (CSIR and CIDB, 2007). This includes staff that have already retired and those who will retire in the coming years (ibid). Therefore, staff incompetence, either due to lack of skills, or lack of will to deliver services, is a factor that cannot be contested. While the shortage of competent staff continues, the state of the Emfuleni's water and sanitation infrastructures worsens. Consequently, sewage spills and the deterioration of the Vaal River persist. .

5.2.3. Noncompliance with regulatory requirements and ineffective enforcement of the law

It is apparent from the previous chapters that there are many issues underlying the on-going pollution of the Vaal River. Non- compliance with regulatory requirements comprising relevant legislation, water use guidelines and specifically infrastructure asset management standards, is one of the reasons for the collapse of infrastructure and continued sewage spillages in the Vaal River (SAICE, 2017). In terms of the non-compliance with water use guidelines, the level of E- coli found in Vaal River and its tributaries indicates gross negligence and lack of effective water quality monitoring measures. For example, E. coli is above 1 000 000 cfu/100 ml where the Rietspuit River and Vaal River meet (Mabuza, 2019). Similarly, laboratory results of an assessment conducted by SAVE of the Vaal River Barrage in November 2007 found that there were over 1 million cfu/100 ml of E. coli and faecal coliform bacteria in the samples collected for the assessment (Tempelhoff, 2009a). This confirms that E.coli levels in the Vaal River and its tributaries have been exceeding acceptable standards (discussed in chapter 3) for over a decade due to sewage pollution.

The sewage pollution crisis in the Vaal River reveals that Emfuleni Local Municipality is negligent concerning environment management (Tempelhoff, 2009b). Although the Minister of DWS is the trustee of water resources, NEMA Section 28 provides for duty of care and remediation of environmental damage. NEMA Section 28 (RSA, 1998:41) clearly states that:

> (1) 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 to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

This provision places the responsibility to prevent, control and remedy pollution upon the person, organ of state or private persons causing it. Emfuleni Local Municipality is expected to adhere to all provisions of the legislation relevant to the pollution crisis.

Lack of compliance monitoring and enforcement contribute to the Emfuleni's lack of urgency with regard to addressing the crisis (ibid). The DPME (2014) asserts that the public sector, especially municipalities lack awareness of the legislation which affects its implementation. There is also a culture of non-accountability within local government. According to AGSA (2018:20), in terms of local government, 'accountability refers to the need for municipal leaders to be able to answer to local communities and to be responsible for their actions, decision and policies'. Correspondingly, DPME (2014) makes the point that lack of accountability in municipalities sets the precedence that it is acceptable for Officials and political leaders to not deliver services or comply with regulatory requirements. Furthermore, lack of accountability has led to communities' distrust and low confidence in local government which is part of the reason for increasing service delivery protests (ibid). An interesting occurrence, however, is evident in many local municipalities, particularly in Johannesburg where politicians disguise their political fights over economic resources as protests (Olver, 2016). According to Olver (2016), ANC members holding top positions in the organisation's local structures have been found to be at the forefront of service delivery protests. The intention of the protests is usually to disrupt developments which do not allow them access to economic resources and positions (ibid). Olver (2016) further contends that using violent protests to gain access to resources signifies the moral decay of South Africa's

politics. The significance of this statement is that political leaders are continuously proving to be serving their own economic interests instead of serving the South African public.

5.2.4. Inefficient and ineffective planning and poor leadership

Anonymous Official 1 (interview, 17 October 2019) argues that in addition to the abovementioned reasons for the ongoing pollution, Emfuleni does not have effective planning systems and leadership in place. This assertion is due to the evident fragmentation of the departments within ELM and external stakeholders 1 should be working together to solve the pollution problem. Failure to manage stakeholder relations may also be a result of the evident leadership vacuum within Emfuleni Local Municipality. The constant change of leaders in Emfuleni affects the effective management of the Municipality. Emfuleni's IDP documents for the 2017-2021 period, 2018 and 2019 reviews indicate that the Emfuleni administration changed Executive Mayors every year. The Executive Mayor for the 2017-2021 IDP is Cllr. Mahole Mofokeng. Cllr. Jacob Lehana Khawe is the Executive Mayor for the 2018 IDP review while Cllr. Gift Moerane is the Executive Mayor for the 2019 IDP review. This may also signify the evident infighting and factionalism within the ANC which has led to constant change of leadership in the Municipality (Marais et al, 2016; Olver, 2016). Factionalism and infighting are more often than not prompted by what Olver (2016) refers to as 'transactional behaviour' whereby politicians are guaranteed access to, inter alia, resources and political appointments. Politicians seem to form alliances with individuals who can guarantee them resources and appointments. When deals and promises of economic benefit are not fulfilled, division and fights within the organisations start. The political space becomes a market where political positions and economic resources are sold or reserved for the most powerful faction.

The institutional interventions employed to address the sewage spills and Vaal River pollution exposed existing inadequate stakeholder management and lack of effective communication the stakeholders and the community. For instance, Mabuza (2019) states that SAVE highlighted the uncertainty in the community about the exact mandate of the SANDF due to contrasting reports. Some reports stated that the mandate given to the Army was for the rehabilitation of the Vaal River, while some reports stated that the SANDF was deployed to fix the dilapidated sanitation infrastructure. This deployment should have been clearly defined and communicated prior the commencement of the project to avoid

confusion and so that there could be accountability from stakeholders. Nevertheless, the Army was successful in refurbishing some parts of the infrastructure at the Sebokeng WWTW. The SANDF also managed to guard the municipality's pump stations and WWTWs and subsequently reduced equipment theft and vandalism incidents (Mahapa, 2019). The departure of the SANDF came amidst talks about the appointment of water and wastewater management specialists, Ekurhuleni Wastewater Treatment Works. In terms of technical capacity, ERWAT is the ideal service provider to undertake the task of upgrading dilapidated infrastructure in Emfuleni. However, in terms of the budget, it is not clear if the funds allocated by National Treasury in 2018 will be revised.

5.3. The impacts of water pollution in the Vaal River, Emfuleni

The negative impacts of water pollution are also evident from the killing of aquatic life particularly fish amongst other impacts (Tempelhoff, 2009b; DWS, 2016). These impacts have a detrimental impact on the ecosystem's biodiversity and sustainability. From the assessment of the causes and impacts of the pollution, it can be deduced that the relevant stakeholders in water resources management have been employing a reactive approach instead of a proactive approach in terms of addressing the pollution crisis. This kind of management is not ideal in the context of Emfuleni that confronted with capacity and governance challenges comprising financial constraints, old infrastructure and poor leadership. What also stands out from the findings of this is lack of infrastructure maintenance. Section 152(1) of the Constitution (RSA, 1996) specifies that the objectives of local government are to inter alia:

a) ensure the provision of services to communities in a sustainable manner;
b) promote a safe and healthy environment

The Municipal Systems Act (RSA, 2000) sets similar provisions to which municipalities must give effect. In terms of service delivery, Section 73(2) of the Act stipulates that municipal services must, *inter alia*:

a) be equitable and accessible;
c) be financially sustainable
d) be environmentally sustainable

Since infrastructure is fundamental for economic development, the collapse of essential infrastructure has negative implications for Emfuleni's LED, as well as sustainable service

delivery. Correspondingly, CSIR (2010) emphasises that water services infrastructure is fundamental for economic development and improving quality of life by delivering accessible and reliable services. Accessible and reliable services are possible only when infrastructure is effectively operated and maintained (ibid). The Officials that I interviewed in the course of my fieldwork agree that ELM's water and sanitation infrastructure is old, dysfunctional and not maintained. Therefore, the municipality is not in a position to ensure sustainable service delivery.

In 2007, Emfuleni's economy was already experiencing the negative impacts of the deteriorating quality of the Vaal River due to sewage pollution. Tempelhoff (2009a) writes that during this period, the number of tourists booking holiday accommodation in the riverfront decreased due to bad odour coming from sewage spillages in the Vaal River. Sewage pollution affects the aesthetic value of recreational water (DWAF, 1996). Although the Tourism sector has never been a significant contributor to ELM's economic development (see Table 5.5), Emfuleni and Sedibeng District Municipality Officials believe this sector has potential to make a significant contribution to Emfuleni's LED. This is due to its natural landscape which consists of the Vaal River, several watercourses which form a greenbelt and the Sharpeville Monument (Emfuleni Local Municipality, 2018). Consequently, Sedibeng and Emfuleni have developed the 'River City' and 'Vaal 21' and concepts which put emphasis on the endowment of Emfuleni with watercourses and to promote the renewal of the Emfuleni towns in order to become tourism corridors and nodes (Emfuleni Local Municipality, 2017; Sedibeng District Municipality, 2018). On the other hand, the River City concept might never be realized due to the ongoing pollution of the Vaal River and Emfuleni's environment as a whole.

Table 5.5 Economic performance by economic sectors in Emfuleni (Source: Emfuleni Local Municipality Annual Report: 2007/2008).

Economic Sector	Employment (Number)	Percentage
Agriculture	2 029	1.9
Mining	1 230	0.8
Manufacturing	34 122	22.2
Electricity/Gas/Water	2 367	1.5

Construction	7 812	5.1
Trade	25 717	16.1
Transport	7 277	4.7
Financing	13 228	8.6
Services & other	29 105	18.9
Tourism & Entertainment	**2 176**	**1.4**
Private Households	17 124	11.1
Undetermined	10 580	6.9
TOTAL	**153 657**	**100.00**

The deteriorating water quality of the Vaal River causes a decline in property investments which contribute to the LED of Emfuleni (Tempelhoff, 2009a; Anonymous Official 3, interview, 12 December 2019). Additionally, sewage- polluted Vaal River has resulted in the suspension of recreational events responsible for generating income for Emfuleni by attracting visitors from across the country. For example, bass angling is one of the major sport events that take place in the Vaal annually, contributing a significant amount of money to Emfuleni's LED and about R1,2 billion to the national economy (Tempelhoff, 2009a). Angling is, nevertheless, an intermediate- contact recreational use which may not have the same health risks as full contact recreation (DWAF, 1996).

5.5. Institutional responses to the Vaal River pollution problem

5.5.1. Cooperative Governance

A number of factors affect effective cooperative governance in Emfuleni. The Rand Water and ELM seem to be cooperating effectively in terms of the delivery of potable water. This statement is supported by the fact that 96% of households in Emfuleni have access to clean and safe piped water which is provided by both ELM and Rand Water. The remaining four percent is the number of households who get water from sources such as boreholes. Rand Water also does notable work by developing training programmes to train the local youth for basic technical skills needed to fix broken taps in the community. One important achievement of the training programme is the reduction in non-revenue water. The programme, however, is not a long- term or sustainable initiative because it does not offer permanent employment for the youth. These newly trained people could improve the

capacity of technically skilled human resources in Emfuleni Local Municipality. Another notable threat to effective governance in ELM is the fragmentation of the departments within the Municipality. The departments may have strategies in place to address the pollution crisis, but it becomes difficult to achieve their goals if they are not integrated in their goals.

5.6. Conclusion

The assessment reveals that the causes of water pollution are underlain by numerous institutions issues. Regarding dysfunctional and inadequately maintained bulk infrastructure, the argument is that WSA's noncompliance to the regulatory requirement to maintain infrastructure has led to the breakdown of the infrastructure. This chapter also suggests that insufficient capacity (design, financial, human resources) is exacerbated by poor leadership, as well as ineffective and inefficient planning and management within the administration of Emfuleni. Noncompliance with water resources management legislation and guidelines, as well as infrastructure asset management regulations is due to lack of law enforcement in all spheres of government The impacts of the Vaal River pollution are detrimental for Emfuleni in terms of economic, social and ecological aspects. Additionally, cooperative governance remains a challenge for Emfuleni and relevant stakeholders. therefore, comprehensive measures must be taken to capacitate stakeholders and improve their relations in order to ensure sustainable service delivery.

CHAPTER SIX

Conclusion and recommendations

6.1. Concluding remarks

The findings of this study reveal that water pollution is a major environmental challenge in South Africa due to, inter alia, acid mine drainage, eutrophication and solid waste. The findings indicate that sewage spillage is the main cause of the Vaal River pollution in Emfuleni Local Municipality. The underlying factors of the sewage spillage are due to evident institutional factors which include, among others, capacity constraints, collapse of ageing wastewater infrastructure and noncompliance with regulatory requirements. Emfuleni's capacity challenges encompass financial constraints, lack of technically- skilled personnel and design capacity of old infrastructure that has become inadequate in size and use due to population growth and outdated technologies, respectively. Emfuleni's many challenges are also linked to governance issues such as poor leadership. It is apparent from the findings that corruption, political in-fighting and lack of accountability within the leading party have enabled unconstitutional activities and poor service delivery in Emfuleni to continue, including failure to address the sewage pollution crisis.

In addition to revealing the underlying factors to the main cause of water pollution in the Vaal River, this study also highlights the impacts this crisis has on the environment encompassing ecological, economic and social impacts in Emfuleni. The negative impacts of the pollution crisis are evident in the ecological state of the Vaal River as E. coli levels and other pollutants remain high due to the ongoing sewage spillages. This results in fish kills and deterioration of the ecosystem. The social impacts are concerned with the health risk of E. coli to people who may come into contact with the sewage polluted water. Additionally,

the negative impacts are evident on Emfuleni residents' quality of life due to bad odour emanating from the River. This was also a firsthand experience as I was driving to the pump stations around Emfuleni. The bad odour became unbearable I drove closer to the river and the dysfunctional pump stations. This study suggests that the impact on Emfuleni's economy manifests in the tourism sector and property market. With regard to tourism, the sector is experiencing a decline in the number of visitors coming to enjoy the recreational activities offered by the Vaal River and other entertainment amenities close to the river. Lastly, the value of riverfront properties has also been negatively affected due to the declining aesthetic value of the Vaal River as sewage floats in the water and odour overwhelms the town.

This study has managed to show that South Africa has a conceptually sound water legislative framework which is adequate to address the Vaal River pollution crisis. Yet, implementation and compliance remains a challenge. For instance, the study shows that regulatory requirements for, *inter alia*, protecting the environment or water resources and operating or maintaining wastewater treatment infrastructure and are not adhered to. This could be motivated by the lack of monitoring and reporting by relevant institutions, as well as the perception that there are no repercussions for noncompliance with the law, especially in local government. For example, no arrests or prosecution followed the audit findings on Emfuleni's irregular expenditures of approximately R872m in the 2017/2018 financial year. Although the Premier of Gauteng placed the municipality under administration, it is apparent that this action alone was not sufficient to fix the corruption challenge in the municipality. Perhaps the community could also a part in ensuring that public service leaders are accountable for their actions, especially corruption. They can do this by taking back their 'power' and finding an alternative political party to support and elect to lead Emfuleni. Furthermore, the Constitutional provision in section 41 (1) (h) (vi) which states that 'spheres of government and organs of state must co-operate with one another in mutual trust and good faith and avoid legal action against one another' may be misconstrued as enabling noncompliance and unaccountability within government. Nevertheless, this sets a bad precedent for private entities who may not be compliant with the legislation at present or in future. The municipality should lead its constituents by example.

The deployment of the SANDF and ERWAT in response to the pollution crisis signifies the institutional intervention which was in question in terms of addressing the ongoing pollution. However, challenges such as financial constraints which led to the termination of SANDF's services, are indicative of the existing institutional capacity challenge in all spheres of government and organs of state in South Africa. Adequate institutional capacity enables government or institutions to effectively execute their obligations and service delivery. Thus, it is obvious that unless Emfuleni's institutional challenges are addressed, the pollution and deterioration of the Vaal River will continue, and so will the associated impacts.

6.2 Recommendations

The following recommendations pertain to the River pollution crisis in Emfuleni, how it can be addressed and how to strengthen the institutional aspect of the challenge.

(a) Improve institutional capacity

Emfuleni local municipality needs to invest in improving its capacity in terms of financial resources, design capacity of sanitation infrastructure and technically- skilled personnel. With regard to financial capacity, the study reveals that municipalities do receive adequate budget for service delivery such as infrastructure development and maintenance from the Municipality Infrastructure Grant, for example. Emfuleni must ensure that infrastructure funds are effectively used. This will require qualified and experienced professionals to plan, commission and maintain infrastructure. Therefore investing in boosting capacity in this regard is important. Additionally, ensuring optimal use of available funds from the National Treasury is also pivotal. Improving technical capacity is not only about hiring more personnel but, it also includes further training and up- skilling of current staff who may not be competent for the posts they are in. It should be noted that the three components of capacity are closely interlinked. The improvement of financial capacity will enable the municipality to hire more technically- skilled personnel. This in turn will enable the municipality to effectively manage and use the funds provided by the MIG to upgrade or construct new sanitation infrastructure and ultimately solve the sewage pollution crisis. At the same time, the municipality needs to ensure that infrastructure is maintained according

to the norms and standards of infrastructure asset management. It is also recommended that Emfuleni recruits retired engineers who had decades- worth of experience in the water and sanitation sector to train and mentor newly qualified or inexperienced personnel. These posts can be on consultative or contract basis. These recommendation are not limited to Emfuleni but, also to the other spheres of government and organs of state which have demonstrated to have the same capacity challenges.

(b) Integration of sectoral departments within Emfuleni

This study shows that sectoral departments are disintegrated in Emfuleni. The municipality needs to focus on the integration of Metsi-a-Lekoa whose responsibility is to deliver effective management of water and sanitation infrastructure and the finance department to ensure effective financial management. It is also recommended that, the environmental management & planning department must be involved in the rehabilitation project of the Vaal River and other environmental issues in the area. Noting that the management of water resources is a Department of Water and Sanitation mandate, it is important that the Department allocates adequate budget for the rehabilitation of the Vaal River once the infrastructure has been upgraded. Lastly, Emfuleni Local Municipality must also ensure that the measure taken regarding infrastructure asset management and water resources management are coherent with applicable policies.

(c) Strengthen cooperative governance

This research indicates that although effective cooperative governance is evident is some partnerships with the municipality, there is a need to strengthen the old and new partnerships. Effective cooperative governance is not only important vertically or between the spheres of government but, also horizontally with other relevant stakeholders such as private sector and community or its representatives. For example, the provincial or national governments can intervene in assisting Emfuleni solve its capacity challenges since the municipality has failed to address the problem on its own. In terms of governance with organs of state such the SANDF which was deployed to assist eradicate the pollution crisis, deeper engagements on issues such as financial capacity need to be ongoing. SANDF running out of funds in the middle of the project indicates there may have been

communication breakdown or lack of transparency among the stakeholders involved in decision- making.

(d) Introduce stringent legislation enforcement mechanisms

The apparent noncompliance with legislation in Emfuleni is of grave concern. Emfuleni was found to be noncompliant with various regulatory requirements including, inter *alia*, water quality guidelines, infrastructure asset management standards, as well as water resources management requirements. It is recommended that Emfuleni adopts and implements monitoring programmes to ensure that regulations or norms and standards for water resources management and infrastructure are adhered to. It may be a Constitutional provision for spheres of government to avoid taking legal action against one another but the magnitude of the pollution of the Vaal River warrants for rigid measures to be taken against Emfuleni. Sewage spills have been happening for over a decade. Therefore, measures including monetary penalties (polluter pays) should be enforced, especially by the national government. Lastly, government must introduce stricter actions such as dismissal and prosecution of municipal Officials found guilty of corruption or mismanaging funds intended for service delivery and ultimately the community's socio-economic development.

(e) Noting that the sanitation infrastructure in Emfuleni is currently being upgraded, it is equally important that the rehabilitation of the Vaal River is considered. For future research, it is recommended that rehabilitation measures are explored in order to restore the natural function of the Vaal River.

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