A comparison of the legal environmental sustainability requirements of those engaging in the mining cycle, with actual practice in the Carolina X11B quaternary catchment, Mpumalanga, South Africa

Gareth Thomson

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This thesis is submitted in fulfilment of the requirements for the degree of Master of Science Degree, Water Resource Science at Rhodes University

by

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Supervised by

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and

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Summary

Mining is one of the most contentious water users. The mining sector has assumed that promises of economic growth and job creation will enable environmental concerns to be by-passed with as little interference as possible. More recently, the reality of legacy issues related to the inappropriate sign-off of mining sites has become increasingly clear, with acid mine drainage (AMD) being a prime example. There are also increasing concerns regarding uncontrolled prospecting.

Climate change is one of the major issues faced in the 21st century, with predictions of heightened water stress for the Southern African region. This, coupled with increased population growth is putting a massive strain on the water resources currently available, making it vital to better protect and ensure the longevity of our water resources.

The Carolina Crisis of 2012 highlighted the importance of protecting our water resources, and how easily they can be contaminated to a point where water is not usable. The Carolina crisis provided researchers with a suitable study site to better understand the role mining operations have in a catchment that has experienced a major pollution incident, and what changes have occurred since.

In order to understand coal mining practice in relation to regulatory provisions, this project critically explored the processes involved within the mining sector, from ‘cradle-to-grave’, which is known as the coal mining life cycle. In addition, the composite suite of requirements of all the legislative provisions involved in the industry were investigated and the relationship between coal mining practice and environmental protection was explored.

These elements were researched in the Upper Komati River Catchment specifically for catchment X11B, using Cultural Historical Activity Theory (CHAT), which gives a holistic understanding of mining as a human activity system. CHAT also sheds light on the issues, gaps and overlaps currently being experienced in the coal mining sector. The Thesis refers to case studies of where mining issues have caused environmental degradation.

A complete mining lifecycle in terms of regulatory provisions was compiled, and major issues were uncovered with current legislation in the mining sector that can contribute to the degradation of water resources in South Africa.

An integrated water resource quality management plan is needed in order to streamline conservation mandates, identify and reduce duplication of effort and specify roles and responsibilities of authorities involved with decision making process. A Decision Support System (DSS) has been proposed, which would involve adaptive, participatory and inclusive management.

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LIST OF ABBREVIATIONS AND ACRONYMS

AMD	Acid Mine Drainage
AWARD	Association for Water and Rural Development
CER	Centre for Environmental Rights
CHAT	Cultural Historical Activity Theory
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DEDET	Department of Economic Development, Environment and Tourism
DMR	Department of Mineral Resources
DSS	Decision Support System
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Electrical conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan (MPRDA)
EMPr	Environmental Management Programme (NEMA)
EWT	Endangered Wildlife Trust
FSE	Federation for a Sustainable Environment
GDACE	Gauteng Department of Agriculture, Environment and Conservation
GN	Government Notice
I&APs	Interested and affected parties

ICMM	International Council on Mining and Metals
IPCC	Intergovernmental Panel on Climate Change
IUCMA	Inkomati-Usuthu Catchment Management Agency
IWUL	Integrated Water Use Licence
MPRDA	Mineral and Petroleum Resources Development Act (No. 28 of 2002)
MTPA	Mpumalanga Tourism and Parks Agency
NDP	National Development Plan
NEMA	National Environmental Management Act (No. 107 of 1998)
NEMPAA	National Environmental Management Protected Areas Act (No. 57 of 2003)
NGO	Non-governmental organisation
NHRA	National Heritage Resources Act
NWA	National Water Act (No. 36 of 1998)
pH	Power of hydrogen
PPP	Public Participation Phase
RBM	Richards Bay Minerals
SANBI	South African National Biodiversity Institute
UKF	Upper Komati Forum
WCWDM	Water Conservation and Water Demand Management
WMAs	Water Management Areas
WQ	Water Quality
WRC	Water Research Commission
WWF	World Wildlife Fund

ACKNOWLEDGEMENTS

I would like to thank my supervisors, Prof. C.G. Palmer and Dr V. Munnik for their constant advice, assistance and motivation for the duration of this research project. I would like to thank Prof. C.G. Palmer, the Institute for Water Research and The Water Research Commission for funding this project and making it possible.

I would also like to thank the Inkomati-Usuthu Catchment Management Agency for their support and for having provided me with office space. A special thanks goes to the Compliance and Monitoring and Enforcement Team for their consistent help throughout this project and who were happy to include me on site visits and meetings.

I would like to thanks Ben Cobbing from the CSSGIS for producing improved GIS mapping in this project.

I would like to thank my family for their continuous support and motivation throughout the duration of my studies.

DECLARATION

The following thesis has not been submitted to any university other than Rhodes University, Grahamstown, South Africa. The work presented here is that of the author.

Chapter 1: Introduction

1.1 A catchment-based approach

A water catchment or watershed is widely recognized as a structural and functional basis for delineating a bio-physical boundary for surface land and water system (Flotemersch *et. al.,* 2016). A watershed comprises of physical, biological and chemical elements that are connected by the flow of water (Flotemersch *et. al.,* 2016). Watersheds provide ecosystem services that are important and in many cases necessary for society, including supporting services, provisioning goods and services, regulating services and cultural serves (Millennium Ecosystem Assessment, 2005). According to Flotemersch *et. al.* (2016) the quality and quantity of these services are declining due to land-use change, water consumption and climate change, which is evident by the global deteriorating state of freshwater biodiversity.

Catchments comprise essential natural resources including land, water, geological resources, and people (catchment residents, workers and visitors) (Pollard and Du Toit, 2008). These systems have multiple drivers, and the components of the systems are independent, for example ground water and geological resource boundaries may not coincide with surface water catchment boundaries (Pollard and Du Toit, 2008). Folke (2006: 257) states a complex system "consists of heterogeneous collections of individual agents that interact locally, and evolve in their genetics, behaviour, or spatial distributions based on the outcome of those interactions". A social-ecological system is an integrated system of ecosystems and human society with a corresponding feedback, and a dependence of each other (Folke *et. al.,* 2010). Therefore we conceptualise the catchment as a complex social ecological system (Pollard and Du Toit, 2008)(Folke, 2006).

Coal is one of the world's most contentious geological resources – driving the major proportion of energy, in South Africa, where 93% of electricity production is coal based, and contributing to anthropogenic climate change (EBERHARD, 2011). South Africa is the 15th largest emitter of CO2 from fuel combustion, and 65% of these CO2 emissions were through the burning of coal to produce electricity by Eskom (EBERHARD, 2011).

Since coal mining already has a recognised environmental impact (WWF, 2011), and may have a limited future (30 – 100 years) (Eberhard, 2011), there is a risk that environmental legislation and enforcement will become increasingly difficult. A major risk is that large international mining corporations, with some regard for reputation, disinvest and smaller less well-resourced companies take over, without any capacity for responsible closure, leaving an even worse legacy of environmental degradation.

In many areas, and in the selected study area, agriculture may well be more sustainable as a long term natural resource-use option, as long as mining-related impacts do not irreparably harm agricultural futures (van der Waals, 2016). The Bench Marks Foundation (2014) believes coal mining is reducing the highly arable land of Mpumalanga.

In South Africa the quaternary catchment X11B in the Carolina district is located in an area where farming and mining compete. It was therefore selected to explore gaps between environmental legislative requirements for coal mining and actual mining practice, and to view these through a lens of the current environmental condition of the catchment.

Therefore the aims of this research are to provide a consolidated synthesis of environmental protection considerations and legislative provisions for coal mining in South Africa (Chapter 3); to compare actual coal mining practice with the environmental legal requirements (Chapter 4); to describe aspects of ecological conditions in Carolina quaternary catchment (X11B)(Chapter 4); and to examine research findings with stakeholders in the study catchment (Chapter 5).

Conceptual and theoretical framing

In terms of the use of legislation to achieve environmental protection and sustainable use of resources (or indeed social equity [Clifford Holmes *et. al.*, 2016]) there is often a gap between "rules in form", such as formal legal provisions, and "rules in use" – the actual practices that emerge as "the way things are done". It is often this gap that emerges as evident environmental degradation or social inequity (Clifford Holmes *et. al.*, 2016).

To make these connections across law, coal mining practice, and ecological condition conceptual framing was developed based on an understanding of catchments as a complex social-ecological system (Folke, 2006).

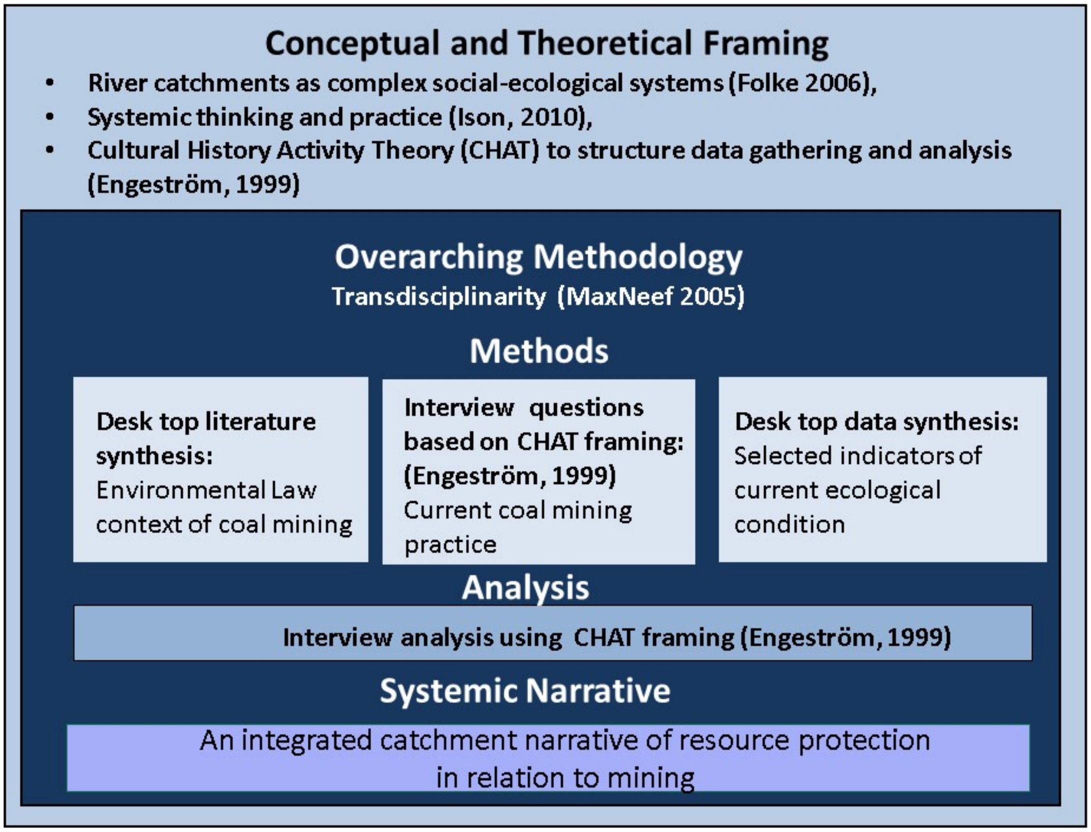


Figure 1.1. A heuristic relating the conceptual and theoretical framing to an over-arching methodology. The research is case-study based, and is located in a specific quaternary catchment (X11B, in Mpumalanga South Africa) because this catchment experienced a dramatic acid mine drainage crisis in 2012, providing a clear illustration of the environmental risk of coal mining. Relevant methods are related to each of the content chapters (Chapter 3-5), with Chapter 4 requiring appropriate data analysis. After the results of the three content chapters are presented, the final systemic narrative (using Ison 2010), brings the content together using the overall methodology of transdisciplinarity (Max Neef 2005).

1.2 Water scarcity and mining

Water is recognised throughout the world as the most fundamental and indispensable resource; without it the sustainability of social and economic development and environmental diversity would not be possible (Ashton *et al*., 2001). Virtually every country is facing a severe and growing challenge to meet the rapidly increasing demand for water, while fighting dwindling water supplies due to resource depletion and pollution (Ashton, 2002). According to the World Wildlife Fund (WWF), (2014), one of the most decisive factors that will affect South Africa's economic, social and environmental well-being over the next decade is water availability, which is already limited. According to the Department of Water Affairs (DWA), (2013), South Africa is speedily reaching full utilisation of available surface water yields, which includes the current water infrastructure, where all the financially viable freshwater resources are being used, and further dam development will be unable to address the issue. South Africa is the 30th lowest country in per capita water availability, and will have an estimated 1.7% water shortfall by 2025, according to current water use and population growth (WWF, 2014). Water availability is varied in both space and time and its short- and long-term availability is uncertain (International Council on Mining and Metals (ICMM), 2015). Figure 1.2 illustrates South Africa as a water-stressed country.

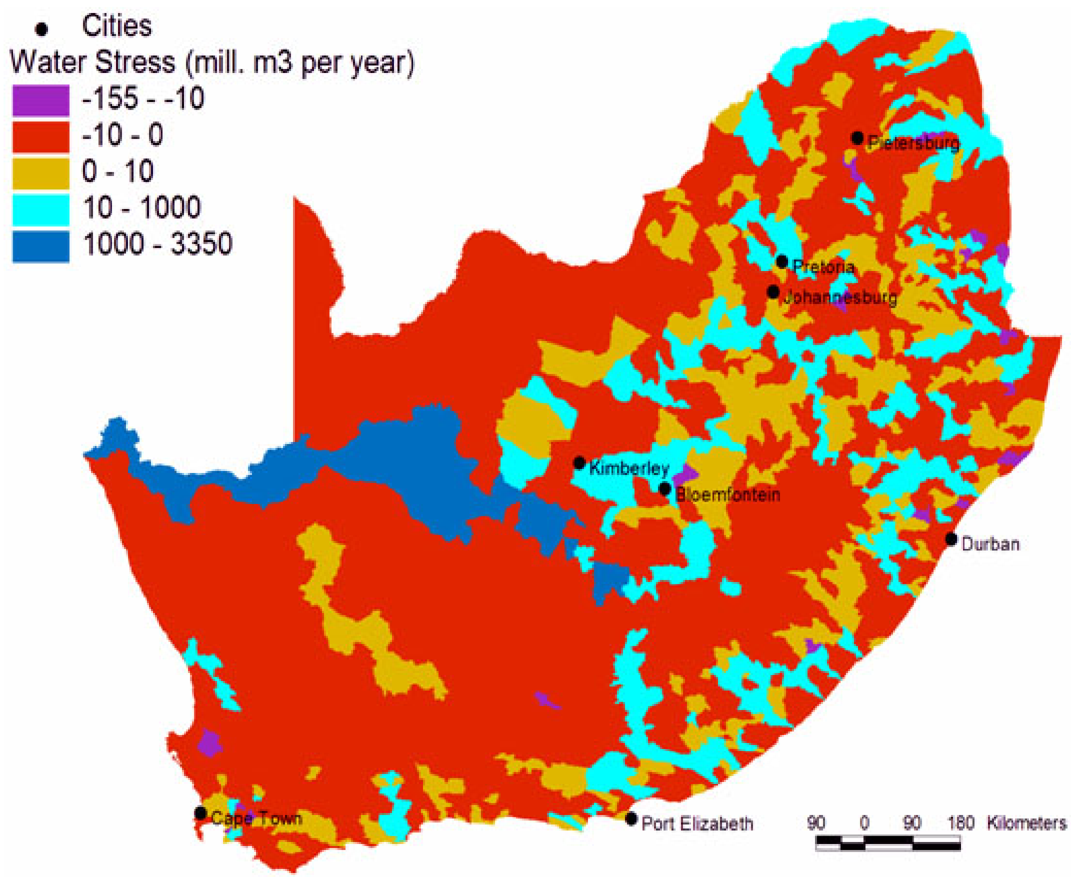


Figure 1.2: The 2005 annual water balance in South African Catchments, where water stress occurs when the demand for water exceeds the amount that is available, and is measured in this figure by million cubic meters per year, with purple and red showing high amounts of water stress (Council for Scientific and Industrial Research (CSIR), 2014).

In South Africa, most of the fresh water resources have been allocated to specific uses and, as a result of pollution caused by "industry, urbanisation, acid mine drainage, inflows of treated and untreated sewage, deforestation, and agricultural return flows and energy use", the quality of the water resource is declining (Oberholster *et al*., 2009: 1). Mining, among other industries, is one of the main contributors to the problems being faced in terms of water quality, affecting acidity and increased metal content (DWA, 2013).

Water resource use is the absolute basis of South African economy and society, while the mining sector is a traditional economic driver in that it depends heavily on water abstraction, waste disposal and landscape alteration (Inkomati Catchment Management Agency (IUCMA, 2014). While agri-tourism and conservation efforts frequently offer alternative land use and economic development options, it is not always possible to choose options that are 'less economically feasible' in the shorter term (IUCMA, 2014). For example, at present, prospecting and mining licensing processes are threatening more sustainable and less water-intensive development in many parts of South Africa. According to the IUCMA (2014), an estimated 12% of Mpumalanga's arable land will be transformed due to current and planned coal mining and a further 14% is affected by prospecting rights.

The mining industry is a contentious water user. The mining sector has presumed that promises of economic growth and job creation will mitigate the negative environmental concerns and issues caused during mining operations and long after mining has stopped. Mining companies do not always accept responsibility for the true costs, from a technical perspective, of water management throughout the life cycle of a mine (ICMM, 2015). Legacy issues in the mining sector are becoming a more common occurrence in South Africa, with historic mine sites causing environmental degradation through acid mine drainage (AMD) (ICMM, 2015). There is often no record of previous or current owners, or the companies/individuals no longer exist, which leaves the rehabilitation efforts to an unprepared government (ICMM, 2015). Mining and metal operations, not only through their physical impact on the land but also their use of water, by the means of extraction, processing and discharge, can and do impact catchment dynamics (ICMM, 2015). There are also increasing concerns regarding uncontrolled prospecting which threatens the country's landscape and also its water resource availability.

Coal-fired power stations for electricity generation contribute over 90% of South Africa's electricity. These power stations, the drivers of coal burning for power generation, are water intensive processes (Greenpeace, 2012). In 2010 half the coal mines supplying Eskom (South Africa's primary electricity producer) with coal did not have valid water use licences (Greenpeace, 2012). Water related impacts are one of the risks associated with mining operations and although many mining companies already have water management strategies, there is a need to consider the local availability of, and the local demand for, water.

1.3: Climate Change and mining

Activities that use water, and are inherently involved a pollution risk, will pose an exacerbated environmental risk under climate-changed conditions. There are considerable risks associated with climate change and predicted changes in the hydrological cycle, which will lead to a range of climate-related impacts and risks (Intergovernmental Panel on Climate Change (IPCC), 2014). In Southern Africa, Ragab and Prudhomme (2002) suggest an increase in the annual temperature ranging from 1.5°C to 3°C, by the 2050s. There is also a predicted increase in global precipitation of 3–15%, although precipitation in arid and semi-arid regions may decrease (Ragab and Prudhomme, 2002). Davis (2010) believes that Southern Africa will experience heightened water stress, the spread of the malaria transmission zone to the south and an increase in mean annual temperature—by 1°C in coastal regions and 3°C in the interior—by mid-century. There are likely to be drier conditions, with an increase in rainfall intensity (although not an increase in total rainfall) and greater evaporation rates are likely to cause an increase in drought frequency and intensity (Davis, 2010). The Department of Environmental Affairs (DEA) (2013) suggests an average annual temperature increase in the Limpopo/Mpumalanga region of 1–2.5°C in the near future (2015–2035); a further increase of 1–3°C for the period 2040–2050; and another 3–6°C for the period 2080–2100. This area also has a projected pattern of drying in terms of rainfall and an increase in the frequency of natural disasters, such as flooding and drought (DEA, 2013). According to The Gauteng Department of Agriculture, Environment and Conservation (2008), mining and supporting infrastructure have long design lives, which will be challenged repeatedly by climate extremes over their life cycle, and the effects of climate change will need to be considered early on in the mine life cycle. Some of the risks that climate change may have on mining operations according to The Gauteng Department of Agriculture, Environment and Conservation (2008), are:

- water supply security
- damage to mines and supporting services due to flooding and other extreme weather events
- sea level rise may affect port and shipping operations
- human health effects for staff of the mine, with different working conditions

- changes in surface and groundwater interactions that will have implications in acid mine drainage

These effects may cause: “operational delays, revenue losses, increased production costs, labour shortages and adverse mine legacies. If properly understood and managed at the right time in the mine life” (Gauteng Department of Agriculture, Environment and Conservation, 2008: 10-9).

In addition to increasing water scarcity there is the question of AMD. The rate of acid generation is determined by the following primary factors: temperature, the power of hydrogen (pH), oxygen concentration, the degree of ground water saturation, ferric ion chemical activity, exposed surface area of metal sulphide and the chemical activation energy required to initiate the generation of acid and bacterial activity (Akcil and Koldas, 2006). An increase in dissolved oxygen in the water and lower pH leads to the greater release of heavy metals and a higher absorption rate of heavy metals (Li *et al*., 2013). An increase in temperature leads to the greater release of heavy metals from sediments (Li *et al*., 2013). The flow rate of water also significantly increases the rate of heavy metal ion release from sediments (Li *et al*., 2013). Future scenarios of increased storm events, floods, droughts and temperature changes lead to uncertainty about how even current AMD decant rates may impact water resources.

1.4: Acid Mine Drainage

Johnson and Hallberg (2005) state that in 1989 an estimated 19 300 km of streams and river and 72 000 ha of lakes and reservoirs, worldwide, had been severely damaged by mine effluent. This kind of damage usually occurs once a mine is closed or abandoned, because water that was previously pumped out of the workings during production, which kept the water table artificially low, returns to its natural level, inundates exposed rock surfaces, causing the contaminated groundwater to be discharged (Johnson and Hallberg, 2005). Figure 5.1 shows decant occurring within quaternary catchment X11B, where closed underground mine workings are now producing AMD.

Figure 1.3: AMD decant from closed mine workings in quaternary catchment X11B, near Carolina. The decant had occurred once the mining operation had been seized, and during the plans to rehabilitate the land, the mining company who owned the rights to the land filed for liquidation, which is discussed later on in this work.

According to Akcil and Koldas (2006), various factors determine the severity and rate of AMD generation. These are:

- pH
- Temperature
- Oxygen content (in the gas phase, if not completely saturated)
- Oxygen content (in the water phase)
- Fe^{3+} activity
- Amount of exposed surface area of total metal sulphide
- Amount of chemical activation energy required to start acid generation
- Bacterial activity

The oxidation of sulphide-bearing minerals (e.g. pyrites in coal mines) causes the generation of acid. This process involves the minerals reacting with water and oxygen in the presence of a certain bacteria (thiobacillus); this produces sulphuric acid and iron hydroxide or iron sulphate. The sulphuric acid and iron hydroxide usually have low pH values which contribute to the further dissolution of minerals and the release of toxic metals into the waterways (Tiwary, 2000). This is AMD, which has a detrimental effect on the quality of surface and subsurface water which, in turn, negatively affects the surrounding environments (Tiwary, 2000). AMD is considered a serious environmental hazard and is toxic to aquatic life, wildlife and vegetation (Akcil and Koldas, 2006) (Tiwary, 2000).

According to Akcil and Koldas (2006) the primary and secondary sources of AMD include:

Primary:

- Mine rock dumps
- Underground and open pit mine workings
- Underground water (pumped or natural)
- Diffuse seeps from overburden in rehabilitated areas
- Construction rock

Secondary:

- Treatment sludge ponds
- Concentrated load-out ('load-out' refers to the rapid loading of coal into trains)
- Stockpiles (i.e. mine dumps)
- Emergency ponds

Akcil and Koldas (2006) further state that water is the main medium of transport for contaminants and that all mitigation measures for AMD are concerned with water flow control. They believe that the entry of water into the site that is acid forming can be controlled by taking the following steps:

- Diversion of water flow heading towards the pollution
- The prevention of infiltration of water into the polluted site
- The prevention of hydrological water seepage into the polluted site
- The strategic placement of acid-generating waste

Johnson and Hallberg (2005) believe prevention (if possible) is the best option when dealing with AMD and show source control measures that may be followed in Figure 5.2.

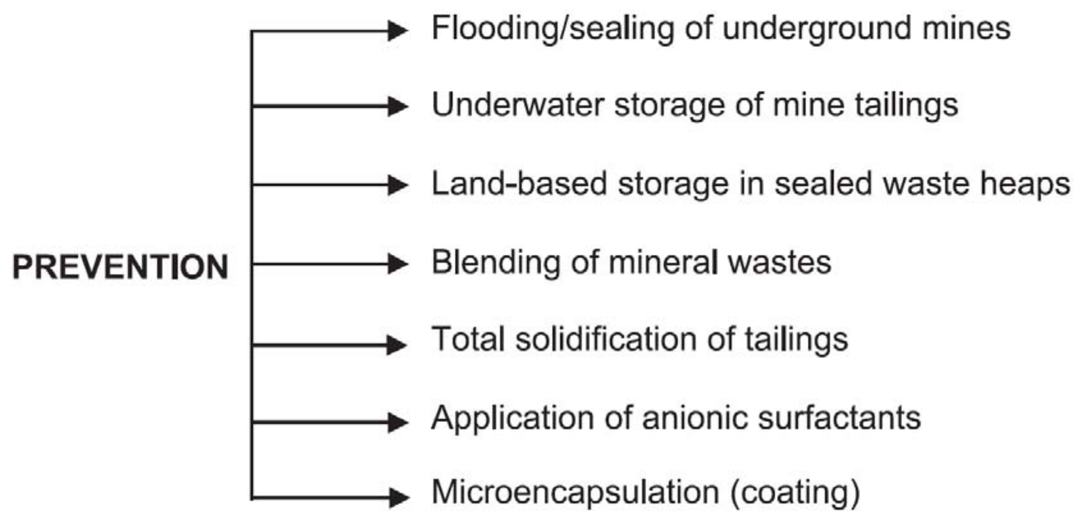


Figure 1.4: Approaches to prevent or minimise the generation of AMD (Johnson and Hallberg, 2005).

The treatment of AMD in open pit mines could include: Flushing (the rapid draining of water from spoil heaps before it can accumulate); Containment (flooding of the area in order to prevent oxidation—this is not a very successful technique); Evaporation; Discharge through wetlands (which are capable of removing iron, manganese and other metals from AMD, as well as effecting a change in the chemistry of AMD due to the physical and biological processes that occur when contaminated water flows through a wetland); Dilution; and Neutralization (the most environmentally effective technique for the mitigation of AMD; it can range from complicated to simple methods, such as lining streambeds with limestone). Figure 5.9 shows the use of a lime wall that temporarily treats AMD decant until a permanent solution is found.

Figure 1.5: Lime being used as a temporary treatment for AMD decant in Carolina. This was a plan put in place while the mining company and regulators discussed long term solutions to the decant at the seized mining operation.

1.5: Case studies

Chapter 3 will provide a synthesis of the regulatory provisions necessary to mine coal at the different stages of a mining life cycle. Chapter 4 will explore the gap between legislative provisions and practice, identified the coal mining activity system and explored tensions between rules-in-form and rules-in-practice. Throughout this dissertation, case studies will be presented which provide narrative evidence of the issues that have surfaced. The aim of these case studies is to provide additional real-world perspectives of mining legislation and practice and the consequent environmental implications.

A case study can generate an understanding of a particular moment or event by analysing the instance that is being investigated and pointing out its relations to the broader context in which it lies (Rule and John, 2011). The case study allows the investigator to extract meaning that was not substantiated by previously generated data (Bassey, 1999). Yin (2009) describes case studies as being a preferred method when descriptive and explanatory questions are being asked, as well as when the researcher has little control over the subject matter.

While legislation is in place to protect the environment, there have been real-life instances where non-adherence to the law has resulted in a negative effect on the environment. Previous chapters have provided clear examples of issues within the X11B catchment that have resulted in negative impacts on the environment. These issues include non-compliance, the historic decant from derelict or ownerless mines, the liquidation of mining companies with resulting impacts on the environment, as well as the DMR's lack of involvement in compliance and other legislative processes.

Given the probable gap between law and practice in the catchment, this chapter will focus on case studies relating to environmental damage in X11B. These case studies are not in depth detailed studies but rather descriptive narratives that give contextual detail to the analysis of the legislation and the gap between legislation and practice.

The water quality data interpreted in this chapter were made available by IUCMA (2015), as well as from Union Colliery supplied via IUCMA (2015), the raw files can be found in Appendix 1.

Case-Study Method

According to Bromley (1990, 302), a case study is a "systematic inquiry into an event or a set of related events which aims to describe and explain the phenomenon of interest". The purpose of a case study is to be exploratory, descriptive, interpretive and explanatory (Zucker, 2009) and, according to Yin (1994), there are six sources of evidence when collecting data for a case study: documents, archival records, interviews, direct observations, participant observation, and physical artefacts. These complex social ecological systems (Folke, 2006) are characterised by having many variables of interest, more than one source of evidence, and one or more theoretical propositions as a guide to collecting and analysing data.

The case studies presented here were formulated by means of (1) document review—water quality monitoring data was supplied by the IUCMA and mining companies; and (2) participant observation as well as observation (as discussed in Chapter 4)—which enabled insights concerning rules-in-practice as opposed to rules-in-form, and the consequent impacts these may have. The interviews presented in Chapter 4 contributed to understanding the issues that arise when rules-in-practice do not align with rules-in-form.

Clifford-Holmes (2015) states that rules-in-form are formalised policy that describes the way certain institutions should function, whereas rules-in-practice are informal rules that are applied in practice. Contestation of the formal and informal divide is where change or transformation can occur (Clifford-Holmes, 2015).

Observation was key to uncovering interactions that are not normally experienced by an outsider among diverse mining related agents. Various meetings were held between 2014 and 2015, mostly with regulators addressing issues with mining agents within the catchment, as well as regular inspections and reviews of these agents.

1.6: Thesis structure

Chapter 2 provides information on the study site, including water quality data and background information on the mining operations in the area.

Chapter 3 provides an insight into the coal mining lifecycle and regulatory provisions by discussing the process of coal mining, a brief history of South Africa's mining history, and then progresses to an analysis of the legislative provisions. The case study provided in chapter 3 relates to current mining legislation and provides a real life example of a mining company going into liquidation while being in the process of rehabilitation.

Chapter 4 describes the Cultural-Historical Activity System (CHAT) for coal mining environmental practice, how the data was collected and how CHAT was used as a tool of analysis. The case study provided in chapter 4 illustrates the issues with rehabilitation and how cost saving short cuts had been taken on the expense of the environment. A second case study presented in this chapter discusses an issue raised in interviews where mining agents were seen to be cutting corners and risking the environment and water resources in the process. The third case study in this chapter demonstrates the issued raised in chapter 3 (section 3.4) as well as chapter 4 (Section 4.3.2), which demonstrates a real life example of issues raised during interviews as well as legislative shortcomings with regards to the DMR and its decision making powers. The fourth case study raised in this chapter illustrates the issues that were raised in chapter 3 and 4 with regards to delayed response time to pollution incidents due to legislative issues and the processes that need to be followed.

Chapter 5 contains the general discussion and recommendations from the research discussed in this paper. It also contains the limitations of the thesis.

Aim and objectives

The overall aim of the research was therefore to explore gaps between environmental legislative requirements concerning coal mining, and actual mining practice, and to view these through a consideration of selected environmental indicators of the environmental condition of the catchment.

The aim was achieved through addressing a set of four objectives:

- To provide a consolidated synthesis of environmental protection considerations and legislative provisions for coal mining in South Africa (Chapter 3).
- To compare actual coal mining practice with the environmental legal requirements (Chapter 4)
- To describe aspects of ecological conditions in Carolina quaternary catchment (X11B)(Chapter 2); and
- To examine research findings with stakeholders in the study catchment (Chapter 5)

Chapter 2: Study Site

Carolina is a small town with a population of 23,000 people, situated in the eastern Highveld between Middleburg and Ermelo, in the province of Mpumalanga, South Africa. It was founded in 1883 as a service point for the local farming community, but extensive coal mining activity in the last decade has led to a more diverse economy for the town (McCarthy and Humphries, 2012).

Carolina is located in the upper Komati River catchment (IUCMA, 2014) and lies within the X11B quaternary catchment within the Inkomati Water Management Area. The Boesmanspruit Dam supplies the town of Carolina with potable drinking water. Downstream the Nooitgedacht Dam provides relatively uncontaminated water to a number of power stations in the area (Golder Associates, 2014).

This area experiences a typical climatic condition to that of the Highveld in South Africa, with warm and wet summers and mild to warm winters with frost (Golder Associates, 2014). The mean annual rainfall ranges between 700–780 mm per annum, with evaporation ranging between 1,650 and 1,900 mm per annum, creating a relatively dry landscape (Golder Associates, 2014). There is a large commercial agricultural sector in this region which could contribute to the water quality in the area, as soil ameliorants would be used to cultivate the land (Golder Associates, 2014).

According to the IUCMA (2014), an estimated 12% of Mpumalanga’s arable land will be transformed due to current and prospective coal mining, and a further 14% is affected by prospecting rights. The Carolina area is surrounded by land owned by mining companies, as well as areas being prospected, as seen in Figure 2.1.

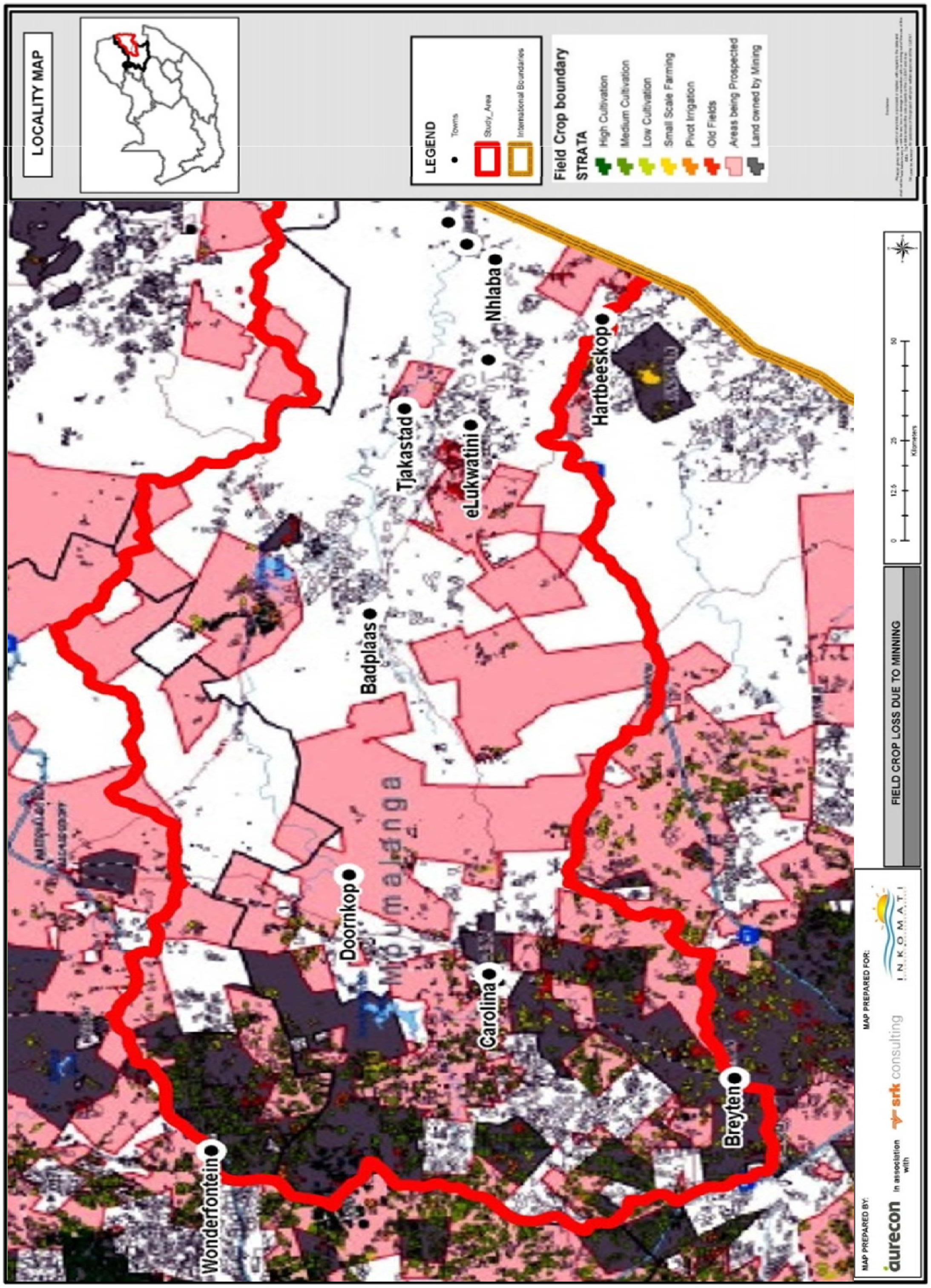


Figure 2.1: Shows land use in relation to the impact of coal mining on agriculture, in terms of current and prospecting mining applications (IUCMA, 2014).

According to the IUCMA (2014), the terrestrial biodiversity assessment has designated the area of Carolina as ‘Important and Necessary to the South West, Irreplaceable to the North and either Highly Significant or No natural habitat remaining’ for the rest, as seen in Figure 2.2. Carolina falls within a vulnerable eco-status, according to the Ecosystem Status of the South African National Biodiversity Institute (SANBI), as seen in Figure 2.3.

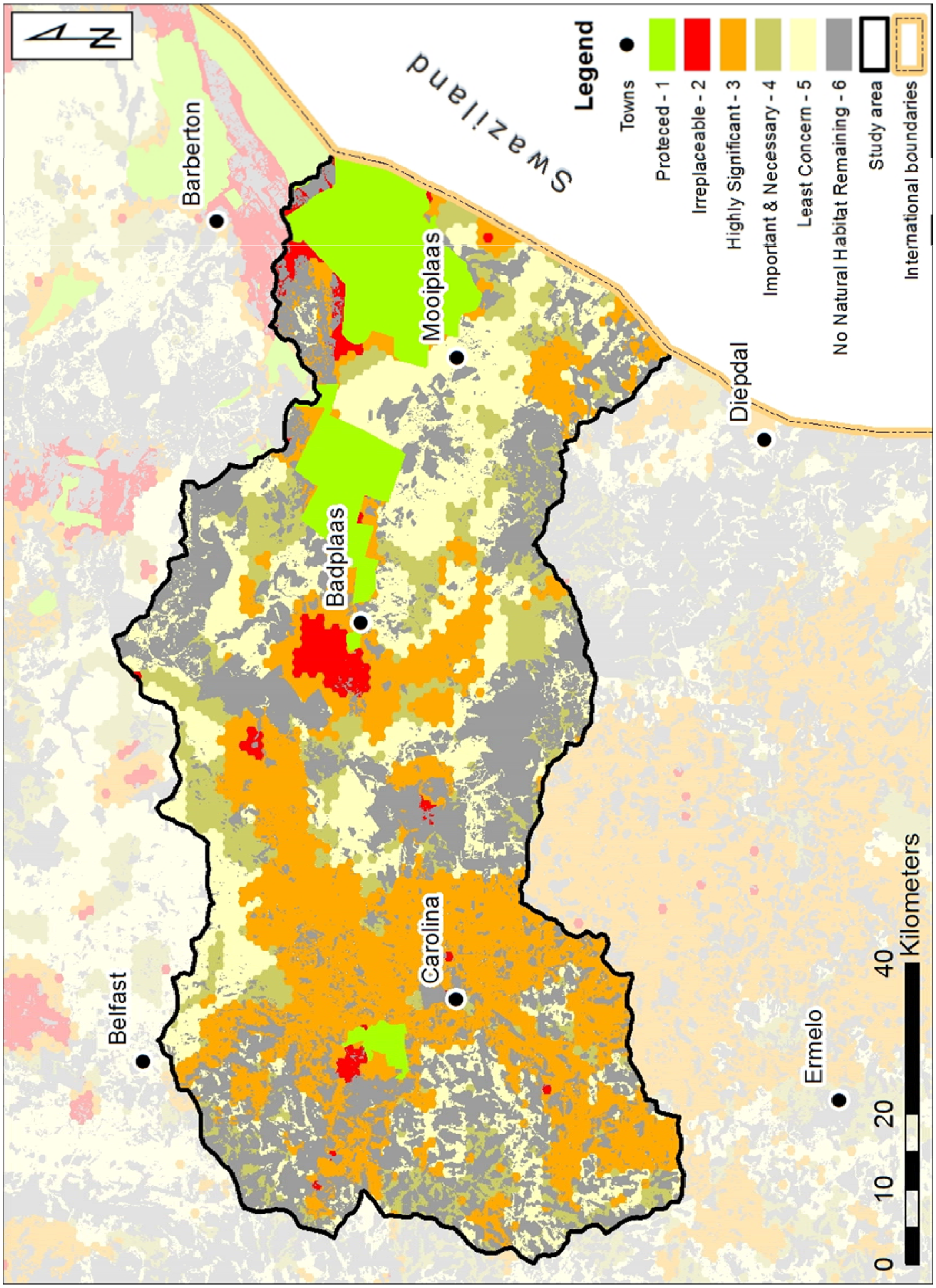
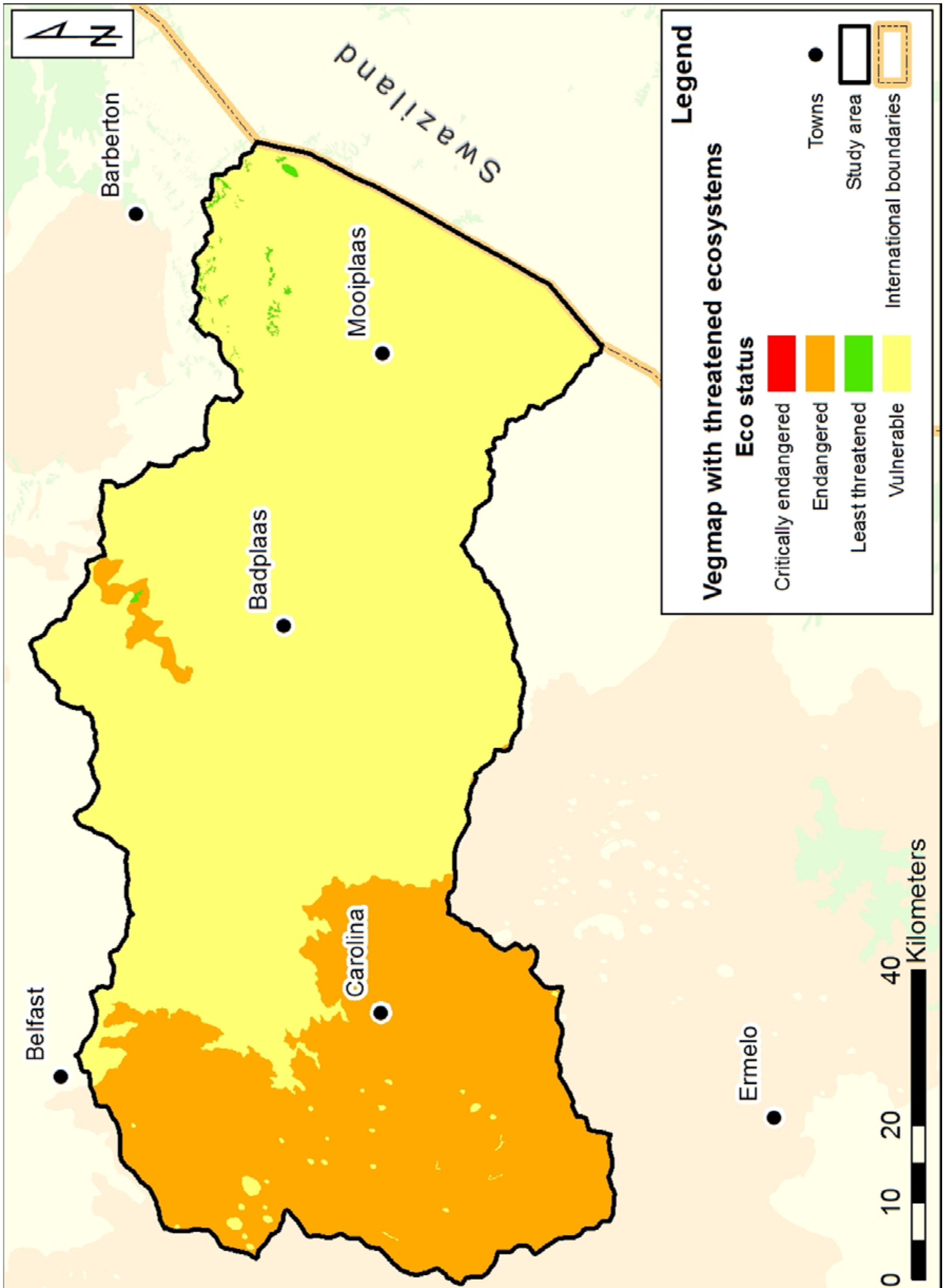


Figure 2.2: Terrestrial Biodiversity Assessment, showing the biodiversity found in the Mpumalanga region, with Carolina highlighted (IUCMA, 2014).



Legend
Vegmap with threatened ecosystems
Eco status
Critically endangered
Endangered
Least threatened
Vulnerable
Towns
Study area
International boundaries
Belfast
Barberton
Badplaas
Mooiplaas
Carolina
Ermelo
Swaziland
N
0
10
20
40
Kilometers

Figure 2.3: SANBI's ecosystem status of the Upper Komati River Catchment, putting Carolina and its surroundings as endangered as an eco-status (IUCMA, 2014).

While the Komati basin receives 63% of its GDP from mining, current and future mining embody a significant threat to the water quality in the Upper Komati (IUCMA, 2014).

Mpumalanga is in the middle of the 'maize triangle', an area of high maize production in South Africa, where coal mining is drastically reducing the amount of land available for maize production (Bench Marks Foundation, 2014). The Mpumalanga region currently produces an average of 22.4% of the countries maize, and holds up to 46.4% of the countries arable soil (Van der Burgh, 2012)(Pretorius, 2015).

There is a conflict of land use between coal mining and the agricultural sector, where farming is being side lined by mining, and is putting food security at risk, which is addressed in Chapter 3, looking at providing a consolidated synthesis of environmental protection considerations and legislative provisions for coal mining in South Africa (Pretorius, 2015).

The IUCMA (2014) has identified six operational coal mines that occur within the Carolina quaternary catchment (X11B), namely: Droogvallei, Mimosa (two separate mines) and Tselentis Colliery (three separate mines). There is one unauthorised mine and one closed mine (Witkranz) in the quinary catchment as well. There is also an application to mine, or a prospecting application, relating to the Onbekend mine, seen in Figure 2.4.

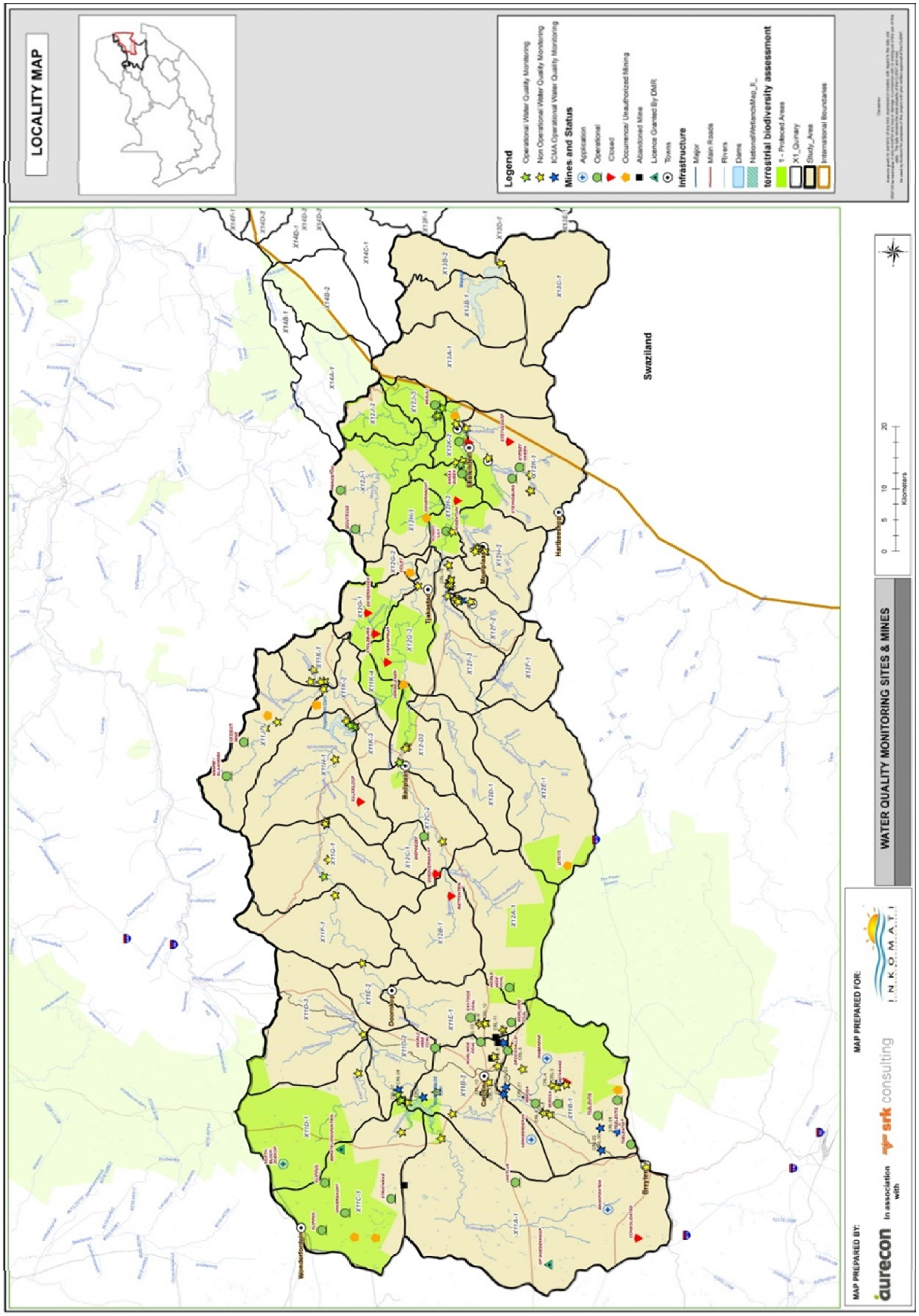


Figure 2.4: Identified mining operations and water quality monitoring sites (blue stars) in the Carolina area, with a full resolution map available in the appendix (IUCMA, 2014).

In order to compare actual coal mining practice with the environmental legal requirements as discussed in Chapter 4, it is necessary to understand where coal mining operations are occurring within the study area.

Golder Associates (2014) identified five operational mining companies in the Carolina quaternary catchment, as well as numerous defunct colliers and coal sidings. These are listed below and can be seen in Figure 2.5.

Mining Operation	**Location**	**Extra Information**
Msobo Tselentis Colliery	30km South of Carolina	Mining right covers a notable portion of X11B catchment. It has 5 years remaining life-of-mine
Msobo Verkeerdepan Colliery	Located in vicinity of Jagtlust Colliery of Norhtern Coal.	MR and EMP approved, waiting for IWUL, only prospecting at Verkeerdepan has taken place, 12 year expected life-of-mine
Msobo Coal siding (Witrand Siding 1) and Northern Coal (Witrand Siding 2)		
Northern coal Jagtlust Colliery	10km South of Carolina, 40km North of Ermelo	North-west of R36
Northern Coal Mimosa Colliery	5km South-east of Jagtlust Colliery.	Ceased mining in 2008, rehabilitated land, benefication plant still operated by Mimosa Colliery to support operation of Jaglust Colliery.

Siphethe Coal Witrand Colliery; Coastal Fuels Colliery	Siphethe Coal is located 10km South of Carolina. North of Northern Coal processing plant premises, on Witrand 52 IT farm. Coastal Fuels Colliery: East of Northern Coal Processing plant, near Goedeverwagting Road, Farm Droogvallei 41 IT, portion 2	Now closed, mined as open pit from 2000 – 2006, ceased prior to 2012, some rehabilitation occurred. Both mines are presently abandoned.
Eastside Coal Company	Outside of X11B boundaries, however historic bulk sampling activity has taken place in X11B (Black Gold Colliery) to the west of Northern Coal processing plant, and is located 10km South-West of Carolina,	Mining area has been rehabilitated
Pembani Colliery	5km East of Carolina.	Drains below the Boesmanspruit Dam, drainage from this mine flows west and north to the Nooitgedacht Dam.

The following are defunct mines found within the X11B quaternary catchment:

Old Witrand Colliery	Msobo's Verkeerdepan Colliery land	Abandoned prior to the granting of Mining Rights to Msobo Coal. Its ownership is unclear. This area has been rehabilitated, but there is a decant point on site.

BHP Billiton's Union Colliery	5–10 km west of Msobo	Although surface infrastructure is located outside the X11B catchment, the historical underground workings, as well as historically rehabilitated coal discard dumps, fall partially within the catchment, with underground water flowing in the direction of Msobo Coal.
BHP Billiton's Black Diamond Colliery	5–10 km north-west of Msobo	The public data available for this colliery is limited. However, there is evidence of rehabilitated and abandoned coal discard dumps that fall within the catchment.
Siphethe Coal rail siding	immediately to the east of Carolina	It is abandoned and its run-off flows away from the Boesmanspruit Dam, to the north.
Unknown abandoned rail siding	North of Black Diamond rehabilitated and unrehabilitated discard dumps	
Droogvallei coal siding	2km South-East of Carolina	It is currently operated by Pembani and is a joint venture between Pembani Coal and the Eastside Coal

		Company, which is called Droogvallei Rail Siding Company. It drains into a tributary of the Boesmanspruit Dam.

There are no other known active mining or industrial activities within the X11B catchment that could potentially influence the water quality of the Boesmanspruit Dam.

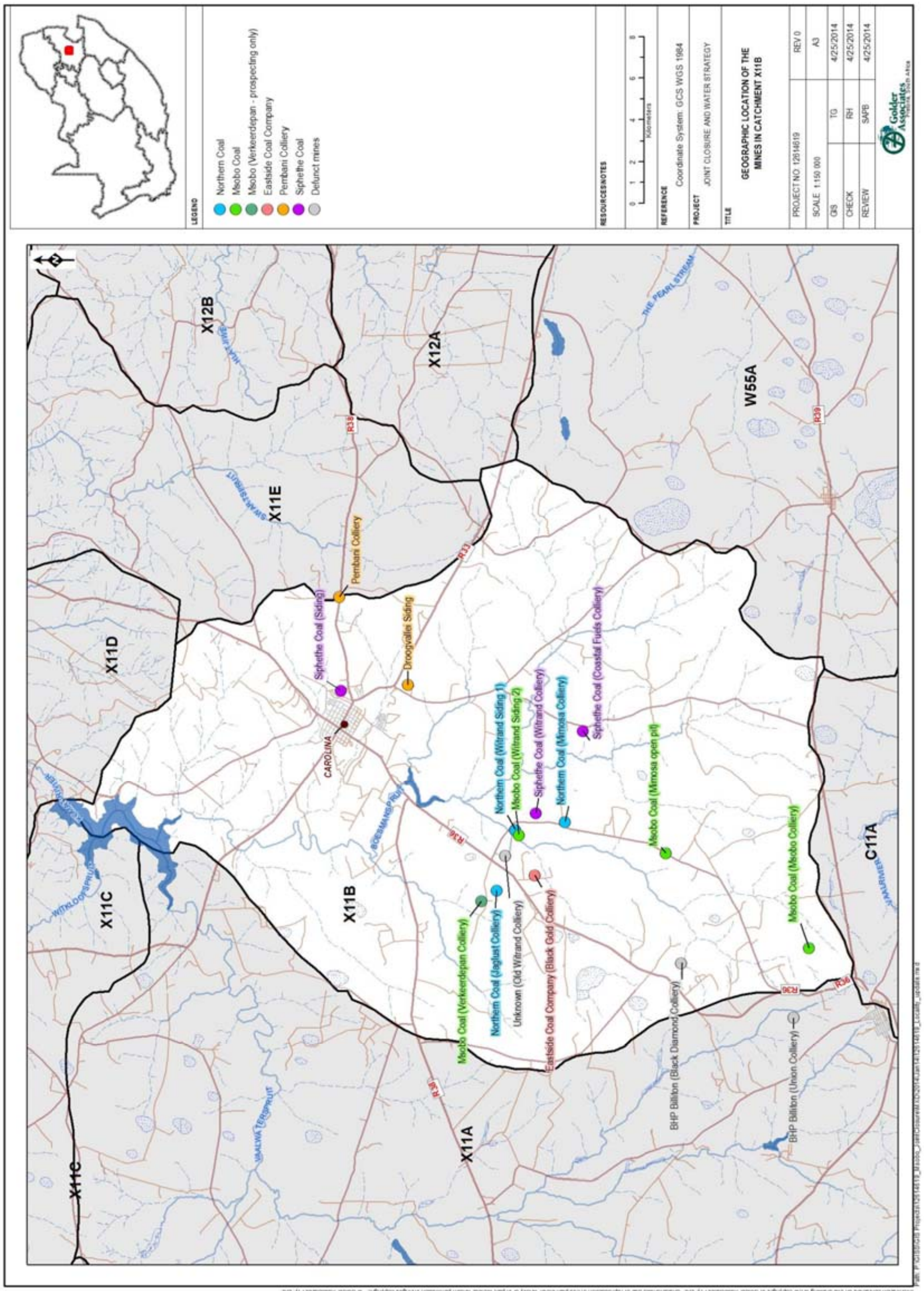


Figure 2.5: Map of quaternary catchment X11B, showing the locations of current and defunct mining activity (Golder Associates, 2014).

The DWA and IUCMA currently have seven active monitoring points in the Carolina quaternary catchment. The parameters being monitored are dependent on the activity in the area, but when looking at mining activity, pH, electro-conductivity, iron, aluminium, manganese and sulphate are measured.

There are trends that are of concern in the Upper Komati, although at present the water quality monitoring data suggests that the water that is available is still fit for use by all current water users (IUCMA, 2014). Figure 2.6 shows the average electrical conductivity (EC) for the tributaries that feed the Komati River, and eventually the Boesmanspruit Dam.

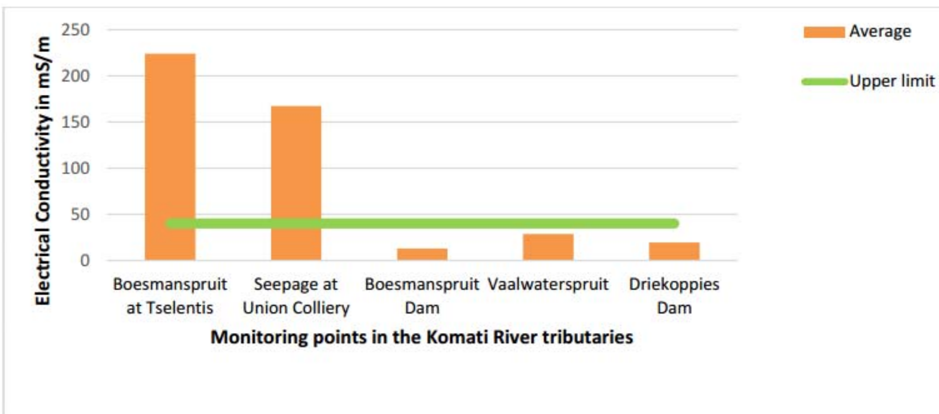


Figure 2.6: Average monthly electrical conductivity (EC) levels (mS/m) in the tributaries of the Komati River, from January 2013 to January 2014, showing the increased EC found in the catchment that is being looked at in this study, where 40 mS/m is the upper acceptable limit (IUCMA, 2014).

This study area has naturally acidic soil, with a lack of alkalinity, meaning there is little natural ability in the surface water to counter the effect of AMD (Golder Associates, 2014). This was confirmed by in-stream water quality in the unmined areas. The presence of AMD was confirmed in other study areas, due to the evidence of high total dissolved solids, high sulphate concentrations, as well as fluctuating pH (Golder Associates, 2014).

It is believed by Golder Associates (2014) that the operational mines are not contributing extensively to the negative water quality effects. They concluded that defunct mines were left with limited or no means to deal with excess water and decant, which is evident in the field as seen in Figures 2.7 and 2.8. Owners of these mines are unclear or unknown, although there have been multiple owners in a short space of time.

Figure 2.7: Decant occurring from a 100 year-old underground working in Carolina, which is flowing across the landscape which was noted during a site inspection by regulators (2014).

The report produced by Golder Associates (2014) identified the main sources of contamination of water resources in the X11B catchment as:

- Decant from the underground workings of Coastal Fuels (Siphethe)—excess mine water
- Decant from the rehabilitated Witrand open pit (Siphethe)
- Decant from the underground workings of Union Colliery (BECSA)—excess mine water
- Dump seepage from the Black Diamond Colliery (BECSA)
- Contaminated seepage from historical plant and discard dump areas of the Tselentis Colliery (Msobo)—shallow seepage
- Imminent potential decant from the Tseletis (Msobo) open pits
- Contaminated surface run-off from Droogvallei Siding (used by Pembani).

This area has experienced an event that had a negative impact on the environment and the residents within it. The area also experiences constant historic decant that is polluting the resource (Golder Associates, 2014). Figure 2.7 shows the current decant found in the area.

This project will focus on catchment X11B and how these issues have arisen, from a legislative and decision making point of view.

The Inkomati water management area (WMA) is considered a water-stressed environment because its water requirements are in excess of the available water resources. This is of particular concern due to the water requirements claimed by Mozambique (IUCMA, 2014). Escalating water use in South Africa means that the water quality deteriorates which limits its suitability for use (Hobbs *et al*., 2008). In addition to specific mine-related case studies, interrogation of the water chemistry records at the IUCMA illustrated deteriorating water quality and consideration of this data comprises the final case study.

Increasing populations are placing water resources under increased pressure. This demonstrates the need for new approaches to water management and planning, to avoid and/or reverse environmental degradation and potential conflicts (Ragab and Prudhomme, 2002). Climate change discussions often focus on the impacts of increased temperature; however, some of the most severe impacts of climate change are likely to be the change and variation in precipitation, evapotranspiration, runoff and soil moisture, which are crucial when it comes to water management (Ragab and Prudhomme, 2002). By the 2050s the annual average temperature in Southern Africa will increase between 1.75 to 2.25°C in the summer and between 1.25 to 2°C in the winter, with a decrease in the annual average rainfall between 10 and 15 per cent (Ragab and Prudhomme, 2002).

An increase in temperature has the potential to change chemical processes in the water resource. Lakes and rivers will have increased sulphates, base cations and silica, as well as increased alkalinity and conductivity (Bates *et al*., 2008).

The Upper Komati River, of which the X11B quaternary catchment is a source, currently has good water quality in general, with localised reports of poor water quality. Water quality is threatened by coal mining as large coal reserves are found in this area (IUCMA, 2014). However the 2012 Carolina Crisis raised pressing issues about the future of water resources in the X11B catchment.

Table 2.1: The combined fitness for use categories of water quality variables (Aurecon, 2011).

Variable	Units	Ideal	Acceptable	Tolerable	Unacceptable
Electrical Cond.	mS/m	< 40.00	40.00 to 150.0	150.0 to 310.0	> 310.0
pH (lower range)	pH units	> 5.00	5.00 to 4.50	4.50 to 4.00	< 4.00
(upper range)		< 8.40	8.50 to 9.50	9.50 to 10.00	> 10.00
Ammonia	mg/l	< 0.20	0.20 to 1.00	1.00 to 2.00	> 2.00
Chloride	mg/l	< 100.0	100.0 to 175.0	175.0 to 600.0	> 600.0
Sulphate	mg/l	< 200.0	200.0 to 250.0	250.0 to 400.0	> 400.0
Nitrate / Nitrite	mg/l N	< 6.00	6.00 to 10.00	10.00 to 20.00	> 20.00
Phosphate	mg/l P	< 0.01	0.01 to 0.03	0.03 to 0.25	> 0.25

Table 2.2: A description of the monitoring point in X11B, with the point ID and description (IUCMA, 2015).

CODE	Point_ID	MONITORING POINTS: CAROLINA AREA
CRL-1	190561	Bosmanspruit upstream of Witrand coalmine
CRL-2	190624	Bosmanspruit downstream of Witrand coalmine
CRL-3	190596	Upstream of Witkrans coalmine
CRL-4	190550	Downstream of Witkrans coalmine
CRL-5	190634	Upstream of Droogvalei coalmine 1
CRL-6	190626	Downstream of Droogvalei coalmine 1
CRL-7		Upstream of Droogvalei coalmine 2
CRL-8	190628	Downstream Droogvalei of coalmine 2
CRL-9	190641	Upstream of Paardeplaats coalmine
CRL-10	190633	Downstream of Paardeplaats coalmine
CRL-11	190631	Upstream of Eastside colliery
CRL-12		Downstream of Eastside colliery
CRL-21	192825	Boesmanspruit at the railway bridge
CRL-22	192823	Boesmanspruit Dam
CRL-23	192824	Tributory of Boesmanspruit Dam
CRL-24	190624	D/S of Northern Coal Mimosa
CRL-25	192876	Sepage from Union Colliery
CRL-26	192826	Tributory of Boesmanspruit at Tselentis Colliery

Figure 2.8 shows the recent pH fluctuations in the water resource in catchment X11B. There is a lack of monitoring data in some areas and incomplete monitoring data for most points. There is acidification during the typically dry season from March to May.

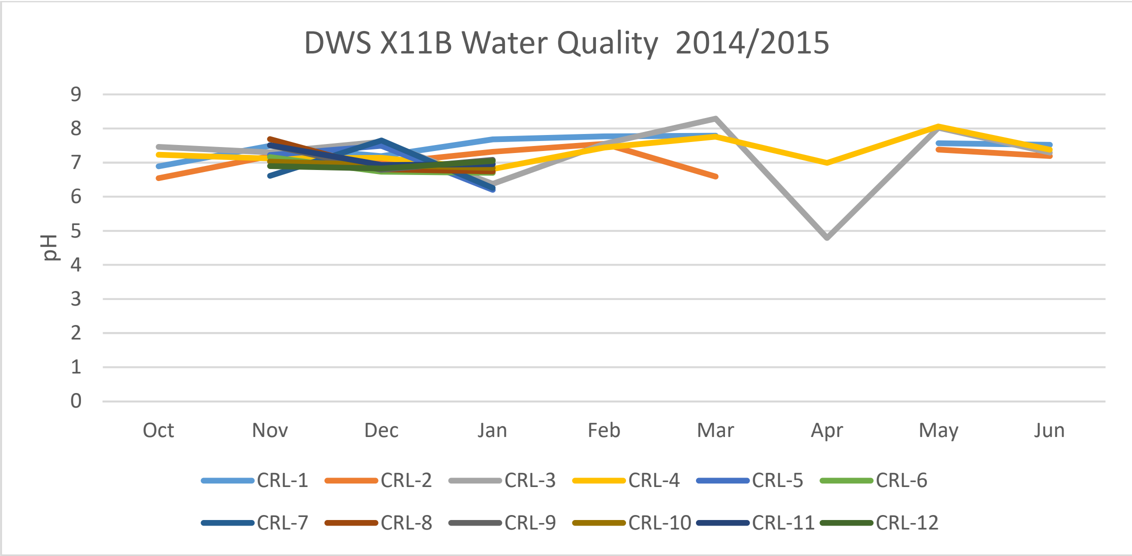


Figure 2.8: A diagram showing the pH for the months of October 2014 to June 2015 in Carolina.

Figure 2.9 shows the recent pH fluctuations in the water resource in catchment X11B. There is a lack of monitoring data in some areas and incomplete monitoring data for most points. The pH remains relatively consistent during this time period, with a slight drop in pH at CRL-24 and a very slight dip in pH at most monitoring points in December 2014.

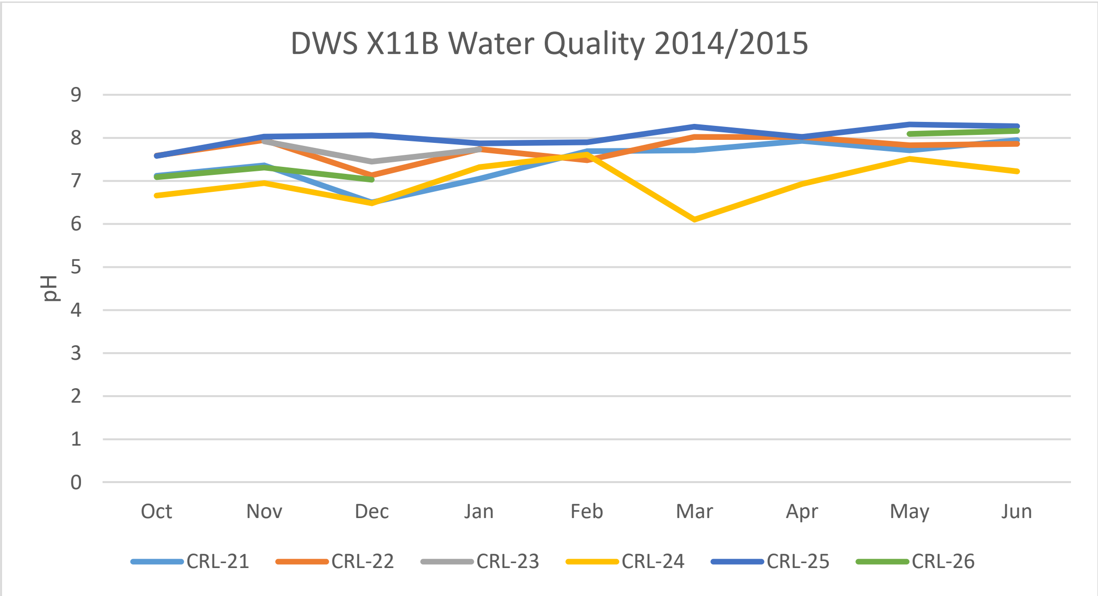


Figure 2.9: A diagram showing the pH for the months of October 2014 to June 2015 in Carolina.

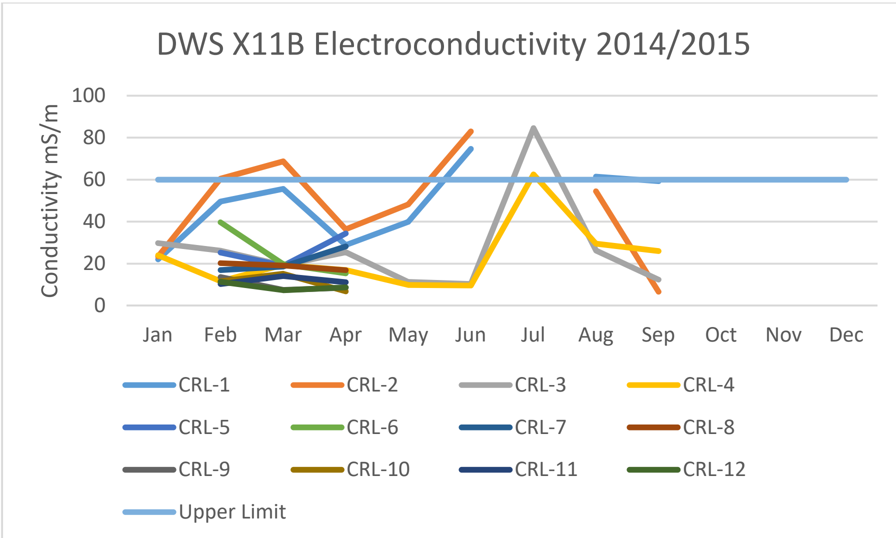


Figure 2.10: A diagram showing the electro conductivity for the months of October 2014 to June 2015 in Carolina.

Figure 2.11 shows low levels of electroconductivity at most points, however CRL-25 and CRL-26 show high electroconductivity readings, although there is a large portion of data missing for CRL-26.

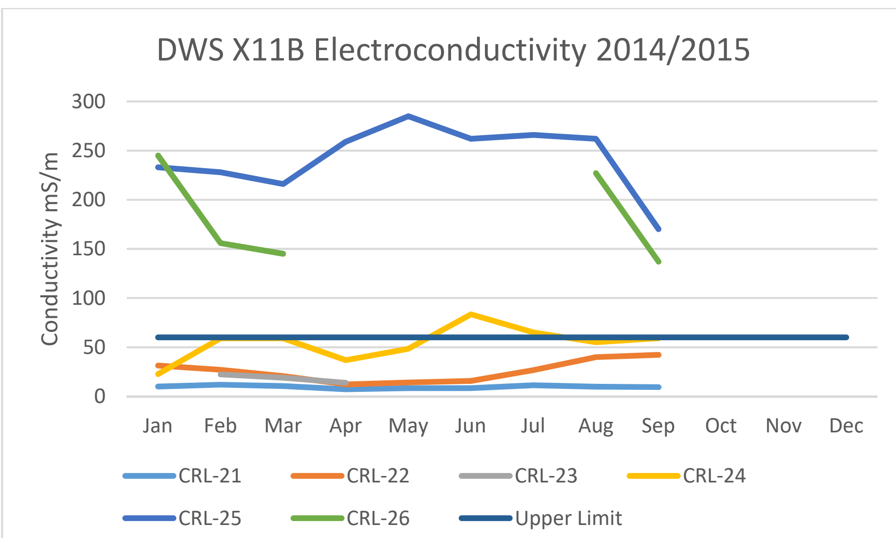


Figure 2.11: A diagram showing the electro conductivity for the months of October 2014 to June 2015 in Carolina.

Figure 2.12 shows the sulphate concentrations found in X11B, where monitoring points CRL-1 and CRL-2 show an increase in sulphate concentration from February to March 2015, then no monitoring data is available until May. Monitoring points CRL-3 and CRL-4 show a peak in sulphate concentration from March until May 2015.

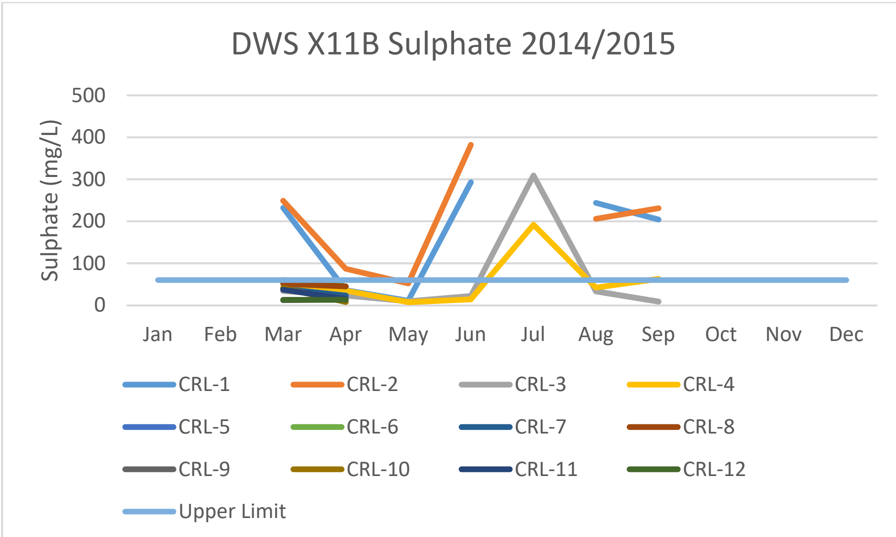


Figure 2.12: A diagram showing the sulphate for the months of October 2014 to June 2015 in Carolina.

Figure 2.13 shows a steady sulphate concentration below 500mg/L for the time period for most monitoring points, but CRL-25 shows elevated sulphate concentration throughout, with a peak in March 2015. CRL-26 shows elevated concentrations of sulphate, however monitoring data is missing between January and May 2015.

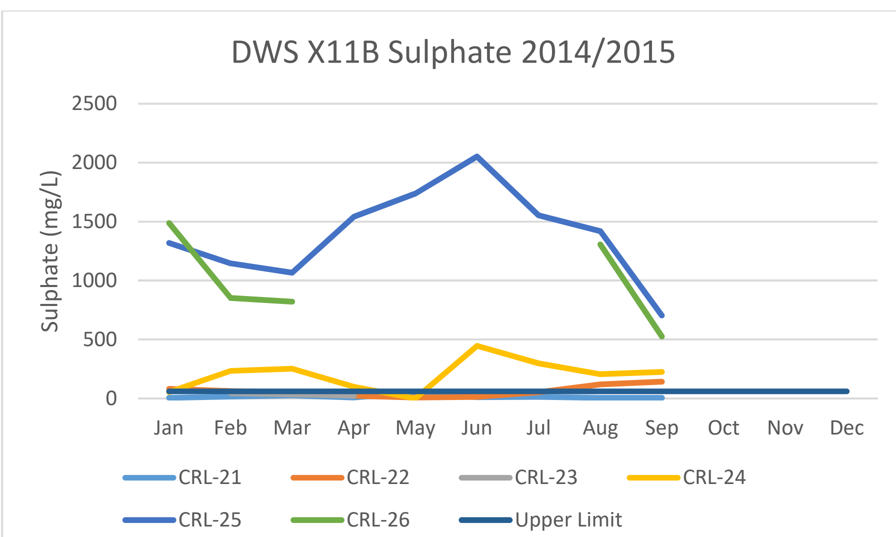


Figure 2.13: A diagram showing the sulphate for the months of October 2014 to June 2015 in Carolina.

Figure 2.14: shows a reduction in pH after the Carolina crisis, although the Witrand coalmine does not seem to have a significant impact on the resource itself at these monitoring points, indicating the drop in pH occurred up stream of the mine.

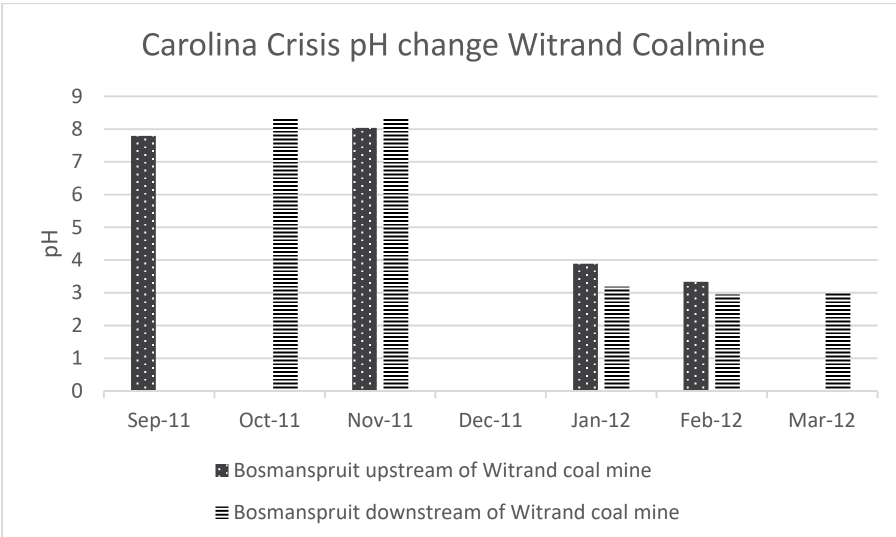


Figure 2.14: Monitoring data showing the pH of the water resource above and below Witrand Coal mine before and after the Carolina Crisis.

Figure 2.15 shows the pH fluctuations for the year of 2014 at Black Diamond V Notch, a decant point found in the catchment. There is little variation in pH throughout 2014, with a slight drop in pH in March.

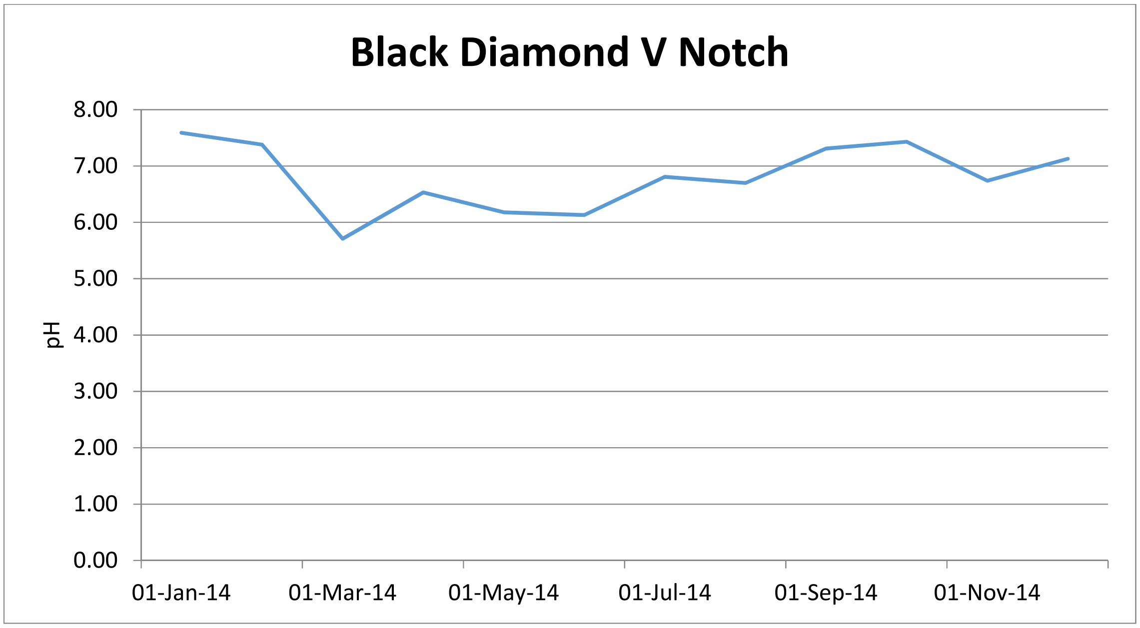


Figure 2.15: The pH of the water resources in X11B at Black Diamond V Notch.

Figure 2.16 shows the electroconductivity fluctuations for the year in 2014 at Black Diamond V Notch, a decant point found in the catchment. There is a large amount of fluctuation in electroconductivity through 2014, with a peak in February and in October. The DWS electroconductivity standard for fitness for use as seen in table 5.1 has the electroconductivity concentration below 40 under ideal. This monitoring point falls under the acceptable range for electroconductivity.

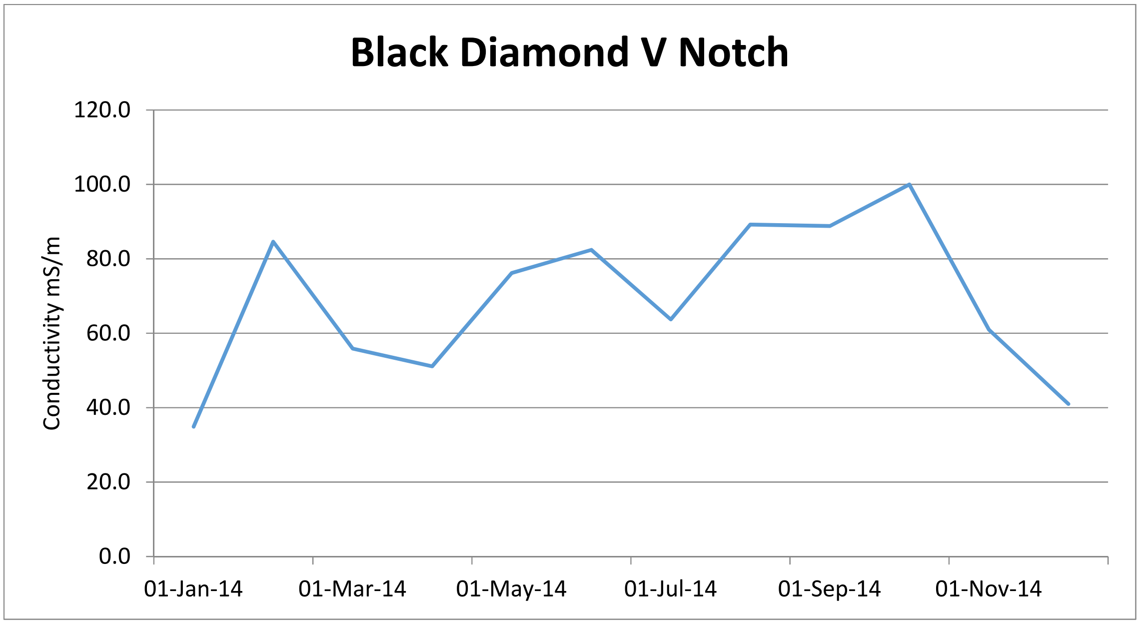


Figure 2.16: the electroconductivity of the water resource in X11B at Black Diamond V Notch.

Figure 2.17 shows the sulphate concentration fluctuations for the year of 2014 at Black Diamond V Notch, a decant point found in the catchment. The DWS sulphate concentration standard for fitness for use as seen in table 5.1 has the sulphate concentration at less than 200 mg/l and the unacceptable range is greater than 400 mg/l, showing this site exceeds the unacceptable sulphate concentrations on various occasions.

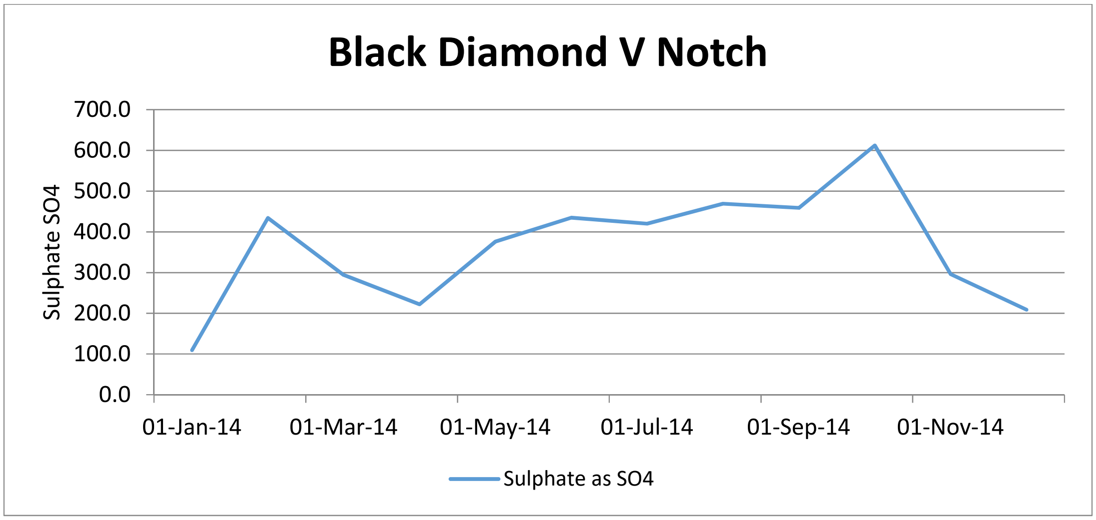


Figure 2.17: the sulphate concentration of the water resource in X11B at Black Diamond V Notch.

This section has demonstrated to some of the issues that will be discussed in Chapters 3 and 4, where issues of legislative compliance can be seen to have a harmful effect on the environment, and this data has shown that the water quality indicates a poor outlook for the resource in the area because of the amount of time the parameters have exceeded the tolerable limits. This suggests there is a bigger issue than just the Carolina Crisis, which was a once off event.

The lack of monitoring data in the area is concerning and presents an incomplete picture of current issues in the area. The absence of available data for months at a time, in instances where variables appear to be taking a negative turn, is particularly worrying, given that it limits data analysis and interpretation.

This data shows us that the impacts of coal mining in the area are widespread and not the result of one or two individual mining operations or decants. The issues are catchment wide and the cumulative impacts are clear. This has been emphasised by investigation of the actions and events that led to the Carolina Crisis.

An important factor is the realisation that pH is not the only measure of AMD; viewed in isolation pH will not indicate that there is a water quality issue in the area. Specific variables must be analysed to determine whether or not there is a problem with the water resource. Decant occurring in this area shows that low pH levels are not the only failing, and that high sulphate concentrations and electroconductivity are also occurring.

Assessment of the impacts of mining operations indicates that seasonal fluctuations must be included in these measurements, due to their influence on water quality variables. High levels of pollution often precede periods of no-flows and there are examples that show high concentrations of sulphate and low pH for flows that follow periods of no-flow.

Chapter 3: Coal Mining Life Cycle and Regulatory Provisions

3.1 Introduction

Legislation governing the mining industry is complex and extensive. It covers a wide variety of different regulations controlled by various national government departments. At the time of initiating this research there was no synthesis of legislation in place, subsequently L has provided this. This research provides more detail, and represents a large proportion of the document- based research. Environmental mining legislation is intended to standardise mining operations and protect the environment from negative impacts that may be caused by a mining company. Such legislation includes the National Environmental Management Act (NEMA), the National Water Act (NWA), and the Mineral & Petroleum Resources & Development Act (MPRDA), as well as other legislation that may be triggered by certain activities. If legislation was followed, mining operations could limit their impact on the environment. The current mining legislative framework and policies have been developed over the past 120 years, with key legislative interventions occurring over the past decade. The current and foremost act is the Mineral and Petroleum Resources Development Act, No. 28 of 2002 (Eberhard, 2011). The act is commonly referred to as 'the MPRDA'.

There are extensive laws to protect the environment and water resources in South Africa. Mining in South Africa is a key economic driver that has the potential to provide a large number of jobs, but it also has the potential to cause suffering for individuals, and communities, in the form of environmental damage such as air, land and water damage (Centre for Environmental Rights (CER), 2013). Mining operations need to follow many different pieces of legislation in order legally to prospect, mine/produce and close a mining site, including the NWA, 1998; the NEMA, 1998; the MPRDA, 2002; the Mine Health and Safety Act (MHSA), 1996; and the National Heritage Resources Act (NHRA), 1999).

The MPRDA, 2002 (Act 28 of 2002) is intended "To make provision for equitable access to and sustainable development of the nation's mineral and petroleum resources; and to provide for matters connected therewith." (MPRDA, 2002 (5)).

To effect a critical exploration of coal mining practices in relation to regulatory provisions, one needs to understand (1) the mining life cycle; and (2) the composite requirements of a range of legislative provisions.

The MPRDA is the primary statute that regulates mining activities in South Africa. It is a complex piece of legislation containing various legislative objectives, with an emphasis on the orderly and ecologically sustainable manner in which resources must be developed, in order to protect the environment (Humby, 2010).

According to Munnik *et al.,* (2017), legislation in South Africa involves licensing, authorisation or permitting processes, which exist to prohibit activities until the state has given its approval. This is to allow the state and/or public interest to be secured while conducting the relevant activities. The regulator is empowered by the law to define the conditions pertaining to an activity, to monitor it and to enforce compliance through various legal channels, such as the issuing of directives or the initiation of criminal cases. The holder of a right to conduct an activity will have responsibilities that must be adhered to, in order to proceed, and these responsibilities and conditions are defined by the right or licence issued. The South African licencing process governing the mining industry is not a single one, but consists of multiple pieces of legislation which occasionally overlap in terms of procedures and responsibilities.

Development and environmental degradation are unrelentingly linked, where unlimited development is detrimental to the environment and the degradation of the environment is detrimental to development. Thus sustainable development is a key factor when considering the way forward (Munnik *et al.*, 2017). In order to bring about change in the way the system works, it is important to understand the weaknesses and overlaps within our legal system that cause reduced compliance pertaining to mining activities. This will ultimately lead to a more sustainable process of mineral extraction.

The Legal Resources Centre (LRC, 2016) released a report after the submission of the first draft of this thesis that was developed for the catchment management forum (CMF) in the UKF with the intension of sharing their experiences and to help other CMF's in understanding the damage that the coal mining industry can do for the water resources. This report was for citizens and decision makers who want to protect the water resource and biodiversity, and for those who are concerned by the decision making around the coal mining industry.

The LRC report is a simpler piece of work than the work done in this chapter, and provides a user friendly account of legislative provisions recorded in appendix 1.

ONE

Compile a regional-scale (for example on quaternary catchment scale but nested in bigger scales, such as provincial plans, catchment management strategies) overview of existing ecological infrastructure (water resources, biodiversity, climate and soils for agriculture). This forms part of the Decision Support System. They need to be analysed in terms of ecological infrastructure as they might not be expressed in that form.

List authorities and their roles.

These plans must be found, brought to the attention of stakeholders and participants in the CMF. The plans are worked through in capacity-building exercises, and then are accessible to all members of the CMA and CMF, both in terms of detail – an URL or on a website – as well as an executive summary for immediate use. All decisions depend on understanding these plans.

TWO

Gather all stakeholders to discuss and establish an overview of land use options and the reasons for choosing those options – cultural resources, needs for historical redress including land claims, options for land use and Integrated Development Plans (IDPs).

There may be conflicting agendas among stakeholders, but if the discussions are carried out in an atmosphere of respect and mutual understanding, agreement (if not consensus) can be reached. The advantage of the discussions is that a deeper understanding of a complex situation becomes clearer and trade-offs are possible, or can at least be put into words. All voices should be heard, and options should be considered in the long-term rather than in the immediate or short-term.

THREE

Develop directions for long-term development in terms of the National Development Plan, including options for (and resources needed for) a changeover to the green (low carbon) economy. This involves assessing current economic activities and their impacts, and imagining the change from what is practised now to what the future may be. This discussion should be part of any decisions about coal mining and water.

FOUR

Assess coal mining options in terms of:

4.1 benefits to the national and local economies
4.2 impacts on hydro-ecological-infrastructure (water resources, the ecological infrastructure)
4.3 whether proceeding with coal mining would make competing land uses and other development options impossible in future
4.4 future costs of rehabilitation and restoration of land (eco-infrastructure).

Based on the plans developed in Step 3 above, assess the current and proposed future uses of ecological infrastructure in terms of how those uses relate to current economic activities, and also how they support or eliminate future uses of ecological infrastructure in a green economy. These discussions should happen in an atmosphere of respect for each other and as a result of empowerment and dialogue-type facilitation.

FIVE

Weigh up the options in terms of their sustainable use and impact on eco-infrastructure, future land use and development options, benefits and costs, and need (socio-economic need).

Stakeholders discuss and negotiate, in their own and other forums, such as the local government's Integrated Development Plan processes, departmental processes and in terms of SPLUMA*, how these options contribute to public welfare and the public interest. Stakeholders in the CMFs act as protectors of hydro-ecological-infrastructure. These discussions must happen on a level playing field with empowerment and facilitation for dialogue.

SIX

The knowledge that comes out of these discussions forms the basis of a monitoring system that is supported by legal instruments, for example water-use licences, mining authorisations, social and labour plans, etc.

For the monitoring system to be effective, stakeholders within the catchment area must be able to access, read and comment on these legal instruments, and must be helped to understand and use them. Stakeholders should automatically have access to this information, and actively participate in processing them. Access to the information should be free and straightforward; there should be no legal costs involved. Mines' compliance is made public in a system similar to the Green and Blue Drop incentive schemes.

SEVEN

The decision-making and monitoring system is streamlined in terms of a principled pragmatic approach to IWRM (Integrated Water Resources Management). Documents are concise, accessible and honest.

Decisions and information are written in easily understandable language, are of a reasonable length, and present the relevant conclusions in an understandable way, making it clear, for example, who polluters are, or what the potential for pollution is. Technical data and analysis should be available in appendices, and stakeholder or interest groups have access to publicly-funded technical support to cross-check the conclusions presented and the data and the analysis that these conclusions are based on. Annual reports give information about monitoring results.

EIGHT

Relevant departments participate in and assist this process by offering specialist knowledge, sharing and considering inputs, and supporting participation, especially of historically disadvantaged groups, through capacity building.

All departments understand their duty to invite and support public participation, including through regular capacity building. They have dedicated officials, such as those in CMAs, for this task. These tasks can also be undertaken by civil society organisations or Chapter 9 institutions, with regular monitoring and evaluation by the participants who are supported in this way. These functions are Key Performance Indicators (KPIs) for these departments, according to the principles of *Batho Pele*. The system is underpinned by easy access to information. Media is used extensively and public awareness is built and maintained.

NINE

The CMA co-ordinates the process in terms of water issues. National departments assure alignment and integration with national priorities, through task teams (such as the current AMD task team), with a focus on job creation, to changing to a green economy, etc.

Because water is central to most of these land-use options, the Catchment Management system will become stronger through the opportunities for co-operative governance, clear role descriptions and integration of land use plans. Processes to develop, update and extend Catchment Management Strategies are ideal opportunities for this function.

TEN

The Upper Komati Catchment Forum developed a Decision Support System through knowledge of the networking process, as a linked constellation of knowledge resources, including precedents of decision making. Knowledge sources are developed, archived and made accessible, for example, through websites linked to the IUCMA, national, provincial and local governments, as well as civil interest groups.

These steps are related to the mining life cycle as explicated by this study in section 3.3 Results.

The aim of this chapter is to provide a synthesis of the regulatory provisions necessary for the mining of coal at the different stages of a mining life cycle.

3.2 Methods

A desktop study of current South African legislation was performed, in order to understand and describe the legislative framework used to govern the mining industry, with a particular focus on water and the environment. A life cycle approach was taken and mining was considered from cradle to grave, to understand better the different steps that are taken at different stages in the life of a mine.

The desktop analysis aimed also to synthesise the regulatory provisions that govern actions within the mining life cycle. All the national acts pertaining to mining and mining related activities were downloaded from government websites and reviewed. Data held by non-governmental organisations (NGOs), such as the WWF and the Endangered Wildlife Trust (EWT), assisted with access to relevant legislation through their websites and downloadable guidelines. The DMR online application portal for mining rights was used to assess guidelines and templates for required documentation. The Mining and Biodiversity Guideline (DEA *et al*., 2013) was used to indicate issues with the current legislative requirements.

A legal expert was consulted to improve the understanding of the current legislation and to help investigate the shortfalls it currently experiences (Humby, 2015).

The Mining and Environmental Impact Guide produced by the Gauteng Department of Agriculture, Environment and Conservation (GDACE) (2008) was also assessed.

3.3 Results

Table 3.1: A list of legislative acronyms used.

Acronym	Legislative Framework
MPRDA	Mineral and Petroleum Resources Development Act 29 of 2002
NEBA	National Environmental Biodiversity Act 10 of 2004
NEMA	National Environmental Management Act 107 of 1998
NEMPAA	National Environmental Management Protected Areas Act 57 of 2003
NEMWA	National Environmental Management Waste Act 59 of 2008
NHRA	National Heritage Resources Act 25 of 1999
NWA	National Water Act 36 of 1998

3.3.1 Mining Life Cycle

In order to understand the composite suite of legislative requirements to which the mining industry must adhere throughout the mining process, the complete mining life cycle needs to be understood. This section will discuss the process of coal mining from cradle to grave in order to understand the legislative requirements of such an operation.

What is mining?

"The activity, occupation and industry concerned with the extraction of minerals" (Ciência Viva, 2015: 3). It is the extraction of naturally occurring solids, liquid minerals and natural gas and involves underground or open cut mining, dredging and quarrying (Australian Bureau of Statistics, 2013). It is the process in which minerals are removed from the earth for various uses and applications. It is required to obtain resources that are non-renewable and cannot be artificially created or grown (iMinco, 2015). Mining is a vital component of our modern way of life and is essential to the production of materials for construction, manufacturing, electricity generation and distribution, the production of electronic devices as well as other daily needs (NSW Mining, 2014). Ciência Viva (2015) lists the various needs for minerals by humans in Table 3.2.

Table 3.2: The need for minerals by humans over time, showing their purposes for each use (Ciência Viva, 2015:2).

Need or Use	Purpose	Age
Tools and utensils	Food, shelter	Prehistoric
Weapons	Hunting, defense, warfare	Prehistoric
Ornaments and decoration	Jewelry, cosmetics, dye	Ancient
Currency	Monetary exchange	Early
Structures and devices	Shelter, transport	Early
Energy	Heat, power	Medieval
Machinery	Industry	Modern
Electronics	Computers, communications	Modern
Nuclear fission	Power, warfare	Modern

The formation of coal occurs when peat (decomposed vegetation residue) is subjected to pressure and temperature over a long period of time; the greater the pressure and temperature, the higher the coal rank (Chamber of Mines of South Africa, 2008). There are five ranks for coal: peat (the lowest rank); lignite; sub-bituminous; bituminous; and anthracite (the highest rank).

There are two basic methods of extracting coal from the ground, surface mining—which is the excavation from ground level downwards to the coal bed—and underground mining—where excavation is done by tunnelling along the seam with only narrow openings to the surface (Kang, 2004). In South Africa coal reserves are found in sediments from the Permian age which generally occur as thick, flat and shallow-lying coal seams. Roughly 51 per cent of production is from underground mining, with the remainder from surface mining (Chamber of Mines of South Africa, 2008) (GCIS, 2013).

Surface mining, also known as open-cast and open-cut mining, has a greater recovery rate of coal resources, higher safety for personnel and overall better productivity than underground mining. Its main disadvantage is the fact that it has an unfavourable environmental impact (Kang, 2004).

South Africa's mining history

South Africa is ranked second in the world for having the greatest variety of important mineral commodities—more than 65 mineral commodities are known to occur in South Africa (GDACE, 2008). Munnik *et al*., (2010) state that mining gave South Africa its current shape and that gold mining was the primary focus because of its importance to the British and the ability to make profit. The first profitable concentrations of gold were mined in the present day Limpopo Province in 1871 (GDACE, 2008).

According to van der Schyff (2012), exploitation of the country's minerals has been strictly regulated by the state. The MPRDA is different from the previous act that administered mining in South Africa, which ultimately tried to advance mining by restricting the state's regulatory power to the activity itself, preventing it from becoming involved with a landowner's right to decide whether or not someone could mine on their property (van der Schyff, 2012). The MPRDA regulates the state as the sole authority and responsibility for the management and exploitation of the country's minerals.

Stages of a mining life cycle

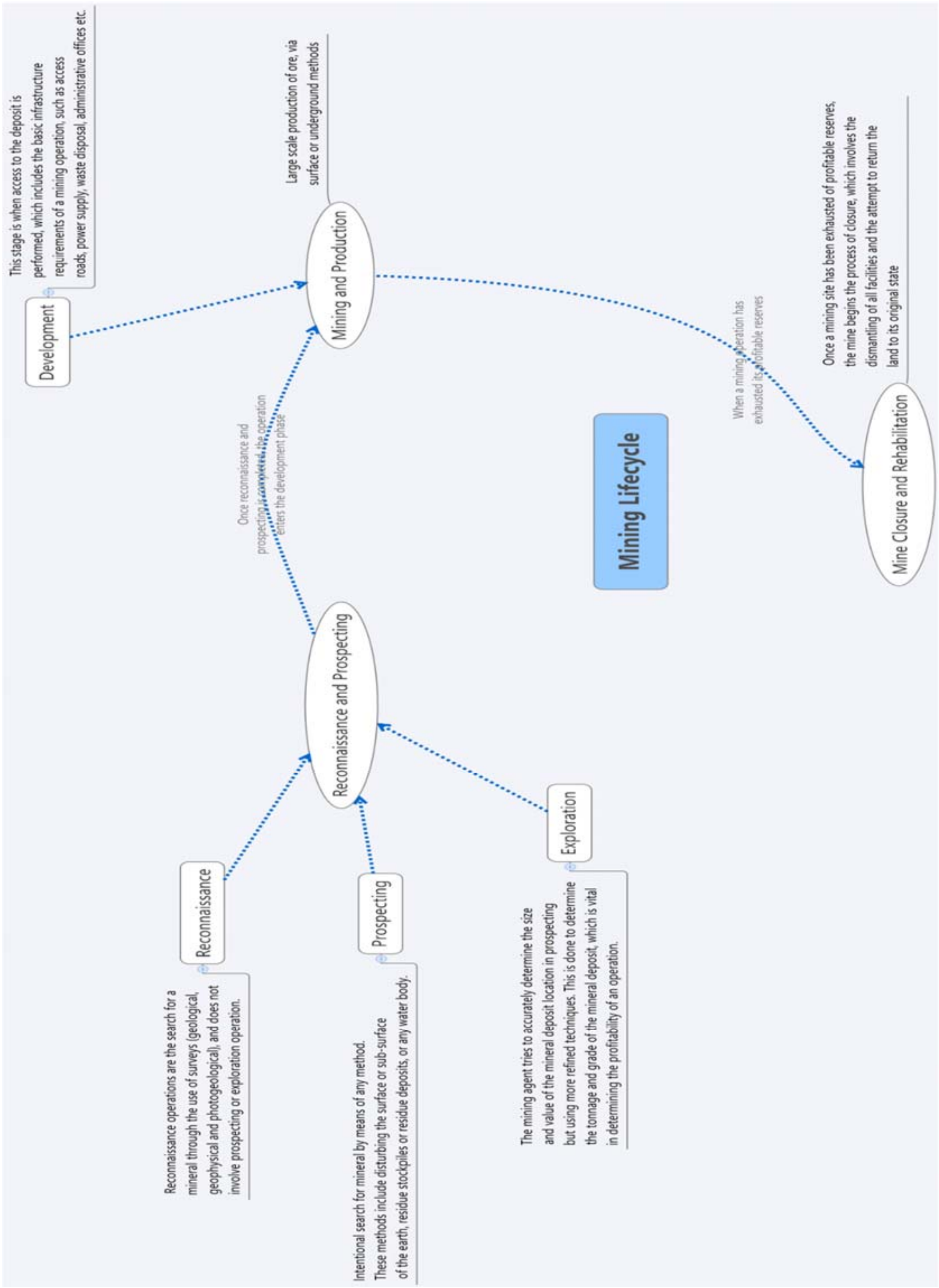


Figure 3.1: This diagram depicts the mining life cycle as it occurs during mining operations (Appendix 1).

The process of mining involves several different stages. These will be discussed in this section and will later be synthesised with various legislative requirements.

There are three phases to a mining life cycle—Reconnaissance and Prospecting; Mining Production; and Decommissioning and Closure (DEA *et al.*, 2013). According to Ciência Viva (2015:6) the stages of a mining life cycle can be expanded further to: "prospecting, exploration, development, exploitation and reclamation."

Reconnaissance/Prospecting

The reconnaissance phase of a mining life cycle is the period in which the region being investigated for potential mineral or petroleum resources is surveyed. This is a quick and low cost operation, conducted to find an area that has sufficient potential for more extensive research, known as the prospecting phase.

According to Kang (2004), coal exploration is undertaken to determine the location, nature and extent of the resources available in the area being researched, and to delineate any features that could potentially affect the economy of the extraction. Exploration generally has two objectives: (1) to find a location in which a certain amount of coal of a required quality may be recovered successfully; and (2) to determine the amount of a required quality of coal that can be extracted economically from a certain location.

The evaluation of coal deposits requires the following operations, according to Kang (2004):

1) Obtain a prospecting right from the South African government
2) Evaluate the available geological information
3) Perform a surface exploration
4) Perform a subsurface exploration
5) Analyse collected samples
6) Assess the coal resources available as well as the significance of any geological factors in their potential extraction

Prospecting is the first stage of a mining operation; it involves a search for ores or valuable minerals, either below or at the surface of the earth (Ciência Viva, 2015). Exploration is the second stage of the mining operation; the mining agent tries accurately to determine the size and value of the mineral deposit located during prospecting, but uses more refined techniques (Ciência Viva, 2015). This is necessary to establish the tonnage and grade of the mineral deposit, which is vital for determining the profitability of an operation.

Development is the third stage of mining, according to Ciência Viva (2015). It is the stage in which exposure of the deposit is commenced. This is achieved by stripping the overburden (the material covering the deposit), or by underground mining, which is chosen usually to access deposits found at a deep location under the surface. Underground mining is more expensive and complex and requires technical planning and operations. This phase also includes the establishment of the basic infrastructure required by a mining operation, such as access roads, power supply, waste disposal, administrative offices, etc. (Ciência Viva, 2015).

Mining/Production

This phase of the mining life cycle is when the greatest environmental impacts are likely to occur. This stage requires the largest effort and investment by mining agents, and also by regulators in terms of authorisations, monitoring and enforcement (DEA *et al*., 2013). Ciência Viva (2015) states that this is the fourth stage of mining and refers to it as the Exploitation phase. The method used is determined by the characteristics of the deposit as well as environmental, technological, safety and economic concerns. The Exploitation phase comprises two broad categories—surface and underground mining (Ciência Viva, 2015).

Mine Closure and Rehabilitation

Once a mining site has been exhausted of profitable reserves the mine begins the process of closure. This involves the dismantling of all facilities and the attempt to return the land to its original state (*Mining Global*, 2015). Ciência Viva (2015:13) states that this phase is the process of closing the mine and engaging in "recontouring, revegetation and restoring the water and land values".

Mining Global (2015) states that the objectives of a rehabilitation programme could include the minimisation of environmental damage, health and safety of the public, preserving water quality, the removal of hazardous material, the removal of waste, establishing vegetation and protection of the land against erosion through stabilising the land.

3.3.2 Legislative Provisions

Introduction

The legislation involved with the mining industry is complex and extensive and covers a wide variety of different regulations from various state departments. A desktop study of current legislation was performed, to gain a better understanding of the legislative framework that governs the mining industry, with a particular focus on water and the environment. A life cycle approach was followed and the mining process was reviewed from cradle to grave, in order to appreciate the different actions that are performed at different stages in the life of a mine.

Environmental mining legislation has been developed to standardise mining operations and protect the environment from the negative impacts that mining operations can cause. Mining companies that adhere to this legislation could limit their impact on the environment.

Mining operations must abide by many different pieces of legislation throughout the process of prospecting, mining/producing and closing a mining site. These include: the National Water Act, 1998; the National Environmental Management Act, 1998; the Mineral and Petroleum Resources Development Act, 2002; the Mine Health and Safety Act, 1996; and the National Heritage Resources Act, 1999. The Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002) was designed "To make provision for equitable access to and sustainable development of the nation's mineral and petroleum resources; and to provide for matters connected therewith." (MPRDA, 2002:5).

There are three phases to the life cycle of a mine—Reconnaissance and Prospecting; Mining/Production and Decommissioning and Closure. Each of these phases needs its own distinct licences from various government authorities.

The focus here is to determine what the MPRDA (2002) requires of mining agents to ensure they abide by the law, prior, during and post any mining operations, and also to note the other pieces of legislation that have bearing on each of the three phases. Issues with the current mining legislation will be highlighted in this section.

Legislation in the mining life cycle

Section 3.1 discussed the mining life cycle. This section will include details of the legislative requirements of each stage of the mining life cycle.

Reconnaissance and Prospecting

At this stage, the Mining and Petroleum Resources Development Act (MPRDA of 2002) requires the mine to get permission for the reconnaissance and prospecting (DEA *et al.*, 2013). This is known as a Prospecting right.

Application for a Prospecting Right

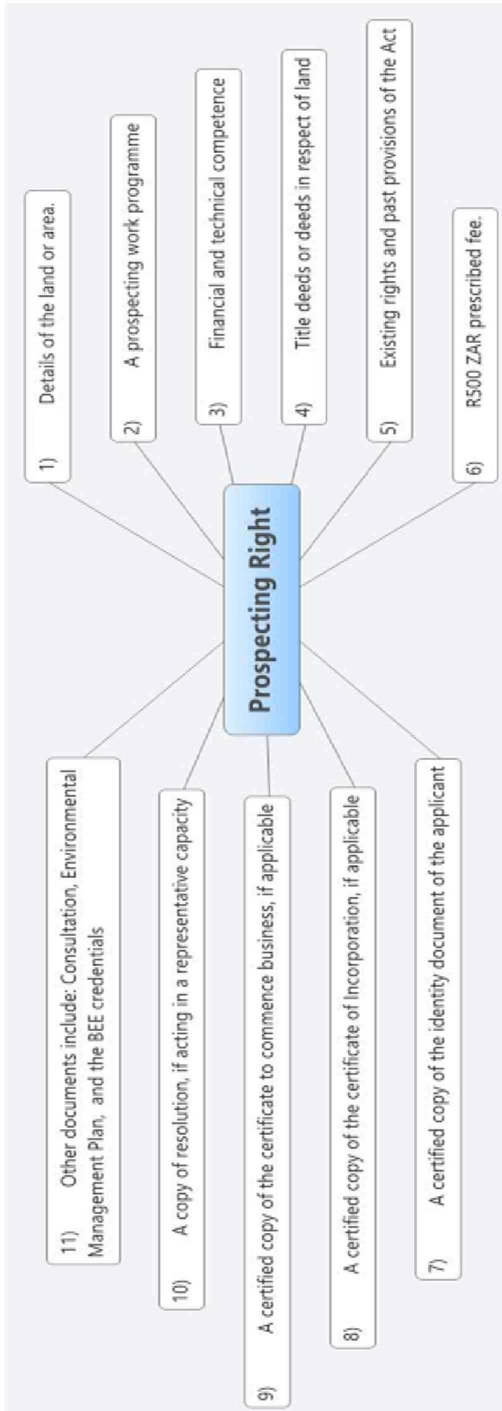


Figure 3.2: A diagram demonstrating the items needed for an applicant to apply for a prospecting right (Appendix 1).

The requirements for the consultation, Environmental management plan and the prospecting work programme will be presented in this section as these are the more complex parts of the requirements needed to apply for a prospecting right.

Consultation

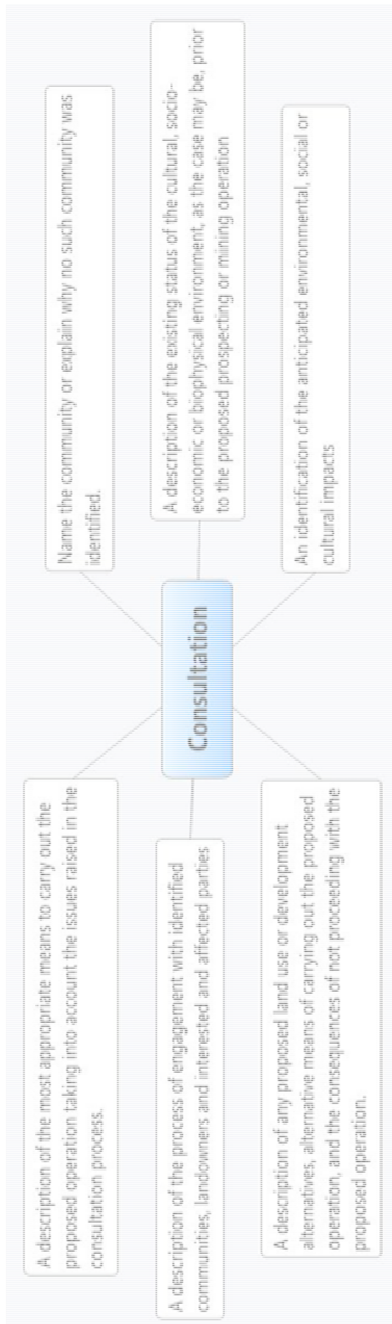


Figure 3.3: A diagram demonstrating what is needed during the consultation processes during the prospecting right application phase.

Agents applying for a prospecting right are required to consult with interested and affected parties, and include a consultation report as laid out in this figure. This is an important part of the application process as it engages the community with the potential effects the mining operation could have on the community in the area.

A Prospecting Work Programme

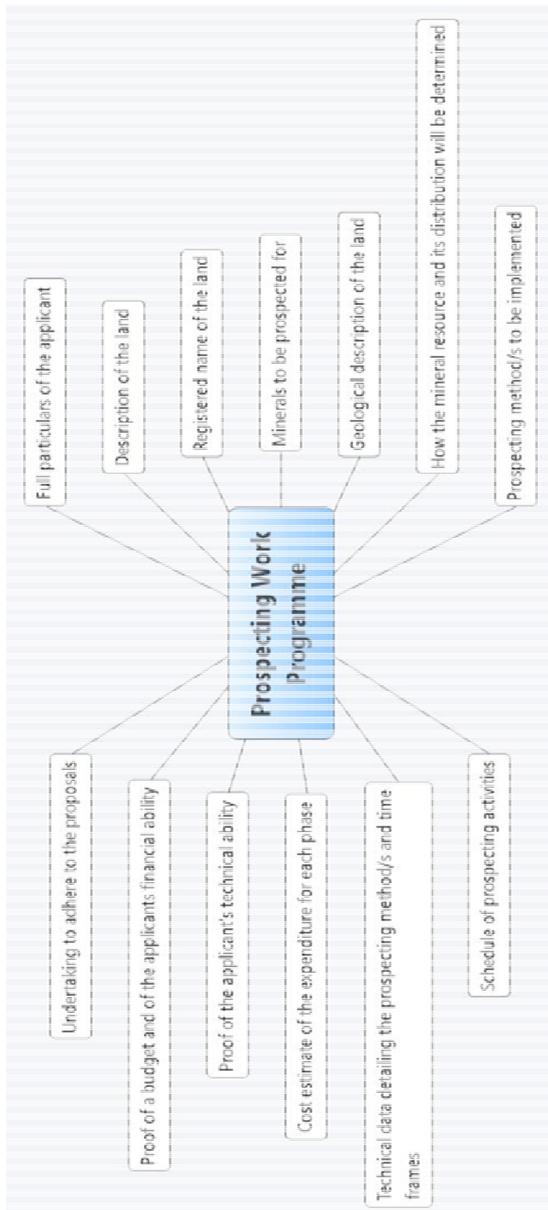


Figure 3.4: A diagram showing which items are needed for a prospecting work programme which is required in the prospecting right application phase.

A prospecting work programme is needed for authorities to technically assess the planned mining operation, and the ability for the agent to efficiently mine the resource, and if the agent has the capability and capacity to do so.

Environmental Management Plan

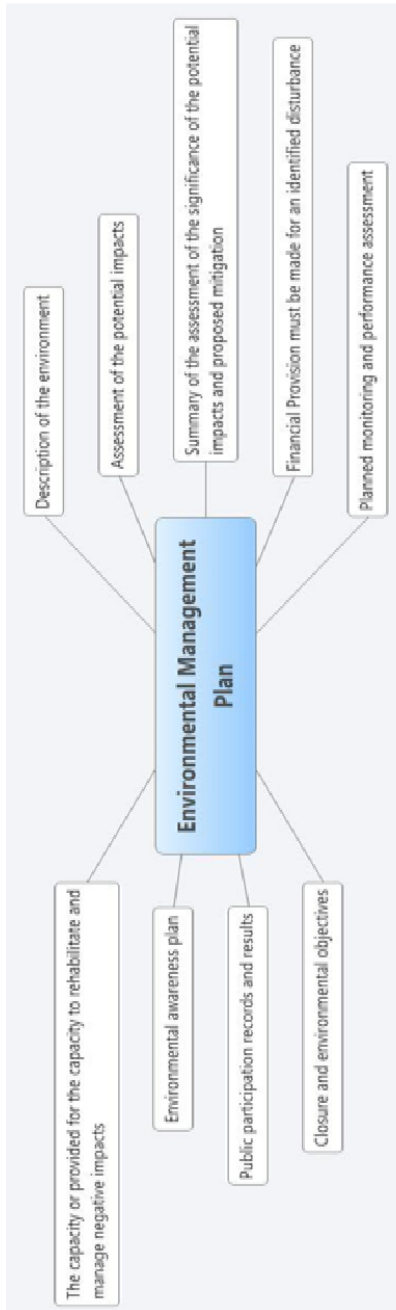


Figure 3.5: A diagram showing what is required for an environmental management plan required during the prospecting right application phase.

The Environmental Management Plan is essential for authorities to assess the potential environmental impacts and implications of the mining operation, as well as assess the agents planned mitigation and rehabilitation measures that will be required to improve the environmental footprint the operation has. The agent needs to show it has the financial and technical ability to achieve its planned rehabilitation and mitigation efforts.

Mining / Production

This phase of the mining life cycle is where the greatest environmental impacts are likely to occur. In this phase, the adequacy of the mitigation measures as described in the EMP, which have been approved by DMR and/or DEA, are tested. The EMP will direct the management of impacts on biodiversity and ecosystem services (DEA *et al.*, 2013).

Application for a mining right

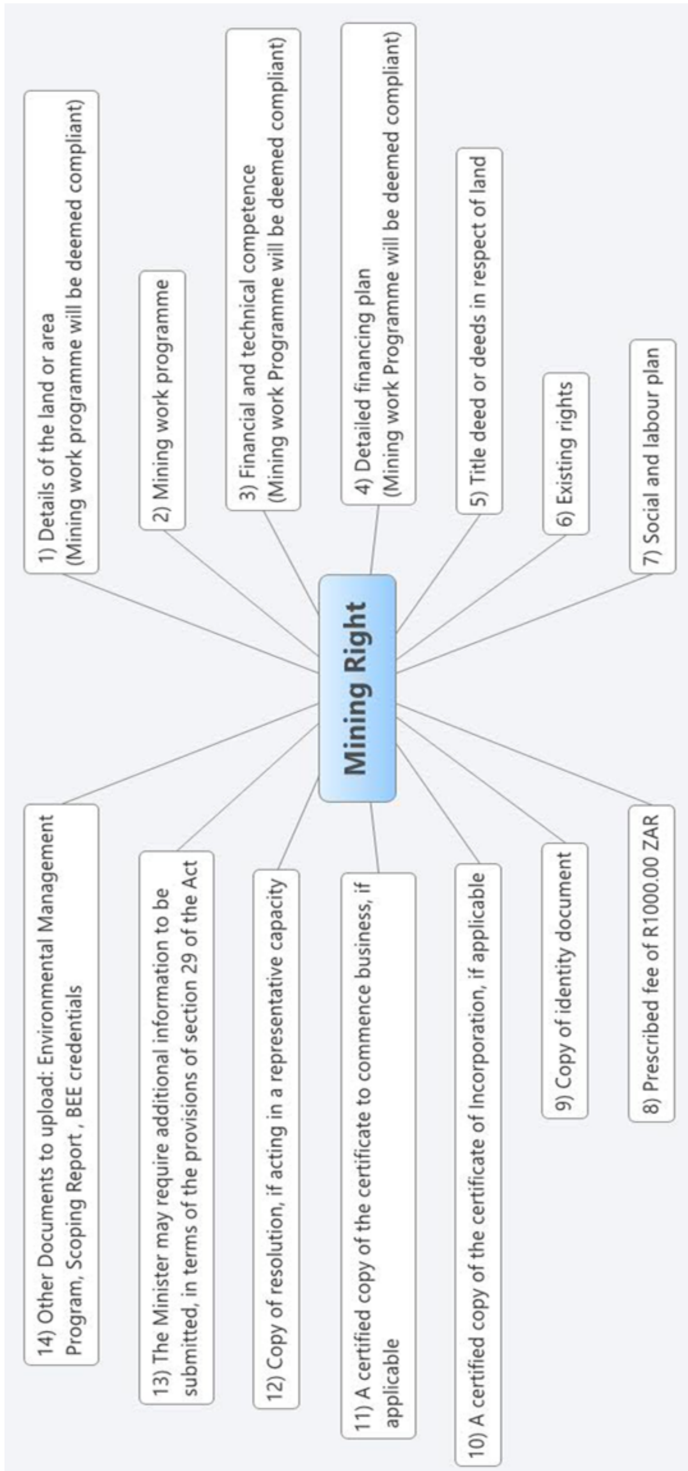


Figure 3.6: A diagram showing what items are required when applying for a mining right (Appendix 1).

When an agent applies for a mining right, they are required to submit information in order for the authorities to assess whether or not they should be permitted to mine. Figure 3.6 shows what needs to be submitted to the authorities.

The Mining Work Programme

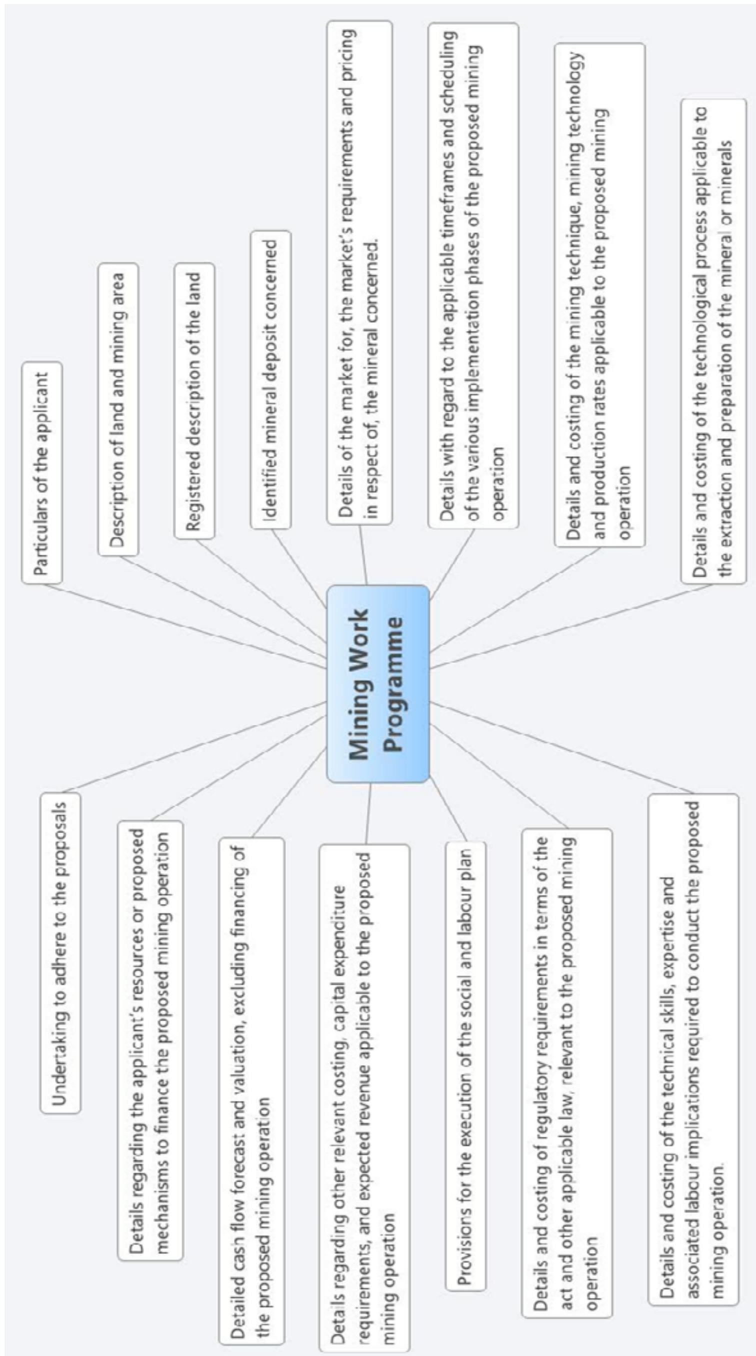


Figure 3.7: A diagram showing what items are needed for the mining work programme required during the mining right application phase.

The mining work programme is necessary for the authorities to determine if the agent is technically and financially able to mine the resource efficiently and effectively. This is a technical report that includes a large amount of information that shows the authority the mining agent is able to mine the resource.

Environmental Management Programme

According to DEA *et al*., (2013), an EMP refers to a detailed description of identified mitigation and management measures from an EIA, which includes prevention or avoidance of impacts, minimisation of impacts, protection of the environment, continuous impact management, remedial and rehabilitation actions, adaptive management and monitoring.

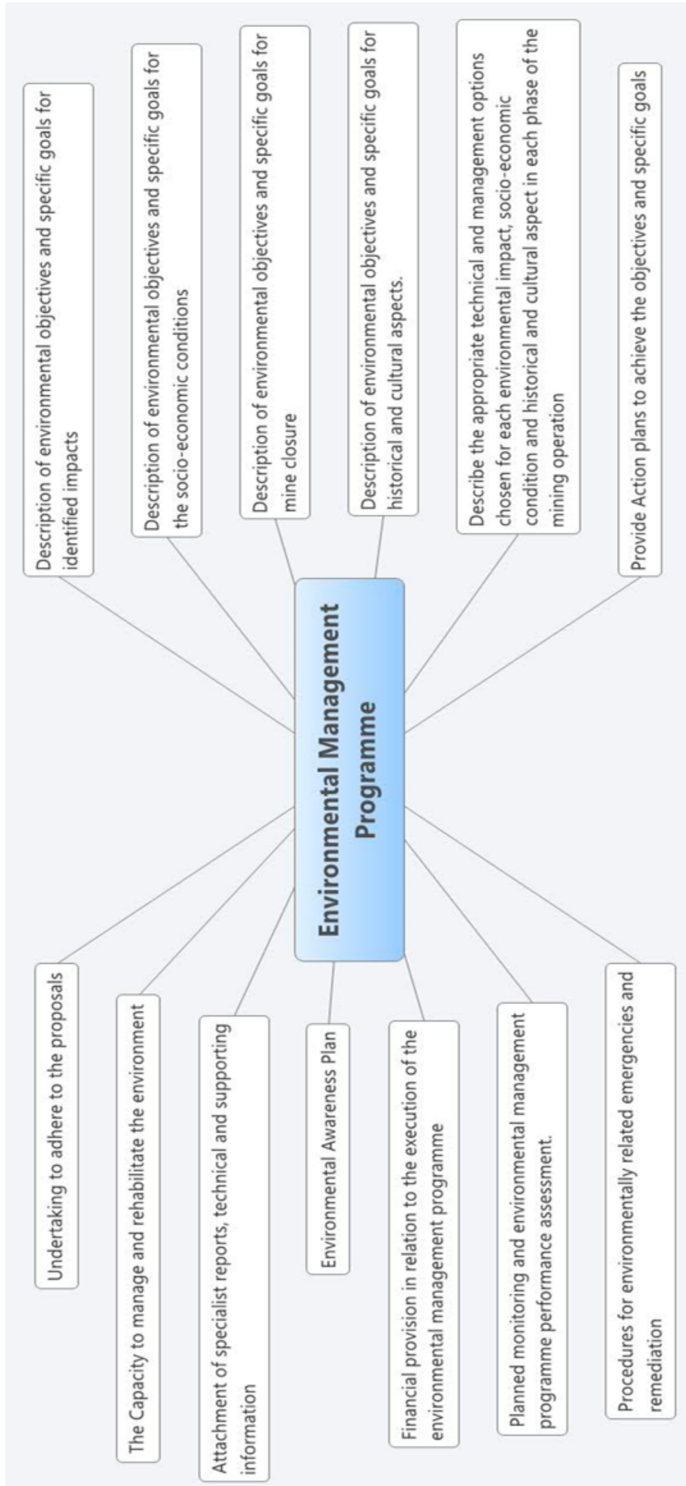


Figure 3.8: A diagram showing what items are needed for the environmental management programme.

Closure and rehabilitation

Figure 3.9: A diagram showing what is needed during the closure and rehabilitation phase of the mining life cycle (Appendix 1).

According to Endangered Wildlife Trust (2012), closure objectives, in general, are to return the land that was being mined to as closely as possible to the pre-mining condition. Before prospecting or mining rights can be approved, there needs to be a financial provision for rehabilitation and closure. This may be made by an approved contribution to a trust fund, a financial guarantee from a registered or DMR approved bank in South Africa, a deposit into a specified account, or any other method that is determined by the DMR.

The holder of a prospecting right, mining right, retention permit or mining permit remains responsible for any environmental liability, pollution or ecological degradation and the management thereof, until the Minister has issued a closure certificate to the holder concerned (MPRDA, Act 28 of 2002).

The Minerals and Petroleum Resources Development Act, 2002 provides for the issuing of a closure certificate by the Minister of Minerals and Energy, in which the environmental liabilities are transferred to a competent person. The application for a closure certificate must also have an environmental risk report, with supporting regulations for mine closure such as the principles for mine closure, the application for mine closure, the application to transfer environmental liabilities to a competent person (including the qualifications of such a person), the content for an Environmental Risk Report and the content of a closure plan.

The National Water Act No 35 of 1998

The National Water Act, 1998 (Act No. 35 of 1998) sets a water management hierarchy, which is based on a precautionary approach and consist of: Pollution prevention, Water re-use or reclamation, water treatment, discharge. In order for a mine to comply with this hierarchy, they require an integrated mine water management system which adhere to these principles: comply to all legislation, follow a life-cycle approach for water management throughout the life of the mine, cradle-to-grave approach to waste streams and consequential impacts, the long-term and current risks of water management need to be quantified with a risk-based approach

National Environmental Management Act 107 of 1998

Any activity that requires a reconnaissance permit (excluding reconnaissance by means of a flyover), an exploration right or renewal, production right or renewal, or mining right or renewal in terms of the MPRDA will require an EIA as they are listed activities according to NEMA. The EIA's will need to be reported to the competent authority that is authorised to grant environmental authorisation.

NEMA applies to all mining phases where necessary and serve as guidelines for the administration, interpretation and implementation of the environmental requirements of the MPRDA. The holder of mining related right/permit must:

- Consider, investigate, assess and communicate the impact of their activity on the environment
- Manage all environmental impacts
- Rehabilitate the environment as far as reasonably practicable to its natural state, or to a land use that is considered to be a generally accepted principle of sustainable development
- Take responsibility for environmental impacts, pollution, or degradation of the ecology that has resulted from mining activities, regardless of the phase and include areas outside the boundaries of the right to preform mining activities

Environmental Impact Assessment

An EIA is the process in which the likely impacts of a proposed project will have on the environment (DEA *et al*., 2013). Mining activities at all phases may have the following impacts (Endangered Wildlife Trust, 2015):

- The degradation of Ecosystem services due to the destruction and alteration of habitat
- Water pollution
- Water and energy usage
- Noise and air pollution from processing and transport
- Cultural and socio-economic impacts on local inhabitants

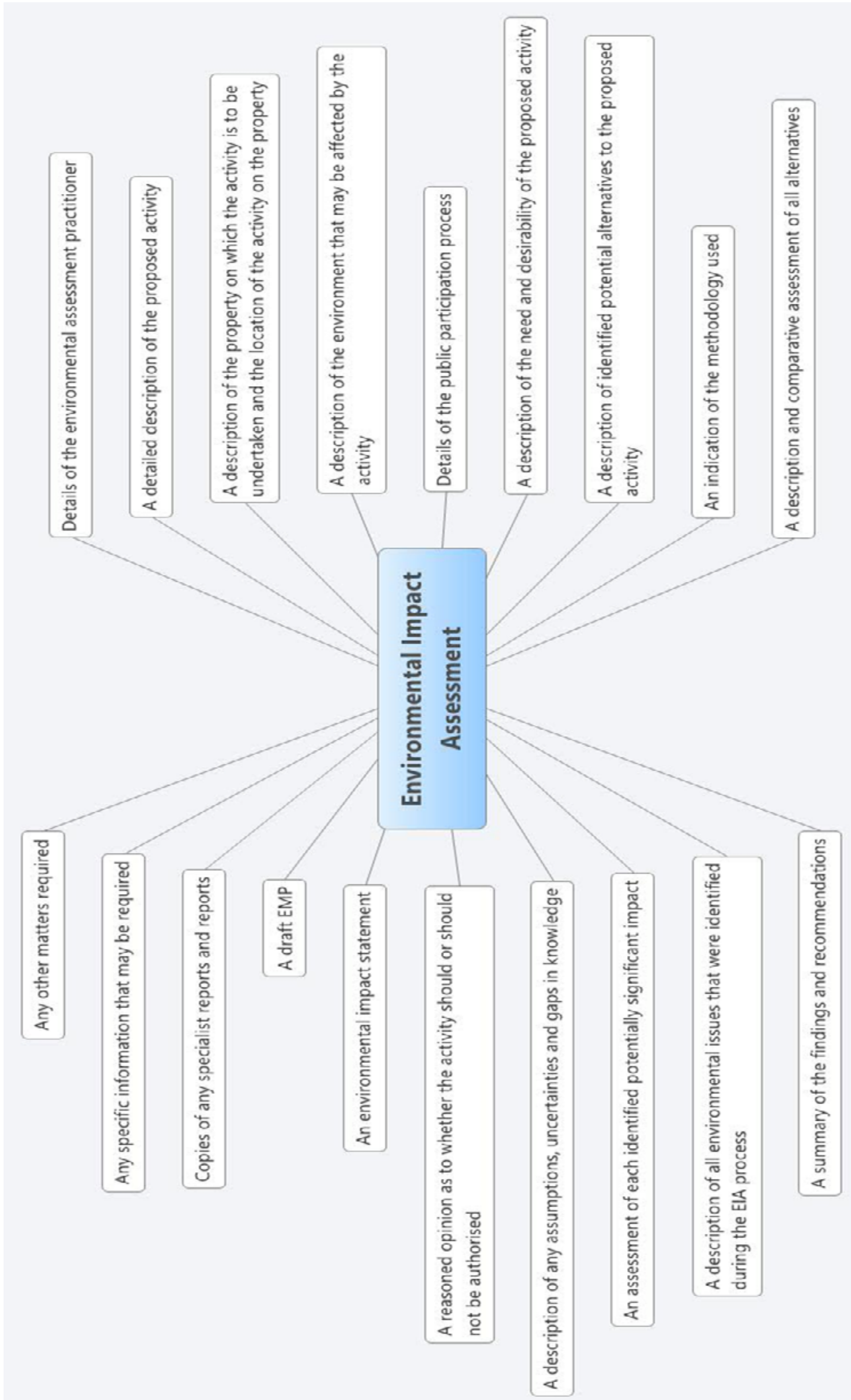


Figure 3.10: A diagram showing what is required to complete an environmental impact assessment required by the NEMA.

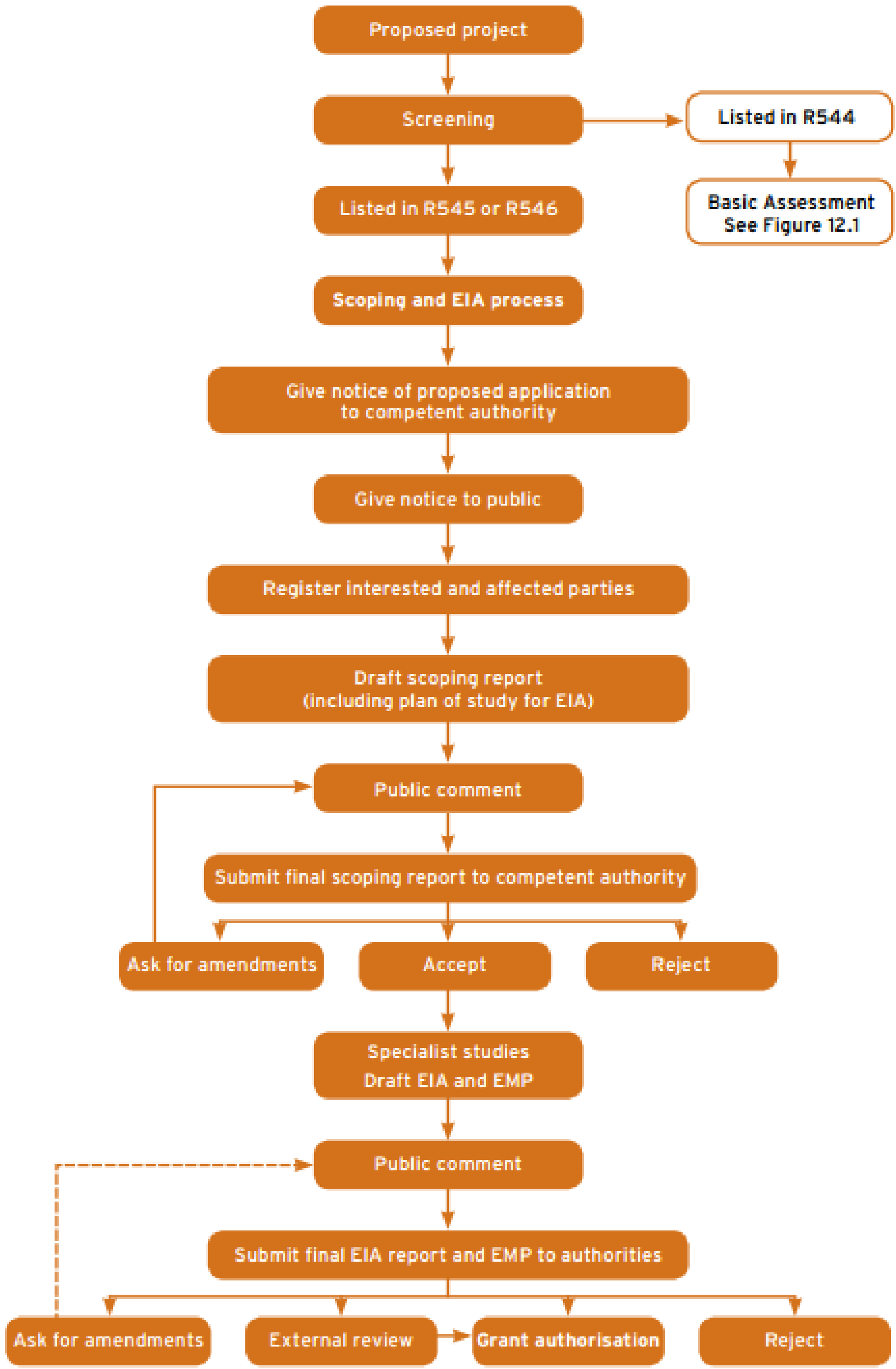


Figure 3.11: A diagram demonstrating the flow of processes the applicant is required to follow during the scoping and EIA phase (Walmsley and Patel, 2011).

A mine will need to comply with the National Environmental Management: Waste Act, 59 of 2008 (Waste Act) with regard to any waste management activities. The applicability to prospecting and mining activities is limited due to the fact that the Waste Act excludes ambit residue deposits and stockpiles. A holder of a prospecting or mining right may have to comply with general duties imposed on them by the Waste Water Act, which include the obligations to avoid generating waste, to minimise the toxicity and amount of waste to unavoidably produced waste, to reuse, reduce, recycle and recover waste among others.

The National Environmental Management: Air Quality Act, 39 of 2004 (AQA) is the law that governs air quality in South Africa. In terms of mining, any activities which impact air quality require licencing by the Department of Environmental Affairs. These include dust control (which should be addressed in the EMP or EMPr), noise and offensive odours.

Heritage Resources are protected by the National Heritage Resources Act, 25 of 1999 (NHRA). These resources include movable and immovable objects of historical, archaeological, paleontological or astronomical interest. A heritage impact assessment needs to be done in such areas for certain linear developments (such as a pipeline), which is submitted in the EIA process, which must take into account the Heritage Resources Agency's comments when considering the application (Endangered Wildlife Trust).

No mining activities may be conducted in: 1) a special nature reserve, national park or nature reserve, 2) in a protected area without permission of the Minister and Cabinet member responsible for minerals and energy, or 3) in a protected area, according to the National Environmental Management: Protected Areas Act, 57 of 2003 (NEMPAA) (Swart, 2003).

3.4 Discussion

An EMP refers to the environmental management *plan* required by the MPRDA. However, EMP also refers to the environmental management *programme* found in the NEMA. To distinguish between the two, the EMP within NEMA is referred to as the EMPr. NEMA's EMPr is the documentation required before consideration of an application for environmental authorisation. In the MPRDA, the management and rehabilitation of environmental impacts are found in the EMP for the reconnaissance, prospecting and mining permit, whereas the EMPr for mining and production rights is found in the NEMA (DEA *et al*., 2013). An EMPr is specific to organs of state; it refers to procedures for co-operative governance and the coordination and harmonisation of environmental policies, plans, programmes and decisions within various national departments that exercise functions that may affect the environment (DEA *et al*., 2013).

There is no standard for the scientific work being done in order to compile environmental studies and compliance with associated legislation. According to the WWF (2012), the content and quality of EMPs and EMPrs vary significantly in practice and include specific procedures that are problematic:

- EMPs/EMPrs that do not include rehabilitation plans; which limits any ability to trace the links between these plans and the financial provisions that should be clearly present
- EMPs/EMPrs that have rehabilitation plans; which are found to be insufficient regarding links to the calculation of financial provisions; which have limited distinctions between the areas that can be rehabilitated only when closure occurs and rehabilitation that can take place while the mining operation is running
- EMPs/EMPrs that do not account for, or are inadequate for, longer term water quality issues

The DMR has nevertheless approved EMPs with these deficiencies, which shows a lack of standards within the DMR and a possible inconsistency regarding the qualifications and experience of practitioners (WWF, 2012). Also, the figures used in EMPs/EMPrs frequently contain under-estimations of financial provisions, use 2005 values and inflation is not taken into account (WWF, 2012). In 2010, the financial provisions of some EMPs/EMPrs were under-estimated by up to 35 per cent, because they had been based on 2005 values (WWF, 2012).

The CER (2012) found 32 legal cases in the period from 1980 to 2011 that were related to some aspect of mining and the environment and/or public participation. Twenty of those cases were initiated in 2004, which shows a significant increase in cases being brought to the courts. In addition, CER found a further 77 cases that had not yet been resolved.

The DMR is the institution most obviously involved with the granting of mining related rights in South Africa. According to legislation, the DMR is obligated to consult with other departments, such as the DWS and the DEA, that administer legislation relating to activities that will affect the environment, when deciding whether or not to approve an environmental plan submitted to it. However, the departments that must be consulted are not specified. Also, if the relevant departments fail to comment or respond to the DMR within 60 days of being notified, there is no legislation that prevents the Minister of Mineral Resources from deciding the fate of the application. Comments that are submitted by other departments regarding applications to the DMR are not legally binding; the Minister of Mineral Resources is only required to consider such comments before approving the environmental management plan. According to the CER (2012), it is not known if the MPRDA over-rides the NEMA or if this issue would be considered if a matter is taken to the Constitutional Court.

Law is inherently adaptable, especially when different legal instruments are read together (Munnik *et al.,* 2017). According to the MPRDA, there is nothing that suggests prospecting cannot begin without a water use licence, as long as a prospecting licence has been granted. This has caused instances of mining companies applying for water use licences from the DWS, but continuing with prospecting activities regardless. "The illegality of mining without a water use licence has therefore almost become institutionalised" (Munnik *et al.,* 2017). In addition, the MPRDA does not define the term 'unacceptable pollution', despite the fact that authorisation of prospecting licences depends on whether or not a mining company can prevent unacceptable pollution from occurring. Also, the timeframe in which an applicant for a mining right must compile and submit environmental reports to the DMR is 180 days, which ignores the natural cycle of seasons—a wet or dry period will have an impact on the environmental report.

This being said, South Africa already has many policies in place, including legislative instruments, which can be used to help balance the present and future use of water resources with mining operations, to ensure the sustainability of the environment (Munnik *et al.,* 2017).

The MPRDA requires, during the process of closure, that the mine concerned rehabilitate the environment to a natural or predetermined state, or to a land use conforming to the generally accepted principle of sustainable development. This leaves room for interpretation and could be used to justify post-closure land use that is not focused on offsetting environmental issues caused by the mining operations, but is focused on minor economic or social profits.

The legislation does not take into account rehabilitative requirements of a mining operation that has been put under liquidation by a court of law, where the assets seized will be used to settle debts owed by the mining company that is being liquidated. Case study 1 gives an example of how this affects the environment when this sort of situation occurs.

Mining companies can transfer their environmental risks to another party, legally, by applying to the Minister of Mineral Resources for the right to transfer. This right may well be granted, providing that the other party meets prescribed standards and is capable of managing the environmental risks and liabilities that may occur. This may be done by mining companies who do not wish to rehabilitate but who apply for a closure certificate.

At the end of 2008 the DMR did not have an approved strategy for the rehabilitation of abandoned mines, nor did it have approved policies or procedures relating to abandoned mines and their rehabilitation. As a result, no new rehabilitation projects were started in the 2008/2009 financial year, nor were there plans to rehabilitate in the 2009/2010 financial year (Auditor General, 2009). In the 2010/2011 financial year the DMR rehabilitated five asbestos mines (*Business Day Live*, 2012). According to *Business Day Live* (2012), Mintek was contracted to rehabilitate 10 mines between 2010 and 2013 and was expected to complete the rehabilitation of 15 asbestos mines by the end of the 2012/2013 financial year. The MPRDA does not take into account cumulative impacts of a mining operation, or ecological infrastructure. This information is necessary to make an informed decision on whether or not a mining right is granted.

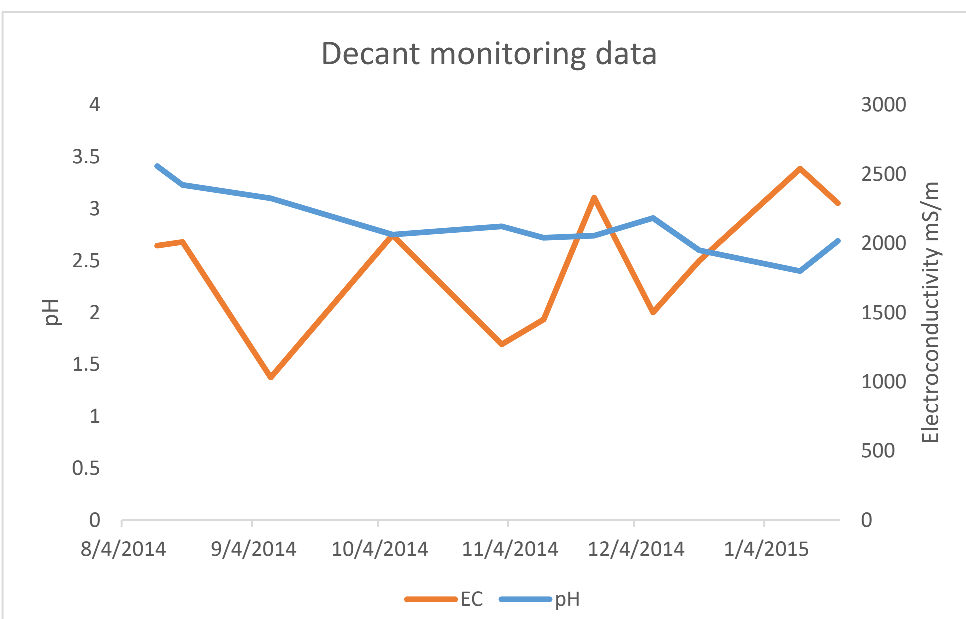
A 10 step integrated monitoring plan and decision-making system was a result of this report, that guide CMA's and CMF's towards a more integrated and balanced decision making process of mining development and protecting ecological infrastructure and biodiversity. Below is the LRC 10 step integrated monitoring plan and decision making system (WRC, 2016), where LRC (Legal Resources Centre, 2016) provides a simplified pathway of what happens.

This chapter aimed to synthesise the regulatory provisions of a mining life cycle. The mining life cycle was discussed and the composite suite of legislation was included in the different stages of the mining life cycle.

Case Study 1 illustrates issues to be raised in Chapter 3 (Section 3.4) and Chapter 4 (Section 4.3.2) with regard to current mining legislation and the process to liquidate a mining company. It also discusses the lack of clarity on mine closure and the liquidation of a mining company.

A mine that had been addressing its historic AMD decant went bankrupt and is currently being liquidated. It had been engaged in talks with regulators to address the AMD decant from its previous workings, which was flowing into water resource. The mine was developing a strategy for permanent treatment of the decant, when it filed for bankruptcy and ceased all rehabilitation plans and activities. This situation begs the question: What happens to the site now? The liquidators assigned to recover costs are prioritising funds for investors and have no plans to recover funds for general rehabilitation of the site or to remedy the decant from the site. This is currently a grey area: should the liquidator consider the rehabilitation of the area; and if not the liquidators, then who should be responsible for its rehabilitation? The DMR is far from being able to rehabilitate abandoned and derelict coal mines in the area.

The figure below shows the pH and electroconductivity of the decant entering the water resource in X11B, over a period of five months prior to the company being liquidated. This data shows the quality of the water after measures were taken to increase the pH by means of adding lime to a holding dam. The image below shows the lime barrier constructed in a temporary holding dam to treat the AMD, while the company was planning more permanent treatment options.



A diagram showing the pH and electro conductivity at an AMD decant point entering the resource in Carolina.

A lime wall built to temporarily treat AMD at a decant in the Carolina Catchment.

Since its liquidation the company has not made any effort to rehabilitate the site and no funds have been set aside for rehabilitation of the decant. This leaves the DMR as the authority responsible for rehabilitation of the site, but to date it has done nothing to remedy the site or the decant.

The MPRDA states that if no closure certificate has been issued and the agent responsible for the mining operation cannot be traced and held accountable for the liabilities of an abandoned mine, it is classified as derelict or ownerless and becomes the responsibility of the state. The state must then attend to rehabilitation of the ownerless mine by means of a treasury allocation (Auditor General, 2009).

According to the WWF (2012), current legislation (MPRDA 28 of 2002) allows for the liquidation and deregistration of mining companies without explicit consultation with the DMR. WWF believes that no company in possession of rights or permits issued by the DMR should be allowed to deregister, liquidate or be wound up without first consulting with the DMR. Such consultation would enable the DMR to secure an assurance from the company that it will comply in full with its obligations in terms of the MPRDA, prior to deregistration or liquidation.

Chapter 4: The Activity System for Coal Mining Environmental Practice

4.1 Introduction

In Chapter 3 the mining licence procedure was investigated by looking at the complete mining life cycle and relevant regulatory legal provisions, to understand better the current composite suite of legislation with its potential pitfalls and overlaps. Chapter 3 included evidence to show that legal provisions are dispersed over different pieces of legislation and this has created a situation where the over-regulation of an industry has resulted in less effective law enforcement. Dominance by the Department of Mineral Resources (which is responsible for the promotion of the mining industry), over other state departments is problematic. There is a need for greater understanding of how this situation affects the environment. This chapter will look at the activity of mining as a collective system, drawing on Cultural Historical Activity Theory (CHAT), as developed by Engeström (1987), in which an activity exists in relation to governing and historic rules, tools used to achieve objectives, a community of practice and the division of labour. This enables understanding of the psychological, cultural, social and institutional functioning of the system. Engeström (2001) suggests that where there are points of tension in a system, which generate disturbances and conflicts, there is an opportunity for learning and interventions that can change the system, as well as provide the tools to achieve an objective—all of which will deliver a richer understanding of the system. For actors in an activity system to develop a shared vision and address the tensions within the system, it is crucial to identify contradictions in the activity system. This will help agents focus their efforts on resolving the causes of problems in the system (Engeström, 2000).

Having described the mining life cycle and provided the composite suite of legislation requirements, this chapter will explore the gap between legislative provision and practice by viewing mining as an activity system. This will be achieved by using CHAT to develop an interview process that will enable analysis of current mining activities in the X11B quaternary catchment of the Upper Komati River.

A number of different mining companies operate within this catchment and they all have their own approaches and styles, including the size of the company, accountability for their actions, preventative measures, social responsibilities and programmes, outlook and actions with regard to rehabilitation and pollution incidents. These differences will be discussed in this chapter, which will also describe their effect on the environment.

It is possible to build a holistic picture of all the agents involved, how they make decisions, the rules they follow, the tools they use, the sharing of tasks, their communities of practice and their objectives, all of which link together to achieve their desired outcomes. This information will be vital in determining the workings of the mining system as a whole and identifying opportunities to reduce the impacts of mining on the environment.

Clifford-Holmes (2015) investigated water policy and municipal water service delivery, using transdisciplinary research to engage local water authorities who could increase the possibility of equitable water supply in the Lower Sundays River Valley, through the process of institutional change. The aim of this chapter is to explore the coal mining activity system and to identify tensions between rules-in-form (Chapter 3) and rules-in-practice.

4.2 Theoretical Framing and Methods

Interviews were conducted with agents involved with the mining licence procedure, including government regulators, decision makers, land use advisors and mine managers. Various concerns emerged, as perceived by the actors, with the current procedures regarding mining operations in the area, and the relevant licences for these activities.

This chapter uses CHAT as a framing and analytical tool to explore interviews with agents, to determine points of tension and the potential for intervention and learning within the system.

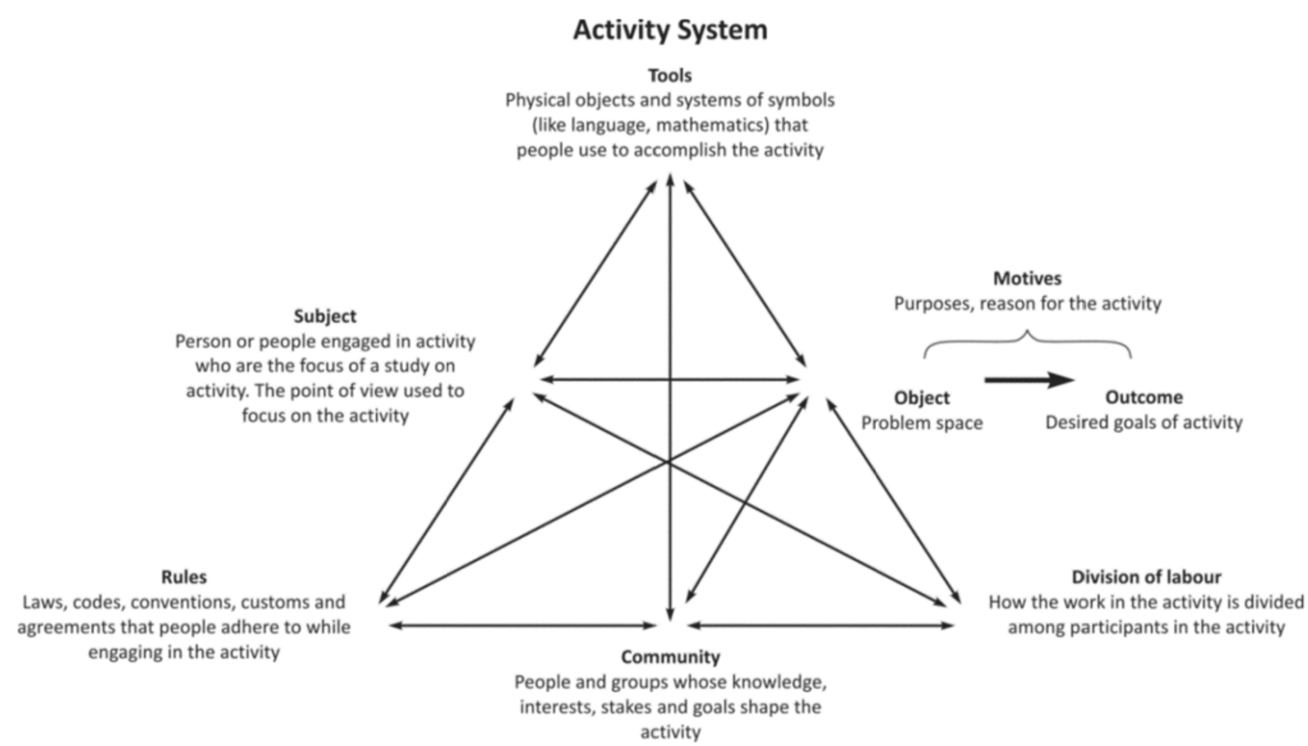

Activity System
Tools
Physical objects and systems of symbols (like language, mathematics) that people use to accomplish the activity
Subject
Person or people engaged in activity who are the focus of a study on activity. The point of view used to focus on the activity
Motives
Purposes, reason for the activity
Object
Problem space
Outcome
Desired goals of activity
Rules
Laws, codes, conventions, customs and agreements that people adhere to while engaging in the activity
Community
People and groups whose knowledge, interests, stakes and goals shape the activity
Division of labour
How the work in the activity is divided among participants in the activity

Figure 4.1: Cultural Historical Activity Theory Framework (Engeström, 1987:78, adapted by Sahula, 2014)

The CHAT framework is a cross disciplinary approach that is used to support and understand human activity and learning as a collective (Association for Water and Rural Development (AWARD, 2013). It acknowledges that activities are socially and contextually bound, i.e. that the context in which activities take place should be understood and that activities develop over time. Consequently, understanding the history of activity development is essential for their expansion. (AWARD, 2013).

CHAT offers a multi-dimensional, systematic approach that includes the dynamics of power, culture, history, money and the tools used. It enables the researcher to analyse complex practices that are constantly evolving (Foot, 2014).

CHAT analysis was used in this study to explore the systemic entirety of coal mining as an activity, making it possible to analyse multiple relations in a system at a set point in time, as well as to derive insight into developments over time (Foot, 2014). CHAT is a useful framework for identifying contradictions in an activity system and therefore assists to identify the root causes of problems (Engeström, 2000).

Engeström (2001) describes CHAT as a global, multidisciplinary research approach which focusses on the study of work and technology. It originated in the 1920s and 1930s and was initially designed by Russian psychologists, Vygotsky and Leont'ev (Kuutti, 1996).

Jonassen and Rohrer-Murphy (1999) detail a series of steps that should be followed when working with CHAT:

- Step 1: Clarify the purpose: One needs to understand the context of the activity that is occurring, what motivation there is for a particular activity and what contradictions may occur between the motivation and context.
- Step 2: Analyse the activity system: One needs to define the components of the activity system which include: subject, object, community, rules and division of labour, while understanding any contradictions that exist.
- Step 3: Analyse the activity structure: One needs to understand what activities the subject consciously and unconsciously engages in.

- Step 4: Analyse tools and mediators: One needs to understand the tools and signs that facilitate the interactions between the object, subject and community.
- Step 5: Analyse the context within which the activity occurs: These include objects and goals (the internal context of the activity) as well as tools and broader movements of society (the external context of the activity).
- Step 6: Analyse the activity system dynamics: One needs to look at the description of the activity system which has been developed and assess how the components interact with each other and what their relationships are.

Jonassen (1999) gives examples of the sort of questions that can be asked in order to use CHAT to better understand the system as a whole:

- Agent: Who is involved with the activity? Who or what is being assessed?
- Objective: What is the expected outcome of the activity?
- Outcome: What is actually achieved by the activity?
- Division of Labour (Sharing of Tasks): Which agents are involved in this activity? How are the tasks shared?
- Community: How does the location in the system affect the agent? How does the agent affect the system? What conflicts have arisen and how do they influence interactions?
- Tools: What tools may be used in this activity? How readily available are they? How have they changed over time?
- Rules: What rules-in-form and rules-in-use are there? Which are most important in this sector? Are there any problems with these rules for this activity?

When used as an analytical tool CHAT can help the researcher to (AWARD, 2013):

- Better understand how activities are functioning through the analysis of different components, while identifying contradictions and gaps
- Better understanding on how change in practice influences the different components of an activity and whether or not this leads towards reaching a collectively desired outcome from the activity.

CHAT was used successfully in this research project. The information generated from CHAT-based interviews created a more in-depth view of the mining activity system and how it functions; it identified and located the contradictions and gaps in the mining licensing procedures; and it produced a better understanding of the practices and routes used by various agents in this field. At the same time, there were certain instances when it was difficult to use the CHAT framework, when interviews and observations in meetings did not reveal as much as was needed to achieve a coherent understanding. This may have been due to actors being cautious in their disclosures.

4.2.1: Interviews

Interviews were a vital component of this project. Contributions from various agents involved in the process augmented the overall understanding of decision making involved with mining licensing procedures.

According to Ritchie and Lewis (2003), one of the main methods of data collection used in qualitative research is in-depth or unstructured interviews. In addition to interviews, participant observation, observation, a stakeholder workshop (where data was generated through both participant observation and observation, covering the first meeting on a decision making and monitoring plan for coal mining in the Carolina District, held in Carolina, 19/01/2016) and documentary analysis were used as methods to generate data while conducting this research (Ritchie and Lewis, 2003).

Ritchie and Lewis (2003) describe participant observation as the recording of actions, interactions or events that occur in the organisational setting in which the researcher also participates; this allows the researcher to gain an additional perspective through his/her interaction with other participants. Observation, on the other hand, allows the researcher to analyse and record the behaviours and interactions as they occur; this is useful particularly when studying a process involving many agents (Ritchie and Lewis, 2003). Document analysis is the study of existing documents in order to understand their content, or to highlight their deeper meanings, according to how the data is presented and the style of the writing (Ritchie and Lewis, 2003). Documents to be analysed could include publicly available documents, such as minutes of meetings, media reports, government papers, letters and accounts, or personal documents. This method of data collection is useful whenever there is a recorded history of events that are being researched.

Abiding by the CHAT structure previously described, interviews were designed to achieve a more in-depth understanding of the mining life cycle. They focussed on the views of the different agents involved, how the legislation is perceived, implemented, and adhered to, and also tried to identify any gaps in the statutes and procedures.

Face-to-face interviews were conducted with as many agents as possible, in various locations, between June 2014 and June 2015. All the agents were involved in at least some of the various processes related to the mining industry. The interview questions appear in Appendix 1.

Data analysis was a thematic analysis of the data collected by using the CHAT elements as themes. Data collection was the data collected through various methods, such as interviews, observation, document collection that was all needed for the data analysis stage.

Limitations

As with all research, there are inherent limitations when dealing with complex systems that involve multiple stakeholders from different organisations and backgrounds. The limitations experienced in this study are listed below:

- When dealing with sensitive areas such as mining and its influence on the environment, a limited number of participants are willing to be interviewed, due to this activity leading, potentially, to a 'bad image'. This is especially so in a market dominated by powerful shareholders whose reputations are at stake. This response restricted opportunities to interrogate mining managers and only a limited number were interviewed.
- Schedules and locations of potential interviewees limited the ability to secure a large number of interviews: various agents were unavailable for interviews on various occasions; others were too geographically dispersed to reach
- Poor communication from the DMR, together with its unwillingness to participate in interviews for this study, has meant that none of the officials, in a key department, were interviewed
- The lack of information regarding the Carolina Crisis became a limitation for this study. The scarcity of information was attributed to the transfer of responsibility from the DWS to the IUCMA, during which key documents were not transferred and could not be located during the life of the study. This includes minutes of meetings held during the Carolina Crisis, which would have been of crucial importance to investigation of the decisions taken by the regulators during this time
- The lack of reliable and continuous monitoring data when focussing on the biophysical analysis of the study limited the enquiry. This resulted in an incomplete view of the water quality issues in the X11B catchment, and the lack of clarity regarding the origins and causes of the Carolina Crisis

Specific Agents Interviewed

The following agents were interviewed during this study:

- Five government officials, three from the IUCMA and two from the MTPA
- Two mining agents—one Environmental Manager and one Mine Manager
- One Forum and civil society member

Different questions were asked according to the different fields in which the agents operated (fields including regulators, mining agents, and civil society), and each case required consideration of different aspects. For example, mine managers were asked what they would do if regulators found them contravening legislation, or in breach of their own environmental management programme; whereas land use advisors were asked how they made suggestions for different land uses, to decision makers, such as the DMR.

Regulators who were willing to be interviewed included: the land use advisory unit of the Mpumalanga Tourism and Parks Agency (MTPA); a wetland specialist in the MTPA; managers from the IUCMA; environmental officers from the IUCMA who were based in the compliance and enforcement team; a manager from the DWS; mine managers and a director of the Federation for a Sustainable Environment (FSE). Communications were received from a law professor from the University of the Witwatersrand and environmental consultants with consulting firms. In addition, observations gleaned from meetings with regulators, involved agents, and between agents in forums and task team meetings, were also used in the analysis.

4.2.2: Ethics

The research involved interviews with mining and mining environmental managers, regulators, government officials and members of civil society. Exchanges during the interviews were mostly matters of public knowledge or discussion. Moreover, the interviewees were experienced in public discussion at Catchment Forums, task teams, etc., relevant to these issues. However, in order to observe ethical responsibility towards the interviewees and protect them from negative consequences from whatever source, the interviewees' were individually offered the following options:

1. Complete confidentiality: the whole interview being anonymous, without any publication (for example research reports, thesis, papers) revealing their names, the names of their companies, or any details that may identify them;

2. Partial confidentiality: parts of the interview, as specified by the interviewee, being anonymous, without any publication (for example research reports, thesis, papers) revealing their names, the names of their companies, or any details that may identify them;

3. Open: The interviewee gives permission that any information from the interview may be made public in any publication (for example research reports, thesis and papers).

Interviewees understood that participation in the research was completely voluntary and they had the right to withdraw at any time.

Mindful of the above considerations, all interviewees were presented with a form on which these choices were spelled out. The interviewee was requested to date and sign the form. The forms and interview results will be curated within the Institute for Water Research (IWR) at Rhodes University, in accordance with their confidentiality requirements.

The Upper Komati Forum (UKF) was an essential part of this research. Information housed in the UKF was used extensively to better understand the communications and interactions between stakeholders in the Carolina area, who are involved with or concerned about current mining licence procedures. The UKF helped to identify issues with the system, participated in key dialogues and provided a report back mechanism for stakeholders.

4.3 Results

Categories of Agents Identified

Mining agents

These are the companies and individuals who are directly involved with the mining operations within the X11B quaternary catchment.

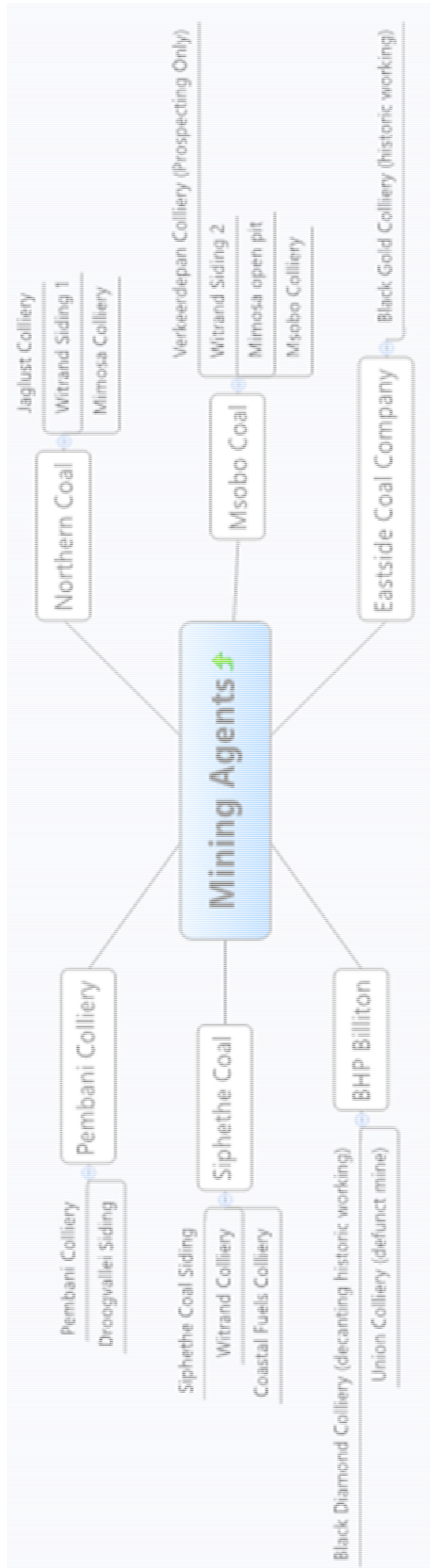


Figure 4.2: Mining agents involved with operations in X11B.

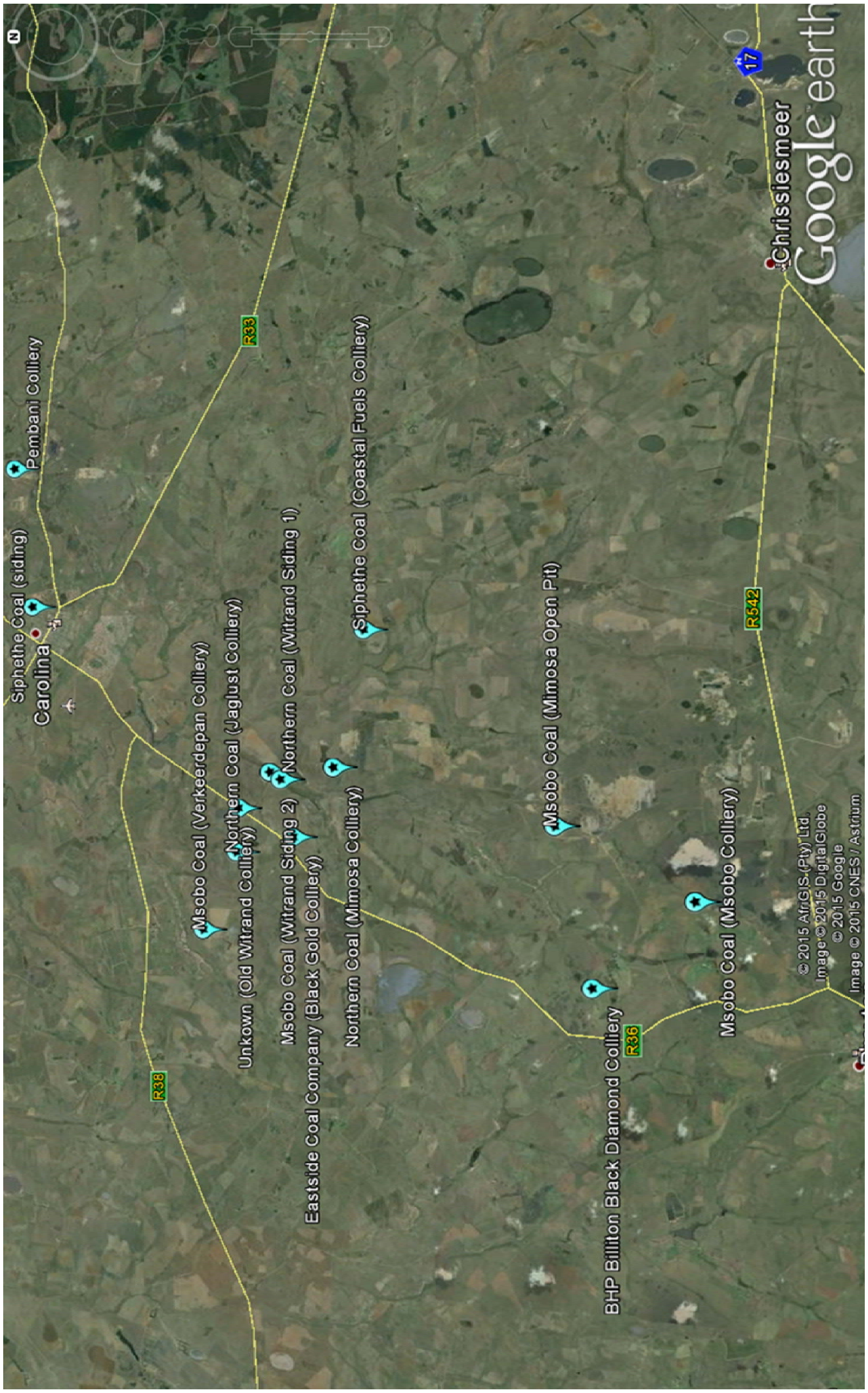


Figure 4.3: Map showing mining agents found in quaternary catchment X11B (Google Earth, 2015).

These agents include mine managers, owners of mining companies, environmental managers, Safety, Health, Environment and Quality (SHEQ) managers, as well as their own closure specialists and legal teams.

Involvement with these teams included direct interviews and participant observation, in which actions, interactions and events were recorded in meetings between regulators and mining agents, as well as in forums with these agents and other parties involved. The locations of the mining operations found in quaternary catchment X11B can be found in figure 4.3.

The mining operations found in this catchment are the following:

- Msobo's Tselentis Colliery

  Msobo's Verkeerdepan Colliery: the mining right area is located in the vicinity of Jagtlust Colliery of Northern Coal

  Msobo also operates Witrand siding 1

- Northern Coal's Jagtlust Colliery
  A beneficiation plant still operates at Mimosa Colliery, which supports the operation at Jagtlust Colliery
- Siphethe Coal operates both Witrand and Coastal Fuels Collieries
- Eastside Coal. The company's main operation does not lie within the X11B boundaries, however some historic bulk sampling activity has taken place within this catchment (Black Gold Colliery)
- Pembani Colliery

The following defunct mines were found within the X11B catchment:

- The Old Witrand Colliery is located on Msobo's Verkeerdepan Colliery land
- BHP Billiton's Union Colliery
- BHP Billiton's Black Diamond
- Siphethe Coal's abandoned railway siding
- Droogvallei Coal

Government institutions

Several government institutions are involved with the mining process. These regulators include: The IUCMA, the DWS (previously the DWA), the DMR, the MTPA, (specific to

Mpumalanga), the DEA and district and local municipalities. Not all these regulators are directly involved with the enforcement of and compliance with mining rights; some of them give advice and support to those who make decisions (such as the MTPA's land use advisory unit which comments on the potential for alternative uses in a specific area).

The IUCMA is directly involved with compliance and enforcement and the issuing of water related licences. It conducts routine inspections of mine sites and attends to any spills, contaminations and reports of illegal activities, with regard to the water resource; it also issues compliance notices, directives and opens criminal cases against mining agents.

The DMR is considered the primary agent on the regulatory side regarding mining and mining related processes. However, officials within the DMR were unwilling to be interviewed for this project.

Forums and civil society

There are various forums and groups that engage with the mining industry in Mpumalanga. These include the Upper Komati Forum (UKF), the Crocodile Forum, the Technical Task Team to Deal with Impacts of Mining, as well as other groups, such as the Centre for Environmental Rights (CER) and the Federation for a Sustainable Environment (FSE). These forums and groups create an environment in which all interested and affected parties (I&APs) communicate and voice their concerns about issues they are experiencing.

The Crocodile Forum is the main water forum in the Crocodile River catchment; it is a large group and many of its stakeholders engage with one another.

The UKF focusses on the upper Komati Catchment (a sub-catchment within the Crocodile River catchment), and has more of a mining focus, due to the large concentration of mining activities in the area.

The Technical Task Team to Deal with Impacts of Mining is a new group. It arises from a study commissioned by the IUCMA to develop a strategy for the proactive management of mining related impacts and was formed to anticipate possible future decants and problems associated with AMD, as well as develop measures to avoid AMD from occurring.

The CER conducts research into mining and mining related issues as these affect the rights of South African citizens, and also researches mining related legislation.

The FSE represents the interests of ordinary people in understanding and defending their constitutional rights, with a specific focus on the environment (FSE, 2008).

Consulting firms

Environmental consulting firms are often used by mining agents to conduct the necessary research for constructing, maintaining and closing a mining operation, and to improve, update or attend to any issues found by government agencies. Golder Associates and Menco are two of the agents involved in the X11B quaternary catchment.

Chat Analysis

Regulators

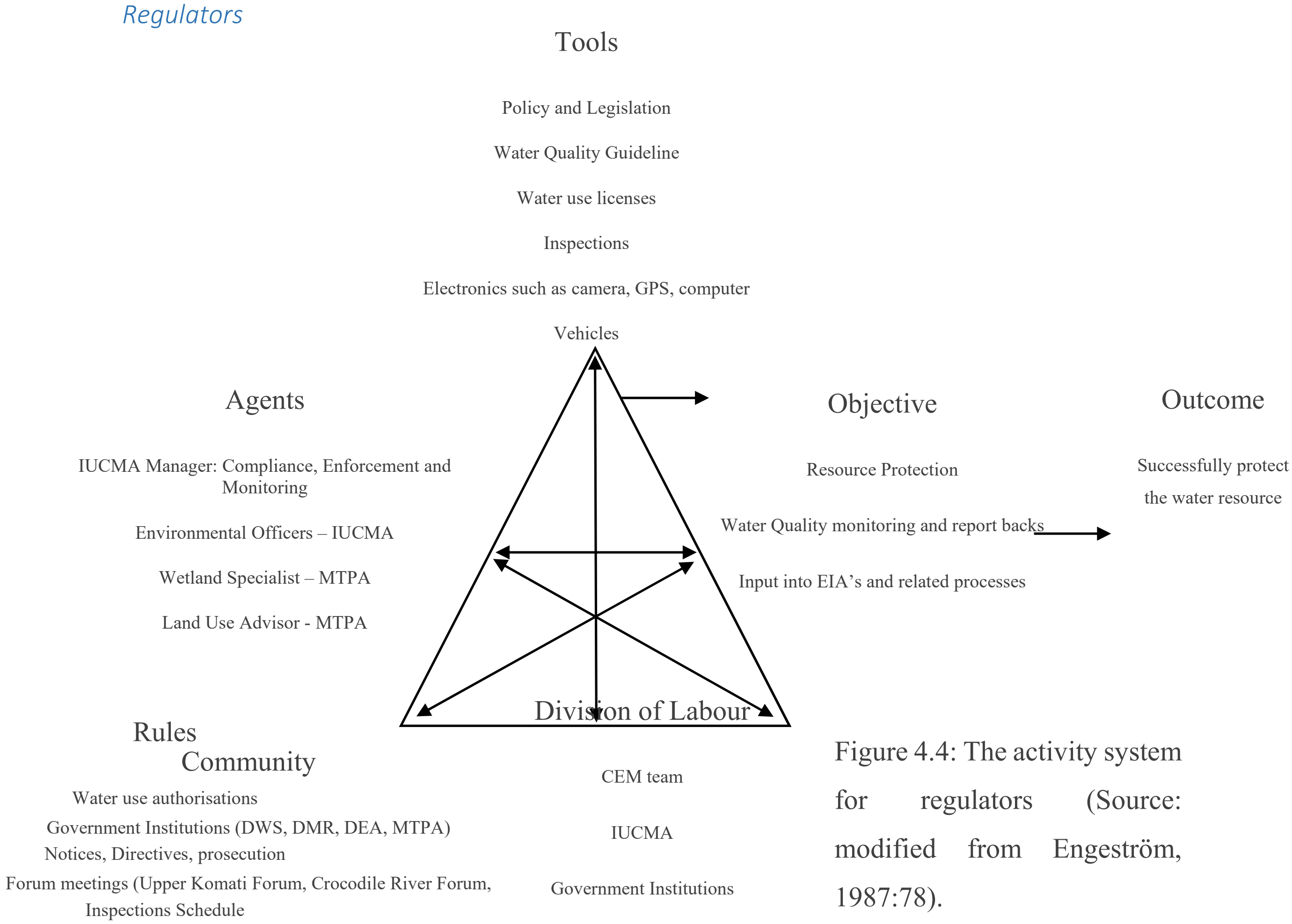


Figure 4.4: The activity system for regulators (Source: modified from Engeström, 1987:78).

The **agents** of the activity system for regulators are staff members at the IUCMA, including two environmental officers and one manager, as well as a wetland specialist and a land use advisor from the MTPA. They are responsible for the protection of the environment.

The **objective** of agents in this activity system is to protect the water resource and the environment, to the best of their ability, through enforcing the regulations. They are responsible for issuing directives or driving prosecution, if there is a lack of compliance.

The **tools** that are used by agents in this activity system include: policy and legislation, water quality guidelines, water use licences, inspections, electronic hardware (cameras, global positioning systems, and computers) and vehicles. These tools are used to achieve the agents' objective of water resource protection and resource quality objectives, through the correct monitoring and inspection of the environment and the water resources, so as to make informed decisions regarding potential actions that may be taken in relation to other agents.

The **rules** that are followed in this activity system include water use authorisations, notices, directives, prosecution, inspections timetables and the Catchment Management Strategy. These rules are applied to ensure that all agents in the area comply with set requirements and, by following these rules, that the regulators are able to make appropriate decisions.

The **community** involved in this activity system includes: government departments involved with the process (DMR, IUCMA, MTPA, DWS, DEA); forums that are found in the area (Crocodile River Forum, Upper Komati Forum, Upper Komati Technical Task Team for AMD); and stakeholders that are interested in and affected by the system.

With regard to the **division of labour** in this activity system, the IUCMA makes its own decisions within the organisation and comments on some reports from other departments. It shares its knowledge with forum members at meetings and takes note of what is going on within the forums. The MTPA shares its knowledge and advice with regard to land use and wetland reports and also comments on reports from other regulatory bodies.

The **outcome** of this activity system is to ensure that the water resource and the environment are protected for current and future users.

The Regulators are involved with various stages of LRC 10 step integrated monitoring plan and decision making system (WRC, 2016) that has been discussed in chapter 3. They are the key agents in the LRC steps as they have the ability to effectively protect the water resource and biodiversity, and they are involved in various parts of the decision making process. They should be involved in the following steps of the LRC:

Step 1: The regulators have key information when it comes to compiling a regional overview of ecological infrastructure.

Step 2: The regulators have a land use advisory team that is equipped to advise stakeholders on the overview of land use options and reasons for choosing those options. Through the use of stakeholder engagement, and useful scientific data compiled by the land use advisory unit, informed decisions could be made that will better protect the environment and water resources.

Step 3: The regulators are the key role players in this step as it requires them to develop long term development directions in terms of the National Development Plan, which takes into account different economic activities (as potential alternatives for coal mining) that may have a long term benefit.

Step 4: Similarly to step 3, the regulators need to look at the overall positive and negative impacts of coal mining and their potential to eliminate or support future uses of ecological infrastructure. This could be help in making informed decisions when it comes to coal mining, and if done in a collective environment with various stakeholders, it could ease tension in the sector.

Step 5: Building on step 4, the regulators should be involved with decision making in a collective suite of stakeholders input with regards to coal mining and the potential for alternative land uses.

Step 6: Regulators will need to use the knowledge generated in the discussions as a bases for monitoring systems that are supported by legal instruments, which would potentially make the monitoring system more effective, with stakeholders having access and input to these systems, aiding in collective understanding and commitment to improving the state of the environment and water resources.

Step 7: Regulators will need to be involved with the formulation of the documents, with other stakeholders

Step 8: Regulators are key to this step as they have the necessary information and specialist knowledge, and are able to assist and involve stakeholders where possible.

Step 9: The creation and maintenance of CMA's is key to the success of the LRC steps, of which the regulators are the primary stakeholder. Regulators need to align and integrate national priorities with a focus on job creation, to move to a greener economy.

Step 10: Knowledge resources developed in these steps will be used when decision making is needed by regulators, and regulators would be able to develop, archive and give access to the information, such as through a website linked to the regulators page.

Regulators' tensions

Tensions within the regulators' activity system relate to communication and interaction between government departments. Under the headings of 'the division of labour' and 'community', government departments need to engage with one another in order to successfully reach their objective. The DMR is a source of significant tension; it has very little involvement or communication with other agents, which makes it difficult for regulators to achieve their objective.

Another point of tension within the regulators' activity system is the non-implementation of appropriate legislation, i.e. tools that are available to the agent are not properly administered, which, yet again, makes it difficult for them to meet their objectives. For example: the NWA allows the DWS and the IUCMA to receive financial payments from a mining operation before they grant a water use licence for mining activities; these payments are to be 'saved' by the DWS or IUCMA, until such time as the money is needed to rehabilitate the water resource during the closure phase of the mine. The problem is that the DWS does not exercise its right to demand or receive this money, and the IUCMA does not yet have the power to do so. This means that the water authorities do not have the financial resources necessary to remedy the environmental and water resource pollution when the mine closes. As a result, agents in the regulators' activity system are unable to achieve their objective.

Coal Mining

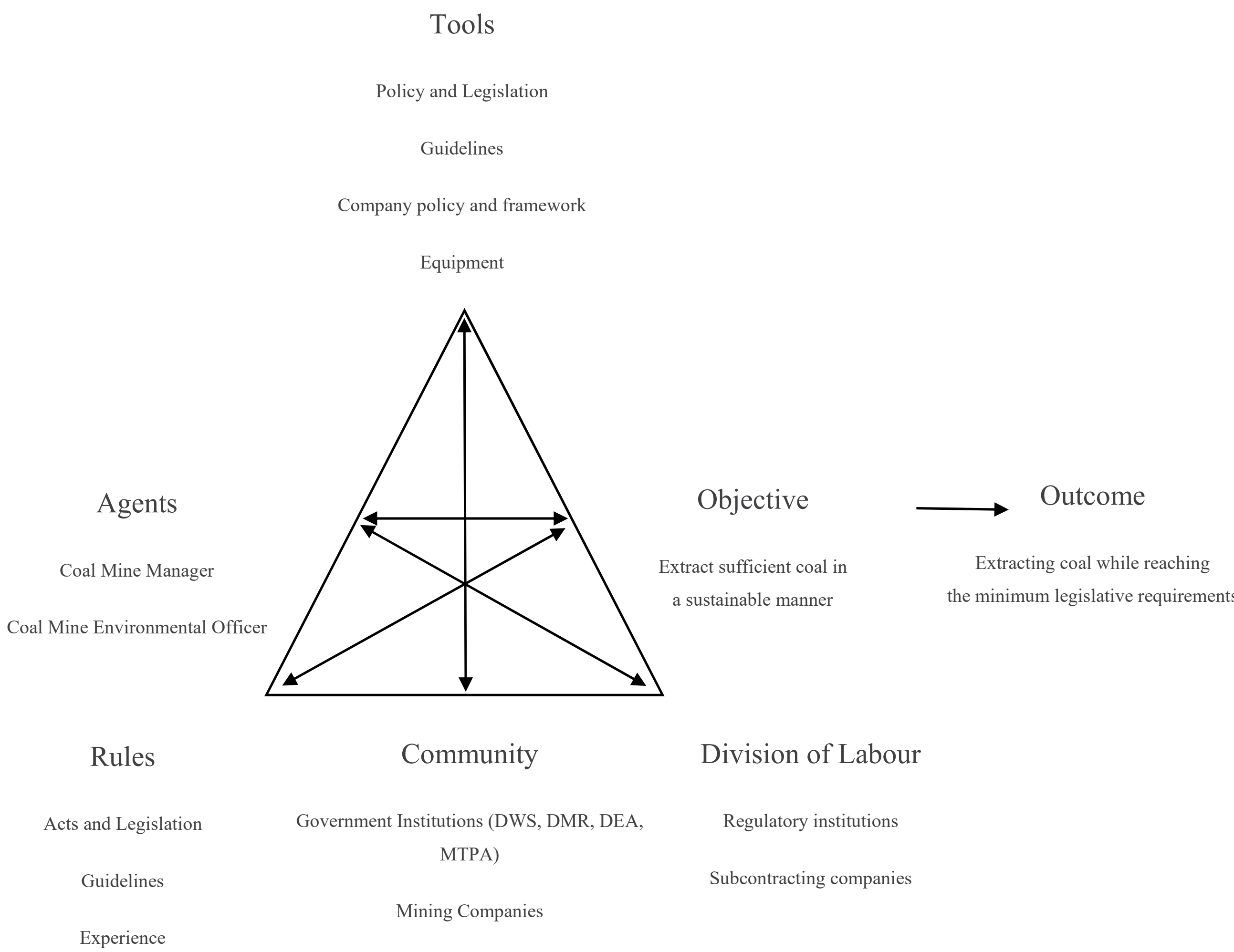


Figure 4.5: The activity system for coal mining agents (Source: modified from Engeström, 1987:78).

The **agents** of the coal mining activity system are the mining manager and the environmental manager.

The **objective** of these agents is the extraction of sufficient coal to make a profit, in the most sustainable manner, while ensuring the protection of the environment and the associated water resource.

The **tools** used by agents in this activity system include: policy and legislation, water use licences, the guidelines associated with each piece of legislation and company policies and frameworks. These tools are used to try and achieve the agents' objective.

The **rules** that are followed in this activity system include: the relevant acts and legislation, the guidelines for these acts and the experience of the agent on the specific site. These rules are used to ensure the agent is complying optimally with the legislation that governs mining.

The **community** involved with this activity system includes: government departments involved with the process (DMR, IUCMA, MTPA, DWS, DEA), consulting companies for specialist studies, and stakeholders who are interested in and affected by mining operations.

With regard to the **division of labour** in this activity system, the mining agents make their own decisions. However, they rely on external consultants to conduct specialist studies, such as environmental audits, and they may also subcontract other companies to run parts of their operations, such as construction.

The **outcome** of this activity system is the production of coal at an optimal level, while complying with environmental laws and legislation.

Coal mining agents are involved with various stages of LRC 10 step integrated monitoring plan and decision making system (WRC, 2016) that has been discussed in chapter 3. They have a responsibility to adequately protect the environment and the water resources during the mining life cycle. They should be involved in the following steps of the LRC:

Step 2: The coal mining agents will need to participate in stakeholder discussions, justifying the need for coal mining over land uses in each particular case.

Step 3: The coal mining agents need to show how they can contribute to long-term development with regards to the National Development Plan, and how to achieve this with a lower environmental footprint throughout the mining life cycle.

Step 4: The coal mining agents include their EMP's with discussions on a green economy and ecological infrastructure with other stakeholders.

Step 5: Building on step 4, the coal mining agents need to enter discussions with other stakeholders about weighing up their options in terms of sustainability, impacts on eco-infrastructure, future land use, need and costs and benefits of their proposed operations.

Step 9: The coal mining agents should ensure catchment management is addressed appropriately to ensure the water resources are maintained.

Step 10: The coal mining agents should contribute and advise where suitable to a knowledge network that is used as a decision support system.

Coal Mining Tensions

Tensions within the coal mining activity system relate to: legislative issues, where it was believed that the mining industry was over-policed; and the duplication of legislation (between NEMA and MPRDA), which requires separate applications for authorisation. This causes delays and unnecessary expense. These tensions indicate that agents are expected to satisfy too many rules to reach their objective successfully; and that the rules that must be followed are complicated and at times contradictory.

Another tension within the coal mining activity system is the belief that there is a lack of capacity among qualified individuals within regulatory departments. It is difficult to follow the rules properly when the agents responsible for their enforcement do not fully understand the complexities involved, at a technical level.

Civil Society

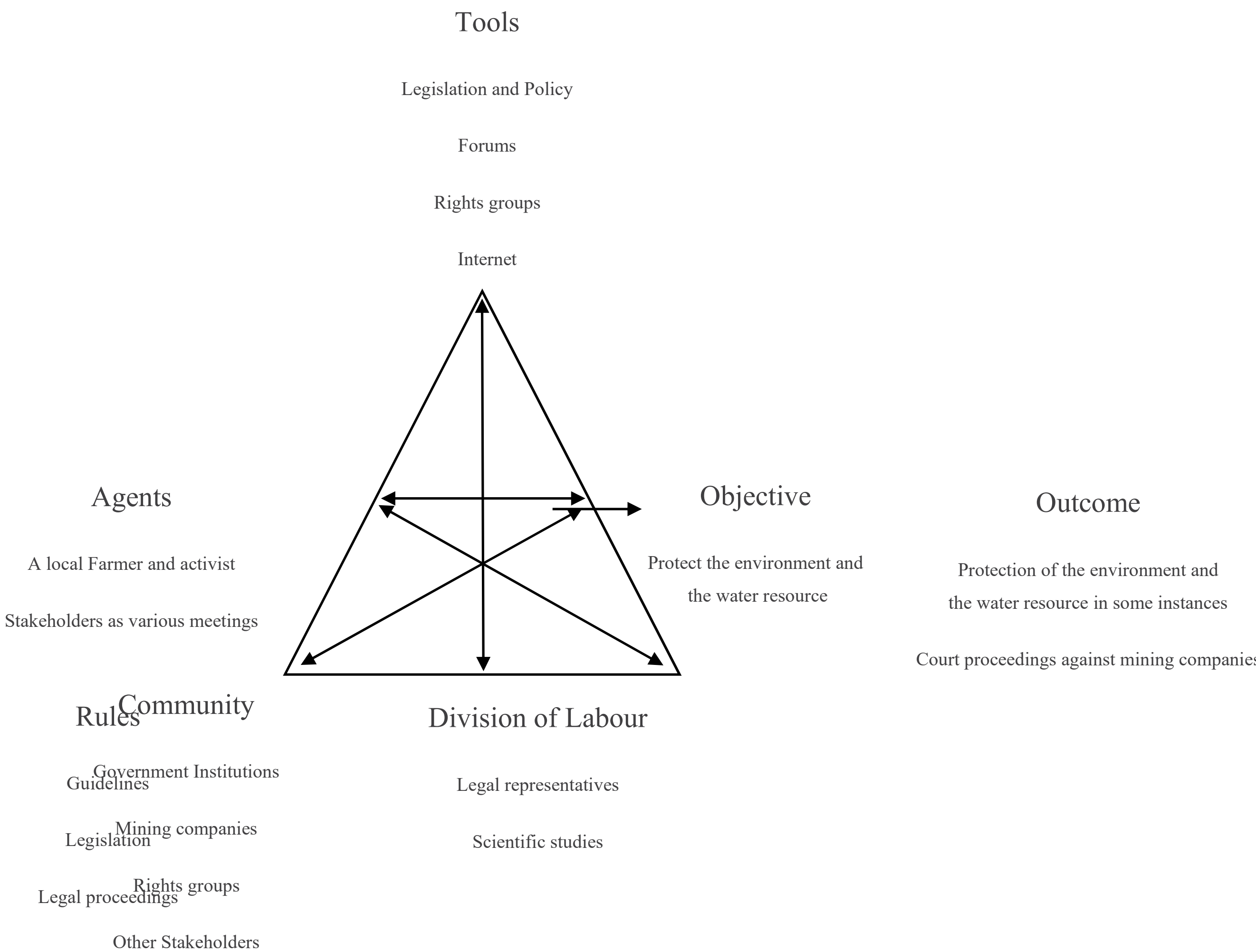


Figure 4.6: The activity system for civil society (Source: modified from Engeström, 1987:78).

The **agents** of the activity system for civil society include farmers and activists as well as various stakeholders who attend forums and workshops.

The **objective** of agents in this activity system is to protect their environment and limit the problems caused by other agents in the area. They are responsible for whistle blowing, raising public awareness and the protection of their livelihoods (especially farmers).

The **tools** that are used by agents in this activity system include: policy and legislation, water quality guidelines, water use licences, the internet, legal firms and rights groups, as well as forums in which to discuss the issues they face. These tools are used to try and achieve the agents' objective.

The **rules** that are followed in this activity system include: water use authorisations, the acts and legislation, various guidelines produced by environmental groups, mining companies and research institutions, and documents that describe how to pursue legal action. These rules are used to ensure that all agents in the area are mining responsibly and are not polluting the environment or water resources used by stakeholders.

The **community** involved with this activity system includes: government departments involved with the process (DMR, IUCMA, MTPA, DWS, DEA), forums that are found in the area (Crocodile River Forum, Upper Komati Forum, Upper Komati Technical Task Team for AMD), rights groups (such as the CER and FSE) and agents involved with mining processes.

With regard to the **division of labour** in this activity system, agents share their knowledge and issues with other stakeholders, often require legal help from rights groups and lawyers, as well as experts and consultants. They share their knowledge with forum members at meetings.

The **outcome** of this activity system is to ensure that water resources and the environment achieve and maintain a high standard of health.

Civil society can be involved with various stages of LRC 10 step integrated monitoring plan and decision making system (WRC, 2016) that has been discussed in chapter 3. They have the ability to raise issues and queries that could lead to the protection of the water resources in their area. They should be involved in the following steps of the LRC:

Step 1: Civil society may have the best local knowledge which would benefit a regional-scale overview of ecological infrastructure.

Step 2: Civil society will have the most information about local cultural resources, local issues, potential or historic land use options and could benefit discussions by supplying a deeper understanding of complex situations.

Step 4: Civil society should participate in discussions about current and proposed future uses of ecological infrastructure.

Step 5: Building on step 4, civil society should discuss and negotiate with other stakeholders about weighing up the options of land use, and this should be done on a level playing field with empowerment and facilitation for dialogue.

Step 6: Civil society should have access to monitoring systems, with access to help in understanding legal instruments, and how to use them.

Step 7: Civil society should have access to easily understandable decisions and information such as the planned processes and what risk they pose to the environment.

Step 8: Civil society should be invited to and have the ability to attend and support public participation events.

Step 10: The knowledge networks and all of their contents will be available to interested agents, such as civil society through a website link.

Civil Society Tensions

Tensions within the activity system for civil society relate to the lack of accessibility of regulatory agents, especially officials within the DMR. Acquiring feedback or help from the DMR on issues relating to environmental compliance and protection is extremely difficult. This indicates issues with the community of practice and this hinders the ability of agents to reach their objective. Civil society believes there are issues within the DMR with regard to decision making and that these are causing problems with the entire process to protect the environment.

Another point of tension within the civil society activity system is the complexity of legislative provisions; these should be simplified by combining them into an integrated legislative system which becomes the responsibility of a single government department. This would help align conservation efforts and increase compliance. The present complexity indicates that the rules followed by these agents are difficult to understand and realise.

Apparent problems with the mining licence procedure

Interviews with many of the agents involved with the mining licence procedure, including government regulators, decision-makers, land use advisors and mine managers, raised various issues with the current procedures regarding the licensing of mining operations. These will be discussed here.

South Africa is a megadiverse country, which is home to a vast amount of species in relation to other countries (Mining and Biodiversity Guideline, 2013). This landscape and the environment in general needs to be adequately protected, in order to maintain the ecosystems that sustain all of this life. Mining can result in considerable impacts on biodiversity and ecosystem services, including direct, indirect, cumulative and induced impacts, which may be short or long term, could be permanent and irreversible, and which pose serious risks to other economic activities, ecological infrastructure and livelihoods (Mining and Biodiversity Guideline, 2013).

Although the mining industry plays a vital role in the growth and development of the South African economy (Mining and Biodiversity Guideline, 2013), there is often a loss in land use potential for other socioeconomic benefits. Some of the most basic of these are: a loss of ability to hunt, fish and gather; a loss of freedom of movement; local people being forced to resettle or relocate; and a fundamental disrespect for traditions (Hilson, 2001). Coal mining tends to have a noticeable, negative impact on the environment and the severity of the impact depends on whether or not the mine is operational, the mining methods used and the local geological variables (Bell *et al.,* 2001).

AMD, dangerous sinkholes and collapsing entry points are just some of the consequences of inadequate rehabilitation of the environment after mining. These are major problems in South Africa (WWF, 2012) and government will struggle to address them adequately, due to the scale of the problem—more than 6 000 abandoned mines have been found in South Africa (WWF, 2012). Figure 4.7 shows the extent of abandoned mines in the country and indicates that a large number of them can be found in the provinces of Gauteng and Mpumalanga.

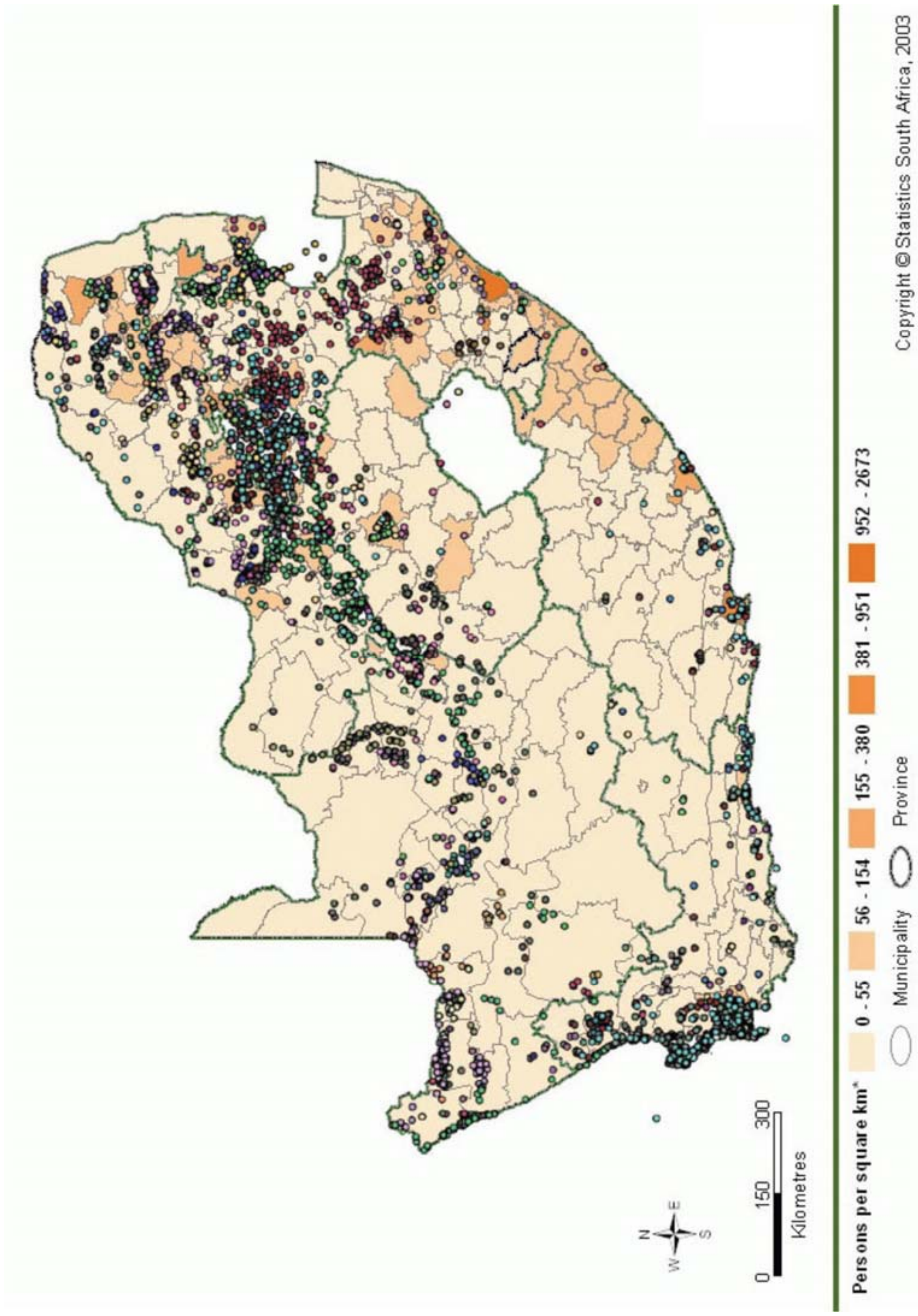


Figure 4.7: Map showing known abandoned mines in South Africa, together with population density (Auditor General, 2009).

The perspective of personnel involved in mining operations

The interview data was used to better understand the perspectives of personnel involved in mining operations. Mine managers believe that legislation generally is insufficiently monitored, that monitoring is not applied uniformly across industries, and that legislation is monitored specifically in certain industries, particularly mining, which they claim is over-policed. Other industries, including agriculture, are not monitored as much but are also damaging the water resource. Mine managers would like to see equal restrictions and implementation of the legislation amongst all industries.

In addition, there is much duplication within the existing legislation and NEMA and MPRDA are seen to be extremely similar. This leads to financial strain for mining companies who must hire specialised consultants who frequently must perform similar tasks for the different pieces of legislation. The IUCMA believes there is a lack of interaction and communication between regulators involved with the mining licence procedure and that this should be addressed in order for the regulatory body to act more effectively (IUCMA, 2014).

The need to apply for separate authorisations is an issue: the government requires mining companies to apply for various different authorisations through different departments; this causes a delay in mining operations as the applications are processed at different speeds. Also, applications should be processed within specific time periods, but these are often not obeyed; this results in significant delays in the mining industry, which adds to the large financial burden on mining companies.

The DMR has funds with which to finance the rehabilitation of damage caused by mining, but these funds are never used. Mining companies make payments to the DMR, which holds this money for potential future rehabilitation, but mining companies have come to accept that their money will not be returned to them to fund, in advance, the rehabilitation that is necessary on conclusion of their operations. Further, the money spent by mining companies on rehabilitation is not refunded to them by the DMR, when rehabilitation has been completed. Section 41(2) of the MPRDA states: "… if a holder of a prospecting right, mining right or mining permit fails to rehabilitate or manage, or is unable to undertake such rehabilitation or to manage, any negative impact on the environment, the Minister may, upon written notice to such holder, use all or part of the financial provision to rehabilitate or manage the negative environmental impact in question" (DMR, 2005). This financial provision should be used accordingly. Mining closure finances are rarely transferred directly into the DMR's account due to (1) the financial provision not being made available, and (2) constraints on the working capital requirements of the mining company—even though this is the lowest risk to the DMR in terms of remedial work in the case of insolvency of the mining company (WWF, 2012).

In this province, (Mpumalanga), the IUCMA is seen as a mirror image of the DWS, and are perceived to do the same work as the DWS, often repeating its work. This creates issues concerning authorisations because mine managers believe the two organisations must be treated as separate entities, while they should be dealing with just one. This increases cost and time and there is a lack of clear communication between the departments. Also, who should be contacted for what, by the mining companies, needs to be addressed; often the companies do not know who the relevant official is, or in which organisation he/she is to be found.

The Mining and Biodiversity Guideline (2013) is known amongst the mining community, but it is not followed because it is seen as just another duplication of legislation, and mining officials believe there are already enough regulations to be implemented. This indicates the attitude of the mining companies towards biodiversity and the environment—they have demonstrated that they will adhere to the bare minimum, only, in terms of legal requirements. Houdet and Chikozho (2014) believe that mining companies historically have complied with the absolute bare minimum regarding legislative requirements. In addition, Environmental Assessment Practitioners (EAPs) show a 30% margin (approximately) of non-adherence to the principles described in the Mining and Biodiversity Guideline. This is cause for concern and the lack of adherence to relevant environmental laws in the mining sector must be urgently addressed (Houdet and Chikozho, 2014).

Smaller mining companies frequently find it easier to circumnavigate legislation rather than adhere to it. For example, a mine can choose to engage in bulk sampling, (i.e. take very large samples as part of the exploration and evaluation of a mineral deposit), for which it does not need a mining right. According to the mine managers and regulators interviewed, this manoeuvre is used frequently by small mining companies wanting to avoid having to apply for a licence.

Bigger mining companies with ‘deep pockets’ tend to have a more negative and sometimes hostile attitude regarding legislation. According to a mine manager interviewed, they often threaten to cut thousands of jobs when told they are not adhering to legal requirements, or when they are not granted the rights they require.

There is also a lack of capacity within the government departments that deal with the licence process. More often than not, highly qualified consultants deliver reports and assessments that are not understood properly by poorly trained officials, and this leads to problems with authorisations.

Mining managers and regulators indicated that there is an issue with the sale of mining operations that are close to the end of their productive life. This is a frequent occurrence among larger mining companies who, when the operation's production can provide only as much value as rehabilitation will require, will sell the mine at a fairly cheap price to a smaller mining company, which cannot afford to rehabilitate the operation. This results in environmental problems and often leads the smaller companies into bankruptcy. Legislation must be amended so that it is more difficult, perhaps even impossible, for directors and companies to abandon operations by any means at all, so as to avoid rehabilitation costs. Case study 2 gives an example of the issues associated with rehabilitation.

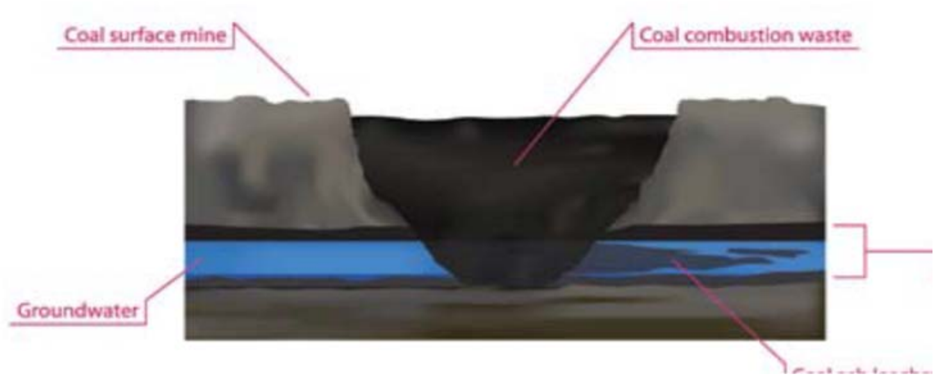
Case study 2 illustrates the issues relating to rehabilitation and describes the short cuts taken by mining companies to avoid this costly exercise, at a cost to the environment and water resources, as demonstrated by the interviews discussed in Chapter 3 (Section 3.4) and Chapter 4 (Section 4.3.2).

Mining companies avoid the costly exercise of rehabilitating land which they have mined. This is achieved by 'passing the buck': the company sells its environmental and social responsibility to other mining companies; and the other mining companies utilise the remaining operational life of the mine without taking into account rehabilitation costs post operation (Swart, 2003).

According to the Auditor General (2009), there are several major risks associated with abandoned mines, including:

- Air pollution, in the form of dust
- Combustion of mine workings and dumps, especially in the coal mining industry
- Contamination of the water resource, via runoff or groundwater infiltration with acid, salts and metals
- Hazards in the form of open shafts and steep slopes

The figure below demonstrates the way in which open pit mining and irresponsible back filling can cause AMD and polluted groundwater.



Pit backfilling and its potential to pollute groundwater (Earth Justice, 2009).

In 2008 the cost of rehabilitating 5 906 known abandoned mines was estimated at R30 billion (Auditor General, 2009). This did not include the long term treatment of AMD and the construction costs and operating fees of the required treatment plants. Of the known abandoned mines, 1 730 were classified as high risk mines and would require R28.5 billion of the estimated R30 billion for rehabilitation (Auditor General, 2009). The long term treatment of AMD, which includes construction costs and operating fees for treatment plants, could cost as much as R5 billion. Ongoing operational costs must be added and these are estimated at several hundred million rand per annum.

By the end of 2008 the DMR had rehabilitated only five of the 5 906 abandoned mines, at a cost of R42 million rand over a three-year period. It had focused on the rehabilitation of asbestos mines, only, which account for 3.56% of the estimated cost of the rehabilitation of high risk mines (Auditor General, 2009). Asbestos mines were targeted due to their high health risks, including: lung cancer, mesothelioma, an increased risk of cancer of the intestinal tract and larynx, as well as scarring of the respiratory system (Auditor General, 2009).

The perspective of the Mpumalanga Tourism and Parks Authority (MTPA)

The work of the land advisory unit within the MTPA, is to assess whether or not mining should take place in a specific area and what possible mitigations should apply. However, this work is considered by the DMR as recommendations only. There is nothing binding about the assessments compiled by the unit and the DMR may grant a mining licence regardless of the assessments. This process should be scrutinised; decision making should be checked more carefully; and decisions should be mindful of the issue of biodiversity and the environment as a whole.

Legislation does not take into account the cumulative impacts of mining operations which have considerable potential to cause damage to the resource. Mine closure without adequate cumulative impact assessments results in negative social and national economic impacts and will also be severely detrimental to the physical environment (van Tonder *et al*., 2008). A regional closure strategy is necessary, according to van Tonder *et al*. (2008), as mine closure without accounting for the cumulative impacts places burdens on pumping and treating water from the interconnected voids. Closure strategies would identify and possibly prevent issues arising from these instances.

Wetlands are overlooked and mining operations clearly do not have too great a concern for them or for biodiversity and water quality. These are seen as being in their way, rather than something they should be protecting.

There is an additional concern regarding mining operations that occur on previously rehabilitated areas. There is no legislation to prevent mines from such operations and this provides a challenge when deciding to rehabilitate an area or not; there is no guarantee that the land and water resource will remain in a rehabilitated state.

The perspective of the regulators

Implementation of the legislation and guidelines demonstrates a range or problems, especially regarding provisions in the act not being properly applied or explored. For example, the NWA allows for the DWS/IUCMA to receive financial payments from a mining operation before the authorities grant the mine its water licence. This money will be kept by the authorities for the purpose of rehabilitating the water resource once the mine is closed or, if the mining operation closes without rehabilitation, authorities will be able, financially, to rehabilitate the operation themselves. However, the DWS does not exercise this right and the IUCMA does not yet have the power to do so.

There is also an issue regarding the skills and capabilities of mining environmental practitioners. There have been many instances of mine managers being ill-informed about the operations; this had led to bad decisions arising from their lack of knowledge.

Closure certificates are no longer being issued and mines instead are placed in a temporary care and maintenance programme, once they have stopped production for a variety of reasons (technical, environmental, financial or labour-related), and applies particularly when the licence holder has not declared their intent to close the mine altogether. This situation is a direct result of the relevant authorities not wanting to take responsibility for mining operations after closure. This must be examined from a legislative point of view. Mining houses need to consider, and commit to, a long term closure plan; they should not be permitted to just pack up and leave once the mineral reserves have been exhausted. However, according to the *Financial Mail* (2012), mine closure certificates are, in fact, being issued on a regular basis, as long as the mines comply with the closure requirements of the act and regulations; the article stated that 157 closure certificates were issued in 2010/2011.

The DWS is reluctant to implement section 12 of the NWA which allows it to prohibit activities in order to protect the resource. Such actions are rarely seen. The Nooitgedacht Dam catchment provides an example of mining and prospecting activities that continue, although the IUCMA has advised that these activities should cease. The DWS says this is a problem for NEMA, who should declare the catchment a protected area if it wants to prevent these mining operations—even though the DWS itself is empowered to call a halt to mining activities. The IUCMA has no power in this regard; it can dispense advice, only, until such time as all the relevant powers and responsibilities are transferred from the DWS to the IUCMA.

The lack of cooperation by departments has also hindered other departments from doing their work according to regulators interviewed. This was especially evident during the Carolina Crisis: prior to the Carolina AMD event monitoring data for the Boesmanspruit Catchment was held by the DWS. The IUCMA asked the DWS to find out what had happened in Carolina and to help decide the best way forward, which it did not do. Consequently, the IUCMA was forced to ask mining companies in the area for their historic monitoring data, in order to do its job. This lack of cooperation is also seen between the DMR and other departments: the DMR shares information and/or helps other departments only when it will receive a direct benefit. Certain departments indicated that the DMR attends meetings to which it has been invited only when it has issues with which it needs assistance.

There are very few cases where a mining company or individuals have gone to court as a result of not having a valid water related licence. This has caused mining companies to be less concerned with water licences and more concerned with the MPRDA procedures, because misdemeanours related to the MPRDA could lead to jail time or hefty fines. Case study 3 is an example of a mining companies disregard for the law and the environment.

Case study 3 illustrates the issues raised in Chapter 4 (Section 4.3.2) which emerged from interviews with the government authority; mining agents, on occasion, were seen to be cutting corners and, by doing so, risking the quality of the water resource and breaking the law.

A mining company was caught dumping its toxic discard into a pit, to be buried. A farmer had notified the IUCMA about a mine on his property with which he had various issues, including illegal mine dumps and the illegal disposal of toxic waste. The IUCMA set up a meeting with the managers of this mine, which included a site visit. During the site visit it was discovered that the mining company had various major issues and was contravening its EMP as well as the MPRDA. These contraventions included: broken berms (used to contain rainwater runoff in material dumps; the rainwater becomes polluted due to the exposed material and can lead to AMD); an overflow from unbroken berms (making the berm itself pointless, as polluted water will spill freely from a dump when the berm fills with water); and having dumped 80 000 metric tons of toxic wash plant waste into a disused pit at the mine, to be buried. When these infringements were discovered the mine managers were given six months to remove the discard from the pit and to remedy the other issues, failing which a legal case would be opened against them as they were found to be contravening the conditions of their MR as discussed in Chapter 3. A second inspection was conducted five months later and found that an insignificant amount of the toxic waste had been removed from the pit. A new manager informed the regulators that the mine was under new management and needed an extra eight months to remove the discard. At that point the mine had removed only 8 000 metric tons and was involved in negotiations to sell the discard to various companies. The image below shows the discard in the pit during a site inspection; and Figure 5.4 shows the discard in the pit as captured by Google Earth.

The perspective of the South African Collieries Environmental Practitioners Association

The following is based on communication between the South African Collieries Environmental Practitioners Association and the Acting Director General of the DWA, 2013. A copy of this letter is found in Appendix 1.

There are different interpretations of the law by regional offices and officers; some regional offices do not apply the same approach as others and this causes problems with companies that have operations in more than one region.

Access to DWS officials is difficult and obtaining feedback for applications that have been submitted is extremely difficult. These problems are due largely to the rapid turnover of DWS staff, as well as the fact that these changes are not communicated to relevant stakeholders.

The environmental impacts of mining operations are regulated by three pieces of legislation: the NWA, the NEMA and the MPRDA. These pieces of legislation do not integrate very well with the EIA and EMP processes. Compliance with all these elements increases the costs borne by mining companies, and also takes up a lot of time. These processes should be better aligned under one piece of legislation to improve efficiency and reduce associated costs.

The perspective of civil society organisations

Koos Pretorius (2015), one of the leaders of the FSE, a group representing civil society, believes that coal mining is just a conflict of land use. His key question was: How can this be resolved in a decision making process?

In South Africa, 244 million tons of coal was mined in 2006, with South Africa being the fourth biggest coal exporter in the world (Stephan, 2010). South Africa has an estimated 55.3 billion tons of coal reserves left (Eberhard, 2011).

Pretorius argues that although there are enough coal reserves in South Africa to last more than 50 years, coal mining will have only a 30-year horizon, because the world is becoming less dependent on natural resources. There are two reasons for this: (1) The impact of climate change will be so severe that countries will have to move away from coal mining; and (2) alternatives to coal and related natural resources are becoming cheaper, at an exponential rate.

The issue to be decided is: From which pieces of land should South Africa take its coal reserves? Debates on this question should consider various factors. Food security is an important issue, especially as Mpumalanga has a large portion of South Africa's high potential soils. High runoff catchments should be excluded, due to South Africa being a water constrained country (WWF, 2014). Wetlands and biodiversity also need to be considered—protection of biodiversity and related services will help society and communities address vulnerability, while providing various other benefits (Mining and Biodiversity Guideline, 2013).

Pretorius (2015) believes that if South Africa continues to mine in areas with high potential arable soils (i.e. soils that are best suited for cash crop production), we will be compelled to begin importing maize as we will not be able to produce enough maize within South Africa. This will mean a substantial increase in the price of maize products. To emphasise this point, the Bench Marks Foundation (2014) claimed that in Mpumalanga, in an average year, a single coal mine (the BHP Billiton Middelburg Mine) will have the following impacts:

- Remove 6 million cubic metres of topsoil
- Use 65.5 million kilograms of explosives
- Require 2.5 million metres of drilling
- Remove 125 million cubic metres of overburden
- Produce 23 million tonnes of coal
- Disturb 339 hectares of land that will require rehabilitation

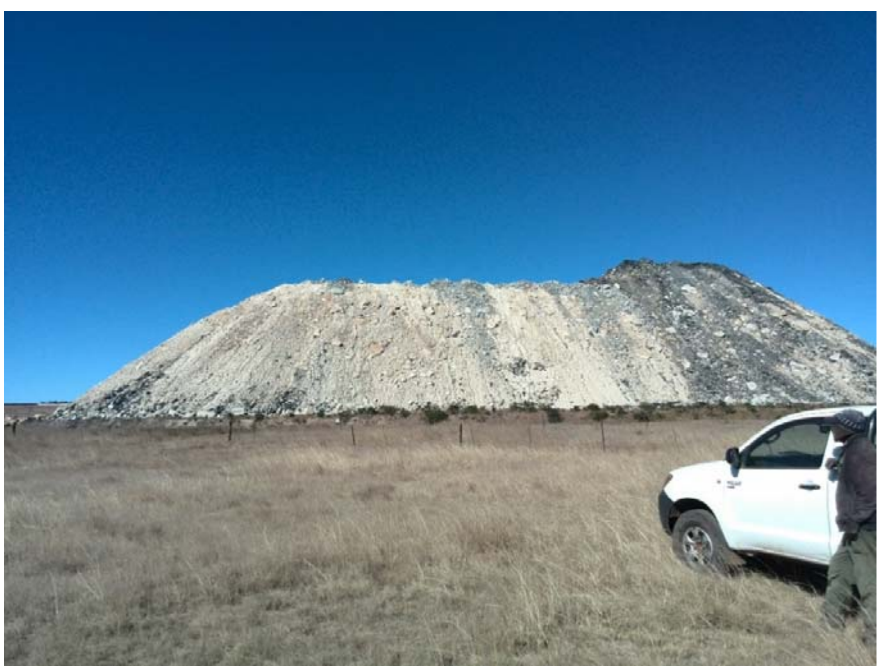


Figure 4.8: A typical mine dump of overburden in quaternary catchment X11B.

Mpumalanga is in the middle of the 'maize triangle', an area of high maize production in South Africa, where coal mining is drastically reducing the amount of land available for maize production (Bench Marks Foundation, 2014).

Mpumalanga produces an average of 22.4% of South Africa's maize but in drought years this percentage rises to 37% of the total. This is due to its high potential soils which we cannot afford to lose (Pretorius, 2015). Van der Burgh (2012) states that 1.5% of South Africa's soil is high potential arable soil, of which 46.4% is found in Mpumalanga. According to the IUCMA (2014), an estimated 12% of Mpumalanga's arable land will be transformed due to current and prospective coal mining, while a further 14% will be affected by prospecting rights.

Mining activities are still occurring in these areas, even though this has been restricted by the government. Mining companies are still receiving authorisation to mine in these areas yet, if South Africa loses these critical areas, it will not be able to sustain the environment. Pretorius (2015) believes the chain of decision making within the DMR is broken: mining plans show that mining operations will permanently damage these areas; the objections are noted; but the mining rights are granted, nevertheless.

Van der Burgh (2012) estimates that the potential loss of maize production from current mining activities in Mpumalanga is 284 844 tons per annum, with a further 162 736 tons of maize being under threat from prospecting areas, and that this would cause a 14% rise in average maize prices. This means that approximately 12% of South Africa's total high potential arable soil will be transformed by mining operations, with a further 13.6% under threat in Mpumalanga, due to prospecting (Van der Burgh, 2012).

Even when the rehabilitation of coal mines is effective, mining operations will have resulted in soil degradation. Studies have shown that when rehabilitation programmes cease, the grass cover deteriorates after a period of five years (Van der Burgh, 2012). According to van der Burgh (2012), all underground mines will eventually collapse, taking 100 to 120 years to subside.

The Bench Marks Foundation (2014) points out that farmers complain about the following issues with regard to coal mining in Mpumalanga:

- The original landowner is responsible for relocating his farm labourers, not the mine
- There is deterioration of the service roads
- The farm land surrounding mining operations is devalued

- There is loss of agricultural land, with a resultant loss of food security
- There is loss of fertile topsoil
- There are increased levels of crime due to the influx of people attracted to mining areas

Only 14.5% of South Africa's surface is classified as a critical biodiversity area, but if these areas are lost, the current ecological status of the area cannot be maintained (Pretorius, 2015). According to Pretorius (2015), despite the Minister having agreed recently to ensure a 1 km buffer area between biodiversity and mining activities, mining rights are still being granted within critical biodiversity areas. This occurs even though the applications include reports stating that the areas cannot be rehabilitated properly and/or that there is no mitigation for the impact. Further, certain areas are zoned specifically for certain industries, such as agriculture and tourism, and if these need to be changed an investigation must be conducted. However, the DMR changes these areas without conducting any investigations (Pretorius, 2015).

Farmers experience major insecurity with regard to land tenure. Once a mining company has been granted a mining right on a piece of land it can pursue mining activities on that land, even if (in the case of a farmer) the owner has said 'no'. He/she cannot deny access to the farm if the mine has a mining right to it. The mining company must give a 21-day notice of its arrival on a farm. If a farmer denies the mine access to his/her farm, the mine will go to court to obtain a court order. Existing MPRDA legislation favours mining companies and a mine will usually win a legal battle against a farmer. The farmer can then exercise section 54 of the MPRDA. This will result in the DMR's regional manager investigating the issue and deciding the financial compensation, which means the state will expropriate the land on behalf of the mining company (Pretorius, 2015).

Alternately the mining company can offer to pay the farmer a certain amount of money for the land. The farmer can accept the amount or fight the battle in court. If the farmer loses the legal case the state will expropriate the land and pay the farmer even less money than was offered by the mine. In the end, the farmer usually receives three times less the financial compensation originally offered by the mining company.

Apparent functioning of the mining licence processes

Although the current mining licence procedure has many negative aspects, a few positive trends emerged from this set of interviews. The data used in this section was from observation, participatory observation as well as from the interviews conducted.

Nearly all the government authorities interviewed believed that water users, including mining companies, are improving their practices with regard to water management. They believe the managers are realising that they will be negatively impacted in the long run if they do not manage their water properly.

All the interviewees believed the tools, in this case the relevant legislation and guidelines for mining legislation, are more than adequate to protect the resource and the environment as a whole. Mine managers and regulators believe the tools are well written and are easily understood, such as the GN704 which was 'made for idiots' and can be followed easily. The GN704, known as regulation 704 is a guide on risk assessment (Vedanta Resources, 2013). It is a government notice under the National Water Act (1998) and focusses on regulations for the use of water for mining and related activities (GDACE, 2008).

Most of the interviewees believed the Carolina Crisis led to a positive outcome. It stimulated better communication between all the parties involved; a lot of information was shared; it encouraged greater awareness in the country as a whole, concerning problems related to AMD and the negative impacts of mining; and it triggered improved monitoring and governance by state departments. Mining companies have been more diligent since this event; they have been eager, and have tried hard, to correct any issues or problems detected in their operations. There has been a lot less finger pointing by mining companies and many of them are now working together to rectify problems in their catchments, including with their downstream mining operations.

The IUCMA has recently established an AMD Task Team which includes mining companies and other agencies as key stakeholders. It aims to address the AMD problems being experienced in Mpumalanga and also explore possible ways to rectify legacy issues, such as decants from abandoned mines.

Stakeholder Workshop

On 24 November 2015 the Water Research Commission (WRC) hosted a workshop to "take the first steps in developing a decision support system for balanced decision making between coal mining and the protection of resources" (Munnik, 2015). The aim of this workshop was to establish a forum that would participate in and contribute towards decision making in the catchment, to build a knowledge network and form a reference group for a study that examines the economic benefits or ecological economics within catchments. Researchers involved in the study presented their work at this meeting, conducted a participatory observation session, and recorded the responses given by meeting participants.

In this case, a decision support system is referred to as a knowledge network in which systemic participatory action could lead to an improved decision making process. The idea revolves around the fact that local knowledge, inclusiveness, information sharing and scientific research will help the process of decision making and understanding of a broader system in which decisions made about coal and water will lead to a more sustainable process. By way of starting the process of information sharing and improved decision making, key questions were asked of groups comprising stakeholders from various backgrounds.

One of these questions was: What do you think of the current decision making with regard to balancing coal mining and the protection of water resources?

Key answers to this question, provided by stakeholders, indicated that there are numerous issues with the current decision making process, including:

- The DMR dominates the decision making process and rarely takes into account other departments or the concerns of and inputs from communities
- Mining operations are required to apply for water licences from the DWS. Regardless of the merit of the applications, the DWS will usually award the water licences, but may add certain conditions to the licences. This is despite the DWS being empowered to stop mining from happening altogether
- Political influences are involved in some instances. Non-compliant mining companies with political figures on their board or among their staff will be considered compliant, despite having failed to comply with relevant legislation or guidelines
- There is a need to look at the long term cumulative impacts of mining. Forecasts that look 20 years into the future cannot show what will happen for the next 80 years post mining
- The DMR is not releasing guarantees (financial insurances held by DMR on behalf of the mining company). This dereliction of duty obviously is apparent to the mining companies who, consequently, do not bother with proper rehabilitation of their workings—they know that a closure certificate will not be issued. Clearly, the closure approach has failed and the closure system must be revised

Question: How do we support regional decision making about coal mining and alternative land uses within catchment management?

Stakeholders raised the following key points:

- There is a need to simplify licensing requirements which should encourage users to comply. This will require integrated legislation so that a single application document can be submitted to a single authority.
- There is a need to make it easier to comply with legislation. It is believed that the requirements are too complicated and excessive. The state's paranoia about omissions has resulted in massive amounts of documentation which is not read by regulators and decision makers. In this instance the phrase 'requisite simplicity' should be applied.
- There is a need to identify water producing areas and prevent mining from taking place in them.

4.4 Discussion

The following discussion will focus on the results of the interview processes, the participatory observation, observation, documentary analysis and the outcome of the WRC workshop.

One of the issues with the MPRDA concerns the process whereby an agent appeals (against) a mining right (such as an appeal from civil society against a mine being granted a mining right). Regardless of whether the right is for prospecting or mining, the appeal does not suspend the administrative decision. Suspension is at the discretion of the Director-General or the Minister. Although suspension has been requested routinely by civil society it has never been granted, according to case reviews (CER, 2012).

Accordingly, while an appeal is being considered, the mining company can continue with its original mining operations, which may alter or permanently damage the environment which the agents appealing the mining right are trying to protect. This is a major issue and it is compounded by the fact that there is no statutory guideline on the time period in which the Minister must finalise an appeal (CER, 2012). There are documented cases of an appeal still being considered by the Minister, 18 months later; another case took up to three years before the Minister notified the agents that the appeal had been upheld (CER, 2012). Even if the Minister upholds an appeal against a mining right, it does not mean that mining will not commence. The Minister may uphold but also set conditions to which the prospecting or mining right must adhere, following which the right may well be granted (CER, 2012).

According to Davies (2014) the DMR "reigns supreme in Mpumalanga". Even though the department faces overwhelming opposition to the granting of prospecting and mining rights, it constantly grants these rights. It is also responsible for policing of the environmental impacts of mining, at which it is failing dismally. In addition, the DWS and local municipalities are either unwilling or unable to have any impact on this problem.

The IUCMA (2014) has identified a shortcoming in terms of communication when it comes to mining licences. There is a lack of communication and collaboration between the DMR, the Regional Manager of the provincial Department of Economic Development, Environment and Tourism (DEDET), the DWA (now known as the DWS) and the IUCMA. In some cases the DMR has granted the authorisation to mine without having asked other authorities for input into the application. The IUCMA (2014) believes that it and the DWS should be notified by the DMR and the Regional Manager, *during* the process to consider the authorisation of prospecting and mining rights, not just *after* the right has been granted, as happens presently. It would be beneficial if the DEA, DEDET, DWS and the IUCMA were involved from the start of any application for prospecting rights, due to there being sensitive areas (no-go areas) about which the DMR may not be informed (IUCMA, 2014).

Turton (2009) believes there has been little reform with regard to the MPRDA. One of the issues which arises is the description of mining waste as 'residue stockpile', which renders it exempt from waste management practices. This protects the industry from having to engage with the issue of waste management.

The IUCMA and the DWS are required to uphold the law and ensure that the water resource is protected as best as possible, by implementing certain strategies and developing proactive plans. Both these agencies require mining companies applying for water use licences to include a Rehabilitation Strategy and Implementation Programme (RSIP) in their applications, and to present an updated version of this programme on an annual basis. The programme must describe the mine's progress with continual rehabilitation, to ensure it is utilising its resources while these are still active and that it is not delaying the process until the mine reaches the end of its lifespan (IUCMA, 2014). The IUCMA has limited to no control over a number of approval and licensing processes involved with regulating, planning and designing new mining operations (IUCMA, 2014).

Stakeholder engagement in the dialogue sessions at the UKF has developed the direction for potential resolution of issues inherent in current processes governing mining licences. These dialogues involved stakeholders from various backgrounds, including mining managers, environmental officers, consultants, members of civil society and government agencies. The DMR chose to absent itself from the process, demonstrating yet again its lack of interest in contributing to and communicating with stakeholders and other spheres of government.

There is a need for an integrated water resource quality management plan. Such a plan will contribute to the streamlining of conservation mandates, identify and minimise the duplication of effort, and specify the roles and responsibilities of the different authorities involved in the decision making process. Further, this plan should be supported by a decision support system (DSS) that adequately involves adaptive, participatory and inclusive management.

According to Munnik *et al.,* (2017) the proposed DSS for an integrated water resource quality management plan should have the following characteristics:

- It should be embedded in the catchment management system
- It should involve national and provincial departments as well as land use planning and related bodies
- Its decisions should protect sensitive, irreplaceable and important water eco-infrastructures in which key areas are off-limits for coal mining activities
- It should provide a comprehensive view of legacy issues that are taken into account to restore and protect water eco-infrastructure
- Land use planning should be integrated into the proposed system
- The supporting knowledge network should be able to support the proposed system, including existing plans, maps, information and the classification of rivers, as well as access to legal interpretation and support
- The proposed system should be aimed at long term sustainability that keeps options open, is accessible, participatory, inclusive, fair, transparent, adaptive and takes into account issues of transformation and historical redress

Munnik *et al.,* (2017) has developed a draft integrated decision making and monitoring plan, which contains the following steps:

1. A regional scale compilation of existing ecological infrastructure that forms part of the DSS, which is available to stakeholders and participants through an online link as well as an executive summary for immediate use, to be worked through with them as a capacity building process during forums and/or workshops

2. An overview of land use options that include cultural resources, the need for historical redress, land claims and the various options of land use, with drivers behind them. This is necessary for an overall discussion so that a mutual understanding is reached from a point at which the basic to more complex situations are clear to all the participants, and possible trade-offs can be put forward, as stakeholders may have conflicting agendas
3. Long term development plans are developed in terms of the National Development Plan (NDP), including options to move to a green economy and what resources will be needed to do so
4. Coal mining options are assessed by: their benefit to the local and national economies; their impacts on eco-infrastructure, particularly water resources; their negative impact on alternative land use and development options, such as soil degradation; their future rehabilitation and restoration estimated costs. This step is necessary in order to preserve future uses of eco-infrastructure, where proposed land uses are assessed not only in terms of current activities, but how they affect future uses too
5. Land uses are assessed in terms of their sustainability, impact on eco-infrastructure, potential future land use options, benefits and costs and the socio-economic need of an activity. This step involves discussions and negotiations between stakeholders at different institutional levels, such as forums and local government
6. This monitoring system is enabled by legal instruments, such as mining authorisations and water use licences, with stakeholders being able to comment on these legal instruments, with access to help in understanding them. This information should be freely accessible to the stakeholders and they should actively participate in their processing, without incurring legal costs to access the information
7. Decision making and the monitoring system is streamlined and documents are concise, honest and accessible. The information used in decision making as well as other information is written in accessible language (making it understandable to all stakeholders), is of a reasonable length and conclusions are presented in an understandable way. Technical data is found in appendices and stakeholders or interested parties can access publicly funded technical support to better understand the processes and potential issues
8. Departments relevant to the activities participate in and enable the process through specialist knowledge, consider inputs, support participation and generate capacity building of historically disadvantaged groups. All departments have a duty to invite and support public participation

9. The co-ordinator of this process in terms of water issues will be the Catchment Management Agency (CMA) and national departments through task teams which, for example, focus on job creation and the movement to a greener economy. Catchment management systems are strengthened by opportunities for co-operative governance and integration of land uses, where water is the centre of most of the land use options

A DSS should be developed by means of a knowledge network that is found within forums. This includes linked knowledge resources in which the history of decision making, with reasons, can be located, and in which new knowledge sources are developed and archived through a website that is accessible to those involved.

This DSS is necessary so that decisions can be made more responsibly, through an adaptive management strategy that caters for a complex environment and helps decision makers to reach more effective decisions. Collaborative work by stakeholders and their contributions to the proposed knowledge network around coal mining processes, will enable decisions that are more inclusive and better informed, and which can develop through a process that builds trust and social capital, while taking local context into account.

A knowledge network, which would be a network accessible to those who can have access that contains all the data and information that is used in the mining and legislative processes, and should contain identified and collaborated aspects of the authorisation and enforcement practices that are ineffective, overlap, or place unnecessary strain on protecting the environment, such as extensive time frames. The authorisation processes should be streamlined and existing mining and water licensing processes should be investigated and aligned to better environmental practices that take into account key ecosystem services, where the evidence of benefits from such services are considered when the licensing procedure is undertaken.

Results are presented in the form of a proposal for a new system (Munnik *et al.*, 2017), which should be understood on two levels: first, there is a need to simplify the decision making process; secondly, there is a need to increase the strength of other land users in the decision making and resource monitoring process. In the long term, a balanced system must be developed. Case study 4 and 5 give an example of how the current issues have resulted in environmental degradation and pollution incidents. Without improving the current system, these incidents are likely to continue with a negative effect on the environment.

Case study 4 illustrates the issues raised during interviews described in Chapter 3 (Section 3.4), including legislative shortcomings with regard to the DMR and its decision-making powers, as well as Chapter 4 (Section 4.3.2), regarding the lack of inter-governmental communication.

Chapter 4 described a major concern for stakeholders and interviewees: the lack of communication between government departments and the lack of interest by the DMR for including other departments when considering mining rights and environmental regulations. In 2009 a letter was sent from the MTPA to the DME (now the DMR), showing how the DME had accepted an amendment to an EMP in the Carolina area, prior to the Carolina Crisis. The letter stated: "Within MTPA's previous letters reference numbers 3129 of July 2008 and 3193 of January 2009 it was made clear that MTPA objects to the acceptance of the EMP and EIA reports on the following grounds:

- The area consists largely of wetlands
- The rehabilitation of the open void and the long term purification of water plans are not clear
- The risks of permanent damage and pollution of the environment is too great" (MTPA, 2009)

The letter states also that the areas which the Tselentis Colliery had planned for extensions was unsuitable for coal mining because they were terrestrial and aquatic biodiversity sensitive areas and were at risk of permanent damage by pollution from such activities (MTPA, 2009). There would be a total loss of wetlands, which occupy 51% of the study area. This was reported also by the consultants commissioned by the mining company, who stated that the wetlands would be negatively affected and some endorheic pans would be destroyed, without any chance of rehabilitation.

This provides an example of the concern voiced by stakeholders—that the DMR did not consider input from other departments (the MTPA), nor did it consider the environmental implications of its decision to grant an amendment to the EMP which, in this instance, led directly to the destruction of the environment and the pollution of its water resources.

Case study 5 illustrates issues that were raised in Chapter 4 (Section 4.3.2), which emerged during interviews, and also in the desktop study of legislation involved with the coal mining industry, in Chapter 3 (Section 3.4). It demonstrates that legislation can cause a delayed response to pollution incidents due to processes that need to be followed, which can result in increased pollution of the water resource.

Contrary to the situation described in Case Study 1 there are some responsible companies conducting mining activities in this area. At least one of them is doing its best to adhere to legislation and rectify any issues that occur on its property, and has engaged with the IUCMA regarding AMD decant and other issues. Historic mining on land owned by this company has resulted in legacy issues as well as the regular occurrence of sinkholes. The company has a team dedicated to tracing and rectifying sinkholes as they appear, by deploying heavy machinery to affected areas and filling the sinkholes with earth. Sinkholes that arise from collapsed workings have a detrimental effect on both surface and ground water quality (Akcil and Koldas, 2006). The company also has a team dedicated to mine closure activities which enables it to address mine closure more rapidly than usual.

This company has initiated a process to build a long term treatment plant for the decant but, even if it manages to treat 100% of the decant, water flowing out of the property will show variables that are higher than the allowed levels, due to decant that occurs upstream. The timeline for completion of the construction and operation of this treatment plant is many years from now, purely because of legislation that is delaying the process. Many different consultation periods, investigations and approvals by different government agencies must be concluded before the mining company can begin constructing the treatment plant. In the interim the AMD will continue to pollute the water resource.

Figures 1 to 3 show the conductivity, sulphate and pH levels of decant occurring in a union stream on this site and how these vary over seasons and what happens during periods of no-flow. This site demonstrates the importance of monitoring networks in order to identify AMD, which can occur in various forms with different variables, where pH is not always the primary concern. This particular decant has pH levels that are compliant with levels established for the resource, but the levels for electroconductivity and sulphate are above the legal limits set by DWS and will be exacerbated by no/low-flow events.

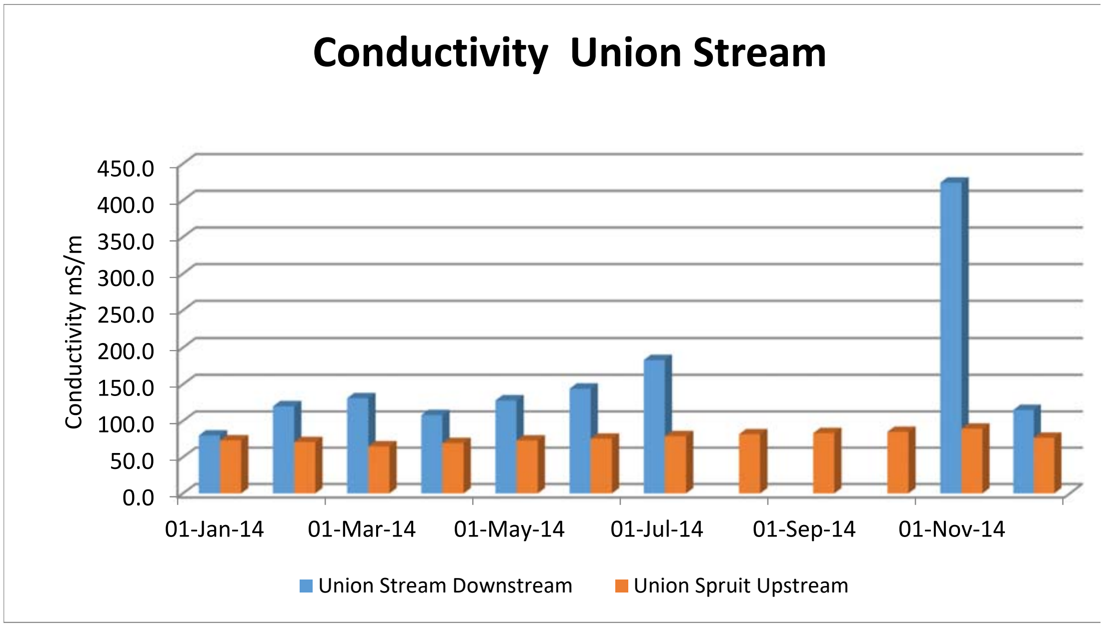


Figure 1: A diagram showing the electroconductivity at an AMD decant point entering the resource in Carolina, and the effect of seasonal variation.

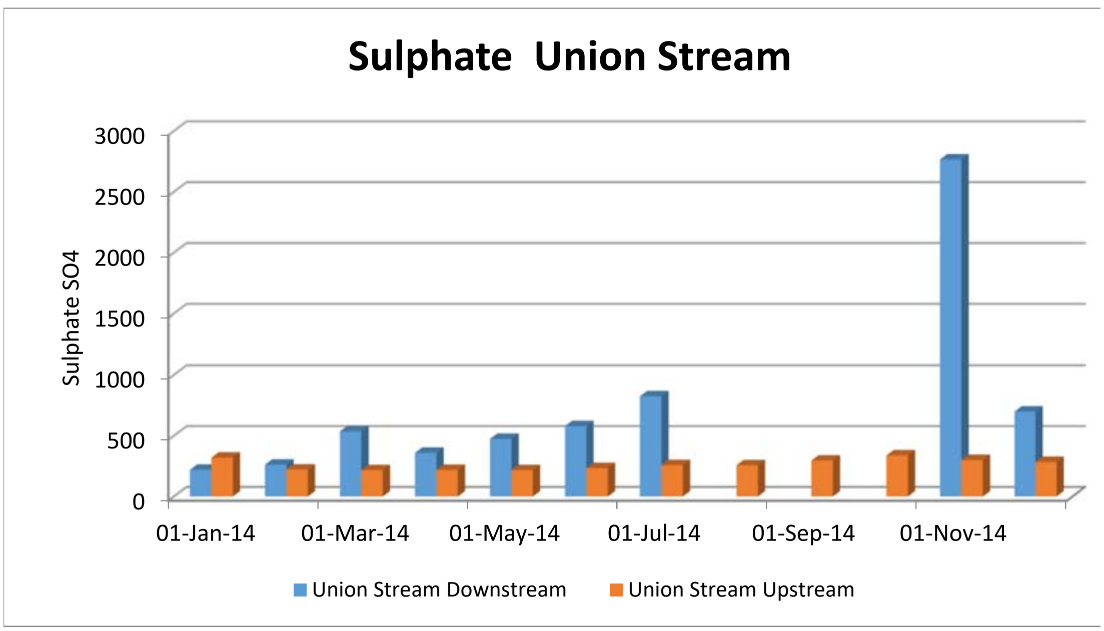


Figure 2: A diagram showing the sulphate concentration at an AMD decant point entering the resource in Carolina, and the effect of seasonal variation.

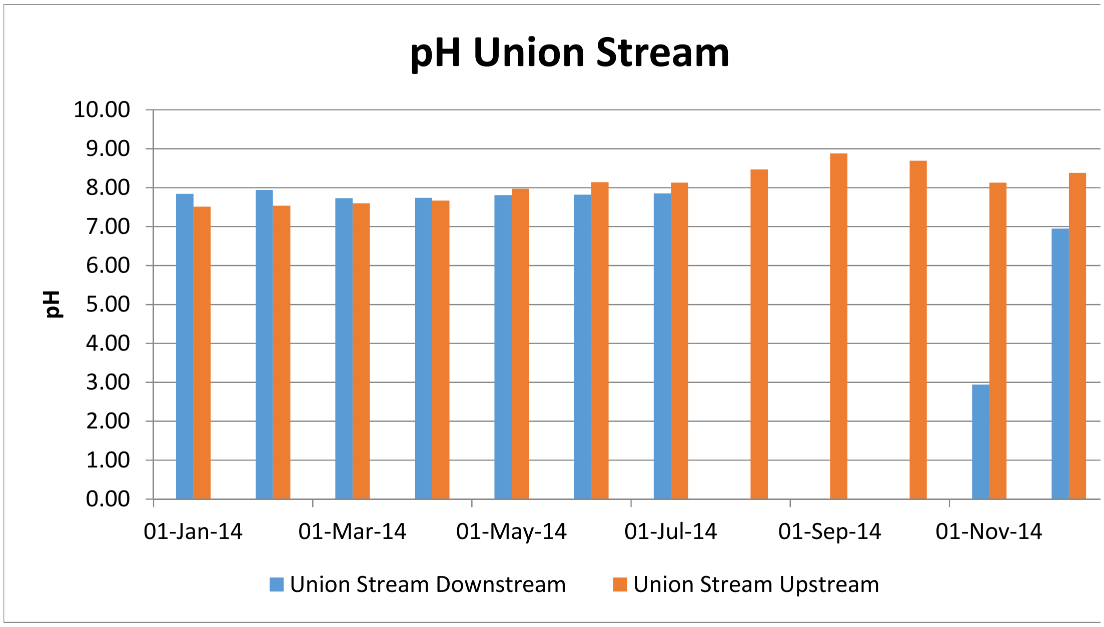


Figure 3: A diagram showing the pH at an AMD decant point entering the resource in Carolina and the effect of seasonal variation.

Chapter 5: General discussion and recommendations

According to WWF (2012b), South Africa is a chronically water-stressed country and water availability will be one of the most decisive factors that will influence the South African economic, social and environmental health over the next decade. A staggering 98% of South Africa's total water supply has already been allocated, with a predicted water shortfall of 1.7% as early as 2025 (WWF, 2014). South Africa receives more than half its surface water resources from only 12% of its land area; consequently, it is vital that these areas are protected from utilisation that could negatively impact the resource (WWF, 2012b).

South Africa faces significant socio-economic implications from climate change scenarios, under both drier and wetter climate predictions and even if international mitigation responses to climate change are followed and are effective (DEA, 2013). The water resource will be the resource most affected by changes that are expected due to climate change. Its availability will be reduced and this will be accompanied by increased frequency of flooding and drought events. Accordingly, effective water resource planning and utilisation will be vital for the country and its inhabitants (DEA, 2013).

This research has shown that a narrow focus on the operational life of a coal mine should not be the primary factor when assessing its potential to pollute or negatively affect the environment and the water resource. There should be a broad focus that encompasses also the long term effects that will occur post production, including the potential for AMD once closure has been completed. According to ICMM (2012), mining is able to use water of a much lower or poorer quality than water that is used in other industries. This must be taken into account when mining agents seek water for their operations. Water use and the disposal of water during a mine life cycle is strictly regulated and does not allow for water pollution incidents to regularly occur. However, the long term effects of water pollution incidents, especially AMD and landscape change, may have a greater impact in the future, as it is less well-regulated (ICMM, 2012).

Chapter 3 of this study assessed the mining life cycle in terms of the regulatory provisions required at each stage of a mining operation; it assessed the various legislations in place and the potential issues with them. It is evident that there are major issues on the regulatory side of the mining licence process, particularly with the DMR as the foremost regulatory body. It has been shown that legislative processes have failed to protect the environment and water resources. This was emphasised in Chapters 4 which indicated that most of the stakeholders involved in both coal mining and water management believe that the DMR is not doing an effective job of protecting the environment. There are instances of the DMR having granted mining-related rights to applicants, who followed legal procedures, despite other authorities and stakeholders having indicated that mining operations in the area would be detrimental to the environment, and that prospecting or mining rights should be refused. It has been shown that the DMR is responsible for the rehabilitation of abandoned and ownerless mines. This is a time-sensitive and costly exercise, given that there are just under 6 000 abandoned mines in South Africa, which are already polluting, or have the potential to pollute, the water resource (Auditor General, 2009). Thus far the DMR has focused on the rehabilitation of abandoned asbestos mines as its priority rehabilitation sites. However, in view of the impending water issues facing South Africa, which will be exacerbated by legacy issues from historic mining, there is an urgent need for the DMR's priority focus to be reviewed (Auditor General, 2009).

The monitoring of water quality variables is a vital component of plans to protect the resource. Monitoring data should focus on particular variables specific to the site in question and include potential impacts from sites upstream. This data can be used to assess the influence exerted by industries on an environment, and should form part of the assessment conducted by mining agents, prior to any mining activity taking place, to determine the potential impact of such activities on the environment. This study has shown that AMD does not correlate only with the pH levels in the resource and that pH should not be the only factor when AMD is being assessed. Accordingly, monitoring processes must scrutinise other variables equally stringently, especially **electroconductivity** and **sulphate** concentrations. It is clear that seasonal variations alter water quality and this aspect must be included in pre-mining assessments. These variations will influence the impacts that a mining operation may have on the resource, especially when climate change scenarios are considered. Participation in the assessment process by environmental practitioners should be reviewed. The quality of the work delivered by some practitioners is unacceptable and this should be addressed by the regulators. It is necessary to establish an appropriate standard against which the work of environmental practitioners can be measured because these agents may influence the decisions made by regulators.

According to Coleman *et al.* (2011), the process followed by mining companies regarding water quality is not geared to improving water quality during mining operations, but to ensure that actions are taken at appropriate times. These actions are intended to reduce the quantity of water being used (at the time), which will improve the quality of water that will be produced post mining operations (in the future). While this process often leads to increased expenditure of capital early in the life of a mine, it may well decrease expenditure post closure. Effective, early planning, which includes the careful design of operations, is essential to minimise the pollution caused by mining activities. The management options or groups of management options, available for pollution prevention are based on limiting one or more of the following elements (Coleman *et al.*, 2011):

- The amount of pyritic material
- The availability of oxygen to pyritic material
- The contact of water with the pyritic material

This research has shown the need for an integrated water resource quality management plan which should contribute to improving the coal mining life cycle in terms of streamlining conservation mandates, minimising the duplication of effort and specify the roles and responsibilities of the authorities involved at all stages of the life cycle in the form of a decision support system, such as one put forward by Munnik *et al.,* (2017) as discussed in chapter 4.

The research has shown the relationship between the licensing processes and environmental responsibility, exploring where the two do not align, and where the resource has been placed at risk. The mining practice that occurs within quaternary catchment X11B is varied due to the vast number of operations in the area, and it has been shown that although there are sufficient mining regulations in place to protect the environment and water resource, there are still major incidents of disregard for the law resulting in pollution incidents. A major finding of this research is that the DMR acts with impunity and disregard for its water governmental responsibility. This research has contributed to the overall understanding of the legislative provisions for the coal mining lifecycle in South Africa, and has shown the problems that it currently faces, while giving examples of pollution incidents that have occurred due to these problems.

Through the use of the CHAT framework, information generated helped to create a more in depth view of the mining activity system, identifying contradictions and gaps in the licensing procedures and practices, and determined points of tension within the system. The research was then reported back to the stakeholders via forums that the researchers in the project were a part of, as well as reporting back findings to government institutions that are continuing the research through the greater WRC project. This information will hopefully be taken into account in future decision making procedures and fed back to future forums with relevant stakeholders.

This study set out to:

- Provide a consolidated synthesis of legislative provisions for coal mining in South Africa and to explore the relationship between licensing processes and environmental responsibility, so as to understand if and where the two do not align, placing the resource at risk (Chapter 3).
- Explore coal mining practice in relation to environmental protection, so as to relate legal provisions to actual mine management (Chapter 4);
- Relate legal provisions and coal mining practice to the condition of water resources in the Carolina quaternary catchment (X11B) (Chapter 3 and 4 presented as case studies);
- To mirror the findings of this research to the stakeholders involved and develop a potential way forward (Chapter 5).

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Appendix 1

Appendix 1 is found on the CD provided.