Yesterday's World, Tomorrow's Landscape

Modelling Landscape Change in the Free State Goldfields, and Implications for the Development of Resource Regions

Academic thesis completed by research

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Declaration

I, Ingrid Watson, declare that thesis is my own original work conducted under supervision. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg, South Africa. It has not been submitted before for any degree or examination at any other university or institution.

9 December 2020 in Johannesburg, South Africa

Dedication

I dedicate this thesis to my parents, John and Judy Watson. Thank you for the gift of education.

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Abstract

The discovery and exploitation of a mineral deposit catalyses development that drives change and profoundly alters the landscape. Traditionally, the assessment of the impact of such developments focuses on a particular location at a specific time, having limited spatial and temporal scale, and so does not provide a full understanding of the consequences of mineral development. There is increasing awareness that the off-site and cumulative impacts of mining over its entire lifecycle are significant and leave resource regions ill-prepared for life after mining. Using the Free State goldfields as a case study, a landscape biography of this region was developed based on five key drivers of landscape change over four time periods between 1945 and 2018. This period covers the full lifespan of most gold mining operations in the region, from development, through production to closure.

The most significant drivers of landscape change in the Free State goldfield over its 73 year lifespan have been mining development, including the disposal of mine waste; urban and infrastructure development to support the mining enterprise; and legislation and political factors, which have played an important role in directing the form of landscape change. The original construction of the numerous mines and associated settlements fixed foundations which set the trajectory for future growth, initially allowing the area to thrive but, with mine closure and its social and economic consequences, have perpetuated unsustainable development to its current state of economic demise.

The three themes emerging from this research are that a landscape approach provides the big picture view and so is a useful tool to gain a comprehensive understanding of the whole system. Secondly, in resource regions mining does not act in isolation in driving landscape change, and thirdly, the consequence for resources regions are significant and existing measures to regulate these are inadequate. Based on these lessons, a model for managing resilient resource regions is developed.

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Abbreviations

AAC	Anglo American Corporation of South Africa
ANC	African National Congress
ARM	African Rainbow Minerals
CALS	Centre for Applied Legal Studies
CEO	Chief Executive Officer
COGTA	Cooperative Governance and Traditional Affairs
CSIR	Council for Scientific and Industrial Research
DMR/DME/DMRE	Department of Mineral Resources/ Department of Minerals and Energy/ Department of Mineral Resources and Energy (the government department responsible for mining)
ECA	Environment Conservation Act No 73 of 1989
EIA	Environmental Impact Assessment
ESCOM/ESKOM	Electricity Supply Commission
FSGDS	Free State Growth and Development Strategy
FSGDC	Free State Goldfields Development Centre
GG	Government Gazette
GIS	Geographic Information System
GN	Government Notice
ICMM	International Council on Mining and Metals
IDP	Integrated Development Plan
JMS	Joint Metallurgical Scheme
JV	Joint Venture
kg	kilogram
km	kilometres
LDA	Lejweleputswa Development Agency
LED	Local Economic Development
LOM	Life of Mine
LULC	Land Use Land Cover
mamsl	metres above mean sea level
MMSD	Mining, Minerals and Sustainable Development
MPRDA	Mineral and Petroleum Resources Development Act No 28 of 2002
NDVI	Normalized Difference Vegetation Index
NEMA	National Environmental Management Act No 107 of 1998
NGI	National Geo-Spatial information Services
NP	National Party

NRC	Native Recruiting Corporation
NRDC	Natural Resources Development Council
NUM	National Union of Mineworkers
OFS	Orange Free State
RDP	Reconstruction and Development Programme
RS	Remote Sensing
RSA	Republic of South Africa
SDF	Spatial Development Framework
SLP	Social and Labour Plan
TB	Tuberculosis
TEBA	The Employment Bureau for Africa
Tvl	Transvaal
USA	United States of America
USD	United States Dollar
WNLA	Witwatersrand Labour Organisation
WSSD	World Summit on Sustainable Development
ZAR	South African Rand

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Note on population groups

Up until 1991 apartheid legislation required that South Africans be classified according to race, as either black, white, coloured (mixed race) or Indian. Race also dictated where people could live, what schools they could attend and what jobs they could hold. As almost two-thirds of the period reviewed in this thesis was under apartheid, the racial classification of the population of the goldfields and mine employees, and its implications on the landscape, cannot be ignored.
The term 'race', which is not only considered derogatory but also reflects the rejection of a concept that is considered flawed and non-existent by much scientific literature, has now been replaced by 'population group'.

In the literature reviewed for this research, various terms have been used to refer to Black Africans. The terms white and European have been used to describe white South Africans. Unless a direct quote, I have opted to use the term 'black' to refer to Black Africans, and 'white' to refer to South Africans of European descent. Related to this is the term 'location' or 'township' which are depicted on the maps, to refer to the settlements of black residents.

Note on place names

Over the period under review the names of some places have changed. These changes are either mentioned in the text or the current names are used. Name changes include:

- Odendaalsrust (or Odendaals Rust) which during the 1940's was change to Odendaalsrus
- 'Old' Virginia, the settlement around the original Virginia Station, was change to Linabo when the settlement of 'new' Virginia was established in 1950
- The pan outside Allanridge, which was called Stinkpan (smelly/stinky pan) on the 1975 maps, is called Voëlpan (bird pan) on the 1997 edition. This pan is adjacent to the sewerage works and is used by the mines to manage their water.
- In April 1994 the boundaries of the four provinces and the homelands of apartheid South Africa were dissolved and nine new provinces established. The boundaries of the Orange Free State stayed the same, but it was renamed the Free State. The Transvaal province, which incorporated the Witwatersrand goldfields, was divided amongst four new provinces, Mpumalanga, Limpopo, North West and Gauteng.
- In 2000 local municipalities were established. The individual towns of the Free State goldfields were incorporated into the Matjhabeng Municipality, and the population data aggregated. The Matjthabeng Municipality includes the city of Welkom and the towns of Odendaalsrus, Virginia, Hennenman, Allanridge and Ventersburg.

Chapter 1

1. Introduction and background to the study

1.1 Introduction

> *'Mining disrupts: it ruptures the boundary between the surface and the sub-surface, it upsets pre-existing modes of living on the surface, it changes biogeochemical, social and economic flows across surfaces, and it transforms imaginations of the future. Mining not only moves mountains, it also moves people – physically, emotionally, politically and economically'*
> (Bebbington & Humphreys Bebbington, 2017, p.441)

This quote highlights the significant and disruptive impact of mining, how it catalyses social, economic and environmental change, and that this becomes visible in the landscape. This research uses the case study of the Free State goldfields (*Figure 1*) between 1945 and 2018 to understand the processes that drive landscape change in a resource region. Through this the landscape biography of the Free State goldfields is reconstructed and learnings identified.

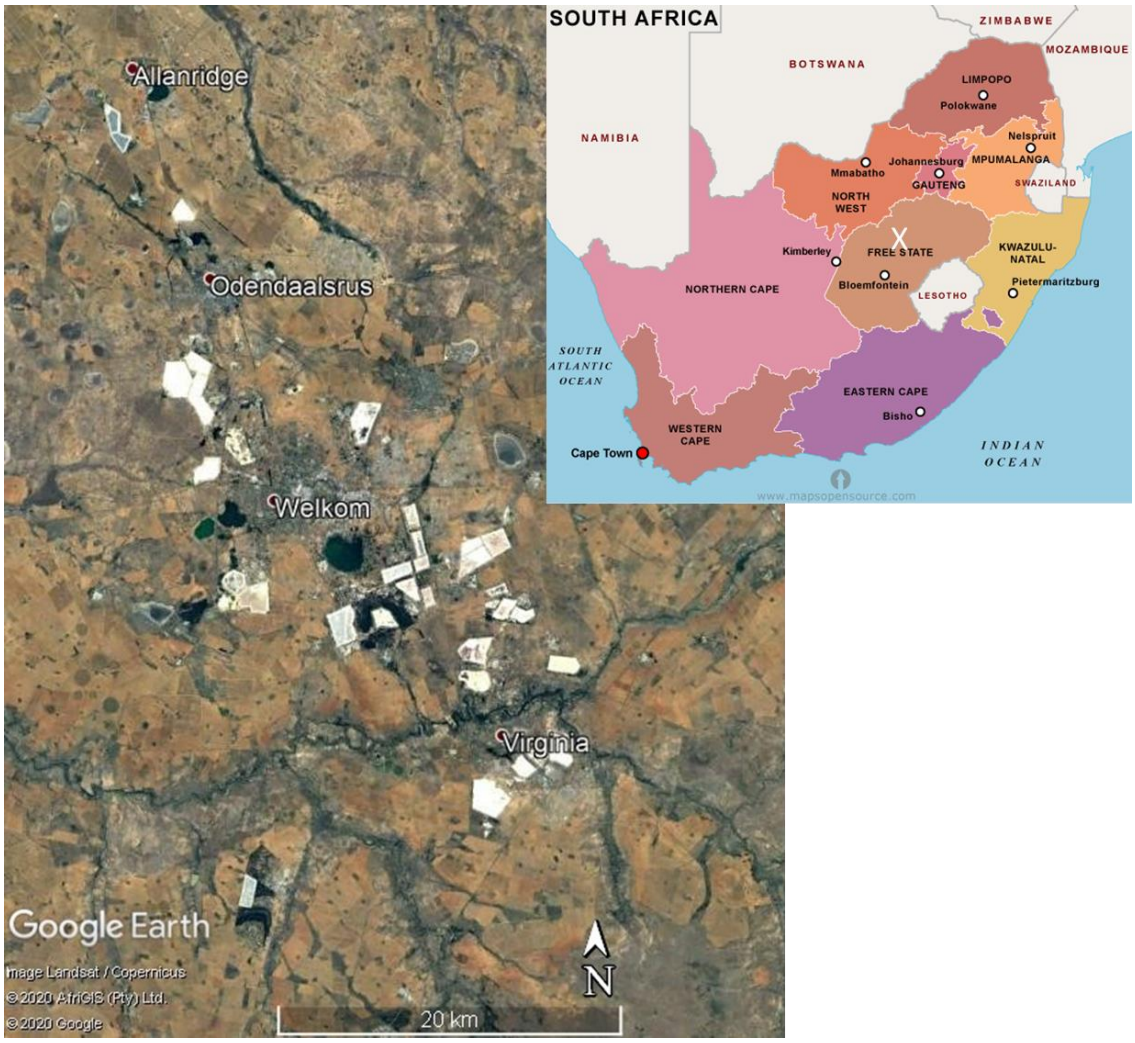

Figure 1. The Free State goldfields is located in the central Free State, South Africa

The discovery of gold in the Free State in 1945 set in motion a series of developments that would transform the remote rural landscape around Odendaalsrus in the Free State into a booming resource region with grand new settlements and highly productive mines, providing employment for hundreds of thousands of people. Many of which were black migrant workers drawn from across southern Africa. However in the late 1990s this all came to an abrupt halt with the downsizing and closure of most of the regions gold mines, leaving the area devastated.

This chapter sets the scene for the study, providing a brief history of the Free State goldfields up to the present and the justification for the research. Core to the research are the concepts of landscape and mining, both of which are defined in the context of this study. Based on this, the aims and objectives are discussed and the methodology to meet these summarised. The chapter concludes with an overview of the thesis.

1.2 Background

Gold had been discovered in the Free Sate as early as 1886, but it wasn't until the 1930s that there was an active effort to prospect for gold, initially around the area of what today is Allanridge (Greathead & Graadt Van Roggen, 1986). The breakthrough came in May 1938, with the discovery of payable gold on St. Helena mine by Western Holdings. This was the discovery of the Basal Reef, the only consistently payable horizon in the Free State goldfields (Greathead & Graadt Van Roggen, 1986). Timing was unfortunately an issue. With the outbreak of World War II manpower and capital were in short supply, and although mine developments continued, it was at a slower pace.

The St Helena mine was the first to be developed. Between then and 1961, 13 new mines came into production. With the further development of another five mines in the 1980s (Greathead & Graadt Van Roggen, 1986; Handley, 2004). The Free State goldfields extended from the Loraine mine in the north, around what was to become Allanridge, south east to the Merriespruit mine and the new mining town of Virginia, a distance of over 45 km (*Figure 1*). In 1968 the Free State goldfields accounted for 35 percent of total South African gold production, 12 percent of the global total (Nel & Binns, 2002).

Mining in the Free State relied heavily on migrant labour and while it was the vision of Ernest Oppenheimer, Chairman of Anglo American Corporation (AAC) to '*see the native mine labourers housed in villages rather than compounds, with adequate provision made for married quarters*' (from a 1946 interview with the Rand Daily Mail, quoted in Jacobsson, 1948, p.115), this was not to be the case. Mine hostels to accommodate the tens of thousands of migrant labourers from the Eastern

Cape province of South Africa, Lesotho and Mozambique were thus developed (Marais & Cloete, 2013).

Along with the development of the mines came the necessary development of mine towns and infrastructure. Oppenheimer appointed a town planner William Backhouse and landscaper Joane Pimm to design and develop the garden city of the Free State within the circle of the five new AAC mines (Greathead & Graadt Van Roggen, 1986). Gladys Roberts (1984) in her book 'The story of the discovery of the Orange Free State goldfields' describes the rate at which the goldfields developed and more specifically the growth of Welkom town. Following its proclamation in 1950 '*the little township was growing so rapidly that even local officials could hardly cope with the development. Houses were springing up constantly*' (p.74). She goes on to document the building of business blocks and hotels, a big bazaar, the first chemist shop, asphalting of the roads, the tree planting project and the development of an aerodrome. According to Ernest Oppenheimer its establishment was `*probably the biggest single enterprise in the history of our country*' and by 1952 Welkom was the second-largest town in Free State province after the capital Bloemfontein (Nel & Binns, 2002).

The new towns of Allanridge and Virginia were also proclaimed and the existing town of Odendaalsrus expanded to accommodate the mining and associated infrastructure boom. '*This was the Free State "Rand" stretching from Allanridge in the north, to the growing new town of Virginia to the southeast of Welkom, with Odendaalsrus and Welkom occupying central positions*' (Roberts, 1984, p.76). The population of the goldfields region grew from approximately 80,000 in 1951 to nearly 500,000 in 1991 (Marais, 2013a).

The development of transport infrastructure and the provision of water and power was also critical for the growing goldfields. The Odendaalsrus railway line, an extension from the Johannesburg-Bloemfontein line from Henneman, via Welkom, was opened in 1948 (Roberts, 1984). Jacobsson (1948) highlights how water was a potential limiting factor to the development of the Free State goldfields, with a need for considerable investment by the state to pump water from the Vaal River, some 60 km away. Similarly the case for an assured and adequate supply of electric power, which was initially secured from the Vierfontein generating station (near Vereeniging) but which later necessitated the development of new power stations and delivery networks (Jacobsson, 1948).

At the time of the discovery of gold the main economic activity was livestock and crop farming. Over the years significant tracts of agricultural land was converted to settlement and mining. The

footprints of the mines extended well beyond the mine shaft to include workshops, mine hostels, waste rock dumps, tailings storage facilities and evaporation pans. The latter two having a significant negative impact on water quality and soils.

Over the years, and particularly during the 1980s, the different mines changed ownership, with AAC, Western Holdings and Union Corporation being the main players, and were consolidated to optimise exploitation (Greathead & Graadt Van Roggen, 1986). By the end of the 1980s approximately 180,000 people were directly employed in the mining industry, with 72 percent of the economic contribution of the region coming from mining (Marais & Cloete, 2013). This came to an abrupt end in September 1989 when the price of gold dropped from nearly USD900 per ounce to USD300 (Marais & Cloete, 2013). This price crash compounded an already deteriorating situation for the gold industry. Together with the drop in the gold price, decreasing production, increasing production costs and falling ore grades (Nattrass, 1995), resulted in the closure of uneconomic mines and massive job losses. This affected the entire gold industry, but the Free State goldfields, as a single-sector economy, was devastated (Nel & Binns, 2002). Anglo Gold (the consolidated gold interests of AAC), the largest mining company in the area, withdrew from the Free State in 2002, selling off its remaining mines to other companies (Marais, 2013b). This sale also brought with it a change in operating practice, which involved focussing on core business at the expense of the recreational and other facilities previously enjoyed by the mining community. Gradually more shafts were closed, having a devastating social and economic impact on the region. These include the obvious decrease in formal employment and the resultant decline in population, significantly amongst working aged men. There was also a change in settlement patterns, with the proliferation of informal settlements as mine workers left the hostels. This had implications for the municipality and their obligation to provide services. Coupled to this were credit management issues within the municipality, who could no longer rely on rates and taxes paid by the mining houses and from mine salaries. They were consequently unable to sustain municipal infrastructure and make adequate capital investment. House prices also decreased due to low demand (Marais, 2013a). Not unlike the other declining gold mining areas in South Africa, illegal mining has sprung up. This poses significant health and safety risks to the miners themselves, operating mines and their employees, and local communities.

This history is located within the context of significant political change in South Africa, at the time of the discovery of gold South Africa was a Union and part of the British Commonwealth, with Jan Smuts' United Party in power. However in 1948 the National Party under DF Malan was elected to power, with the implementation of their apartheid policy of segregation especially visible in the

areas of land use planning. Under the National Party South Africa became a Republic in 1961. 1994 saw the first elections of a democratic South Africa and the subsequent change in policy focus, to redressing past injustices. Each of these political periods too has made its mark on the Free State landscape, as have various other disparate decisions and actions at an international, national and local level. An understanding of the history and landscape of the Free State goldfields needs to consider this broader system, as this research attempts to do.

1.3 Justification for the research

The Free State goldfields presents the case of a resource region that is suffering the consequences of its prosperity. The once vibrant goldfields are now environmentally, socially and economically devastated. This is the legacy of mining for the region and is not atypical globally (Worral et al., 2009; Milaras et al., 2014; Robertson & Blackwell, 2014). Human activities, including mining, have acted on and shaped the landscape, affecting environmental functionality and future opportunities for the region (what you do impacts what you can do). Legislation and practice focus on individual rather than regional approaches to planning and implementation, and do not recognise the complexity of the social-ecological systems. As is demonstrated by the Free State goldfields, this is problematic, especially from an environmental and social perspective. The use of a landscape approach, motivated through this research, can provide a better understanding of the various factors that have shaped the landscape over a longer period of time. This understanding can lead to better decisions.

Since 1994 the South African government has focussed on mining as an important area for transformation and a source of much needed development. The increased rate of mining since the introduction of the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA) and the opening up and expansion of resource regions is an example of this (Hermanus et al., 2015). The objective of South Africa's mineral legislation is the sustainable development of the nation's mineral resource, meaning that mineral resource development serves present and future generations. This is not the reality of the Free State goldfields. It is thus appropriate and important to reflect on and analyse the development of the Free State goldfields region and its changing landscape. It is argued that a better understanding the factors that shaped the landscape of these goldfields, may contribute to improved plans for the future of this area and lessons for the development of resource regions in South Africa and globally.

1.4 Key concepts

This research brings together two main themes, mining and landscapes. The discussion below provides some explanation of both these concepts as they relate to this research.

Mining

Mining involves the extraction and concentration of a valued resource from the earth. Depending on the commodity in question the process differs, involving either or both mechanical and chemical methods, requiring water, power and other materials. The desired commodity may be easily accessible from the surface, or located deep in the earth crust, requiring the development of shafts. These activities modify the landscape through the development of pits, waste piles, built structures and secondary geomorphological features such as debris fans, sand bars and turbid rivers or physical pollution in the form of particulate matter – dust, sediments, suspended solids and solid waste. In addition to these discrete, localised impacts. Mining also generates chemical pollution through the complex geochemistry of metal ores, which are now exposed to surface (water and air), and the use of reagents for mineral processing. Mining modifies ecological processes operating over a broad geographical scale, through influencing biological productivity, impacting biogeochemical cycles and driving land use and land-cover change (Bridge, 2004).

In addition to transforming the physical landscape, mining also has, often profound, negative and positive social and economic effects. New mines catalyse the development of bulk infrastructure, settlements and secondary industries and have traditionally employed large numbers of skilled and semi-skilled workers. This contributes to the local economy and the national fiscus. However, the influx of workers and the changing land use may be disruptive to local communities and their traditional way of life.

The mining lifecycle extends from early prospecting well beyond mine closure (Figure *2*). Prospecting, or exploration, involves the search for mineral resources and includes activities such as surveys, soil sampling and drilling. These activities generally have small individual impacts spread over a large geographical area, but the nett effect on a landscape of prospecting trenches can be significant. Associated with prospecting may be the construction of access roads, local small scale processing plants and temporary accommodation. As prospecting advances more detail on a resource is obtained allowing for a decision on whether further work is necessary or not. Promising resources may be further evaluated to determine whether it is viable to develop into a mine. Criteria

for this decision have largely been around the economics of the deposit, however, legal, social and environmental considerations are increasingly important (Watson et al., 2018).

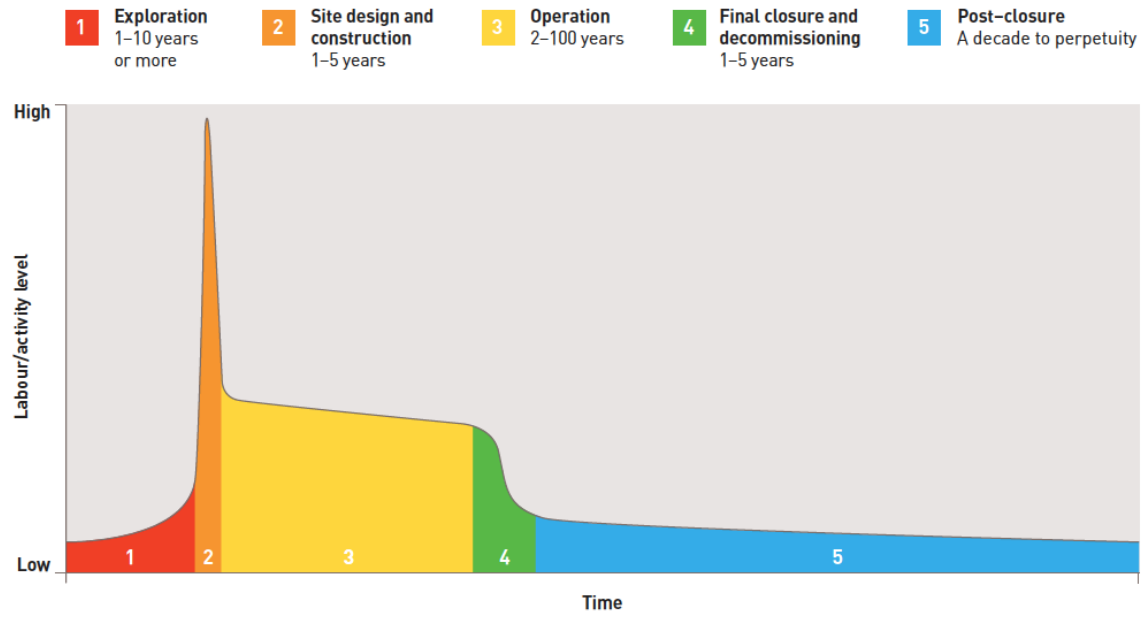

Figure 2. The mining lifecycle (ICMM, 2008)

The second phase of the mining lifecycle is mine planning and construction. This involves increased investment, a larger work force and more significant impact on the environment. As illustrated in Figure *2*, the development of a mine may take between 1 and 5 years. Once developed, the mine begins to operate. This is the productive phase of the mine and may extend over many decades. The life of mine (LOM) refers to the number of years that an operation is planning to mine and treat ore, taken from the current mine plan. This may change during the operational phase depending on ongoing prospecting and evaluation activities, where resources are proven and may extend the mines' life. A fluctuating price obtained for the product and changing working costs may also influence the life of mine. A higher price allows for the profitable extraction of more marginal areas in a mine. (Watson et al., 2018)

Mineral resources are non-renewable, and once mined out, mines close. Closure may also be due to economic factors such as a decline in commodity prices, geological reasons such as an unanticipated change in grade, technical or regulatory factors, the banning of asbestos being an example, or through social or community pressures (Laurence, 2006). Regardless of the reason, the consequences of mine closure are wide and varying and include social, economic and environmental impacts, both locally and to the wider region. Traditionally closure has been seen as the end of the mining lifecycle. However, the impacts associated with mining persist and may either be addressed

by government through an abandoned mines programme, or borne by the communities around them. Increasingly legislation and best practices have been developed to force mines to consider closure early on in the lifecycle of a mine and make provision for an orderly closure which incorporates both environmental and socio-economic aspects.

Depending on the mineral, deposits are often continuous (e.g. gold, platinum, coal), resulting in a number of mines and companies operating within a region, with mining dominating the local economy. These are referred to as resource regions (Franks et al., 2013). Doloreux et al. (2008, p.473) define resource regions as those '*that are remote from metropolitan influence and where the leading economic activity and employment are resource-based and/or natural extraction and transformation*'. Resource regions often experience boom and bust cycles linked to the commodity cycle, where prices rise and fall in relation to supply and demand. This has obvious impacts on mining and the broader mining community.

Landscape

The concept of landscape is contested and ambiguous, with use across a range of scientific discourses, as elaborated by Angelstam et al. (2013) and Plieninger et al. (2015). The understanding has also changed over time. Historically it has been understood as a purely natural phenomenon, or scenic space, devoid of people, as depicted in landscape paintings. However, the discourse has shifted during the 20th century with the recognition of the interconnectedness of social and ecological systems. Landscapes are socio-ecological systems, intertwined systems of people and nature (Folke, 2016). The spatial arrangements and governance of a landscape contributes to its unique character (Denier et al., 2015). Landscapes are therefore the interface between society and nature, where the combined effects of society and nature become visible (Burgi et al., 2004). 'Reading' and interpreting the landscape allow for the reconstruction of its past. This can be documented as a landscape biography, the approach taken in this research.

The landscape concept is used by a number of different discipline, including sociology, anthropology, architecture, history, geography and ecology and is useful for interdisciplinary work, such as this. In the social sciences the landscape is often referred to as cultural landscapes (Farina, 2000). As a boundary object[1] the landscape concept facilitates communication between these different

[1] Boundary objects are entities that enhance the capacity of an idea, theory or practice to translate across culturally defined boundaries, for example, between communities of knowledge or practice (Fox, 2011, p.40).

disciplines, and so needs to be simultaneously concrete and abstract, simultaneously fluid and well-defined (Stoytcheva, 2013). Implicit in this concept of landscape is the following understanding:

- Landscape imply physical and temporal scale, described by Palang (2010, p.170) as a '*spatio-temporal bubble'.* A landscape is a continuous surface rather than a point or focus (Meinig, 1979), with boundaries that are transition zones, rather than sharp or linear (Palang, 2010). Landscapes also have a temporal dimension which is connected with anthropogenic activity (Karro et al., 2014).
- Landscapes are dynamic, a 'work in progress', and are shaped by the connections and disconnections between people and the environment (Roymans et al., 2009; Wu, 2013; Karro et al., 2014). Humans are thus integral parts of landscapes, rather than just observers or users (Matthews & Selman, 2006).
- Landscapes are important as they provide the foundation for human well-being, through the provision of ecosystem services (Plieninger et al., 2015). It is critical to maintain these life-support systems provided by the landscape if we are to contribute to sustainable development (Griggs et al., 2013). Landscapes thus provide the arena for sustainable development (Council of Europe, 2000; Plieninger et al., 2015).
- Landscapes of today are legacies of the elements and processes that occurred in the past, and so too, future landscapes will reflect current elements and processes (Marcucci, 2000). By studying a landscape we are able to understand some of its history, and by intervening and changing practices today, we are able to influence its future.
- Successive landscapes exist over previous ones. Landscape transformation involves a reordering, reuse and representation of the past which gives landscape development an almost non-linear character (Roymans et al., 2009).

Brining these two concepts, mining and landscape, together allows for a new perspective on mining. As a major transformational activity, through the lens of landscape, one is able to identify how mining catalyses change well beyond the boundaries of the mine (the focus of traditional mining – environment research), how these linger over time, and how the different mining lifecycle stages influence people, the biophysical environment and the interactions between the two. It also offers the opportunity to identify ways in which to intervene to change the trajectory of landscape change, to a more virtuous, rather than vicious, cycle.

1.5 Research aims and objectives

At its simplest, this research aims to tell the story of the Free State goldfields through the lens of the landscape – its landscape biography. The spatial and temporal scale of the study extends to the broader mining region and covers the start of the development of the goldfields, after World War II, across the full mining lifecycle to its current state of mine closure (2018). The physical changes to the landscape are the outcome of a complex and accumulating system of actors, decisions and actions acting on a receiving social and physical environment. Different drivers of change predominated at different stages of its growth, stabilisation, stagnation and decline. The history of the Free State goldfields is important as it has implications for the future of the area. Lessons learnt from the Free State goldfields case study may also be relevant to other resource regions in South Africa and globally.

A secondary aim is to demonstrate that a landscape biography is useful for the study of resource regions as it provides a much richer picture of the social-ecological system over an extended period, rather than the short term, more focussed approaches commonly used. In order to meet these aims the following objectives have been set:

1. Assess how the landscape of the Free State goldfields has changed between 1945 and 2018.
2. Determine and quantify the drivers of change, that have shaped the Free State goldfield's landscape between 1945 and 2018, and how these have been experienced by long-term residents of the Free State goldfields.
3. Critically evaluate post mining plans, visions and objectives for the Free State goldfields against the current post mining reality, and limitations and opportunities posed by the changed landscape.
4. Distil lessons from the Free State goldfields case study and the landscape biography approach and develop a model for the management of resource regions.

1.6 Research approach and methodologies

This study has taken the form of an in-depth, cross disciplinary, descriptive case study, relying on a mix of quantitative and qualitative evidence. The overarching methodological approach is that of a landscape biography (as described in Roymans et al., 2009; Palang et al., 2011; Plieninger et al., 2015) – it covers a specific place or geography, it describes a holistic system, and it reveals the keystone processes or drivers that shape the landscape over multiple time frames (Marcucci, 2000).

The physical and temporal scope of the study is limited to the Free State goldfields between 1945 and 2018. Geographically, the Free State goldfields has been loosely defined as an area in the central Free State province, surrounding and including the towns of Allanridge, Odendaalsrus, Welkom and Virginia, all of which have been directly and significantly impacted upon by gold mining, as illustrated in *Figure 1*. This region now falls within the Matjhabeng local municipality of the Free State province. The area has intentionally not been specifically defined by a municipal, environmental or other boundary as it is recognised that impacts may extend beyond such a boundary. The 73 year period has been divided into four arbitrary timeframes (1945 to 1955, 1956 to 1975, 1976 to 1997 and 1998 to 2018), based on the availability of topographic maps.

As a social-ecological system there are a number of elements that to a greater or lesser extent interact and influence the landscape. However, in order to model the system five key elements have been identified and are used to structure the landscape biography. These are the natural and spatial context, political and legislative context, urban and infrastructural development, mining and agriculture. Each of these elements interact with each other and with the physical landscape, driving change. The extent of the interactions and the consequences differ over time.

Both qualitative and quantitative data were collected and analysed for each of the elements to reconstruct the landscape biography of the Free State goldfields. The initial source of data was a set of 1:50 000 topographical maps covering the study area at five time periods. Changes to the landscape between these were noted and documented. Aerial photos, journal articles, archival material, documents, books, company and Chamber of Mines publications, field trips and key informant interviews were used, through an iterative process, to develop timelines and reconstruct the history of the Free State goldfields, according to each of the identified five elements. Looking forward, the mine closure plans of the existing mines, Integrated Development Plans (IDPs) of the Matjhabeng municipality and interviews with long term residents were used to understand the plans for the future.

The result is a landscape biography of the Free State goldfields, identifying and discussing the main drivers of change over each period. Based on the learning from this, a model for the management of resource regions is developed.

1.7 Organisation of thesis

The thesis is structured into eleven chapters. A brief discussion on each chapter is presented below.

Chapter 1 – Introduction and background to the study

Chapter 1 sets the scene for the study, providing an introduction to Free State goldfields and the justification for the research. Core to the research are the concepts of landscape and mining, both of which are defined in the context of this study. Based on this, the aims and objectives are discussed and the methodology to meet these summarised.

Chapter 2 – Landscapes and mining

This chapter presents the literature on landscapes and mining. The chapter addresses the literature under three broad headings, firstly reviewing how landscapes are studied across various disciplines. It then provides an overview and examples on the various approaches to studying mining landscapes. The final section looks at how mining drives landscape change.

Chapter 3 – Methodology

Chapter 3 sets out the methodological approach taken in this study, detailing the sources of data and analysis of these. It also discusses the development of the conceptual model that was used to guide the study.

Chapter 4 - The Free State goldfields, contextual information

The story of the Free State goldfields obviously did not start in 1945, there are many historical factors that end up having a sometimes profound influence on the development of the region post-1945. These factors are discussed in Chapter 4 as contextual information to the case study. The chapter includes background on the deposition of the gold that was to make the area the focus of development, the geomorphology of the region, the political context in South Africa at the time, the discovery of gold and a discussion on the important role that the gold price has on influencing the development and prosperity of the Free State goldfields.

Chapters 5 to 8 - Landscape change in the Free State goldfields from 1945 to 2018

These chapters present the results of the research, the landscape biography, over four time periods, namely from 1945 to 1955 (Chapter 5), 1956 to 1975 (Chapter 6), 1976 to 1997 (Chapter 7) and 1998 to 2018 (Chapter 8). Within each time period a description, supported by maps and photographs, of how the landscape has changed and persisted is given, identifying the various actors and institutions

that have been active, and through this, providing an insight into the processes that have driven these changes. It considers the development of the mines and the associated development of infrastructure and settlements, against the backdrop of changing politics and legislation, which to a large extent shaped the form of landscape change. The impact of this on the original land use, agriculture, is also discussed. Each chapter concludes with a summary map representing the location of the key developments over the period under discussion.

Chapter 9 – Post-mining realities and plans for the future of the Free State goldfields

Chapter 9 presents the voice of long term residents of the Free State goldfields, providing an insight into what it was like growing up alongside the mines, and their perspectives of the current situation that the goldfields finds itself in. The second component of this chapter presents an overview of the local, provincial and national government plans for this region, post-closure. The response from mining is then discussed.

Chapter 10 – Discussion

The key drivers of landscape change for each of the periods discussed are reviewed in Chapter 10. For each time period the drivers of change are weighted as either major or minor, and classified as proximate or underlying. The outcome of this informs a review of the conceptual framework developed to inform the research. Three themes emerge from this analysis and are discussed in this chapter. The chapter concludes with the development of a model for the management of resource regions.

Chapter 11– Conclusions and Recommendations

The key conclusions are presented in Chapter 11 with recommendations for the Free State goldfields, the development of resources regions and further research.

Chapter 2

2. Landscapes and mining

This chapter reviews the literature on landscapes and mining over three broad sections. Looking first at the various approaches to studying landscapes and in particular landscape change and the drivers of this. The second section focuses on mining landscapes. Various studies are reviewed to illustrate different approaches taken, tools used and conclusions drawn. The final section provides an overview of the activities associated with mining, the regulation of these and how mining drives landscape change.

2.1 Landscape as a unit of study

The use of landscape as a unit of study is common across a number of disciplines and employs a variety of techniques, tools and approaches. As a boundary object this allows for interdisciplinary studies and the consideration of the whole system (Plieninger et al., 2015).

2.2.1 Different approaches to the study of landscapes

There is a growing body of research recognising the interconnectedness of social and ecological systems which takes the view that social, economic and biophysical components considered in isolation can each only provide a partial understanding at best, and that all three aspects must be taken together with an understanding of how they co-evolve over time and space to provide a more complete picture of the issues (Matthews & Selman, 2006). These social-ecological systems are linked systems of people and nature, where people depend on nature and nature is influenced by people (Cummings et al., 2013; Levin et al., 2013). From an ecological perspective, such systems can be considered as complex adaptive systems. Complex systems include a number of interacting components, affected by an infinite number of variables interacting at different speeds. Complex system behaviours include such phenomena as non-linearities, feedbacks, the existence of thresholds, the potential for alternative stable states and self-organisation (Cumming, 2011). Also important to understanding complex systems is that they are hierarchical, with interactions between different levels, that defining the system is subjective and that the system boundaries are fuzzy, they are also scale sensitive. Complex systems have emergent properties which arise for a combination of system components and relationships (Cumming, 2011). Understanding and modelling complex systems with sufficient precision to assess causes with any certainty or to predict outcomes reliably is therefore never possible (Rindfuss et al., 2008; Pollard, 2014). Landscapes are considered to be social-ecological systems in that they consist of natural and/or human-modified ecosystems that interact with and are influenced by ecological, historical, political, economic and cultural processes and activities (Denier et al., 2015)

Understanding landscapes as a social-ecological system is not the only approach that is taken in the study of landscape. Another view is from an ecological perspective. Here landscape ecologists view landscapes as '*spaces, places and networks where environmental services function, food/water/timber supply and residential and recuperative attributes are integrated*' (Matthews & Selman, 2006, p. 200). Their focus is on land change – the conversion of land from one form to the next, and change in the use of this land. Decisions to use land affect the goods and services, with consequences for the structure and function of ecosystems and so habitats, flora and fauna (Turner et al., 2007; Bürgi et al., 2010; Hersperger et al., 2010). This approach doesn't necessarily consider humans as part of the landscape, but rather as impartial observers, as external drivers of change on ecosystems (but not influenced by them), or as users of the environment (but not influencing it) (Matthews & Selman, 2006). An ecological focus on landscape is largely interested in understanding the biophysical and human causes of land use and land cover change, and the land use and land cover patterns and dynamics affecting the structure and function of the earth system (Rindfuss et al., 2004; Hersperger et al., 2010). The terminology used in this context is largely related to impacts, with a linear relationship between human activities and the environment. Rather than the complexity described by a social-ecological system. This approach provides a limited understanding of the various relationships, feedback and intertwined nature of drivers of landscape change.

A further perspective is the human centred approach which looks at actors as the main drivers of landscape change, and hence the focus on what is termed cultural landscapes. Landscape biography is a common approach used by cultural geographers to study landscape change from a human perspective. It looks at long-term transformations in landscapes, preferably from prehistory to the present, and views landscape at each point in time as a complex interplay between social and economic developments, culturally specific perceptions of the environment, histories of institutions and political formations and ecological dynamics (Roymans et al., 2009; Palang et al., 2011; Plieninger et al., 2015). At the core of landscape biography is the role of individuals, authors or actors, in making a landscape, based on the belief that it is 'unreasonable' to have a human landscape lacking inhabitants, or the '*geography of man, devoid of men'* (Samuels, 1979, p. 52). Another description, by Karro et al. (2014, p. 12), states that '*the biography of landscape deals with what was and is; notably the concrete world of individuals in their contexts, a world of authored landscapes*.' This recognition of the crucial role played by humans in transforming the landscape is important and what differentiates land cover from land use. The understanding of actors also now includes other types of human actors, such as governments, businesses and non-governmental

organisation (Rindfuss et al., 2008). Business and non-government organisations (e.g. conservation bodies) often own large tracks of land and use them to achieve certain objectives, e.g. species conservation. These may also have unintended consequences or influence the trajectory of change.

Governments have an important role to play in regulating land use which it does through policies, plans, zoning and providing incentives or disincentives on a range of land use activities such as infrastructure, agriculture, forestry, nature protection and urban development (Hersperger & Bürgi, 2010). Through their study of collective farms in Estonia between 1947 and 1994, Palang (2010) demonstrates how changing political regimes results in significant landscape change. Prior to 1947 agricultural land was held and used by private landowners, but with the annexation of Estonia by the Soviet Union a policy of collective farming and state-owned estates was established. This was accompanied by rapid urbanisation. This significantly changed the landscape. Following a political decision to dissolve collective farms in the 1990s, there was an attempt to restore the landscape back to that of the 1930s, which was met with mixed success (Palang, 2010).

The three approaches described above are rooted in different disciplines and approach the landscape through a different lens. However there is significant overlap between the approaches and opportunity to combine the different views.

2.2.2 Landscape change and drivers of change

The intensity and scale of modifications to the earth's surface have increased significantly over the last century in association with human population growth and processes such as industrialisation, urban sprawl, mass migration and agricultural intensification (Amici et al., 2017). The impacts are wide ranging with significant effects on the structure and functioning of ecosystems and the greater earth system and is a major global concern with equally far-reaching consequences for human wellbeing (Turner et al., 2007; Rockström et al., 2009; Harden et al., 2013). These include concerns around water shortages, extreme weather, deteriorating conditions for food production, ecosystem loss, ocean acidification and sea-level rise (Griggs et al., 2013).

There is a need to interpret these changes by looking at patterns, structures and processes in the landscape, the drivers of these and the quantification of change. The study of drivers or causes of landscape change has received increasing focus. There are three main features of these assessments, assessing change and persistence, the drivers of change and, thirdly, the actors (Hersperger et al., 2010).

Land use and land cover change

A change in land use and/or land cover is the result of a change or intensification of a specific, or grouping of drivers. This change to the landscape can be measured by comparing land cover/land use at two or more points in time (Hersperger et al., 2010) and has been described and quantified at local, regional and global scales, over different timeframes (Plieninger et al., 2016). The extent of change may be small and incremental or dramatic and wholesale (Marcucci, 2000). This differing rate of change may allow for adaptation, or alternatively disruption and total loss of functionality or sense of place (Wood & Handley, 2001; Bürgi et al., 2004). There may also be no change at all, where the landscape and landscape features persist. In this case driving forces can be too weak, i.e. below the threshold at which change would take place, they can have a stabilizing effect (e.g., zoning regulations), or several driving forces can operate in opposite directions (Bürgi et al., 2004; Hersperger et al., 2010).

As hypothesised by Domon & Bouchard (2007), and subsequently applied and supported by Bürgi et al. (2010) in a different context, landscape changes are closely associated with the geomorphological characteristics of the land. The original natural and spatial configuration of a landscape sets the context within which change happens. They also propose that landscape changes are the expression of a socio-economic demand for specific ecosystem goods and services, and that technological transformations stand at the origin of landscape changes. Technology determines how the demands for certain goods and services are translated into land use and so change. The demand for and use of goods and services may influence the functionality or utility of a landscape.

Matthews & Selman (2006) differentiated between vicious or virtuous change. The preferred change in a landscape is where feedback between humans and their biophysical environment result in positive outcomes or accumulated value, a virtuous circle. Vicious circles are characterised by the loss of properties which are socially preferred, where value diminishes, resulting in landscape deterioration and loss of multi-functionality, such as biodiversity loss, erosion of visual character, hydrological disruption, community decomposition and environmental dereliction (Selman & Knight, 2006; Matthews & Selman, 2006). Policies and strategies should therefore seek to promote virtuous circles by slowing or reversing undesired changes (Harden et al., 2013). The outcome being to create sustainable landscapes where '*people and place interact in mutually reinforcing ways, so that human agency nurtures the resource base, which in turn rewards this stewardship by providing life-support functions and economic opportunity*' (Selman & Knight, 2006, p. 298). However, given the complexity within landscapes it is not clear what these policies are or how a policy focussing on one area may influence another (Matthews & Selman, 2006).

Drivers of change

The second feature of the assessment of landscape change, is driving forces. These, together with actors, are the forces behind observed landscape changes, the processes that are influential in the evolutionary trajectory of a landscape (Wood & Handley, 2001; Bürgi et al., 2004, Hersperger et al., 2010). In the Millennium Ecosystem Assessment (2005) drivers are defined as any natural or human-induced factor that can cause change in the structure and/or function of a social-ecological system. These forces have also been called keystone processes (Marcucci, 2000). Various driving forces can act on a single landscape and can form a complex system of dependencies, interactions and feedback loops over several temporal and spatial levels, each with different rates of change (Bürgi et al., 2004; Hersperger et al., 2010; Plieninger et al., 2015), thus the '*interwoven change processes'* within a given landscape (Plieninger et al., 2016, p. 211). For this reason it is challenging to analyse them and quantify their contribution to change.

Driving forces are variously grouped by different authors, according to type of driver, and/or the origin. Antrop (2005) for example identifies three main driving forces from his study of landscape change in Europe over the past centuries, these are accessibility, urbanisation and globalisation. To this he adds calamity, as an unpredictable factor. In their research into livelihoods and landscapes in southern Africa, Masunungure & Shackleton (2018) identify drivers related to climate, for example unreliable rainfall, higher temperatures and strong winds, demographic drivers (population growth, the provision of social grants) and drivers related to development, such as the provision of piped water and electrification. In a similar rural geography Giannecchini et al. (2007) identified various local livelihood strategies such as formal employment, cattle ownership and fuelwood usage as drivers of landscape change.

In order to address this wide range of drivers of landscape change, Bürgi et al. (2004) identified five broad categories based on type of driver, these being natural, political, economic, cultural and technological driving forces as illustrated in *Figure 3*. Natural driving forces are the site level factors such as geomorphology or climate, or natural disturbances and disasters, such as drought. These may be slow or fast acting. For example the impact of climate change on a landscape is a slow-acting natural disaster (Bürgi et al., 2004). Political drivers relate to political programs, laws and policy, and are strongly linked to economic drivers, which include trade conditions, prices on the world market, taxes and subsidies, and consumer demands (Hersperger & Bürgi, 2009). Cultural driving forces include population and comprise both the size and the characteristics of the population as well as their attitudes, values and beliefs which influence their indirect and consumptive demands on the land (Hersperger & Bürgi, 2010; Hersperger et al., 2010). As indicated technological drivers are often

at the origin of landscape change (Domon & Bouchard, 2007; Bürgi et al., 2010) and range from past developments in mechanisation for transport and agriculture, to the recent focus on information technology and modernisation.

Driving forces based on origin or impact are differentiated as primary, secondary and tertiary driving forces, and intrinsic and extrinsic (Bürgi et al., 2004), or, a more recent interpretation, as proximate or underlying drivers of change. Proximate refers to drivers/human activities at a local level acting directly upon landscape features, such as urban development, mining or agricultural intensification. Underlying forces are fundamental social and natural processes that underpin the proximate drivers and operate at either a local level or have more indirect impact from the national or global level, these are the political, economic, cultural, technological and natural factors discussed above and illustrated in *Figure 3* (Bürgi et al., 2004; Hersperger & Bürgi, 2009; Hersperger & Bürgi, 2010; Plieninger et al., 2016). What is not depicted in this figure is the relationship between the different underlying drivers, so as much as they are drivers of landscape change, they are also the outcome of the other drivers – the linkages and feedback loops of social-ecological systems.

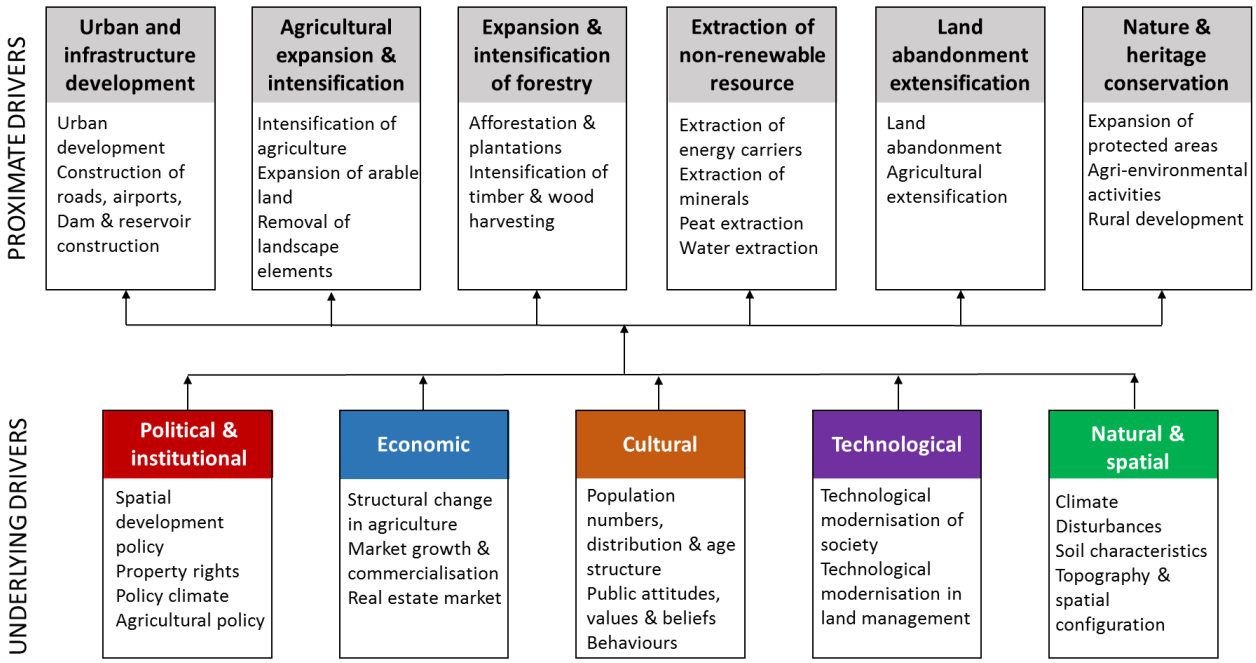

Figure 3. The relationships between type and origin of drivers of landscape change (redrawn from Plieninger et al., 2016)

From their review of 144 studies of landscape change across Europe Plieninger et al. (2016) mapped the relationship between the type and origin of drivers (*Figure 3*). They found that a number of proximate drivers of landscape change may be related to a single key underlying driver (the political

and legislative underlying driver may for example impact urban development, agriculture and resource extraction). They also found that landscape change was more typically determined by a combination of underlying drivers, with political and legislative, cultural and natural/spatial factors being identified as the most frequent underlying drivers. This co-occurrence of multiple causes of change was common in multifunctional landscapes that are dedicated to different (and often contrasting) land uses. A further finding from this research was that in the European context, global and regional economic and environmental changes are increasingly influencing local landscapes, this is in line with earlier finding by Lambin et al. (2001), Matthews & Selman (2006) and Palang et al. (2011) but related to landscapes more generally. Palang et al. (2011) indicate that although these global drivers are becoming increasingly similar, the development paths of each landscape depends on the local situation, local decisions and practices.

Actors

The third feature of landscape studies are the actors**.** Actors make decisions, act accordingly, and influence other actors and the environment with their actions. Generally, actors are to some degree autonomous and therefore control their own actions (Hersperger et al., 2010). Actors need not only be individuals, but can also be agencies and institutions, such as governments, businesses and non-governmental organisation (Rindfuss et al., 2008). Hersperger et al. (2010) distinguishes between two types of actors: actors that affect driving forces (actors of underlying drivers) and actors that directly change land (actors in proximate causes). Examples of actors that affect driving forces, such as policies and markets, are political parties and administrative entities. Actors that directly change land are, for example, farmers or urban investors.

The relationship between these three features - change, drivers of change and actors, is not always clear and one of the core challenges is to determine not only the correlations but causal relationships between driving forces, actors, and land change. Hersperger et al. (2010) propose four models to link land change to actors and driving forces, which are useful to help focus research and make the underlying assumptions more clear. In these models driving forces either 1) have a direct influence on landscape change, 2) act through an actor, 3) interact closely with actors and as a result drive change, or 4) are only one of a number of elements that influence actors, who play the central role in landscape change. All of these models are applicable but one may be more suitable than another, depending on the aim of the study and research questions, the system being studied and the availability of data and resources.

2.2 The study of mining landscapes

As Francaviglia (1991) points out, drastic landscape alteration is the very essence of mining, with mining landscapes being '*hard places – where making a living is tough work, where mining interests continually struggle to outwit both nature and the economy, and where miners are constantly transforming the earth, from bedrock to boulders, from rubble to dust'* (Francaviglia, 1991, p. 4). The outcome being a distinctive and changing landscape, which has been studied from various disciplinary perspectives, for various purposes and at different stages of the mining lifecycle. The timeframes for these studies vary from a few years to hundreds, even thousands, of years. As is the case with landscape studies generally, some consider landscape from a purely physical perspective, focusing on landform and/or land cover. However, there is also a large body of literature focussing on people in these landscapes, how mining shapes their lives and what happens when mines close.

2.2.1 Focus on the physical components of mining landscapes

A number of studies of mining landscapes use the concept of landscape from a biophysical perspective to imply landform, geomorphology or physical environment (see for example Hancock, 2004; Brown, 2005; Malaviya et al., 2010; Lei et al., 2016). In this context, a widespread approach to assessing landscape and environmental change is through the use of remote sensing and geographic information systems (GIS). A range of remotely sensed images, from very high spatial resolution image data (e.g. QuickBird images, IKONOS) to medium spatial resolution such as Landsat or SPOT (Petropoulos et al., 2013) and even aerial photographs, provide spatial data for assessing and managing the impact of mining on the environment (Latifovic et al., 2005; Koruyan et al., 2012). A variety of classification techniques are used to quantify the effects of mining activities, the focus of which has been on identifying and quantifying areas of impact (Malaviya et al., 2010). Studies include determining the success of reclamation activities (Petropoulos et al., 2013), quantifying the spatial extent of waste dumps (Limpitlaw, 2003; Baeten et al., 2016) and assessing ecosystem fragmentation through landscape patterns and diversity (Limpitlaw & Woldai, 2004; Malaviya et al., 2010).

Mining brings significant changes in land use and land cover (LULC) and therefore a common assessment is to quantify LULC change (Malaviya et al., 2010). Land cover relates to the type of feature present on the surface of the earth, such as agricultural fields, highways, rivers and dams. Land use is the human activity or economic function associated with a specific piece of land, for example agricultural use, residential use or mining (Lillesand & Kiefer, 2000). The different land uses and land covers are classified and mapped and may include, for example, urban land, which could be further classified as either residential, commercial or industrial. Similarly agricultural land could be

cropland or orchards, depending on the level of detail required (Lillesand & Kiefer, 2000). In this way mining and mine waste can also be delineated as a class. The change in the extent and location of the different classes over time, using consecutive images of the same location, and so the impact on the natural vegetation and other land uses, can be quantified (Koruyan et al., 2012). Through this the cumulative impacts of mining are determined. The classification of LULC classes implies that the different classes are discrete with clear boundaries. However this is seldom the case in natural ecosystems, leading to some error and uncertainty (Rocchini et al., 2013). Differences in the resolution of sensing instruments or quality of historical data may also reduce the accuracy of change detection (Limpitlaw, 2003; Amici et al., 2017) or may not always capture the activity under study. For example, DeWitt et al. (2017) found that LULC classifications of Landsat imagery do not consistently capture areas of artisanal mining. This requires the integration of high resolution imagery with Landsat imagery (DeWitt et al., 2017).

An example of the use of LULC to reconstruct the history of a mining region is that of Hendrychova & Kabrna (2016) study of a coal mining region in northwest Bohemia, Czech Republic. Using topographic maps, and archival maps for the earliest periods, they quantified the extent of different land uses over six time periods from 1845. They also included a future time period (2050) based on maps from plans for the revitalisation of the area. Their results quantify the changing land-uses over the 200-year history of this landscape, illustrating how mining boomed and then declined and how, with restoration, mining will disappear as a land-use. What is also evident from their results is the impact mining has had on other land-uses, where the landscape has undergone '*a complete metamorphosis*' (Hendrychova & Kabrna, 2016, p.158). By mapping areas that at one or other time over the past 200 years have been influenced by mining the authors were able to demonstrate the cumulative impact that mining has had on this landscape (46,9% of the total area has been affected by coal mining). However, as this was aggregated over the entire landscape and presented in a graph, there is a loss of detail on where exactly the main impacts and changes occurred. This is a limitation of this approach.

Remote sensing techniques can also be used to assess the amount and health of vegetation on the earth surface. One of the more commonly used vegetation indices is the normalized difference vegetation index (NDVI) (Kriegler et al., 1969). NDVI is calculated from satellite imagery and can be used to assess vegetation productivity, photosynthetic activity of the vegetation and percent ground cover (Kriegler et al., 1969; Koruyan et al., 2012). In the mining context this is useful for determining an ecosystems sensitivity to change and the impact of pollution (Koruyan et al., 2012).

The use of remote sensing allows for independent, frequent observation of a large area over a long time period at a relatively low cost. It is particularly useful in remote or inaccessible areas where it may be the only available dataset (Latifovic et al., 2005; Malaviya et al., 2010; Petropoulos et al., 2013; DeWitt et al., 2017) and where historical information is needed in order to determine baseline conditions (Latifovic et al., 2005; Koruyan et al., 2012). The maps produced can provide timely and valuable information for subsequent assessment of the impact of mining activities in an area and with continuous monitoring and simulation have the potential to project future scenarios in LULC change over studied regions (Paudel & Yuan, 2002; Petropoulos et al., 2013). Remotely sensed data can also be integrated with other qualitative and quantitative datasets, such as mineral production figures, operating dates or ore grade, to construct a GIS related to the research question (Baeten et al., 2016).

Remote sensing and GIS focus on documenting and analysing spatial pattern which is not always sufficient to fully understand the cause-effect relationships between mining activities and the environmental impacts, and therefore are best combined with other field-based measurements (Latifovic et al., 2005), some of which are discussed in the following section.

2.2.2 Social perspectives of mining landscapes

Literature (Francaviglia, 1991; Amundson, 1995; Goin & Raymond, 2001; Cater & Keeling, 2013), stemming largely from the social sciences and historical geography, takes a different perspective of mining landscapes. Here landscape is generally understood to be the outcome of the interactions between people, mining and the biophysical environment, and places to which meaning is attached – a cultural landscape perspective. As opposed to the studies discussed above, much of this work is qualitative, providing a description of how mining influenced the landscape and what this means for the residents, particularly when mining ceases.

Perhaps the most comprehensive account of mining landscapes is Richard Francaviglia's 1991 book *Hard Place, Reading the landscape of America's historic mining districts*. This publication is based on the author's visits to all major mining sites across America over a 30 year period, supported by historical documents, maps and photographs. Although he defines landscape narrowly (an image of a place based on its visual characteristics, akin to scenery) his work takes a broad perspective on mining landscapes, covering the physical features directly associated with mining activities, mining towns, their layout and architecture, and perceptions and memories of these landscapes. The approach taken by Francaviglia (1991), a historical geographer and architectural historian, is to firstly 'read' the landscape - observing, identifying and describing the different features of mining

landscapes. In addition to the obvious mining features, made up of mine infrastructure, the altered geomorphology and connecting railways, Francaviglia (1991) indicates that residential architecture is also often diagnostic of a mining town. Company housing has little variation, identical maintenance and simple architectural styling. Having 'read' the landscape he then 'interprets' it through understanding the processes and forces that have shaped them. Mining landscapes are the legacy of several process that explain the distinctive look of these regions, according to Francaviglia (1991) these include:

- Isolation – Mining regions are often physically remote requiring the establishment of extensive transport networks (road and rail) and the development of local amenities and services.
- Nucleation – Mining settlements are tightly clustered around the mines and appear as if they were 'thrown together'. This is especially the case for boom towns where there is, initially, little conscious planning.
- Differentiation – Over time both the mining activities and the settlement diversify. Mature metals mining district includes a series of separate activities such as mine workings, ore crushers and smelters, and associated with this, separate communities of workers each with their own character or identity.
- Stratification – Stratification refers to the social geography, where social position is structured according to occupation, class (labourer, supervisor or financier) or ethnic group. Related to this are different housings schemes. The large mine owner or mine manager's house stands in contrast to the labourer's cottages.
- Homogenisation – Eventually individual mines are taken over by a larger company and consolidated, with this comes standardisation to minimise costs and improve efficiencies. The landscape loses more and more of its vernacular individuality and becomes more uniform in its design, construction and maintenance.
- Transformation – Mining changes the physical structure or geomorphology of a landscape. The form of this is largely an economic and technological decision – the cost of moving earth and the technology available to do it determines where it is moved and how. This physical transformation occurs over the entire lifecycle of the mine, with the different phases (e.g. exploration, operation, closure) being identifiable by the state of the landform.
- Seriation – Similar to the physical transformation discussed above, the broader landscape of a mining regions also relates to the stage of its development, from the formative years, through development to a mature mining region, restructuring and finally divestment. These stages are visible through the landscape.

Francaviglia (1991) concludes his book by highlighting the importance of mining landscapes - '*historic mining landscapes provide a visible connection with the past and reveal much about the attitudes and the lifestyles of those who created them*' (p.186).

The importance of mining landscapes is also discussed by Cater & Keeling (2013) in their work on nickel mining around Rankin Inlet, Nunavut, Canada, based on ethnographic research and oral histories. This research illustrates the link between the physical landscape, memory and identity. Even though mining activities were short lived (over a 5 year period), ceased in 1962 and left the environment and economy ravaged, mining is still seen to be core to the communities' identity. The industrial ruins of this mining past have become landmarks and continue to be '*folded into present practices and identities*' (Cater & Keeling, 2013, p.61). This illustrates how the mining landscape also influences the future of a region. As stated by one of the local residents when asked whether mineral development is an important part of Rankin Inlet's future, '*of course [mining is] an important part of the future, because that's where our future came from*' (Cater & Keeling, 2013, p.61).

The idea of identity and meaning of mining landscapes is also discussed by Goin & Raymond (2001) in their study on landscape history of the Wyoming Valley, Pennsylvania, USA, an anthracite mining region. The authors draw on literature to develop a landscape narrative. Anthracite mining between the 1820s and 1960 altered the physical landscape, causing destruction to the environment through the pollution of water and generation of waste. These altered landscapes provided a sense of place and meaning to the residents once mining had stopped and the mine abandoned. As described by Goin & Raymond (2001), '*these derelict scenes constitute monuments of sorts*' (p.38) and because they had been landscape features for so long, seemed natural. An initiative to rehabilitate the valley and restore the abandoned lands to productive uses, which involved the removal and retreatment of waste dumps, was met with resistance from some residents. It was seen as *'the process of erasure'* (Goin & Raymond, 2001, p.43) of the mining past that produced the landscape. In addition to the importance of sense of place, this also highlights the potential for conflict between environmental improvements and cultural and historical preservation.

Amundson (1995) uses population numbers, specifically mine employment numbers, school enrolment, voter registration numbers and change of address forms, to reconstruct the development of Jeffrey City in Wyoming, USA, between 1957 and 1988. Jeffrey City was built to house labour for an adjacent uranium mine. Although this study does not focus on landscape *per se*,

it tracks the changing fortunes of a mining town over two booms and busts, to its state of near abandonment, and with this the changing form and structure of the settlement. Jeffrey City was initially impermanent, trailer park accommodation, but over the years and associated with the changing fortunes of the mine, developed to a permanent settlement with services, including a school, library, sports facilities, churches and recreational facilities, accommodating over four thousand people at its peak in 1980. However, in 1982, following a collapse in the uranium market, the mine cut its operations significantly, laying off workers. As a consequence 75 percent of the town's population left (Amundson, 1995). According to Amundson (1995) '*Jeffrey City was doomed from the beginning because its extractive economy was not regenerative. Further, the town's ups and downs reflect its reliance on a boom-and-bust industry*' (p.505). Jeffrey City's fate was tied to uranium mining, the viability of which fluctuated over the years due to supply and demand and importantly, to policy. Initially the Unites States' uranium industry was protected through, for example, guaranteed markets and haulage allowances, but when the international free market took control, the Jeffrey City mine could no longer compete, eventually closing its operations in 1988. In 2010 there were only 58 people still living in Jeffrey City[2]. The once booming mine town is now marketed as a ghost town tourist destination, and described as follows – '*Today the streets sit empty, an asphalt grid cracking under the harsh weather. Street lights still stand, but remain dark, rusting away. Empty home plots are nothing but weeds and useless utility meters. Here and there mobile homes lie, shattered, discarded. An abandoned bath tub sits among the elements. The schools, hotels, churches, and shops are all boarded up. Main Street is a sad testament to old promises, shattered hopes. A park is now only brown prairie grass, an abandoned teeter totter sitting still, a swing set twisting in the wind. Today, you can stand in the middle of a once thriving town and see not a soul around*.' [3]

The examples discussed in this section are all of post-mining landscapes and draw largely on qualitative data, interviews and observations, to reconstruct the history of the mining region and describe what remains. This approach provides a useful, and personal, perspective of the consequences of mining development where the economy has not been diversified over the life of the mine, and so when mining ceases, so does the mining town. In these example the landscape is a product of the physical, the social and economic dimensions. However, the environmental and physical consequences are not able to be quantified, rather just described from an individual's perspective. Hence the need for an interdisciplinary approach that draws on both the lived

[2] US Census Bureau https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk [accessed 8 August 2019]
[3] https://www.atlasobscura.com/places/jeffrey-city-ghost-town [accessed 8 August 2019]

experience of individuals in a particular landscape and the quantification of changes to the landscape through mapping. This would provide a more holistic perspective of the landscape.

2.2.3 The study of South African mining landscapes

Unlike the towns described above, there are a handful of mining towns that have managed to survive beyond the boom-bust scenario of a minerals-based economy and develop into diverse and competitive cities (Harrison & Zack, 2012). Johannesburg, South Africa, being an example. Harrison & Zack (2012) discuss the development of Johannesburg from its origins in 1886 to 2012, using literature on mine labour, the political economy of mining and of Johannesburg, and its spatial structure. Johannesburg developed as a consequence of the discovery of gold and grew around mining. The landscape of Johannesburg was '*profoundly shaped by the physical presence of mining and by the hierarchies and intersections of a society that emerged around the mines*' (Harrison & Zack, 2012, p.557). Although as a city it did experience the changing fortunes of mining, it still survives and, some would argue, thrives. However, it was not always straight forward. Harrison & Zack (2012) describe it as a '*turbulent roller coaster, with peaks of optimism and troughs of despair*' (p.555). The continued existence of Johannesburg as a major economic centre is due to technological development, initially, and then the diversification of its economy early on (Harrison & Zack, 2012) and its first mover advantage. In the very early years of mining (1889), having mined the rock outcrops, the miners struck pyritic ore below the surface and had no technical means to extract the gold. Johannesburg seemed doomed to a future as a ghost town. However a method to extract gold using cyanide was developed and mining continued. Diversification of the economy was facilitated by the mines which created a demand for industrial production, explosives, construction material and chemicals and, because of its remote location, there was an incentive to produce it locally. The disruptions to supplies due to the First World War also pushed local manufacturing. The large mining companies established to develop the reef set up their headquarters in Johannesburg, and so channelled profits towards the city (Harrison & Zack, 2012). With these services and infrastructure already developed in Johannesburg there was no sense to duplicate them in nearby centres when mining extended to these areas, such as Carletonville to the west of Johannesburg or Welkom in the Free State. Even though active mining has all but ceased in the central goldfields, Johannesburg continues to be the corporate centre of the South African mining industry. The success of diversification is illustrated by the fact that even with the slump in gold mining in the 1990s there was very little impact on Johannesburg, unlike other gold mining areas in South Africa, as other sectors had long since replaced mining.

The spatial change associated with mining in Johannesburg is documented by Mubiwa & Annegarn (2013), using two different methodologies. In the first part of their study, they review historical planning documents to trace the evolution of urban spatial development between the 1880s and the late 1980s. Johannesburg was initially a mine camp but soon developed a more formalised linear layout along the mining belt. As more people came to the city and with a growth in affluence, the city expanded to the north, avoiding the mines and mine tailings to the south. Along with post-war industrialisation (1930 to 1950) there was further extension towards the north and a road network built to connect the newer northern suburbs to central Johannesburg. In the 1950s, with the formalisation of apartheid, high density townships for non-whites were developed on the periphery of the city. These segregation-driven developments, and the road and rail infrastructure necessary to support them, were evident from the 1960s and created a highly fragmented urban landscape (Mubiwa & Annegarn, 2013). The late 1970s and 1980s saw a shift from manufacturing to tertiary service industries and a service-based economy which resulted in the rapid growth of low-density residential suburbs and the decentralisation of commerce to peri-urban areas. Along the mining belt, south of the city, mine tailings dumps were reprocessed and revegetated with many informal settlements developing in this area.

In the second part of their study Mubiwa & Annegarn (2013) use satellite images to map and quantify LULC classes and describe the growth of the urban landscape between 1991, 2001 and 2009. Using this methodology they are able to show how, over the two decades, urban areas expanded, from just over 228,000 hectares in 1991 to over 333,000 hectares in 2009, at the expense of cultivated land and woodlands. They were also able to demonstrate that the rate of change was greatest between 1991 and 2001, this being as a consequence of the repeal of discriminatory legislation, allowing the free movement of the black population, and South Africa's new political dispensation in 1994. This second approach, using LULC mapping, allows for the quantification of landscape change and determination of rates and patterns of change, and the visual representation of these. This is contrary to the approach used to reconstruct the early development of Johannesburg, which is largely descriptive. The lack of satellite data makes LULC mapping difficult for the earlier time periods.

In this same geographical context Bobbins & Trangoš (2018) use the concept of landscape to '*highlight the need for a comprehensive and collaborative approach to manage the after-effects of the Witwatersrand's gold mining'* (p.10). Drawing on a range of literature and research reports they highlight the outcomes of gold mining on the landscape and the lingering consequences of these.

According to Bobbins & Trangoš (2018) mining divided the city into 'landscapes of pleasure' and 'landscapes of production' (north and south of the mining belt respectively, as mentioned by Mubiwa & Annegarn, 2013). The gold reef on which Johannesburg was founded outcropped in a roughly east-west band across the landscape. This is where mining started and then gradually moved south, east and west in line with the dip of the underground gold reef. Mining waste was deposited and industries associated with mining were developed to the south of the reef. To the north of the mining belt is were affluent residents chose to settle, away from the mines, on the ridge with views across the Highveld and where the air quality was better. This 'landscape of pleasure' is described as '*a suburban utopia replete with mansions, manicured gardens, parks and a fixed social order congenial to the interests of elites*' *(*Bobbins & Trangoš, 2018, p.36) where '*mining capital and the imperial elite shaped the Highveld landscape into the image of a British heartland*' (p.36). This spatial divide along the mining belt is still a defining features of contemporary Johannesburg (Harrison & Zack, 2012; Harrison & Zack, 2014). As are the tailings storage facilities and waste dumps which continue to contribute to water pollution, dust and soil contamination, impacting the environment and human health and limiting productive use of the land. Mining waste also poses a physical barrier to development (Bobbins & Trangoš, 2018). In concluding their report, Bobbins & Trangoš (2018) recognise the potential that landscapes have to perpetuate patterns of development and so call for '*sustained, collaborative and innovative approaches to unshackle the towns and cities of the Witwatersrand from their gold-mining inheritance*' (p.18).

South Africa has a number of other mining areas that have been the subject of research, none focussing specifically on landscape but, through different research projects, addressing aspects that influence landscape. For example, Singer's (2011) research on coal-based pollution in the Witbank (now called eMalahleni) coal fields of Mpumalanga between 1903 and 1948, through oral histories and document review, includes a discussion on landscape change. She indicates how, prior to mining, the predominant economic activity in this area was agriculture, particularly maize farming. However, to support industrial and gold mining development, coal mining expanded and by 1920 the colliery dumps '*rivalled those of the gold mines and made the first dent in the landscape of the rapidly transforming district*' (Singer, 2011, p.285). This became more significant during the Second World War where, due to a massive increased demand for coal to support the war effort, miners returned to previous workings to mine low grade ore and remove coal left in the floor, roof and pillars. Pillars designed to support the mine ceiling were 'robbed' resulting in only 25 percent of the original pillars being left behind. The consequences being subsidence, cracking or collapse. The size of the '*black mountains of coal waste*' (Singer, 2011, p.289) also increased. By the 1940s the impact

of acidic water decanting from abandoned shafts was also noted. These pollution impacts from coal mining altered the landscape and influenced other land use activities, particularly agriculture. The preferential treatment of mining over agriculture, highlighted by Singer (2011), continues to be the case in this region, as demonstrated in two reports by the Bureau for Food and Agricultural Policy (Van der Burgh et al., 2012; Delport et al., 2015). Both demonstrate how high potential arable land in the Mpumalanga coal field is being transformed by mining. The increasing physical footprint of coal mining around eMalahleni and its negative impact on agricultural production, the environment and communities in more recent times (1991 – 2014), is also discussed by Hermanus et al. (2015). This they attribute to a change in policy since 1994. The post-democratic mining policy in South Africa requires that mining activities commence within a year of obtaining a mining right, otherwise the holder runs the risk of losing the right – the 'use it or lose it' clause in the Mineral and Petroleum Resources Development Act. Under previous legislation mining companies could, and did, hold rights and sit on them for years, preventing others from mining these resources. The change in policy has had a significant impact on the rate of mining and so the rate of landscape change in some regions.

Hermanus et al. (2015) also consider the case of platinum mining in the North West province of South Africa, around the town of Rustenburg. Here too they see an increase in the number of mines, with the footprint of mining more than doubling between 1994 and 2006. Ololade et al. (2008) has mapped this change over a longer time period, 1973 to 2002, using Landsat images to assess LULC change. They find significant changes, with an increase in mining related land uses (tailing storage facilities, mine dumps and return water ponds), and a decrease in vegetation cover. Related to this is the expansion of the built-up area due to the development of transport networks and formal and informal settlements.

The Free State goldfields regions has also been extensively researched (Marais, 2006; Marais, 2013a; Marais & Nel, 2016; Marais & van der Walt, 2011). However, the focus has been on settlements, housing, the decline of gold mining and its consequences, rather than a focus on mining and the landscape. The Free State goldfields is the focus of this research and this literature has been drawn on in the development of the landscape biography as presented in Chapters 4 to 9.

2.3 Mining as a driver of landscape change

The physical impact that mining has on a landscape is evident in the changed topography, disrupted ecosystems and new developments. The extent to which mining drives landscape change is influenced by the importance that mining is given relative to other land uses and how it is regulated. The increasing demand for minerals, associated with a growing global population, development and new technology, is also a major driver of mining and so landscape change. These, together with the various physical impacts of mining, are discussed below.

2.3.1 Geographical expansion and intensification of mining

As the demand for minerals increases, so mining continues to drive landscape change. Between 1900 and 2005 the extraction of ores and industrial minerals increased by a factor of 27 (UNEP, 2011). This is due to both a doubling in average per capita use of resources, driven largely by increasing consumption in middle- to high-income countries, and an increasing global population (UNEP, 2011; Prior et al., 2012).

The ore grades in many mines in the older traditional mining areas have been declining (Henckens et al., 2016). Prior et al. (2012) illustrate this long-term trend for copper, gold, nickel, lead, silver and zinc ores in Australia and gold in Brazil, the USA, South Africa, Australia and Canada. In response to declining grades, further exploration is undertaken and mines dig deeper or, for surface mines, bigger. They also start mining lower grade ores, which may require more complex processing and result in greater environmental and social impacts, being more water and energy intensive (Canel et al., 2010), generating more waste (Prior et al., 2012) and requiring more land to produce the same amount of mineral product (Sonter et al., 2014). In Australia, and it is likely to be the case elsewhere, changing ore grades, mine depth, waste rock and mining inputs are associated with increased environmental costs and growing social issues associated with regional development, cumulative impacts and quality of life in mining regions (Prior et al., 2012).

The '*unprecedented and unregulated geographical expansion and intensification of extractive exploitation'* characterise the current phase of mining and petroleum growth (Canel et al., 2010, p.6). In response to the exhaustion of easily accessible and rich deposits mining activities have moved into ever more remote areas, often occupied by indigenous peoples, and into countries with little history of extractive industry operations (Canel et al., 2010). With the construction of access roads and development of camps and settlements, and job and business opportunities, the mines open up these previously inaccessible areas to agriculture, logging and other developments. Sonter

et al. (2017) in their case study on mining in the Amazon, have shown how mining indirectly caused more extensive deforestation off the mine site than was observed within the mine lease area. They found that these impacts extend 70 km from mining leases, further than previously thought, and were due to the combined effects of land use displacement, urban expansion, development of commodity specific supply chains and concerns over mine waste discharge and spills (Sonter et al., 2017). Once a mineralised area has been discovered other companies move in, resulting in a densification of mining regions, with a shift from green field to brown field exploration, as the probability of finding economically feasible reserves close to established mines is higher and cost of developing infrastructure less (Sonter et al., 2014).

Similar expansion of mining was described by Hermanus et al. (2015) in the coal mining region of Mpumalanga and platinum mining areas of the North West Province in South Africa. However, the authors attribute this to the change in policy since democracy in 1994. They argue that the new legislation accelerated the pace and scope of mining and along with this, land disturbance.

2.3.2 Policy, access to minerals and management of mining

The way in which land is accessed for mining and the status of mining as a land use relative to other land uses is important in understanding its role in driving landscape change. In a number of countries (e.g. Canada, USA, South Africa,) mining has traditionally been given precedence over other land use activities (Canel et al., 2010; Hoogeveen, 2015; Watson et al., 2018). For example in Canada and the United State, the 'free-entry' system allows prospectors to stake a claim on private or Crown land prior to informing the land owners and users (Canel et al., 2010). According to Hoogeveen (2015), this approach is based on the assumption that mining trumps private property interests and is the best use of land, that all land is open for exploitation unless declared otherwise, that mining prevails over aboriginal property rights, that mineral tenure is granted on a first-come-first-served basis and that mineral potential is so valuable that it warrants leaving the staked area potentially unusable for other resource interests. This is clearly problematic when considering other user of land, especially indigenous communities, the range of alternative uses for land and the destructive nature of mining. However, even though critics have argued against this system, stating that it is archaic and colonial, it remains. Industry argue that it is fundamental to a vibrant mining economy (Hoogeveen, 2015).

The South African system resembles the North American 'free-entry' approach. Historically mining has been given pre-eminence with legislation geared to its development and reducing potential obstacles (Watson et al., 2018). Initially there was no distinction between mineral and surface land rights. However, over time through administrative practice and legislation these were severed, with

mineral rights becoming a form of property that could be owned, traded, used and leased (Capps, 2012). With the passing of the Minerals Act No. 50 of 1991, these rights were vested with land owners, i.e. private mineral rights (Cawood & Minnit, 1998). Following South Africa's 1994 transition to democracy, the new government sought to create a regime for governing extractive industries that would respond to the claims for the redistribution of land and wealth to the benefit all South Africans. This is achieved through the MPRDA, where mineral rights were vested in the state which would be the custodian on behalf of the nation. Access to mineral rights would be achieved through an application whereupon a license with a limited time period would be granted. Also important to note is that companies with mineral rights would have to act on them within a period of a year, the 'use it or lose it' clause in the legislation. This was to prevent companies hoarding mineral rights. The consequence of this is a proliferation of mining with negative social and environmental consequences (Hermanus et al., 2015). Although not generally referred to as a 'free-entry' system, the legislation clearly gives precedence to other mining rights and titles in determining whether a new permit may be issued (Hermanus et al., 2015). For example, MPRDA 16:2(b) states that "*The Regional Manager must accept an application for a prospecting right if – no other person holds a prospecting right, mining right, mining permit or retention permit for the same mineral and land*" (RSA, 2002). The same is true for the application for a mining right under 22:2(b) of the MPRDA. In addition to this, landowners and users do not need to give consent to mining on their land, they do however need to be consulted and compensated for any damage. This is in line with the assumptions of the 'free-entry' system, as listed by Hoogeveen (2015). The current system of accessing mineral rights in South Africa creates a hierarchy of land-use values, with mining at the top, and little regard in practice for the social and environmental consequences of this hierarchy (Hermanus et al., 2015).

In addition to the legislation on how mineral rights can be accessed and so what areas of land are available for exploitation, is policy that regulates how this activity takes place and what should happen once mining ceases. Globally, this has evolved over the years along with the sustainable development discourse and society's increasing expectation of mining and other industries to operate in a manner that contributes to sustainable development. It is now generally accepted that an environmental impact assessment needs to be conducted prior to mining, that identified impacts be mitigated and managed throughout the life of the mine and, at closure, sites are rehabilitated. Increasingly requirements to contribute to local communities and manage the social impacts of a mine are being legislated or required by project funders. The effectiveness of, and compliance to,

legislation differs, resulting in some mining landscapes being degraded significantly more than others.

2.3.3 Physical impacts of mining

The processes of land use change associated with mining are distinctive and as such, mining landscapes are distinctive (Francaviglia, 1991; Sonter et al., 2014). They are a result of mining activities and non-mining activities resulting in environmental and social impacts, which may be positive or negative. These activities need to be managed throughout, and beyond, the life of a mine. In resource regions these impacts are magnified.

Mining and on-site activities

Bridge (2004, p.205) differentiates between three aspects of mining's impact on the landscape, firstly as '*earth moving*', a physical modifier of the landscape, as a polluter ('*the big sink'*) and as a driver of regional and global environmental change. This also illustrates a growing understanding of the impacts of mining and how we manage these, from an initial focus on addressing pollution and levelling ground, to a greater understanding and broader perspective of its impacts on ecosystem functionality and global biogeochemical processes. The extent of the impact is associated with the commodity mined, the mining method used (e.g. opencast or underground), associated value-adding activities (e.g. smelting and refining) and mine reside deposits, and will differ depending on the receiving environment, its geography, climate and sensitivity (Watson et al., 2018). The extent and type of impact varies across the mining life cycle.

Over the life of a mine, mining activities cause changes to surface topography, the ground and surface water regime, geology, soils and natural vegetation (Smith & Underwood, 2000). The physical act of mining requires the movement of earth. In the process the natural landscape is modified with the development of pits, tailings dams, waste rock dumps, and the associated mining infrastructure (water storage facilities, power lines, water pipelines, transport networks), while displacing soil and clearing vegetation (Sonter et al., 2014).

Mining is a segregative process where relatively small quantities of the valuable substance are removed from a much larger mass of less valuable material, each step giving rise to a different waste stream, including waste rock, processing waste such as tailings, and metallurgical waste (Lottermoser, 2011). The mineral-to-waste ratios can be significant, making tailings storage facilities a major contributor to chemical and physical pollution, landscape change and safety risk. The impact of mine waste depends on its volume and contamination potential (Bridge, 2004).

The pollution from the mines, together with modified landscapes, interacts with ecological processes in the receiving environment and has implications for biodiversity, ecosystem functioning and ecosystem health at a local, regional and global level. This, and mining's need for resources, in particular water, energy and land, places it in competition with communities who also require these resources to support their livelihoods.

Non-mining and off-site activities

A mining license is generally granted over a portion of land and the holder of that license is responsible for the management of impacts on that land. Although their responsibility extends beyond this, it is more difficult to manage and control off-site activities. Some of which are generated directly by the mining activity, but may extend beyond the site boundaries, such as dust, polluted water and risk associated with tailings dam failure. However, many of the off-site impacts are indirect, induced or cumulative and so less easy to identify and manage.

Prospecting and mining open up previously inaccessible areas for other land uses, such as agriculture, resource harvesting and settlement. This is demonstrated by Sonter et al. (2017). They found that deforestation surrounding mining areas (mining induced deforestation) was 12 times greater than that associated directly with the mining activities (within mining leases) and accounted for nine percent of all deforestation. Other non-mining activities and developments catalysed by mining, such as the road and rail network, water and power provision and settlements to house workers, also alter the landscape (Weng et al., 2013).

Settlements associated with mining are distinctive features of the landscape (Marais et al., 2018b). The form they take depends largely on the history of the discovery of minerals and development of the mine. Where the development of a settlement is associated with a 'rush', a sudden influx of people seeking their fortune, the settlement is initially informal, more a mine camp than a town, and unplanned, with a 'helter-skelter' layout (Francaviglia, 1991). Hostetter (2011, p.59) describes these natural resource 'boomtowns' or frontier towns as '*places of absurd growth'* with a development pattern of *'1) rapid, and rampant, overproduction of the built environment; 2) social atmosphere of excessive consumption and indulgence; and 3) eventual, inevitable, scaling back'.*

Company towns, on the other hand, are towns that are owned and controlled by a particular company and where potential wealth is not accessible to all prospectors but rather concentrated with the mine owners (Hostetter, 2011). Although these towns may have been built rapidly in order

to start operations and house the large labour force, the development is more ordered and controlled, often with a distinctive architectural style (Francaviglia, 1991). Company towns were built to provide accessible and affordable housing for employees and their families near to the site of extraction. In some cases the ambition was to create a model town, '*where workers could be healthy and moral and become educated*' (Deacon et al., 2018, p.40), in others is was an economic calculation of the most efficient way to organise space and accommodate workers (Deacon et al., 2018, p.40). In addition to housing, which was often owned and maintained by the mine, the company would also be responsible for the provision of services, such as water and sanitation, health care and education, and recreational facilities (Marais et al., 2018). These towns may be closed, exclusively for mine employees, or open for others to live in.

There is of course a whole range of models of mine towns between these extremes, involving more or less and different forms of planning, there are also elements of both within the same settlement. Mineral discoveries are not always associated with the development of a new town, rather the expansion of an existing settlement. The development of a mine attracts an initial influx of people seeking employment opportunities. This rapid population growth often strains community services and local infrastructure beyond its capacity to meet demand. This growth results in a number of interrelated social impacts such as social disruption, transiency, inflated housing costs, insufficient urban infrastructure and services, and a lack of a sense of community (Deacon et al., 2018). Many of these mining towns battle to develop independently from mining companies and to diversify their economies, they are particularly vulnerable to the volatility of commodity prices and eventual closure of the mines (Marais et al., 2018).

In the South African context, two parallel settlement systems were developed by companies, the company town as described above to house the white labour force, and then hostels to accommodate black migrant labourers who, under apartheid legislation, were not permitted to live permanently in white settlements. Instead they were housed in hostels. Although this system of hostels has changed following democracy, a new form of parallel settlement has developed, being informal settlement around mining towns (Rubin & Harrison, 2015).

Globally there is a trend towards normalisation of mining towns, where services and facilities previously provided by the mines are being taken over by local municipalities (Marais et al., 2018, Deacon et al., 2018). There is also a reluctance to establish new mining towns. Both are due to a greater focus on core business by mining companies and a change in labour regimes (Marais et al.,

2018). Fly-in-fly-out (FIFO) commuting is a growing practice in the industry where non-resident workers are flown to a mine site and housed in temporary camp-like accommodation for the duration of their rotation (Deacon et al., 2018).

2.3.4 Cumulative impacts

Resource regions are particularly vulnerable to the cumulative impacts of mining and associated activities. However, these impacts are seldom adequately assessed or addressed. Currently, individual mining projects are approved based on an upfront assessment (Environmental and Social Impact Assessment - ESIA) to predict the extent of environmental and social impacts and mitigate those that are not acceptable. This form of assessment and approval is becoming increasingly problematic as it does not adequately consider off-lease, indirect or cumulative impacts, and where they are considered, the approach needs to be improved (Duinker et al., 2013; Sonter et al., 2017). Cumulative impacts in mining regions are significant, given the numerous impacts, the duration and extent of mining and the catalysing effect mining has on other developments. Cumulative impacts are not well managed as they are not the responsibility of any single entity (Atlin & Gibson, 2017). Franks et al. (2010, p.299) also find this from their research in coal mining regions of Australia, where they conclude that *'the compounding impacts of multiple mining operations have stretched environmental, social, human and economic systems and rendered conventional mine-by-mine governance approaches ineffective'*.

As discussed by Duinker et al. (2013) there are a number of definitions for cumulative impacts. Broadly these focus on one of four different perspectives or units of analysis, namely the actor, the action, the impact or the receiving environment, with the most common understanding being that cumulative impacts result from the presence of multiple projects or actors (Franks et al.,2013). In their earlier work, Franks et al. (2010) used a definition which places impact at the centre and considered the aggregation of impacts over time and space, and interactions between impacts, namely the '*successive, incremental and combined impacts of one or more activities on society, the economy and the environment. Cumulative impacts result from the aggregation and interaction of impacts on a receptor and may be the product of past, present or future activities*' (p.300). A counter argument to this broader definition is that it '*renders all impacts cumulative*' (Franks et al., 2013, p.642) and so propose that the cumulative dimensions of impacts should be considered, rather than trying to agree on what is and is not a cumulative impact.

In their conceptual framework for the cumulative dimensions of impact (*Figure 4*) Franks et al. (2013) differentiate between the impact drivers and the impact domain. The impact drivers include

the actors, their decisions and actions. The impact domain describes the receiving system and includes the receiving environmental and social systems. As indicated, these are linked by flows of energy, materials and information that result from management decisions. The three cumulative dimensions of impact are governance, impacts and cumulating processes. Through governance (1) implicit and explicit forms of information flow through to the impact domain where actions are taken, resulting in impacts (2). These may be either first order impacts or consequential impacts, and result in cumulative processes (3). Cumulative processes include both aggregation or disaggregation (over time and space) and interaction of impacts, where one impact triggers another or where an activity has multiple associated impacts. Cumulating processes may generate complex feedback loops as well as adaptation responses from the impact entities within the environmental and social systems. In turn the impacts and cumulating processes from the impact domain (the environmental and social system) may influence decision making and the drivers of impact, represented by the information feedback. Including this feedback mechanism is novel as impact processes have largely been seen as linear processes. In practice we see how environmental circumstances influence decision making and actions (e.g. on a global scale how climate change influences policy and practice). Exogenous factors influence both the impact drivers and impact domain and may include variations in climate, global economic conditions or social and cultural trends that influence a system from outside the domain of impact.

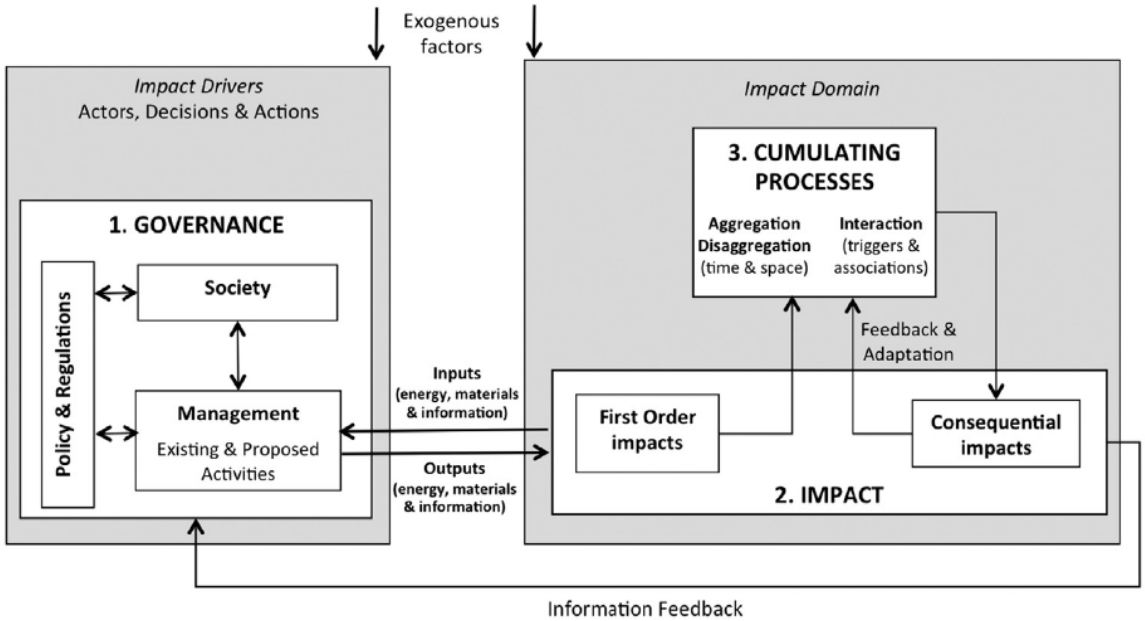

Figure 4. The cumulative dimensions of impact (Franks et al., 2013, p. 643)

This conceptual approach to the cumulative dimensions of impacts shifts the study of impacts away from a linear approach, the approach that has traditionally been adopted, to a systems approach.

This is useful in understanding the complexity and interconnectedness of impacts, how the actions and decision of actors play out within a system, and so how to respond to issues of concern or address priorities (Franks et al., 2013). This approach is conceptually aligned with a landscape approach discussed earlier in this chapter.

2.3.5 Mine Closure

Mine closure is an inevitable part of mining. Mines close for a number of reasons, ideally because the mineral reserve has been extracted. However, economic factors such as a decline in commodity prices, geological reasons such as an unanticipated change in grade, technical and regulatory factors may also be the cause (Laurence, 2006). Mines may also be forced to close by social or community pressures.

Historically when mines have closed they have been boarded up and abandoned. This is no longer appropriate. Mine closure is now an integral part of the mining lifecycle with stringent requirements for environmental remediation, and the need to consider regional social and economic issues. Ideally the closure process should start even before a mine opens, where closure objectives are identified and the mine is planned with closure in mind. Over the life of the operation financial provision for closure is made, progressive rehabilitation is undertaken and the closure plan is further developed, becomes more detailed and implemented where appropriate. Once mining operations cease, site rehabilitation ramps up and monitoring and maintenance get underway. A mining company may relinquish the site once it receives sign-off, usually from government. Ideally the land is released in an accepted, ecologically sustainable state, for other land uses (Lima & Wathern, 1999).

After relinquishment, the company has no further obligations under its mining lease. This is the state to which most mining companies aspire (Butler & Bentel, 2011). It allows the mining company to move on, and the land to be handed back to landowners or local communities and used for other productive land uses (Absolom & Limpitlaw, 2005), as per the mine closure plan, and in line with the understanding that mining is a temporary land use. Although many mines have been closed (ceased operations), there remain far fewer that have been signed off and relinquished (Butler & Bentel, 2011). This is especially the case for large mines (Watson & Olalde, 2019). Even with evolving and improving closure criteria, relinquishment remains elusive (Butler & Bentel, 2011). By way of an example, a 2017 report by The Australia Institute indicated that '*there is no single example of a rehabilitated and relinquished large, open cut mine in Australia*'(Campbell et al., 2017 p. 10). This is also the case in South Africa where mine closure is problematic (van Druten & Bekker, 2017; Watson & Olalde, 2019). While this may in part be attributable to administrative issues it is also true that

restoration is often unachievable, due to the devastating impacts of mining such as the altered hydrology, habitat fragmentation and contamination, as well as climate change, prohibitive costs and other environmental and socioeconomic conditions (Lima et al., 2016). Evidence of a 'closed' mining region without permanent impacts is yet to be demonstrated or predicted with certainty in planning (Sonter et al., 2014).

In addition to the environmental concerns, mine closure also has devastating social and economic impacts (Bainton & Holcombe, 2018). This is especially the case where mining is the major source of employment, income and services for a community. These include the obvious decrease in formal employment, often with the proliferation of informal mining, and the resultant decline in population, significantly amongst working aged men. Settlement patterns also change. This has implications for the municipality and their obligation to provide services. Coupled to this are credit management issues within the municipality, who can no longer rely on rates and taxes paid by the mining houses and from mine salaries, and consequently unable to sustain municipal infrastructure and make adequate capital investment. House prices may also decrease due to low demand (Marais, 2013a; Bainton & Holcombe, 2018). Residents often experience negative health impacts, having to live with poor water quality, river and underground water problems and dust (Smith & Underwood, 2000). These impacts are particularly severe in resource regions were they are magnified by the number, size and dependency of mining (Franks et al., 2013).

Mine closure is an increasing concern as more large mines close or are due to close, but with few case studies of successful closure (Bainton & Holcombe, 2018). There is also a growing trend of major operators divesting prior to closure and passing on the liability to junior operators who are unable to adequately address the impacts (Humby, 2014; Bainton & Holcombe, 2018).

2.4 Conclusion

This chapter reviewed the literature related to landscapes and mining from three perspectives. Firstly the diversity of approaches to studying landscapes and landscape change, then focussing on mining landscapes and the various approaches used to understand these. Finally an overview of mining and how it modifies landscapes was provided.

Although different approaches are taken to the study of landscapes, rooted in different disciplines, there is alignment and benefit from approaching this work from an interdisciplinary perspective to gain the most holistic understanding possible. This is particularly important in our current context where landscapes are undergoing rapid and fundamental change (Plieninger et al., 2015).

Landscapes are important as they provide the base or foundation for human well-being. The composition and configuration of the landscape affect, and are affected by, human activities (Wu, 2013), and if the we are to contribute to sustainable development it is critical to maintain the life-support systems provided by these landscapes (Griggs et al., 2013).

Chapter 3

3. Methodology

3.1 Study design

Using the landscape as the core unit, this study undertakes a descriptive case study of a particular landscape to develop its landscape biography. Through this, an understanding of how and why the landscape changed is gained, identifying the drivers of change and the lessons that can be learnt.

3.1.1 The case study approach

The Free State goldfields between 1945 and 2018 provides a unique opportunity to study the entire lifecycle of mining within a single region over a relatively short period of time. This lends itself to the case study approach. A case study is empirical research that *'investigates contemporary phenomenon (the 'case') in its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident*' (Yin, 2014, p. 2). Although the case study methodology focuses on contemporary phenomena, it does not exclude the recent past where direct observations can still be made and people are alive to be interviewed.

The physical and temporal scope of the case study is limited to the Free State goldfields between 1945 and 2018. Geographically, the Free State goldfields has been loosely defined as an area in the central Free State province, surrounding and including the towns of Allanridge, Odendaalsrus/Kutlwanong, Welkom/Thabong/Bronville and Virginia/Meloding, all of which have been directly and significantly impacted upon by gold mining. This region now falls within the Matjhabeng local municipality of the Free State province. The area has intentionally not been specifically defined by a municipal, environmental or other boundary as it is recognised that impacts and change may extend beyond such a boundary. The 73 year period has been divided into four arbitrary timeframes based on the availability of topographic maps. Although arbitrary, these timeframes align roughly with specific periods in the development of the landscape, i.e. initial development (1945 to 1955), rapid growth (1956 to 1975), stabilisation (1976 to 1997) and decline (1998 to 2018).

3.1.2 Landscape as the unit of study

This research uses the landscape and changes to the landscape to reconstruct the development of the Free State goldfields across the entire mining lifecycle. Through this the factors driving change can be identified and consequences of these assessed. This is based on the understanding that the landscape is the physical manifestation of the interactions between society and the environment over time, and is dynamic. The approach taken is primarily the social-ecological systems perspective,

however the result of the analysis is a landscape biography, which focusses on the role of individuals, groups and institutions, in shaping a landscape.

Figure 5 depicts the social-ecological system, where environment is understood as the physical components, the geomorphology, the natural resources and ecological processes (Roymans et al., 2009; Palang et al., 2011; Plieninger et al., 2015). Society includes various interdependent and interacting subsystems. These comprise individuals, groups and institutions, their values, activities and the systems within which they interact, including political, economic and land use systems. Society is not homogenous, with different parts of society interacting with the environment differently depending on, for example, cultural background, scarcity and accessibility of the services provided (Plieninger et al., 2015). Society is also not static and so the way society interacts with the environment may change over time (Roymans et al., 2009). An acknowledged critique from the social sciences is that research on social-ecological systems undertheorizes social entities. There is rather an emphasis on institutions, economic incentives, land use, population, social networks, and social learning. However, they conclude that the concept of social-ecological systems remains relevant because of the central insights concerning the dynamic coupling between humans and the environment, and its relevant critique about the need for multidisciplinary approaches to solve real world problems, (Stojanovic et al., 2016).

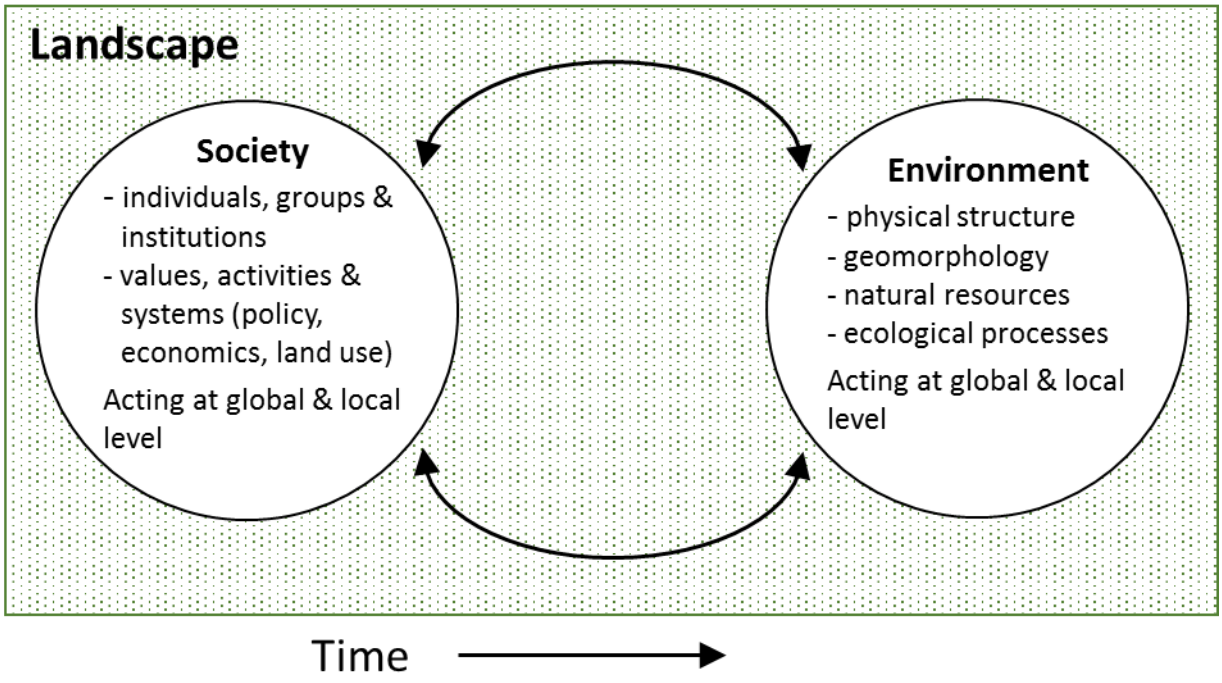

Figure 5. The landscape is the expression of the interactions between society and the environment

The resulting changes to the landscape can be observed through changing land cover and land uses. Land use represents the interaction between people and their environment and is used to assess the causes and consequences of land use change (Sonter et al., 2014). However, changing spatial patterns provide only a partial understanding of the system. In order to have a holistic understanding of the processes driving these changes, a combination of physical, ecological, social and cultural factors, should also be studied (Campos et al., 2012). These processes are the drivers of change.

The outcome of an application of this approach is the story of a resource region seen through the lens of its landscape, its landscape biography. As defined by Palang (p. 345, 2011), a landscape biography is '*both a description of the history of the material landscape and of the world of social meanings and individual ideas grafted onto that landscape during various periods*' and is an opportunity to combine the three aspects of landscape together – the physical, the social and the individual dimension.

3.1.3 Conceptual model

A conceptual model has been developed to frame this descriptive, cross-disciplinary case study. A conceptual model is an abstraction of reality and provides the context for the research by illustrating the key concepts representing it and the relationship between them. The development of this model was informed by the various approaches to studying landscape change and social-ecological systems discussed in the literature review, and the specific context of the case study.

As illustrated in Figure *5*, but using the terminology proposed by Franks et al. (2013), actors, decisions and actions, the *impact drivers*, interact with the environment and form a complex system of dependencies, interactions and feedback loops over several temporal and spatial levels, creating and modifying the environment, or *impact domain*. These are the first two components of the conceptual model. The impact drivers are either natural, political, economic, cultural or technological in nature (Bürgi et al., 2004) and may act directly on the environment (proximate drivers), or be fundamental social and natural processes that underpin the proximate drivers (underlying drivers) (Plieninger et al., 2016). Drawing on the work of Plieninger et al. (2016), five major impact drivers, specific to this case study, have been identified through a review of the maps and the literature, and included in the conceptual model. These are not the only impact drivers influencing the system, but in an attempt to model it, only the most significant drivers are included. The impact drivers are not only land uses, but also refer to decisions and institutions related to these land use activities.

The original land use in the Free State goldfields, which has persisted over the entire period under study, is **agriculture**. Agriculture persists over the time period studied although there are some changes in the extent, location and intensification of agricultural development. It is therefore one of the identified drivers of change. The second driver is the extraction of non-renewable resources, or **mining.** Following the discovery of gold, the development of a number of mines rapidly changed the landscape, and to some extent underlay other drivers, one being urban and infrastructural development. The mines required labour, power, water and transportation networks and so the need for the development of settlements and the establishment of other supporting infrastructure, the third driver of change thus being **urban and infrastructure** development. The two underlying drivers of change included in the conceptual model are natural and spatial factors and political and legislative factors. **Natural and spatial** factors as a driver of change illustrate how the physical landscape facilitates certain activities happening, or not, and so also influences change. These are environmental factors and include topography, climate, soil characteristics and natural disturbances. **Political and legislative** factors are the fifth key driver of change. As discussed in the literature review, governments, through developing policies, plans, zoning and providing incentives or disincentives on a range of land use activities, drive landscapes change (Hersperger & Bürgi, 2010). Over the period of study, political and institutional factors in South Africa and internationally have had a significant role in driving landscape change, apartheid spatial planning being a key example.

The conceptual model (*Figure 6*) illustrates these five impact drivers. These influence the impact domain, which may in turn also constrain the impact drivers, to a lessor or greater extent, as indicated by the bi-directional arrows. The impact drivers are also not isolated from one another and do influence each other (the dependencies, interactions and feedbacks mentioned above). This is depicted by the hatched lines between the different impact drivers. The timeframe chosen for this case study, 1945 to 2018, is also indicated in the conceptual framework. This timeframe is largely practical, based on a time period for which data is readily available. However, it covers the entire lifecycle of mining. The outcome of these various interactions shape the landscape, the lens through which this case study is viewed.

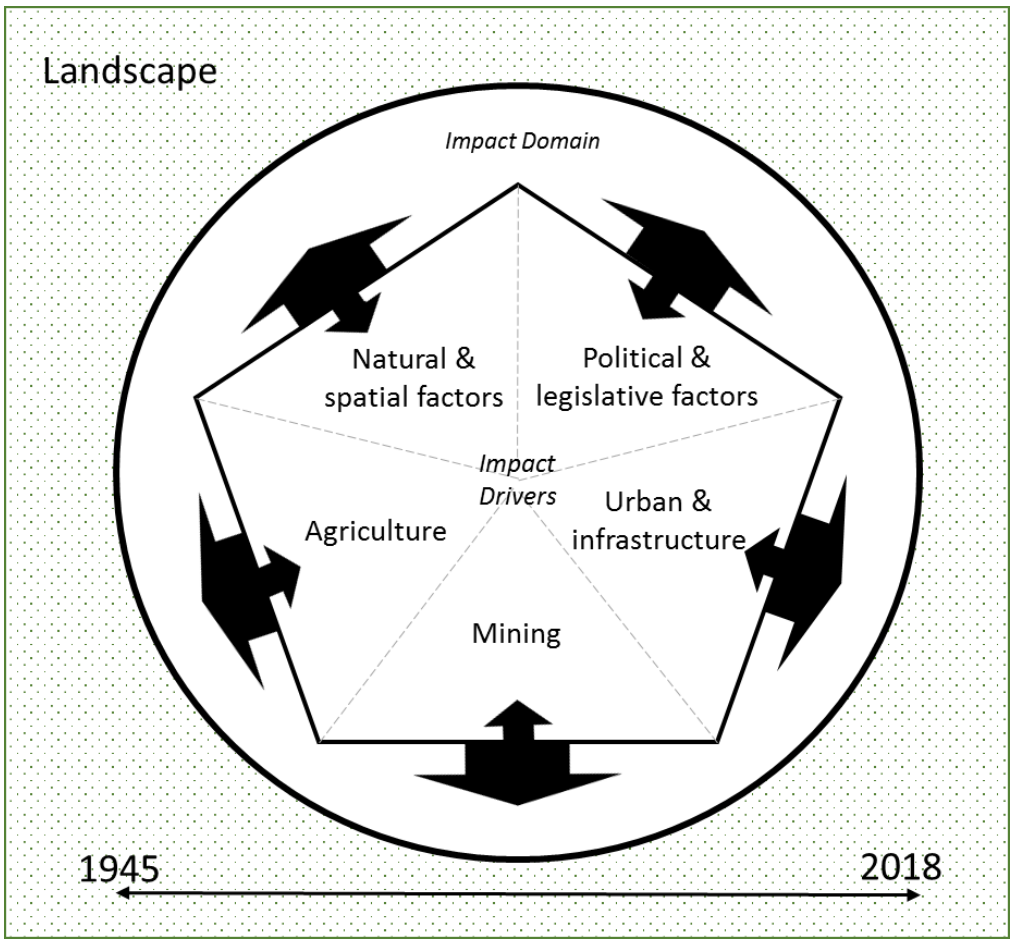

Figure 6. The conceptual model developed for this research

3.2 The data collection process

Documenting this case study required both qualitative and quantitative data from a variety of historical and contemporary sources. A benefit of this mixed methodology approach is that the combination of qualitative and quantitative data provides a richer understanding of the issues than either approach used alone. With two or more sets of data, data and results can also be validated.

As a study of a geographical region, the foundational data was a set of four 1:50 000 topographical maps extending over five timeframes. A review of various documents and records, supported by observations from field visits and interviews with local residents, provided contextual data which allowed for the development of the case study. As described by Yin (2014) a case study is '*a linear but iterative process*', and this was the case with the data collection. Changes noted on the maps required explanations from the literature or interviews, and similarly where the literature indicated changes, these needed to be identified on the maps and verified on the ground. More detail on the various sources of data is provided below.

3.2.1 Maps

The primary source of data was cartographic and included a range of different maps, aerial photographs and Google Earth images. Comparing maps of different dates allowed for the identification of change.

The 1:50 000 topographical maps provided the principal source of cartographic data. These maps were based on aerial photographs and printed by the relevant government authority of the time. Some time would have elapsed between the original aerial photograph and the final map being published, both these dates are included on some of the maps. A standard 1:50 000 map sheet covers a rectangle of 15 minutes of latitude by 15 minutes of longitude or approximately 640 km^2, and uses a Gauss Conform projection, with the central meridian of 27° E. The map system of the earlier maps (up to and including 1975) was Clarke 1880 spheroid, with WGS84 spheroid on the more recent maps (from 1997).

The 1:50 000 topographical maps listed in *Table 1* were obtained from the South African National Geo-Spatial information (NGI) services and Wits University library archives. Unfortunately the first edition of map 2726DC Odendaalsrus was no longer available from the NGI or any of the archives reviewed.

Table 1. The 1:50 000 topographical maps used to determine landscape change in the Free State goldfields

Map title	Map edition, date				
2726DC Odendaalsrus		2nd, 1955	3rd, 1975	4th, 1997	5th, 2009
2726DD Riebeeckstad (1st edition - Braunzynkop)	1st, 1946	2nd, 1955	3rd, 1975	4th, 1997	5th, 2009
2826BA Bloudrif (1st edition - Blaauwdrift)	1st, 1946	2nd, 1957	3rd, 1976	4th, 1997	5th, 2007
2826BB Virginia	1st, 1945	2nd, 1957	3rd, 1975	4th, 1997	5th, 2007

These maps depict a range of landscape features, including farm boundaries, natural features (e.g. drainage channels, pans, elevation), different land uses (e.g. cultivated land, mines, settlements), infrastructure (e.g. road and rail network, powerlines) and community services (e.g. schools, churches, post offices, police stations). For each time period, four land use classes were digitised across the four map sheets to summarise the land use change over that time period. The land use classes are slimes dams (tailing storage facilities), settlement (town) for the white settlements, settlement (township) for the black settlements and mine land. The latter class includes all land used by and under the control of the mines. This includes evaporation plans, but excludes the tailings facilities (which are listed as a

separate class). The final maps were annotated and are included at the end of each chapter as a summary. These maps are projected in UTM 34S.

Table 2. The aerial photographs used to provide additional information

Date	Job No.	Scale
1944	78 and 80	1:20 000
April – June 1963	490	1:36 000
May – August 1968	606	1:20 000
May 1986	899	1:150 000

Aerial photographs (Table *2*) covering the same area as the topographical maps for 1944, 1963, 1968 and 1986 were also obtained and used. These, together with the 1:250 000 topo-cadastral map sheets for 2726 Kroonstad (for 1943, 1973, 1986, 1997, 2003 and 2010) and 2826 Winburg (for 1972, 1986 and 2004) provided additional contextual information. For more recent time periods, Google Earth images were used to identify changes to the landscape. The earliest Google Earth images for the area are from December 1984.

Annotated maps, aerial photos and Google Earth images are included as figures in the biography to provide orientation to the landscape and illustrate change.

3.2.2 Documentation and records

In order to identify the actors, decisions and actions that have driven the observed landscape change in the Free State goldfields over the period of study, various documents and records were accessed and reviewed. The primary sources are listed in *Table 3*.

Table 3. Documents and records reviewed for each impact driver

Impact driver	Examples of documents and records
Agricultural development	Agricultural production figures Previous studies and academic publications
Mining development	Technical and academic publications Project reports Company reports and publications, particularly for Anglo American Corporation for the early years and Harmony for recent times Production and employment figures Gold price Individual company and Chamber of Mines annual reports Government documents – Annual report, policy documents, legislation Mine closure plans

Urban & infrastructural development	Local newspaper articles Biographies of residents and others involved in the development of the region Census data Municipal reports and publications Minutes of development organisation meetings Historical photographs Student research reports
Natural & spatial factors	Weather data Biographies Maps and aerial photos
Political & legislative factors	Legislation Government reports Spatial development plans Integrated Development Plans

Literature was obtained from internet sources, university, municipal and company libraries and directly from companies and government. Included in these sources are historical accounts and it is acknowledged that these are the perspective of the authors and so may reflect a particular perspective or bias. Census data for the entire time period was obtained from Statistics South Africa and weather data from the South African Weather Services.

3.2.3 Observations

Observation as a research tool allows for the collection of contemporary data from the case study site and seeks to answer the question 'what is going on here?'(Yin, 2014). Observation also allows for a better understanding of the context. Over the period of this research four field trips were undertaken to the study area, in October 2015, March 2016, October 2016 and October 2017. These field trips allowed for orientation to the entire study areas, direct observations of economic, social and environmental conditions, ground truthing of what was observed on the maps and found in the review of documentation, and detailed observation of specific locations of interest. During the field trips each of the four major settlement areas in the Free State goldfields and the current and closed mine sites were visited. More detailed and extended visits were made to Virginia and Meloding (October 2016) and Odendaalsrus and Kutlwanong (October 2017), which included 'walkabouts' through the settlements, interviews with key informants and visits to the respective municipal libraries where documents and newspapers on the history and development plans for the settlements were reviewed.

Observations were unstructured and focussed on the lay of the land - how things are organised, the layout, form and state of settlements, location of the mines and their current status, the state of

public infrastructure, evidence of other land use activities and signs of pollution and environmental degradation. Observations were documented in field notes and photographs. Initial impressions, conversations with residents and issues to investigate further or follow up on, were also noted.

3.2.4 Interviews

The experience of long-term residents of the Free State goldfields added a further level of detail to understanding the landscape changes in the area and the implications of this for them and the future of the region. Key informant interviews were conducted with long term residents of Virginia and Meloding, and Kutlwanong. These were either in the form of small group interviews (two to four people) or with individuals, as reflected in Table 4. An initial group interview of seven people was useful in highlighting the main issues. In total 31 people were interviewed, these included long-time residents of Meloding, Virginia, Welkom and Kutlwanong, retrenched and retired mine workers, including an ex-mine manager and two local business owners. The interviewees were a mix of male and females and population groups. Interviews lasted on average an hour and were conducted in the language of preference to the interviewee (English, Afrikaans or Sesotho). The interviews were recorded, transcribed, and where necessary translated into English. Prior to this, ethics clearance was obtained from the Wits Human Research Ethics Committee (non-medical), protocol number H16/04/22 (included in Appendix 1). The interview material, including the participant information sheet, consent forms and interview guide, are included in Appendices 2 to 5.

Table 4. Number and location of interviews

Interview no.	Number of people	'Category' description	Location
1	7	Long term residents, ex-mine worker	Meloding
2	1	Long term resident, school teacher	Meloding
3	1	Long term resident	Meloding
4	1	Long term resident	Meloding
5	1	Long term resident	Meloding
6	2	Long term resident	Meloding
7	3	Long term resident	Meloding
8	1	Long term resident	Meloding
9	4	Long term residents, ex-mine workers	Meloding
10	2	Long term resident, ex-mine worker	Virginia
11	1	Long term resident	Virginia
12	1	Business owner	Virginia
13	1	Ex-mine manager	Virginia
14	1	Business owner	Welkom
15	2	Long term residents	Kutlwanong
16	1	Long term resident, evictee	Kutlwanong
17	1	Long term resident	Kutlwanong
	31	**TOTAL**	

The intention was to interview more resident in Kutlwanong, however this proved difficult. As will be discussed later in the research the community of Marobe were forcibly removed to Kutlwanong in the 1950s, the only forced removal to have taken place in the Free State. The original residents lodged a successful land claim, where claimants were paid out. However, there are various issues around this payment, with some indicating the full amount was not paid out and so are still waiting for payment of the balance. This has caused a level of distrust within the community and a general unwillingness to discuss the history of the township.

3.3 Approach to data analysis -review

As part of the landscape biography, changes over four time periods are described and an explanation for these changes built. The explanation is based on the identification of changes to the landscape and the drivers of change in any particular time period. In the description of landscape change and identifying the drivers of change, aspects of both the approach taken by Francaviglia (1991) and the methodology described by Bürgi et al. (2004) will be used. Francaviglia (1991), in his work on mining landscapes, starts by 'reading' the landscape - observing, identifying and describing the different features of mining landscapes. Having 'read' the landscape he then 'interprets' it through understanding the processes and forces that have shaped them. This is similar to the '*standard procedure to study driving forces of landscape change*' used by Bürgi et al. (2004, p.865). Their three-step approach is rooted in general systems theory and involves system definition, system analysis and system synthesis. The approach used is detailed below:

Step 1. System definition

During this step the system under study is clearly defined, including the study area, its extent and the grain of the study, the study period and the temporal resolution, and the landscape elements of interest. For the mapping work, the grain of the study will relate to landscape features that are visible on the 1:50 000 topographical maps (i.e. landscape and landscape element level). However, the other data will allow for descriptions at a more local level. In terms of the institutional scale, the activities and decisions of individuals, groups and organisations from both within and outside the area, the community and the state will be considered. Where global institutions and events drive change, these will also be identified and discussed.

The study period extends from when payable gold was discovered in the Free State and the first mines were built (1945) to 2018. This 73 year period is broken down into four timeframes of roughly 10 years (for the first time period) and 20 years (for the remaining periods), dictated by the

availability of topographical maps and aerial photographs (1945 to 1955, 1956 to 1975, 1976 to 1997, and 1998 to 2018).

The main landscape elements of interest are aligned to the impact drivers and include the mines (including mining infrastructure, tailings storage facilities, evaporation pans, mine hostels), settlements (including infrastructure associated with settlements e.g. roads, recreational facilities, water treatment works, airport), regional infrastructure (including road and rail network) and agricultural land (arable and grazing land, irrigation canals). Additional context to the system is provided in Chapter 4.

Step 2: Reading and analysing the system

The interactions between society and the environment results in change and persistency of physical landscape elements. These, the actors and institutions, and the driving forces are identified and analysed – Francaviglia's 'reading; of the landscape. In this research landscape change and persistency was assessed through the manual pair-wise comparison of the four 1:50 0000 topographical map sheets (e.g. 1955 with 1945, 1975 with 1955, and so on) noting the physical changes in each of the landscape elements. Parallel to this, a historical chronology (timeline) of important events and decisions related to each of the five impact drivers was developed. This was based on a detailed review of documents and records, observations and interviews. Through this process the actors and institutions were identified. The changes noted on the maps were then matched with events on the timeline to develop the outline of the landscape biography. This was elaborated upon, drawing on the conceptual framework and the various sources of data. The landscape biography is presented over the four time periods in Chapter 5 to 8. This addresses research objectives 1 and 2.

Parallel to this, the current reality of long term residents and future plans for the region, as depicted in Mine Closure Plans, Social and Labour Plans (SLPs) and the municipalities Integrated Development Plans (IDPs), were reviewed. Plans for the region developed by Provincial and National government were also review. This is presented in Chapter 9 and addresses research objective 3.

Step 3: System synthesis

In the final synthesis, the entire system is assessed and the actors, institutions, and driving forces are linked in causal relationships and their impact on the landscape elements under study assessed (Bürgi et al., 2004; Hersperger & Bürgi, 2009; Plieninger et al., 2016), and presented in the discussion

in Chapter 10. This allows for a broader understanding of the processes underlying change, leading to the current reality being experienced in the region and the consequences of these for its future. Drawing on the findings from the case study of the Free State goldfields and the landscape biography approach to understanding change, recommendations for the development of resilient resource regions are made. These are presented in Chapter 10 and address research objective 4.

3.4 Limitations

The findings of this study have to be seen in light of some limitations. These are primarily related to the nature of the research and the methodology employed.

As noted by Karstens (2009), the adoption of a particular scale sets the bounds on the types of problems to be addressed, the solutions to be found and the impacts to be evaluated. In assessing landscape change in the Free State goldfields there are various geographic and temporal scales at play and the boundaries of these are not clear or constant. However, specific scales and a broad scope had to be set based primarily on the availability of data and the practicality of doing this research. The use of the 1:50 000 map sheet provides a good level of detail for a study of the landscape, showing for example the individual settlements and their layout and changes to this. However, changes around a mine shaft are not discernible, rather only the presence or absence of the shaft. In this case aerial photographs and Google Earth provide a greater level of detail. As regards the scope, the selection of the four maps sheets detailed above excludes a major mine, Beatrix. The timeframes assessed are also not aligned with major events, but rather the next edition of the map sheets. This illustrates the difficulty in matching socioeconomic, environmental and cartographic data by timeframe and scale (Turner et al., 2007). The frequency of publication of new map editions, every 20 years after 1954, has only allowed for a broad understanding of the progress of change.

Reconstructing the history of a landscape over 73 years requires accessing historical data. However, this data may not always exist, just because it was not recorded, or be unavailable or difficult to locate, influencing the level of detail that the case study can go into. The inability to locate the 1st edition of the 2726DC Odendaalsrus map sheet, for example, means that landscape changes for the key period between 1945 and 1955 cannot be assessed for this important area. Any discussion needs to rely on written accounts. A further issue on data is that there may be only a single source, making verification difficult, or different sources of the same data but which may differ. This was the case with some of the population numbers for the different settlements and employment figures for the

different mines. In such cases either the primary source was used, or both figures notes in the discussion indicating the difference.

Data has also been deliberately removed, which was the case with a number of the 1968 series of aerial photographs covering mines. As just one example, the three images covering the Saaiplaas mine shaft (aerial photographs 606_012_00384 to 606_012_00386) have been removed, with adjacent photographs stamped as 'RESTRICTED/BEPERK', as shown in *Figure 7*. It is presumed that these photographs would not previously have been available to the general public, as is now the case. The 1968 aerial photograph series fits between the 2nd (1957) and 3rd (1975) editions of the 1:50 000 topographic maps and was used to clarify some of the changes observed on the map, firm up on the dates of developments and provide additional detail not depicted on the maps. The absence of these aerial photographs meant this was not possible for the mines.

Figure 7. Access to aerial photo 606_012_00381 from 1968 was restricted

It is also recognised that the reliance on maps as the foundational set of data may introduce some bias. As argued by Crampton & Krygier (2006) mapping has been continually contested throughout its history, and no map is thoroughly objective or value neutral. Maps are representations of reality and the process of map-making requires cartographers to limit content in

order to create a readable map, and through this, whether deliberate or not, manipulate the users with the information they choose to include (Monmonier, 1995). In addition to this there are a number of specific issues as regards the maps used in this study, these include:

- The map dates listed in Table *1* is the year in which they are drawn. However some time elapsed between taking the aerial photographs, on which the map is based, ground truthing, drawing and the publication of the final map. These dates are shown on the earlier maps, for example the 2nd edition of map sheet 2726DC Odendaalsrus was printed in 1956, drawn in 1955 and based on aerial photographs taken in 1952 and a field survey in 1954. This may cause inaccuracies in the development of timelines.
- It appears that in some cases future plans are depicted on maps, this becomes evident when the plans do not proceed. For example the 1975 edition of 2726DD Riebeeckstad show an existing road network on the north eastern side of the settlement. However, it seems that these were only under construction in the 1997 edition. They were depicted as 'tracks' in the 2009 edition. This is illustrated in *Figure 8*. What this means is that some of what is seen on the maps may actually not exist, at least not at the time indicated, causing inaccuracies in the assessment of landscape change and the rate of change.

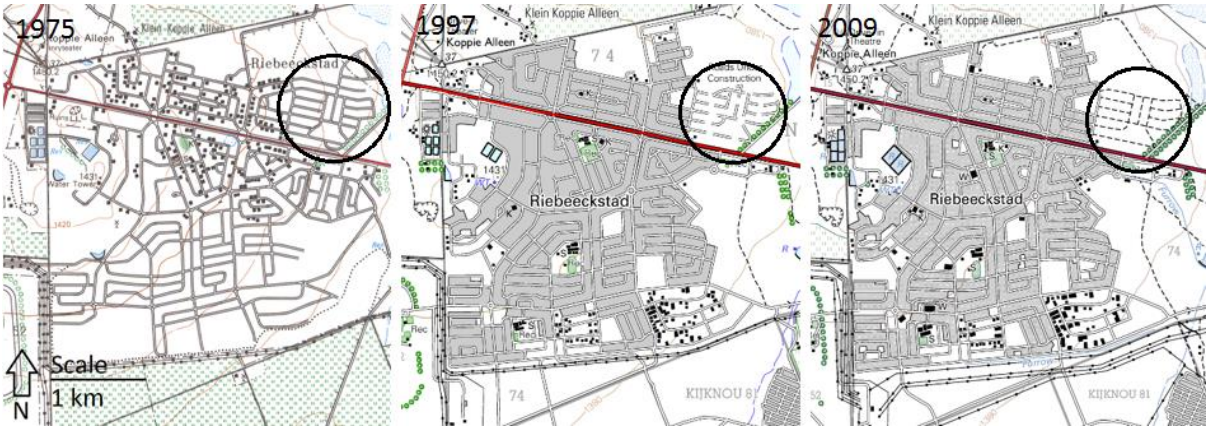

Figure 8. The 1975, 1997 and 2009 editions of map sheet 2726DD Riebeeckstad illustrating how some landscape elements depicted on the maps, in this case roads, may be plans rather than already be in place

- As the maps are based on aerial photographs, the depiction of natural and agricultural features may be influenced by the season in which the photographs were taken. For example, the relative size of pans and wetlands and the year (drought vs flood).
- As already discussed, the choice of scale of the maps, 1:50 000, means that only certain features can be included and in some cases only represented. For example the individual houses and

layout of the township of Marobe (depicted as 'Location' on the 1954 edition of 2726DC Odendaalsrus, *Figure 9*) is not shown. This is in contrast to Odendaalsrus, and would have been valuable context for the description of the forced removals and resettlement to Kutlwanong, as discussed in Chapter 6. A further reason for it being depicted as it is may be the influence of the politics of the time and/or that there was no discernible layout.

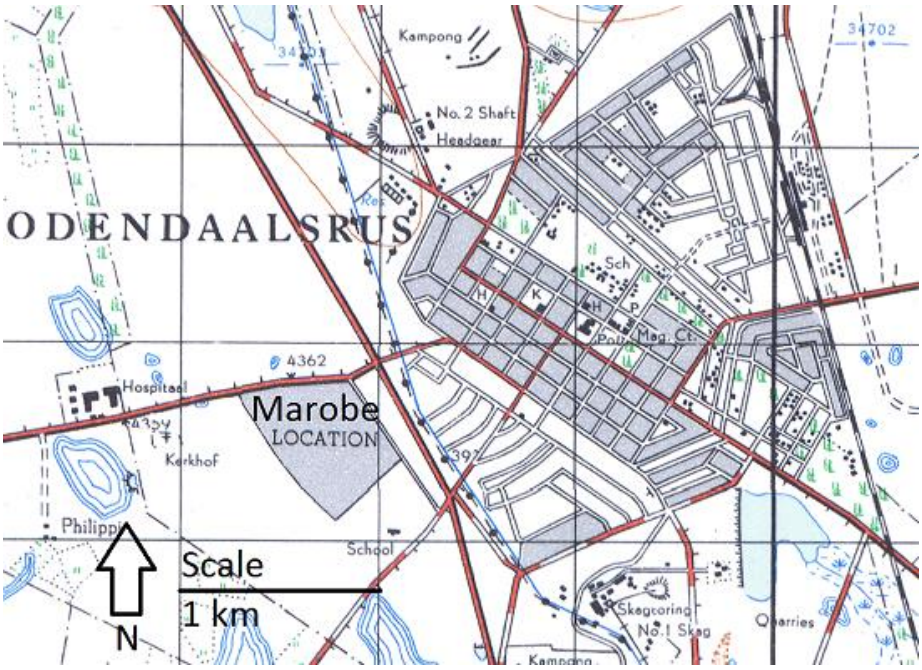

Figure 9. Illustrating how Marobe, the black African 'location' is depicted as a block with no indication of layout on the 1954 version of map 2726DC

A landscape biography requires a cross-disciplinary approach, ideally undertaken by a team of researcher representing various fields of expertise. Although various sources of information and formats of data have been drawn on, this study has been conducted by an individual with a background in environmental sciences. As such there are limitations in the depth of understanding and so analysis of some of the drivers discussed. For example detailed LULC change mapping using remote sensing (RS) for each period and other spatial analysis would have been useful to provide additional data on the quantification of change. However, data for the earlier periods of this study are not available and although RS could be integrated with topographical maps for these periods, this leads to unsatisfactory results and is limited (Ajayi O, 2017). Similarly the use of Landsat imagery is not effective for the type of fine grained analysis involved in this research.

3.5 Conclusion

A landscape biography has been selected as the approach to meet the objectives set for this research. Drawing on various sources of data, primarily cartographic, and supported by literature and interviews with long term residents, the changes to the Free State goldfields landscape between 1945 and 2018 will be described and analysed. This period represents the entire lifecycle of mining for this resource region and includes periods of initial development (1945 to 1955), rapid growth (1956 to 1975), stabilisation (1976 to 1997) and decline (1998 to 2018). Future plans for the post-mining development of the region will also be reviewed. The lessons learnt from this case study will be distilled for application to other developing resource regions.

Chapter 4

4. The Free State goldfields, the pre-mining landscape

This chapter provides a brief overview of the landscape and identified impact drivers immediately prior to the rapid development associated with the discovery of gold (up to 1945). It sets the baseline for this development. It is also the first step in the methodology employed, defining the social-ecological system under review. In the previous chapter the spatial and temporal boundaries of the system, the resolution of the case study and various landscape elements were identified. What follows builds on this, providing some of the context to the future development of the Free State goldfields landscape. Each of the five impact drivers from the conceptual model is discussed, illustrating the different social, technical, environmental, financial and political circumstances that influence the extraction of minerals and associated development (D'Angelo & Pijpers, 2018). Key landscape elements relevant at this time, are indicated in map, *Figure 10*, and discussed in the text that follows.

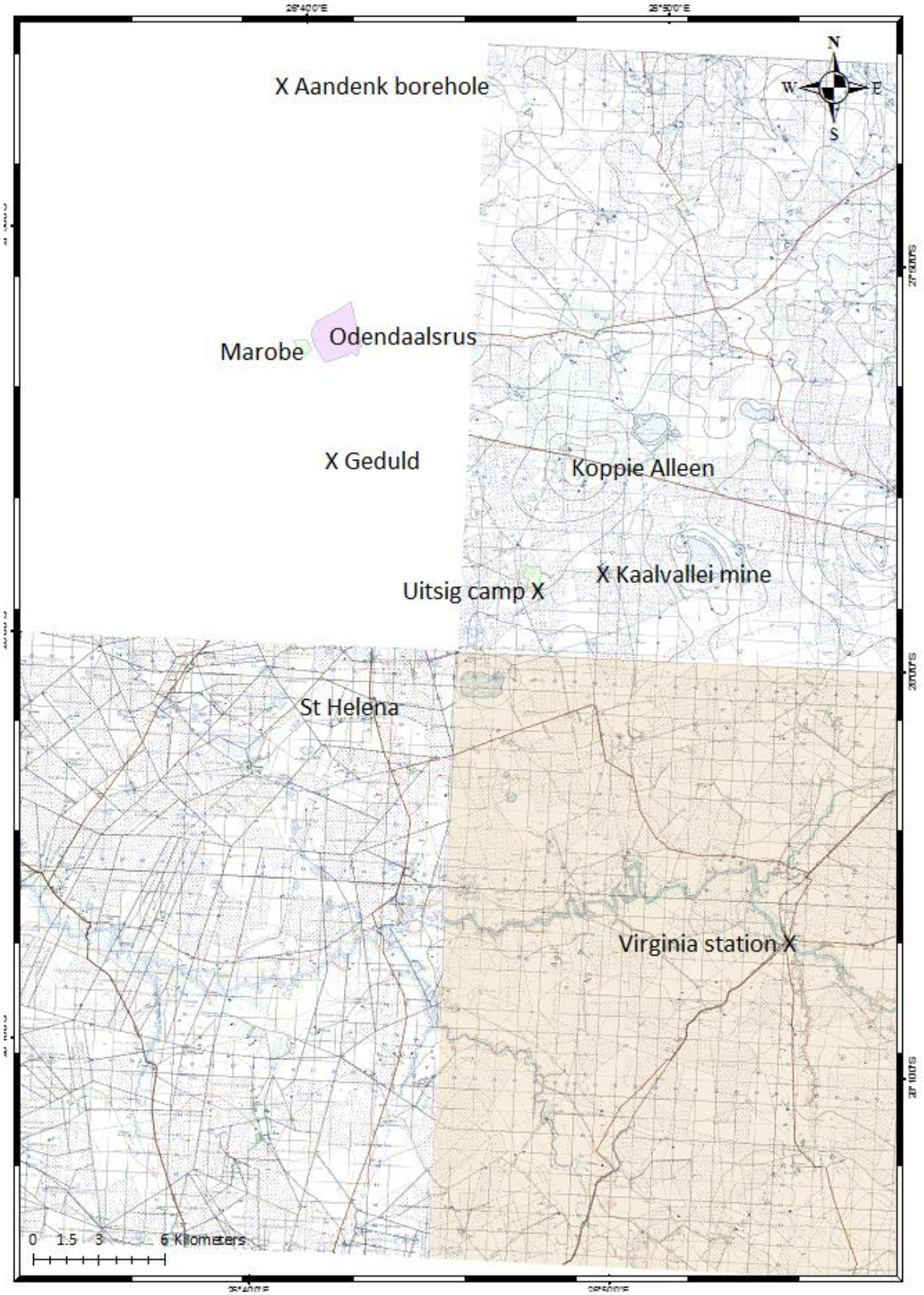

Figure 10. The 1945/46 topographic maps with the key landscape elements discussed in this chapter (maps 2726DD Braunzynkop, 2826BA Blaauwdrift and 2826BB Virginia, map 2726DC Odendaalsrus is not available for this period)

4.1 Political and legislative context

Impact drivers operate at different levels, and this is particularly the case with the political and legislative drivers. In this context, what is happening at a global level, as well as that which is taking place in South Africa and locally, have a bearing on the development of the goldfields. In the context of South Africa, since 1910 it was a Union of the two Boer Republics of the Transvaal and Orange Free State and the British colonies, the Cape and Natal, with strong ties to Britain and the commonwealth. However, the 1939 decision to take South Africa into the Second World War and the disruption the war effort caused, alienated many Afrikaners, ultimately resulting in the election of DF Malan's National Party (NP), over Jan Smuts' ruling United Party, in the 1948 elections (Giliomee & Mbenga, 2007). The election of the NP not only increased the rivalry between the Afrikaner and the English community, but also formalised the policy of racial segregation, known as apartheid (Giliomee & Mbenga, 2007). Both were to provide an important backdrop to the development of the Free State goldfields. Policies that segregated the population were already in place. For example, the 1936 Black Land Act, and the 1923 and 1945 Native Urban Areas Act, resulted in black people being seen as visitors, or 'temporary sojourners' in white South Africa and meant that little planning and development went into black townships bordering white towns as black people where in principle not allowed to settle permanently in these areas (Steyn, 2005).

At the time of the discovery of payable gold in the Free State, mining had already been established as an important industry in the country, and in particular the gold mines as the *'goose that lays golden eggs'* (Border, 1981, p. 338). As such and as discussed in the literature review (section 2.3.2), the 'free-entry' system gave mining pre-eminence with legislation geared to its development and reducing potential obstacles (Watson et al., 2018). This is also demonstrated through the interventions that government would make to support the industry through subsidies, tax relief and other forms of financial assistance, to keep the gold mines open.

As an established industry there were already a number of mining houses operating on the Witwatersrand, with the Transvaal Chamber of Mines representing their interests. Similarly the systems and practices, such as the migrant labour system, had already been set up and so were largely carried across to these new goldfields. Even the legislation, the Transvaal Precious and Base Metals Act, Act 35 of 1908, was used until the Orange Free State Metals Mining Act, Act 13 of 1936, was proclaimed. The latter declaring that the former, and other legislation regulating mining in the Transvaal, would be applicable to the Free State. The Free State goldfields was declared a mining district in terms of this new legislation. Mining rights would be registered at the mining titles office in Johannesburg and were linked to land rights.

4.2 Natural and spatial context

The landscape of the Free State goldfields can be traced back to about 3,100 million years ago, with the onset of sedimentation into the Witwatersrand basin, a shallow-water inland lake. Over a period of approximately 1,200 million years the basin, roughly oval in shape and extending 350km long and 150km wide, was filled with sediments from the surrounding area, creating one of the largest deposits of mineral wealth on earth. Five Supergroups overlie the Archaean basement granites, namely the Dominion, Witwatersrand, Ventersdorp, Transvaal, and on surface, the Karoo (Janisch, 1986) (Figure *11*). The mineral resources tend to be concentrated in tabular reef bands in the Witwatersrand Supergroup (upper Central Rand Group). The most common gold reefs exploited in the Free State are the Basal, Leader, B and A reefs. In the southern area of the Free State goldfields the Beatrix reef is mined and in the north the Elsburg-Dreyerskuil conglomerates (Harmony, 2010). There are a number of geological faults that compartmentalise the area, in particular, the De Bron Fault which divides the goldfields into two main sections along a north-south orientation.

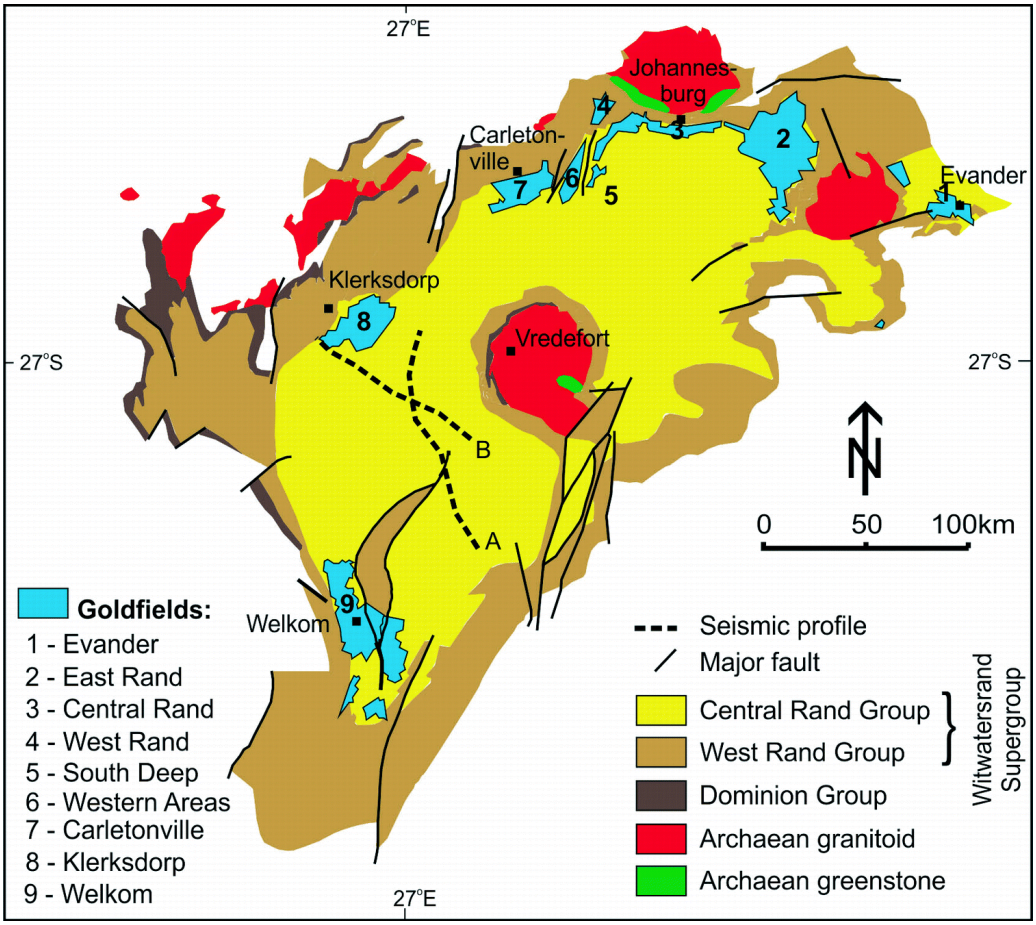

Figure 11. The geology of the Witwatersrand goldfields. The Ventersdorp, Transvaal and the Karoo Supergroups are not shown (Frimmel, 2019)

During Permian-age Karoo sedimentation (deposition the Karoo Supergroup), significant quantities of saline water was trapped beneath the Karoo rocks. Greathead & Graadt van Roggen (1986) indicate that this fossil water was frozen in place during the Dwyka glaciation and so remained under the Karoo rocks. As will be discussed, the significant volume and high salinity of this water (Herold et al., 1996), proved to be problematic for the future development of the mines.

Over the years the surface was eroded leaving the generally flat to slightly undulating topography that is seen today, broken only by drainage lines, the Sand River and the isolated hill, Koppie Alleen. Koppie Alleen, at an altitude of 1,450 metres above mean sea level (mamsl), is a local landmark above the adjacent plains which range in altitude between 1,280 and 1,340 mamsl. The area lies within the Sand River catchment, which joins the Vet River in the south west of the study area, flowing into the Vaal River, at Bloemhof. Characteristic of this area of the Free State are endorheic pans, pans with an inlet but no outlet (see *Figure 12*). These circular to oval shaped shallow depressions in the landscape collect water after rain but dry up seasonally, due mainly to evaporation. The pans in this area of the Free State are part of a pan 'belt' that coincides with an area of less than 500mm mean annual precipitation and extends from the North West Province through the Northern Cape Province and the western Free State to south of the Orange River. In the western Free State the belt runs south-westwards from Kroonstad to Kimberley (Shaw, 1988; Janecke et al., 2003).

The northern Free State falls within a temperate to warm summer rainfall climate with cold, dry winters (semi-arid). Temperatures range between 15^{o}C and 30^{o}C in summer and 1^{o}C and 20^{o}C in winter. The average annual rainfall for Odendaalsrus is 515mm (between 1940 and 2015), but is highly variable with a number of consecutive years experiencing either above or below average rainfall (Cogho et al., 1992). This is associated with the El Nino phenomenon, where in the Free State the rainy season is shorter with less rainfall, influencing crop production (Moeletsi et al., 2011). The climate, and geology/soils supports extensive savannah grasslands which have over the years attracted vast herds of game and sustained settlement by Iron Age farming communities and following them, trekboers (migrating farmers).

4.3 Agriculture

Prior to the discovery of gold the main land use was agriculture. This was in fact the reason for the establishment of white settlement of the area. Initially agriculture focussed on livestock farming, but following the great depression (1930 to 1934) and the great drought of 1932 where much of the livestock and game died, there was a shift to crop farming. As shown in Table *5*, for the larger north-

western Free State region, this shift continued with an overall increase in area under cultivation, but a slightly smaller average farm size, and a diversification from maize to wheat, ground nuts and other crops (NRDC, 1954). The 1944 series of topographic maps shows a patchwork of cultivated fields in amongst natural veld (*Figure 12*).

Table 5. Agricultural production in the north-western Free State (Agro-economic sub-region B5) (source: NRDC, 1954)

	1937	1945
Percent of farm area cultivated	38.7	41
Average farm size (hectare)	668	573
Percent farm income derived from -		
Crops -	74.7	77.9
Maize	73.4	51.2
Wheat	0.1	14.4
Groundnuts	0	9.9
Others	0.9	2.4
Stock -	25.6	22.1
Cattle	10.2	10.1
Sheep	11.6	8
Poultry, Pigs, etc.	3.8	4

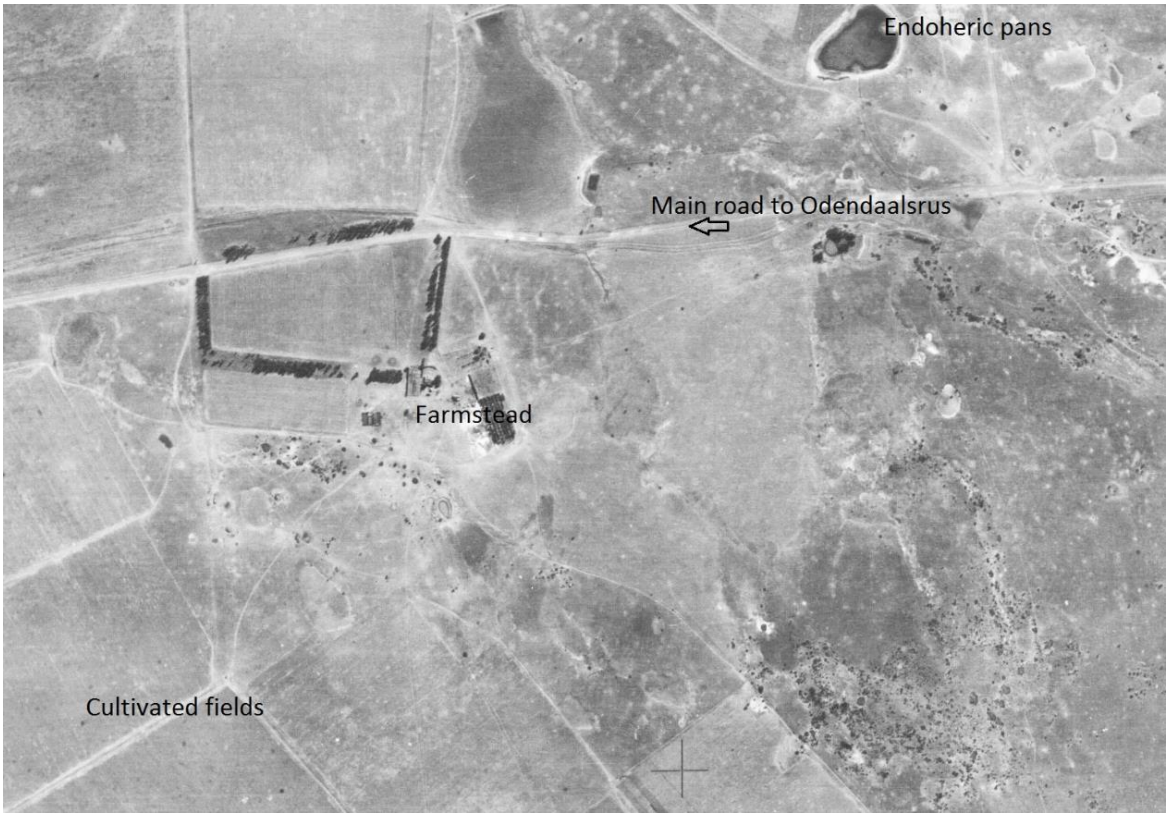

Figure 12. The agricultural area directly to the east of Odendaalsrus in 1944. Showing cultivated lands, endorheic pans and farmstead (aerial photo 78_041_02248)

Also evident on these early maps and aerial photographs are the layout of the farms, with fenced boundaries, homesteads and farm workers huts and a number of wind pumps. There are also a number of prospecting boreholes shown. The farm boundaries and the names of the farms are important elements of the landscape, as they endure with the development of mining. These boundaries are also applicable to the mineral rights, with many mines being named after the farms on which they were located.

4.4 Urban and infrastructural development

Remains of stone-walled settlements along the Sand River on the farm Vaalbankskuil, dating from the early 1800s indicate the early settlement of this landscape by Leghoya, ancestors of the present day Basotho people (Viljoen, 1994; Dreyer, 2001). At much the same time the first European settlers, the Voortrekkers, crossed the Orange River into what they later declared the independent Orange Free State. These trekboers had left the Cape Colony which was under British rule to seek a place of their own. This they found on the plains of the Free State. Whittle (1987, p.4) in his history of Odendaalsrus, describes the arrival of the first trekboer, a Mr Huyzer, to the area around 1870, '*When the trekker saw that the plain was vast and fertile, with water and game in abundance, he decided that he had reached the end of his months' long journey. He had arrived at a place where he would establish a new home and where he would live in accordance with this free, unfettered nature'*. Mr Huyzer established the farm Kalkkuil, which would be sold to a Mr Odendaal in 1878 and on which Odendaalsrus, 'the mother town of the Free State goldfields' would, in 1899, be established (Whittle, 1987).

Contemporary to this was the development of the railway line from Cape Town to the newly established goldfields of the Witwatersrand. This reached and crossed the Sand River in 1892. After the station was built a store was established and later a school. The collection of houses round the station became known as Virginia, apparently named by Major Louis Seymour, an American mining engineer responsible for railway construction during the Anglo Boer war. However, the name was never registered and the town had no official standing (Cartwright, 1962).

With the outbreak of the Anglo Boer war in 1899 the landscape was laid bare. As described by Deneys Reitz from atop Koppie Alleen in 1901 '*It is a curious isolated hill visible for sixty miles around. As a boy I used to sit on its summit watching the game-covered plains below, and now, as then, great herds of antelope and troops of wildebeest were grazing at its foot. I climbed to the top, partly for old times' sake and partly to see whether the land was clear, but there was no need for anxiety, as we were in empty country. The farmhouses stood abandoned, the fields lay unploughed,*

and we saw neither human beings not domestic animals, even the Natives had fled. We rode through this unpeople waste until, some days later, we fell in with a party of Freestaters near the Sand River railway bridge' (Reitz, 1948, p. 180). This railway bridge had been blown up by the Boers on 10 May 1900, but was temporarily repaired and opened to traffic on 16 July 1900, with permanent repairs in the form of a new central support pillar visible in Figure *13*, completed by May 1901 (Viljoen, 1994).

Figure 13. The original railway bridge across the Sand River in October 2015. The second support was repaired having been blown up in 1900 (Source: Author)

Following the Anglo Boer war, people returned to the land and the settlement of Odendaalsrus (originally Odendaalsrust) was officially proclaimed in 1912. The town had 201 surveyed ervan and a dam to supply water, when there was water in the dam (Whittle, 1987). The closest towns were Hoopstad, 96km away and Kroonstad and Winburg, both 85 km away. At this time there were 175 white residents (51 adult men, 49 adult women and 75 children) (Whittle, 1987), with a small black township, Marobe, situated on the western side of town (*Figure 14*). Jacobsson, (1948, p.53) described the Odendaalsrus of 1946 as a '*straggling settlement typical of the Free State*', consisting of the market square and municipal offices, the Dutch Reformed Church, one school, one post office, one hotel, and a few general stores, sandy tracks for streets, few pavements and no public lighting system. There was one medical practice, one registered district nurse, no chemist and no hospital. The fortunes of the village were closely linked with that of maize farming (Fleischer, 1968).

Figure 14. The settlements of Odendaalsrus and Marobe in 1944 (aerial photo 78_041_02252)

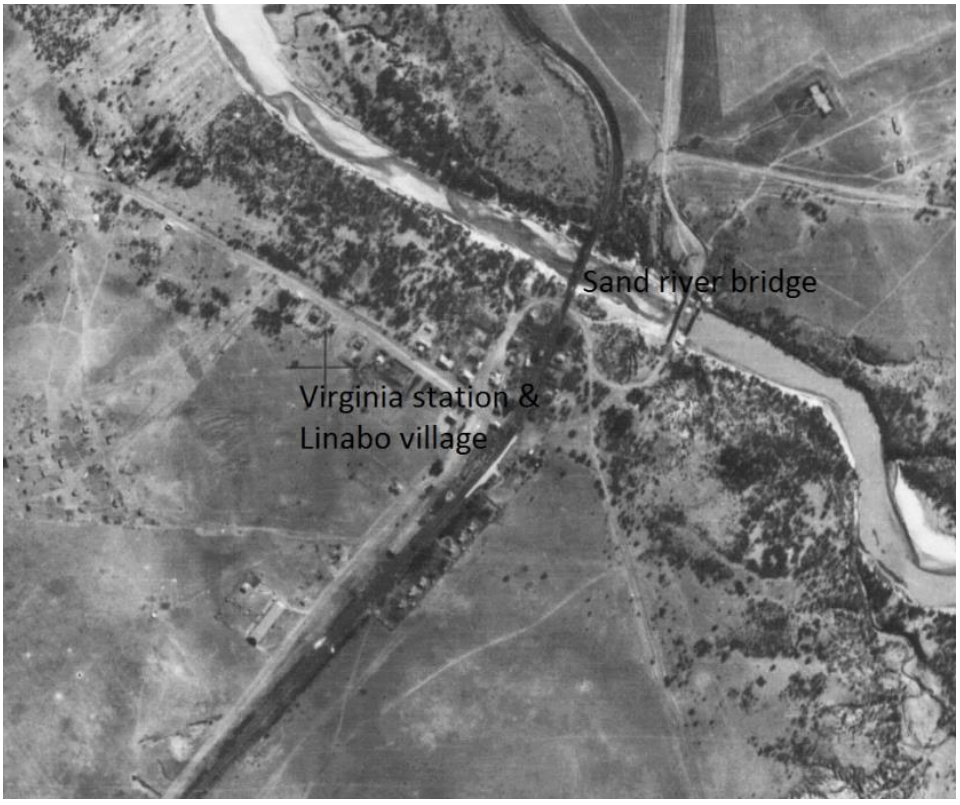

Figure 15. The settlement of Linabo, around the Virginia station on the banks of the Sand River in 1944 (aerial photo 80_007_00645)

The settlement around the Virginia station had also grown, this became known as Linabo (*Figure 15*). By the mid-1940s it consisted of three clothing shops, a post office (Figure *16*), two schools (one for black and the other for white scholars), with a population of 170 white resident in 20 houses and around 200 black residents (Viljoen, 1994).

Figure 16. The original Linabo post office in October 2016 (note the tailings storage facilities in the background) (Source: Author)

By the early 1940s the landscape of the Free State goldfields was already starting to be transformed with drill rigs working across the region, the establishment of the Uitsig camp and expansion of Odendaalsrus. But the area was still very remote with the closest tarred road being 48km away and the general standard of roads in the area poor (NRDC, 1954). There was no local electrical power and no power-grid, with the only accessible large-scale power source at Vereeniging 193 km away. As stated in a report by the Natural Resources Development Council '*This was an unpromising stage for the enormous developments that were soon to be witnessed*' (NRDC, 1954, p. 16).

4.5 Mining

Mining was not entirely new to the region, diamond and limestone mining were other, albeit very small, land uses prior to 1945. The Kaalvallei diamond mine is located 7.5 km east of the current day Welkom. Diamonds were first discovered here in 1890, the kimberlite was mined until the start of the Anglo Boer war in 1899. Mining resumed after the war but the miners encountered a major aquifer which flooded the mine and it closed as a result. Kaalvallei has been mined on and off until

the early 1990s (Field et al., 2008). Further along the railway line from the Virginia siding was the settlement of Whites, where limestone was mined by White's South African Portland Cement Co. Ltd (NRDC, 1954).

4.5.1 The discovery of gold

The discovery of gold in the Free State was a series of fits and starts. During the wave of prospecting that followed the discovery of gold on the Witwatersrand, outcrops of quartzites and conglomerites were detected south of the Vaal River near Klerksdorp and on the farm Aandenk, about 13 km north of Odendaalsrus. These were drilled in 1896 and ore was discovered which yielded up to 227 grams of gold to the metric tonne. After these results, a Mr Donaldson and Mr Hinds sailed to England taking samples of the ore, with the purpose of forming a company to mine the gold. The ship, the Drummond Castle, sunk and with it the early dreams of gold in the Free State (Fleischer, 1968).

In 1904 the prospector Archibald Megson sunk a pit on Aandenk, which, nearly 30 years later, was revisited by Allan Roberts. Roberts, pursuing his belief that the Witwatersrand basin extended south into the Free State floated the company Wit. Extensions Limited in August 1933. Wit. Extension took out options and started drilling on the farm Aandenk later that year. However, the company ran out of funds and ceased drilling in February 1935. They did not find payable reef but they did establish the geology of the region – the borehole passed through the Ventersdorp lavas and entered the Witwatersrand quartzites of the Elsburg series. They struck a reef carrying gold, but not the Basal Reef, which was only reached once the Anglo American Corporation (AAC) extended this borehole by a further 122 metres in 1945 (AAC, 1950). Roberts was convinced that there was gold and apparently left Odendaalsrus predicting that *'Someday, someone who believes and has faith, shall come forward and the drill will again start eating deep into the earth. Eventually the earth will give up its treasures*' (Roberts, 1984).

Following confirmation of the geology, various other mining interests took out options on land surrounding Aandenk. As the gold bearing rocks did not outcrop, only borehole drilling could show whether payable gold reefs lay below the surface and the heavy cover of barren rocks, and this is why we do not see the same 'gold rush' that took place in the Witwatersrand. The discovery of gold in the Free State and subsequent development was largely due to a combination of geophysics and targeted drilling, which required significant funding. Following experience using geophysical methods along the Western Reefs, Western Holdings undertook magnetometer surveys in conjunction with gravimetrics over their ground holdings south of Odendaalsrus starting in 1937.

From this they were able to successfully distinguish between the Lower Witwatersrand, Upper Witwatersrand and Ventersdorp Systems. Other companies soon followed suite, initiating geophysical surveys of their own (Greathead & Graadt Van Roggen, 1986). As correctly summed up by AAC (1950, p.4) '*The discovery of payable gold reefs at workable depths in the Orange Free State was not just a happy chance: it was the result of prolonged and persistent scientific exploration, backed by vision and courage'.*

Drilling started at numerous points over a wide area, but payable gold was first discovered in 1938 on the farm St Helena, which was drilled by Union Corporation working with Western Holding. They later intersected the Basal reef in April 1939 (Fleischer, 1968; Greathead & Graadt Van Roggen, 1986). These discoveries created a sensation in the mining world with results indicating that a shaft sinking and development programme would be justified (Fleischer, 1968). Timing was unfortunately an issue. With the outbreak of World War II manpower and capital were in short supply and while developments continued, it was at a slower pace. In 1941 the government granted a mining lease over the St Helena block, the first gold mining lease in the Free State, and the St Helena Gold Mining Company was floated to develop the property (Fleischer, 1968). Prospecting continued and was centred on the Uitsig camp, which was established in 1942 and consisted of eight houses and a boarding house, a recreation club and office block (AAC, 1957). This was later to become part of the President Steyn Gold Mining Company lease.

Post-war developments of the Free State got off to a '*Big Bang'* (Jacobsson, 1948, p.15) with the Geduld No.1 borehole, about 4 km from Odendaalsrus which yielded an '*almost incredible assay of 22967 inch-dwt'* (equivalent to 90,719.65 g cm) (Greathead & Graadt Van Roggen, 1986, p.214). This mine would go on to produce 12% of the free world's gold, with Welkom producing 35% of the country's gold (in 1968) (Fleischer, 1968). Property prices in Odendaalsrus also shot up from £50 to as much as £12,000 within a week (Greathead & Graadt Van Roggen, 1986). This was also the case with the surrounding farm land, which changed hands and was sold to companies with mining prospects. People from all over South Africa descended on Odendaalsrus in search of employment, living in corrugated iron huts, tents and caravans. The town council could not keep pace with development and had limited funds, but they were assured that Odendaalsrus would be at the centre of a number of large, wealthy mines (Whittle, 1987).

4.5.2 The gold price

The gold price is a key factor in the fortunes of the gold mining industry, and will be one of the threads followed throughout the discussion of the Free State goldfields. Prior to 1931 most Western powers implemented the gold standard, where their currency was pegged to a fixed amount of gold. However, in September 1931 the United Kingdom abandoned the gold standard and devalued their currency, pound Sterling. Initially South Africa, a commonwealth country at the time, did not follow suite as the economy was reasonably stable due to the continuing strength of the gold-mining industry. However, sectors other than mining, specifically agriculture, started to suffer from the overvalued South African currency (Sander, 2000). The Gold Producers Committee of the Chamber of Mines, based on an in-depth study, concluded that the benefits of leaving the gold standard would outweigh the disadvantages, with marginal mines standing to benefit significantly if the South Africa Pound was devalued. In December 1932 South Africa also departed from the gold standard (Sander, 2000). Suddenly freed, the price of gold doubled overnight, and continued to rise over the next five years (Chilvers, 1948). This saved a number of marginal mines (Border, 1981) and provided the incentive to extend and intensify the search for new, low grade gold mines (Chilvers, 1948; Gregory, 1962; Greathead & Graadt van Roggen, 1986), the Free State goldfields being a consequence.

Following World War II, in 1944, the Bretton Woods agreement was signed by the Allied Nations which set the framework for the post-war international monetary system. This reinstated the gold standard and pegged the price of gold at USD35 per ounce, which was to last for roughly 25 years (Handley, 2004). Subsequent to this, as depicted by *Figure 17*, the gold price fluctuated bringing boom and bust to the Free State goldfields. The gold price is given in US dollars per troy ounce. For South African producers the Rand-Dollar exchange rate would influence, positively and negatively, the actual price obtained.

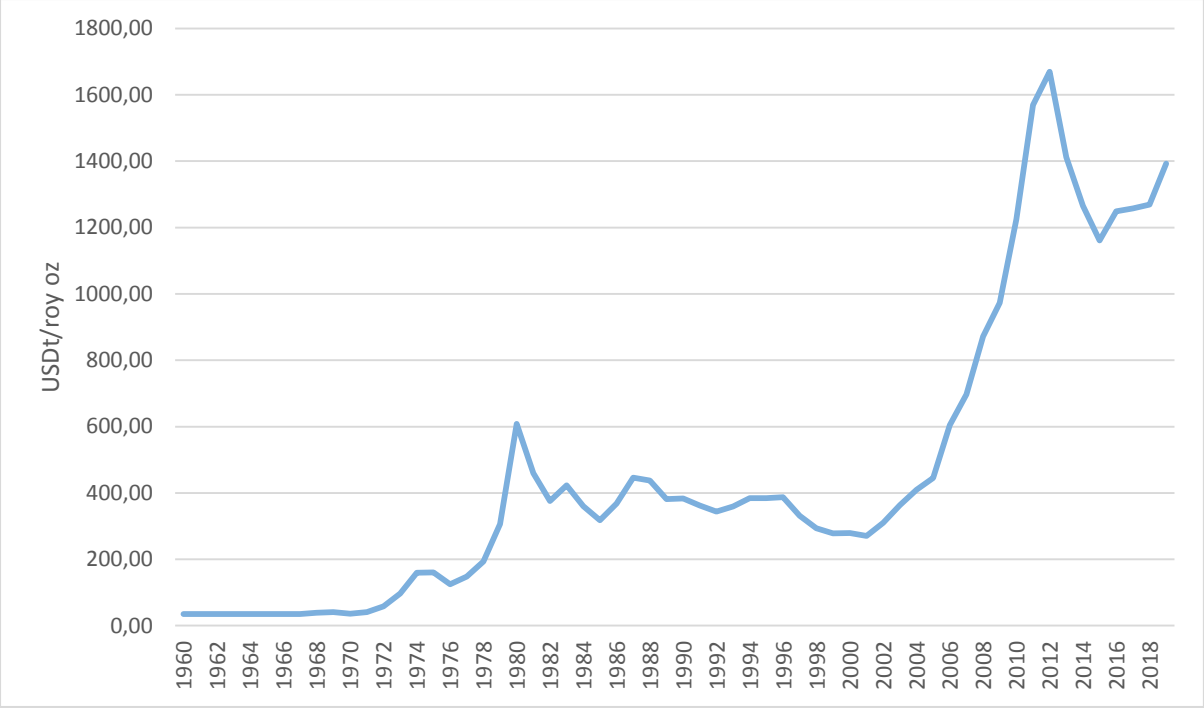

Figure 17. The gold price from 1960 to 2018 in USD (Source: World Bank, 2020)

4.6 Conclusion

This chapter has set the context within which the development of the Free State goldfields occurred. Details on each of the five drivers of change, identified in the conceptual framework, are provided. This includes a brief history of the landscape over the period of time immediately before the discovery of gold and the discovery of gold in this remote location. It is from this baseline that the drivers of change modify the landscape.

Chapter 5

5. Landscape change in the Free State goldfields from 1945 to 1955 – Laying the foundations, opening mines and building towns

With the discovery of gold and subsequent development of mines and towns, the landscape of the Free State goldfields underwent a rapid change. This and the following three chapters describes the change in the Free State goldfields landscape between 1945 and 2018, each chapter discussing a different time period. For each time period changes associated with the five drivers are reviewed. At the end of each chapter a map summarises the key landscape elements for the period.

The first ten years, between 1945 and 1955, involved perhaps the greatest and most rapid change to the landscape of the region. Moving from a largely unpopulated and undeveloped landscape, to one inhabited by 119,608 people in three new settlements and numerous mine hostels, the establishment of thirteen mines, eight of which had already started production, and the provision of infrastructure and services to accommodate this development. The catalyst for this change in the landscape was the discovery of gold in quantities that justified exploitation. The key developments in the goldfields, and national and international events that influenced these, are summarised in the timeline (Table 6).

Cartwright (1962, p. 295) describes the landscape, from the air, in 1945 as follows '*You would have seen immense maize fields, an occasional dam near a farmhouse and the cloud of dust that marked a car moving along one of the roads of the district….you might have noticed two tiny villages and, further south, a railway halt on the banks of the Sand River. The chances are that there would have been no water in the river – nothing but an expanse of sand banks. Here and there amongst the maize stalks you might have observed, in the summer of 1945, the triangular, ribbed frame of a derrick. A puff or two of smoke would mark the spot. Nearby there would be two or three shacks of corrugated iron, petrol drums, a line carrying washing and possibly a steam engine. There would also be a motor car covered with a tarpaulin. These were the drillers' camps.*'

From very early on, a key requirement for the establishment of the new goldfields, emphasised by both government and mining companies, was for planned and orderly development. Government introduced the Natural Resources Development Act in 1947 to coordinate development, and in terms of this legislation declared the Free State goldfields the first controlled area. Ernest Oppenheimer, Chairman of AAC took a personal interest in the development of the region and played an active role in the transformation of the landscape. He stressed the need for cooperation

with provincial and Union authorities in regional planning for the entire area, in 1945 stating that '*The opening up of the Free State mines requires a bold policy. The companies there will require many services, I refer particularly to railway connections, roads, power, water and to the establishment of townships to serve these new mines. All these problems can be dealt with more easily if it is a question of catering not for one mine, but for several, and for this reason it is to my mind important that part of the vast area being prospected, which has proved to be payable, should be opened up promptly, and that we should not wait until a first mine has been established and is in production before proceeding with other flotations.'* (Gregory, 1962, p 562).

Another important aspect of the development of the region was the need to attract a skilled workforce, who were in short supply at the time and in high demand on the Witwatersrand goldfields. As such, care was taken to build urban centres that were attractive and provided amenities, but in the most efficient manner. Again to quote Oppenheimer '*When I speak of 'efficient' I do not just mean the lowest possible working costs on the best possible tonnage, but also that we pay special attention to the welfare of our employees and to the development of the region as a whole' (*Gregory, 1962, p. 573). Although his intention may have extended to black labour, the political context, with the election of the National Party to power in 1948 and the embedding of apartheid, meant that the system of mine hostels, as developed in the diamond fields and applied to the Witwatersrand, was implemented here too, albeit with some improvements. Spatial development which segregated the population according to race was the practice and is evident in the planning of the Free State settlements.

Table 6. Timeline of the development of the Free State goldfield between 1945 and 1954

1945	World War II ends
1946	Prospecting starts in the Virginia area
April 1946	Famous gold strike on the farm Geduld
May 1946	Anglo American Corporation applies to establish a town, to be called Welkom
December 1946	First houses at St Helena occupied, to support shaft sinking
January 1947	St Helena Gold Mining Company starts sinking first shaft on new goldfields
April 1947	Administrator of OFS approves establishment of Welkom
June 1947	Natural Resource Development Act published
August 1947	Railway line, branch of Cape Town-Johannesburg main line, reaches Welkom (opened in 1948)
1947	Allanridge established
May 1948	Malan's Nationalist party wins the elections
1949	Welkom aerodrome in operation
October 1949	Welkom Township Company formed by Anglo American Corporation
February 1950	First Vaal River water flows through Welkom taps

June 1950	Construction of first 200 houses in Thabong starts
August 1950	First roads tarred in Welkom
1951	Virginia Land and Estate Company formed by Anglo Transvaal Mines Consolidated and Central Mining and Investment Corporation Ltd
October 1951	First bar of gold poured at St Helena Mine
November 1951	Welkom mine starts production
December 1951	Railway line between Odendaalsrus and Allanridge opened
January 1952	Ernest Oppenheimer hospital opens (although only completed in 1957)
July 1952	First public building in Allanridge occupied
October 1952	First uranium plant in South Africa opened, in the Free State goldfields
January 1953	Transfer of assets of Welkom Township Company to Welkom Village Board of Management
April 1953	32-inch water pipe line from Balkfontein on the Vaal to the goldfields completed
July 1953	Western Holdings mine starts production
July 1953	Freddies North and Freddies South mines start production, but amalgamated to form Freddies Consolidated Mines in 1954
1954	Welkom becomes the 2nd largest industrial centre in the OFS
January 1954	First township area in Virginia proclaimed
April 1954	President Steyn mine starts gold production
August 1954	President Brand mine start gold production
September 1954	Virginia mine starts production
September 1954	Harmony mine starts production
1955	Jeanette development suspended
1955	ANC Freedom Charter
1955	First families moved from Marobe to Kutlwanong
18 April 1955	New Virginia railway station opens
1954-1958	Bad drought in the region

5.1 Mining development

Before the gold underlying the Free State could be accessed, financially viable reefs needed to be located, shafts sunk, processing plants built, water and power provided and sites for waste disposal delineated and prepared. The building of mines, with all their resource and labour needs, changed the landscape, transforming land previously used for agriculture into what would produce a significant proportion of South Africa's gold.

5.1.1 Shaft sinking

Prospecting of the Free State goldfields continued alongside the establishment of the first mines, by 1950 no fewer than 466 different boreholes had been drilled across the landscape, equalling a combined depth of 576 km (AAC, 1950). Although the first prospecting and mining lease was granted in February 1942 it was only once the Second World War ended that shaft sinking could begin. St Helena Gold Mines Ltd was registered in February 1946 and the first shaft of the first gold mine of

these goldfields was started on New Year's Day 1947 (No. 3 incline shaft) (Fleischer, 1968). This mine was the 'trailblazer' of the new goldfields, with some of the problems being the lack of suitable roads, roads were meandering tracks which turned to quagmires in wet weather, building materials, cement, steel and corrugated iron, being in short supply (MacWilliams, 1949) and the scarcity of skilled artisans (Fleischer, 1968). The first gold bar from the mine was poured on 25 October 1951. Close on the heels of this development was that of the Welkom mine by the AAC, which was established in 1947, with first production in 1952.

Prospecting in the southern part of the goldfields, around Virginia, started in 1946. It was assumed that the reefs discovered in Welkom extended south-eastwards. During this period 40 prospecting holes were drilled over this area (Muller, 1956). Once the geology of the area and its economic potential was established, the various companies prospecting the area decided to group their holdings into three compact areas to form three mining companies, namely, Virginia Orange Free State Gold Mining Company Limited, Merriespruit (Orange Free State) Gold Mining Company Limited and Harmony Gold Mining Company Limited. Harmony mine, the seventh mine to open in the Free State goldfields, developed by Central Mining and Investment Company, starting production in September 1954. Anglo-Transvaal Consolidated Investment Company Limited developed the Virginia and Merriespruit mines.

Between 1946 and 1950 thirteen mines (although Freddies North and Freddies South were consolidated shortly thereafter) were established along a 45 km by 11 km band extending from the Loraine mine, close to the site of the original Aandenk borehole, in the north, to the south east and the Merriespruit mine (see *Table 7*). In 1955 a further area was demarcated to the north of Virginia, namely Saaiplaas Gold Mining Company Limited (Muller, 1956). This rapid rate of development is summarised by Fleischer (1968, p. 164) - '*Sinking went on day and night, the gaunt headgears above the shafts becoming landmarks on the featureless veld'.* Production from these mines started making a significant contribution to national production – between 1948 and 1952, 58 288,741 fine ounces of gold was produced (0.4 percent of South Africa's total production for the period). By 1954 this had increased to 8.5 percent of national production (13 237,119 fine ounces) (Gregory, 1962).

However, the two Freddies mines of JCI struggled. Freddies North and Freddies South (both having shafts 1 and 2), located on either side of Odendaalsrus, were at the time the four largest vertical shafts in the world. There were significant technical difficulties which included heat, minor faulting and poor hanging wall conditions. Pressure to move the mine into production in order to pay back

loans taken for the development meant that it was not possible to do enough development ahead of mining or enough research into how to overcome the technical problems. This, together with the relatively low ore grade, resulted in the decision to consolidate the two mines to form Freddies Consolidated Mines Limited in 1954. The old Freddies No. 2 shaft was taken over by Geduld and became their No. 3 shaft in 1955 and the Freddies South shaft No. 1 was abandoned in January 1956. *Table 7* lists all the mines developed by 1954.

Table 7. Gold mines in the Free State by 1954 (AAC, 1950; NRDC, 1954; Fleischer, 1968; Handley, 2004)

Controlling Company	Mine	Date of establishment	Date of production	Town housing workers
Union Corporation Ltd.	St Helena Gold Mines Shaft 3 and 4	1946	October 1951	Welkom
Anglo American Corporation of South Africa	Welkom Gold Mining Company, Ltd – shaft 1 (N) and 2 (S)	1947	November 1951	Welkom
	Western Holdings Ltd Shaft 1 (N) and 2 (S)	1948	July 1953	Welkom
	Free State Geduld Shaft 1 (w) and 2 (E)	1948	January 1956	Welkom
	President Steyn Gold Mining Company, Ltd Shaft 1 (N) and 2 (S)	1948	April 1954	Welkom
	President Brand Gold Mining Company, Ltd Shaft 1 (N) and 2 (S)	1949	August 1954	Welkom
	Loraine Gold Mining Company, Ltd Shaft 1 and Shaft 2	1950	May 1955	Allanridge
	Jeanette Gold Mining Company, Ltd	1950	Suspended in 1955	Allanridge
Johannesburg Consolidated Investment Company (controlled by Anglo American in 1957)	Freddies Consolidated Mines Ltd. (initially two mines, Freddies North (2 shafts) and Freddies South (2 shafts), merged in 1954)	1948	July 1953	Odendaalsrus
Central Mining and Investment Company	Harmony 2 shafts (Shaft 3 & vent shaft)	1950	September 1954	Virginia
Anglo-Transvaal Consolidated Investment Company Ltd	Virginia Gold Mining Company Shaft 1, 2 and 3	1950	September 1954	Virginia
	Merriespruit Gold Mining Company Shaft 1 & 2	1950	January 1956	Virginia

Uranium and gold occur in the same reefs and so are mined simultaneously, but the gold is recovered before the uranium is extracted. By adding an additional process, valuable uranium oxide can be recovered from the tailings, as a by-product of the gold mining industry. Uranium plants were erected at Welkom mine and President Steyn mine (Gregory, 1952; Greathead & Graadt van Roggen,

1986). This process involved the use of sulphuric acid, which was produced at a plant built at Virginia mine using pyrite from the mines (AAC, 1957).

Although the focus was on gold mining, coal seams were also intersected during drilling. These were of low quality and at a depth that made exploitation uneconomical, apart from one area a few miles north-west of Odendaalsrus, where the coal was shallower and of better quality. This prospect was suggested for further investigation (farms Spes Bona, Weltevreden and Welgevonden) (NRDC, 1954). At this time the Kaalvallei diamond mine was flooded and not in production.

5.1.2 Technical challenges

Shaft sinking was not without issues. The greatest setback to mine development was caused by water-bearing fissures which burst into shafts and development ends at great pressures, occasionally at a rate of tens of thousands of litres per hour (AAC, 1957). This was addressed through cementation to block water entering the workings. This involved drilling ahead of shaft sinking and when water was found, injecting cement under high pressure to seal the fissure (AAC, 1957; Fleischer, 1968). The extensive ground water had to be pumped from underground on a daily basis. It was saline and so could not be used in all processes on the mine, or on the uranium mines. Discharging the water into the Sand River was '*strenuously opposed by the Irrigation Department authorities*' (Muller, 1956, p. 416) and it was of no use to the surrounding farmers. A solution was the establishment of evaporation pans which involved purchasing extensive tracks of land adjacent to the mines (AAC, 1957). Through a joint Virginia-Merriespruit project 133 hectares of land was converted into an evaporation area (known as the 'paddy fields'). This consists of a gently sloping area with a series of shallow dams separated by low contour walls. The mines also obtained options to use the pans in the area for water storage and evaporation (Muller, 1956).

A further issue was the steep geothermal gradient and presence of methane, which necessitated that ventilation considerations play an important part in the design and spacing of the shafts, hence the construction of cooling plants, and sinking of ventilation shafts (Findlay, 1949; AAC, 1957). The first methane explosion occurred during the sinking of St Helena No 4 shaft in November 1949, followed by three more the following year (Greathead & Graadt van Roggen, 1986).

The shortage of senior experienced men was also a problem for these mines, influencing the rate of progress (Muller, 1956). As is discussed later, the provision of suitable housing and amenities to attract labour, was thus a major motivator for the mines.

The development of the Free State mines shows innovation and learning, through overcoming the challenges posed and increasing the speeds of shaft sinking. A number records were set for the greatest distance sunk per month. Innovation included the increase in shaft sinking platforms, from one, to two to three, with a cactus grab, from steel to cement headgear, and the use of cementation to block water entering the workings and delaying sinking rates.

5.1.3 Surface infrastructure

Mined rock is sent to the surface to be processed. Processing involves washing and sorting waste rock from ore, crushing the rock containing ore, dissolving the gold with cyanide, filtering this solution from any rock particles, precipitating onto zinc dust, acid treatment and roasting to remove impurities, further purification and then moulding into ingots (Fleischer, 1968). This requires water and energy to drive the process, and generates waste in the form of waste rock and tailings pumped to tailings storage facilities.

The surface infrastructure constructed at each mine, located around the shaft, included reduction works, workshops, stores, salvage yards, mine offices, change houses and an extensive transport system (railway lines and roads) (Muller, 1956). Each mine had a tailings storage facility linked to the reduction works, for the AAC mines these would be located furthest away from the town of Welkom, in order to minimise the dust nuisance (AAC, 1950). Initially the AAC mines would have two shafts (AAC, 1950). These structures are evident around all the developing mines, as illustrated on the map (*Figure 18*). Also associated with each mine was a compound housing black mine workers.

Figure 18. Infrastructure associated with mine development is evident on the 1955 map, showing the Welkom and President Steyn mines (indicated in black ovals), east of Welkom. Plans for the black township of Thabong, on the site of the original Uitsig prospecting camp, are also evident (red square) (map 2726DD Riebeeckstad)

5.1.4 The group system

Although numerous companies held lease areas over the goldfields, amongst these there were cross holdings and collaboration, which continued through to development. As elaborated by Gregory (1962) the various mining houses worked jointly and with cross financing, the '*inter-penetration of financial relationships*' (p.532). This is also how, through various financial transactions and

amalgamations, Ernest Oppenheimer was able to ensure that AAC would play a major part in the Free State development (Fleischer, 1968), specifically the mines around Welkom and Allanridge. In 1937 AAC through West Rand Investment Trust took over Hans Merensky's options over the Wit. Extensions area in Odendaalsrus (Gregory, 1962). AAC later acquired the controlling interest in Western Holdings, Limited from the estate of Sir Abe Bailey and assumed responsibility for the further exploration of an area held by Western Holdings to the north of the St Helena block (AAC, 1957). African and European Investment Company, Limited came under the administration of AAC in 1945, they had leases over what was to become Welkom, President Steyn and President Brand gold mines (AAC, 1957). AAC would later acquire control over Freddies Consolidated Mines from Johannesburg Consolidated Investment Company. Although each of these mines were registered as separate companies, they were all controlled by AAC. This arrangement facilitated the development of a number of mines at the same time, which was also the case with Anglo-Transvaal, which developed the Virginia and Merriespruit mines. This 'group system' was unique to South Africa at the time. The head office made available expert services to each mine, which may not have been able to afford the expertise as a 'stand-alone' operation. The centralised and pooled administrative and technical skill were a great advantage to the individual mining companies. This also allowed for standardised shaft layouts and surface workings, housing, hostels and other amenities (Muller, 1956; AAC, 1957), equipment (AAC, 1950) and centralised stores serving all the group mines (Limebeer, 1951). According to Limebeer (1951, p. 29) '*it is no exaggeration to say that without the group system of organization the Free State mines could hardly have been brought into being'*.

5.1.5 Mine hostels

Critical to the development and production of the mines was labour. Due largely to the nature of the ore body, a narrow reef which was often disjointed and broken, the relatively low grade and extensive nature of the ore, mining was labour intensive (Wilson, 1972). As shaft sinking was completed and mines went into production, labour numbers increased (*Figure 19*). The system of migrant labour, already well development on the Witwatersrand mines, was employed in the Free State, with hostels, or compounds as they are indicated on the maps, built around each mine to house black migrant labour.

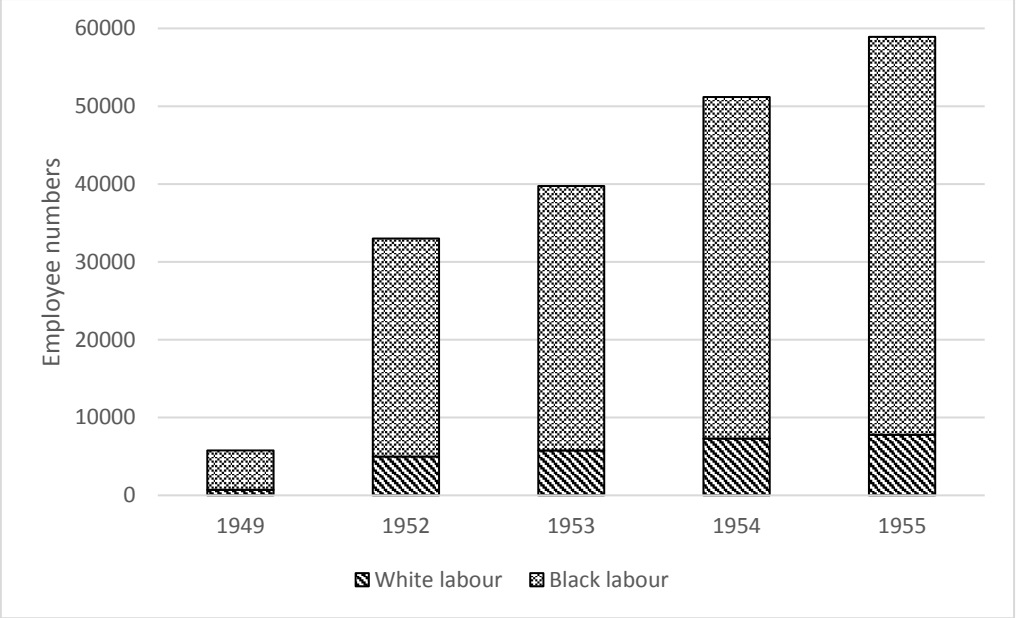

Figure 19. Labour employed by the gold mines of the Free State (AAC, 1950; NRDC, 1954; Muller, 1956; AAC, 1957)

The labour system involved what is termed oscillating migration, where unskilled black workers came to the mines for a limited time and then returned to their rural homes (Wilson, 1972). Procedures for recruiting, training, housing and administering the migrant workforce had been developed to a high level of efficiency (Janisch, 1986), with the Chamber of Mines establishing the Native Recruiting Corporation (NRC) to organise the recruitment of black labour from within South Africa and the three 'Protectorates' (Bechuanaland, Swaziland and Basutoland) in 1912 (Wilson, 1972). In 1977 the NRC was amalgamated with the Witwatersrand Labour Organisation (WNLA), set up in 1900 to recruit labour from Mozambique, to form The Employment Bureau of Africa (TEBA) (Harington et al., 2004). Labourers were transported to the mining areas from the recruiting stations and returned home at the end of their contract. Housing was provided in hostels (Handley, 2004). Conditions in the hostels were not ideal with many men sharing a room and confined to the hostel area. This system was adopted on the Free State mines, where black labour was obtained '*on the normal Chamber of Mines basis'* (Muller, 1956, p.405) which involved firstly establishing the needs of each mine and then either employing people directly from the pool of volunteers offering their services on site i.e. people who had moved to the area in search of work, or through the official Chamber of Mines recruitment process (Muller, 1956).

Construction of the first hostel in the Free State, at St Helena No. 4 shaft, started in 1947, and was one of the largest on the goldfields, designed to accommodate 6,000 men (Fleischer, 1968). The layout of the hostels differed between the companies developing mines. For example AAC saw the

new mines as an opportunity to provide improved living and working conditions for mineworkers. The layout of mine hostels in these new goldfields, almost identical on all AAC mines, was based on a detailed investigation by a committee of experts appointed by AAC and offered an opportunity to incorporate many new and advanced ideas. The thinking was that '*if sufficient care, consideration and foresight are given to the welfare, well-being and health of Native employees, standards of efficiency should rise and a contented labour force should bring great advantages to the mines'* (AAC, 1950, p.21). The typical AAC hostels comprised four or more double-storied blocks of rooms around a large central dining hall and modern kitchen block, the main innovation for the Free State hostels. Each block consisted of 64 rooms with ten people per room. Recreation grounds and facilities for '*developing hobbies*' (AAC, 1950, p. 15) were also provided. Another new addition was a tunnel directly from the mine to the hostel. This served two purposes '*It ensures that a proper check can be kept on Native employees, from safety and efficiency viewpoints, it also ensures that, in winter, Native employees will not be exposed to the effects of bad weather conditions, particularly rain and cold, after leaving hot underground workings'* (AAC, 1950, p. 15).

Ernest Oppenheimer had felt that the opening up of an entirely new mining area was an opportunity for a fresh start as regards housing labour, and had hoped to create a stable labour force by the construction of adequate quarters for married black workers and their families, to accommodate about ten percent of the black labour work force (Brookes, 1951; Gregory, 1962). However this was opposed by government. The Minister of Native Affairs (then Hendrik Verwoerd) stated, in response to a question on the issue posed by MP for Kimberley, Harry Oppenheimer in June 1952 that '*I want to state quite unequivocally that I am opposed to that development. I too, have objections, and my department has been instructed to investigate the positon very thoroughly and to stop the development of such villages as far as possible. Let me give my reasons for this. Within that Free State gold mining area every mine can then establish its own Native town with married quarter. That will then mean a series of Native towns. While we are already establishing Native towns in the vicinity of the big cities to provide housing for the Natives, it will mean that in addition a large number of black spots will be spread out throughout the whole Free State mining area. Now we must bear in mind that when the mines stop working one day that large number of towns will remain there spread out over that area. They may amount to 20 or 30 or 40 within that area! They do not fall under our control either. The Department of Native Affairs has no jurisdiction over those Native towns on mining land'* (Gregory, 1962, p. 579). He (Verwoerd) went on to state his concern that the children from these mining towns will become a burden to surrounding towns when they grow up and leave the mining town. As a consequence AAC were only allowed to develop married quarters

for men who were South Africans and belonged to the category of essential and semi-skilled worker, and for not more than three percent of the total labour force (Fleischer, 1968). According to Crush et al., (1991), AAC constructed small villages of 150 houses adjacent to the compounds on six of its Free State mines. This they refer to as AAC's '*stabilization experiment'* (Crush et al., 1991, p.76), which never took root owing to the NP apartheid policies of the time.

Innovation and thinking around migrant labour accommodation does not appear to have been shared by the Anglo-Transvaal mines (Virginia and Merriespruit). On these mines the housing consisted of rooms housing between 12 and 20 men in a single-storey blocks opening on to lawns, with ablutions facilities provided at convenient points. The blocks were situated between radiating roadways. Unlike on the AAC mines, there was no central dining room and workers were expected to fetch their food from the kitchen (Muller, 1956).

5.2 Urban and infrastructural development

Associated with the development of mines was the need for infrastructure and settlement. Within the 10 year period the veld and maize fields were changed into a busy hub of development, with a network of roads and railways connecting it to the rest of the country, power and water infrastructure linking to the grid and, at its peak, a new house being completed every day.

5.2.1 Infrastructure – linking developments

The powerlines, railway lines and roads crisscrossing the landscape, absent in 1945, are very evident features of the 1955 map series (*Figure 20*). The Free State goldfields was very remote with only a few sand track roads, local borehole water supply and no electrical power grid. In addition to building mines the companies, with government assistance, had to first establish the necessary infrastructure to support this massive operation.

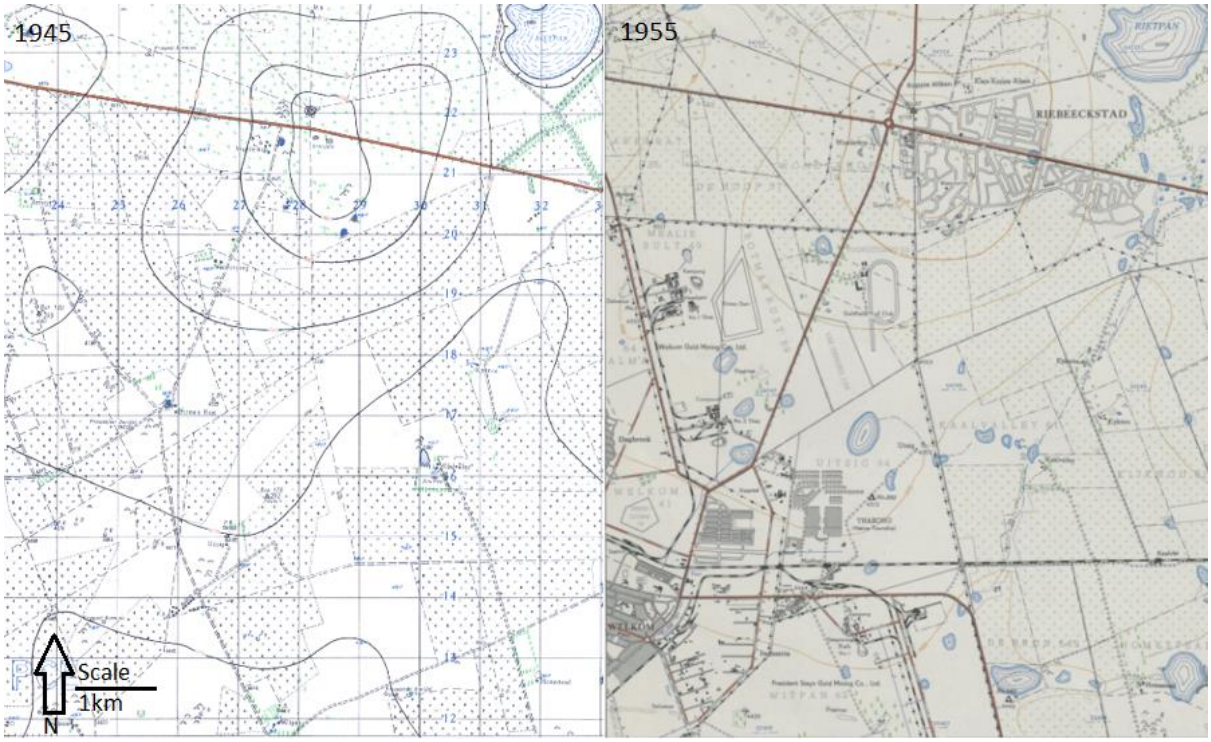

Figure 20. The extensive development of infrastructure, specifically roads, railways and powerlines, and settlement is evident in when comparing the same areas on the 1945 map sheet and 1955 (maps 2726DD Braunzynkop, 2726DD Riebeeckstad)

Fortunately the main Cape Town-Johannesburg railway line skirted along the eastern side of the newly discovered goldfields, crossing the Sand River at Virginia and passing through Whites. The extension of the railway line to Welkom was one of the first priorities. In 1946 Parliament approved the construction of a branch line from Whites to Odendaalsrus, a distance of 40 km, which reached Welkom in August 1947 and was opened in 1948 (Department of Mines, 1953; Fleischer, 1968). This was followed, in 1950, by the development of the Welkom station which included four lines of railway traffic into town, a large marshalling centre on the outskirts, a separate station for black passengers and a ten kilometre private line to serve St Helena mine (Fleischer, 1968). The line was later extended to Odendaalsrus, and then Allanridge. Railway lines were also extended to the mine shafts, greatly aiding transportation (Muller, 1956). By September 1954 a new bridge over the Sand River and a new railway station at Virginia had been constructed (NRDC, 1954), this was officially opened on 18 April 1955.

Road development was also key to connecting the mines and new towns to other areas. In 1949 an interdepartmental committee of nine state departments was set up to plan and prioritise road development. The first need was to provide a direct link from the Witwatersrand to the Free State goldfields, and so the road from Kroonstad to Odendaalsrus, with a branch road to Welkom was

constructed (NRDC, 1954). Secondly the road network connecting the various planned and existing towns was designed and then the connections to other parts of the country (NRDC, 1954). By September 1954 the following main tarred roads were complete:

- Kroonstad-Odendaalsrus
- Odendaalsrus-Riebeeckstad-Henneman-Ventersburg
- Allanridge-Odendaalsrus-Welkom-Harmony-Virginia
- Odendaalsrus-Welkom-Blaauwdrift-Theunissen
- Henneman-Virginia
- Riebeeckstad-Welkom

Roads within the new towns were the responsibility of the town developers. In the case of Welkom this was delayed as there was a lack of suitable stone, lack of water and there were still many drainage, sewerage and electrical excavations to be made. As the depths of the mine shafts increased suitable rock for road building was brought to the surface. By 1951 there was more than 180 km of road in Welkom, of which 27 km was tarred (Fleischer, 1968).

Air transport was an important mode of travel in the early years, an aerodrome was put into operation in 1949 on the farm Theronia with daily flights (except Sunday) between Welkom and Rand airport (Johannesburg), and three times a week to Bloemfontein, the provincial capital (AAC, 1950). The aerodrome was later upgraded to an airport (Fleischer, 1968).

Initially water for the mines and growing settlements was supplied from local boreholes. AAC refer to the use of up to 40 local boreholes to provide water for their operations and settlements (AAC, 1950). The closest source of permanent water was the Vaal River. Through an amendment of the Vaal River Development Scheme Act of 1934, approved by Parliament in 1946, an intake pipe on the south bank of the Vaal River near Bothaville (Balkfontein) was constructed. From here water was treated and then piped 66 km to service reservoirs on Koppie Alleen, from where it supplied the goldfields (van Vuuuren, 2012). The pipeline was constructed by the Union Irrigation Department (AAC, 1957). The first Vaal River water flowed through Welkom's taps on 20 February 1950 (Fleischer, 1968).

Power for the early drilling activities was supplied by diesel generators. Later power supplies came via transmission lines from Electricity Supply Commission (ESCOM) power stations in the Vereeninging area. However, in 1952 a new coal-fired thermal power station, Vierfontein, 112 km north of Welkom near Vereeniging, came into production and provided power to the Free State and

Klerksdorp goldfields. This was later supplemented with power from another newly constructed power station, Taaibos, near Coalbrook in the Free State, and Highveld power stations (under construction in 1957) to supply the increasing needs of the fast developing goldfields (Jacobs, 1951; AAC, 1957).

5.2.2 Settlements - New towns

As the only established settlement in the goldfields it was assumed that Odendaalsrus would be at the centre of the development of the mines. However, the decision by the Natural Resources Development Council (NRDC) was to establish the new town of Welkom and a further two new mining towns, and to plan the region as a whole.

The three new mining towns of Allanridge, Welkom and Virginia were developed on land within the controlled area declared through the Natural Resources Development Act of 1947 (discussed in section 5.4) and as such planning was supervised by the NRDC (Muller, 1956). Any further development of the existing town of Odendaalsrus also fell under the jurisdiction of the NRDC. In its annual report in 1948 the NRDC laid down certain planning principles for the orderly development of the goldfields. These principles '*related to the provision of suitably-spaced towns of average size (in preference to one or two large cities) in place of a multiplicity of mine residential units and scattered businesses, the discouragement both of the excessive sub-division of farm land and of the establishment of small holdings in the neighbourhood of the new towns; the setting of the broad pattern of the major road network, and so on*' (NRDC, 1954, p. 5). The towns were developed by companies set up and administered by the mining companies controlling the mines in the area – the Welkom Township Company for Welkom, the OFS Lands and Estate Company for Allanridge, and the Virginia Land and Estate Company for the town of Virginia. The rate of growth of each of these was governed by the extent of mining activity in the vicinity. In addition to these three mining towns, applications were made to establish towns slightly removed from the main centres of mining, predominately for residential use, Blaauwdrift (in 1949) and Riebeeckstad (in 1953) were thus approved, with Riebeeckstad having 5,784 plots developed by the beginning in 1954 (NRDC, 1954).

Welkom

Welkom officially came into being on 15 April 1947, following '*a battle between legal giants*' (Fleischer, 1968, p.20). In March 1946, the SA Township Mining and Finance Corp, AAC's land company, applied to establish a town called Welkom on certain farms (Bedelia, Enkeldoorn, Alma, Welkom, Meribah, Jacobsrust, Toronto and Theronsrust, district Ventersburg) in the vicinity of the Uitsig Camp, being the centre of the six mines that were being developed by the company. However,

this was opposed by New Nigel Estate and Gold Mining Co. Limited and New Union Goldfields, General Exploration (OFS) Limited, the Odendaalsrus Town Council and some private individuals (Fleischer, 1968). The objections were that the development of Welkom was not in accordance with government policy which was that the goldfields would be developed as a whole, and that they should at least await the findings of the NRDC investigation. A further argument was based on the general policy that no township should be established within 32 km of an existing township. Welkom was to be only 13 km south of Odendaalsrus. On the strength of this general policy large sums of money were invested in Odendaalsrus and it was argued that the investors had the right to benefit from these investments.

On the other hand, AAC argued the urgency with which they needed to develop housing for employees in close proximity to their work, and that a delay in allowing township development would eventually delay mine production. They also indicated that as they held both the mineral and surface rights, development would fall under centralised control and township development would be ordered and planned (de Kock & Holtzhausen, 2005). In addition there was a shortage of townland in Odendaalsrus, with municipal land having previously been sold to prospectors, and surface and mineral rights being held by different parties (NRDC, 1954). AAC's application was approved and the development of the 'Capital of the Orange Free State goldfields' started (Fleischer, 1968). The town was to be developed by the Welkom Township Company, a subsidiary of the mining houses that were exploiting gold (AAC and Union Corporation). A local authority, the Welkom Village Management Board, was established to enforce by-laws, levy taxes etc. Any profit made was for the further development of the town. The mines would purchase many of the stands to provide housing for their skilled (i.e. white) employees (Oppenheimer, 1950).

Even though permission was only granted in 1947, building of the first houses for employees of St Helena mine had already commenced in what was to become the St Helena suburb of Welkom (Fleischer, 1968). Sir Ernest Oppenheimer was very involved in the planning and development of Welkom, so much so that Welkom was seen as 'Oppenheimer's town' (Marais & van der Walt, 2011). He employed Mr W. O Backhouse, a town planning consultant, to develop '*a township on bare veld*' (Fleischer, 1968). His directive was to design a town in accordance with the most modern principles of town-planning and that combines the attributes of a garden city with the more practical needs of ordinary commerce and industry (Backhouse, 1951; AAC, 1957). An area of 4000 morgen (just under 3,500 hectares or 34 km^2) was set aside for the township with opportunity to adjust the boundaries to accommodate future mining development or settlement expansion (Oppenheimer,

1950). To start with the area was divided into land use zones, including residential areas, the civic centre, industrial sites, the black township, waste and sewage disposal (Oppenheimer, 1950). These were dictated by topography, existing infrastructure, the projected layout of the mines with their tailings facilities and a consideration on the most efficient method of reticulating water and power (Backhouse, 1951). Size and location of the zones considered the future movement and concentration of the population, the prevailing winds (to limit the impact of dust from the mines), types of industry to be catered for, the population size and further development opportunities.

Regional and town planning drew on British thinking at the time, the so called 'garden city' principles, which included planning in neighbourhood units, the provision of green wedges, planning of the commercial area with adequate parking lanes, and many other modern ideas that add to the convenience and appeal of a town (Backhouse, 1951). In the South African context, with the existing regulations around segregation, this also meant racially distinct, separated zones (Mabin & Smit, 1997).

In his paper on the Orange Free State goldfields, Oppenheimer (1950, p.155) described the detailed planning that went into the design and layout of Welkom, as follows: '*The civic centre, for which sufficient ground has been set aside in the centre of the town to permit of its ultimate expansion to meet the needs of the possible maximum population, is divided by the main 220 ft. traffic-way which traverses the whole town from east to west. On the southern side is the shopping and business area. On the northern side is the area for public buildings, banks, courts and the like, the width of the streets, the permissible height of buildings, their coverage on the stands, and the provision of special loading lanes behind the business stands, have been most carefully worked out to eliminate on the one hand the cramped conditions, the congestion of pedestrian and vehicular traffic and the parking problems associated with towns planned according to bygone standards, and on the other hand the inconvenience of unduly large spaces and long distances. Regulations have also been adopted to ensure high and harmonious standards of architecture and the massing of buildings according to a preconceived plan.*'

The town was laid out, building started, and Welkom boomed. Within three years (by August 1950) 1,000 houses had been built. The first suburb to be developed was Doorn, and by November 1950 Welkom had three suburbs (St Helena, Bedelia and Doorn), with the development of Dagbreek to house workers employed on the Welkom mine (Fleischer, 1968). A feature of the residential areas are the numerous 'park wedges' all within easy access to houses and designed to enable school

children to walk to school and pedestrians to town (Oppenheimer, 1950). Although the initial houses were developed by the mines, by 1951 the first houses built by the National Housing and Planning Commission were completed. Another milestone was the first transfer of land to private owners in May 1952 (up until then it was all owned and developed by the Township Company).

People started moving to the area, at a rate of two families a day by June 1950. Mine employees and their families came largely from the Witwatersrand (Springs, Brakpan, Germiston and the West Rand), bringing their possessions by rail and road (Fleischer, 1968). Along with the influx of people (*Table 8*) was the need for schools, medical and other facilities. The first school was St Helena private school which started in 1947, with others opening shortly after – Welkom Primary School in 1950, Convent of St Agnes in 1952, Dagbreek Primary School in 1953, Welkom High School in 1953 and the Goldfields Technical Institute in 1953 (Fleischer, 1968). Churches for different denominations were also built, by 1952 Welkom had five church halls (Fleischer, 1968). Medical services where initially only available in Odendaalsrus, with a small nursing home in a house in Welkom. However hospitals were soon built, the St Helena mine hospital, the Ernest Oppenheimer hospital (the largest industrial hospital in Africa serving black mine workers, first stage completed in 1952 and finalised in 1957), and the Chamber of Mines 60 bed cottage hospital in 1954 (one of three in the goldfields, the others being in Virginia and Odendaalsrus) (Fleischer, 1968).

Table 8. Population growth and housing development in Welkom (AAC, 1950, NRDC, 1954; AAC, 1957; Fleischer, 1968)

Date	White population	Number of houses
1947	100	-
1949	3 060	608
1950	6 700	1 000
1951	6 681	1 450
1952	11 500	-
1953	-	3 000
1954	18 500	-
1955	≈22 000 (1/3 non-mining)	-

The provision of recreation facilities for mine employees and their families, and the greater community, was regarded as important. The Welkom Mines Club was built by AAC and opened in 1951 and provided facilities for tennis, cricket, bowls, soccer, rugby and later badminton, swimming and squash. The hall included seating for 400 people, a sprung dance floor, a large stage with orchestra pit and dressing rooms. The Oppenheimer Park Golf Club, cinema and drive-in (with the largest screen in the Southern Hemisphere), were also constructed during this time.

From 1950 the promise of Welkom as a 'garden city' was addressed through the planting of trees and laying out of parks and gardens. This was largely under the direction of Joane Pim, a landscape gardener who was appointed by AAC on 1 May 1950. She started her work traveling across the region noting which trees and plants were growing and based on this started a nursery at Klippan where thousands of seedlings were sprouted and grown before being planted out in and around Welkom. Joane Pim was apparently a great believer in the benefits of the use of manure in the garden and as the Free State soils had been depleted by drought, dust storms and years of maize farming, she ordered manure to be brought from the Karoo, some 320 km away. Trees were planted on both sides of every street in every suburb and two trees were also planted in the garden of every house built for mine employees. Cognisant of the water shortages in the early years, residents were expected to water these trees using their bath water (Wiesmeyer, 2007). Miss Pim, as she was known, carefully selected trees to suit the different areas, for example, trees with white trunks were selected to warn motorists of roads with turns and intersections, while leguminous fodder trees were planted at outspan areas to serve as food for animal drawn vehicles (Wiesmeyer, 2007). Double rows of trees and other plantations were also placed along the boundaries of the town wherever the residential areas adjoined mining properties (Fleischer, 1968).

The first park to be developed, in 1951, was the Peter Pan Park in the suburb of Doorn. Then the Van Riebeeck Park and extension, followed by the East Park, which involved improvising with a heap of rubble dumped in the middle of the planned park. This was turned into a miniature hill and planted with trees and shrubs. Central Park, the large park alongside Stateway and opposite the still to be developed Civic Centre, St Helena Park and a park in Dagbreek were also developed and planted by Joane Pim during this period. By 1955 five parks had been completed and a number of park strips had been planted with trees and indigenous grasses. Joane Pim is given credit for overseeing the planting of over 200,000 trees across Welkom, including its mines, golf course and 60 km of streets (Wiesmeyer, 2007).

On 11 December 1953 Welkom was formally handed over from private to public ownership, from the Welkom Township Company to the Welkom Village Board. The Company had spent ZAR 9 million on the development of the town (including buying land, electrical and water reticulation, sewage, roads, railway lines, town planning). In April 1954 Welkom became a separate magisterial district and by October the second largest industrial centre in the Free State and seventeenth largest town in the Union (Fleischer, 1968). The building of a new city in the veld was an accomplishment and not always easy for the early residents. This was recognised by Ernest Oppenheimer when he awarded

'Pioneer Medals' to the pioneers of Welkom in 1956. The message with the medals sums up the experience of those early years, it read, in part '*You were the true pioneers of the Orange Free State Goldfields. It took courage to uproot yourself from established parts of the country to take part in this new enterprise. It took hardiness to face up to the discomforts and privations of those early years when there was little but bare veld and those dreadful dust-storms that seemed to come so frequently then. Above all, it took enthusiasm and hard work to build up from virtually nothing the thriving mines and townships that today form one of the nation's greatest assets*' (Fleischer, 1968).

Thabong

At the time one of the requirements for the development of a town was the provision of a 'native location' or more recently termed, 'township', whose position, size and relationship to the rest of the town was approved by the Minister of Native Affairs. In line with the prevailing planning policy the township was to be a '*separate, complete and self-sufficient town with all the facilities and amenities of the European town according to standards appropriate to the needs of the native population*' (Oppenheimer, 1950, p.155). There were also requirements for undeveloped buffer strips between the township and other types of development. For example, a 457 metre buffer between the township and the nearest built-up area of a white or other 'non-European' group, 167 metres next to farms without houses near the boundary, and 457 metres next to a national road. There was also a need to reserve land for future expansion of the township and to provide a separate access road for the inhabitants of the township. The size of the township was calculated on the basis of 12 families (or approximately 60 people) per morgen (equivalent to 70 people per hectare), including the area of the roads, open spaces and public places (NRDC, 1954). In the goldfields the location of these townships was to facilitate easy access to the industrial and commercial areas, which were in turn located considering the location of the railway line and the prevailing north-west wind (to minimise the impact of dust and smog on the white town). As a consequence the new township for Welkom, Thabong, was located to the east of the town.

Thabong ('place of joy') was established in June 1950 on 540 hectares of the farm Uitsig (incidentally the site of the original prospecting camp, see *Figure 18*) to house black workers and their families that had moved to the developing goldfields for work and initially settled in an informal settlement near Witpan. Thabong was designed to accommodate a population of between 30,000 and 40,000 people, largely in detached single-storey houses (*Figure 21*), within five neighbourhood units (Backhouse, 1951). The first houses were occupied in June 1951 (Fleischer, 1968). By 1954, 1,704 houses had been built for the population of 11,500 (NRDC, 1954), which almost doubled by 1957, to 22,000 (AAC, 1957). In addition 1,000 sites were made available under a site-and-service scheme

(AAC, 1957) where water and sewerage services were provided with the expectation that tenants would construct their own house. Schools, a community hall and churches were built and land allocated for a Provincial black hospital and parks, playing fields and schools (AAC, 1957).

Figure 21. The first houses in Thabong, around 1951 (Source: Welkom public library)

Allanridge

The smaller town of Allanridge was planned and developed to serve the two AAC mines being built on the original Wit. Extension Block in the north of goldfields, the Loraine and Jeanette mines. As was the case with Welkom, AAC established the OFS Lands and Estate Company Limited to plan and develop the town, which was named after Allan Roberts, responsible for drilling the original borehole on Aandenk, and located adjacent to this. It was planned to provide for an initial population of 25,000 white and an equal number of black residents. The first houses were built in 1950 in extension 1 (NRDC, 1954), at one stage builders were completing a house a day (AAC, 1957). Further extensions (2 and 3) were laid out. In 1951 the white population was 731, increasing to 2,607 by 1954 (NRDC, 1954). A site for the black township to the south east of the town was approved, but was only developed after 1954.

New Virginia

By 1949 the original settlement of Virginia was well established around the railway siding. Although the initial plan was to include this village in the development of the new Virginia settlement, the land owner, Mrs von Abo, did not support mining development and so refused to sell the land

(Viljoen, 1994). Mine workers and their families were instead accommodated in temporary camps, Paddavlei and Kassieshoogte, on the farm Adriansrus. The NRDC (Virginia also falling within the controlled area) also indicated that it was '*highly undesirable to permit any unplanned expansion of Old Virginia*' (NRDC, 1954, p36). Old Virginia subsequently became known as Linabo, a combination of the surnames Lindsay and von Abo, the farm owner and his brother-in-law (Viljoen, 1994).

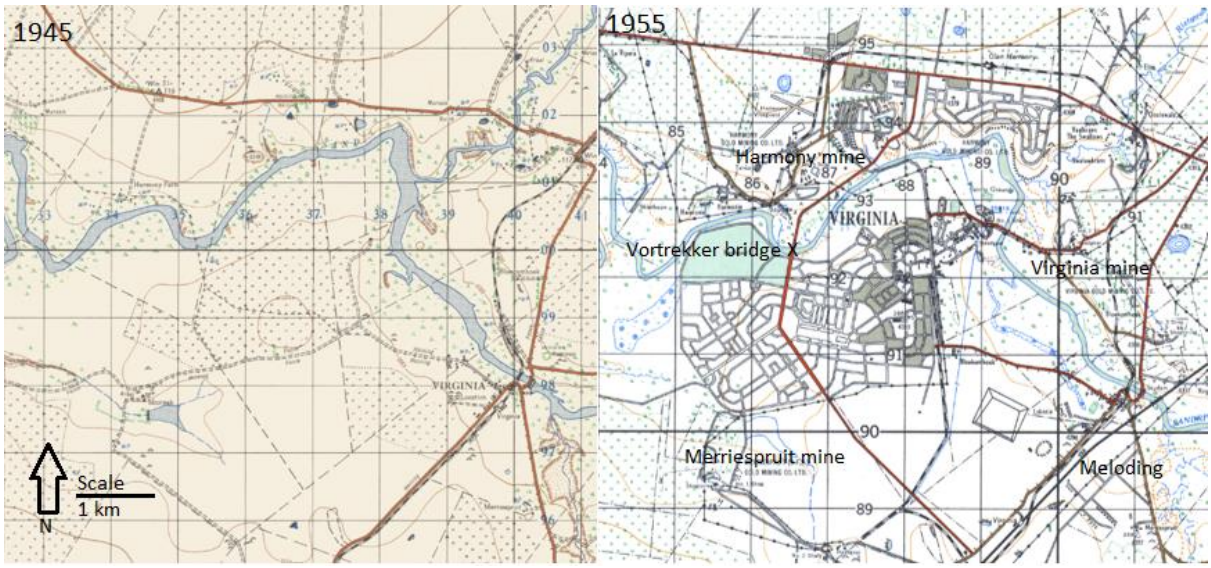

Figure 22. The development and growth of Virginia is clear when comparing the maps of 1945 and 1955 (map 2826BB Virginia)

Following a meeting between the two mining groups working in the immediate area in August 1949, it was agreed to develop a new town on the banks of the Sand River (NRDC, 1954), on the farms Harmony, Vaalkranz, Adriansrus, Merriespruit, Kaallaagte, La Riviera and Morijah (Viljoen, 1994). Similar to the process of town development in Welkom, the Virginia Land and Estate Company was established in 1949 as a not for profit organisation by the Anglo Transvaal Mines Consolidated and Central Mining and Investment Corporation Ltd to develop the town (Muller, 1956; Viljoen, 1994). Major JC Collings and Associates were appointed to plan the town along the same principles as Welkom, to be examples of good town planning in South Africa and globally. The first plan, making provision for three mines, was completed in March 1950, with a second, with four mines (the addition of Saaiplaas), released in November 1950. The plans considered the immediate landscape and topography, locating residential, commercial and industrial uses in the higher lying areas, while the flood plains along the river were demarcated for recreational uses and the sewage treatment plant (Viljoen, 1994). As illustrated in *Figure 22*, the design included a central area, an industrial area and four residential suburbs (Harmony, Saaiplaas, Merriespruit and Virginia) collectively referred to as Virginia town. Each residential area was located near a mine shaft, with the distance to work

being around 1.2 km (Muller, 1956). Each settlement was provided with all the amenities, including churches, schools, shops, offices, hotels, community centres, police station and recreational facilities (Viljoen, 1994). A hospital for the town was built through the Chamber of Mines in 1954 (Muller, 1956). The Voortrekker bridge over the Sand River, connecting the southern and northern sides of Virginia, was constructed and opened in 1955 (*Figure 23*) (Viljoen, 1994).

Figure 23. The growing town of Virginia around 1955, showing the newly constructed Voortrekker bridge over the Sand River (Source: Welkom Public Library)

The population of Virginia steadily increased but not at the same rate as neighbouring Welkom, which serviced more mines which reached production earlier than the Virginia mines. As the number of mine employees and their families increased, the proportion of the non-mining population, who moved into the town to set up business and provide services, increased (*Figure 24*).

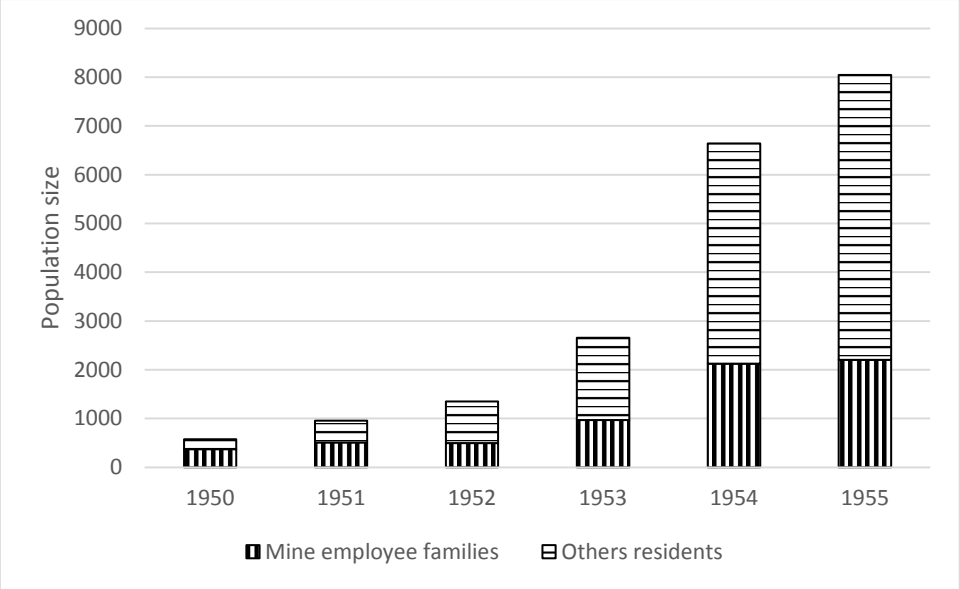

Figure 24. Rapidly increasing white population of Virginia from 1950 to 1955 (Muller, 1956)

During the early years of the development, facilities were inadequate and '*undoubtedly had an effect in discouraging the right type of men from emigrating to these fields*' (Muller, 1956, p. 403). According to Muller (1956), on reflecting on the development of Virginia, provision of the right type of permanent housing was important in attracting the right 'type' of worker, and for staff morale. Housing provided included 'bungalows' of different sizes and flats, to rent and buy. The purchasing scheme included assistance for purchasers, all in the hope to keep employees (scarce resource at the time) happy, stabilize staff and reduce company investment in housing. Support was also provided to employees through nominal rent and extra allowances for power and water (Muller, 1956). Linked to this was the importance of the provision of recreational facilities, which were initially provided at Virginia, and then later at Merriespruit. Between 1950 and 1956 tennis courts, sports fields, swimming pools and recreation building were built for employees of both Virginia and Merriespruit mines, with the Virginia golf course being completed in 1954.

Although designed along garden city principles, Virginia did not benefit to the same extent as Welkom with regards to the development of parks and open spaces. Joane Pim was appointed by Harmony mine in 1954 to take care of the landscape architecture and gardening requirements of this mine. Here too she established a nursery and developed the gardens of the Harmony Native Hostel (No. 3 compound), apparently the envy of other mine workers (Wiesmeyer, 2007). She is also credited with the development of the Harmony Country Club gardens, which included extending the old farm dam to become a pond and water bird sanctuary – the Joane Pim Park, a much visited and enjoyed recreational area by the locals.

The Virginia district was proclaimed on 4 December 1951, with the suburbs of Virginia, Merriespruit, Harmony and Saaiplaas being proclaimed between 1954 and 1959. Virginia was transferred from the town developers to the town council in August 1956.

With the development of the mines, a number of black workers seeking jobs on the mines increased. At the time the black settlement was located at Linabo, however, Mrs von Abo prohibited further black settlement on her land, despite a request from the town management. As a consequence 330 hectares of the farm Merriespruit was obtained for the development of a new township to be called Meloding. Meloding was located across the railway line from the developing mines and new town of Virginia. As seen from the 1954 topographic map of the area (*Figure 22*) some settlement had already started, although Meloding was only officially proclaimed in April 1956 (Viljoen, 1994).

Odendaalsrus

Although Odendaalsrus didn't become the central town of the Free State goldfields as was hoped by residents and property speculators, it did see some expansion and growth in the early years of the goldfields. From a population of 341 white residents in 1941 it grew to housing 8,300 white residents in September 1954 with 9,000 people living in the black township of Marobe located to the west of Odendaalsrus (indicated as 'LOCATION' in Figure *25*), and a further 6,628 housed in the mine hostels (NRDC, 1954).

An indication of growth of the town is the value of building plans approved. In 1949 the value of building plans approved was £99,000, increasing to £1 094,000 in 1952 (NRDC, 1954). This expansion is evident when comparing the aerial photograph of Odendaalsrus taken in 1944 with the topographical map based on 1952 images (*Figure 25*) and a photograph from 1949 (*Figure 26*). The town has more than doubled in size, with further extensions laid out, and the railway line and powerlines passing the town, and mine shaft of Freddies North and South being development.

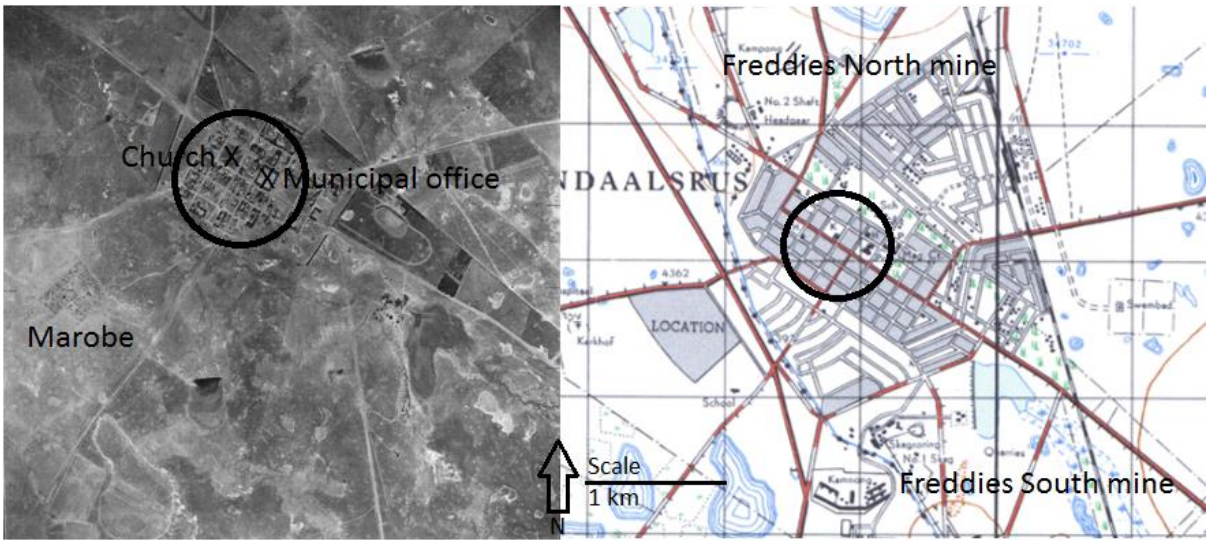

Figure 25. The growth of Odendaalsrus is evident when comparing the 1944 aerial photograph and 1955 topographical map. The black circle indicates the original settlement. The Marobe settlement is labels as 'location' in the 1955 map (map 2726DC Odendaalsrus)

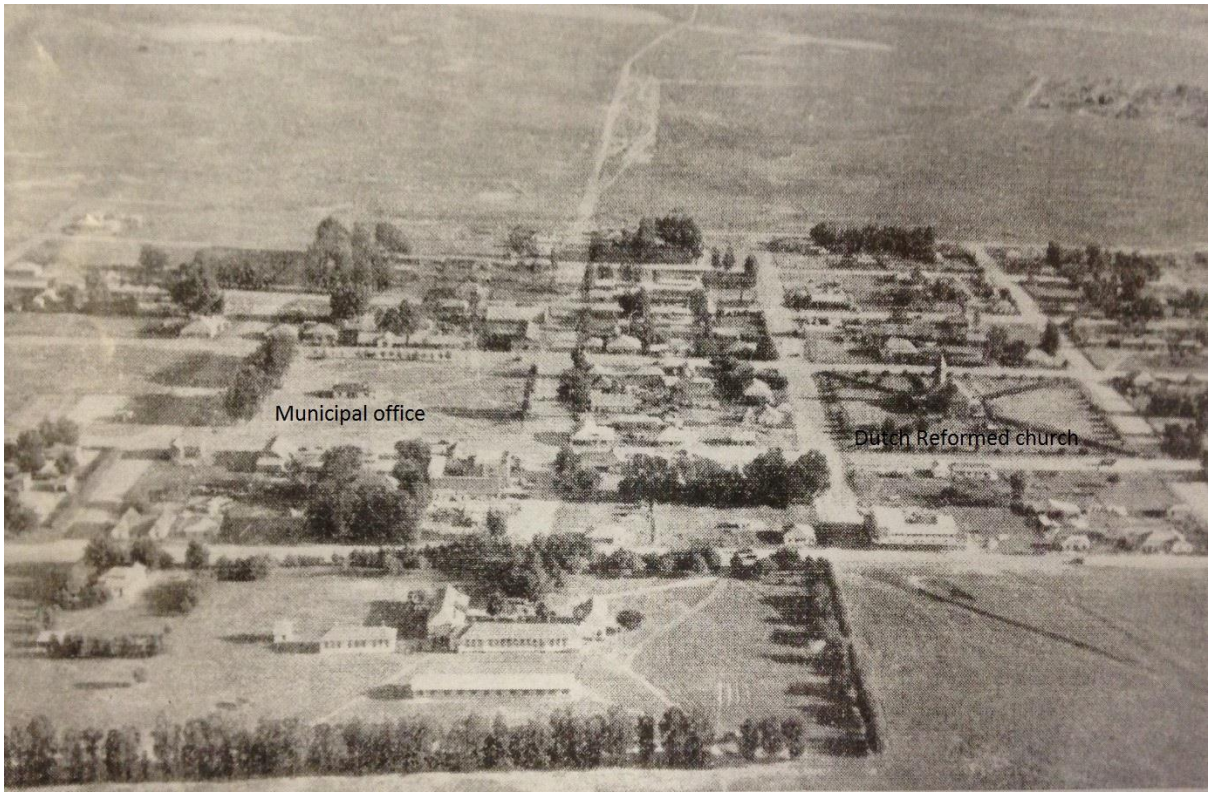

Figure 26. A view of Odendaalsrus, looking south-west, in 1949. The church and municipal offices are indicated. Marobe is visible in the top right corner. (de Kock & Holtzhausen, 2005)

5.3 Agricultural development

There is limited data available on agricultural development during this period. One could assume that, with the transformation of agricultural land for the development of mines and settlements and

land speculation, agricultural activities and production in the immediate vicinity would decrease. However, a comparison of the 1945/46 and 1955/57 map series shows that areas of natural veld were converted to cultivation. This was a continuation of the earlier trend of moving away from livestock farming to cultivated agriculture. A 1950 survey indicated that as much as 58.8 percent of the area was cultivated with maize and wheat roughly in the proportion of 2 to 1 (NRDC, 1954). Interestingly the form of agriculture did not change in response to the mine developments in order to supply the increasing local demand for milk and fresh vegetables. This being due to the shortage of water and the cold winters (NRDC, 1954). With the railways servicing the settlements, milk and vegetables could be brought in from established diary and vegetables farms in the vicinity.

5.4 Political and legislative change

The discovery of gold in the Free State provides a useful illustration of the interplay between legislation and the landscape. The discovery of gold, the rapid development of the region and the experience of mineral based development in the Witwatersrand prompted the development of new legislation, which regulated the physical development of the landscape. The earlier mentioned Orange Free State Metals Mining Act, Act 13 of 1936, was implemented to regulate mining and the new Natural Resources Development Act, Act 51 of 1947, developed to regulate spatial planning.

At the time of the discovery of gold in the Free State the development of mine settlements was regulated by the Precious and Base Metals Act of 1908, as amended and applied to the Free State by the Orange Free State Metals Mining Act of 1936. When this Act came into force (1908) deep level mining was in its infancy and only relatively small mining communities had to be provided for. While it did allow for the establishment, on mining land, of houses, trading stores, schools, churches and other public buildings, hotels, garages, theatres, bottle stores and other facilities necessary for a large modern urban community were not allowed. Mine employees would also have no freehold title to houses on mining land. In addition, the development of housing on mining land was not subject to other legislation relating to urban planning and development (NRDC, 1954). It was in this context that the Natural Resources Development Act was enacted.

The Natural Resources Development Act made provision for the creation of the Natural Resources Development Council (NRDC) which was to oversee the planning of housing for the urban population in so-called controlled areas. According to the Act, this regional committee would comprise three members selected by the Minister of Economic Development, two for their knowledge of, and interest in, regional planning and one for their knowledge of and interest in agriculture. The Administrator of the province would nominate two members (Union of South Africa, 1947). This

Council succeeded an ad hoc 'Advisory Committee on Development in the Northern Free State', and was the first regional planning body established in the country with significant, if limited, powers (Mabin, 1992). It had powers '*not only to co-ordinate the activities of other planning bodies, but, in 'controlled areas'… no township development could take place without its approval*' (Mabin, 1992, p.418). The Free State goldfields was the first controlled area, with boundaries defined in the Act. The Act also allowed for coordination of government activities, bearing in mind that housing, transport, power, water and other services had to be provided to the rapidly developing goldfields (NRDC, 1954). The controlled area, originally declared in 1947, was enlarged in 1950 to include the area between the Vet and Vaal Rivers contained roughly in the triangle formed by Vereeniging, Bothaville and Winburg. This was to address the '*undesirable developments'* along the borders of the original area (NRDC, 1954, p.2).

As discussed, the NRDC laid down certain principles of planning for the orderly development of the goldfields, including the preference of having a number of average sized towns rather than a single large city or, on the other extreme, a number of dispersed mining settlements. It was also in a position to initiate planning for the general allocation of land uses and exercised this power with respect to racial zoning (Mabin, 1992), as can be seen in the establishment and location of the new black townships of the Free State goldfields. This was entrenched with the passing of the Group Areas Act of 1950, following the election of the NP in 1948. According to this Act, urban areas were to be divided into racially segregated zones where only specific races could live and work, making it a criminal offence for a member of one race group to live or own land in an area set aside for another race group (Steyn, 2005).

The focus of environmental action at the time was on the preservation of wilderness areas and particular plant or animal species (Steyn & Wessels, 2000). There were no requirements directly regulating how mining and settlement development impacted the environment. Any environmental considerations were incidental and largely to minimise nuisance, for example locating mine dumps furthest away and downwind from the white settlements.

The implications of the 1948 NP election victory and their policy of apartheid, had already started to influence spatial planning, as discussed. However, the impacts were most profound during the next period of this study and so are discussed in more detail in chapter 6.

5.5 Natural and spatial change

The initial development of the goldfields was shaped by the geomorphology of the landscape. For example, Koppie Alleen, being the highest point, was important in the reticulation of water. Water pumped from the Vaal River was stored in service reservoirs here before being gravity fed to the new towns and mines. The settlement of Virginia was located on the higher lying areas, with the areas along the Sand River demarcated for recreation. Other natural features, such as the steep geothermal gradient and presence of methane necessitated ventilation shafts in close proximity to the main shaft. The presence of saline groundwater restricted shaft development and in order to manage the vast quantities the mines acquired additional land to evaporate the water. This is the concept of environmental control, which states that landscapes are closely related to the physical environment (Lewis, 1979). What is not mentioned as a consideration in the initial development of the landscape was existing residents, apart from those already settled in Odendaalsrus. Land development at the time seemed to have considered the land as void of people, in particular, native people.

Rainfall in this area of the Free State is variable, and this was the case between 1945 and 1955. The Free State goldfields experienced two years of very low rainfall in 1945 and 1949. With the period of 1949 to 1952 being a prolonged drought. This aligns with an El Nino period (1951 to 1954), where, for the Free State as a whole, the rainy season is shorter than normal and seasonal rainfall is lower (Moeletsi et al., 2011). This would have impacted on mining development.

5.6 Summary of landscape changes between 1945 and 1955

The developments of this period are depicted in *Figure 27*. The key to this map is as follows:

Settlements	**Mines**	**Other points of interest**
A - Allanridge	1 – Loraine	New railway line to Odendaalsrus
B – Odendaalsrus	2 – Jeanette	
C - Riebeeckstad	3 – Freddies Consolidated	
D - Welkom	4 – Free State Geduld	
E – Thabong	5 – Western Holdings	
F – Virginia	6 – Welkom mine	
	7 – President Steyn	
	8 – President Brand	
	9 – St Helena	
	10 – Harmony	
	11 – Virginia	
	12 – Merriespruit	

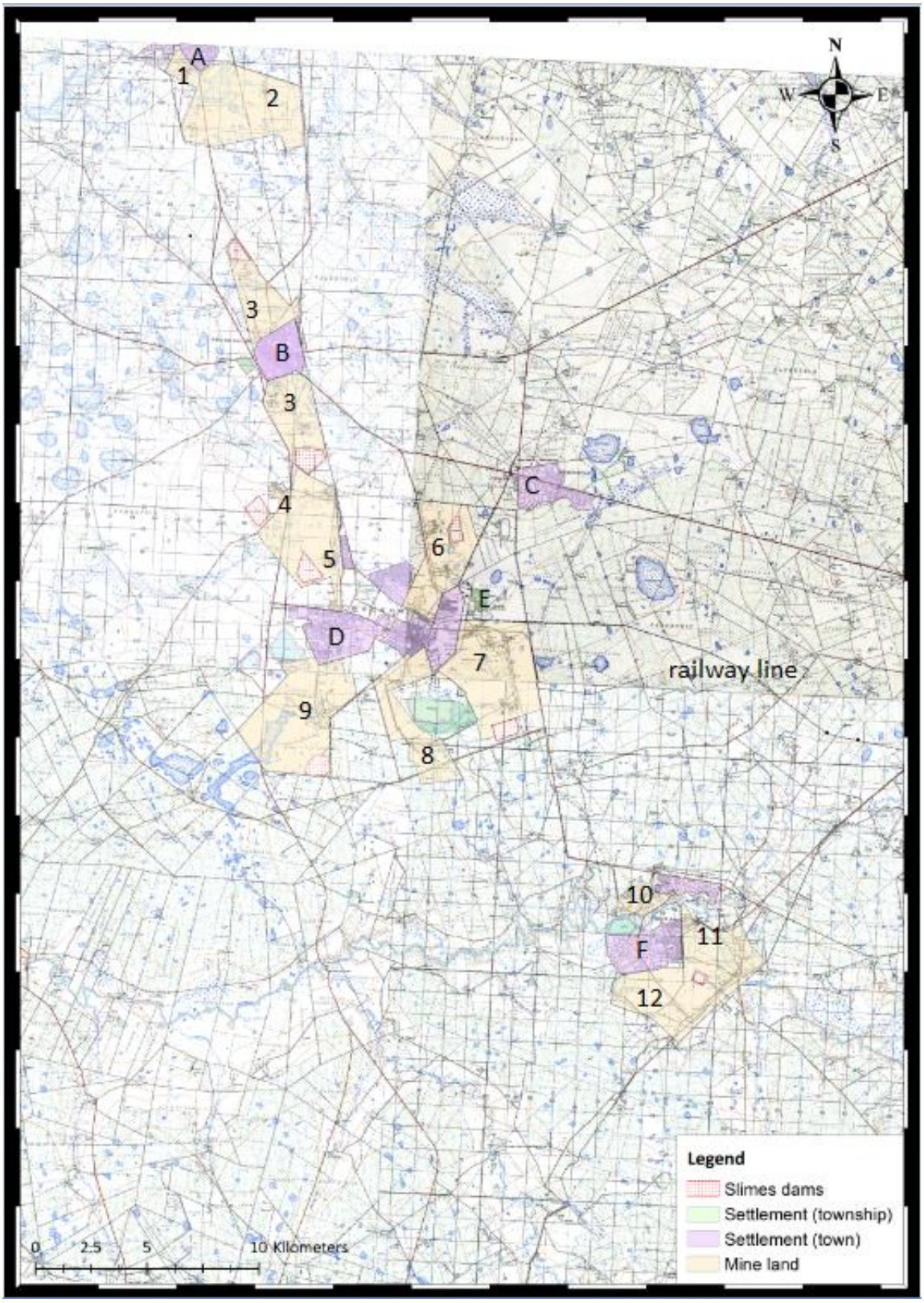

Figure 27. Landscape elements and their extent in 1955 (maps 2726DC Odendaalsrus, 2726DD Riebeeckstad, 2826BA Bloudrif and 2826BB Virginia)

Chapter 6

6. Landscape change in the Free State goldfields from 1956 to 1975 – Rapid growth

The second period of the development of the Free State goldfields, extending over 20 years, sees further growth of the area, with an expansion of the new settlements along the existing plans, the relocation of two black settlements and growth of the mines. During this period gold production in the Free State peaks, but along with this was the increasing impact of mine waste, in the form of tailings storage facilities and extensive evaporation pans for the saline ground water that was hampering mining. This growth took place in the context of changing political power in South Africa, the continued formalisation of apartheid and the consequent international isolation, and the first shoots of global environmental awareness. Some of the major local and international events are noted in *Table 9* and the landscape elements are summarised in Figure *47*.

Table 9. Timeline of the development of the Free State goldfield between 1955 and 1975

1954-1958	Bad drought in the region
1956	Mines and Works Act, Act 27 of 1956 promulgated
1956	Welkom airport established
October 1956	Merriespruit mine (shaft 1) flooded, with 10 fatalities. The shaft closes.
January 1957	Industrial area of Virginia proclaimed
1958	Verwoerd becomes Prime Minister
1958	Experimental water demineralisation plant erected in Free State Geduld. As it proved uneconomic it was put on care and maintenance in 1961.
April 1959	Virginia magisterial district declared
1960	Free State Saaiplaas mine start producing gold
March 1960	Allemanskraal dam completed, as part of the Sand-Vet irrigation scheme
March 1960	Sharpeville massacre following protests against pass laws
January 1961	Welkom becomes a municipality, with first town council elected
1961	Construction of Bronville, the goldfields' coloured township, starts
31 May 1961	South Africa becomes a Republic
1961	Production at uranium plants suspended due to global over-supply
1963	Freddies, Geduld and Western Holdings pooled production
1963-1964	Rivonia Treason Trail
1966	Verwoerd assassinated, Vorster becomes Prime Minister
February 1968	Official opening of the Civic Building Complex in Welkom
1969	Flooded Merriespruit mine reopened
1971	The USA abandons the gold standard
1972	Gold price booms
1972	Stockholm Convention on the Human Environment, focussing on the preservation and enhancement of the human environment and ultimately establishing the United Nations Environmental Programme (UNEP)
1975	Seven Free State mines ranked in top 20 global gold produces

6.1 Mining development

By 1956, 12 mining companies had been formed (following the merger of the two Freddies mines) to develop operations across the new Free State goldfields, sinking 25 shafts. Between 1956 and 1967 the production of gold more than tripled, increasing by between eight and 22 percent annually. Gold production in the Free State peaked at 350,823kg in 1970, over a third of South Africa's production (*Figure 28*). 1970 was also the year in which South Africa's gold production peaked, accounting for 78 percent of global output (Viljoen, 1994). By 1975 seven of the Free States mines were in the top 20 producers globally (*Table 10*). The sinking of additional shafts and two new mines further changed the landscape, but it was the waste from the increased production and the need to evaporate saline water, that contributed most to expand the footprint of mining between 1956 and 1975.

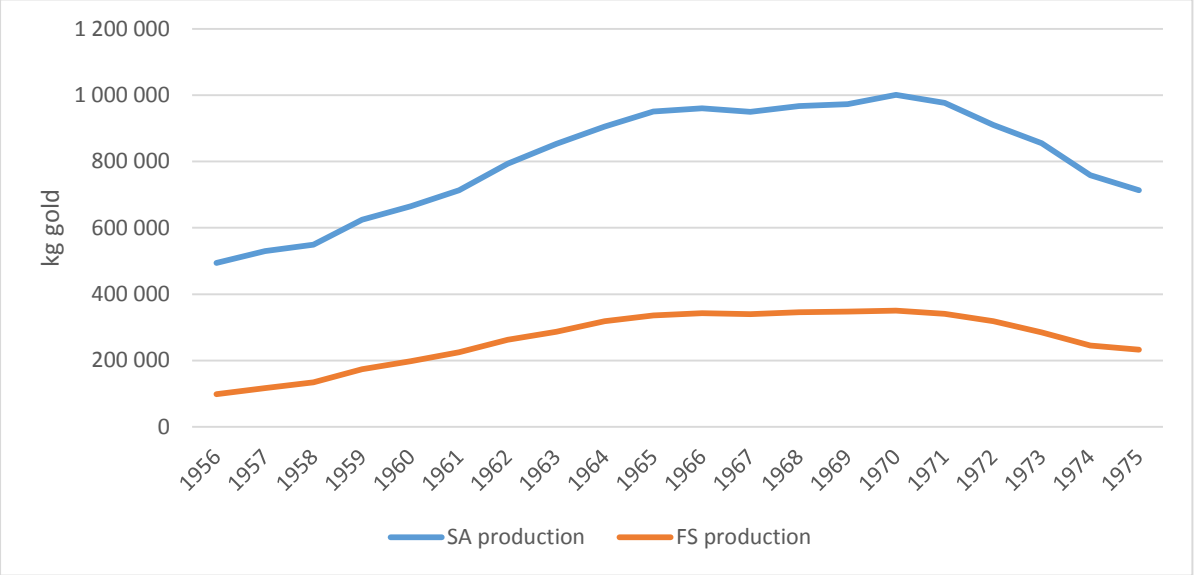

Figure 28. Gold production in the Free State, compared to total South African production (Gregory, 1962; Department of Mines, 1960 to 1974; MCSA, 2020)

Table 10. By 1975 a number of Free State gold mines ranked as the highest produces globally (Ericsson & Tegen, 1988)

Global Rank	Producer/Mine	Production (kg)	Share of Western world production (percent)
4	Western Holdings	40,231	3,7
5	President Brand	40,070	3,7
6	FS Geduld	39,098	3,6
8	Harmony	31,011	2,8
11	St Helena	25,533	2,3
15	President Steyn	17,661	1,6
20	Welkom	14,043	1,3

6.1.1 New developments, some closures and consolidation

The Free State Saaiplaas Gold Mine was the first new mine during this period, the company being registered on 14 June 1955 by the Gold Fields Company of South Africa. The mine was located between Welkom and Virginia, bordering President Steyn mine to the west. Shaft sinking started in 1957. Here again the steep geothermal gradient, and so need for adequate ventilation, influenced the type and size of the two shafts sunk (Merricks & Thompson, 1958). Production commenced in 1960. The sinking of a third shaft started in October 1975, following the takeover by AAC, in 1965 (Viljoen, 1994).

Around this time, a number of existing mines were sinking additional shafts (see Table 11). A second Harmony shaft was sunk in September 1956, going into production in 1958. Western Holdings No. 3 shaft was completed in 1958 with Geduld No. 4 shaft and President Steyn No. 3 shaft both being completed in 1962. The President Steyn No. 3 shaft was bought by President Brand mine in 1968 to allow them to mine an area east of one of the faults (Stuirmanspan), it was renamed President Brand No. 4 shaft. The President Steyn No. 4 shaft came into production in 1971. Excavations for the second new mine, Unisel, commenced in September 1974. This mine, a joint venture between Union Corporation and Selection Trust Limited, located directly south of President Steyn Mine, was to come into production in 1979 (Greathead & Graadt van Roggen, 1986; Handley, 2004).

Uranium production started in the Free State in 1955, from the Welkom, President Steyn, Virginia and Harmony mines. Loraine mine was also accepted as a uranium producer in 1956. However, production was suspended in early 1961 following an agreement with the South African Atomic Energy Board, due to production costs being high and a looming over-supply of the global market (Fleischer, 1968; Greathead & Graadt van Roggen, 1986).

Relatively early on in the development of the goldfields it became evident that not all mines were as productive as hoped - of the 13 mines initially opened four were good, four were bad and five were average (Greathead & Graadt van Roggen, 1986). The Jeanette mine of AAC was a failure (Sander, 2000) with development being suspended in 1955 (Handley, 2004). The mine infrastructure around Jeanette shaft No. 2 was converted to a tuberculosis (TB) hospital (*Figure 29*). The prevalence of TB amongst gold miners was very high due to their exposure to silica dust underground (te Water Naude et al., 2006). The Riebeeck Gold Mining Company, which started sinking the first shaft of their Riebeeck mine in 1957, had to merge with the neighbouring Loraine mine in 1958. This shaft became Loraine No. 3 (Greathead & Graadt van Roggen, 1986). As discussed in the previous section, the two Freddies mines of JCI also struggled and so were consolidated to form Freddies Consolidated Mines Limited in 1954. However even after this rationalisation, mining could still not be brought on to a profitable basis. And so, in 1963 the neighbouring mines of Geduld and Western Holdings (both part

of the AAC group) took over the entire issued share capital of Freddies. Between them they sent sufficient high-grade ore for treatment at Freddies mine to enable it to continue production for at least another eight years. In this way the total closure of the mine was prevented, although the Freddies South shafts and infrastructure was demolished, as illustrated in the 1975 topographical map (*Figure 30*). The Freddies lease was eventually acquired by, and merged with, Free State Geduld (in 1977) (Greathead & Graadt van Roggen, 1986; Sander, 2000).

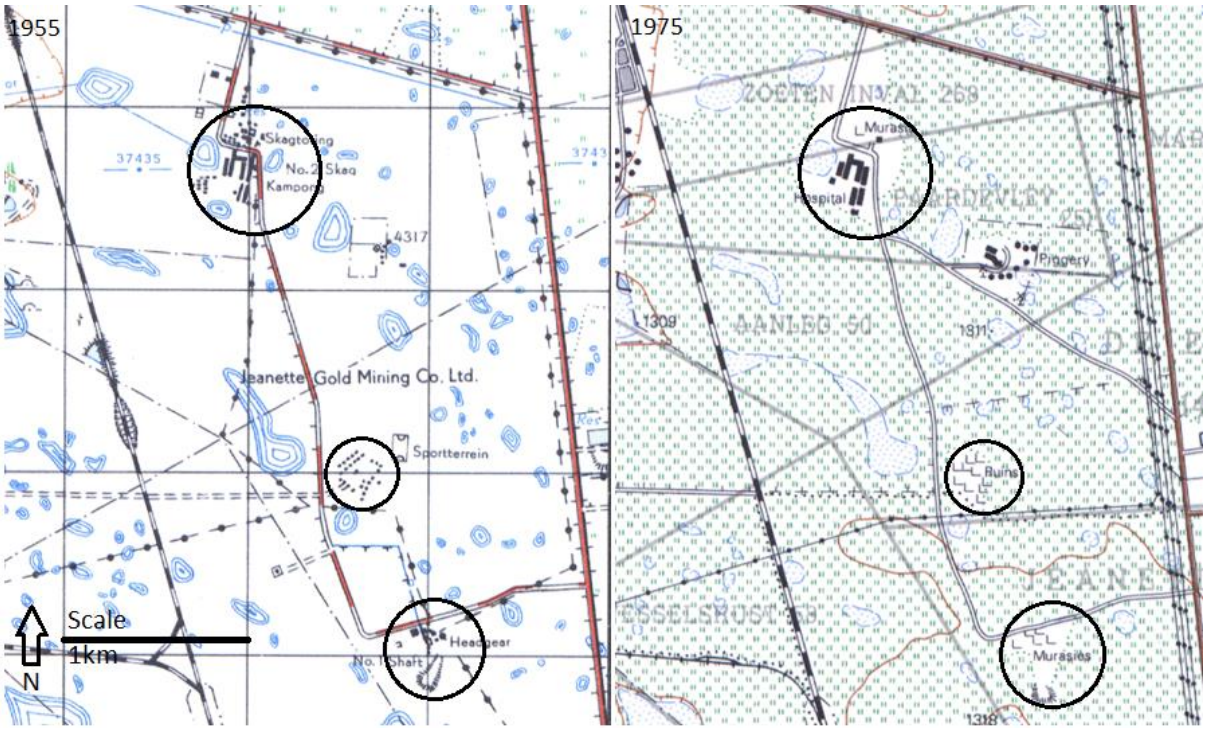

Figure 29. The Jeanette gold mine was a failure. Development was suspended in 1955, with the demolition of infrastructure leaving ruins ('murasie' in Afrikaans) on the landscape, evident on the 1975 topographical map and highlighted by the black circles (map 2726DC Odendaalsrus)

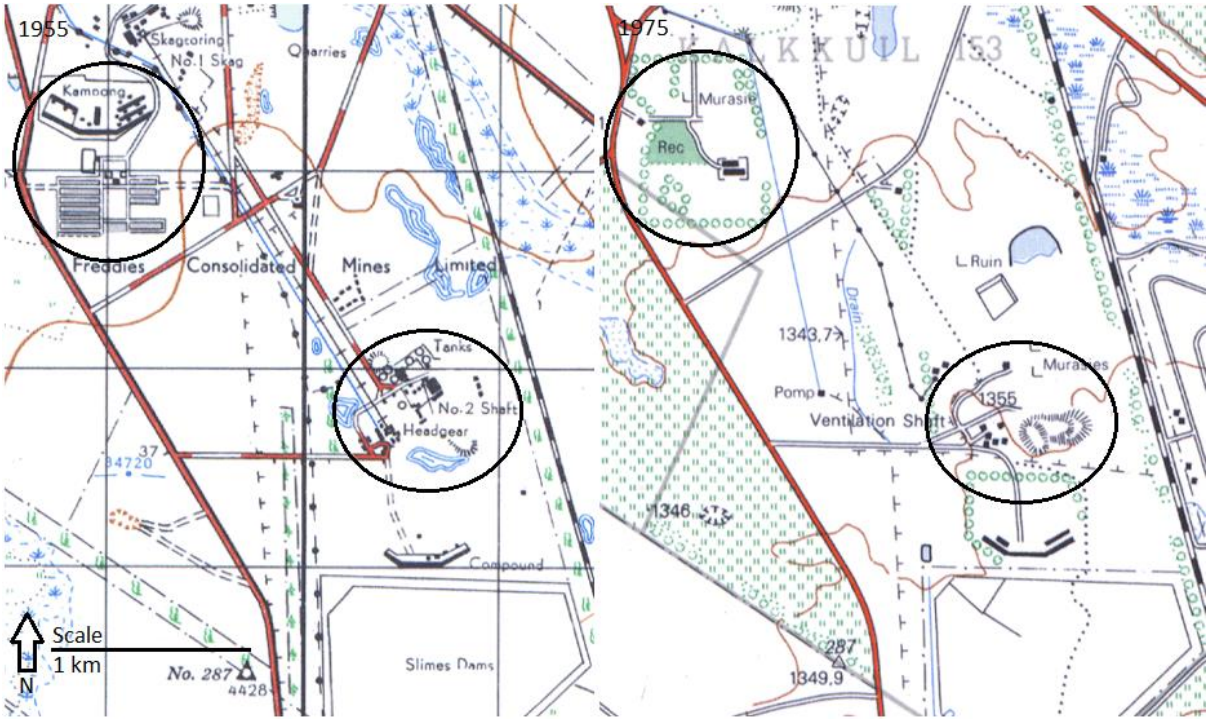

Figure 30. The original Freddies South shafts and infrastructure, in place in 1955, were demolished by 1975, as highlighted by the black circles (map 2726DC Odendaalsrus)

In the south of the goldfields, recognising the potential benefits of amalgamation, Harmony acquired the entire capital of Merriespruit and Virginia Gold Mining Companies, resulting in consolidation into a claim area of 99.3km^2 in 1973 (Greathead & Graadt van Roggen, 1986). These developments, up to 1975, are summarised in Table 11.

Table 11. Gold mines in the Free State by 1975 (AAC, 1950; NRDC, 1954; Fleischer, 1968; Greathead & Graadt van Roggen, 1986; Viljoen, 1994; Handley, 2004)

Controlling Company	As at 1955		As at 1975	
	Original mines	Date of production	New/further development	Date
Union Corporation Ltd.	St Helena Gold Mines Shaft 3 and 4	1951	?	
Anglo American Corporation of South Africa	Welkom Gold Mining Company, Ltd, shaft 1 (N) and 2 (S)	1951		
	Western Holdings Ltd, shaft 1 (N) and 2 (S)	1953	Shaft 3 Shaft 4	1958 - production 1969 - production
	Free State Geduld Shaft 1 (w) and 2 (E)	1956	Shaft 4	1962 - production
	President Steyn Gold Mining Company, Ltd Shaft 1 (N) and 2 (S)	1954	Shaft 3	1962 – production 1968 - transferred to President Brand

				to become shaft no.4
	President Brand Gold Mining Company, Ltd Shaft 1 (N) and 2 (S)	1954		
	Loraine Gold Mines, Ltd Shaft 1 and Shaft 2	1955	Taken over by Riebeeck Mine (Anglo Transvaal)	1958
	Jeanette Gold Mining Company, Ltd	Suspended in 1955		
	Freddies Consolidated Mines Ltd. (initially two mines, Freddies North (2 shafts) and Freddies South (2 shafts), merged in 1954)	1953	South shaft 1 abandoned Merged production with Geduld and Western Holdings	1956 1963
New Consolidated Gold Fields, Limited Taken over by AAC in 1965			Saaiplaas Shaft 1 and shaft 2 Shaft 3	 1960 - production 1975 - development
Central Mining and Investment Company	Harmony 2 shafts (Shaft 3 and ventilation shaft)	1954	Shaft 2	1958 – production 1973 – consolidated with Virginia and Merriespruit
Anglo-Transvaal Consolidated Investment Company Ltd	Virginia Gold Mining Company Shaft 1, 2 and 3	1954		1973 – consolidated with Merriespruit and Harmony
	Merriespruit Gold Mining Company Shaft 1 and 2	1956	Shaft 1 flooding	1956 - closed 1969 - reopened 1973 – consolidated with Virginia and Harmony
			Riebeeck Gold Mining Company Limited	1957 - development 1958 - merged with Loraine
Union Corporation and Selection Trust			Unisel	1974 - development

6.1.2 Difficult times for gold mining in South Africa

With increasing depth, the working costs of the mines increased. This was the case in the Free State mines, as reported in the 1963 annual report of Western Holdings (Greathead & Graadt van Roggen, 1986). At this time the price of gold was still fixed, at USD35 an ounce, and actually declining in real terms (Crush et al., 1991). The consequence of this was that mines had to absorb cost increases and gold mines across South Africa were at risk of closing. There were calls on government to act, and as a consequence there were a series of interventions to assist low grade and vulnerable gold mines.

In 1963 the Minister of Mines announced support for mines on the East and Central Witwatersrand in the form of a pumping subsidy, to meet the costs of pumping out water threatening them from the neighbouring closed mines. Recognising that the issue was broader than just mines in those

areas, in 1964, the government announced the granting of loans to assist other mines to keep operating. The motivation being that *'This will not only help the mine employees but also give more time to the communities serving these mines to adapt themselves to changing conditions. It will permit a considerable quantity of gold to be mined which would otherwise be lost to the country, and will enable the relevant mines to resume full and profitable production if and when the price of gold is increased.*' (Minister of Finance (1964), in Border, 1981, p.340).

Following an investigation into the case of vulnerable gold mines, industry presented a memorandum '*The role of the gold mining industry in the future of South Africa*' to government in 1966. This included suggestions and recommendations for greater state assistance, which formed the basis of the Gold Mines Assistance Act (Act 82 of 1968). This Act provided for tax relief in a case of a mine that pays tax, or direct financial assistance for mines that operated at a loss or had a low profit margin and so did not pay tax (Border, 1981). A further initiative was the minting of the Kruger Rand in 1968, a means of allowing the 'man on the street' to own gold and so increase the demand (Handley, 2004). According to Border (1981) these schemes were generally successful at preventing mine closures and community disruption associated with closure. It is unclear from the literature reviewed which Free State mines, if any, benefited directly from these initiatives.

The fate of the gold mines changed in the early 1970s when the United States left the gold exchange standard, as established by the Bretton Woods Agreement. By 1975 the price has increased to USD162 per ounce. The devaluation of the rand (in 1975) also benefited the mines. This made it profitable to mine lower grade ore and so extend the life of the mines (Greathead & Graadt van Roggen, 1986).

6.1.3 Mine waste – tailings and saline water

The two most noticeable physical changes to the landscape of the Free State goldfields during this period, directly attributable to mining, was the increasing size of the tailings facilities and the use of large tracks of land as evaporation ponds. Both these have lasting pollution impacts, related specifically to high concentrations of sodium, chloride, sulphate, calcium and to a lesser extent, heavy metals, cyanide and other organic constituents used in the gold extraction process (Cogho et al., 1992). Being long-term, if not permanent, features they also render land unproductive.

With the steady increase in gold production, waste from the reduction works (tailings) increased and the tailings storage facilities grew, as illustrated in *Figure 31* for the Geduld and Western Holdings

Mines. Mine tailings is the waste product from the production process, and is made up of finely ground rock and chemicals used in the reduction process. Depending on the effectiveness of the process, there may also be small quantities of gold left in the tailings. The mine waste is suspended in water and pumped to a tailings dam for disposal. Siting, design and management of tailings dams are key to limiting their pollution impact. They should be sited on impervious, stable geology, which is free from faults, fractures and intrusions. Many of the Free State goldfield disposal sites were sited without investigations (Cogho et al., 1992), rather considering proximity to the newly developing white settlements. The reduction plant and tailings facilities for each of the mines were located at the shaft furthest away from the settlement, to limit dust and nuisance.

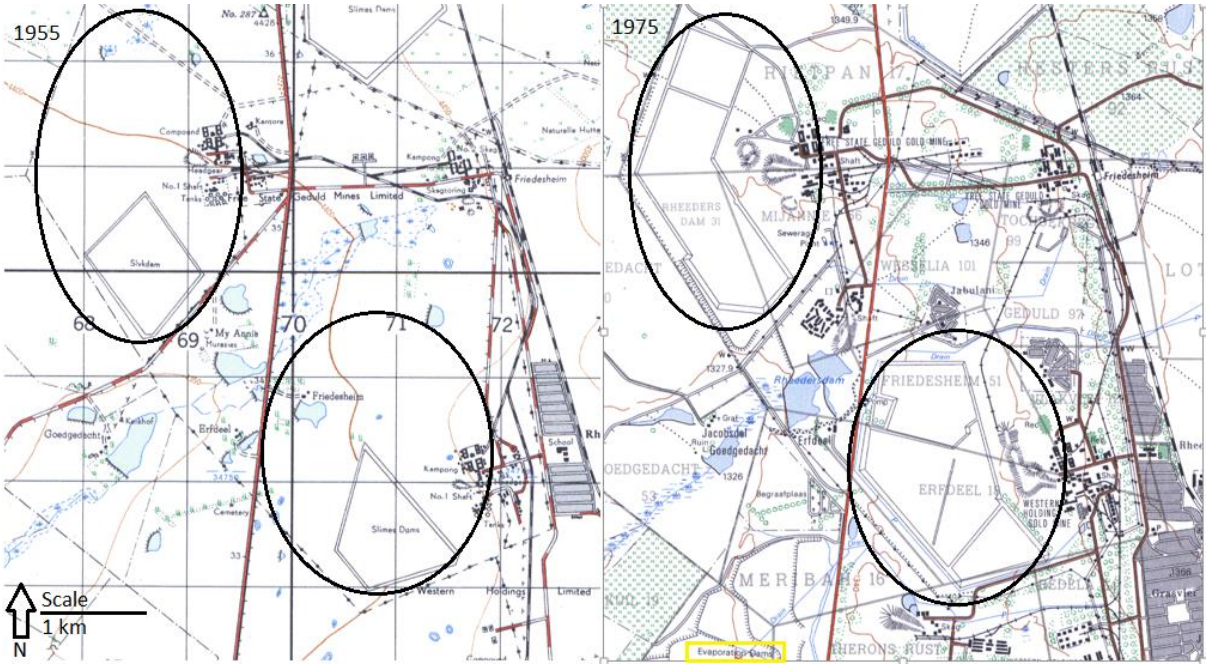

Figure 31. Expansion of tailings storage facilities between 1955 and 1975 on the Geduld and Western Holdings mines, highlighted by the black circles. The evaporation pans (highlighted in yellow) used by these mines are also visible on the 1975 map (map 2726DC Odendaalsrus)

Extensive groundwater continued to be a problem for the Free State mines, and on 19 October 1956 Merriespruit No. 1 shaft flooded, when water burst from a fissure (2 metres x 1.4 metres) at a rate of 2.2million litres per hour. The pump chambers were flooded and concrete plugs, installed to keep the water down, failed. The mine was flooded by 400 million litres of water, rising up to 180 metres below the surface, drowning 10 men. The shaft was subsequently closed. Dewatering of the mine started in 1963 through a collective effort from all three mines in the area (Virginia and Harmony, with Merriespruit), it was reopened in 1969 (Greathead & Graadt van Roggen, 1986).

Across the Free State goldfields the mines continued to pump out excess saline groundwater on a daily basis. They were not permitted to discharge this water into the Sand River and, due to the high salt content, it was of little use for agricultural production or in the mines. As a consequence the mines purchased large areas of land and constructed many miles of canals and dams to evaporate the water. The extent of the evaporation pans around some of the mines is evident from the maps and aerial photographs of the time (*Figure 32* and *Figure 33*). However, a report from the Interdepartmental Committee on Mine Water (OFS), recommended that these evaporation fields be dispensed with and that all the water from underground rather be pumped into natural pans where, after evaporation, the salt could be recovered (Department of Mines, 1964). Based on the topographic maps and aerial photographs subsequent to this, it does not appear that this was immediately implemented.

Figure 32. The extensive water management and tailings storage facilities at President Brand and President Steyn mines in 1968 (aerial photo 606_012_00387)

Figure 33. The evaporation pans at St Helena mine in 1963 (aerial photo 490_006_00206)

A further solution to the excess saline water, which was investigated by the mining groups together with the CSIR, was treating it. Through a process of electrodialysis they were able to remove the salts. An experimental demineralisation plant was erected on the Geduld mine property in 1958. The plant was a scientific achievement and was able to supply all fresh water requirements to both Geduld and Western Holdings mines and a large proportion of water needed in the Welkom uranium plant (Fleischer, 1968). However, as it was not possible to reduce unit costs and as the disposal of underground water became less urgent in this immediate area, it was decided to suspend operations and to place the plant on care and maintenance in 1961 (Greathead & Graadt van Roggen, 1986).

6.1.4 Mine labour

With the established mines coming into full production and two new mines being developed, mine labour increased significantly. In 1956 there were 57,257 black mine workers, and 8,262 white workers. This increased to 93,759 black mine workers and 10,154 white workers in 1965 (Department of Mines, 1956; Department of Mines, 1965). At the time of peak gold production in 1970, the number of black worker across all Free State mines totalled 100,400 (Wilson, 1972) (*Table 12*).

Table 12. Labour on the Free State gold mines (1970) (Wilson, 1972)

Company	Mine	Black labour December 1970
Union Corporation Ltd.	St Helena Gold Mines	9,600
Anglo American	Welkom Gold Mining Company, Ltd	9,500
	Western Holdings Ltd	10,800
	Freddies Consolidated Mines Ltd.	3,300
	President Steyn Gold Mining Company	11,000
	President Brand Gold Mining Company	11,700
	Free State Geduld	10,200
	Loraine Gold Mines, Ltd	7,500
Central Mining and Investment Company	Harmony	14,200
Anglo-Transvaal Consolidated Investment Company Ltd	Virginia Gold Mining Company	7,800
	Merriespruit Gold Mining Company	unknown
New Consolidated Gold Fields Ltd	Free State Saaiplaas	4,800
	Total	100,400

Black labour continued to be housed in hostels associated with each mine. Towards the end of this period there is an indication that the system was shifting to a more stable work force with mine workers extending their contracts or returning for further contracts on the same mine (Greathead & Graadt van Roggen, 1986).

6.2 Urban and infrastructural development

6.2.1 Infrastructure

When comparing the topographical maps of 1975 with 1955 it is evident that infrastructure (roads, powerlines, mine rail lines) were further developed along the foundations set out during the original design and layout of the towns and mines. With the growth of Virginia, a weir was constructed in the Sand River and completed in December 1967, presumably to augment supply to the town and mines, and possibly part of the Sand-Vet irrigation scheme. This kept the level of the water upstream of the weir high. The existing aerodrome was upgraded to an airport in 1956. At this stage 700

passengers and 45 tons of freight were transported to and from Welkom every month (Fleischer, 1968).

6.2.2 Settlement – Growth and resettlement

The planning of the three new towns was largely completed by 1955, with the road networks laid out and some of the early suburbs established with houses, schools, shops and other facilities. From 1955 this development continued apace, but largely within the existing footprint of the settlements. This was not the case with the black townships. To accommodate the increasing number of people moving to the goldfields for job opportunities three new black settlements were established, these were Phathakahle, adjacent to Allanridge, Meloding, outside Virginia, and Kutlwanong, a resettlement from the existing township of Marobe at Odendaalsrus. A new 'coloured' township, Bronville, was also established. The different approaches to planning and the consequent structure of these settlements, compared to those of the white towns, is evident. This was the nature of apartheid planning. Also very evident is the proximity of the mines, the tailings storage facilities and the evaporation pans to the new settlements.

Welkom

With the structure of Welkom having been laid out during the planning and development of the 1950s, this period involved development within this structure, building more homes, business premises, schools. As the town flourished, the population increased (*Figure 34*), with a greater proportion not being linked to the mines. In 1955 a third of the white population were not in the employ of the mines (Fleischer, 1968).

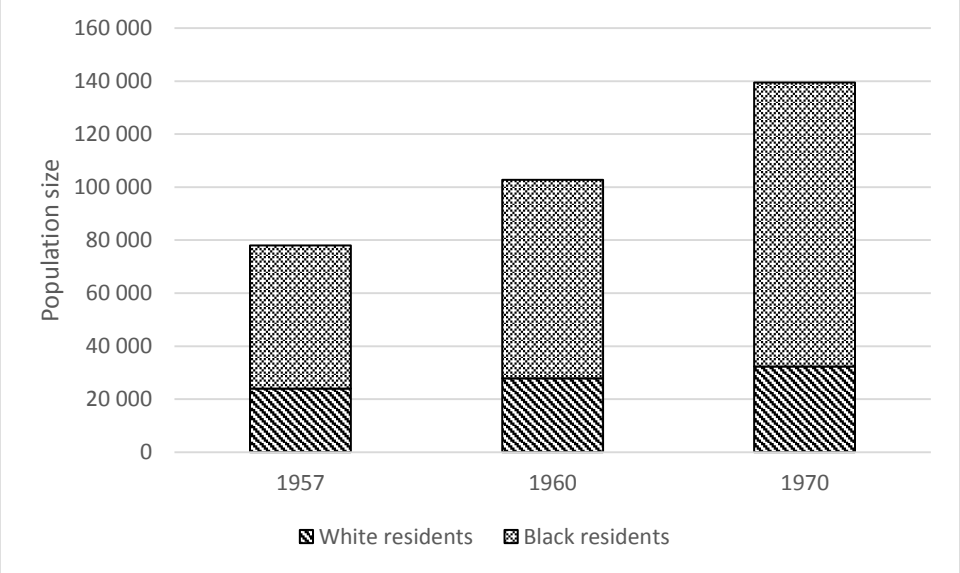

Figure 34. Population of Welkom (ACC, 1957; Central Statistical Services, 1960, Central Statistical Services, 1970)

Distinctive of the Welkom landscape is the civic centre, overlooking horseshoe shaped gardens. The civic centre was designed in 1955 and officially opened in February 1968. It consists of three main elements, the office block housing all the administrative functions and council chamber, a banqueting hall and the civic theatre, located behind the clock tower (Fleischer, 1968). *Figure 35* illustrates this distinctive feature of the Welkom urban landscape. During this time Welkom grew to include seven government primary schools, three government secondary schools, four primary and secondary private schools, a Technical College and Commercial High School. A new hospital officially opened on 20 November 1964 (Fleischer, 1968).

Figure 35. Welkom in 1963, illustrating significant growth in St Helena, Bedelia and Doorn, the first suburbs to be established. The civic centre and horseshoe shaped gardens are a distinctive feature of the Welkom urban landscape (aerial photo 490_005_00228)

In 1961 the town clerks of the surrounding towns agreed that Welkom should be the site for the goldfields' coloured township. In terms of the Group Areas Act, Welkom was given the responsibility to develop Bronville, on a portion of the farm De Bron immediately adjacent to the President Steyn mine, and south of Thabong (*Figure 36*). Bronville was included in the Welkom municipal area in 1965 (Viljoen, 1994).

Figure 36. The establishment of the new 'coloured' township, Bronville, in 1968. The location of the Welkom drive-in is also indicated (aerial photo 606_011-00272)

Thabong

The black township of Thabong continued to grow, with houses as well as community and recreational facilities being established. By 1968 there were 3,200 houses, housing 22,800 people and four hostels for 4,200 occupants. Tarred roads, a clinic, isolation hospital (for TB), police station, crèche, sport stadium, four tennis courts, children's playground, schools (secondary school, two lower primary and one higher primary school), and churches with electricity were developed (Fleischer, 1968).

Allanridge

Initially a second extension had been laid out at Allanridge, to accommodate the employees working at the two AAC mines. However, with the development of Jeanette being suspended in 1955, only a small portion of this extension was settled. This is evident from the 1963 aerial photographs in (*Figure 37*). A TB hospital was developed at the site of the Jeanette mine. By 1963 the black township of Phathakahle had been established to the south east of the town, adjacent to the Stinkpan.

Figure 37. Allanridge in 1963 (aerial photo 490_001_00429)

Virginia

As mining around the new town of Virginia started a little later than around Welkom, the development of Virginia only took off from 1958, but it grew very rapidly (Viljoen, 1994). Virginia was initially established to house employees from the Harmony, Merriespruit and Virginia, and later Saaiplaas, mines and had suburbs adjacent to each of these, in addition to a central and industrial area, which was proclaimed in 1957 (*Figure 38*).

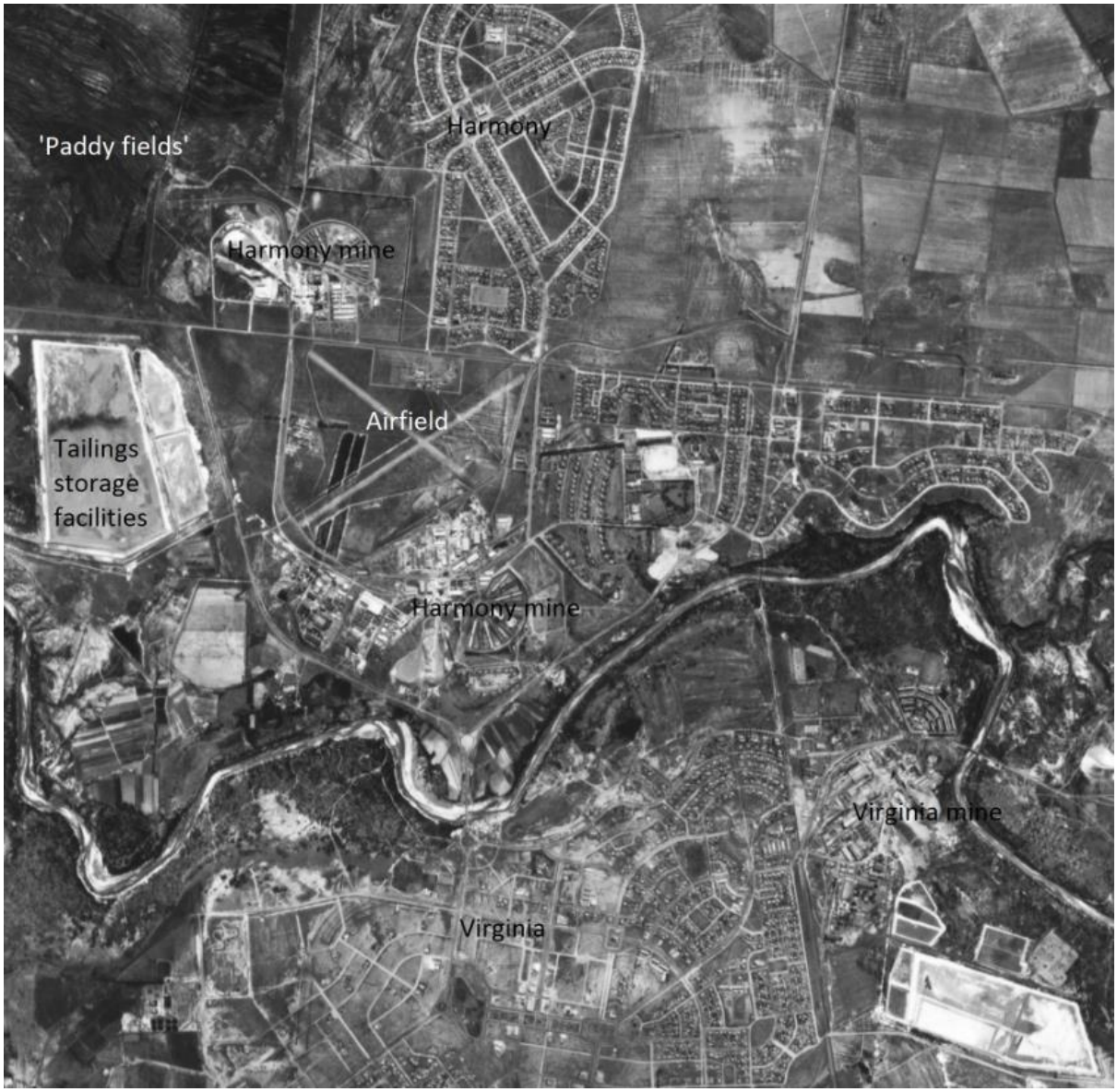

Figure 38. The 1963 aerial photograph of Virginia, showing the development of the Harmony suburb north of the Sand River, with the main town of Virginia largely laid out but not yet settled (aerial photo 490_007_00185).

By 1954, 600 houses had been built with a further 2,000 built in 1957. In 1958, 752 new houses were constructed in the Harmony suburb, with a further extension in 1960 and 382 houses built in Saaiplaas (Viljoen, 1994). As the Virginia News reported in 1961 '*This place is growing so fast that one should be able to hear it grow on a quiet night*'. On a monthly basis the Virginia News reported on the value of building plans passed, increasing from £686,645 in the first nine months of 1958 (Virginia News, 1958) to £740,000 for just September 1959. Comparable to the £1 million average of Johannesburg at the time (Virginia News, 1959). By December 1960 the value of housing was nearly £12 million, with the news headlines reading '*Nearly £12m home in Virginia today. Bare veld 10 years ago*' (Virginia News, 1960). Population increased along with this development (*Figure 39*).

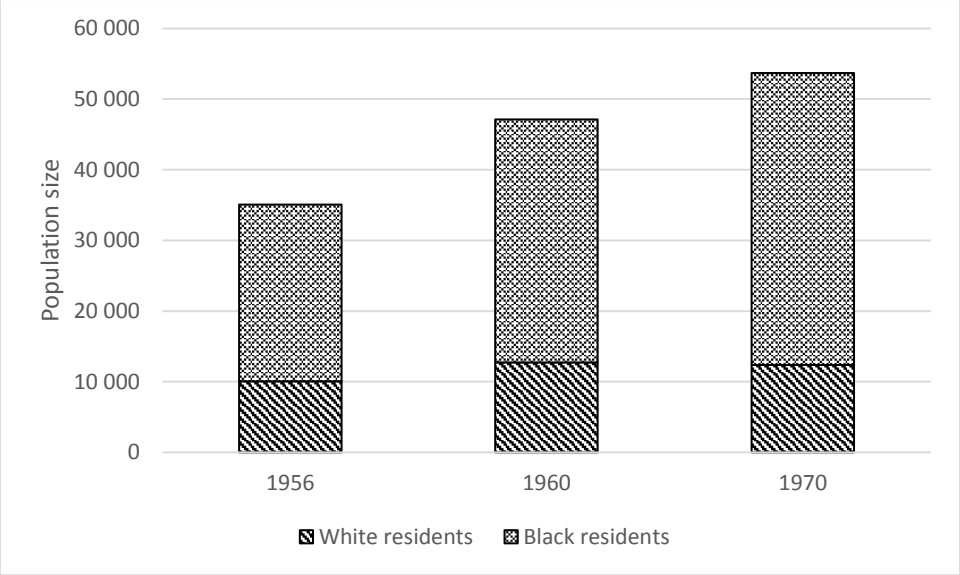

Figure 39. Population of Virginia (Muller, 1956; Central Statistical Services, 1960; Central Statistical Services, 1970)

As with Welkom, the planning of Virginia drew on the garden city principles popular at the time to create a modern town, as described by a journalist of the Virginia News, '*Though only nine years old, the impression of the visitor of to-day is one of painstaking thoroughness on the part of the town planners. Here indeed is a true 20th century town, with wide macadamised streets, exceptionally well lit at night. With parks and gardens and park-like traffic circles, it has transformed the wilderness*' (Virginia News, 1961). Transport services and infrastructure to the developing town improved. Along with the new railway station, an airfield was developed adjacent to Harmony mine.

During this period there were attempts to attracted other industries to Virginia, through reducing rates on industrial sites, providing electricity at ESCOM cost price and water at low cost. The central location of Virginia was also emphasised (Viljoen, 1994). However, this did not succeed. Rail tariffs and labour being important limiting cost factors.

Meloding

Settlement of Meloding started in the early 1950s even though it was only declared a township in 1956. During these early years the black residents of Linabo were resettled to Meloding by the government. Their proximity to the mines and the need for further development, being the given reasons. Subsequent development of the Virginia mines tailings storage facility was in close proximity to the settlement and cemetery, visible in Figure *40*.

Figure 40. The Linabo settlement cemetery, which pre-dates the mines, adjacent to the Virginia mines tailings storage facility, October 2016 (Source: Author)

During 1957, 335 economic houses were built and 212 stands were made available under the stand-and-service scheme, and a hostel of 60 units (each housing 16 people) was built (Viljoen, 1994). By September 1959 there were 793 completed houses and two hostels housing 2,000 people, and a new beerhall (Virginia News, 1959). *Figure 41* illustrates how removed Meloding was, relative to Virginia. With tailings storage facilities and a railway separating these two settlement. During 1964 a sports stadium, community centre and tar roads were developed in Meloding (Viljoen, 1994).

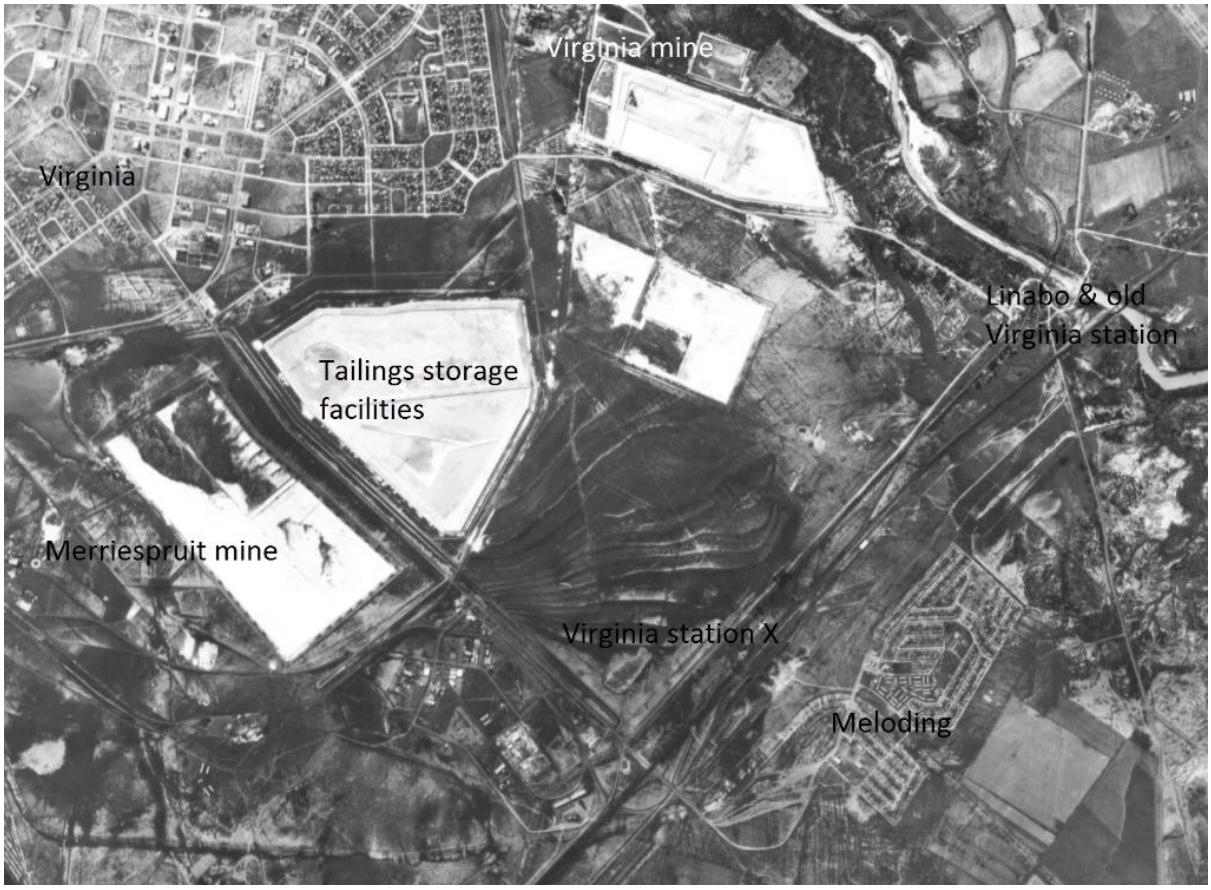

Figure 41. The newly established black township of Meloding in 1963, to the south east of Virginia town (aerial photo 490_008_02161)

Odendaalsrus

The geographical extent of Odendaalsrus did not change significantly over this period, but the areas where erven had previously been laid out were settled. The size of the white population decreased between 1960 and 1970, from 9,109 to 5,666. This was probably due to the consolidation of the two Freddies mines and the subsequent closure of the Freddies south shaft. The black population increased from 26,903 to 32,186 (Central Statistical Services, 1960; Central Statistical Services, 1970).

Kutlwanong - removal and resettlement

Alongside the building of new towns, was the breaking down of existing settlements. This was the case of Marobe, the black township of Odendaalsrus. It is understood that the black township of Marobe, also known as Marantha, located to the west of Odendaalsrus, developed alongside the original settlement of Odendaalsrus, and is evident on the aerial photograph from 1944, prior to the gold boom (*Figure 14*). However, the settlement was never formally laid out and was not surveyed or proclaimed (Anon, 1985). Key informant interviews indicated that Marobe was named after the local stream and comprised four sections, namely Old location, Sardins, Top location and Sofasonke.

According to the NRDC (1954) this settlement quickly proved inadequate when mining began, with overcrowding becoming a serious issue. It was decided by the Minister of Native Affairs (Hendrik Verwoerd) to rather move the township and in 1952 the farm New Kameeldoorns was bought by the Odendaalsrus municipality for this purpose (Anon, 1985). Interviews with current residents of Kutlwanong indicate that the reason for moving, rather than formalising and expanding the settlement, was as '*they were too close to the white area'* and '*to make way for the mines'*. This is in line with policy at the time which required a buffer between black and white settlements. The location of Marobe is also in close proximity to mined land. The footprint of the settlement is still visible in the 1963 aerial photographs (*Figure 42*).

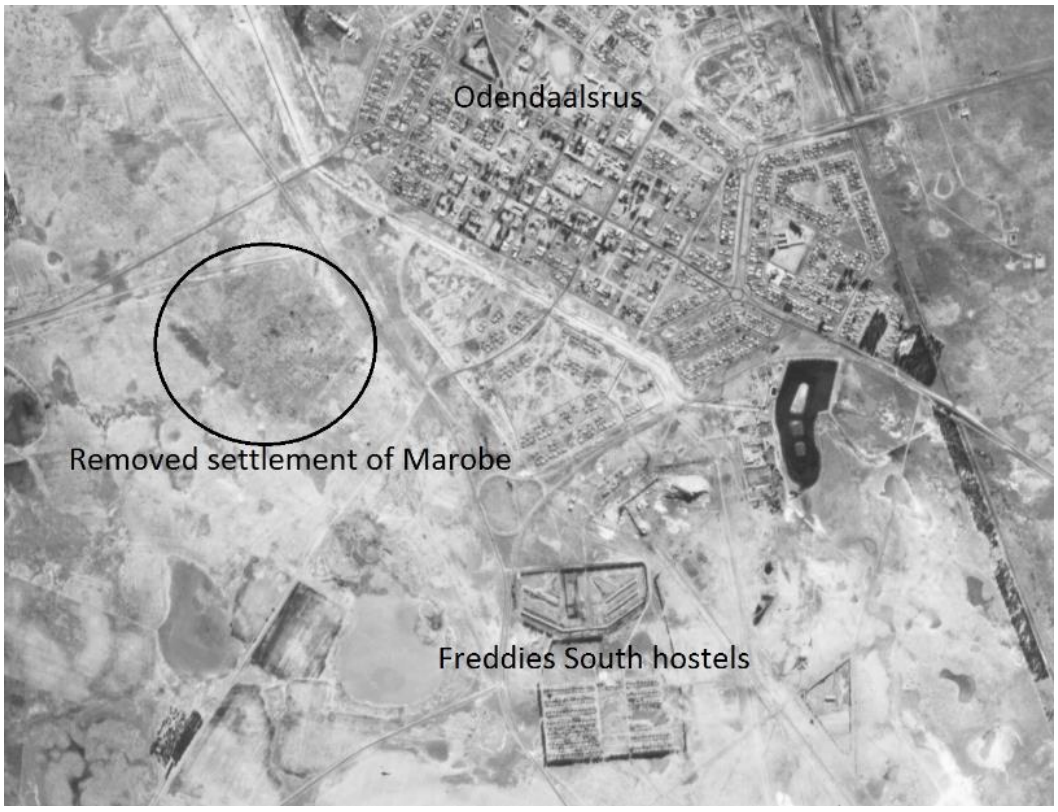

Figure 42. The black settlement of Marobe outside Odendaalsrus was relocated in the 1950s. The 1963 aerial photo shows the remaining footprint of the settlement after relocation (aerial photo 490_003_00022)

The new township, Kutlwanong (*Figure 43*), meaning 'working together' was established on 428 hectares of the farm New Kameeldoorns, to house between 30,000 and 36,000 people. The location of the settlement, to the east of Odendaalsrus, provided direct access to the industrial area and station, a deliberate planning decision also implemented in Welkom and Virginia. The first families were moved in 1955, with the first houses being offered on the stand-and-service scheme. According to an interview with a one-time residents of Marobe, the resettlement took place over a number of

years with batches of 50 people moving at a time. The last group moved in 1960. In 1961 the Department of Community Development provided a loan which was used to build 1,250 four-roomed houses. The first school and church where constructed in 1960, with a modern beer hall (1962), community hall (1964) and swimming pool (1965) being completed. By 1969 there were five schools (Anon, 1985).

This resettlement is one of few recognised forced removals to have taken place under the Group Areas Act in the Free State and a restitution claim involving 435 claimants was settled in 2006 (Commission on the Restitution of Land Rights, 2007). In response to a parliamentary question (2298) the pay out to the Marobe claimants totalled ZAR19 291,600, made up of ZAR7 581,600 grants and ZAR11 710,000 financial compensation (Parliamentary Monitoring Group, 2010). However, media reports and interviews with claimants indicated that some had not been paid out the promised ZAR40,000, only receiving ZAR25,000, and so wanted to return to their land in Marobe (OFM news, 2 September 2015). Community dissatisfaction and mistrust around this issue was evident during the October 2017 field visit to Kutlwanong. Residents were reluctant to discuss the history of the settlement or the land claim.

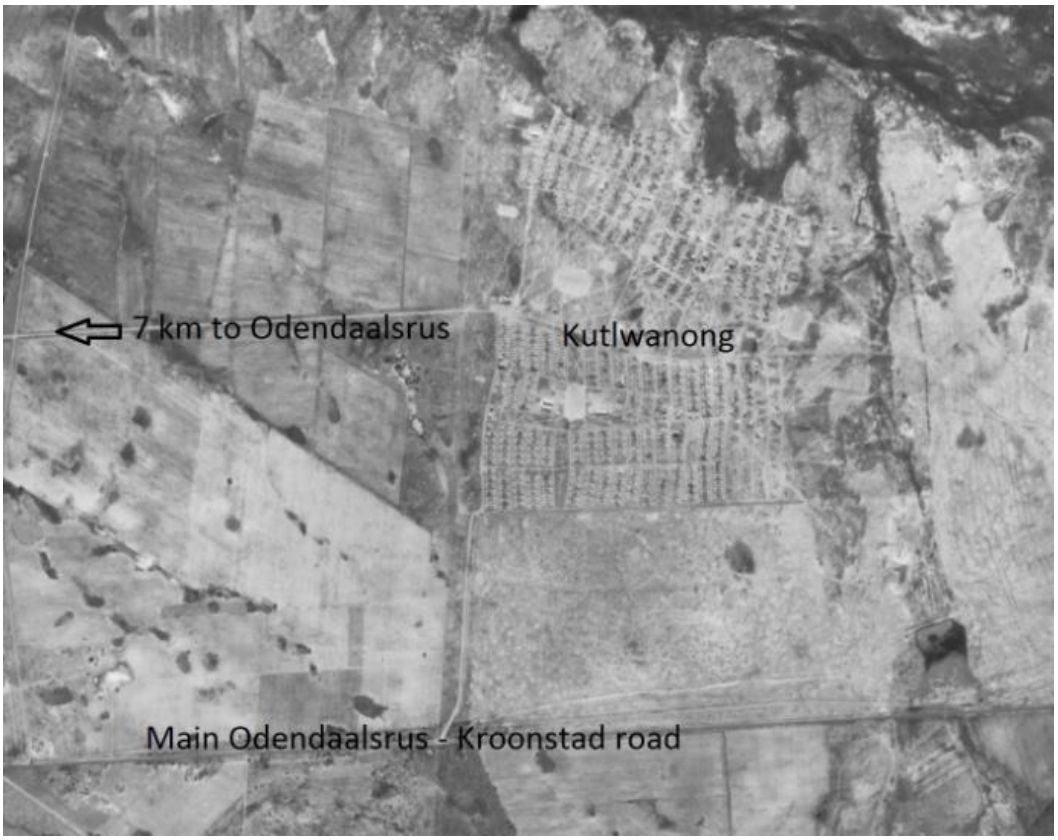

Figure 43. The new settlement of Kutlwanong was relocated some distance to the east of Odendaalsrus, as shown in this aerial photograph from 1963 (aerial photo 490_003_00021)

Riebeeckstad

The development of Riebeeckstad, a town located to the north east of Welkom but not directly linked to any of the mines, was approved in 1953, with development starting in 1954 (NRDC, 1954). The 1960 census indicates a population of 1,019 in 1960 (Central Statistical Services, 1960).

6.3 Agricultural developments

With the growth and increasing footprint of mining and the new settlements, the land available for agricultural production in the immediate area decreased. *Figure 44* illustrates the conversion of agricultural land (cultivated land in 1944) around the Enkeldoorn farmstead, to being surrounded and eventually covered by settlement by 1952 and 1963, respectively. From the 1963 aerial photo it appears that large tracts of cultivated land around the towns and mines were left fallow, presumably having been bought for further urban and mining development.

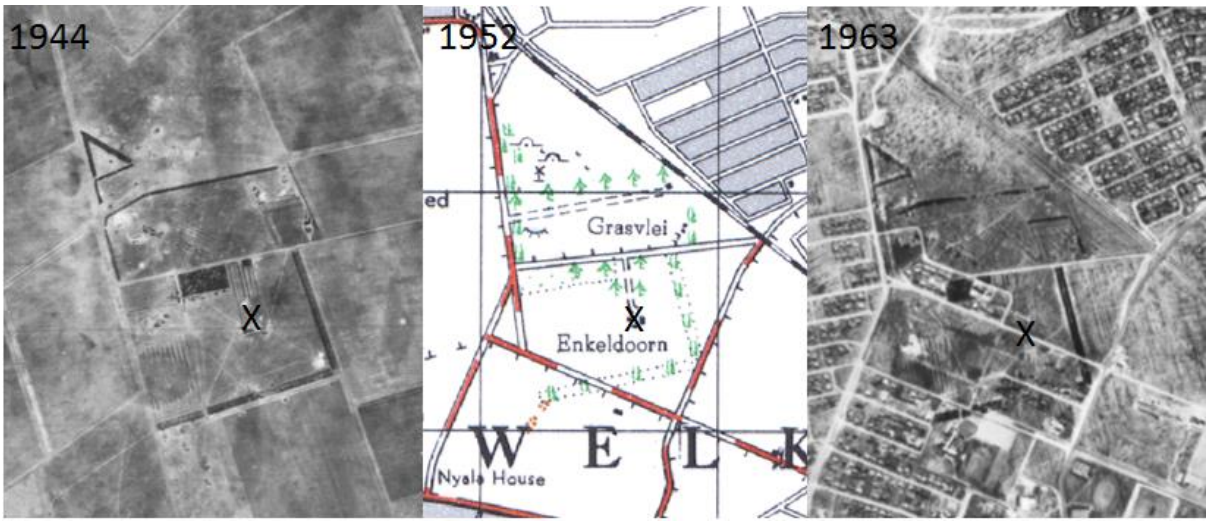

Figure 44. A time series illustrating the conversion of agricultural land to settlement. The farmstead Enkeldoorn (marked X) and adjacent land, is gradually incorporated into suburban Welkom (aerial photo 78_045_02515, map 2726DC Odendaalsrus, aerial photo 490_005_00228)

An important development during this period was the building of the Allemanskraal dam on the Sand River upstream of Virginia, and the Erfenis dam on the Vet River, both completed in 1960, as part of the Sand-Vet Government Water Scheme. This development was part of a larger, long term government programme to supply water for irrigation, which commenced following the formation of the Union Irrigation Department and the subsequent promulgation of the Union Irrigation and Conservation of Water Act of 1912. After the Second World War the focus shifted from building dams exclusively for irrigation to also providing water for domestic, industrial, and in the Free State case, mining use (van Vuuren, 2012). Through an extended system of concrete-lined canals water from the dams supplied an area of about 10,101 hectares of irrigated land, 4,997 hectares along the

Sand River (Herold et al., 1996; Turton et al., 2004). As a consequence the form of agricultural land in the immediate area changed, from large fields under dry land cultivation to small intensively farmed plots under irrigation. This is evident in the aerial photograph from 1968 (*Figure 45*).

Figure 45. Canals and irrigated land along the Sand River, on the farm Vermeulenskraal, west of Virgina, in 1968 (aerial photo 606_015_00529)

The September 1960 edition of the Virginia news carried the arrival of the first water through the tunnels on its front page (*Figure 46*). More than 800 families settled on small holdings along the scheme in 1961 allowing for the irrigation of fodder, fruit and vegetables to supply the growing demand from the goldfields (Fleischer, 1968).

virginia
-nuus · news

SIXPENCE REGISTERED AT THE G.P.O. AS A NEWSPAPER SEPTEMBER, 1960

GIANT PIPES READY

Die reuse-pype lê reg om ingepas te word. Vergelyk die grootte met skoolseun op die voorgrond.

IRRIGATION schemes were going to play an increasingly important role in the future of the Union of South Africa, Mr. Boet van Wyk, M.P., told the first twelve settlers to arrive at the Sand-Vet Scheme near Virginia. He referred to the magnificent Allemanskraal Dam and the growing needs for feeding the world's teeming millions in years to come.

The photograph above shows some of the giant concrete pipes which are used to complete this irrigation scheme. These pipes are local products from Virginia. Note the diameter compared with the schoolboy in the foreground.

The Sand-Vet portion of the scheme will cost £2½ million to complete. The first small holdings to be irrigated are only 3 miles away from Virginia.

DIE EERSTE

DIE Afrikaanse afdeling van H.A.D.A. M.S., (Harmonie Amateur Dramatiese en Musiekvereniging) sal op 15 en 16 September weer eens 'n Afrikaanse Toneelopvoering aanbied. Die naam daarvan is: „Sakke vol Geld" en dit is 'n fantastiese klug.

Die hoofrolle sal deur Len Swanepoel en Katie Jooste vertolk word. Die regie staan onder leiding van Charl Jooste en die dekor word deur Judy Mathieson versorg. Die fondse is vir die Winburgse Weeshuis bestem.

Die opvoering word in die Harmonie-buitekub aangebied, een van die beste sale in die land. Hierdie opvoering beloof om allesins die moeite werd te wees.

NUWE TYDVAK INGELUI DEUR DIE SAND-VET-SKEMA

METTERTYD 6,500 MORG BESPROEI

OP MAANDAG 8 AUGUSTUS het die eerste water van die Sand-Vet-skema by die hoewes naaste aan die Allemanskraaldam oor 'n distansie van 40 myl aangekom.

Dit het na vier jaar van harde werk aan hierdie kanale plaasgevind en gevolglik was dit vir die amptenare en die werkers 'n heel dramatiese oomblik.

Dit het ook die begin van 'n nuwe tydvak vir die omgewing ingelui. Hier sal uiteindelik 6,500 morge onder besproeiing geplaas word, met kanale wat 200 myl lank sal wees.

Dit is ook net die een helfte van die skema, naamlik die Allemanskraaldam - gedeelte. Die ander helfte van die skema se water word uit die Erfenisdam by Theunissen verkry en sal oor meer as honderd myl minstens 8,000 morge besproei.

£2½ MILJOEN

Die Allenmanskraalkanale, of die Sandriviergedeelte van die skema sal by voltooiing £2½ miljoen kos. Dit sal die water 75 myl ver van die dam af lei, maar met al die verdelingspunte en sykanale sal daar dan nie minder as 200 myl van voltooide kanale wees nie.

Die eerste hoewes om besproei te word, is net drie myl buite Virginia geleë. Die grootste gedeelte van die besproeibare gebied aan weerskante van die Sandrivier lê dan ook so na aan Virginia dat dit 'n hele nuwe landbougemeenskap vir die dorp beteken. 'n Groot aantal huise is reeds op die hoewes gebou en die eeste proefhuurders het ook op 8 Augustus hul intrek geneem.

MILJOENE GELLINGS

Die Allenmanskraalkanale is gebou om bo by die dam 150 kuseks water te dra. Dit is gelykstaande aan 3,375,00 gelling per uur. Die gewone waterkraan in enige tuin in die dorp, wanneer vol oop gedraai, lewer maar van ses tot agt gelling per minuut of van 360 tot 480 gelling per uur.

Die kanale moes deur verskillende spruite gebou word en op twee plekke selfs deur die Sandrivier en op sulke plekke moes daar dus reusagtige deurgange gebou word.

Om dit te kon behartig is daar gebruik gemaak van reuse-betonpype van 60 tot 72 duim in deursnee.

Hierdie pype kon gelukkig in Virginia vervaardig word en een van die swaar nywerhede hier vind daar dus baie baat by.

REKORD

Vir die Erfenisdamkanale word by hierdie fabriek pype met 'n deursnee van 81 duim vervaardig. Daar word algemeen aanvaar dat dit die grootste betonpype is wat nog in die Suidelike Halfrond vervaardig is.

Met die daarstelling van die nuwe besproeiingsskema so na aan Virginia, word daar nou 'n hele nuwe mark vir nywerhede geskep.

Terseltdertyd is daar reeds 'n geweldige afsetgebied vir die produkte wat van die nedersetting verwag kan word. Algemeen word aanvaar dat goudveldse skole, veral Virginiaskole, groot uitbreiding kan verwag as gevolg van hierdie ontwikkeling.

NOG GROTER KANALE

Voorsiening is ook reeds gemaak vir die konstruksie van baie groter kanale, met 'n vermoë van oor die 600 kuseks, om langs hierdie bestaande kanale gebou te word wanneer die Caledonskema eendag voltooi is. In daardie stadium sal die besproeibare gebied hom tot teenaan die Vaalrivier strek.

EERSTE WATER KOM AAN

Die eerste water kom by Merriespruit onder die 6½ myl lang toekanaal uit. Dit is 37 myl van die dam af. Die persone op die wal, wat uit pure blydskap, met die hoede waai, is mnr. C. J. Ehlers, Algemene Werksvoorman, en een van sy assistente, mnr. Mybourgh (regs).

A lovely view of the Cableway up Table Mountain—a familiar holiday haunt for many people

Figure 46. The front page of the Virginia News (September 1960) was dedicated to the Sand-Vet irrigation scheme (Source: Virginia Public Library) (Headlines – 'New era introduced through Sand-Vet scheme' and 'First water arrives')

6.4 Political and legislative change

1956 to 1975 was a period of significant political change and unrest in South Africa's history, with some of the most draconian acts of the apartheid era being introduced. As a consequence it was a period of resistance and intense struggle that was brutally repressed by the government. The international response was increased isolation through boycotts and sanctions.

6.4.1 Apartheid

The impact of the 1948 election of the NP starts becoming evident from the 1950s with various pieces of new legislation implementing the policy of apartheid. This involved strengthening the pass laws to control the movement of black South Africans and so prevent black urbanisation, and the classification of South Africans according to race (Population Registration Act of 1950). In line with

the Group Areas Act of 1950, many black communities were forcibly removed from 'black spots' and resettled. Alongside this was the establishment of 'Homelands', or black national states (in terms of the Promotion of Black Self-government Act of 1959) (Wilson, 2017). The Bantu Education Act of 1953 was another key piece of apartheid legislation which '*embodied a philosophy that specified that it would not educate black South Africans for positions in the economy beyond those they were expected to occupy*' (Wilson, 2017, p. 88).

Resistance to the pass laws and other apartheid policies grew, as did the government's repression of this. By way of example three key events are highlighted here. On 21 March 1960 a demonstration in Sharpeville ended in tragedy with the killing of 69 peaceful and unarmed protesters by the police. In the aftermath the government declared a state of emergency and banned the African National Congress (ANC) and Pan African Congress (PAC) (Manson et al., 2007). ANC leaders soon resorted to violence through the armed struggle with the formation of Umkhonto weSizwe (MK). Key leaders, including Nelson Mandela, Walter Sisulu and Govan Mbeki, were arrested and charged with sabotage, attempting to start a guerrilla war and the promotion of communism. In 1964 they were sentenced to life imprisonment during what is known as the Rivonia Trial (Manson et al., 2007). The 1976 Soweto uprising, where twenty thousand Soweto school children protested against the use of Afrikaans as a language of instruction, initiated violent protests across the country. The government's response received widespread condemnation leading to increasing international isolation with economic, diplomatic and sport sanctions (Manson et al., 2007).

Towards the end of 1960 South Africa withdrew from the commonwealth and the government, under now Prime Minister Hendrik Verwoerd, called for a referendum on a Republic. This was voted for, by a narrow margin, with South Africa becoming a Republic in 1961. Verwoerd, the architect of apartheid was assassinated in 1966 and succeeded by John Vorster.

Apartheid policies had a significant and lasting impact on the South African landscape as a whole. The most obvious impact on the Free State goldfields landscape was a perpetuation of the separate development of the white, black and coloured settlements. The establishment of the coloured township of Bronville and the resettlement of the Marobe community to Kutlwanong being examples.

6.4.2 South Africa becomes a Republic

With the formation of a Republic, there was a change in government structures and a gradual shift in legislation. Provincially based legislation was replaced with legislation applicable across the Republic. As a consequence both the OFS Metals Mining Act and the Transvaal Precious and Base Metals Act were repealed by the Mining Rights Act (Act 20 of 1967). This Act regulated what could happen on proclaimed land or land under mining title and regulated water rights. Mining rights holders did not have automatic access to water on or below the property, but were required to obtain a water right from the mining commissioner. This was aligned with the requirements of the Water Act (Act 54 of 1956) where industrial users had to apply to use water in excess of a given amount. The Mining Rights Act also made provision for state assistance to prospecting or mining, through the erection of processing facilities, power stations, pumping station, roads, pipelines and powerlines, and any other manner deemed appropriate (RSA, 1967). This legislation also included the requirement to give notice and outline a process for when a mine would discharge workers or not operate optimally. This was to avoid the closure of mines, reflecting the state of, in particular, gold mining at the time.

The NRDC, which had been responsible for overseeing the development of the Free State goldfields, was absorbed into a new Department of Planning. This department was also responsible for environmental matters. Environmental issues were slowly being recognised in legislation with a focus of the Water Act of 1956 being pollution prevention, and the Atmospheric Pollution Prevention Act, Act 45 of 1965, focussing on the prevention of pollution of the atmosphere including the control of dust from mining. Nationally, from 1970, there was an increasing awareness and shift in focus on environmental issues. Incorporating considerations of water, air, soil and human artefacts, in addition to the protection and conservation of wildlife (Rabie & Fuggle, 1992).

With South Africa's increasing isolation it was not actively involved in global efforts to address environmental problems associated with uncontrolled economic development (Steyn, 2005), in particular, the 1972 Stockholm Convention on the Human Environment, which is seen as the birth of the green revolution. It was attend by 113 participating countries and led to the creation of the United National Environmental Programme (UNEP). For the first time the human impact on the environment and the need to address this at a global scale was recognised. The official declaration from the Convention included 26 principles focussing on the preservation and enhancement of the human environment (UN, 1973).

6.5 Natural and spatial change

The natural environment underwent significant change as a consequence of mining and the development of settlement. Apart from the change to the surface, as already discussed, the act of mining was changing the subsurface environment, digging tunnels and bringing the rock to the surface, and pumping saline groundwater out of aquifers to evaporate on surface. The mine waste and groundwater impact surface water quality, soil and ultimately the functionality of the biophysical environment. These impacts are not visible on the maps, and judging by the lack of environmental awareness, were not really a concern.

6.6 Summary of landscape changes between 1956 and 1975

The developments discussed in this chapter are summarised in *Figure 47*. The key to this map is as follows:

Settlements	**Mines**	**Other points of interest**
A - Allanridge	1 – Loraine	X – evaporation pans
B - Phatakhale	2 – Jeanette	
C – Odendaalsrus	3 – Freddies Consolidated	
D - Kutlwanong	4 – Free State Geduld	
E – Riebeeckstad	5 – Western Holdings	
F - Welkom	6 – Welkom mine	
G – Thabong	7 – President Steyn	
H - Bronville	8 – President Brand	
I – Virginia (includes suburbs of Saaiplaas, Harmony & Merriespruit)	9 – St Helena	
	10 – Harmony	
	11 – Virginia	
J - Meloding	12 – Merriespruit	
	13 – Saaiplaas	
	14 - Unisel	

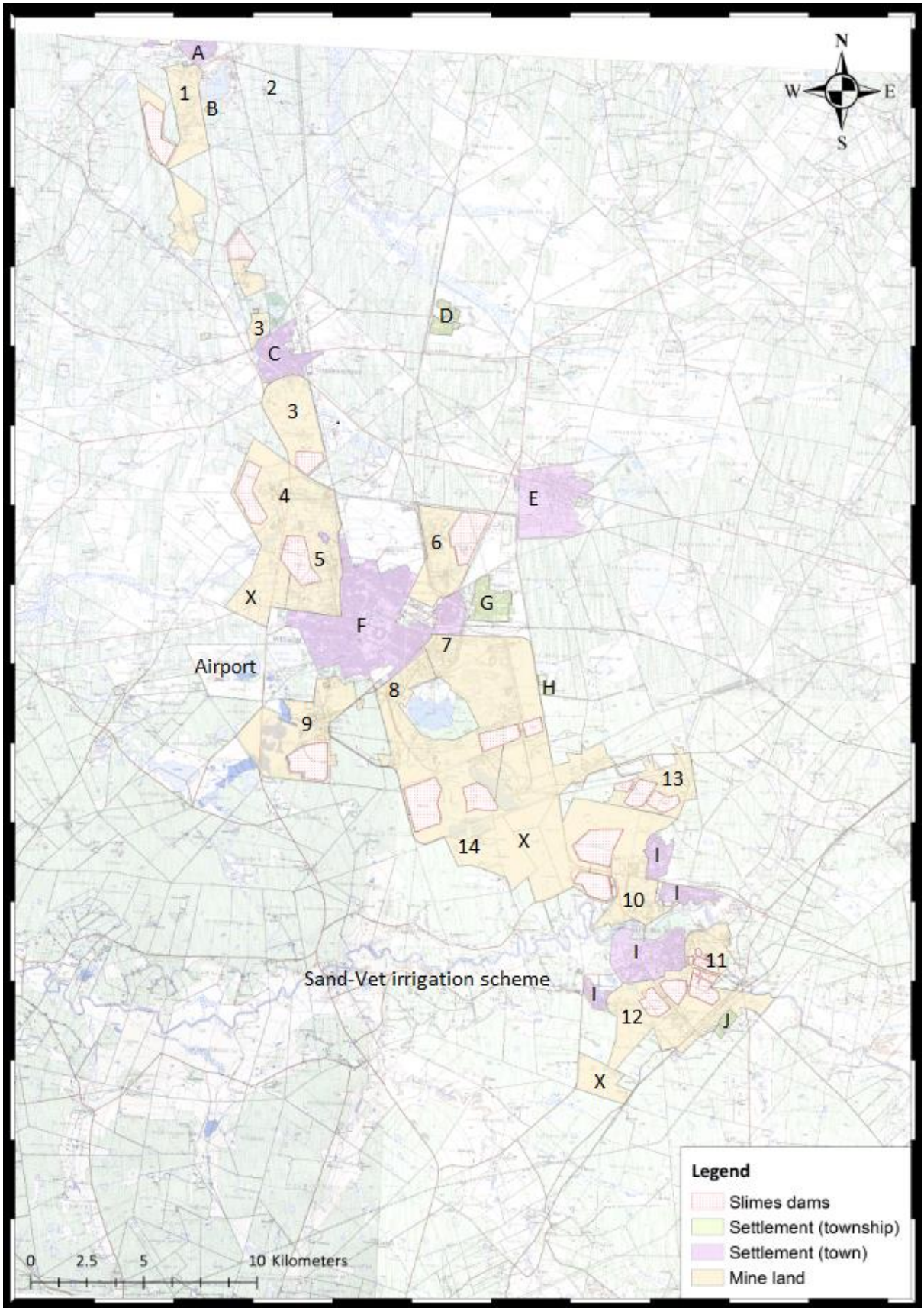

Figure 47. Landscape elements and their extent in 1975 (maps 2726DC Odendaalsrus, 2726DD Riebeeckstad, 2826BA Bloudrif and 2826BB Virginia)

Chapter 7

7. Landscape change in the Free State goldfields from 1976 to 1997 – Consolidation of the goldfields, expansion of townships

Between 1976 and 1997 there were significant events in both the gold industry and South Africa that further shaped the landscape of the goldfields. Firstly, as regards the gold mining sector, about midway through this period the price of gold dropped resulting in the downscaling of mines, with shaft closures, mergers and job losses. This in turn impacted other businesses in the goldfields, the local community and the environment.

The second major event was the advent of democracy, with the first democratic elections being held in 1994. In the lead up to this, with the gradual demise of apartheid, there were a number of shifts in policy which had a direct impact on the landscape, in particular around the growth of black settlements. These and other key events are summarised in the timeline in *Table 13*.

Table 13. Timeline of the development of the Free State goldfields between 1976 and 1997

1976	Soweto uprising
1977	Freddies Consolidated mine merged with Geduld mine
1977	Joint Metallurgical Scheme begins to produce gold, uranium and sulphuric acid
7 April 1977	Virginia becomes a municipality
1979	PW Botha becomes Prime Minister
March 1979	Unisel mine came into production
1980	Development of Beatrix mine starts
1980	Regulations to the Mines and Works Act publish - establishes the first rudimentary framework for the regulation of mine health and safety, mine residues, and the impacts of mines on water and air
1982	Beisa mine starts producing uranium primarily, and gold
1983	Beatrix mine starts producing gold
1984	Beisa mine closes
1984	South Africa passes a new constitution, PW Botha become first President
Mid-1980s	Mines start privatising housing
1986	Biggest drought in 29 years
1986	Abolition of Influx Control Act allows for free movement of black South Africans
1988	New HJ Joel gold mines start producing gold
1988	Major floods in the Free State
1988	Mine employment on Free State goldfields peaks at over 180 000
1989/1990	Gold price falls from USD900 to USD300
1989	South Africa's first piece of dedicated environmental legislation, the Environmental Conservation Act 73 of 1989, enacted
1990	Randgold retrenches 6,000 mine workers from Harmony mine
1991	Abolition of Racially Based Land Measures Act 208 of 1991, repealing racially based land allocation and spatial planning, including the Group Areas Act

1991	Minerals Act 50 of 1991 comes into force
1991	Rio summit on Sustainable Development
1991	*Ontwerpdigsplan vir die Vrystaat Goudveld* published by Department of Planning, Provincial Affairs and National Housing on plans to diversity the economy of the goldfields
22 Feb 1994	Merriespruit disaster, collapse of a section tailings facility, 17 people died, 350 hospitalised and 1,500 left homeless (31 houses destroyed and 72 damaged)
27 April 1994	First democratic elections
1996	New Constitution for a democratic South Africa enacted
1997	Mine employment down to 80,000

7.1 Mining development

During the earlier part this period the gold price increased, bringing prosperity to the South African gold mining industry (Harrison & Zack, 2012), with further developments in the Free State goldfields. Although gold production was declining in South Africa and the Free State goldfields (*Figure 48*), a number of its operations remained in the top 20 producers globally in 1984 (*Table 14*).

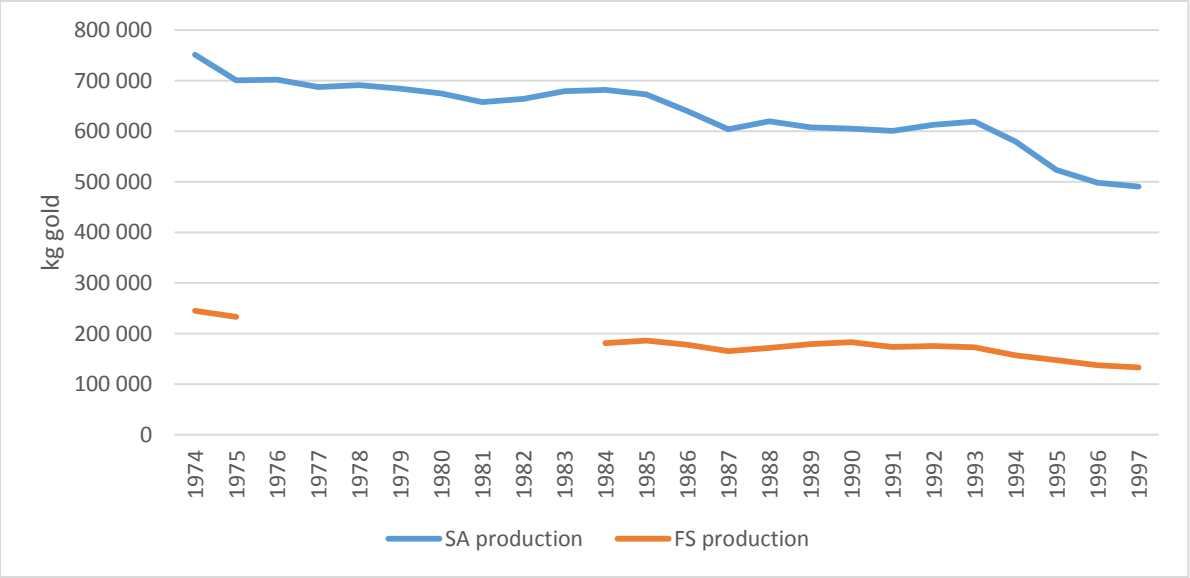

Figure 48. Gold production in South Africa and in the Free State continued to decline from the 1970 production peak (Department of Mines, 1975; Department of Minerals and Energy Affairs 1984 to 1997; Minerals Council of South Africa, 2020*). Due to a change in reporting format by the Department of Mines, Free State gold production figures are not available for the period 1976 to 1983.*

Table 14. Mines from the Free State goldfields continued to rank in the top 20 produces globally, although production had largely decreased (Ericsson & Tegen, 1988)

Producer	1975			1984		
	Global Rank	Production (kg)	Share of Western world production (%)	Global Rank	Production (kg)	Share of Western world production (%)
Western Holdings	4	40,231	3,7	3	38,956	3.6
President Brand	5	40,070	3,7	12	22,599	2.1
FS Geduld	6	39,098	3,6	10	26,749	2.4
Harmony	8	31,011	2,8	6	32,264	2.9
St Helena	11	25,533	2,3	18	12,343	1.1
President Steyn	15	17,661	1,6	11	24,373	2.2
Welkom	20	14,043	1,3			

During the 1980s, for reasons relating to the supply and demand for gold, and to changes in sentiment, the gold price declined exerting a major squeeze on the industry (Nattrass, 1995). According to Marais & Cloete (2013) the price dropped abruptly in September 1989 from nearly USD900 per ounce to USD300. As a consequence, across the country, the number of mines, mining houses and production declined, with many gold mining jobs being lost. On gold mines belonging to the Chamber of Mines, employment fell by 6.3 percent per annum during that period (Nattrass, 1995). It also impacted the economy - the proportion of tax revenue collected from the gold mining industry dropped from 26.4 percent in 1981 to less than one percent in 1993 (Nattrass, 1995).

This had a profound impact on the Free State gold operations and its economy. In the Free State the contribution of mining to the Gross Geographic Product (GGP)[4] dropped from 37.4 percent in 1981 (being the largest contributor to the Free State economy) to 20.6 percent in 1991 (McCarthy et al., 2005). This was also reflected in the declining contribution of mining to the overall economy in the goldfields, which dropped from 70 percent in 1980 to just under 50 percent in 1996 (Marais, 2013a). Here mine employment was cut significantly, from 154,343 in 1980 to around 80,000 in 1997 (Marais & van der Walt, 2010). For the AAC operations the number of jobs were halved, from 110,000 in 1988 to 55,000 in 1998. This was the start of mine downscaling and closure which continues to impact the Free State goldfields landscape.

This section tracks these changing fortunes of the mining industry between 1976 and 1997 and describes the increasing environmental legacy of mining in this region, with the growing tailings facilities and continued and expanded use of evaporation pans for saline ground water. The shifts in mine labour, in response to mine downscaling and the changing political climate, are also discussed.

[4] GGP is the final value of the goods and services produced within the geographic boundaries of a country or region during a specified period of time, normally a year.

7.1.1 New developments

By 1976 many of the Free State mines were already over 25 years old, and much of the most easily accessible payable ore reserves had been mined. At this stage most of the mining was of the pillars, which came with reduced productivity and increased costs. Also as operations moved further from the shaft, travelling times to the face increased and so productivity decreased (Greathead & Graadt van Roggen, 1976). Fortunately the increasing gold price in the earlier part of this period, which rose through the 1970s to USD800 an ounce in 1980 (Crush et al., 1991), allowed for the mining of previously unpayable ore. In addition to further mining from existing shafts, there were also new shafts sunk during this period. The Western Holdings No. 4 shaft came into production in May 1979. Sinking of Saaiplaas shaft No. 3 commenced in 1975, commencing production in 1980, but only after being stopped for a period of nearly three months following an accident in 1977 in which 14 people were killed (Viljoen, 1994). The President Brand mine also sunk a new shaft, shaft No. 5, in 1979. Activities around the Merriespruit mines increased with a new shaft (M3), associated hostels and reduction works being completed in 1977, a ventilation shaft in 1979 and uranium works in 1980. The neighbouring Virginia mine developed its acid plant in 1980 (Handley, 2004).

The feasibility for the new Tshepong section of the Free State Geduld mine was concluded in 1984. This section is situated directly to the east of Odendaalsrus, where the Odendaalsrus landing strip was located. Shaft sinking started in 1986 with commissioning in 1991 (Harmony, 2017). Another new shaft of Free State Geduld, initially known as Free State Geduld 4, then Freddies 4 and then Tshepong South, was sunk from 1994. However, operation of this mine was delayed due to the low gold price of the mid-1990s (Harmony, 2017).

With the high gold price in the early part of this period, even minute traces of gold left in the mine dumps could be profitably extracted (Crush et al., 1991) and so in 1977 AAC started retreating some of its dumps. The Joint Metallurgical Scheme, based at President Brand mine, produced gold, uranium and sulphuric acid from existing tailings from seven of AACs Free State mines and by the end of 1985 had recovered 24,500kg of gold (Greathead & Graadt van Roggen, 1986). The retreatment scheme stopped operation in 1988 (Handley, 2004).

Union Corporation and Selection Trust's Unisel mine, which had started development in 1974, came into production in March 1979. Having only a single shaft, this mine was connected to President Steyn, which was to be used as a secondary exit (a legal requirement). The mines' ore was conveyed to the St Helena reduction plant for treatment (Greathead & Graadt van Roggen, 1986), further

indicating the linkages between the various operations. In 1996 Harmony mines took over the operations of Unisel (Handley, 2004).

In 1980 AAC also announced the development of a new mine adjacent to Saaiplaas, Erfdeel. Production from Erfdeel shaft No. 1 started in 1987, but almost immediately merged with the Saaiplaas mine, shaft No. 1 becoming Saaiplaas shaft No. 4. Sinking of Saaiplaas shaft No. 5 started in 1985 (Viljoen, 1994).

Prospecting of the area south of the Sand River had continued, with geologists from Union Corporation credited with discovering a new extension to the goldfields (Greathead & Graadt van Roggen, 1986). The result of this was the Beisa mine, which was principally a uranium producer. Shaft sinking started in 1979 with the mine going into production in 1982. The mine was closed in 1984, when the uranium market collapsed (Greathead & Graadt van Roggen, 1986). However, in 1987, with the mine now being under the control of Gencor, two new sub-vertical shafts and a ventilation shaft were sunk. The mine was renamed Oryx mine and started producing gold in 1993. The extensive evaporation pans at Beisa are evident on the aerial photographs and topographical maps (*Figure 49*).

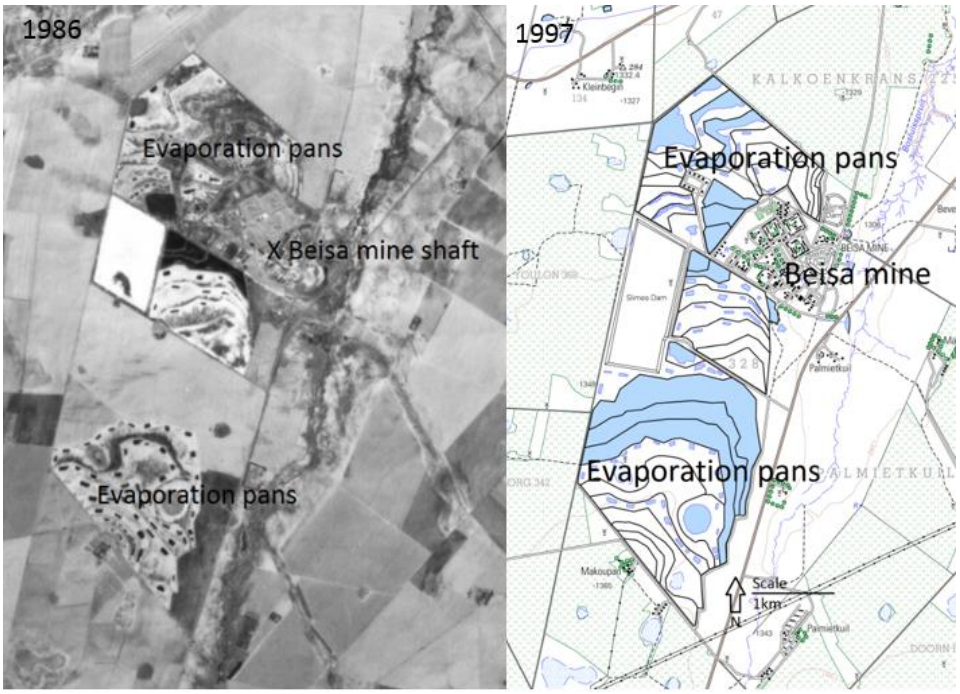

Figure 49. Beisa mine in 1986 and 1997 (aerial photo 899_005_01543, map 2826BA Bloudrif)

A further two new mines were developed in the new southern extension of the goldfields in the early 1980s. These being the Beatrix and HJ Joel Gold Mines. Sinking of the twin shaft system at Beatrix (shafts 1 and 2) was completed in August 1983, with commissioning in 1985 (Greathead & Graadt van Roggen, 1986). Beatrix mine, also operated by Gencor, was the first mine to exploit the

Beatrix reef (the other operations mining the Basal reef). The Beatrix operation is only just evident on the map sheets used in this study. HJ Joel Gold Mine, owned by JCI (45 percent), Randfontein Estates (45 percent) and AAC (10 percent), but operated by JCI, was announced in 1984, with production starting in 1988 (Greathead & Graadt van Roggen, 1986).

7.1.2 Consolidation

As stated by Greathead & Graadt van Roggen (1986, p.250) '*If events in the Free State in the 1980s had to be summarised in one word, that word would be: CONSOLIDATION*'. They point out that although consolidation was not new to the Free State, with the previous mergers of the Riebeeck and Loraine operations, the two Freddies mines, Virginia and Merriespruit with Harmony and, in 1977, Geduld acquiring Freddies Consolidated, the scale of the 1980s consolidation was significant. The motivation to consolidate operations was to '*optimise the exploitation of the total ore reserve, maximise the utilisation of the capital assets and create a stronger financial base. This would lead to more efficient operations in this area and as a consequence the lives of the mines could be extended*' (AAC announcement to shareholders quoted in Greathead & Graadt van Roggen, 1986, p.250). This through the mining of boundary pillars, mining marginal areas which previously could not be mined and rationalising the management structure.

Firstly there was the formation of the Western Holdings Complex, effective from 1 July 1981, through the amalgamation of the AAC operations of Western Holdings and Welkom mines. Further and significant consolidation of the goldfields occurred in 1985 when AAC announced its intention to create a 'megamine' from the combination of Free State Geduld, President Brand and President Steyn mines under a single company. The new company was known as Free State Consolidated Gold Mines, Freegold (Greathead & Graadt van Roggen, 1986). By the end of the 1980s all the AAC mines in the Free State were consolidated as Freegold, with Freegold South (President Brand, President Steyn and Saaiplaas, which incorporated Erfdeel) and Freegold North (Free State Geduld, Freddies, Welkom and the Western Holdings). With the consolidation shafts were closed and the services, regional offices, workshops and other support services were merged and rationalised. The management structures also changed, where there was initially a General Manager for each of the original mines with various levels in the hierarchy, this become a single regional General Manager, with services grouped together in a flatter hierarchy.

By the end of this period, 1997, the consolidation of mines is evident (*Table 15*). With the mergers and renaming of shafts it becomes difficult to keep track of the mines and who owns them.

Table 15. The organisation of mines and their owners in the Free State goldfields by 1996 (Herold et al., 1996)

Mining Group	Mine
AAC	Freegold North incorporating Free State Geduld, Freddies, Welkom and the Western Holdings Freegold South incorporating President Brand, President Steyn and Saaiplaas, which incorporated Erfdeel
Gencor	St Helena Unisel Beatirx Oryx (previously Beisa)
Harmony (a Randgold company until 1995)	Harmony mines incorporating Harmony, Virginia and Merriespruit operations
JCI	HJ Joel

7.1.3 Mine waste – tailings

The impact of mine waste on the landscape increased during this period. The cumulative production of the mines, with their new shafts and deeper operations, resulted in an increasing number and size of tailings storage facilities. A 1996 report estimated the total surface area of tailings storage facilities in the Free State goldfields was around 4,930 hectares with the President Brand and President Steyn mines tailings storage facilities being the largest at 871 and 781 hectares respectively (Herold et al., 1996). New tailings facilities are evident at most operations when comparing the 1975 and 1997 topographical maps (e.g. Geduld in *Figure 50*), with those at President Steyn mine starting to surround the Bronville township (*Figure 51*). In the early layout of the mines and settlements, tailings facilities were placed furthest away from settlements (at least the newly developing white settlement of Welkom) and, where possible, to the east as the prevailing wind was from the west. This was clearly not a consideration when it came to the black and coloured townships.

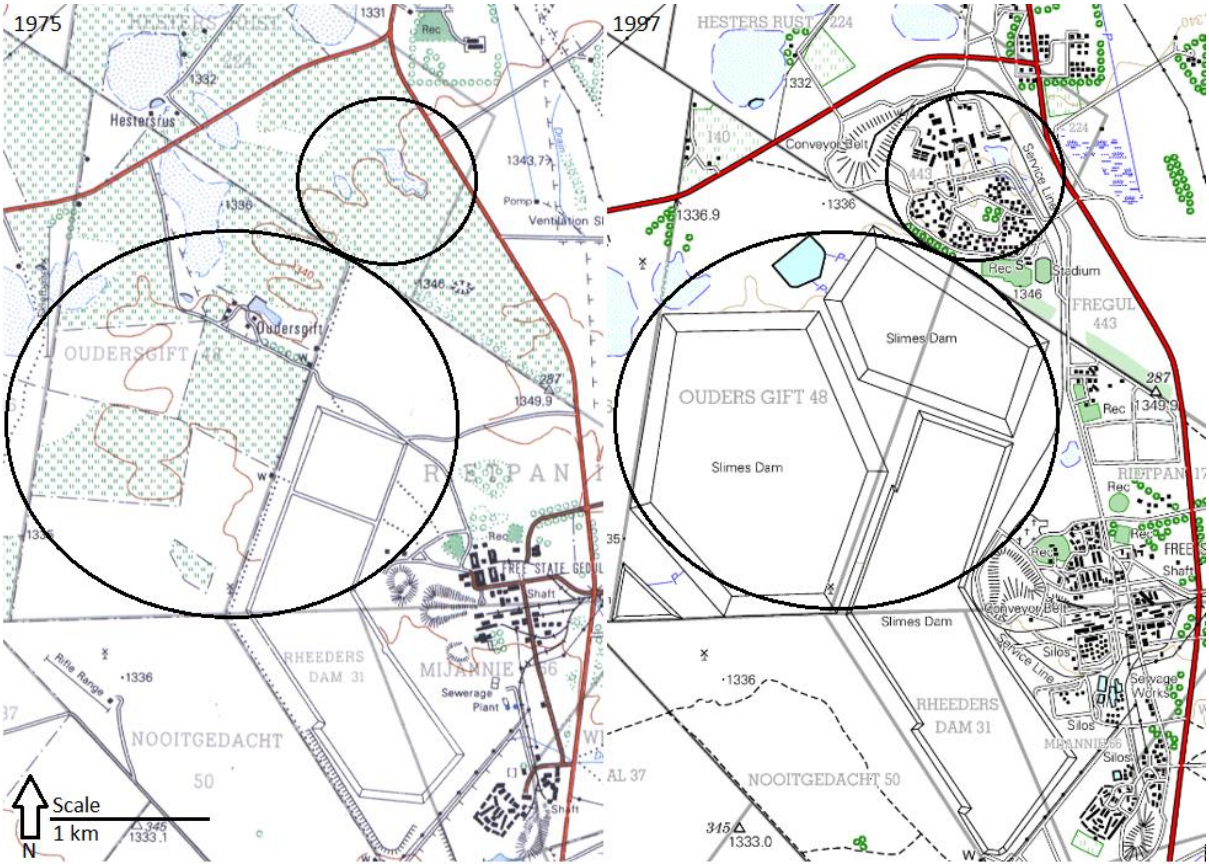

Figure 50. New tailings storage facilities were constructed for an expanded Geduld mine. The new Geduld No. 4 shaft with hostels is also highlighted by the black circle (map 2726DC Odendaalsrus)

Figure 51. New tailings dams starting to 'hem' Bronville in by 1986 (aerial photo 899_005_01544)

In the early 1990s there was a series of tailings failures. In March 1992, there were three failures within a week of each other at the Saaiplaas tailings facility (*Figure 52*). Tailings from the first two failures, on 18 and 19 March, did not move very far. However, the third failure, occurring during a period of light rain on 22 March, flowed until it was stopped by the wall of the return-water reservoir (Blight, 1997). None of these appear to have caused damage beyond the immediate area.

Figure 52. The tailings failures at Saaiplaas tailings dam in March 1992 (Fourie et al., 2001)

In February 1994 the Merriespruit tailings facility failed, resulting in the death of 17 people, destroying 80 houses and damaging a further 200. Merriespruit mine had established its new No. 4 tailings dam in 1978, this was a 154 hectares rectangular dam, 320 metres south of the existing Merriespruit settlement. Following a brief thunderstorm and about 50 mm of rain on the evening of 22 February 1994, the 31 metre high north wall of the facility collapsed. In a matter of minutes more than 2.5 million tonnes of liquefied tailings flooded through Merriespruit and finally stopped about 3 km down gradient of the tailings dam when it reached a small tributary of the Sand River (*Figure 53*). The wave of tailings which was about 2.5 metres high when it reached the first houses in Merriespruit, swept many houses off their foundations and others had walls demolished (Fourie et al., 2001; van Niekerk & Viljoen, 2005).

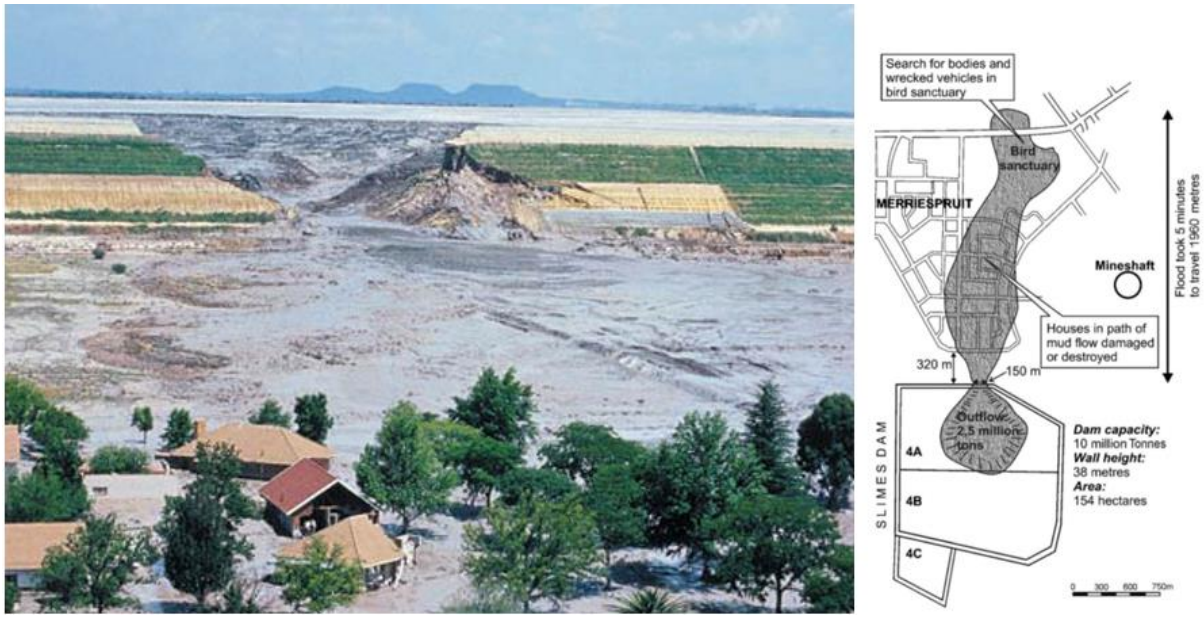

Figure 53. The Merriespruit tailings failure of 22 February 1994 (left) (Minerals Councils of South Africa, n.d.a) with a graphic showing the flow path and damage caused by the liquefied tailings (right) (van Niekerk & Viljoen, 2005)

An enquiry into the disaster found that legislation requiring a tailings dam to have sufficient capacity to contain a 1:100 year, 24 hour storm with a half metre freeboard was not complied with, that the dam was in an unacceptable state before its wall collapsed, and that water was allowed to accumulate on top of the dam. This moisture build-up, together with a heavy rainstorm on the evening of the disaster, caused the tailings dam to overtop, resulting in a series of slip failures ultimately leading to a massive overall failure that released the tailings. The owner (Harmony), operator (Fraser Alexander) and six of their employees were found guilty of negligence and fined (van Niekerk & Viljoen, 2005). The disaster resulted in a major review of operating procedures on tailings dams in South Africa and contributed to the development and publication of a Code of Practice for Mine Residue Deposits (Fourie et al., 2001). The wall was subsequently repaired (*Figure 54*) and the tailings facility continued to be used.

Figure 54. The repaired section of wall of Merriespruit No. 4 tailings storage facility in October 2015 (Source: Author)

7.1.4 Evaporation pans

Evaporation pans continued to be a characteristic of the Free State goldfields landscape, although this shifted to the use of ephemeral pans. The 1964 Interdepartmental Committee on Mine Water (OFS) report recommended that the evaporation pans be dispensed with and that all the water from underground be pumped into natural pans (Department of Mines, 1964). This does not appear to have happened immediately, but does become evident on the maps during this time period. Ephemeral pans now appear to have permanent water and increased size (*Figure 55* and *Figure 56*). Mine water was disposed into Dankbaarpan, Brakpan, Rietpan, Wolvepan and Swartpan (Herold et al., 1996). By 1992 more than 5,000 hectares of land in the goldfields was used as evaporation areas for effluent and mine water, with a total storage capacity in excess of 145 x 10^6 cubic metres (Cogho et al., 1992). Based on this, the quantity of water pumped and its average conductivity, Cogho et al. (1992) modelled the quantity of salts pumped to the surface over the 37 year period (from 1955 to 1992). They estimated this to be 7,717 million tonnes, which either precipitated out or seeped into the ground.

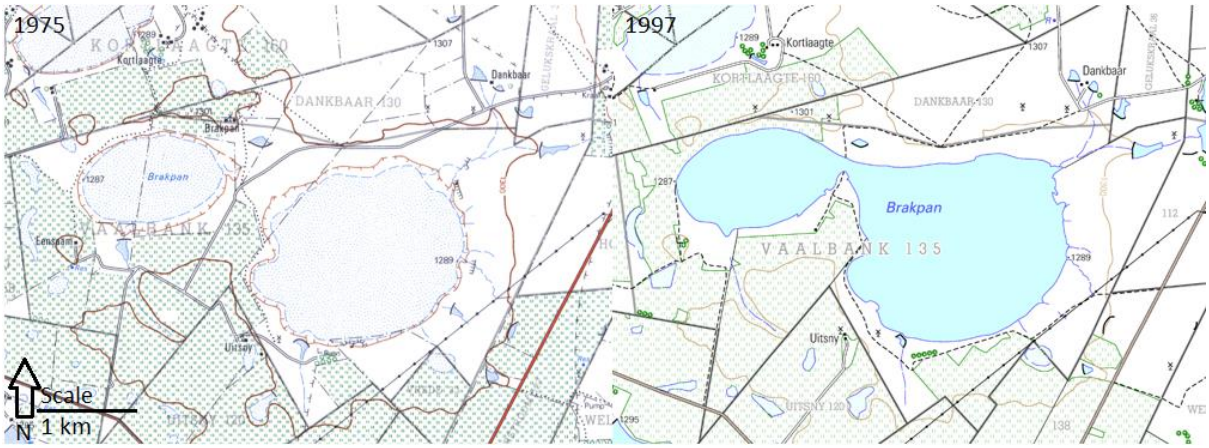

Figure 55. Dankbaarpan (larger pan on the right) and Brakpan, were used to evaporate mine water. The increase in water volume is evident when comparing the size of the pans between 1975 and 1997 (map 2726DC Odendaalsrus)

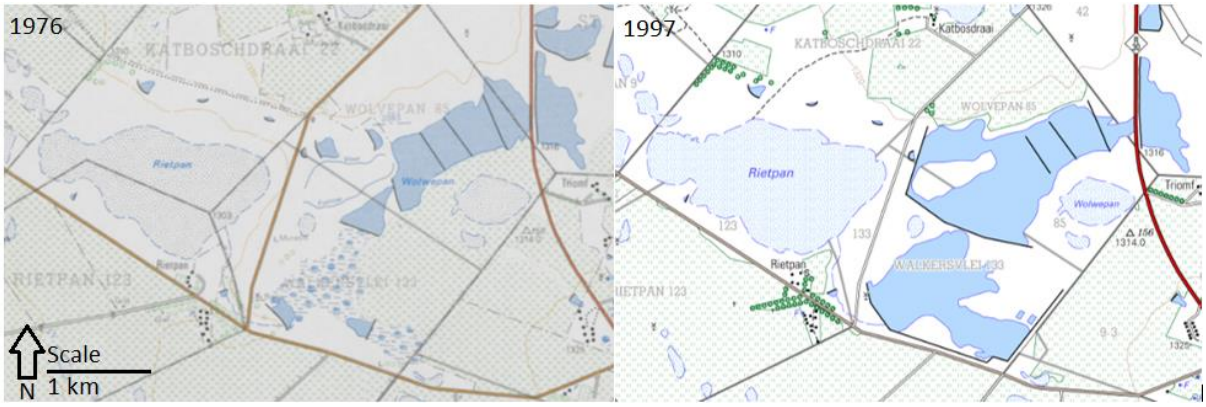

Figure 56. Rietpan and Wolwepan were two other pans used for disposal, showing increasing water cover in the 1997 map compared to 1975 (map 2826BA Bloudrif)

The resultant contamination of surface and subsurface water resources was noted in two separate studies commissioned by the Water Research Commission during this period. Both concluded that gold mining was the main cause of the salinisation of the ground-water, pans and rivers, and that this was largely from the disposal of saline water into natural pans and wetland systems, and the subsequent seepage from evaporation pans and tailings dams. Discharges and effluent spillages were also a concern (Cogho et al., 1992; Herold et al., 1996). Although one study noted that the mining industry had taken preventive actions, such as providing containment works to prevent the seepage of saline water to local streams, the high salt concentrations in the streams draining the mine properties recorded during the study indicated that the containment measures were not fully effective (Cogho et al., 1992). For example, results indicated that electrical conductivity increased seven-fold from east to west along the drainage, across the mining area, and chloride concentrations increased 20-fold (Herold et al., 1996). Although much of the treated sewage water in the area was

used by the mines (Herold et al., 1996), sewage disposal into pans and rivers was also noted as a source of pollution (Cogho et al., 1992).

7.1.5 Mine labour

With continued production and some mine expansion there was an initial increase in labour numbers on the mines, peaking at 184,634 in 1987 (Marais, 2013a), making up approximately 80 percent of the jobs in the Free State goldfields (Nel & Binns, 2002). New hostels to accommodate some of the additional labour were built at FS Geduld Shaft No. 4 (Figure *50*). However, with the significant drop in the price of gold many of these jobs were cut. By the end of this period (1997) mine employment numbers in the Free State goldfields had dropped to around 80,000 (*Figure 57*), severely impacting employment in other sectors. An assessment in 1996 found that the loss of 70,000 mining jobs between 1988 and 1996 resulted in the loss of 40,000 other jobs in the Free State goldfields – a loss of approximately 40 percent of available jobs in just eight years (Marais, 2013a).

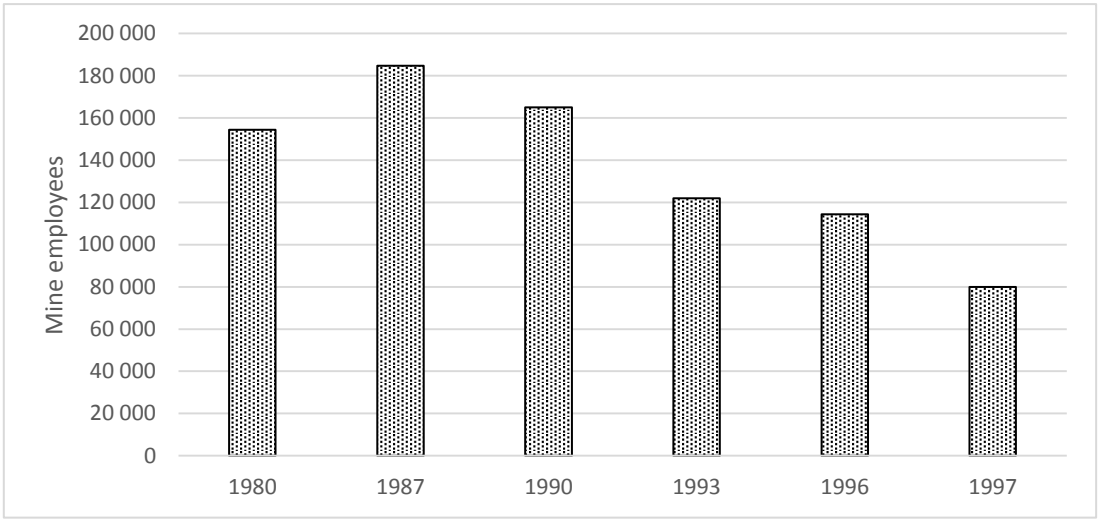

Figure 57. Mine labour between 1980 and 1997 (Marais, 2013a)

In addition to the change in labour numbers, there were a number of other factors related to mine labour which drove changes to the landscape. The first was a gradual shift towards a more stabilised labour force with workers returning to the same mine, and often work gang. Periods of employment were standardised and included eleven months work followed by several weeks leave before returning on a date fixed by management (Crush, 1989; Crush & James, 1991). As a result these 'career miners' were able to upgrade their skills and productivity. With the eventual phasing out of the colour bar in 1987, which designated certain jobs to certain race groups, black workers were able to move into better positions on the mines, and receive better pay.

A second change was the recognition of labour unions and with this the formation and rapid growth of the National Union of Mineworkers (NUM). In 1982 the Chamber of Mines announced that it would permit black mine workers to unionise, allowing for the establishment of the NUM in August of that year. Growth of NUM was rapid with the most rapid progress in the Free State. This was as AAC, as a '*reformist mining house*' (Crush, 1989, p. 9) with most of their operations in the Free State, allowed NUM onto their mines. By 1985 40 percent of AAC workers belonged to NUM (Crush, 1989). The mining industry initially intended to limit collective bargaining with the union to annual wage negotiations. However, the union soon began to press for debate on working conditions, particularly safety, and to challenge the migrant labour system. At its congress in 1987 NUM called for the abolition of the migrant labour system, improved hostel accommodation and demanded a basic say in the running of the hostels (Crush, 1989). The strength of NUM was demonstrated in the 1987 labour strike against wages, where around 300,000 mines workers from across the country downed tools for three weeks. The strike ended when AAC used the legal strategy of lock-outs, systematically dismissing workers, hostel by hostel and shaft by shaft (Moodie, 1987).

Both these changes, together with the Abolition of Influx Control Act of 1986, lead the mines to review mine worker living arrangements and announce plans to move significant proportions of their black labour force out of the hostels and into family housing units. Again AAC was a leader in this regard. It had long been a desire of first Ernest and then Harry Oppenheimer, and AAC, to allow its employees '*to live with their families at or near their place of work if they so choose*' (Oppenheimer, 1980, p. 71).

In 1986 AAC commissioned a survey of mineworkers' attitudes towards housing. The results showed that 38 percent of the sampled population wished to settle on or near the mines in family accommodation within a five year period. With 47 percent stating that they wanted to bring their families to live with them on the mines. Of this group, 63 percent indicated that the move would be a permanent one and almost 80 percent wanted to own their own home. Based on this, AAC established a home ownership scheme. The decision was to develop new housing in existing black townships, this being cheaper as services were already provided (Crush & James, 1991; Crush, 1992).

The fundamental premise of the scheme was home ownership with various options being considered, including providing a full house, core house or site-and-service scheme. Employees were to conclude agreements with management-approved contractors for the building of housing units in designated sites. They were responsible for a subsidised down payment of two-and-a-half to five

percent of the purchase price, monthly mortgage payments, property taxes and maintenance costs. House prices ranged from ZAR20,000 to ZAR80,000. (Crush & James, 1991; Crush, 1992; Laburn-Peart, 1992).

In the Free State the home ownership scheme was concentrated in Kutlwanong and Thabong, given the location of these townships relative to the AAC mines. At the time a total of 13,000 AAC workers were eligible for participation in the home ownership scheme, with 3,000 of these planned for settlement in Kutlwanong. For Thabong the plan was that there would eventually be 33,000 new housing units in an extension called 'Sir Ernest Oppenheimer Park', of which 16,000 were reserved for Anglo and Gencor employees (Crush & James, 1991). In both townships, dedicated development committees were established to advise the town council. The committees included representatives of AAC, who chaired the committee, the relevant Town Council, local developers and town planners.

Uptake of the scheme was very slow, with only 1,648 participants. Other mine workers opted to receive a living out allowance and rent accommodation, yet the majority chose to remain in mine hostels (*Table 16*). As discussed by Crush (1992) the reasons for this were largely related to costs. With the low wages in the industry at the time, the vast majority of workers could not participate in the home ownership scheme, limiting participation to the skilled, married South African workers. A 1990 NUM housing survey found that 86 percent of workers could not afford the minimum price (Laburn-Peart, 1992). The dropping of influx control also allowed a number of mine workers to rather settle their families into relatively cheap rental housing in neighbouring informal settlements or backyard shacks in townships (Crush, 1992). Many mine workers also opted to maintain their rural base into which they had invested their wages over the years and as the communal land tenure system required that their families remain occupants in order to retain their rights to the land (Laburn-Peart, 1992).

Table 16. Housing options and uptake of the home ownership scheme at AAC mines in the Free State in 1990 (Crush, 1992)

Accommodation option	Number	%
Mine married quarters	1,188	1.3
Living-out allowance	1,659	1.8
Homeowners	1,648	1.7
Applications for homeownership	586	0.6
Mine hostels	89,431	94.6
Total	**94,512**	**100**

The home ownership scheme was suspended in 1992, with discussions rather focusing on the provision of an all-inclusive wage for mine workers, which would include a living-out allowance, although at the time NUM was opposed to this scheme (Crush, 1992).

7.2 Urban and infrastructural development

7.2.1 Infrastructure

A comparison of the 1975 and 1997 series of topographical maps shows that there was very little change in the infrastructure supporting the goldfields, at least as is visible at this scale. One of the shortcomings of using maps as a primary source of data is that it only illustrates presence or absence, rather than condition or quality of infrastructure. There is no evidence from the literature that the provision of services was a problem.

One of the new developments was a bypass between Theunissen and Welkom, passing Virginia via a second bridge over the Sand River. This was built in 1989. With an extension through Thabong bypassing Welkom town under construction in 1997. The road between Virginia and Hennenman was also rebuilt in 1989.

7.2.2 Settlements

The population of the region increased during this period from 233,828 people recorded in the 1970 census, to 476,927 in 1996 as indicated in *Figure 58*. It should however be noted that the latter population figure was for the newly established municipality of Matjhabeng. In addition to the towns of the goldfields, the Matjhabeng municipality also includes the towns of Ventersburg and Hennenman. The population growth rate for Welkom was negative between 1980 and 1985, decreasing from a population of 187,660 to 184,603 (Central Statistical Services, 1980 & 1985). Looking into these numbers one sees that the decrease was attributable to a reduction of just under 10,000 black males from Welkom. These were presumably mine workers who lost their employment when the AAC Joint Metallurgical Scheme closed in 1988 and returned home, and/or were moved to other AAC mines, including the new Free State Geduld mine hostels, which fell under the Odendaalsrus municipality. The black male population of Odendaalsrus increased. With the job losses of the early 1990s one would have expected to see the population decrease, however it increased. This was due to in-migration and the fact that people did not leave the area, there was in fact an increased demand for stands and an expansion of informal settlements as many people believed the gold mines would reopen (Marais & Cloete, 2013).

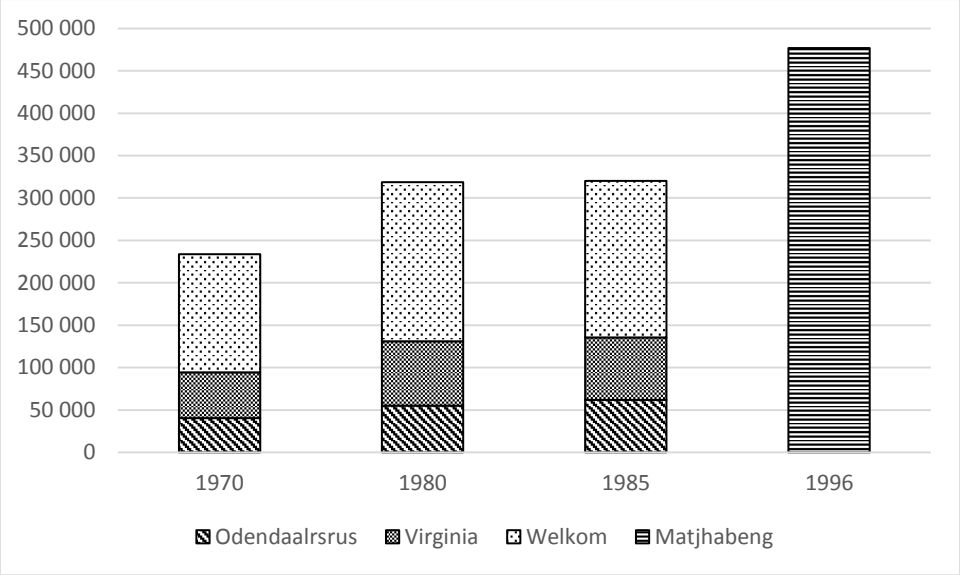

Figure 58. Population change in the Free State goldfields (Central Statistical Services, 1970, 1980, 1985; Statistics South Africa, 1996)

The increasing population is evident in the significant increase in size of the black townships, unlike what is seen in the original white mine settlements. As these trends were similar across the goldfields they will be discussed under two broad headings, rather than at the individual town level.

Black townships boom

The most noticeable change to the settlements was the significant growth in the black townships of Phathakahle (*Figure 59*), Thabong (*Figure 60*), Kutlwanong (*Figure 61*) and Meloding (*Figure 62*), and the coloured township of Bronville (*Figure 60*). The period under review incorporates the advent of democracy and with it the dropping of racially based legislation, specifically legislation regulating where black people could live (influx control) (Tomlinson, 1998; Wilson, 2001). This allowed mine worker families and farm workers to relocate to towns. As discussed, the mines started paying living out allowances during this time, and with a stabilised work force, developed houses in the local townships for their employees. During the latter part of this period a number of mine workers lost their jobs and their linked accommodation in the hostel, yet many of them opted to remain in the area in the belief that they would find employment again (Marais, 2013a; Ntema et al., 2017). This contributed to the expansion of the black townships and the proliferation of informal settlements in the area.

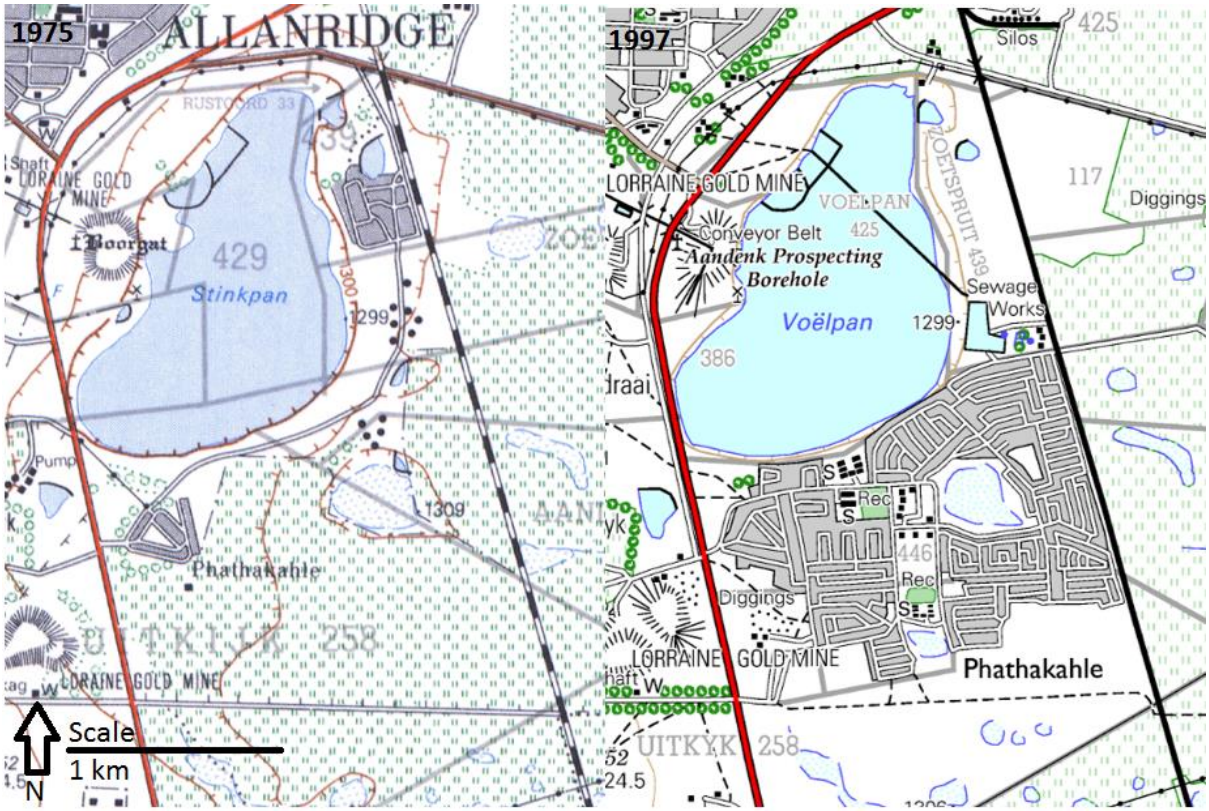

Figure 59. Phathakahle grew significantly between 1975 and 1997 (map 2726DC Odendaalsrus)

A general decline in the agricultural sector across the Free State also resulted in a number of job losses, 55,000 agricultural jobs were lost between 1981 and 1996 across the Free State (Marais, 2006). At the same time concerns by land owners around land rights for farm workers resulted in many black families moving/being moved into the local towns.

In concert with this, the government released the *White Paper on Urbanisation* in 1986 which proposed a strategy to ensure 'orderly urbanisation' (Mabin & Smit, 1997; Tomlinson, 1998). This included site-and-service and other subsidy schemes, all linked to the requirements to buy a housing option (Tomlinson, 1998). Up until this point black residents could not own property, although in more recent times they were able to hold property in the townships through a 99-year lease. In the lead up to South Africa's first democratic elections in 1994, the ANC-led alliance developed the Reconstruction and Development Programme (RDP), an '*integrated, coherent socio-economic policy framework aimed at the eradication of apartheid and the building of a democratic, non-racial and non-sexist future for South Africa*' (ANC, 1994, p.4). The first of the five key programmes was 'Meeting Basic Needs', which included addressing the significant housing backlog in many urban areas (ANC, 1994). Through this policy the government also provided subsidies for housing.

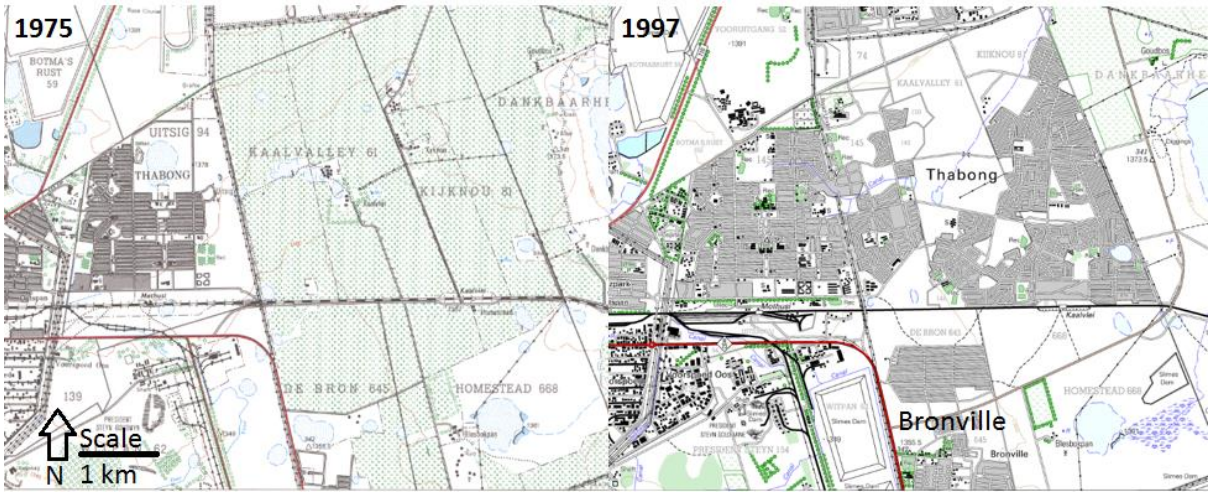

Figure 60. A comparison of the 1975 and 1997 maps illustrates the significant expansion of Bronville and Thabong (map 2726DD Riebeeckstad)

As illustrated in *Figure 60*, Thabong experienced significant growth between 1975 and 1997, with an entirely new section being developed to the east of the existing settlement, more than doubling its footprint. As already discussed, AAC implemented a home ownership scheme in Thabong and between 1988 and1992 spent an estimated ZAR194 million on infrastructure and service provision (Crush & James, 1991). A number of government housing schemes and housing subsidies were also implemented in Thabong. Between 1992 and 1994 the Independent Development Trust, set up by government, funded sites and services (infrastructure) and later houses (Ntema et al., 2017). However, with the downscaling of mining in the early 1990s many mine workers lost their jobs and could not maintain the payments of their new houses, resulting in Thabong being redlined by most banking institutions. There was subsequently very little demand for these houses (Marais, 2013a; Marais & Cloete, 2013).

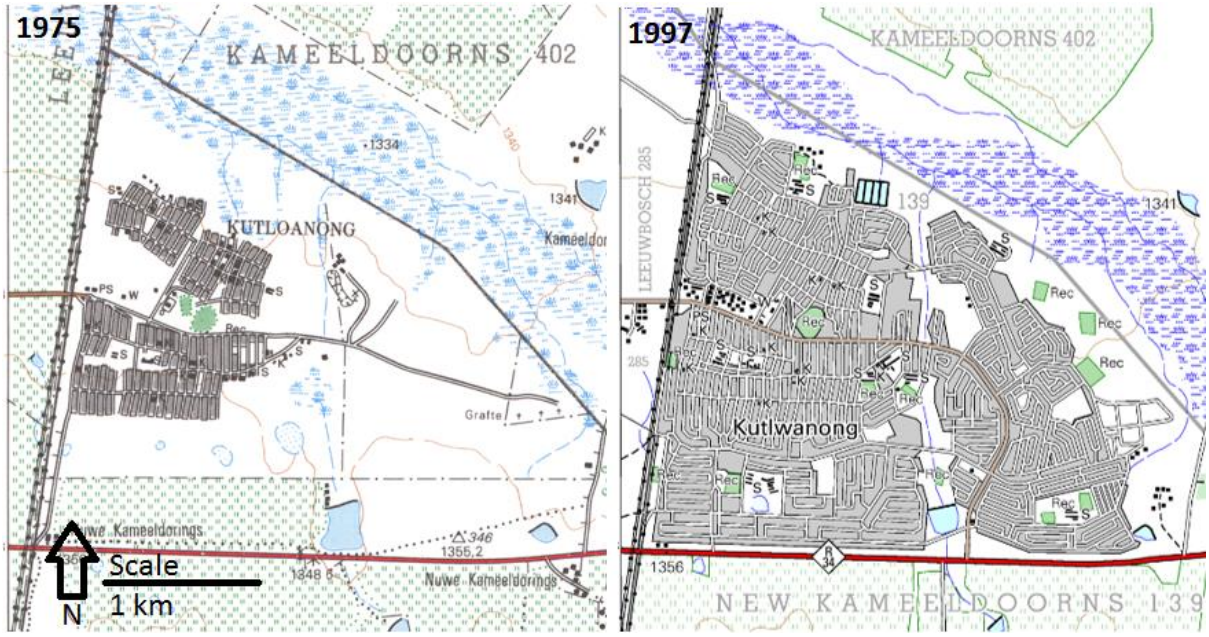

Figure 61. The growth in Kutlwanong is evident from the comparison of the 1975 and 1997 topographic maps (map 2726DD Riebeeckstad)

Similarly the change in Kutlwanong is evident by comparing the 1975 and 1997 topographic maps (*Figure 61*). During 1988 AAC set up the Kutlwanong Development Committee, which included representatives of AAC (and Chaired by them), Kutlwanong Town Council, local developers and town planners. The committee was established to advise the Kutlwanong Town Council and was part of their home ownership scheme for mine workers. A review of the minutes of this committee indicates that they were planning for a number of extensions (K1, K2, K3, K4 and K5) which included erven for businesses, parks, a church and a crèche, as well as residential units for low, medium and higher income earners and erven for self-help schemes (*Table 17*). Some extensions were set aside exclusively for AAC employees, while others were available on the open market. During 1988 there were plans to develop 3,560 erven, with a further 4,200 (K6 and K7) planned for 1989 (Kutlwanong, Development Committee, 1988). However, as discussed earlier, take up of the home ownership scheme was slow. It is unclear whether all these extensions were developed as planned.

Table 17. Development status quo of Kutlwanong as at 18 February 1988, report to the Kutlwanong Development Committee in 1988 (note from MD JWR Henning, Crusader Kutlwanong, Kutlwanong, Development Committee, 1988)

Area	No. erven	Description
K3	200	Medium to higher income groups, mainly Anglo personnel from Freddies shaft 1
K4 (phase 1)	200	Medium to higher income groups, mainly Anglo personnel
K4 (phase 1 extension)	77 single residential erven, 1 flat & 5 business erven, park, church and crèche	Medium to high income groups, available on the open market
K2 (3)	277 erven	Lower income group, for Anglo (Freddies) personnel
K2 (4)	250 Residential erven	For Anglo's lower income group
K1	356 erven	Medium to low income groups on the open market
K4 (phase 2)	1,000	Medium to high income groups
K5	1,200	Low cost housing and self-help schemes
K6	3,000	Low cost and self-help scheme
K7	1,200	Medium to higher income groups

With the mines around Virginia not being owned by AAC, the home ownership scheme did not extend to Meloding. However, the growth of Meloding is still significant (*Figure 62*). By the 1980s Meloding included 2,318 housing stands, eight church buildings, six business areas, four school stands, a cemetery and recreational area. A new library opened in August 1990 (Viljoen, 1994). An informal settlement, Mandela Park, developed in Meloding in 1989. Research by Seidman (1995) reinforces the trends in other townships in the goldfields, finding that retrenched mine workers did not leave the area immediately. Of the households residing in Mandela Park in 1995, 35 percent included a current mineworker and 33 percent a retrenched mine work. About half the residents had been born outside the Free State (largely in the former Transkei, Lesotho and Mozambique) and of those born in the Free State, many came from Qwaqwa, Botshabelo (both previously black homelands) and local farms. Highlighting the continuing system of migrant labour.

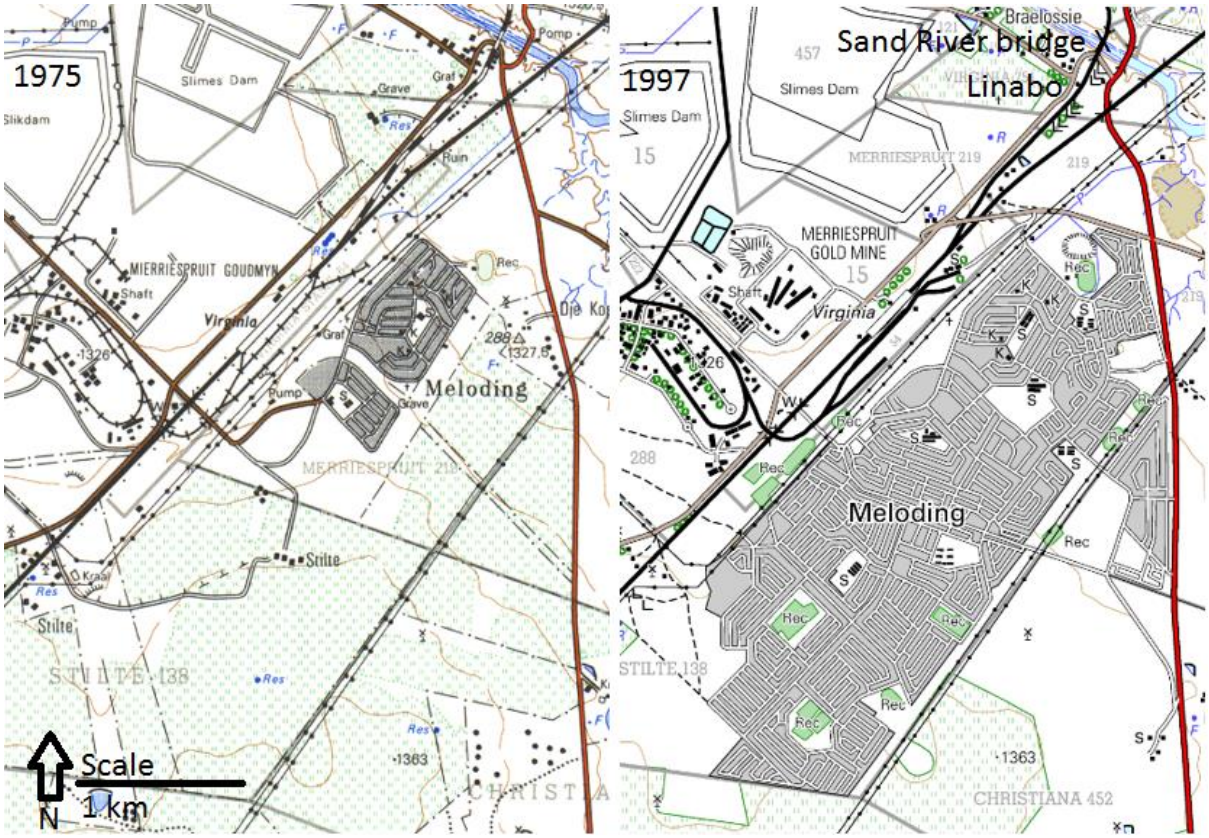

Figure 62. The growth of Meloding between 1975 and 1997 (map 2826BB Virginia)

White mine towns stagnate

There are two trends evident over this period as regards the towns developed by the mining companies to house white workers. In the early part of the period there was a shortage of houses as mines were expanded, the Joint Metallurgical Scheme implemented and new mines developed. Under a construction programme initiative in late 1975, 79 new mine houses were completed in Jan Cilliers Park with a further 249 in Flamingo Park in Welkom (Greathead & Graadt van Roggen, 1986). There was also housing development around Toronto Pan on the west and in Rheeders Park to the north of Welkom. The industrial area on the eastern side of Welkom saw some expansion and a new golf course is also evident on the maps, south of Flamingo Pan. Virginia also saw some growth linked to the development of the new mines (Beatrix, HJ Joel and Saaiplaas). The new suburbs of Saaiplaas and Kitty are evident on the map, with further housing development in Faunapark, Joelpark and Panorama. In Odendaalsrus two new settlement areas were developed. The first, across the main Welkom-Allanridge road, partly on the site of the original Marobe settlement. The second on the eastern side of Odendaalsrus, just across the road from the new Free State Geduld mine. Even with this increase in size, Odendaalsrus did not see the same growth as the other mining towns, with a white population of 10,500, across 3,327 ervan, in 1987, (Whittle, 1987), from 8,300 in 1954. In Allanridge there was minimal further housing development, with some of the earlier road

development no longer evident on the maps. The non-mining town of Riebeeckstad had however seen growth over this period.

By the mid-1980 the majority of houses in the white settlements were owned by the mining companies to house their more highly skilled labour force (Marais & Cloete, 2013). However, from the mid-1980s, in response to the drop in the gold price and the pressures of neoliberalism and globalisation, many mining companies started selling these houses to individual households (Marais, 2013a). As a consequence the house prices in the area declined significantly, leaving middle and lower-income families with unsaleable assets (Marais & Cloete, 2013). According to Seidman (1995), in 1995 Harmony owned 32 percent of Virginia's houses (as the owner and operator of the Harmony, Merriespruit and Virginia operations), and paid around ZAR1 million per month in rates. As was the case in Welkom, the subsequent downscaling and sale of houses to individuals, impacted the finances of the municipality and their ability to provide services and maintain infrastructure (Marais, 2013a). The long-term maintenance risks for what was previously mine infrastructure were devolved to households and local municipalities (Marais, 2018). Related to this, the mines also started withdrawing their support from peripheral activities such as the sports clubs – originally developed and run by the mines specifically to attract the 'right kind of person' to the Free State goldfields in the 1950s.

7.3 Agricultural developments

The growing settlements and increasing footprint of mines and mine waste extended onto agricultural land. This is evident, for example, with the expansion of Meloding and Thabong, where crop land was abandoned for settlement development, and with the extension of the Geduld tailings facilities (Figure *50*) and the new Merriespruit No. 4 tailings dam. Although not necessarily directly linked to this, there is also a loss in agricultural jobs in the area, from 10,735 in 1980 down to 7,844 in 1996 (Marais, 2013a). This may be associated with a general decline in the sector across the Free State linked to deregulation of the sector, loss of subsidies (Kirsten et al., 1994) and concerns around new labour legislation (Basic Conditions of Employment Act of 1993) and changing land tenure (Extension of Security of Tenure Act of 1997) (Liebenberg, 2013).

The maps do not show any increase in the area under irrigation along the Sand-Vet irrigation scheme. According to Herold et al. (1996) of the 4,997 hectares under irrigation in the scheme the main crops are wheat (58 percent), fodder crops (16 percent), potatoes (15 percent) and maize (10 percent), with vegetables (other than potatoes) and ground-nuts making up the balance.

7.4 Political and legislative change

The most profound political change during this period was the transition to democracy, starting in the mid-1980s and culminating in the first democratic elections in 1994. The apartheid government, recognising that change was the only option, gradually started a process of reform that gave black South Africans equal rights. This involved allowing free movement of black South Africans through the Abolition of Influx Control Act of 1986 and repealing the segregation rules of apartheid through the Abolition of Racially Based Land Measures Act 208 of 1991. This repealed the Land Acts of 1913 and 1936, the Group Areas Act of 1966 and the Development of Black Communities Act of 1984, as well as the Population Registration Act of 1950. How this played out on the landscape has already been discussed with regards to changing settlement patterns and the expansion of the black townships in the Free State goldfields. This was through the development of new formal settlements, supported by early initiatives of government and mining companies and after 1994 by government under the Reconstruction and Development Programme, and the development of adjacent informal settlements.

The government of the 'New', post-apartheid South Africa, led by the ANC, set about a process of legal reform. Key to this was the development of a new Constitution, which was adopted in 1996 and flowing from this a raft of new legislation. The Bill of Rights (Chapter 2) of the Constitution (Act 108 of 1996) includes the right of access to adequate housing (section 26) and a responsibility of the state to take reasonable legislative and other measure to achieve the realisation of this right (RSA, 1996). A White Paper on Housing had already been released in 1994 outlining the government's policy on housing. The policy focussed on the poor, the restoration of homeownership and the provision of a subsidy for this. According to Marais (2018), there was very little reference to mine housing and how the policy would be implemented in mining settlements.

Another important right in the Constitution, and relevant in the context of this research, is the environmental right (Section 24). In terms of this, everyone has the right *a) to an environment that is not harmful to their health or wellbeing; and (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that—(i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development* (RSA, 1996, p.9). This was a further development of the RDP document where environment was included as one of ten basic needs, recognising the link between poverty and environmental degradation (ANC, 1994; Steyn, 2005). Environmental issues were a growing concern

since the 1970s and as regards mining, legislation was amended to start addressing the environmental impacts of mining.

Environmental concerns were first reflected in mining legislation in 1977 with the amendment to the Mines and Works Act 27 of 1956 (Wells et al., 1992). This allowed the Minister of Mineral and Energy Affairs to make regulations regarding the conservation of the environment at or near mines or works, including the restoration of land on which activities in connection with mines or works are performed or have been performed. Subsequently, new regulations were promulgated in 1980 (GG 6892 of 21 March 1980) requiring a rehabilitation programme for open-cast mines, that, where practicable, concurrent rehabilitation be conducted in accordance with this programme, that topsoil be conserved and managed, that streams or rivers only be diverted with the permission of the Inspector of Mines in consultation with the Department of Water Affairs and that the footprint of mining be minimised and limited to that which is actually required for the mining activity (RSA, 1980). The regulations also required that at closure infrastructure should be demolished and rubble removed and the surface rehabilitated to '*as near to its natural state as is practicable*' (RSA, 1980, p. 29)

The Mine and Works Act was repealed by the Minerals Act, Act 50 of 1991. This new legislation had an increasing focus on environmental rehabilitation. In fact one of the express purposes of the Minerals Act was to '*regulate the orderly utilization and the rehabilitation of the surface of land during and after prospecting and mining operations*' (RSA, 1991, p. 2), with Chapter 6 dedicated to this. In terms of this legislation authorisation to mine was only to be granted if the regional director was satisfied with the way in which rehabilitation was to be done. Again there was the requirement to remove buildings, structures and objects and 'restore' the surface '*to its natural state to the satisfaction of and within a period determined by*' the regional director (RSA, 1991, p. 45). In terms of section 12 of the Act, a closure certificate was required with the holder of the right remaining liable for meeting all provisions of the Act (so including rehabilitation), until a closure certificate was issued (RSA, 1991). The Minerals Amendment Act of 1993 amended certain provisions of the Minerals Act, in particular Section 39, requiring an Environment Management Programme rather than the original layout and rehabilitation programme. There was also the ability for the State to require the production of environmental impact assessments and to make regulations regarding the establishment of accounts for the environmental management programme (RSA, 1993). These numerous new requirements for mining were not translated onto the landscape of the Free State goldfields during this time. This was largely as all the mines were underground (the 1980 regulations

being applicable only to opencast operations), the legislation being relatively new and as the mines had not yet started to close. However, they, and other new legislation implemented in the early part of the democratic era, would have a direct impact on the mines and the landscape.

At much the same time the Environmental Conservation Act (ECA) was promulgated (Act 73 of 1989). This was a major milestone in the development of South African environmental law, holistically addressing environmental concerns (Rabie & Fuggle, 1992) and an output from the new Department of Environmental Affairs. This department was formed in 1984, having previously been together with the Department of Planning. The ECA provided for the effective protection and controlled use of the environment, and powers for the Minister to oppose developments and resource exploitation that could possibly harm the human and natural environments (RSA, 1989). The legislation also included provisions for Environmental Impact Assessment (EIA) (having been adopted globally from the 1960s), however this was only made compulsory in 1997. Mining was not included as a listed activity triggering EIAs in this legislation, as environmental issues for mining were addressed by the minerals legislation.

Internationally, concerns around the impact of economic development on the environment continued. A second United Nations Conference on Environment and Development took place in 1992 in Rio de Janeiro, referred to as the Earth Summit. It was at this gathering that the concept of sustainable development was introduced and Agenda 21 developed as the action plan to implement sustainable development. The UN Framework Convention on Climate Change, the UN Forest Declaration, and the UN Convention to Combat Desertification were also adopted (UNESCO, 1992). The apartheid government were not allowed official representation at the Earth Summit, although official delegations form the ANC and Pan-Africanist Congress were invited. According to Steyn (2005) this contributed to the South African government of the time not grasping the future importance of sustainable development and the essence of this developmental model, which integrates environmental and development issues. This was key to the ANC's approach, as reflected in the RDP.

7.5 Natural and spatial change

Mining and settlement expansion continued to influence the natural environment, with the impact of gold mining on the ground water, pans and rivers of the region being quantified. These impacts were furthermore not limited to the Free State goldfields, but extended to downstream

environments. As illustrated by the changing legislation, the environmental impacts of mining were being recognised and measures put in place to limit these.

7.6 Summary of landscape changes between 1976 and 1997

The developments of this period are summarised in Figure *63*. The key to this map is as follows:

Settlements	**Operating mines**	**Other points of interest**
A - Allanridge	2 – Loraine	X – evaporation pans
B - Phatakhale	3 – Freegold North (Freddies, Free State Geduld, Western Holdings & Welkom mines)	Y – Merrispruit No.4 tailings
C – Odendaals rus		JMS - Joint Metallurgical Scheme
D - Kutlwanong		
E – Riebeeckstad	4 – Freegold South (President Steyn, President Brand & Saaiplaas mines)	
F - Welkom		
G – Thabong		
H - Bronville	5 – St Helena	
I – Virginia (includes suburbs of Saaiplaas, Harmony, Merrispruit & Kitty)	6 - Unisel	
	7 – Harmony (includes Virginia & Merriespruit mines)	
J - Meloding	8 – Beisa/Oryx	
	Not in this area - HJ Joel & Beatrix	

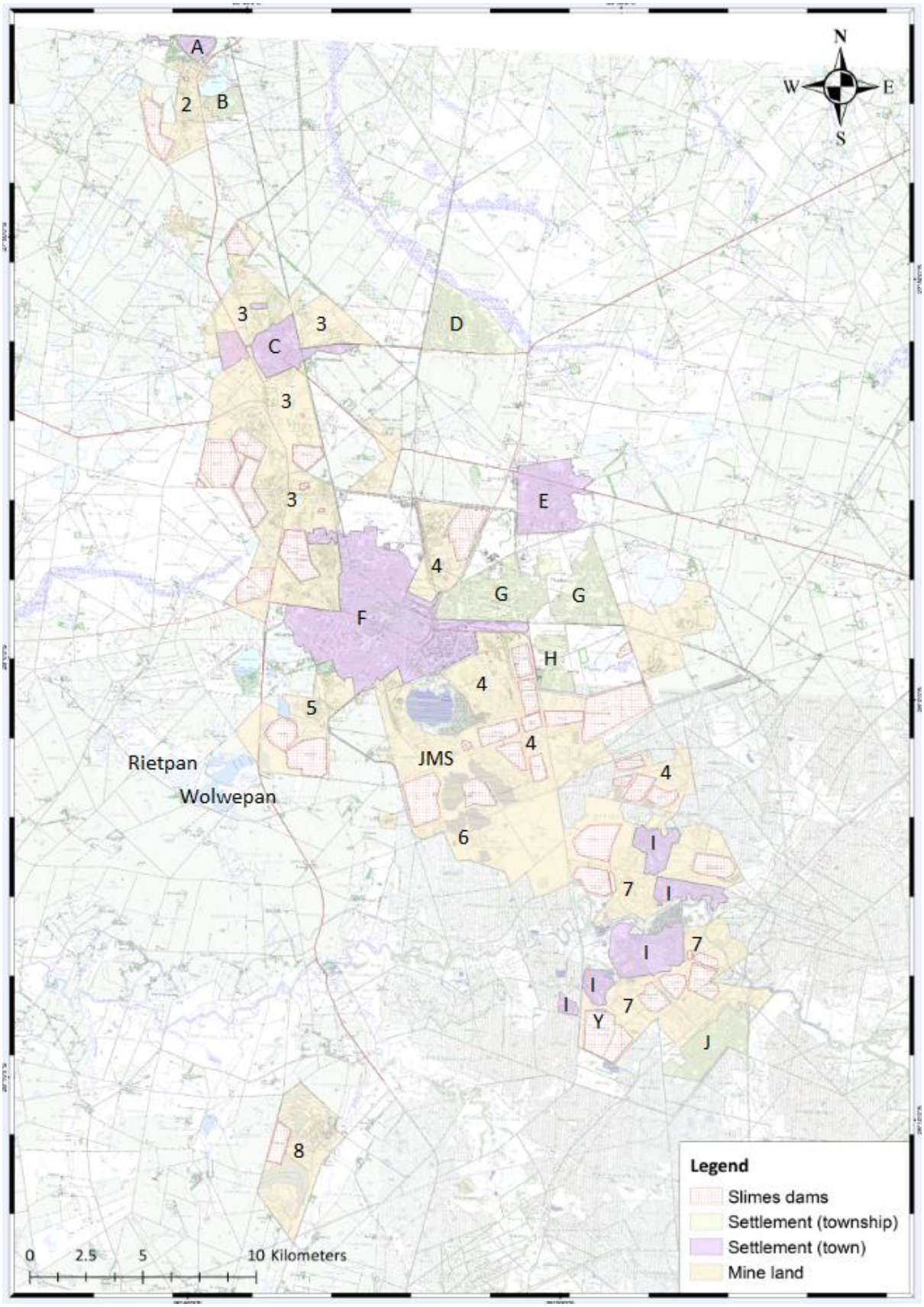

Figure 63. Landscape elements and their extent in 1997 (maps 2726DC Odendaalsrus, 2726DD Riebeeckstad, 2826BA Bloudrif and 2826BB Virginia)

Chapter 8

8. Landscape change in the Free State goldfields from 1998 to 2018 – Mines close, people leave a distressed mining community

This period marks the decline of gold mining in the Free State with closure of many of the mines, the withdrawal of AAC from the Free State and eventually from gold, and the subsequent socio-economic decline, leading to the area being identified as a 'Distressed Mining Town' in 2012.

Declining gold production and mine employment continued into this period. Mining's contribution to the Free State's GGP dropped further, from 20.6 percent in 1991 to 14.3 percent in 2001 (McCarthy et al., 2005) and, for Matjhabeng, the contribution of mining to the overall economy decreased from 50 percent in 1996 to 33 percent in 2010 (Marais, 2013a). This trend was not limited to the Free State, with gold production declining across the country (*Figure 64*) and employment in mining falling from a peak of 480,000 in 1988 (Harington et al., 2004), to 380,000 in 1995, 119,000 in 2014 (Statistics South Africa, 2017) and 98,226 at the end of 2018 (SA Market Insight, 2019).

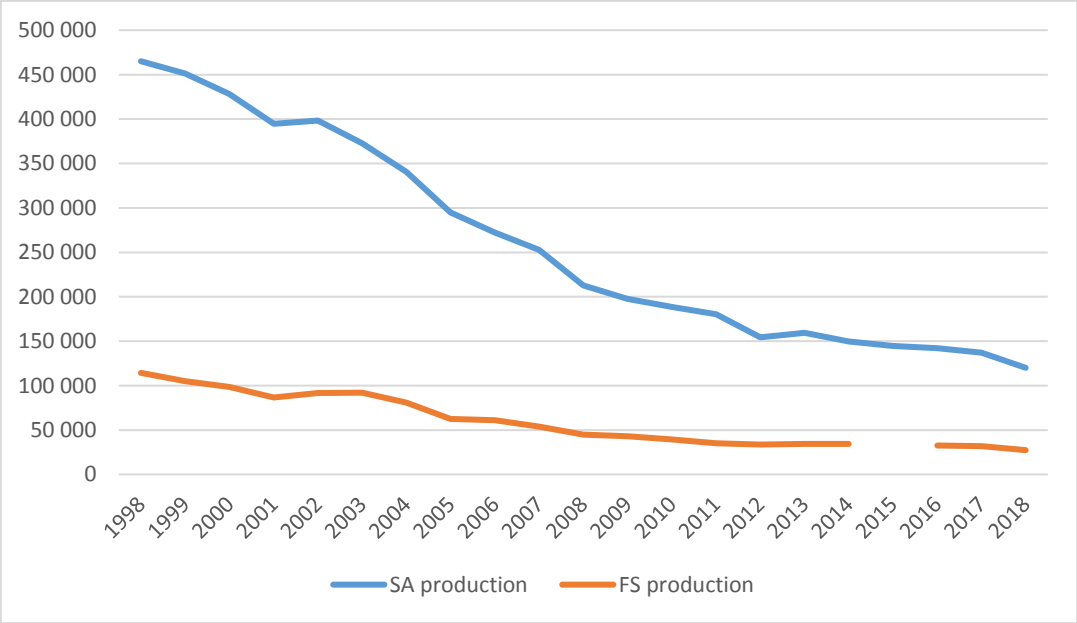

Figure 64. Gold production in the Free State and South Africa continued to decline (Department of Minerals and Energy Affairs, 1998 to 2008, Department of Mineral Resources, 2010 to 2018a, Minerals Council of South Africa, 2020)

Closure had a devastating economic impact on the Free State goldfields community, with many working age males eventually leaving the region. The ability of the municipality to provide services was also compromised, even with an increasing legislative focus on local government to provide for development. The key milestones over this period are summarised in *Table 18*.

Table 18. Timeline of the development of the Free State goldfield between 1998 and 2018

1998	114,300 kg gold produced in the Free State goldfields, a quarter of South Africa's production
1998	AAC unbundles and AngloGold formed to hold all AAC gold assets
1998	White Paper on a Minerals and Mining Policy for South Africa promulgated
1998	White Paper on Environmental Management Policy for South Africa promulgated
1998	National Environmental Management Act 107 of 1998 (NEMA) enacted
2000	Municipal Systems Act No 32 of 2000 requires that the newly elected municipal councils prepare and adopt an integrated development plan
2001	2001 census shows 13,5% decline in total population of Free State goldfields since 1996
2002	Mineral and Petroleum Resources Development Act (MPRDA), Act 28 of 2002, which came into force on 1 May 2004
2002	South Africa hosts the World Summit on Sustainable Development, or Rio +10, in Johannesburg
September 2002	The Broad Based Socio-Economic Empowerment Charter for the South African Mining Industry (Mining Charter) established in terms of Section 100 of the MPRDA, 2002
1 January 2002	AngloGold withdraws from the Free State, selling its Free State operations to ARM/Harmony JV
2007	Project Phoenix starts with the retreatment of tailings
2009	91 illegal miners die in Eland shaft fire (Free State Geduld mine)
September 2010	Following an assessment of progress against the objectives of the Mining Charter, and amended Charter is published.
2010	Total mine employment in the Free State goldfields drops to 36,000
2011	2011 census shows further slight decline in total population of Free State goldfields
2014	Free State goldfields named, along with fourteen others areas, as recipients of the Special Presidential Project focussing on distressed mining communities
2017	Rehabilitated JMS site producing biomass for biofuel production
2017	Central Treatment Plan commissioned to treat re-mined tailing and other mine waste
2017	40 illegal miners die in methane explosion in Elands shaft (Free State Geduld mine)
27 September 2018	Mining Charter III gazetted.
2018	27,294 kg of gold produced in the Free State goldfields 23 percent of SA production

8.1 Mining development

Two parallel, but connected, processes changed the face of mining during this period. The first was the decline in gold production and closure of shafts and mines, and the second a change in ownership of these operations, from one largely controlled by AAC (to become AngloGold), to one dominated by Harmony. As a consequence there were significant job losses, removal of mine and related infrastructure, loss of recreational services and an overall decline in the population and economy of the region.

There was also a significant shift in mining legislation, with the new ANC government publishing a Minerals and Mining Policy for South Africa in 1998 (White Paper) and passing the Mineral and

Petroleum Resources Development Act (MPRDA) in 2002. The policy focus was on redress, addressing ownership and participation in the industry and sharing the benefits of mining more broadly. Environmental requirements were also strengthened.

Towards the end of this period, with gold mining declining, new resource extraction opportunities were being investigated, namely methane and helium from the Virginia Gas Project (https://www.renergen.co.za/virginia-gas-project/). This project is at a very early stage of development so the extent and economic opportunity associated with it is unclear.

8.1.1 Anglo American Corporation withdraws and closures

By 1998 the earliest mines were approaching 50 years old. The cost and risk of mining increases with depth and to keep old mines operating requires a high gold price. This was not the case in the late 1990s. As indicated in *Figure 64* gold production across South Africa continued to decline over this period. In 1998 the Free State goldfields was producing a quarter of South Africa's gold at 114,300 kg. This dropped to 27,294 kg in 2018 (Department of Mineral Resources, 2018a), less than that produced in 1954, at the start of gold mining in the Free State.

Over this period the face of mining in the Free State goldfields changed completely, with mines being closed, and shafts reallocated and renamed. For example President Steyn was closed in 1997 with its No. 4 shaft becoming Bambanani East (Harmony, 2017). Some of the Saaiplaas shafts were closed in 1998, with others being incorporated into the new Masimong operation, and the Eland shaft of Free State Geduld becoming the Matjhabeng mine (Harmony, 2017). In 1998 AAC, or AngloGold as it had become, had the Freegold mines of Bambanani (Steyn No. 4), Matjhabeng (Eland Shaft) and Tshepong, and Joel (Campbell, 2002). Gold Fields (previously Gencor) continued to operate the Beatrix mine, where a new shaft, shaft No. 3, was completed in 2001. In 2009 Beatrix merged with the Oryx operation (originally Beisa), which was renamed Beatrix No. 4 (Gold Fields, 2009). The location of these shafts is indicated in *Figure 90*.

In 1998 the gold and uranium mining interests of AAC across South Africa, including those in the Free State, were consolidated into a single, focused, independent, global gold company – AngloGold (Handley, 2004). Not too long after this, on 1 January 2002, they withdrew from the Free State. Their last four Free State mines Bambanani, Joel, Matjhabeng and Tshepong, associated surface infrastructure, metallurgical plants, equipment, commercial and residential properties, the Ernest Oppenheimer Hospital in Welkom, all AngloGold's shares in Jeanette Gold Mines and all mineral rights in Welkom and the southern Free State goldfields were transferred to a new Harmony/African

Rainbow Minerals (ARM) joint venture (JV), at a cost of ZAR2.2 billion (Campbell, 2002). The Chief Executive Officer (CEO) of AngloGold at the time, Bobby Godsell, described this as a sad day and was quoted in the press saying '*The company that I work for literally created Welkom – planned the city, laid out the streets – and today we leave Welkom. But the Free State has underutilised infrastructure, orebodies divided by farm fences and so we've been punting for regional consolidation for a long time. We, AngloGold, are very happy with the partners we have found ARM and Harmony – we're leaving our assets, employees and corporate infrastructure in good hands and I'm confident that they'll carry on in a nation-building spirit. This is a beginning, not an end*' (Campbell, 2001). AAC eventually exited gold completely, selling its remaining interested in AngloGold in 2009.

The new mine owners, Harmony and ARM, had a very different mining strategy to that of AAC given the marginal nature of their newly acquired operations. They were specialists in taking over mature mines, radically restructuring them, undertaking considerable rationalisation and cost-cutting, changing the psychology of management and workers, and adding years of life to assets previously thought to be nearing closure (Campbell, 2002). This became known as 'the Harmony Way', which was not well received by all across the Free State goldfields (Reed, 2004). Following the transfer, the JV announced the reopening of four shafts in the goldfields previously closed by AAC. These were the Nyala and Sable-Kudu (operated as a single unit) shaft on the Matjhabeng mine and Steyn No. 3 on Bambanani. At this time the JV were operating three processing plants, Freegold 1, Freegold 2 and Joel (Campbell, 2002). In 2003 Harmony and ARM gold merged to create the fifth largest gold producer in the world.

Following the transfer in ownership there was a brief and slight increase in gold production increasing from 86,700 kg in 2001 to 91,700 kg and 92,000 kg in 2002 and 2003 respectively, followed by a significant drop after 2004 (Department of Mineral and Energy Affairs, 2001 to 2004). Gradually other shafts and mines were closed as they reached the end of their economically viable life. In 2010 the closure of the Virginia operation's Harmony No. 2, Merriespruit No. 1 and Merriespruit No. 3 shafts was announced. By the end of 2018, there were 7 golds mines operating in the Free State by 2 companies, Harmony and Sibanye-Stillwater (previously Gold Fields). In some areas tailings were also being retreated. *Table 19* tracks the status of all the mines ever proclaimed in the Free State goldfields.

Table 19. Status of all mines ever operated in the Free State goldfields (Harmony 2019 annual report; Marais & van der Walt, 2011, Sibanye-Stillwater, 2017, Harmony, 2018a)

Mine	Date of first production	Owner in 1997	Owner in 2018, or at closure	Status in 2018
St Helena Gold Mine	1951	Gencor	Harmony	Closed
Welkom Gold Mine	1951	AAC	ARM	Closed
Western Holdings Ltd (renamed Matjhabeng)	1953	AAC	ARM	Closed
Free State Geduld (included the Kudu, Nyala, Sable and Eland shafts)	1956	AAC	ARM and Harmony	Closed
President Steyn Mine, of which shaft No. 4 is now Bambanani	1954	AAC	Harmony	Bambanani - Mature operation with focus on mining of the shaft pillar for the next few years after which it will be at the end of its operating life, LOM = 5 years
President Brand Mine	1954	AAC	Harmony	Closed
Loraine Mine Renamed Target Mine. The Target mine officially opened in May 2002. On the closure of the nearby Loraine mine in August 1998, the Loraine 1 and 2 shafts were transferred to Target, and have become the Target 1 and 2 shafts.	1955	AngloVaal	Harmony	Recapitalisation of operation currently being evaluated, LOM = 7 years
Freddies Consolidated Mines (merged with FSG)	1953	AAC	Harmony	Closed
Saaiplaas, originally Erfdeel, of which shaft 5 is now Masimong	1960	AAC	Harmony	Operating as Masimong Mature, single shaft operation nearing the end of its life of mine, LOM = 3 years
Harmony Mine	1954	Harmony	Harmony	Closed
Virginia Mine	1954	Harmony	Harmony	Closed
Merriespruit Mine	1956	Harmony	Harmony	Closed
Unisel Mine	1974	Gencor	Harmony	Mature operation reaching the end of its life of mine. Mining focused on higher grade areas of shaft pillar, LOM = 2 years
Beisa Mine Reopened as Oryx	1983 1993	Gencor	Sibanye-Stillwater	Part of Beatrix, LOM = 11 years
Beatrix Mine	1983	Gencor		
HJ Joel (now called Joel)	1988	JCI	Harmony	Twin-shaft operation – technically challenging, LOM = 9 years
Tshepong Mine	1991	AAC	Harmony	Steady state operation: development continues LOM = 17 years
Phakisa (previously Tshepong South)	1994	AAC		
Surface operations (Project Phoenix, based at Saaiplaas)			Harmony	Retreatment of tailings, LOM = 12 years
Central Plant Reclamation (near Welkom)			Harmony	Retreatment of tailings, LOM = 18 years

8.1.2 Mine rehabilitation

The physical closure of mines is evident in the landscape, and includes dismantling headgear, buildings and other infrastructure, some tailings storage facilities being retreated and rehabilitation projects implemented. By the time that many of these mines were closing new legislation had come into force, the MPRDA had further elaborated on rehabilitation and closure requirements. The Minerals Act of 1991 required that mines remove buildings, structures and objects and 'restore' the surface 'to its natural state'. The MPRDA requires that a closure plan be developed that includes mine closure objectives, future land use objectives and closure costs, and that these be submitted with the application for a new mining right (Swart, 2003). Transitional arrangements when the MPRDA came into effect made this a prerequisite for applying for a new order mining right – mining companies were required to convert their previous mining rights. Companies were also required, over the life of the operation, to make financial provision for closure. The objective of closure was that land should be rehabilitated, as far as is practicable, to its natural state or to a predetermined and agreed standard or land use which conforms with the concept of sustainable development (RSA, 2002; Watson & Olalde, 2019). Once rehabilitation has been completed the mine can apply for a closure certificate. A closure certificate allows companies to relinquish the mine. The land can then be transferred and used for other productive uses. This is traditionally seen as the end of the mining lifecycle. However, with legal principles such as the 'polluter pays principle' mining companies may still be held responsible for residual and latent impacts even once the mine is relinquished (Watson & Olalde, 2019).

In terms of the MPRDA, and the fact that none of the mining operations in the Free State goldfields have received closure certificates (Watson & Olalde, 2019), all operations should have closure plans and annual rehabilitation plans. In November 2017 an application for access to the closure plans and the most recent annual rehabilitation plans for the Sibanye-Stillwater and Harmony mining operations in the Free State Province was made in terms of the Promotion of Access to Information Act, Act No. 2 of 2000. These plans are generally not in the public domain and were not available directly from the mining companies concerned. This application was partially granted. The list of the documents received and the planned rehabilitation activities included in these are summarised in *Table 20*. Closure plans and annual rehabilitation plans for the Sibanye-Stillwater operations in the Free State were not made available as, according to the DMR official contacted, they had not been submitted.

Table 20. Summary of annual rehabilitation plans for various Harmony mine sites

Document title	Operations covered	Planned rehabilitation/closure activities
Harmony Rehabilitation Action Plan for 2014/2015 – FS30/5/1/2/2 83MR	JMS East/pyrite dam area 103hectaresarea including pyrite tailings facility, pollution control water dams, storm water trenches, effluent, sewerage and water pipelines, waste rock piles, building rubble	Clearing of land, amelioration to neutralise acid forming elements, profiling and conversion to irrigated (centre pivot) agricultural land for production of biomass for biofuel.
Harmony Rehabilitation Action Plan for 2014/2015 – Multiple mining rights FS30/5/1/2/2/85MR, FS30/5/1/2/2/82MR and FS30/5/1/2/2/84MR	St Helena metallurgical plant, Virginia 1 shaft Saaiplaas 3 shaft Matjhabeng – Western Holdings 5 shaft, hostel and supporting infrastructure	Demolition of concrete structures, removal of waste from site or placed down the shaft and revegetation of area
Harmony Rehabilitation Action Plan for 2015/2016 – FS30/5/1/2/2 86MR	St Helena 10 shaft	Demolition of shaft and concrete structures, rubble to be placed down shaft, on tailings facility or buried and revegetation of site
Harmony Rehabilitation Action Plan for 2016 – FS82MR	Merrispruit plant and surrounding areas which contain radiated material– 28ha Masimong 4 and 5 Waste Rock Dumps	Demolition of structures to 1m below surface and remove or bury rubble. Structures containing gold fines to be processed through central plant Waste Rock Dumps to be reclaimed and surface ripped
Harmony Rehabilitation Action Plan for 2017 – ARM 12/2004 (originally Welkom Mine)	ARM 1, and 4 shafts ARM 1A and 2B vent shafts	Demolition of shaft and concrete structures, rubble to be placed down shaft, on tailings facility or buried and revegetation of site
Harmony Rehabilitation Action Plan for 2017 – FS30/5/1/2/2/85MR	St Helena 1A, 1B, 1C, 4A, 5A, 7 and 9 vent shafts	Demolition of infrastructure, filling and plugging of shafts to prevent illegal mining activities. Plan to plant olives on 200hectaresalong eastern edge of St Helena mining right
Harmony Rehabilitation Action Plan for 2017 – FS30/5/1/2/5/226MR	Freddies 7, 8 and 9 shafts Freddies 9 hostel	Demolition of shaft and concrete structures, rubble to be placed down shaft or buried, shafts to be capped and area revegetated

Apart from the specific details listed in the table, the rehabilitation action plans are generic, outlining the broad rehabilitation and closure methodology, a risk assessment, standard management and mitigation measures, rehabilitation plan and standard monitoring and maintenance plan. From the Rehabilitation Action Plans rehabilitation appears to be undertaken in a piece-meal approach focussing on the demolition of infrastructure and local revegetation of these sites, with planning for post-mining activities on only two sites. As access to the Closure Plans was not granted, it is not clear whether the respective mining companies have a long-term consolidated closure vision for the Free State goldfields, and if so, what this is. What should be noted is that rehabilitation activities relate to specific mining rights, the parcels of land, originally based on farm

boundaries, that were granted to a company on (and under) which to develop a mine. There are no closure requirements for infrastructure, settlements and other developments not associated with a mining right.

The rehabilitation activities listed in *Table 20* are evident when reviewing and comparing maps and GoogleEarth images. Mining infrastructure and mine hostels at the closed shafts has been demolished, including at Freddies (*Figure 65*), Free State Geduld (*Figure 66*), Western Holdings, St Helena (*Figure 67* & *Figure 68*), Merriespruit (*Figure 69*, *Figure 70* & *Figure 71*), Virginia (*Figure 72*, *Figure 73*, *Figure 74* & *Figure 75*), Saaiplaas (*Figure 76*), and Unisel mines.

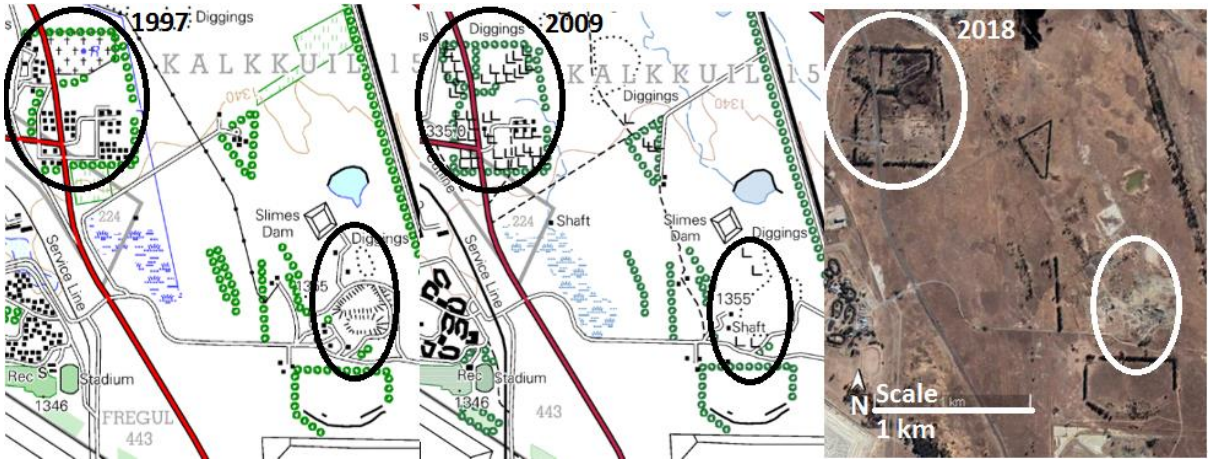

Figure 65. By 2009 the mine infrastructure at the original Freddies south shaft had been removed, yet the footprint is still evident in 2018 (map 2726DC Odendaalsrus, Google Earth image 10/28/2018)

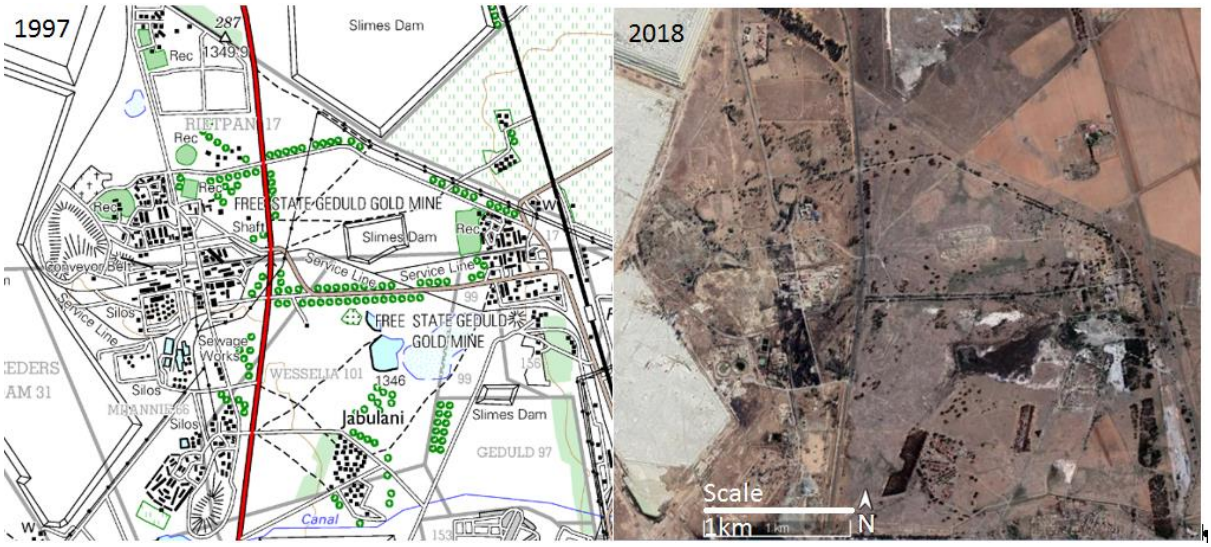

Figure 66. Infrastructure and accommodation evident in 1997 at Free State Geduld was demolished by 2018. However, the land has not been rehabilitated (map 2726DC Odendaalsrus, Google Earth image 10/28/2018)

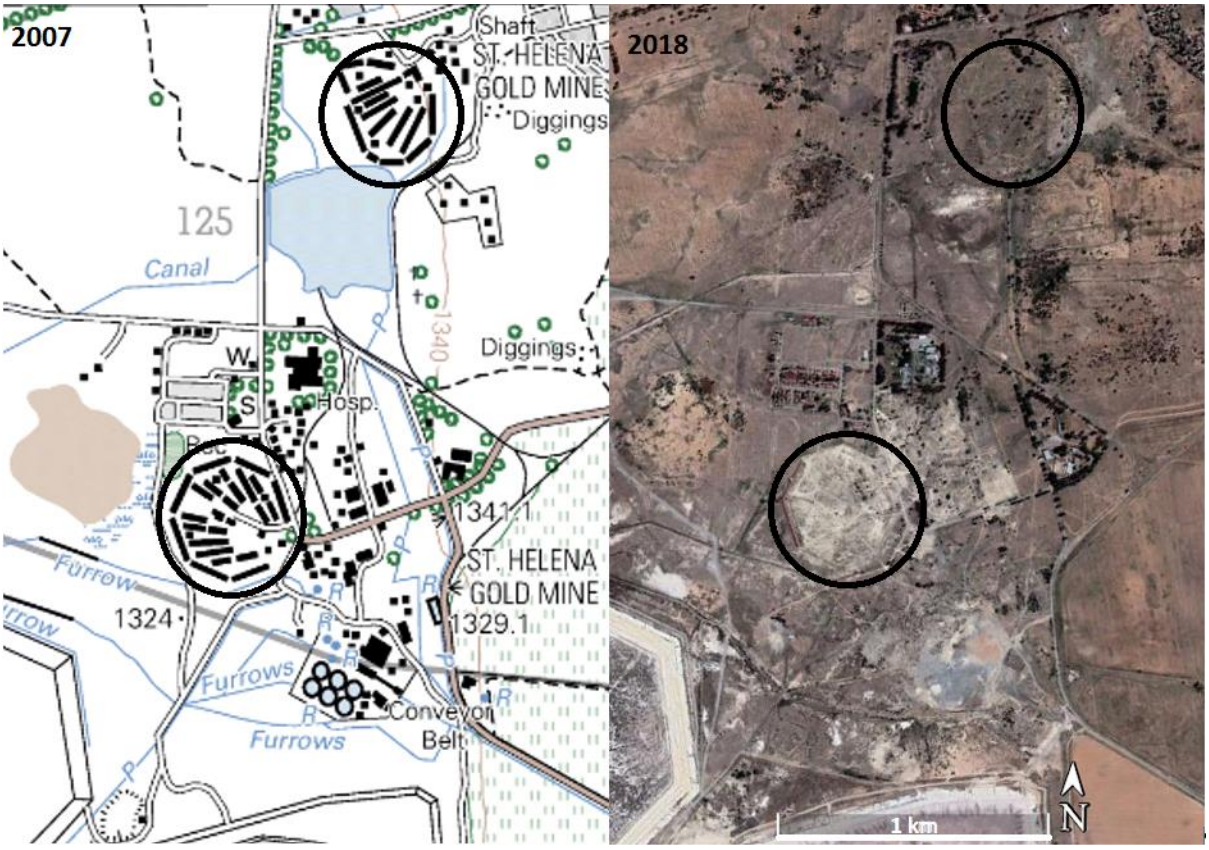

Figure 67. Mining infrastructure of the St Helena mine, the oldest of the Free State mines, is depicted on the 2007 maps, but has all but 'disappeared' by 2018. The St Helena hostel (bottom circle) was the largest in the goldfields (map 2826BA Bloudrif, Google Earth image 10/28/2018)

Figure 68. A view of the St Helena mine depicted above, October 2015 (Source: Author)

Figure 69. The Merriespruit shafts, hostels and associated infrastructure were removed between 1997 and 2007, although their location is still evident on the 2018 image (map 2826BB Virginia, Google Earth image 10/28/2018)

Figure 70. A view of the Merriespruit mine site depicted above, October 2015 (Source: Author)

Figure 71. What remained of the recreation area adjacent to the Merriespruit mine, October 2015 (Source: Author)

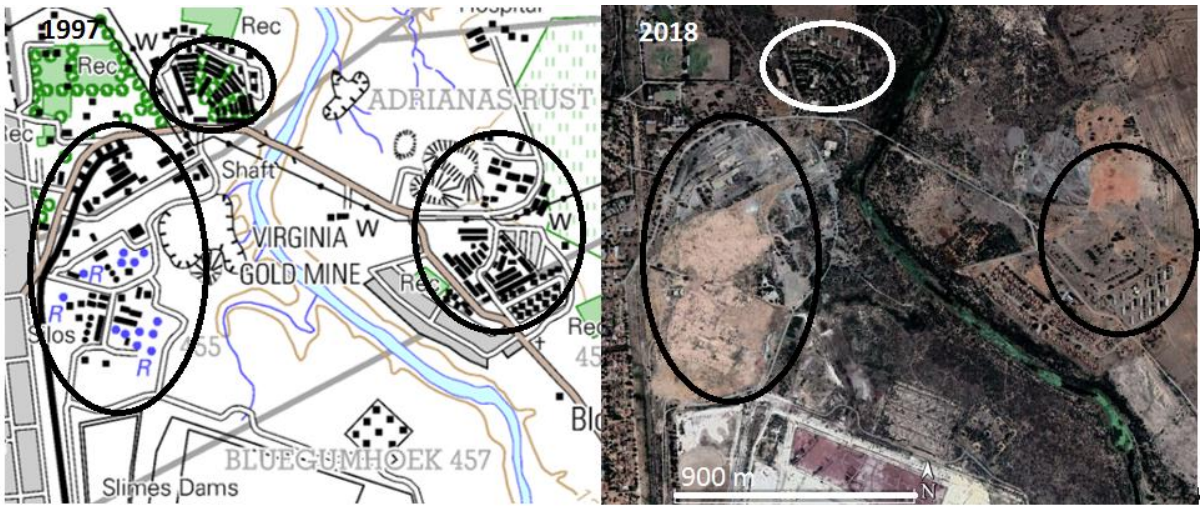

Figure 72. The office and workshop infrastructure (left circle) at Virginia mine has been cleared. Accommodation is still standing but has had the roofs and windows removed (map 2826BB Virginia, Google Earth image 10/28/2018)

Figure 73. A view of the map above showing the Virginia mines office and workshop infrastructure that has been demolished, October 2015 (Source: Author)

Figure 74. Remaining mining infrastructure at Virginia mines, October 2016 (Source: Author)

Figure 75. Virginia mine accommodation, October 2016 (Source: Author)

Figure 76. Saaiplaas mine and accommodation, October 2015 (Source: Author)

The rehabilitation activities to clean up the old Joint Metallurgical Scheme site and grow biomass for biogas are visible on Google Earth imagery (*Figure 77* & *Figure 78*). In this process energy crops harvested from the site are processed through an anaerobic digester to produce a methane rich gas. This is used as a replacement fuel for currently used liquid fuels. In 2017, this 100 hectare area of mine impacted land was planted to sorghum and beet as a pilot to assess whether energy production was feasible and a potentially beneficial post-mining land use for this region. Due to contamination from heavy metals the land was not suitable for food production (Harmony, 2018b). This pilot was successful. However, energy production would not be possible on all land and would depend on soil depth, drainage and textural profile, phyto-toxicty profile, distance from bioenergy production plant, security of infrastructure (e.g. irrigation infrastructure) ecological sensitivity and zoning (Haagner & Cloete, 2018).

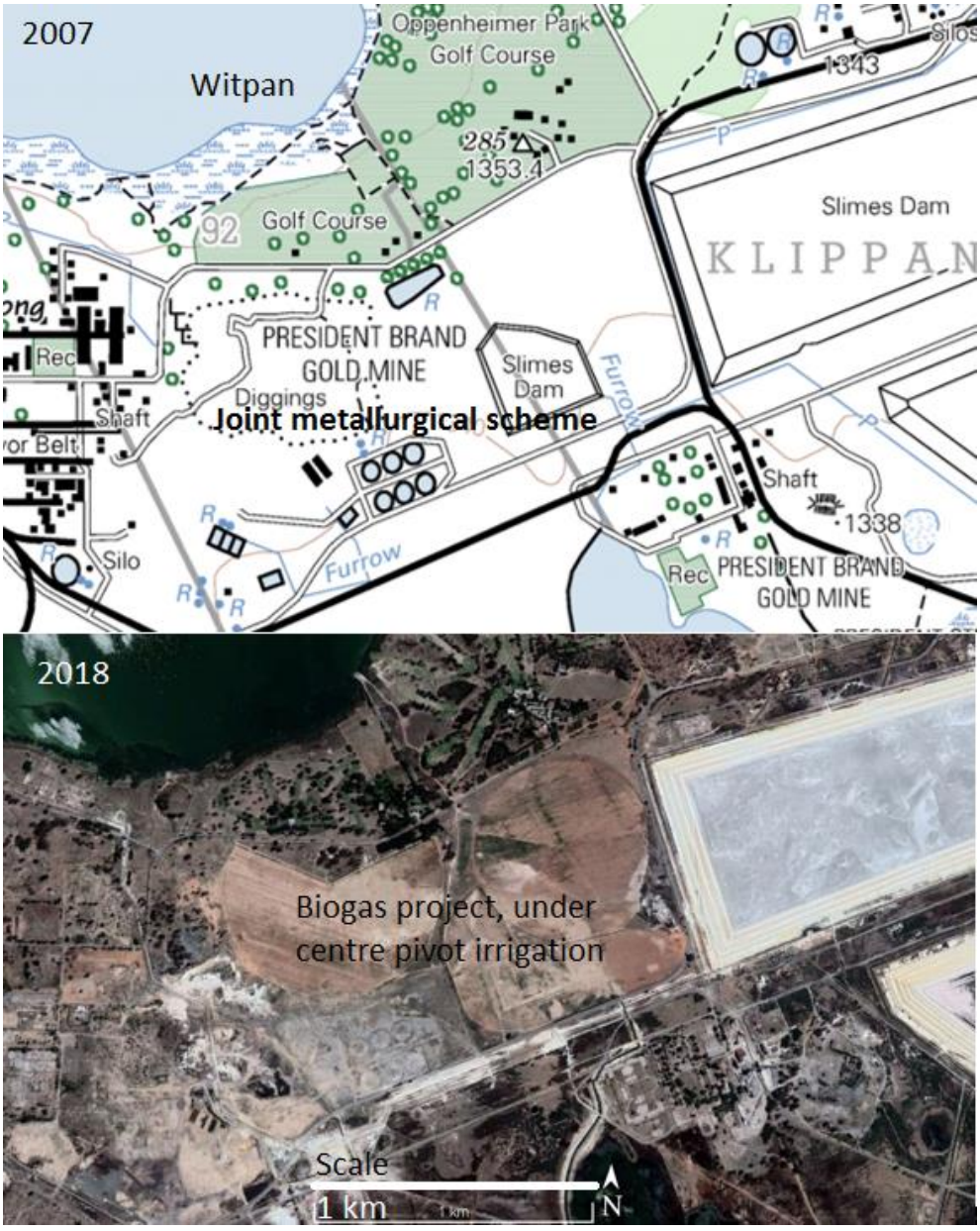

Figure 77. The clean-up and rehabilitation of the old JMS, still evident on the 2007 map, involves the conversion to biomass production for biogas (map 2826BB Virginia, Google Earth image 10/28/2018)

Figure 78. Bio-energy project on the site of the JMS, October 2015 (Source: Author)

In addition to demolishing infrastructure, Harmony also started a process of retreating mine waste. Similar to the Joint Metallurgical Scheme of the 1980s, this process extracts gold remaining in the tailings storage facilities. Hydro-mining is used and involves spraying water from high-pressure water cannons to re-pulp the tailings, which then flow under gravity to a sump from where it is pumped to the plant for processing (Harmony, 2019). In 2018 Harmony were operating two plants, the Saaiplaas plant, as part of Project Phoenix, and the Central Plant, located at the old Harmony No. 4 shaft. Project Phoenix started operations in 2007 and retreated and removed the entire Harmony No. 1 tailings facility by 2011 (Harmony, 2017). Tailings from the north dump (Dam 21) and Brand A tailings facility were being re-mined in 2018 (*Figure 79*, *Figure 80* & *Figure 81*). Waste from this process was deposited on the tailings facility at the closed St Helena mine. The Central Treatment Plant was commissioned in June 2017 and started with the retreatment of the President Steyn mine tailings facility (Harmony, 2019). In their 2018 Annual Report, Harmony indicated that there was 561.6 million tons of tailings material in storage facilities under their management in the Free State goldfields with an estimated 113,398kg of gold (Harmony, 2019). It is unclear whether there are plans to retreat all this waste material.

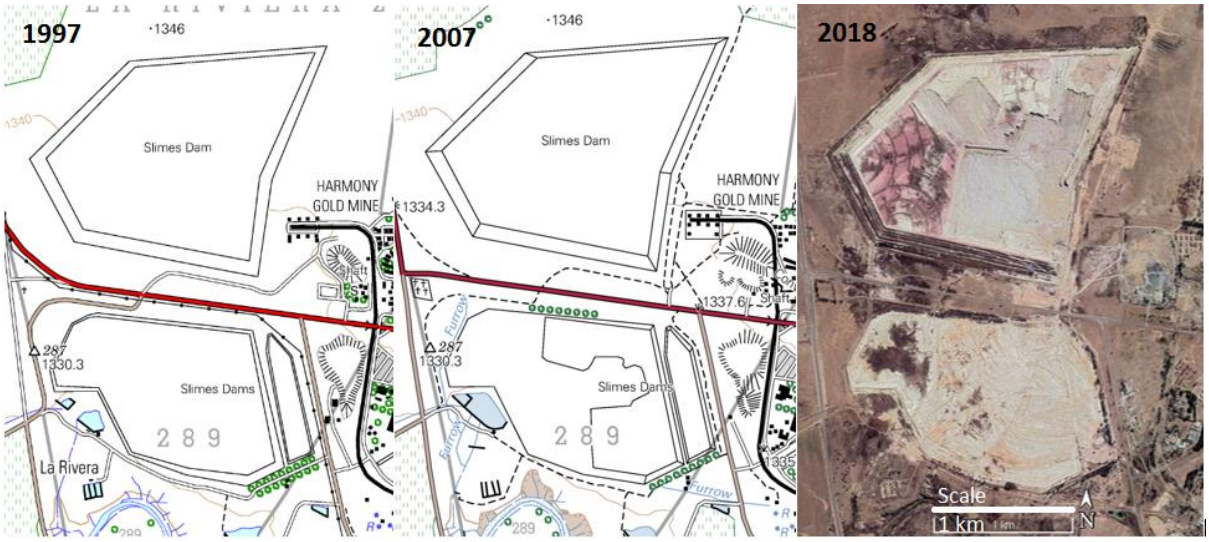

Figure 79. Waste material from the Harmony mine south tailings facility, was partially retreated by 2007 and completed by 2018. Work on the north tailings storage facility is evident from the Google Earth image (map 2826BB Virginia, Google Earth image 7/23/2018)

Figure 80. View of re-mining of the Harmony north tailings storage facility, October 2016 (Source: Author)

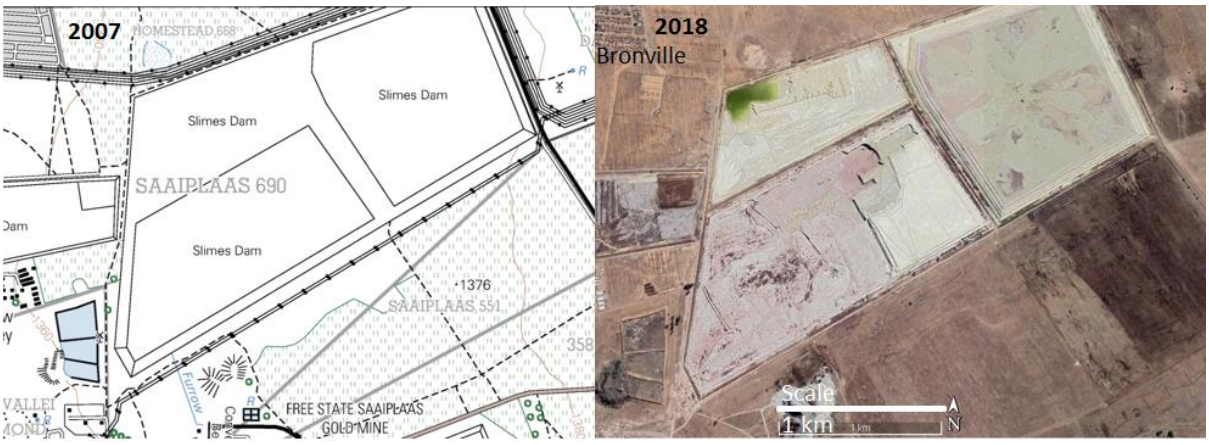

Figure 81. Retreatment of the Brand A (previously Saaiplaas) tailings facility is evident from the 2018 Google Earth image (map 2826BB Virginia, Google Earth image 7/23/2018)

From a review of 2018 Google Earth images there appears to be no rehabilitation activities focussed on the evaporation pans. These areas are also excluded from the Rehabilitation Action Plans reviewed. It may be that these sites do not fall within a mining license, and so rehabilitation is not required, or that rehabilitation of these areas may still occur. The impact on the surface is evident, with tightly spaced contour walls creating the 'rice paddies', yet the greatest impact may well be the salts that remain, salinizing the soil and impacting plant growth.

8.1.3 Mine Labour and worker accommodation

The decline in mine labour that started in the late 1980s continued into this period. The closure and consolidation of shafts and implementation of 'the Harmony way' resulted in further decreases in mine employment. In 1997 there were approximately 80,000 people employed on the mines, this

decreased to 26,556 by 2018 (*Figure 82*). The closure of the mines and the loss of mine jobs impacted labour beyond the mines. For the Welkom district employment as a whole fell from 178,096 in 1996 to 95,687 in 2001, of which 14,203 were non-mining jobs (McCarthy et al., 2005; Marais, 2013a). With the loss of employment, mine workers had to leave the hostels. While mining activities were continuing, raising expectations of re-employment (Ntema et al., 2017), many stayed in the region, moving into informal settlements that were being established. However, after 1996 there is a significant drop in the male population in the 19 to 45 age group (*Table 21*) indicating that many ex-mineworkers did eventually leave the area.

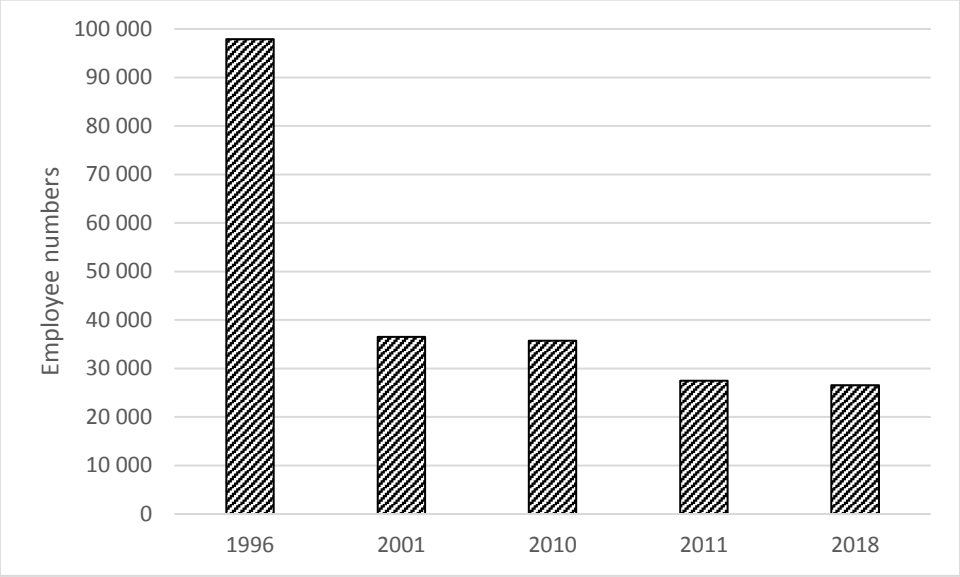

Figure 82. Total mine employment in the Free State goldfields (Marais et al., 2017; Marais, 2013a; Sibanye-Stillwater, 2017; Harmony, 2018a)

Accommodation for mine workers had been one of the key issue taken up by the NUM, and was carried forward by the democratic government post-1994. Consequently, where shafts remained operational, hostels were upgraded, de-densified (one person per room), or converted to family units. This was a requirement of the 2002 Mining Charter. The Mining Charter, developed in terms of section 100(2) of the MPRDA, indicated, amongst other things, that '*Stakeholders, in consultation with the Mine Health and Safety Council, the Department of Housing and organised labour, undertake to establish measures for improving the standard of housing including the upgrading of hostels, conversion of hostels to family units and the promotion of home ownership options for mine employees*' (Department of Minerals and Energy Affairs, 2002b, p.7). These requirements remained much the same in the subsequent Mining Charter in 2010, although a target, to attain the occupancy rate of one person per room by 2014, was set (Department of Mineral Resources, 2010). The most

recent Mining Charter (2018) sets principles for housing, which include decent and affordable housing, provision of home ownership, provision for social, physical and economic integration of human settlements and secure tenure for mine employees in housing institutions (Department of Mineral Resources, 2018b). The 2018 Charter also recognises the need for integrated human settlements, rather than just the provision of housing. This shift may be due, at least in part, to the Marikana Massacre of August 2012 which drew attention to the conditions in which mine workers and their families were living (Rubin & Harrison, 2015). One of the unintended consequences of the living out allowance, across the mining industry in South Africa, has been the increase in informal settlements and poor living conditions associated with this. According to the Department of Human Settlements, over 12,428 mine employees in the Free State goldfields in 2015 were receiving a living out allowance, compared to 5,720 that were housed in hostels (Tshangana, 2015).

In response to the Marikana Massacre, organised labour, business and government entered into the Framework Agreement for a Sustainable Mining Industry on the 14 June 2013. The main goal was to restore peace, attract investors back to mining and so boost the economy. This agreement included a focus on mine towns, committing all parties to work together to upgrade human settlements in mining towns. Building on this, the Strategy on the Revitalisation of Distressed Mining Towns was introduced in 2014. The main aim is the transformation of mining towns through the creation of sustainable human settlements (Tshangana, 2015). Matjhabeng was prioritised as one of fifteen mining areas for revitalisation, specifically the upgrading of 20 identified informal settlements, involving an estimated 6,331 households. Of the 20 informal settlements 15 were to be relocated. This with funding provided by government and industry (with a budget allocation of just over ZAR786 million indicated in 2015), the bulk of which was earmarked for housing and human settlements (Tshangana, 2015; Marais, 2018). This also contributed to the expansion of former black settlements in the goldfields.

8.1.4 Zama zama mining

Largely as a consequence of mine downscaling and loss of jobs is the emergence of, what is colloquially called, zama zama mining. This term, meaning ‘we are trying’, is used to describe illegal miners that work mostly in abandoned and disused mine shafts (Nhlengetwa & Hein, 2015) and is a survival and livelihood strategy for many ex-mine workers and migrants who remain in mining areas and are left without employment. It is understandably particularly prevalent in the Free State goldfields. While zama zama mining appears to play an important role in the economic activities of local communities, it also poses serious risks to the miners themselves and the surrounding

communities in which these activities take place (Ledwaba & Mutemeri, 2018). In 2009, 91 miners died at a disused section of the Elands shaft (Free State Geduld mine) after a fire broke out underground (van der Merwe, 2009) and more recently (2017) approximately 40 zama zamas were killed in a methane gas explosion in the same decommissioned area (Hosken, 2017). These are just two of the more significant incidents. A forensic services officer is quoted in the media as saying that the Free State mines are known as a "*zama grave yard. Every week we collect bodies. The miners send a signal and we go out to collect the bodies. Most are beyond recognition. That's from the heat, crush injuries from rock falls or diseases*" (Hosken, 2017). Local residents also mentioned the activities of zama zamas, during interviews and field visits. They were also observed washing the gravel mined in the Sand River during a field visit (*Figure 83*).

Figure 83. Zama zama miners washing mined gravel in the Sand River near the closed Virginia mine, October 2016 (Source: Author)

The 2009 disaster placed zama zama mining on the agenda of industry, government and law enforcement agencies. It was included as one of the top strategic risks identified by Harmony in its 2018 annual report (Harmony, 2018) and is estimated to cost the industry ZAR7 billion in lost revenue (Minerals Council of South Africa, n.d.b). A measure to mitigate the risks to industry posed by zama zama mining, which is relevant to landscape change, is the demolition, filling and closing of redundant shafts. Although a requirement of the closure plan zama zama mining may have prioritised action on this. Zama zama miners have also caused damage to municipal infrastructure, particularly sewerage infrastructure as they hope to find gold that has come into the sewerage deposits (Saflii, 2015; Will, 2018).

8.2 Urban and infrastructural development

Mine downscaling and changes in municipal demarcation influenced infrastructure development and maintenance, and settlement patterns in the Free State goldfields. With mining as the major source of employment, income and services for the community, mine closure has had devastating economic and social impacts. These include the obvious decrease in formal employment and the resultant decline in population, significantly amongst working aged men (see *Table 21*). This influenced settlement patterns. Firstly, with the proliferation of settlements around former black townships as mine workers left the hostels and government implemented its housing policies, and secondly, the stagnation of growth in the traditional white settlements, were there is little demand for middle and high income residential stands (Marais, 2013a).

Table 21: Population numbers for the Matjhabeng municipality (Source: Statistics South Africa, 1996, 2001, 2011, 2016)

Census Date	**1996**		**2001**		**2011**		**2016***
Age Categories	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Total****
0 – 18	75 091	77 202	74 115	74 647	70 353	69 872	146 118
19 – 45	143 231	102 326	92 294	97 651	88 850	87 760	180 736
46 – 60	34 798	20 585	25 104	22 949	31 129	31 064	68 113
61 +	8 226	10 821	8 857	12 554	11 177	16 256	34 147
Total	261 346	210 934	200 370	207 801	201 509	204 952	
Total	472 280		408 171		406 461		429 114

*Community Survey 2016
**age categories at 0 – 19, 20- 44, 45-59 and 60+ (Community Survey 2016)

Marais (2013a) describes how, when the mines were active and owned a large proportion of the housing stock in the towns of the goldfields, they were responsible for paying the municipal rates and taxes and for maintenance on these buildings. However, once these were sold to individuals, some of whom subsequently lost their employment, debt became a risk for the municipality. With a decreased population there is also a smaller group of rate payers, impacting the ability of the municipality to maintain its infrastructure and make adequate capital investments. This was acknowledged in 2009 by the then Mayor of Matjhabeng, Mathabo Leeto, following a court case related to contamination caused by the municipalities dysfunctional sewerage plants. She stated that the sewerage plants could not be maintained due to financial difficulties (Algotsson & Murombo, 2009).

Further compounding the financial situation in the municipality has been the amalgamation and expanding jurisdiction of municipal areas. Chapter 7 of the Constitution states that municipalities should be established for the whole territory of South Africa, re-demarcating the country with 'wall-to-wall' local and district municipalities (Forbes, 2011). This was facilitated through the Municipal

Demarcation Act of 1998 (Binns & Nel, 2002). On 5 December 2000 the Matjhabeng local municipality came into existence, as part of the Lejweleputsa District Municipality and incorporated the city of Welkom and the towns of Odendaalsrus, Virginia, Hennenman, Allanridge and Ventersburg. As voiced by a long term resident of Virginia, this has been problematic for the smaller towns who do not see local benefits for their rates and taxes, and rather see their tax contributions being spent in Welkom, the seat of the municipality.

8.2.1 Infrastructure

The scale of observation (i.e. the use of 1:50 000 topographical maps) predominantly used in this research has limitations when it comes to assessing the state of infrastructure. From the maps and Google Earth images the presence or absence of a feature is evident. However, as is evident from field visits, infrastructure in the region has deteriorated and been accompanied by poor service delivery during the period under examination. The lack of maintenance of the sewerage treatment plant highlighted above being an example.

With the consolidation and closure of mines and the adoption of 'the Harmony way' a number of recreational facilities deteriorated (Marais, 2013a) or were closed down. These include the Odendaalrus, Allanridge and Harmony golf courses, the Harmony country club (*Figure 84* & *Figure 85*) and the Joane Pim Park in Virginia. The 24 March 2000 edition of a local newspaper, *Netnews*, described the loss of Joane Pim Park as follows: '*One of Virginia's major environmental assets, the park, has been allowed to run to seed. The rare birds were removed and the cages left uninhabited. No longer did majestic black and white swans glide over the waters of its massive lake. The garden seats, barbecues, slides and seesaws were falling apart. The splitpole gazebos had all but collapsed and winter and summer alike, the shutters of the little tuckshop were up. A visit to the park became an exercise in despair'* (Whittle, 2000). The article goes on to indicate that new curators had taken over the park and established a nursery. However, when visiting the park in October 2015, it had again been abandoned.

Figure 84. The abandoned Harmony Country Club, October 2015 (Source: Author)

Figure 85. Rugby field at Harmony Country Club, October 2015 (Source: Author)

Funds from provincial government to stimulate economic growth and job creation through sports tourism contributed to new infrastructure in the region, namely the Phakisa race track project, just south of Odendaalsrus. This involved a ZAR420 million investment over five years (McCarthy et al., 2005) and is discussed in section 9.2.1. Also completed during this time was the new bypass through Thabong.

8.2.2 Settlements

The settlement trend noted between 1976 and 1997 extends into this period with limited expansion of the traditional white settlements, due to little demand for this form of housing, yet the continued growth of former black townships (Marais, 2013a), at least up until 2009. From this it would appear that post-apartheid town planning did not actively facilitate inclusive residential development, as cautioned by Hendler & Wolfson (2013), but rather perpetuated separate development. Numerous government initiatives have focussed on the development of houses in the black settlements, with an emphasis on home ownership. This is evident for both Thabong (*Figure 86*) and Kutlwanong (*Figure 87*), with Thabong and the former coloured settlement of Bronville extending towards each other and merging. Ntema et al. (2017), based on findings from research in the Free State goldfields, have been critical of these government strategies which emphasise homeownership in mining regions. This is especially concerning in the context of mine downscaling. Ntema et al. (2017) found that asset accumulation in the form of homeownership locks people into areas that have little long-term economic viability further entrenching poverty.

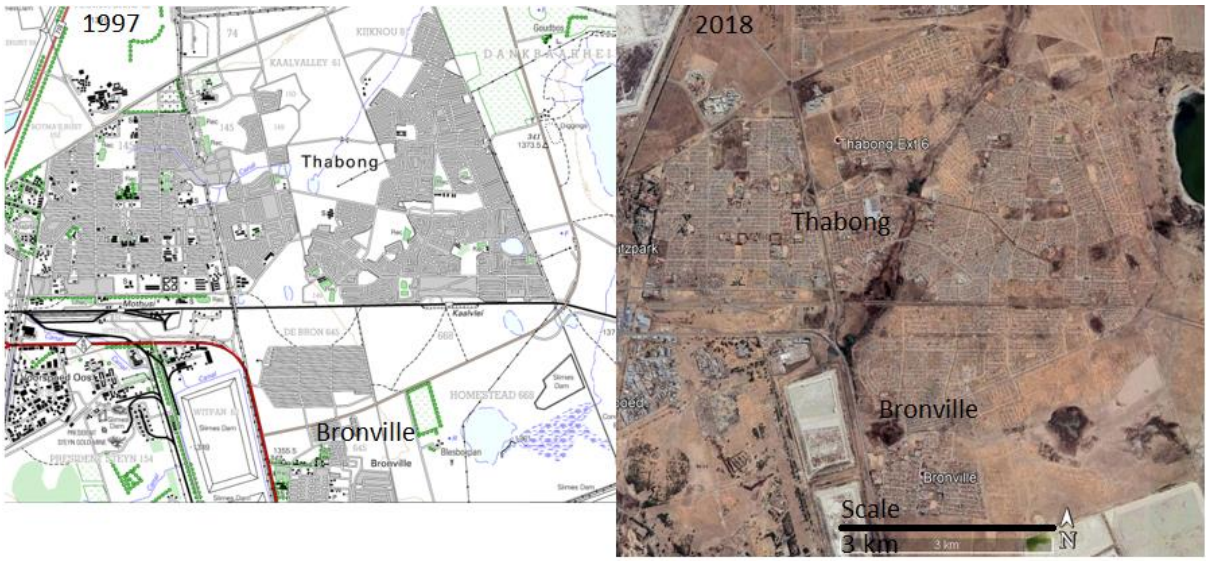

Figure 86. Further growth in Thabong between 1998 and 2018, with infill development

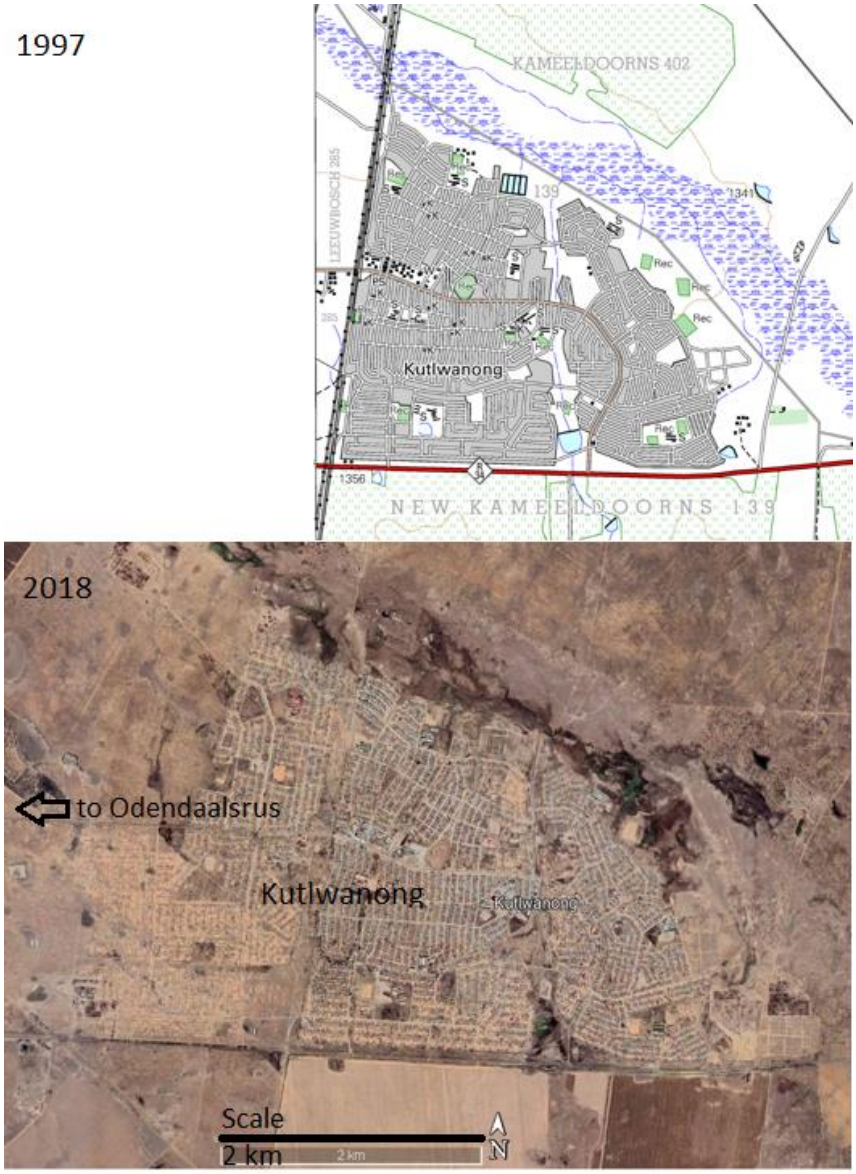

Figure 87. Kutlwanong expanded significantly after 1997, towards Odendaalsrus. This includes both planned formal housing in the north, and informal housing to the south (map 2726DD Odendaalsrus, Google Earth map 7/23/2018)

The physical direction of urban growth was influenced by the declining mine economy – where historically the plan had been to expand settlements towards new mines south of Welkom and Virginia, more recent thinking was to rather link Welkom/Thabong with Odendaalsrus/Kutlwanong, this is also more cost effective as regards service provision (Marais, 2013a). However, with the general stagnation in settlement growth, this infill development is not yet evident when comparing the 1997 and 2007/9 map series and 2018 Google Earth images, apart from the expansion of Kutlwanong, towards Odendaalsrus (*Figure 87*).

In the former white settlements a noticeable number of houses are unoccupied, derelict or abandoned with many retail buildings empty (*Figure 88*). This is an outcome of the declining population and economic situation. The dishevelled state of the town centres, in particular the iconic horseshoe-shaped Welkom civic centre and gardens and the Virginia library gardens, designed by Joane Pim, are particularly apparent (*Figure 89*). The permanent, grand developments of the 1950s are costly to maintain and have become a curse for the current municipality.

Figure 88. Empty retail buildings in Saaiplaas suburb, October 2015 (Source: Author)

Figure 89. The Virginia library gardens, March 2016 (Source: Author)

8.3 Agricultural developments

From observation of the topographical maps and Google Earth images, the extent of agricultural land has not changed significantly, although more land has been converted to settlement, especially around the townships of Thabong, Kutlwanong and Meloding. Apart from the biogas project at the Joint Metallurgical Scheme, no land previously impacted by mining has been returned to agricultural production, and from the closure plans reviewed, this does not appear to be an objective of rehabilitation.

Agricultural development is one of the local economic development strategies of the Matjhabeng municipality, as outlined in their Integrated Development Plan (IDP). Their focus is on urban farming, agric-processing, irrigation and alternative agricultural products, such as melons, herbs and spices, essential oils, flowers and vegetables (Matjhabeng Municipality, 2007). A paprika project established in 2003 is also mentioned. In more recent editions of the IDP, the focus is on emerging farmers and commonages, extending the area of land available for communal agriculture, providing infrastructure on these area and developing an agri-processing facility (Matjhabeng Municipality, 2017). During the field visits cattle were seen grazing around the settlements and the mines, these are presumably owned by individuals living in these settlements and contribute to their livelihood.

8.4 Political and legislative change

Although the scrapping of apartheid era planning regulations happened prior to this period, it is only in the late 1990s that the impacts of these changes becomes visible on the landscape. The new governments' focus was largely developmental to address the legacy of years of apartheid. This is evident in new planning, mining and environmental legislation.

The ANC government recognised that a new form of planning was needed to address the spatial and developmental flaws of the apartheid system, which had created a '*fragmented spatial pattern that was characterised by racial, socio-economic and land-use segregation, unsustainable human settlements far from the workplace, and poor-quality environments*' (Coetzee, 2012, p.11). They were influenced by the major international planning trends of the time which included a focus on community involvement and participation, an emphasis on social planning and communities, recognition of the environment and sustainable development and a focus on Local Economic Development (LED) (Coetzee, 2012). This approach is included in much of the legislation enacted since 1994. As indicated, new local and district municipalities were established in 2000 with a key role being local development, referred to as *developmental local government* (Binns & Nel, 2002).

This was to be achieved through the development of IDPs, essentially strategic plans for the development of the municipality, as set out in the Local Government: Municipal Systems Act, 32 of 2000. The IDPs should include all the functions undertaken by the municipality within a 5 year time horizon guided by long term objectives and strategies and should include a spatial development framework (SDF) – a spatial depiction of the IDP (Forbes, 2011). Disaster management plans, financial plan and key performance indicators are also to be included (Binns & Nel, 2002).

The post-apartheid transition included significant changes in mining legislation, which were first proposed in the White Paper on a Minerals and Mining Policy for South Africa in 1998. These included the shift from private ownership of mineral resources to the state being the custodian of the nation's natural resources, facilitating access to those previously excluded from the industry and a focus on developmental issues including suitable housing and living conditions for employees, and the phasing out of the migrant labour system (RSA, 1998). These were translated into legislation in the form of the MPRDA and, flowing from this, the Mining Charters (of 2002, 2010 and 2018) and Social and Labour Plans (SLP). As already discussed this led to a change in the hostel system and contributed to settlement expansion in the Free State goldfields. SLPs are required as part of an application for a mining right and describe how the benefits of mining will be shared with local communities. Commitments made in the SLPs, which should be developed in accordance with the IDPs of local municipalities, may result in the development of infrastructure, and influence land use activities and settlements.

The MPRDA continued to stipulate its own environmental requirements for mining. This, even though there was new environmental legislation in the form of the National Environmental Management Act 107 of 1998 (NEMA), highlighting the '*special child*' (Humby, 2015, p. 112) status given to mining in South Africa based on its historical importance in the development of the country (Humby, 2015). That being said, the environmental provisions in the MPRDA strengthen earlier requirements, and are aligned with those in NEMA. The department responsible for their implementation remained the Department of Minerals and Energy. This dual role of mining was a concern, with the minerals department being responsible for both promoting mining and protecting the environment (Humby, 2015). Chapter 4 of the MPRDA sets out the mineral and environmental regulations which included Environmental Management Principles (as listed in NEMA), that an Environmental Management Programme (EMP) be developed and approved with the application for a new mine, closure plans be developed and financial provision for rehabilitation be put aside during the life of an operation.

Alongside this was the further development of environmental legislation, in particular NEMA and its Environmental Impact Assessment (EIA) regulations, some of which were applicable to activities related to mining, although not mining *per se*. In addition, mining companies were also required to obtain water-use licenses in terms of a new National Water Act 36 of 1998. The consequence of these legislative reforms for the mining industry was a fragmented model where companies wishing to mine needed multiple authorisation, the timeframes of which were misaligned and occasionally resulted in conflicting approval conditions. This issue was finally addressed in 2014 with the implementation of the Single Environment System, in terms of which environmental authorisations for mining shifted from the MPRDA to NEMA, although implementation would continue to be by the now Department of Mineral Resources (Humby, 2015). The Department of Environmental Affairs has developed and continues to amend regulations related to mine rehabilitation, closure and financial provision. These will continue to shape the future landscape of the Free State goldfields.

These legislative developments were in keeping with the international trend towards increased environmental awareness and the continued focus on sustainable development. The 2002 World Summit on Sustainable Development (WSSD, also known as Rio +10) was hosted by South Africa. From a mining perspective, one of the key initiatives triggered by the approaching summit was a study of how the mining industry performed in relation to sustainable development issues, the Mining, Minerals and Sustainable Development (MMSD) initiative. The MMSD final report, *Breaking New Ground*, highlighted the sustainable development challenges faced by mining, with associated recommendations. This framed the industry's contribution to the WSSD and set in motion the establishment of the International Council on Mining and Metals (ICMM), a CEO-led organisation that would take forward the mining sectors responsibilities on sustainable development (Buxton, 2012). The ICMM continues to lead the industry in this area, with many of the major mining companies as members. However, neither of the remaining two companies operating in the Free State goldfields in 2018 are direct members of the ICMM, only through their membership of the Minerals Council of South Africa (previously the Chamber of Mines of South Africa).

8.5 Natural and spatial change

Many mines closed, with shafts and infrastructure demolished, yet as discussed, the land has not been returned to its previous state. The footprint of mining remains evident on the landscape. In the absence of an overarching closure vision for the region, rehabilitation will continue to be on a site-by-site basis.

During this period there were a number of El Nino events, characterised by a shorter rainy season with lower rainfall (Moeletsi et al., 2011). The summers of 1997-1998, 2002-2003, 2004-2005, 2009-2010 and 2015–2016 were associated with drought events (Moeletsi et al., 2011; Lakhraj-Govender & Grab, 2018).

8.6 Summary of landscape changes between 1998 and 2010

The developments of this period are depicted in *Figure 90.* The map dates are 2010, as topographic maps for later than that are not available. The key to this map is as follows:

Settlement	Operating mines	Points of interest
A - Allanridge B - Phatakhale C – Odendaals rus D - Kutlwanong E – Riebeeckstad F - Welkom G – Thabong H - Bronville I – Virginia (includes suburbs of Saaiplaas, Harmony, Merrispruit & Kitty) J - Meloding	1 – Target 2 - Phakisa 3 - Tshepong 4 - Bambanani 5 - Masimong 6 - Unisel 7 - Oryx (part of Beatrix) Not in this area - HJ Joel & Beatrix	Bio-energy project

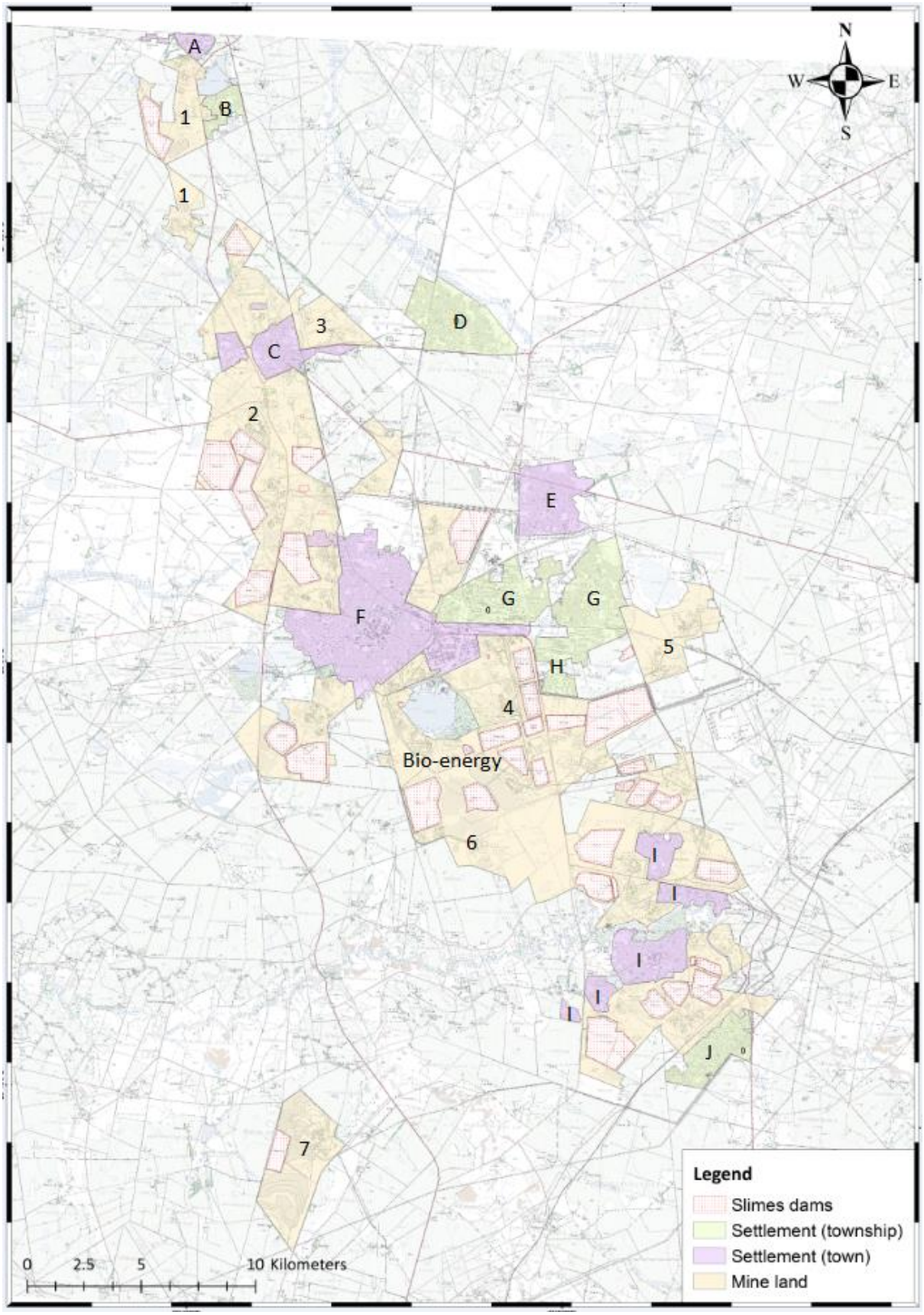

Figure 90. Landscape elements and their extent in 2010 (maps 2726DC Odendaalsrus, 2726DD Riebeeckstad, 2826BA Bloudrif and 2826BB Virginia)

Chapter 9

9 Post-mining realities and plans for the future of the Free State goldfields

Over the previous five chapters the development of the Free State goldfields was discussed through the lens of the landscape and the five drivers of change. This illustrated how the different drivers are linked as part of a social-ecological system. This chapter starts with a review of the experiences of long-term residents of the goldfields. Using many of their own words, the link between the different drivers and the impact on society is highlighted. The residents describe the phases of development and decline and the current state of the region.

The second part of this chapter considers the various plans to address the decline and develop a sustainable post-mining landscape. These plans have been developed at various levels of government and by the mining companies that continue to work in the region.

9.1 The voice of long-term residents

Thirty-one long-term residents of Meloding, Virginia, Welkom and Kutlwanong were interviewed. Most of the residents interviewed had lived in the goldfields since the early 1960s. One was amongst the first to move to the region in 1951, another was born there before gold was discovered, in 1935. A few had come more recently, in the late 1970s and 1980s, to work on the mines. Amongst those interviewed were retrenched and retired mine workers, including an ex-mine manager, school teachers, a local business owner and urban planner. The interviewees were a mix of male and females and population groups.

The purpose of the interviews was to gain a perspective of how long-term residents had experienced the changes to the landscape described in the previous chapters, their current reality, and what they perceive the future to hold for them and the region. The majority of the interviews were conducted in Meloding and Virginia and so in the discussion there is a bias towards these settlements. Although many of the experiences and perspectives of black and white residents are shared, their experience of the past differs. As such they are differentiated in the discussion that follows.

9.1.1 Remembering the 'heydays', for some

Long-term residents of the goldfields have many positive memories of growing up and raising children in the area, especially when compared to their current reality. In interviews they refer to Virginia and Meloding as being '*a very beautiful place*', things being '*so good*' and that '*life was great*'. This was especially the case for white residents who were looked after by the mines ('*the mines looked after their people well*') and had access to a range of recreational facilities.

'Just to give you an idea, I think Virginia had 3 or 4 swimming pools, tennis courts, bowling clubs. Every shaft almost had its own recreational facility. Growing up was great because all these facilities were right there' [long-term resident, white]

The Virginia of the time was a '*booming town*' were there was '*really a lot of money to go around*'. One white resident describes how, when the mine had a dinner function in Johannesburg, the *'managers ladies'* would fly to Johannesburg on the company aeroplane in the morning to do shopping, returning in the early afternoon, before getting ready and going back the same evening to attend the party - '*it was high fliers*'.

Although black residents also had a positive perception of the past, this was overshadowed by the realities of living under apartheid, especially the control of movement and the removals from Marobe. Visitors to the townships needed to '*ask permission in order to come*' and had to leave when their '*visiting days are over'*. The residents of both Meloding and Kutlwanong spoke of patrol cars '*making sure that no one roams around the streets late at night*' and checking for permits.

'When the police get here they will be saying 'permit, permit'. In their yellow van. They would come, light their torches and open every window. When they get here everyone must have their permit in their hand' [long-term resident, black]

During the latter half of the 1950s the residents of Marobe were forcibly removed to the new township of Kutlwanong (see section 6.2.2). Long-term residents give two reasons for this relocation, some state that this was '*to be far away from white people*' and others '*because they were opening new mines*'. First the cattle were moved, in 1955, and then the residents, in groups of 50 families at a time, between 1956 and 1960. It was difficult for the residents to start again, although they did gain access to services (water and toilets) and better, brick houses, rather than the mud houses they had in Marobe.

'It was a big problem because people had to leave their homes and start afresh. You had to build a new house, and go to the municipality to pay for that new house. But at least we had toilets' [long-term resident, black]

The opening of the mines was seen as a positive development, as it provided jobs and brought people to the area.

'They helped a lot of people when they opened the mines. Many people received jobs' [long-term resident, black]

This allowed for the development and growth of the region.

9.1.2 Mine downscaling and closure

The first big transition in mining was the change in ownership of many mines, from AAC eventually to Harmony. This was accompanied by a shift to focussing on core business, and '*mean and lean'* mining. According to a long-term resident (white) of Virginia, who was employed by AAC at the time, AAC knew well in advance of withdrawing from the Free State and started encouraging their employees to buy mine houses, to be *'a proud owner in this vicinity'*. Yet, the resident believes, this was done to avoid sitting '*with all the legal stuff about the houses and sit with a lot of houses that they are not going to do anything with'*. Those houses that were not sold were later transferred to Harmony when they took over AAC's operations. Harmony apparently could not keep up with the maintenance of the empty houses or the burden *'of paying the rates and taxes and things and the vandalisation that went on'*. These houses were subsequently given to the municipality and sold for very low prices. Impacting the housing market and so the value of the housing investments made – *'The property market just fell to pieces because of all these cheap houses that came into the market'*. A second impact of the transition in ownership to Harmony, experienced exclusively by white residents, was the cutting of support to the various recreational facilities, *'so the first things that went out the window was the recreational facilities, the golf clubs'.* [long-term resident, white]

> *'Harmony club has gone to ruins, it's very sad actually when you see those golf courses, pools, tennis courts, bowling greens'.* [long-term resident, white]

With the Harmony approach to mining *('Their* (Harmony) *type of mining is completely different to Anglo'*) came some job losses. As a consequence the Harmony company and their CEO Bernard Swanepoel were not well received, *'because they took away all the nice things. They were here to mine, and on several occasions public speaking he* (Swanepoel) *said you can't be a tick on this cow, because this cow is going to die, but we are going to take this as far as possible, so time for the ticks to get off'* [long-term resident, white]. However, the same resident did credit Swanepoel with extending the life of the mines, stating that *'we would have been far worse off earlier'*.

Yet, as discussed, even with the new lean approach to mining, the mines did eventually close, having a profound impact.

> *'As the mines closed, it impacted on everything – the number of people, economic viability.'* [long-term resident, white]

The primary issues associated with mine closure for the black residents interviewed was the loss of jobs. Residents recall initial retrenchments in 1989, increasing significantly in 1991/2 when *'it started to be bad because they retrenched many, many, many people'* [long-term resident, black]. The residents speak of how *'everything went bad'*, with *'most of the people'* being unemployed, how

people are *'suffering since the closing down of mines',* and that this has *'ruined many people's lives'.* With the loss of employment some mine workers left the Free State goldfields and returned to their rural home, but '*left their second families [5]here'*, creating significant social issues.

> *'As the years passed more and more mines were closing down. More and more people losing their jobs. The closing down of mines took the economy of Virginia away.'* [long-term resident, black]

Residents (black) expressed their surprise and disbelief at the mines closing down and how they were not informed about this – *'They closed the mines without even telling us what was going on'* and *'I think this mine was closed by mistake because it closed out of the blue. We didn't even know that the mine was closing down'*. One indicated that he thought the mines could still operate, stating that *'I don't think that there is no more gold to mine'*. This perspective is reinforced by the presence of zama zama miners, who operate openly in the region and *'get high grade stuff which you can actually pencil out'*.

Amongst black residents the closure of the mines and job losses is conflated with the end of apartheid.

> *'After the black people took over, that is when many mines closed down. Now our town is dead'* [long-term resident, black]

> *'There was a lot of employment during the apartheid regime'* [long-term resident, black]

There are mixed feelings about the physical legacy of mining, in particular the tailings dumps, one resident (white) commented that *'when you saw the dumps and you saw the banks that were bringing the rock then you knew that the mine was working. Now the dump is gone, so now you know…'* (that mining has ended). Yet, these dumps are also, largely, perceived negatively by both black and white residents. This due to dust and associated nuisance and health impacts. The residents state that the chemicals in the dumps are '*very dangerous for our health'*, causing *'people to be infected with asthma and TB'*, and *'to have chest problems'*. Residents also refer to '*conspiracy theories about the amount of cancer patients in the area, because there is cyanide'*. Interestingly, one resident did have a contrary view, acknowledging the high prevalence of disease, but that it was

[5] With the migrant labour system and apartheid legislation, men were not permitted to bring their families to the goldfields. Some men started new families with partners in the goldfields. These are colloquially referred to as 'second families'.

rather *'because people do not take care of themselves'*. Residents say that the government or municipality should address the pollution impacts of the dumps, interestingly not the mines.

> *'Our municipality needs to do something with these dumps. This is very serious to me because my child got sick because of these dumps, I used to take her to the doctor every two days'* [long-term resident, black]

There have been attempts to rehabilitate the dumps*, 'but unfortunately they haven't succeeded'* [long-term resident, white].

9.1.3 Residents' current reality

When describing their current reality, there is an overwhelming sense of despair amongst all residents interviewed. Residents indicate that *'times are tough'*, that they *'are struggling'*, that *'life is now hard'*, there is *'no development'* and that *'things are getting bad'*. This is associated with unemployment, poverty and crime, especially amongst black residents, and the deterioration of the settlement, attributed to the closure of the mines.

> *'The wealth of this town is its mines. But now they are closed. So, basically, we are economically deprived here in Virginia'* [long-term resident, black]

Black residents highlighted that unemployment is a significant issue, especially amongst the youth who *'finish school and they are unemployed'*. Unemployment and poverty are seen to be contributors to crime, *'people are doing crime to try and make ends meet'*, and the abuse of drugs (nyaope[6]) and alcohol.

White residents, in particular, lament the physical deterioration of Virginia, which has been '*neglected*' and '*gone down terribly'* from *'this beautiful little town'* to something that is *'awful'* and *'looks terrible'*. One resident indicated how she has seen Virginia grow and *'now I saw it die'*. Some imply that this is due to the post-apartheid government.

> *'With the passing of the years, starting in 1994, it* (Virginia) *deteriorated'* [long-term resident, white]

On the contrary, residents of Meloding recall '*a huge difference'* after 1994, when *'houses were built, roads were paved'*, another stating that '*the housing project is very helpful, we have tar roads and paving. Education has improved a lot'.*

[6] A street drug commonly found in South Africa

However, resident of all three settlement areas referred to the closure and relocation of retail stores as an issue.

> *'We don't have proper shops, we only have tuck shops here'* [long-term resident, black]

> *'Welkom became your retail hub. So most of the stores* (in Virginia) *closed. So your Edgars, Woolworths, movie houses, closed'* [long-term resident, white]

This perspective of Welkom overshadowing the other settlements in the Matjhabeng municipality was pervasive. New local and district municipalities were established in 2000, with Welkom being the centre of the Matjhabeng local and Lejweleputswa district municipalities. Although this was a national requirement some of the residents perceive it to be a local decision. The perspective is that the rates and taxes from the other towns in the municipality are used to provide services and development in Welkom, at the expense of other towns, with one resident stating that *'Matjhabeng is only Welkom, they don't care about Virginia, Henneman, Ventersburg…they don't care about those towns'* [long-term resident, black].

> *'The centralisation was a fiasco because the municipality in Welkom was already in trouble and the smaller municipalities had a better chance of survival than the bigger one. Our municipality (Matjhabeng) is totally defunct. Corruption of the highest' [*long-term resident, white]

> *'Honestly speaking I think that Meloding is the one that uplifted Welkom. Welkom had no money, the money came from Meloding, but Meloding is now dry'* [long-term resident, black]

9.1.4 No hope for the future

When asked about their thoughts on the future, here again all residents interviewed had a shared and negative response. They see the future as being *'very bad'* or there being '*no future after all, there is only death, that's all*'. This perspective seems to be related to their current geographical context (Meloding), saying that *'if there is a future, (it's) that side, not here'* (implying Welkom). Yet, residents do not see relocating as an option –

> *'where do you go? You sell your house for next to nothing, then you rent a small apartment that's older than your house and pay a lot of money for it. My children want me to sell because they say it is so dangerous. But you have to die one way or another' [*long-term resident, white].

However, residents did '*hope, with all my heart, that Virginia will survive'* and offered some opportunities that could contribute to its survival *'We still have fairly good infrastructure, manufacturing, geographical location that still has a lot to offer'* [long-term resident, white].

9.1.5 Conclusion

The voices of these residents demonstrate that the impacts discussed at a landscape level translate into very real physical, economic and emotional impacts for individuals. The long-term residents are nostalgic for the hey-days of mining development, generally remembering the past with fondness, and this being largely related to the economic wellbeing and social benefits of living in the area. With the downscaling and closure of mines, they cite numerous concerns, associated primarily with unemployment, and from these the declining economy, closing shops, lack of services and the social ills associated with this – crime, drug and alcohol abuse. Related to this is the loss of hope, and for some, dignity. Mine closure has had impacts at a personal scale. Having grown up in a thriving area, albeit under apartheid, they see little hope for the future, and feel trapped in the area.

The focus of the interviews was to hear the experience of long-term residents of the Free State goldfields as a component of understanding the landscape changes in the area and the implications of this for them and the future of the region. Foremost for the residents was the current context of dereliction, unemployment and poverty and understandably this was the focus of the discussion. Further interrogation of the participants of their experiences may well have surfaced other issues of interest, for example what kind of politics emerged alongside the growth and eventual decline of mining, and the changes that went along with this. This presents an opportunity for further research.

The views and experiences of long-term residents of their recent situation, is echoed in a 2005 report on growth and development in the Free State, focussing on Bloemfontein and Welkom and comparing them to other urban areas in South Africa (McCarthy et al., 2005). Even with the background trend of declining small towns (Human et al., 2008), the report shows that the experience of the Free State goldfields, as represented by Welkom, is associated with the closure of the mines and that the extent of decline is unique to the Free State goldfields. At the time, they concluded that *'on most economic indicators Welkom is (or is the leading part of) the consistently worst performing urban area in South Africa'* (McCarthy et al., 2005, p. 58). These indicators included employment, with employment growth being at or near the lowest of the 19 urban areas reviewed, economic growth, where the goldfields experienced negative economic growth for the three periods under study (between 1996 to 2003), and per capita income, where it was lowest and the only city with an annual per capita income of less than R10 000 in 2003. Perhaps most telling is that, of the 19

areas reviewed, Welkom had the highest proportion of people living in poverty in 2003 and that that proportion was over 10 percent more than the next poorest, which was Pietermaritzburg (McCarthy et al., 2005).

More recent indications of the dire situation in the municipality are provided in the IDP (discussed in section 9.2.2) and the exorbitant debt owed to ESKOM, the national power utility, by the municipality. In September 2020 the Free State Division of the High Court of South Africa ordered that 139 farms owned by the municipality have their title deeds endorsed in favour of ESKOM as security for the debt owed. The municipality owes the power utility ZAR3.4 billion. This has been escalating since before 2014, when the debt was ZAR372 million (Jooste, 2020). The municipality are clearly unable to fulfil their service delivery mandate.

9.2 Planning for the future

A region that was once so prosperous and with access to the infrastructure and resources developed over the years through mining, has ended up being the '*worst performing urban area in South Africa*' (McCarthy et al., 2005, p. 58). It would appear that the closure of the mines and the decline of the economy of Free State goldfields took everyone by surprise, with no plans being developed for an alternative to mining. This was not entirely the case. Various attempts had been made over the years to diversify the economy, but for numerous reasons they were met with limited success.

9.2.1 Early attempts to diversify the economy

Plans to diversify the economy of the goldfields were on the agenda from the early 1960s, through initiatives to support industrial and agricultural development. The Sand-Vet irrigation scheme, which came online in 1960, was intended to build the agricultural economy of the region, adding a fourth cornerstone to those of gold, industry and commerce. With the increase in the gold price after the US dropped the gold standard in the early 1970s, the region saw significant growth related to gold mining, and so the need to diversify the economy was forgotten (Marais & Nel, 2016). Subsequent to this, especially during the period of obvious decline, a number of other developments were planned.

In the mid-1980s the Welkom Town Council started investigating options to broaden the town's economic base. With the drop in the gold price in 1989 this became a priority and the Welkom Structure Plan was developed. The plan included a development framework and recommendations based on urban structure, land-use potential, development status and growth potential (Marais, 2013b). However, the Welkom Structure Plan made overly optimistic assumptions about population and industrial growth, which did not materialise. Having always been used to growth, decline was

not considered in the plan, even though some mines had started downscaling. The mining industry was not involved in this plan, contributing to its lack of success (Marais, 2013b).

Following this, the Deloitte Pim Goldby Industrial study, conducted between 1990 and 1992, was commissioned to identify the types of industry that could and should be established in the area, and to provide a plan of how to attract these to the region (Marais, 2013b). The outcome of the study was the identification of four scenarios based on the future of gold, with the most likely one (scenario 2) being used to develop further plans. These included agriculture-related industries, motor-components and gold jewellery. A strategic development plan indicated how the region could go about attracting and establishing new industries. Yet, here again, the extent of the decline of gold was underestimated, with the worst case scenario, scenario 4, being closer to reality (Marais, 2013b).

In 1992 the Free State Goldfields Development Centre (FSGDC) was established to, through collaboration and partnership, *'reorientate the regional economy'* away from one focussing on mining to diversified, competitive and export-driven enterprises (Nel & Binns, 2002, p.258). Compared to the development of the Welkom Structure Plan, this initiative involved a number of partners, including the local municipalities, organised business, parastatals, black business organisations, the Regional Services Council and mining companies (Marais, 2013b), and was funded largely by the local municipality (Nel & Binns, 2002). In 1998 the FSGDC adopted the 'Five Sector Strategy for economic revival' which focussed on the following areas (Marais & van der Walt, 2011; Marais, 2013b):

- Agriculture: Diversification of products and intensification of agro-processing
- Training and Support Centre
- Gold Jewellery Hub
- Tourism, with a particular focus on mining tourism
- The establishment of Matjhabeng as a distribution hub including an international cargo airport and the upgrading of the road network passing through the goldfields to become the National (N1) route between Johannesburg and Cape Town

As reported by Marais & van der Walt (2011), these projects yielded mixed results, with some starting off well but being unable to sustain themselves. For example, an intensive agricultural project focussing on the production of paprika for the export market was started but eventually failed. The facility was successfully used for agricultural training, in collaboration with the mines and

the agricultural sector education training authority (Agri-Seta) but after three years, when the Department of Agriculture did not assist with funding for expansion and the Department of Labour withdrew learnerships, the project collapsed. The jewellery school associated with the Gold Jewellery Hub is still listed as an SLP project for Harmony, yet the jewellery production facilities established around the school failed to become competitive. Tourism initiatives, based on using old mining facilities, needed a financial backer, which they did not find and so also did not get going. The Phakisa freeway was another project implemented during this time. This motor-racing track was constructed to host international Formula One motorcycle *Grand Prix* races, Indy racing, and included a football pitch with a 10,000 seater grandstand (Nel & Binns, 2002). The racetrack hosted five motoGP motorcycle races, but the contract was not renewed after 2003 (Marais, 2013b). A study for an international cargo airport was also conducted, but this was not supported by the Free State Provincial government (Marais & van der Walt, 2011). According to one of the long-term residents interviewed, this was due to political issues within the Free State government. The resident states that this study was subsequently taken by the Provincial government and used to motivate for a cargo airport in Harrismith, in the eastern Free State. This eventually resulted in the Maluti-a-Phofung special economic zone being built in Harrismith, which provides road and rail logistics and handling facilities between the Durban ports and Gauteng.

Internal politics was noted a number of times in interviews, and in the literature, as a reason for why the Free State goldfields had been overlooked for development (McCarthy et al., 2005; Marais & van der Walt, 2011; Marais, 2013b; Marais & Nel, 2016). During Apartheid this was apparently due to the English-Afrikaans divide, where Welkom was seen as an English area and 'Oppenheimer's turf', in contrast to the National party and Afrikaans controlled Bloemfontein. During this time Welkom was never deemed a development priority area (Marais & van der Walt, 2011). Often cited examples to substantiate this are the deliberate rerouting of the N1 highway in the 1960s away from Welkom and towards Winburg, the lack of academic training facilities - the Free State Technicon was apparently originally planned to support the industrial base of Welkom but was subsequently built in Bloemfontein, and the Free State goldfields never benefitting from any decentralisation schemes under the apartheid government, unlike Bloemfontein and other regions (Marais & van der Walt, 2011). In more recent times the split has been between the COSATU-influenced, northern Free State ANC and the more moderate southern Free State ANC, who have traditionally led the Provincial government (McCarthy et al., 2005). This is said to influence investment decisions made in the Provincial capital Bloemfontein, the experience of the cargo airport mentioned above being an example.

Due to changes in municipal legislation, the FSGDC was dissolved in 2004, and replaced by the Matjhabeng Marketing and Investment Company (MMIC). However, according to Marais (2013b), conflict between the MMIC and municipal management and lack of funding resulted in it being shut down in 2005. Further conflict, allegations of corruption, political rivalry, local government interference, amongst other causes, resulted in the gains made by the FSGDC being lost. At the same time the mines shifted their focus and funding to the development of SLPs (Marais, 2013b).

The Lejweleputswa Development Agency (LDA) was set up in 2005 to focus on development for the district municipality (which includes Matjhabeng and two other local municipalities). Marais (2013b) reports that the LDA became dysfunctional by the late 2000s. However, it seems to have been revived following the Premier of the Free States' State of the Province address in 2013, where he set the Free State 2030 vision. The LDA was identified as the vehicle to realize this vision locally. On their website they currently (March 2020) highlight a solar project, film studio, a maize milling cooperative, sunflower processing plant, technology innovation hub and hydroponics as their key projects. However, descriptions on all of these are in the future tense (Lejweleputswa Development Agency, 2020).

Reflecting on these various interventions to diversify the economy Marais & van der Walt (2011) and Marais (2013b) highlight a number of reasons for their limited success, including the dramatic and unexpected nature of downscaling and the inability of planners to change their mind set from growth to decline. There was also the understandable perception that '*the gold mines would never close'* [long-term resident, white]. The closure of individual shafts and mines was not new to the goldfields, starting with the suspension of the Jeannette mine in the 1950s, and the Freddies operations in the 1960s. Yet along with these closures a number of new shafts were sunk, marginal mines made profitable and closed mines reopened, reinforcing the perception that mining would never cease in the region. When the mines did finally close, this was abrupt and widespread.

The political infighting discussed above and poor governance are identified as further reasons, along with a lack of trust between the different role players. The fluctuating and then increasing gold price of the 1970s resulted in early initiatives to diversify the local economy being abandoned (Marais & Nel, 2016). Legislation that does not contribute to integrated planning and partnership is one of the more recent reasons for the lack of success. As will be discussed in the next section, the requirement to develop IDPs for the municipality, and closure plans and SLPs from the mines shifted the approach

of planning and funding development. For mining these plans are directly linked to their mining rights and so not conducive to collaborate planning.

9.2.2 Integrated Development Plans

In terms of the Municipal Systems Act of 2000, local development is the responsibility of both the local and district municipality and should be planned for and implemented through the IDP. The IDPs are developed by the municipality, or consultants appointed by them, and should be based on extensive consultation with residents of the municipality. The most recent, available IDPs for the Matjhabeng local municipality and Lejweleputswa district municipality as discussed below, in the context of the future development of the Free State goldfields.

Matjhabeng Local Municipality

The Matjhabeng municipality has developed an IDP for the Free State goldfields. These are 5 year plans, reviewed annually. The current IDP is for the period 2017 to 2022. This document is drawn up in line with the requirements of the legislation and includes ten chapters providing a situation analysis of the municipality, details and outcomes of the public participation process, the financial and investment plan, development and implementation plans, the performance management framework and overview of the SLPs of mining companies operating in the municipality.

The IDP provides an insight into the worrying situation within the Matjhabeng municipality. Ongoing difficulties with the economy, aging and poorly maintained infrastructure, the poor and declining cash position, and increased costs of water and electricity are recorded as some of the key concerns. The IDP indicates that the revenue collection rate of the municipality for the past financial years varied between 55% and 60% which resulted in a negative cash flow position, and concludes that municipal assets are insufficient to cover its liabilities. During the 2014/2015 financial year the municipality received a disclaimer audit opinion, meaning that there was insufficient evidence on which to base an audit opinion. The IDP further acknowledges the municipality's heavy dependence on mining, that this sector has been decreasing and is impacting the local economy - *'the sustainability of the District's economy is in jeopardy because of a continued negative growth rate in the District driven by a declining mining sector and a shrinking agricultural sector'* (Matjhabeng Local Municipality, 2017, p. 41). This is reflected in the low employment rate, with the IDP reporting only 36% of the population between the age of 15 and 64 being employed, and, up until 2011, the declining population. The population has subsequently grown, by five percent as reflected in the community survey of 2016.

In response to this the municipality have set key performance areas, which include good governance, basic service delivery, inclusive economic development and job creation, institutional transformation and financial sustainability and viability, and developed plans for the 5 year period. The plans focus on infrastructural development, to be funded by various government infrastructure grants. These projects include new, or additions to cemeteries, roads and storm water management, sanitation, water provision, sport and recreational facilities, LED activities and taxi ranks, solid waste management and electricity supply. The municipality allocated R169 million from their own funds for projects related to water and sanitation, municipal office refurbishment, airport refurbishment, a new enclosure for stray cattle and the extension of the main municipal buildings and construction of new council chambers. They also include a 29 page table of 'unfunded infrastructure projects' – a list of new basic infrastructure, such as lighting and storm water cut off drains, and infrastructure that needs to be repaired on upgraded. While these projects respond to immediate needs and address the acknowledge service backlog of the municipality, they are not projects that would significantly impact the economy of the region.

Longer term spatial development is addressed in the high level spatial development framework, although this section of the IDP has not been updated since the 2012-2016 IDP version and refers to outdated legislation. This was also noted by Denoon-Stevens (2017). The framework provides general principles and norms in relation to spatial development and lists a number of 'trends', although these are rather statements of intent. These relate to the integration of the different settlements, noting that the physical integration of the entire Matjhabeng into a single town is '*at present*' (Matjhabeng Local Municipality, 2017, p.247) restricted due to the distances between the towns and the physical restrictions formed by mining activities. However, the IDP indicates that where integration between the original white settlement and black township is possible, this should be pursued. Integration between Virginia and Meloding is currently prohibited by the Merriespruit and Virginia tailings storage facilities. Bronville, Thabong, Riebeeckstad, Kutlawanong, Odendaalsrus and Welkom could be integrated, with expansion of these settlements. Included in this chapter of the IDP is a section on defunct or undeveloped mining areas, which notes that mining land will be released for urban development. The plan recommends that this land and infrastructure be used for residential, industrial and commercial purposes, but that the environmental restrictions (such as radiation, acid mine drainage, ground water quality, geotechnical restrictions) first be clarified, and that some areas be rehabilitated before being released. This is the only comment in the IDP that relates to post-mining land uses, and it is very generic. Given the downscaling and closure of the

mines one would have expected post-mining land uses and diversification of the economy to be core to the IDP.

The final section of the IDP, an addition since the previous version, covers the social and labour plans from mining companies operating in the municipality, listing projects to be funded by the mines. It should however be noted that SLPs funding is committed, rather than actual, funding and is dependent on the performance of the mining company. The Centre for Applied Legal Studies (CALS) research on SLPs found that in most cases only a small fraction of this funding is realised (CALS, 2016). In their review just over half of the SLPs reviewed linked the fulfilment of their commitments to either commodity prices, financial viability or profits. In other words, the company could not be expected to fulfil all the obligations as set out in the SLP if the commodity price fell below a certain threshold, or if profits were not as expected (CALS, 2016). The listed projects include new infrastructure and the maintenance of existing infrastructure, namely road maintenance, water and fencing on commonages, and educational support through bursaries and school subsidies. As regards LED the projects listed include building a business industrial hub, livestock market, supporting agriculture and mine tourism. These project all have budget allocations, between ZAR900 000 and ZAR25 million (the latter for road maintenance), but no timeframes for delivery.

According to Adonis & van der Walt (2017) the implementation of an IDP should realise the needs of the community and, in particular, advance social and economic growth. The reviewed IDP of Matjhabeng municipality focusses on service delivery and sets out to meet the basic needs of the community. However, it is inadequate in addressing and planning for long term social and economic growth and hardly acknowledges the need to build a post-mining economy. The financial and development plan and infrastructure plan focus on service delivery, with only a few projects addressing job creation and poverty alleviation. There are also inadequate funds within the municipality to implement significant development projects. There may be a number of reasons for this, not least the state of local government nationally. A 2009 report by the Department of Cooperative Government and Traditional Affairs (COGTA) on the state of local government in South Africa indicates that there are a '*number of stubborn service delivery and governance problems*' (COGTA, 2009, p.4). These include service delivery and backlog challenges, corruption and fraud and poor financial management, amongst others. These problems are highlighted in the Matjhabeng municipality IDP, as evidenced by the long list of unfunded project, their disclaimer audit opinion and, as discussed in a previous chapter, concerns around corruption. The COGTA report includes Matjhabeng amongst a list of 64 municipalities that were (in 2009) in financial distress.

The Matjhabeng Municipality's IDP is weak. As acknowledged in the Free State Growth and Development Strategy (FS Provincial Government, 2013, p.18) this is not unique to Matjhabeng - '*Integrated Development Plans (IDPs) also have a range of shortcomings. Their quality is not always good enough and strategic direction is lacking in many cases. Many IDPs are not much more than wish lists and poorly contextualise the intended development outcomes.'* The IDP presents no long-term coherent plan for the region to address its current socio-economic challenges and the legacy of its past. This is problematic, the situation will not change without planned, long term interventions. On its own, and as expressed through the IDP, the Matjhabeng local government are not in a position to significantly shift the development trajectory of the Free State goldfields.

Lejweleputswa District Municipality

The future of the Free State goldfields is also considered in the Lejweleputswa District Municipality's IDP and LED strategy. Their most recent IDP, for the period 2018 - 2019 recognises Welkom as the administrative and educational centre of the district (Lejweleputswa District Municipality, 2018). Based on current economic activities and possible value chains associated with these, a potential analysis was done to identify seven strategic thrusts for the district, these are (Lejweleputswa District Municipality, 2015):

- Primary sector expansion, which includes both agricultural and mining projects
- Industrial development, linked to agro-processing and mineral beneficiation, as well as providing mining inputs and services
- Infrastructure development, specifically focussed on transport and connectivity improvements and housing development. Interestingly a nuclear power station is proposed.
- Small, Medium and Micro Enterprise (SMME) development and support to SMMEs
- Human resource development, focussed on skills development, specifically around tourism, and the establishment of training facilities
- Tourism development, aimed at increasing local tourism activity
- Green economy, this considers opportunities for alternative energy sources (solar, methane, bio-fuel, wind and nuclear), eco-tourism and repair/rehabilitation of environmental degradation
- Information Communication Technology (ICT), which involves improved connectivity (VPN and Broadband) and the development of a technology innovation hub.

Specific projects that are identified for the Matjhabeng municipality are an upgrade to the Welkom airport to improve accessibility and enhance economic opportunities, a hub focussed on jewellery, computer and cell phone chip manufacturing identified for Virginia, with the local mining products used as inputs, and the goldfield tourism route. As regards agriculture the expansion of irrigation

around the Sand-Vet irrigation scheme was also identified. The plans for mine rehabilitation and renewable energy projects would also be relevant to this area (Lejweleputswa District Municipality, 2015).

The district municipality IDP and LED strategy propose a number of concrete ideas, although these are not adequately backed up with specific timeframes (rather generic short, medium or long term) or budget allocations.

9.2.3 Provincial and national plans for redevelopment

Local government development is informed by national and provincial initiatives, and these are listed in the IDP, and presumably considered when setting objectives and developing plans. In addition to local development plans, the Free State province and, to a very limited extent, the national government also have initiatives that directly impact the future of the Free State goldfields. These are discussed below.

Free State Growth and Development Strategy

At a provincial level the Free State Growth and Development Strategy (FSGDS) sets out a vision for 2030 – *'the future we want'*, this is premised on the South African National Development Plan of 2012. The FSGDS lists a number of pillars, with specific and time bound targets to achieve these.

The socio-economic status of the Free State province is not dissimilar to that of Matjhabeng, with high unemployment and a very low economic growth rate. In order to address this the Free State Vision 2030, developed in 2013, aims to develop '*a resilient, thriving and competitive economy that is inclusive, with immense prospects for human development anchored on the principles of unity, dignity, diversity, equality and prosperity for all'* (FS Provincial Government, 2013, p.21). The six pillars to support this are:

- economic restructuring, growth and employment creation
- education, innovation and skills development
- improved quality of life
- sustainable rural development
- build social cohesion
- efficient administration and good governance

Specific drivers are identified for each of these, with a long-term programme and strategy. Driver 2, a contribution to addressing economic restructuring, growth and employment, is directed largely at the Matjhabeng municipality. It aims to minimise the impact of the declining mining sector and

ensure that existing mining potential is harnessed. The programme and strategies to achieve this are listed in *Table 22* and cover the continuation of mining, considers alternatives to mining but based on the mining past, and rehabilitation of mined areas.

Table 22. Long term programmes and strategies to minimise the impact of the declining mining sector (FS Provincial Government, 2013, p.20)

Long term programmes	Strategies
Support the life of existing mines and create new mining opportunities	Invest in key infrastructure programmes that are secondary to mining
	Open up opportunities for new mining initiatives
	Market opportunities through new mining business profiles
	Curb crime which impacts negatively on the mining industry
	Promote small-scale mining in sandstone, clay, salt, diamonds and other commodities
Develop a post-mining economy for mining areas	Develop and support partnerships with social partners
	Re-use mining infrastructure in line with spatial development plans
	Implement mine tourism initiatives
Ensure rehabilitation of mining areas	Coordinate mining rehabilitation concerns (road construction) (waste recycling)
	Institutionalise an agreed upon funding model for mining rehabilitation
	Empower local entrepreneurs to benefit from mining aggregates
	Re-mining of existing tailings dams and dumps

The strategy states that there is still high potential for mining in Matjhabeng with two considerable gold reserves with an estimated life of 20 years, although there is no mention of the location of these, or whether there are plans to develop them. The strategy also notes the mining of low grade coal as a potential opportunity. The reuse of mining infrastructure which has previously been investigated as an option for facilitating economic development in the province, is mentioned in the Matjhabeng IDP, and is included in this strategy. In 2004 the Free State Premier's Economic Advisory Council commissioned research into how existing mine infrastructure in the Free State goldfields could be used to benefit the community. This research reviewed mining assets that were available for potential reuse, this included workshops, office complexes, recreational facilities, warehouse, hostels, training facilities, stores and vacant land (CDS, 2004). Meetings with communities were held to assess their needs and aspirations, and based on this, options for reuse and recommendations for building a post-mining economy for the region were presented (CDS, 2004).

In alignment with the Lejweleputswa IDP, the FSGDS identifies mining and other tourism as a post mining activity, although Denoon-Stevens (2017) questions this given the extent of demolition of mine infrastructure, largely in response to zama zama mining activities. The Phakisa race track is also highlighted as an opportunity for tourism events and entertainment. It is also encouraging to see that mine rehabilitation in order to improve the environment and as a means of income generation, is included in this strategy.

The Free State strategy recognises the issues faced in the goldfields as a consequence of mine closure and has formulated concrete and feasible plans to address these. However, as with all plans, implementation is key. The FSGDS sees implementation as being done by the various levels of government *'interweaving various institutional objectives, operational layers and capacities to better respond to the province future aspirations'* (FS Provincial Government, 2013, p.68), in collaboration with social partners. This allocation of responsibility is very vague, and does not bode well for implementation. The alignment between the FSGDS and plans in the Lejweleputswa IDP demonstrates that there is coordination between these different levels. However, the question of funding remains unanswered.

Revitalisation of Distressed Mining Towns

In the case of the Free State goldfields only one national initiative has direct bearing on developments, this is the Revitalisation of Distressed Mining Towns Programme. The programme stems from a commitment to address socio-economic challenges in mining area in the 2012 social accord between government, business and labour and led by the then President. An Inter-ministerial Committee for the Revitalisation of Distressed Mining Communities was established in 2014 to focus on integrated and sustainable human settlements, improved socio-economic conditions, improved working and decent living conditions for mine workers, in order to make a meaningful contribution to the development trajectory of mining towns and labour sending areas (Zulu, 2015). Initially 15, and later 21, mining towns, including the Matjhabeng municipality, and 12 labour sending areas were identified for intervention. Through this programme a number of informal settlements were upgraded, homeownership provided and bulk infrastructure services extended in Matjhabeng, with around ZAR712 million being spent between 2014 and 2019 on this. This Inter-Ministerial Committee has subsequently been abolished, in 2019 (Mkhacane, 2019). It is unclear what, if any, programme will replace it.

It would appear that the focus of National governments efforts in the Free State goldfields has been on human settlements, rather than any of the other focus areas. Some authors have criticised this (Denoon-Stevens, 2017; Ntema et al., 2017), and question the decision to provide homeownership in the context of a relatively stagnant or declining economic situation. This inhibits mobility and essentially locks people into a location, effectively entrenching poverty (Ntema et al., 2017).

9.3 Response from mining

The requirement to think about mine closure, mitigating environmental impacts and leaving viable livelihoods after mining, is relatively new. It was only in the Minerals Act of 1991 that rehabilitation became an obligation. These were gradually strengthened and now require that closure plans are put in place and financial provision for closure made upfront. This legislation focussed on addressing the environmental impacts of closure. However, there are now expectations that mines share the value generated through their mining activities and address the social and economic impacts of mine closure. This is legislated through the requirement for an SLP.

9.3.1 Social and labour plans

The MPRDA requires the submission of a SLP as a pre-requisite for the granting of a mining right. SLPs should be developed by mining companies in consultation with the local communities and relevant authorities in order to ensure that mining contributes to the development of communities affected by its operations. These objectives are listed in Regulation 41 of the MRPDA, as follows (RSA, 2004):

a) *Promote employment and advance the social and economic welfare of all South Africans;*
b) *Contribute to the transformation of the mining industry; and*
c) *Ensure that holders of mining rights contribute towards the socio-economic development of the areas in which they are operating as well as the areas from which the majority of the workforce is sourced.*

In terms of the regulations and SLP Guidelines (Department of Mineral Resources, 2010), the components of a SLP are a comprehensive Human Resources Development Programme, Employment Equity Plans, Local Economic Development Programmes and processes to save jobs and manage downscaling and/or closure. Regarding the latter requirement, companies should consider mechanisms to avoid job losses, provide alternative solutions and procedures for creating job security where job losses cannot be avoided and limit the social and economic impact on individuals, regions and economies where retrenchment or closure of the operation is certain (Department of Mineral Resources, 2010c).

Once an SLP is approved, with approval of the mining right by the DMR, the SLP becomes binding and is valid for a period of 5 years, after which new commitments need to be made, up until closure. The mine is required to report on progress with meeting its SLP commitments annually. If the company is not meeting its obligations the DMR may suspend its mining right (CALS, 2016).

There has been a lot written in the popular media about the failure of SLPs (see for example, Nene, 2017 and Mabuza, 2018). The study by the Centre for Applied Legal Studies (CALS, 2016; CALS, 2017) and the submission to the Marikana commission of enquiry (Brandt, 2014) highlight some of these challenges, which they attribute to shortcoming by mining companies, the regulator and communities. For example, CALS (2017) found that SLPs are largely a compliance exercise, designed and implemented to satisfy the regulator, with little consultation with communities. Other failures include inadequate commitments and limited capacity within mining companies to implement SLP projects, and that LED projects are often submitted as *'concepts'* rather than viable, coherent projects with clear objectives, deliverables and beneficiaries in mind (Brandt, 2014, p. 58).

The remaining mines in the Free State goldfields, operated by Harmony and Sibanye-Stillwater, have developed SLPs for their operations. An overview of these SLPs specifically as plans for the future of the region is presented in *Table 23*. In addition to these the mines provide for bursary schemes and hostel upgrades. Harmony have five SLPs for the Free State goldfields, associated with their different operations, although a number of the projects are shared. These are all dated October 2013 and for the period 2013 to 2017. Sibanye-Stillwater has an SLP for its Beatrix operation, dated July 2017 for 2017-2021.

Table 23. Relevant projects included in the SLPs currently in place for the Free State goldfields (Harmony, 2013a; Harmony, 2013b; Harmony, 2013c; Harmony, 2013d; Harmony, 2013e; Sibanye, 2017)

Mine, license and date of SLP	Relevant projects for Free State goldfields (excluding projects for labour sending areas)
Projects shared across all **Harmony Mining Company** (Ltd) SLPs for the Free State goldfields	**Legacy projects** **Film studio** - To build infrastructure, creating an administrative block, editing suite, sound stages, studios for training, short films, TV sitcoms, racing track, actors' village, hotels, gym and spa, conference facilities and greening screens. Plan to start construction in 2014, start production in February 2015 **Masimong 4 hostel upgrade** - To renovate, upgrade and convert existing hostel blocks into family units. Started in 2010, total cost R350 000 **Merriespruit 3 hostel upgrade** - To renovate, upgrade and convert existing hostel blocks into family units. Contract signed at the end of March 2013, feasibility studies and project management accounted at R350 000. **Enterprise development** **Matjhabeng business development centre** – With a business hive and office that will assist first time small businesses to get off the ground
Harmony - **Unisel & Masimong mines** FS30/5/1/2/82MR October 2013	**Virginia jewellery school** - This project is about training students in the art of making jewellery. The jewellery section and the factory were inaugurated in November 2000. In 2009 a turnaround strategy was approved by the main sponsor Harmony, to make this project self-sustainable.

Harmony - **Tshepong & Phakisa mines** FS30/5/1/2/2/84MR October 2013	**Wellness Centre** - To establish a multipurpose centre in K9 ward, Kutlwanong. A municipal building was renovated at a cost of R521 000 for this project **Water reuse project** - To find an alternative use for purified sewerage water other than discarding it in the Mostert Canal and Sand River. Reuse water in an agricultural project to create jobs and improve food security for the area **Tourism project** - The conversion of a shaft area into a gold mining tourism destination **Thabong light industrial park** - To establish a centre in Thabong where SMMEs can become commercial businesses **Taxi rank** - To build a sheltered and safe taxi rank on the existing site of the informal taxi rank in Kutlwanong
Harmony - **Joel mine** FS30/5/1/2/13MR October 2013	**Brick making plant** - To produce both paving and building bricks for the local market. Costs for phases 2 to 4 for Harmony is R1 million
Harmony - **Bambanani mine** FS30/5/1/2/283MR October 2013	**Sports academy** - The operation of a sports school for rugby and soccer aimed at promoting talent from previously disadvantaged groups in the rural areas that have the ability but not the means to achieve their true potential
Harmony - **Target 1 mine** FS30/5/1/2/14MR October 2013	**Upgrading of Abattoir -** Upgrading in order to provide an abattoir to slaughter chickens from growers, cut and package to market specification.
Sibanye-Stillwater Beatrix Operations FS30/5/1/2/2(81)MR July 2017	**Road infrastructure** development with a proposed budget of R27 million Completion date 2021

Both companies have standard approaches to the management of downscaling and retrenchment, as prescribed by law. These are to establish a Future Forum and consider a number of alternatives to retrenchment, these focus on lengthening the life of mine through reducing costs and mining lower grade areas, redeploying people to other operations, allowing for retirement and similar approaches. Portable skills are provided to employees that are retrenched in the hope that these will allow them to find employment in other sectors.

In terms of content, the SLPs all meet the requirements of the legislation, addressing each of the sections listed. A significant part of the SLP documents provide generic content on the company, its approach to SLPs, the mine in question and context on the region in which they operate. The specific projects identified for implementation are not elaborated in great detail and in many cases budget and timeframes are absent. There is also no provision for monitoring implementation. During the research it could not be established whether the projects that were due to have started have actually been implemented.

The projects listed in the table above, if implemented, should contribute to the socio-economic development of the local area, particularly those that facilitate and support the establishment of further development. The film studio and development of mine tourism have the potential to catalyse other businesses, with the Matjhabeng business development centre and Thabong light industrial park able to support businesses. The other projects address immediate needs or requests from the community or local government, as depicted in the IDP. None of the projects appear to be related to one another, or to contribute to a greater development plan.

The distinction between the commitments made by Harmony and Sibanye-Stillwater is noted, with Sibanye-Stillwater electing to fund a single large project, which is possibly easier from a stakeholder engagement perspective. This may also be as Sibanye is geographically removed from the settlements of the Free State goldfields and has, according to the SLP, a longer life of mine. The generic nature of the plans for closure are of a concern. These appear to be largely compliance in nature with no concrete ideas for addressing mine downscaling and closure. It is also noted that there is no collaboration between the two mining companies as regards their SLP commitments or plans. This may be driven by the legislation, which link SLPs to mining licenses. Making ones' SLP dependant on delivery by another mining company would be a risk. In this context the legislation does not facilitate much needed regional collaboration and the SLPs will not make a significant difference to the economy of the region.

9.3.2 Mine closure planning

Planning for mine closure has been a legal requirements in South Africa since the Minerals Act of 1991. This included the requirement that an Environmental Management Programme (EMP) be submitted, rehabilitation be undertaken, financial provision for closure be made and that a closure certificate be applied for (Swart, 2003). These requirements have subsequently been strengthened through the MPRDA and more recently the closure and financial provisions regulations in terms of NEMA. In line with this legislation the closure of mines in the Free State goldfields should be planned for and funded, and in the long term, the physical landscape should be returned to its natural state, or to a predetermined and agreed standard or land use which conforms to the concept of sustainable development (RSA, 2004).

As discussed in section 8.1.2 and summarised in *Table 20* (in chapter 8), rehabilitation plans are in place for a number of the remaining shafts in the Free State goldfields. As discussed, rehabilitation appears to be undertaken in a piece-meal approach focussing on the demolition of infrastructure and local revegetation of these sites, with planning for post-mining activities on only two sites. As

access to the closure plans was not granted it is not clear whether the respective mining companies have a long-term consolidated closure vision for the Free State goldfields, and if so, what this is. Another important aspect of mine closure is the requirement to make financial provision for closure. This is currently regulated in terms of NEMA, GN R1147 in *GG* 39425 of 20 November 2015 as amended (RSA, 2015). The aim of financial provision is to ensure that funds are available for government to address the environmental impacts of the mining operation and return the land to a suitable state for reuse, should the mining company not be in a position to do so. This is to avoid mines being abandoned and the state having to clean up at the taxpayers' expense. Financial provision is tied to a mining right, and so a physical property, and is only to address the environmental aspects of closure. It should cover rehabilitation, decommissioning and closure activities at the end of the life of the operation, and remediation and management of latent or residual environmental impacts which may become known in future (RSA, 2015). The amount of financial provision at any given time should be equal to the sum of the actual costs of implementing rehabilitation and decommissioning plans for a period of at least 10 years into the future. This amount should be reviewed and updated annually. Financial provision can be made in the form of a financial guarantee, the more common method for large scale mining operations, as a cash deposit into an account administered by the Minister of the DMR, or a contribution to a trust fund (RSA, 2015).

Based on data obtained in 2016, there was just over ZAR 550 million set aside for financial provision, in the form of bank guarantees, for the mining operations currently owned by Harmony and Sibanye-Stillwater in the Free State goldfields. This included ZAR 258 million for the Beatrix operation and ZAR 294 million for Harmony's various mines (openAFRICA, 2018). This is a significant amount of money, but given the extent and duration of mining in the region, it is insufficient. The accuracy of financial provisions across the country have previously been questioned, this due to inaccurate assessments, shortfalls, over-provisions and inconsistent regulatory expectations (van Druten & Bekker, 2017). It is interesting to compare the amounts for the two mining companies – these are roughly similar amounts, yet the operations of Harmony are significantly more extensive than those of Sibanye-Stillwater.

Mining companies are not able to draw down on their financial provision for rehabilitation, and so require additional funds to implement rehabilitation, which should ideally be conducted throughout the life of the operation, termed concurrent or progressive rehabilitation. In addition, partial closure, the closure of a single shaft within a larger mining right, does not release the mining right holder

from their obligations. Only once the entire mining right has been closed and rehabilitated to a level accepted by the regulator, can a closure certificate be issued. A closure certificate allows the company to relinquish the mine. Under the Minerals Act of 1991, an unconditional closure certificate was issued in terms of section 12 (Dixon, 2003). In terms of the MPRDA and associated regulations, the holder now remains responsible for any environmental liability until a closure certificate has been obtained and beyond, the recently introduced concept of perpetual liability (Alberts et al., 2017). Once a mine has received a closure certificate, they are able to claim the majority of their financial provision back, ceding a portion to the DMR to address latent and residual impacts.

Various authors have highlighted that the mine closure system as practiced in South Africa is problematic (Alberts et al., 2017; van Druten & Bekker, 2017; Watson & Olalde, 2019). Closure certificates are not being granted as envisaged by the legislation. Between 2011 and 2016 no closure certificates were granted for large scale operations with a significant environmental impact, with only 27 certificates being granted for mining rights across South Africa and none in the Free State goldfields (Watson & Olalde, 2019). Watson & Olalde (2019) conclude that this may be an *'indication of the difficulty in successfully rehabilitating large mines, confirmation of the extended time needed to do this, and the perception that, with underfunded financial provision, it is easier and cheaper to put a mine on indefinite care and maintenance or sell it to avoid closure'* (p.645). They also indicate that this may be due to the reluctance of the regulator who may not have the required capacity and competence to make the judgement call that rehabilitation is sufficient (Watson & Olalde, 2019). The consequence of this is that mines are unable to claim their financial provision back and that post-mining land uses cannot be implemented.

The lack of closure certificates is problematic, especially in an area like the Free State goldfields which has been extensively mined and is in desperate need of alternative land uses to drive economic development. One of the long term residents of the Free State goldfields, who is also involved in planning, indicated that the lack of integration of the closure and the redevelopment processes makes transitioning to other land uses difficult. For example, mined land would need to be rehabilitated and receive a closure certificate before it can be transferred to a new owner, rezoned and only then can planning for development on this piece of land commence. These two processes are also regulated by different authorities, at different levels of government, namely the DMR at a national level and the municipality at local government level. In order to address this the Matjhabeng municipality have drafted by-laws which will allow these processes to run in parallel and

so significantly speed up development. These by-laws have as yet not been implemented, but any process towards integration is positive.

A further issues with closure is that financial provision, and the closure certificate, is tied to a specific mining right and is limited to environmental rehabilitation. As illustrated, the impacts of mining extend well beyond the mine site, are cumulative and impact more than just the environmental aspects, although environmental impacts are significant. There are no closure requirements for off-site infrastructure, settlements and other developments associated with mining but not on a portion of land covered by a mining right. There is also no requirement for collaboration between mining rights holders in a particular area, and little opportunity, and appetite, for integrating the requirements of different pieces of legislation that relate to closure. Addressing these issues is fundamental to improving the outcomes of closure.

9.4 Conclusion

Long term residents of the Free State goldfields have experienced the boom and bust cycle that is an expected pattern in mining regions and which leaves its mark on the landscape (Amundson, 1995). The decline of mining has been ongoing since the late 1980s and although there were some early initiatives to diversify the economy these were met with limited success, resulting in the current negative social, economic and environmental situation described by the residents.

In line with various legal requirements, local, regional and national government, and mining companies have developed plans addressing the future of the area. However, these plans are not integrated, with only limited alignment between them. They are also not guided by a shared vision or long-term masterplan for the region. Local planning and implementation by the Matjhabeng municipality is weak. The district and provincial plans propose a number of potentially viable project, that build on the identified assets of the goldfields (its mining legacy and existing infrastructure) to address the socio-economic and environmental legacy of mining. These proposed developments are positive, but, at least as described in the documents reviewed, lack a budget, timeframes and the allocation of responsibility. It is therefore unclear whether implementation will take place. The national government's involvement in the Free State goldfields was through the programme on the revitalisation of distressed mining regions. Here the focus was on the provision of sustainable human settlements, which had limited, if any, impact on economic activity and may rather act as a poverty trap (Denoon-Stevens, 2017; Ntema et al., 2017). This is the reality for some of the long-term residents interviewed.

Harmony and Sibanye-Stillwater have complied with legislation, developing SLPs and closure plans for their operations. The closure plans and SLPs for each company, and the funding associated with this, are not integrated and neither are the plans from the two mining companies. With SLPs being linked to mining licenses, collaborating on SLP outcomes with another company is a risk. Here the legislation is an obstacle to integrated planning and development. Furthermore the plans developed by the industry make only a limited contribution to a sustainable post-mining landscape. This is, in part, related to the weak Municipal IDP, which should ideally inform the development of SLPs and closure plans. Overriding this though is the question of how, and whether, the extensive negative environmental (and social) legacy of over 70 years of mining across the goldfields can be left to these two mining companies to address. As described by Humby (2014), a legal loophole in the regulated closure model in South Africa allows the liability for pollution, ecological degradation, the pumping and treatment of extraneous water, and latent and residual impacts, as well as the obligation to apply for a closure certificate, to be passed to the last holder of a mining right. This last holder is often the '*least well-resources and most precarious corporate entity*' (Humby, 2014, p.7). Harmony obtained the minerals rights to most of the Free State goldfields in 2002, leaving them with this liability. One could argue that they are not necessarily the weakest mining company, however, the environmental and social legacy that they have been left with is significant. With the exception of Harmony's two retreatment facilities and the Phakisa mine, the Harmony operations have a life of mine of less than 10 years. The case of Sibanye-Stillwater and their Beatrix operation is similar, with a life of mine of 11 years, but with a smaller physical footprint and almost equivalent financial provision. With this short life of mine and limited financial provision, there is a real concern that the environmental legacy will not be adequately addressed. This will have significant social and economic impacts. Based on evidence from across South Africa closure certificates for large mines are not being granted (Watson & Olalde, 2019). This has the potential to leave the region in limbo.

In contrast to the development of the region in the late 1940s and early 1950s, national government is largely absent from planning for post-mining development. Lessons should be learnt from history, from the role that the NRDC played in coordinating planning. Coordination by a lead agent, integrated planning and the pooling of resources, including funding, towards an agreed long term vision for the Free State, and supported by legislation, could lead to a better outcome.

Chapter 10

10. Discussion

Implicit in the idea of the landscape biography used in this research is understanding the different processes that led to transformation of the Free State goldfields landscape. The first section of this chapter provides a summary and discussion of these drivers of change. The four time periods are revisited and the key drivers of landscape change discussed. For each time period the drivers of change are weighted as either major or minor, and classified as proximate or underlying. Three themes emerge from the review of drivers of change, these inform a review of the conceptual framework initially developed to inform the research. Finally a model for the management of resilient resource regions is proposed.

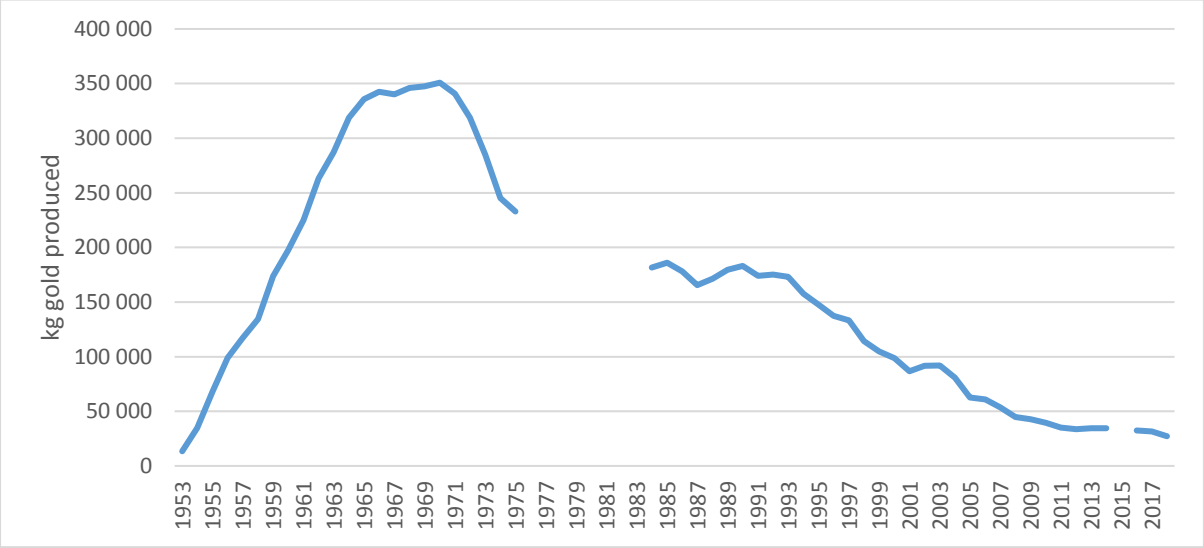

Figure 91. Gold production from the Free State goldfields between 1953 and 2018 (Gregory, 1962; Department of Mines, 1960 to 1975; Department of Minerals and Energy Affairs 1984 to 2008; Department of Mineral Resources, 2010 to 2018a, Minerals Council of South Africa, 2020)

The landscape biography has been presented in chapters 4 to 9 and can be very broadly summarised in two graphs, the gold production figures for the Free State between 1953 and 2018 (*Figure 91*) and population growth from 1951 to 2016 (*Figure 92*). The significant increase in gold production from 1953 to its peak in 1970 was facilitated by the building of new mines. This is mirrored by an increasing population of mine employees, their families and those providing services to the mines. A comparison of the maps of the region over this period (*Figure 10, Figure 27* and *Figure 47*) reflects this growth in the form of infrastructure and settlements, mines, tailings storage facilities and evaporation pans, and a reduction in agricultural land. However, the decreasing gold production post-1970 does not correspond with a decline in population. In fact employment numbers continued

to increase and only peaked in 1987. In 2018 gold production was less than that of 1954, with little prospect of increasing. This is where the Free State goldfields finds itself – a region with a large population and good infrastructure, but with limited economic activity and a degraded environment.

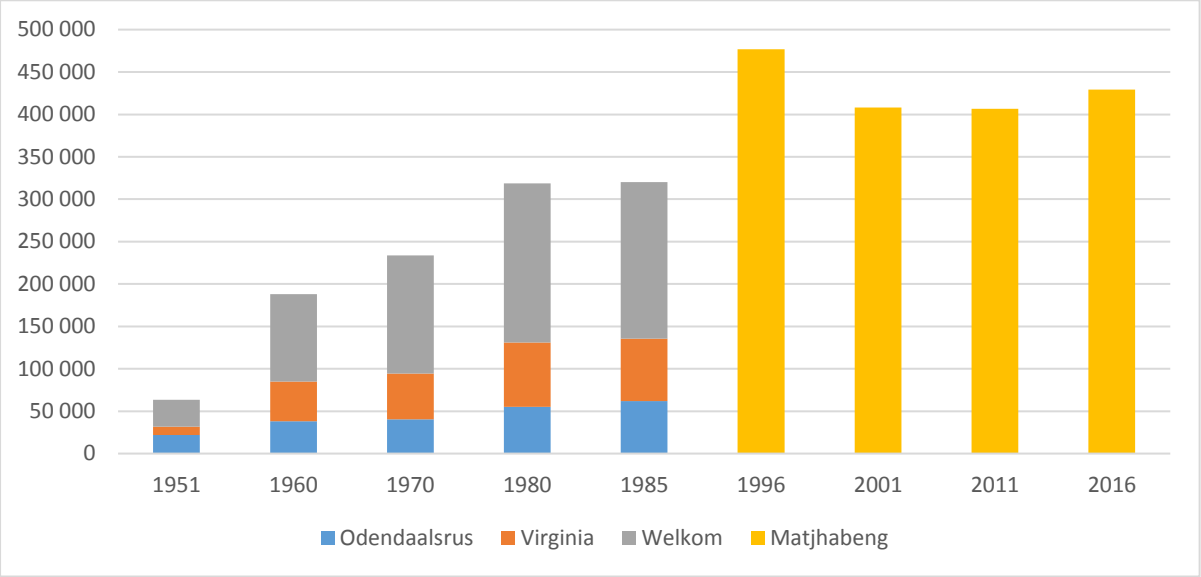

Figure 92. Population of the Free State goldfields from 1951 to 2016 (Central Statistical Service, 1960, 1970, 1980 &1985; Statistics South Africa, 1996, 2001, 2011 & 2016)

10.1 Key drivers of landscape change in the Free State goldfields

The drivers of landscape change and the interactions between them over the four time periods are summarised below. This serves to highlight some of the critical processes, events or aspects behind the drivers that have been key in transforming the landscape. It also illustrates how the significance of drivers changes over time, how the drivers are interlinked and that they influence the landscape directly and indirectly.

10.1.1 Drivers for the period 1945 to 1955

The period between 1945 and 1955 involved the most profound shift in the landscape of the Free State goldfields, from a rural, sparsely populated, remote region with an economy based on agriculture, to one of rapidly growing mining development with stately, permanent settlements and an increasing population. Although agriculture as a land use persisted, portions of agricultural land changed fundamentally, and rapidly, into three new settlements and 13 mines, traversed by roads, railways, powerlines and water pipelines. The role that agriculture played in this landscape declined.

The mining companies, particularly AAC and Union Corporation for the Welkom, Odendaalsrus and Allanridge areas, and Central Mining and Investment Company and Anglo-Transvaal Consolidated for the greater Virginia area, were undoubtedly the main actors that catalysed and drove the development of the mines and the towns. The group structure of these mining companies allowed for the many mines to develop at the rate that they did, this through the cross-funding of the various developments and the standardised approach to development. The standardised approach is evident in the landscape through, for example, the layout of the surface infrastructure associated with the mines and the mine hostels. Government also played a significant facilitating role through the provision of water and power and by creating an enabling policy environment.

Land companies had been established by the mine owners to fund, design, develop and administer three new mining towns. A lot of thought went into the very detailed design of these towns. In particular, the Chairman of AAC, Ernest Oppenheimer, had an intense interest in the development of Welkom as a modern garden city. He was a notable actor in the development of this settlement, which also set the tone for the other white settlement in the region. Oppenheimer was referred to as the giant that built Welkom (Fleischer, 1968). Through him, Mr W.O. Backhouse and Joane Pim also played key roles in the transformation of the Free State goldfields landscape.

There is a strong, reinforcing relationship between the mining development and urban and infrastructural development drivers of landscape change. The establishment of the mines with their need for a permanent, skilled (white) labour force, and power and water resources drove the development of attractive settlements with recreational facilities, improved transport networks and the provision of services. In this context mining was an underlying driver.

Although the mining and settlement development resulted in direct, physical changes to the landscape, the form that this development took was regulated by government through the NRDC and national policies at the time. Political and legislative factors thus being a strong underlying driver of change. The ordered planning of the region, ultimately developing three smaller mining towns rather than a single large settlement, or numerous, small, ad hoc settlements around each mine, and the development of racially segregated settlements, are physical manifestation of the role of government and policy on the landscape of this region. Similarly the extent of mine properties was based on existing farm boundaries, set through the government land administration system, rather than geological structures (Greathead & Graadt van Roggen, 1986). Hendrik Verwoerd, as the then Minister of Native Affairs, was an important actor at this early stage of development in preventing

the establishment of larger settled black mine villages, as planned by AAC. His future influence on the landscape, across South Africa, would be profound.

At this early stage of development, natural and spatial factors were a major underlying driver directing the form and location of change. This is in agreement with the hypothesis of Domon & Bouchard (2007) and the findings of Bürgi et al. (2010) that landscape changes are closely associated with the geomorphological characteristics of the land. Interestingly there appears to be no consideration of or input from the early residents of the area. Clearly the presence of gold below the surface sparked interest in the area. Had the gold not occurred, or had it outcropped as it did in the Witwatersrand, the development trajectory would have been very different. Confirming the resource and accessing the gold buried deep underground took time and money and so allowed for more detailed regulation and proactive planning of the mines and settlements, by established mining companies. Shafts were sunk to exploit the most financially viable deposits, defined by existing property boundaries. However, environmental factors, namely the high geothermal gradient and presence of methane in this area, necessitated that the shafts for each mine be located close together to aid with ventilation. The location of the shafts, in turn, influenced the location of the settlements. Settlements were established within close proximity to each of the mines. Finally, the presence of significant quantities of saline ground water necessitated that vast tracks of agricultural land be purchased by the mines and used as evaporation pans, permanently altering the landscape.

With the exception of agricultural land, which decreased, all identified drivers played a major role in driving landscape change. As is evident from maps at the end of this time period, mining, settlements and supporting infrastructure changed the landscape, yet the form and location of these developments were due to political and legislative factors, and underlying geology. The different drivers acted in concert with one another to set down and lock physical foundations into the landscape which would direct future development of the region.

10.1.2 Drivers for the period 1956 to 1975

With the groundwork of the new landscape having been laid during the early development, the major transformation of the landscape during this period relates primarily to the expansion of settlements. However, mining continues to be a major driver of change, both directly and indirectly. As a proximate driver the footprint of mining increased as new shafts and the infrastructure associate with mines was built, and waste material generated. The continuation and growth of gold mining was facilitated by government intervention in the form of subsidies and tax relief, and later

by an increase in the gold price resulting from the United States leaving the gold standard. This made the mining of lower grade ore financially viable. The direct feedback from this is an increase in mining, an increase in waste generation, an increase in employment and a greater demand for accommodation in the local settlements. The changing gold price, an economic driver directly linked to mining, illustrates how a decision taken distant from the region, through a range of linkages and feedbacks, results in a physical, social, economic and environmental impact on the landscape locally.

As an underlying driver, the mine's need for labour resources results in the rapid development and occupation of the mining towns which had previously been laid out. The physical expansion of Virginia and Welkom and the development of black townships illustrates this. The location and layout of the black townships is in stark contrast to the modern, garden city development of the white mine towns. This is the impact of the separate development policies of the apartheid government, which were now well entrenched. These policies ensured that the original settlements of Marobe and Linabo were removed and residents relocated, and that the new townships of Kutlwanong, Meloding and Phatakhale are located away from white settlements. In the case of Meloding, the settlement is physically separated from Virginia by tailings storage facilities and the railway line. These black settlements are furthermore located closest to the industrial areas, where black labour was required. This is also the case with the new coloured settlement of Bronville.

The mines and towns stretched out over what had previously been agricultural land. Although agriculture as a land use persists, it was on a smaller scale locally. Interestingly the land that had previously been developed for mining, around the Freddies and Jeanette mines, was not returned to agriculture when the mines closed. The remains of these mines are depicted as 'ruins' on the 1975 maps. The provision of reliable irrigation water through the Sand-Vet government water scheme permitted intensification of agriculture in the area to the south-west of Virginia, and with it additional settlement in this area.

Natural and spatial features were key to the initial development of the region, but are not significant in driving change during this time period, at least at this scale. Weather events, for example the drought of 1954 to 1958, may have driven local changes in the short term, but these are not evident on the maps. A changing climate may also be a long term driver of change of this landscape, but again, these are not obvious over this timeframe.

Of the five drivers reviewed, urban and infrastructural development, followed closely by mining and policy and legislation where again key modifying factors of this landscape between 1956 and 1975. Agricultural land and the natural environment were adversely impacted.

10.1.3 Drivers for the period 1976 to 1997

From its peak in 1970, this time period sees a sharp decline in gold production. While the first decade (mid-1970s to mid-1980s) saw continuation and consolidation of mining operations, buoyed by the high gold price, the downscaling and closure of mines became a key driver from the late-1980s. With the high gold price in the early years, the mining of lower grade ores, retreatment of waste material and the development of new shafts was possible. Associated with this was the expansion of tailings storage facilities and the related impact on ground and surface water quality, with impacts extending downstream. In this way mining operations continued to directly transform the landscape.

However, in the late 1980s the gold price dropped, leading to economic decline and the downscaling or closure of many mining operations. The result of this was the loss of employment for many mine workers. Mine employment peaked in 1988 with just over 180,000 employed across the goldfields' operations. With downscaling this dropped significantly and quickly, to 80,000 by 1997. As accommodation was generally tied to a mine job, many now unemployed workers chose to move into the local black settlements in the hope that the mines would reopen. This move was only possible because of the changed political context. The advent of democracy and with it the relaxation and eventual abolition of racially based legislation, allowed black mine workers to stay in the area rather than return to their rural homes. In this context mining, and political and legislative factors, were underlying drivers for the massive expansion of black townships. Prior to this AAC had attempted to provide off-mine housing for its employees through a home-ownership scheme in Thabong and Kutlwanong, yet there was limited uptake. Even with the changes in legislation, housing developments still took place in the established, separate black settlements, demonstrating the persistence of the foundations that were laid early on and of apartheid planning, even into the new democratic era. The significant expansion of settlements and mine waste was, yet again, at the expense of agricultural land, with crop lands being abandoned and converted to other land uses.

Urban and infrastructure development was the major driver of change over this period, however, 1994 saw substantial political change in South Africa and with it the start of a process of legal and institutional reform. It is important to note that mine workers in the Free State played an important

role in driving political change in South Africa through the NUM who were very active in the anti-apartheid struggle.

10.1.4 Drivers for the period 1998 to 2018

By 2018 most mines had either closed or were reaching the end of their life. Gold production was vastly reduced, to levels below that of 1954, and with this the related reduction in mine employment. The Free State goldfields was back where it started, in terms of gold production, but now with a significantly larger population, extensive infrastructure, degraded environment and greatly reduced economic prospects.

Preceding this, and due to the marginal position of the mines, AAC withdrew from the Free State, selling its remaining assets to a Harmony/ARM JV. The new owners implemented a new strategy, 'the Harmony way', which resulted in closing a number of mines and selling or closing company supported facilities. The impact of this on the landscape is visible through the demolition of mining infrastructure (whole mine sites including shafts, hostels and workshops being flattened and the retreatment of tailings) and the dereliction of recreational facilities and buildings.

With the extent of mine closure and the increasingly stringent legal requirement for this, one would expect rehabilitation to be a major proximate driver of landscape change, with what was mining land being rehabilitated, as required by legislation. However, this is only partially true. The demolition of mining infrastructure is evident, but re-establishing a natural or pre-mining state, or implementing other land uses is very limited and done on an ad hoc basis, and largely to address illegal mining activities. The responsibility of a mining company to rehabilitate an area is linked to their mining right, the parcel of land on which their mining activities take place. As demonstrated throughout this case study, mining has catalysed and supported other developments in the Free State goldfields, particularly settlement and infrastructure. Yet there are no requirements to consider these as part of closure. In the same vein, the mines of the Free State have had numerous owners and been restructured and parcelled in various ways, and one wonders what the impact of this is on the environmental liability. It is unclear who will take responsibility for these 'in between' bits.

The full impact of mine downscaling is not visible from maps, but becomes apparent when visiting the area, interacting with local residents and reviewing the literature. It is here that the loss of the economic benefits from mining, through loss of jobs and so incomes, rates and taxes to the municipality and other benefits, become apparent. Mine closure is a major underlying driver of

change, but not at the scale of 1:50 000 maps, rather at a very local and individual scale. This is also evident in the settlements, especially the original established white settlements, where buildings are empty and derelict, the parks, gardens and recreational facilities unkempt, and the infrastructure not maintained. With the declining economic base it is difficult to maintain the infrastructure that was built to support a thriving gold mining region. The physical footprint of the urban settlements changed, with black settlements continuing to expand due largely to housing investments made through government initiatives and in response to local planning as articulated in the IDP and provincial policy, and requirements for the formalisation of housing for mine workers through the mine SLPs.

As over the previous three timeframes, mining, policy and legislation, and urban and infrastructural developments have been the key drivers of change to the landscape. Although for mining it has not been the opening of new mines, rather mine closure that has directly and indirectly shaped the landscape, informed by policy and legislation. The consequences are evident, at both a large and small scale, in the urban settlements and on infrastructure. It is perhaps during this period that the dependencies, interactions, and feedback between the various drivers is most apparent.

Mine closure should, through rehabilitation, lead to improved environmental conditions. Perhaps it is still too early to evaluate the effectiveness of rehabilitation, waste is being retreated, infrastructure is being demolished, but there is little evidence of restoration of these disturbed areas. There is also no indication of how off-site impacts, such as the pollution of soil and water from years of use of the 'paddy fields' and tailings storage facilitates, will be addressed. Agriculture has persisted as a land use in the broader region and presents an opportunity for alternative post-mining livelihoods. The Matjhabeng IDP, mine SLPs and closure plans refer to agricultural development, however only one project is evident.

10.1.5 Summary

Over a period of 73 years the Free State landscape has been fundamentally transformed by a number of factors acting in combination, but initiated by the discovery of gold and the needs of the mining industry to exploit this resource. The key drivers responsible for this change have been summarised and grouped in *Table 24*. Included in the table are the critical processes, events or aspects behind each driver. The drivers are grouped as either major or minor drivers of change according to their role in shaping the landscape over the period under consideration. Unlike with mapping land use change, this role is not necessarily related to a change in the physical footprint of

the land use, rather to the role played or transformation that resulted. Mining, for example, has a comparably small physical footprint, 1.5 percent of the total land area of the local municipality, (Denoon-Stevens, 2017), which has changed only marginally over the years, yet it has been a key driver in modifying this landscape.

For the different time periods the drivers have been classified as either proximate or underlying drivers, or in some cases, both. Proximate (or direct) drivers act directly on landscape features at a local level, with underlying forces underpinning and having an indirect impact on the landscape. Underlying drivers can originate at a local, national or global level (Bürgi et al., 2004; Hersperger & Bürgi, 2009; Hersperger & Bürgi, 2010; Plieninger et al., 2016).

Table 24. A summary and classification of the key drivers of landscape change over the four periods, indicating the critical processes, events or aspects at the origin of each driver

	Drivers and their origin	1945-1955	1956-1975	1976-1997	1998-2018
Major drivers of change	**Mining development** Group system, employment, migrant labour system, gold price, mine waste & pollution, life of mine, subsidies & tax relief, mine closure, retrenchment, rehabilitation	Proximate Underlying	Proximate Underlying	Proximate Underlying	Proximate Underlying
	Urban & infrastructural development provision of services, accommodation, ordered planning, 'garden city', racial segregation, black townships, settlement relocation, dereliction	Proximate	Proximate	Proximate	Proximate
	Political & legislative factors regional planning (NRDC), land administration, apartheid & supporting legislation, democracy & new legislation, development planning (IDP), legislation addressing environmental & social impacts of mining	Underlying	Underlying	Underlying	Underlying
Minor drivers or domains of change	**Agricultural development** loss of land to other uses, some intensification	Proximate	Proximate	Proximate	Proximate
	Natural & spatial factors geomorphology, saline groundwater, geothermal gradient, climate, ecosystem services	Proximate Underlying	Proximate	Proximate	Proximate

As summarised in *Table 24*, three major drivers have been active in driving landscape change in the Free State goldfields, either directly as is evidenced by the extensive mining infrastructure and the growing settlements, or indirectly. Legislation and political factors in particular have played an important underlying role in directing the form of landscape change. In addition to having a direct impact mining has also underlain landscape change through, for example, its changing demand for

labour and the consequences of mine downscaling on settlements. Agriculture has persisted as a land use and economic activity. However, in the immediate vicinity of the mines and settlements, agricultural land has been converted for other uses and/or has been polluted through seepage and runoff from the mines. From the case study it is evident that the minor drivers of change have also been the 'receivers' of change, or part of the impact domain.

10.2 Themes emerging from the case study

The discussion above illustrates that in the Free State goldfields it was not only mining that was responsible for driving landscape change. Other drivers also played a critical role. This finding can only be made because of the approach taken in this research, a landscape biography. A landscape biography starts with what is seen on the landscape and works backwards to understand the various processes and actors that delivered a particular landscape element. It is not limited to one activity or action, and considers these from a large spatial and temporal perspective. In contrast to this, research that takes the mining activity as a starting point and focusses only on this aspect, and only at a single point in time, would in all probability conclude that mining and activities directly related to mining were solely responsible for the current state of the landscape. The landscape biography approach allows for the study of the social-ecological system. As has been discussed in the literature (Marais, 2013a; Sonter et al., 2014; Lima et al., 2016; Bainton & Holcombe, 2018) and what emerges from the case study, is that the post-mining landscape is one of socio-economic hardship and environmental challenges. This, even with increasingly stringent legislation and a plethora of industry standards (Bainton & Holcombe, 2018).

Leading on from this, the following three themes emerge from the Free State goldfields case study, and are more broadly applicable.

- Theme 1. In resource regions mining does not act in isolation in driving landscape change, in the Free State goldfields there were three major drivers of change
- Theme 2. Landscape biography provides a comprehensive and nuanced spatiotemporal account of a region
- Theme 3. Consequence for resources regions are significant and existing measures to avoid these are inadequate

The conceptual framework, initially developed to guide this research (refer to *Figure 6* in Chapter 3), has been updated to illustrate the findings from this research (*Figure 93*). The three key impact drivers are included, the undulating, hashed lines between these demonstrate that the drivers are

not necessarily discrete, but rather linked and often intertwined. These drive change in the impact domain, which includes the natural and spatial features, and existing land uses. The relative size of the bi-directional arrows indicate that impact is greater than what the impact domain can counter, this alludes to the ineffectiveness of existing policy and legislation.

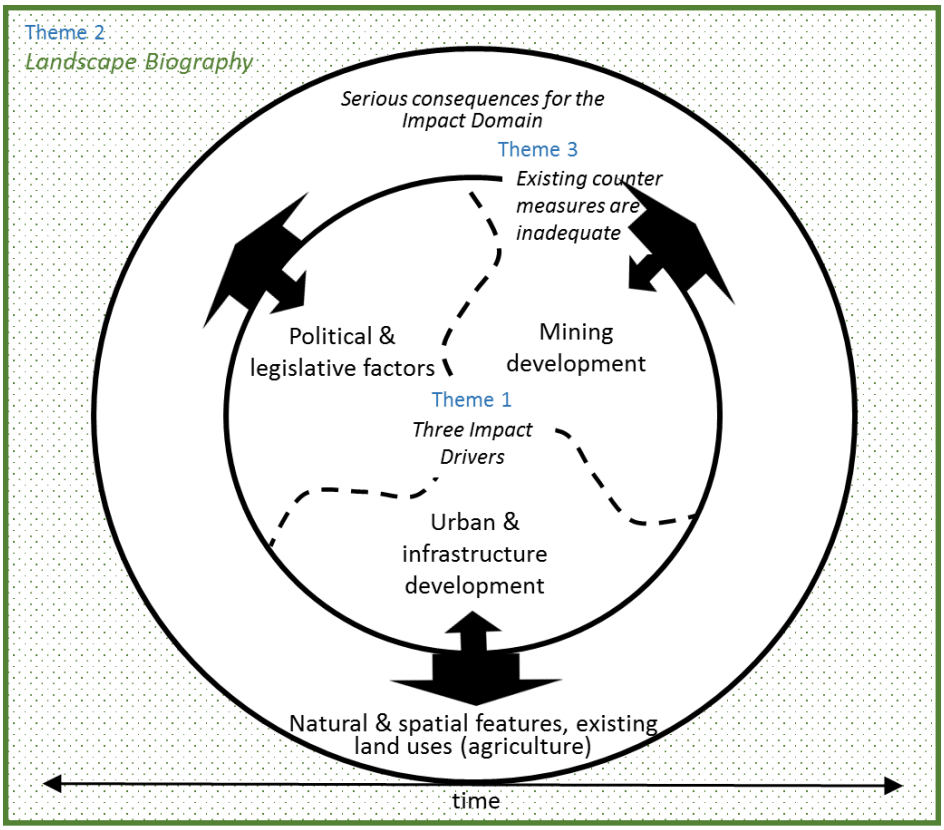

Figure 93. The amended conceptual framework illustrating the three themes emerging from this research

10.2.1 Theme 1. In resource regions mining does not act in isolation in driving landscape change

Mining development is a keystone process in the Free State goldfields landscape. Without a doubt gold mining was and still is a major proximate and underlying driver of change. As a consequence the landscape is distinctively a mining landscape, with some of the defining characteristics described by Francaviglia (1991) – the mine infrastructure, railway lines connecting mines with plants, waste dumps and the standardised company housing, stratified according to pay grade, with a clear distinction between the mine manager's house and the mineworker's hostels.

However, as illustrated through this research and summarised in *Table 24*, mining was not the only force shaping this landscape. Urban and infrastructural development, and underlying this mining,

policy and legislative factors, have also left a profound imprint. Collectively these drivers have shaped the landscape as it is experienced by local residents today.

As was the case in Europe, changing political regimes (Palang, 2010) and government policies and legislation (Hersperger & Bürgi, 2010) are significant drivers of change and this is observed in the Free State landscape. Firstly, the pre-eminence given to mining over other land uses in the law (Canel et al., 2010; Hoogeveen, 2015; Watson et al., 2018) has allowed for mines to be established at the expense of existing land uses, with the long-term goods and services provided by the environment traded-off against the significant, but short-term, financial gains to be made from mining. This is not unique to the Free State. Van der Burgh et al. (2012) and Delport et al. (2015) document how mining trumps agriculture as a land use in Mpumalanga and Mubiwa & Annegarn (2013) and Bobbins & Trangoš (2018) discuss the situation in the Witwatersrand, where through legislation, mining was given preference over other land uses. This is also the case internationally (Canel et al., 2010; Sonter et al., 2014; Hoogeveen, 2015; Sonter et al., 2017).

As much as policy facilitated mining, it also regulated the extent of its impacts, environmental requirements being an example (Humby, 2015; Alberts et al., 2017; Watson et al., 2018). Environmental requirements became progressively more rigorous with current legislation stating that land should be rehabilitated, as far as is practicable, to its natural state or to a predetermined and agreed standard or land use which conforms with the concept of sustainable development. However, as discussed in Chapter 8, the legislation and its implementation is inadequate to address the extent of impacts, especially at mine closure. As Bainton & Holcombe (2018) indicate, national, provincial and local level institutions are often ill-equipped to manage industrial transitions, from mine production to closure.

The transformational impact of political and legislative factors is also evident in the planning legislation. The NRDC was set up in terms of the Natural Resources Development Act of 1947 to ensure that the Free State goldfields was developed in an orderly way and that the appropriate infrastructure and services were provided to the mining endeavour (Union of South Africa, 1947). The NRDC preference of having a number of average sized towns rather than a single large city or a number of dispersed mining settlements, set the foundations for the development of this landscape. The ordered state and company controlled urban development in the Free State is in contrast to the early haphazard growth of the Witwatersrand as described by Mubiwa & Annegarn (2013), the informal settlements that spring up with a ‘rush’ (Francavaglia, 1991) and the boomtowns that

Hostetter (2011) discusses. With the benefit of hindsight, less permanent settlement and lower levels of infrastructure may have been more suitable.

The forced removals of Marobe and Linabo provide examples of how a landscape can be reordered (Roymans et al., 2009) due to changing political regimes. This is not dissimilar to the landscape changes, described by Palang (2010), in response to changing political regimes in Estonia. Under apartheid Marobe was cleared of black residents who were relocated to Kutlwanong, this land was left vacant, and then partially redeveloped as part of the white settlement of Odendaalsrus. With legislation as a key underlying driver, urban and infrastructural development transformed the landscape.

Recognising that mining does not act alone in driving landscape change is in line with the literature on landscape change (Bürgi et al., 2004; Hersperger & Bürgi, 2009; Bürgi et al., 2010; Plieninger et al., 2016). This recognises various drivers of change acting on landscapes. Having numerous drivers at play is characteristic of social-ecological systems and common in multifunctional landscapes, where there is a co-occurrence of multiple causes of change interacting over several spatial and temporal scales (Plieninger et al., 2016).

10.2.2 Theme 2. Landscape biography provides a comprehensive and nuanced spatiotemporal account of a region

Through the lens of the landscape one is able to view, and so better understand, the longer-term histories of a place and the rich interrelationships between society and the natural environment (Kolen & Renes, 2015). This '*complex web of social-ecological relations in constant evolution'* is one integrated system (Hertz et al., 2020, p.328), a social-ecological system manifesting in the dynamic form of the landscape. Using an interdisciplinary approach, the landscape biography of the Free State goldfields has woven together the many different life cycles that play out on the landscape, of mines, of development, of individuals, of political ideas, to tell the story of this region from 1945 to 2018.

The landscape biography approach used in this research stands in contrast to the use of LULC to reconstruct the history of a coal mining region in Czech Republic (Hendrychova & Kabrna, 2016). LULC mapping is useful to quantify change and rates of change of distinct land uses. However, on its own, LULC mapping does not provide insight into the drivers behind the observed change. Furthermore, underlying drivers such as policy and legislation are not able to be mapped. These

were key drivers of change in the Free State goldfields. LULC mapping also excludes the important aspects of memory and identity linked to landscapes, as described by Cater & Keeling (2013) and Goin & Raymond (2001). As a largely descriptive study, a landscape biography is able to incorporate these and other qualitative data. Combining the different approaches, as was done by Mubiwa & Annegarn (2013) but for different time periods, provides more useful insights.

There is increasing recognition that in order to fully understand the issues associated with an activity or a particular location, there is a need to consider the 'whole' - all the components of the system and how they co-evolved over time and space (Matthews & Selman, 2006). This implies an interdisciplinary approach, which is contrary to some of the mining case studies discussed in chapter 2. These examples have taken either a physical or environmental approach, using land cover or vegetation health for example, or considered indicators such as population data (as was the case in Amundson's (1995) research of Jeffrey City). The Free State goldfields case study has combined a range of datasets to obtain a more nuanced account of the region. This is important for understanding the interactions between the different components and the complexity of the system.

Landscapes are dynamic systems, changing due to the combination and relative strength of drivers acting at any one time. The wide spatial and temporal scale inherent in a landscape biography allows for the shifting form of the landscape and the entire mining lifecycle, rather than just one phase, to be reviewed. Change process can be either slow- or fast-acting (Bürgi et al., 2004). The different pace of change between the almost instant impacts of the Merriespruit tailings failure, compared to the steady, but relatively rapid progress of sinking new shafts, or the gradual accumulation of salts on the evaporation pans, are examples of the range of time periods at play in the goldfields, most of which can be identified through a landscape biography. Different rates of change will also be important when considering the impacts of climate change on resource regions into the future.

Even though there was much that did change in the Free State goldfields over the 73 years reviewed, the physical foundations laid in the 1950s persist. As recognised by Bobbins & Trangoš (2018), landscapes have the potential to perpetuate patterns of development and that, as stated so eloquently by Meinig (1979 p.44) *'life must be lived amidst that which was made before'*. In this case study this is evident in the extensive, modern white '*garden city'* settlements which were built for permanence in boom times ('*overproduction of the built environment'* – Hostetter, 2011, p.59), but which are now costly to maintain during times of bust, as experienced by the Matjhabeng

municipality. Similarly, housing development post-apartheid, both formal and informal, continued to be within the former black townships, further extending these areas away from the established urban centres. The provision of duplicate services to these areas is grossly inefficient (Mabin & Smit, 1997), further burdening the beleaguered municipality. Understanding the history of this area and the ideas that drove planning in the 1950s, allows one to recognise these patterns and look to change them, rather than perpetuate them.

These benefits of a landscape approach make it appropriate for use in mining regions. It is acknowledged that it is costly in terms of time and expertise that is needed to pull this type of evidence together. However, having a detailed understanding of the various drivers at play, and being able to recognise where to intervene to effect positive change or change the trajectory of development, should pay for itself in terms of developmental benefits. Gaining this understanding during the life of the mine and intervening could contribute to a different outcome at closure.

10.2.3 Theme 3. Consequence for resources regions are significant and existing measures to regulate these are inadequate

The current experience of the Free State goldfields has been adeptly described by long term local residents. There is no need to revisit this, or the discussions of the previous chapters, here. These highlight the social, environmental and economic consequences of long term extraction and mine downscaling and closure on the landscape. The consequences are overwhelmingly negative and are not dissimilar to the experiences described in the literature (see for example Bainton & Holcombe, 2018).

Selman & Knight (2006) describe how change in a landscape can be either vicious or virtuous, diminishing or accumulating valued attributes. Vicious circles are characterised by the loss of properties which are socially preferred, where value diminishes, resulting in landscape deterioration and loss of multi-functionality, such as biodiversity loss, erosion of visual character, hydrological disruption, community decomposition and environmental dereliction (Selman & Knight, 2006; Matthews & Selman, 2006). The current situation in the Free State goldfields can be described as the consequence of a vicious circle. The extraction of gold has literally and figuratively extracted value from the landscape and any reinvestment back into the landscape was largely to support this extraction and has been insufficient. This concurs with the conclusion of Francaviglia (1991) that mining tends to take more resources from the surrounding landscape than it gives. Mine closure

does not restore this value, as illustrated in South Africa (Watson & Olalde, 2019), Australia (Campbell et al., 2017) and globally (Sonter et al., 2014; Lima et al., 2016).

Mine closure could include a process that leads to a virtuous circles by slowing or reversing undesired changes (Harden et al., 2013) and implementing regenerative processes early on, which could run alongside the extractive process. As described by Bainton & Holcombe (2018), mine closure can create new opportunities through, for example, repurposing infrastructure and mining landscapes, reskilling and redeploying labour, diversifying the economy, strengthening local livelihoods and food security and addressing the social and environmental legacy issues. However, the authors admit that there are few detailed case studies of successful mine closure.

The Free State goldfields was given the status of distressed mining region in 2014 by the Inter-ministerial Committee for the Revitalisation of Distressed Mining Communities, confirming that, up until then, measures to address the consequences of mining were inadequate. These measures would have included the attempts to regulate mining since its inception, the local development initiatives described in Chapter 9 including the local and district IDPs, and the mine closure plans and SLPs. The efforts made by the Inter-ministerial Committee have also largely been ineffective, leading to its abolition in 2019. This state is illustrated by the bi-directional arrows in *Figure 93*, where the impact drivers are not being held in check by the various measures implemented to do so. A number of issues which contribute to the inadequacy of these measures emerge from a review of the initiatives, these are listed below.

- Initiatives and legislation to address mine downscaling and its consequences in the Free State goldfields are fragmented. Addressing the consequences of landscape change falls on different government departments (DPME, DMR, COGTA), is regulated by different pieces of legislation and levels of government (local, district, provincial and national) and there appears to be very little coordination between them. Similarly, a mine closure plan and SLP, and budgets for these, are developed for individual mining rights, rather than for the region. There is also no collaboration between the two mining companies operating in the region.
- As a consequence there is no single, coherent, long-term, funded plan to change the situation in the goldfields. The local municipal IDP is totally inadequate and does not recognise that it is a post-mining landscape. The district and provincial plans are unfunded, and possibly unsupported locally given the level at which they were developed. Mine closure plans focus only on rehabilitation of mine infrastructure on individual mine sites and do not propose long-term plans.

- Mining companies are not able, and should not be expected, to take the lead in regenerating the region. As discussed under theme 1, numerous drivers resulted in the current situation and so mining should not be held solely responsible for the dereliction in the Free State goldfields. Development and regeneration are not key competencies of mining companies and, as they seek to leave an area, improving it is not in their interest. However, mining companies should be key stakeholders and funders contributing to local process to regenerate the region.

10.3 Implications for the development of resource regions

The findings from this thesis have shown that the current models of planning and management for resources regions are inadequate. In the remainder of this chapter an intervention to address this, based on the experiences gleaned from the landscape biography of the Free State goldfields, is proposed. This is developed in the context of South Africa and South African mining legislation, however the core concepts, as illustrated in *Figure 94* are applicable to other mining jurisdictions.

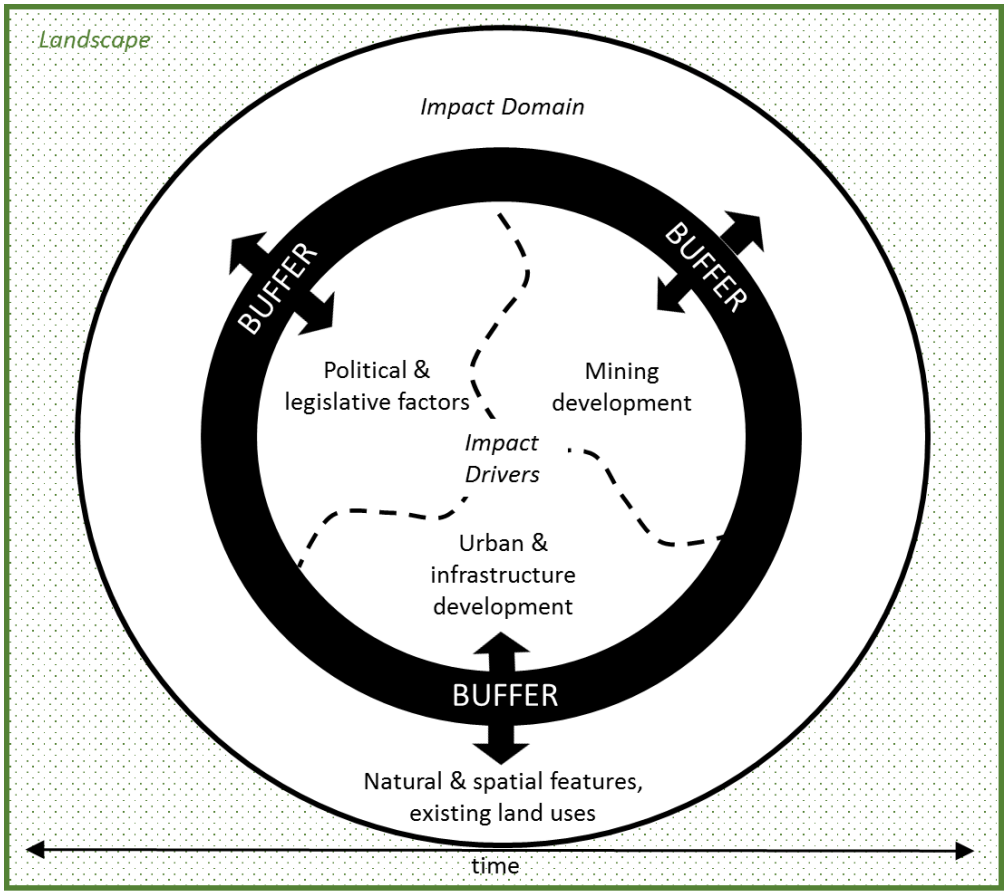

Figure 94. A new model for the management of resource regions

Theme 3 concludes that the drivers of change are not adequately countered by legislation and that in fact some legislation contributes to driving unsustainable practices. The consequence of this is often undesirable change on the impact domain, and in the worst case scenario, a vicious circle of loss across all forms of value over time. This is most evident at mine closure. Something is needed to protect the impact domain and future options for the landscape. By reviewing the amended conceptual framework (*Figure 93*), it becomes evident that a *buffer* between the drivers of change and the impact domain would regulate impacts on the natural and spatial features and provide protection for the future. This is illustrated in *Figure 94.*

This *buffer* is not a physical space, but rather a body that holds and balances the interests of a range of entities within a landscape. This will include consideration of the land, with its existing and possible future land uses, the environment, with the recognition that a healthy and diverse environment provides services and options, and people, especially those that will be most severely impacted by resource development. The objective would be the development of a resilient resource region. The concept of resilience is broad and applied in a range of contexts, as elaborated in vast literature (see for example Folke, 2006; Anderies et al., 2013; Sterk et al., 2017). In the context of resource regions and for the purpose of this thesis resilience is understood as not only the ability to withstand shocks and stresses and remain in a more-or-less stable state, but also the capacity for renewal, re-organisation and development (Folke, 2006). This is important for resources regions which not only face the shocks and stresses of fluctuating commodity prices, but also the risks of disasters, for example the failure of a tailings storage facility, the impacts of pollution, and finally downscaling and closure. Downscaling and closure require that the resource region re-organise and pursue a different developmental trajectory.

Practically it is suggested that this *buffer* manifest in a legislative body (i.e. not voluntary) based within mining regions to promote integrated, long-term, regional planning. The idea of coordinated, regional planning is not new, and was how the development within the Free State goldfields was regulated, this was through the establishment of the NRDC and the declaration of the Free State as a controlled area. The NRDC was set up through the Natural Resources Development Act with the aim of promoting '*the better and more effectively co-ordinated exploitation, development and use of the natural resources'* (Union of South Africa, 1947, p. 120). The Council was based under the Minister of Economic Development and regulated land use planning in controlled areas, and assisted and advised statutory authorities with development responsibilities in these regions. Teaching, study and research and the collection of information related to the aim of the body was encouraged. A core

focus was restriction on the subdivision of land and its appropriate use. Unfortunately, the NRDC, as a national planning body, became intertwined with apartheid planning and in the mid-1960s was incorporated into the Department of Planning. However, the idea of ongoing and coordinated planning is one that we can learn from. Given the era, mineral development was the focus of the NRDC. However, with current understanding of how mining catalyses other activities and the implications of this for the environment and mining communities, other considerations need to be incorporated into regional planning.

It is envisaged that this regional planning body, the buffer, would have access to a fully staffed and resourced office with the relevant multidisciplinary technical and legal expertise. As with the NRDC its authority would supersede the individual government departments, with funding coming from National government, this could be a diversion of the royalties currently paid by mining. The planning body would be in place over the life of the resource region and core to the operation of this body is an understanding of the landscape and the drivers of change. In order to have this understanding a methodology similar to what has been used in this research would need to be followed. A difference would be that the biography would need to be a 'living' biography, rather than retrospective. The biography would first need to provide an understanding of the baseline conditions, as was presented in Chapter 4 of this research. This should consider all the possible drivers of landscape change to date. Based on this an informed decision can be made on how to proceed and whether mineral development is the appropriate land use for the area, and if so, to what extent. This approach is significantly more strategic than the current 'free entry' system employed in many countries (Canel et al., 2010; Hoogeveen, 2015; Watson et al., 2018) and responds to the increasing contestation over whether mining is the most appropriate form of land use (Bainton & Holcombe, 2018).

When the decision is made to open up and develop a resource region, the 'living' landscape biography should be updated to keep track of the different drivers and the role they are planning in landscape change. This is a role of the regional body and would be key to their planning and management of the region. Other important roles of the regional body would be integrated, long-term, regional planning, that is based on managing a landscape rather than the traditional mine-by-mine governance approaches common today. In their decision making the social-ecological system will be considered, other forms of value accounted for and opportunities for the future protected. The long-term plans will include planning for decline, which is inevitable in resource regions, and investing in regeneration to balance extraction.

Where mining proceeds the buffering capacity of the regional body would ensure that the impacts are appropriately mitigated. This would involve enforcement of existing legislation, pollution control and monitoring. These are the traditional roles of the government mining regulator. A further role would be facilitating transparency through ongoing consultation and participation, especially with marginalised communities. The regional body would need to be accessible to communities and be in a position to mediate between a mine and the community, as well as other drivers of landscape change. The aim would be to strengthen community rights and through this facilitate benefit sharing. The benefits accruing from mining should become visible in the landscape. A final role would be to facilitate learning. As with the NRDC, teaching, study and research and the collection of information related to the aim of the body must be encouraged and used to improve the functioning of the regional body and promote virtuous circles.

In the South African context this body could take the form of a Chapter 9 Institution. Chapter 9 of the Constitution of South Africa makes provision for state institutions that support constitutional democracy. These include the Public Protector, the Auditor-General, the South African Human Rights Commission, Electoral Commission, Commission for Gender Equality and the Commission for the Promotion and Protection of the Rights of Cultural, Religion and Linguistic Communities. Given the prominence of mining in South Africa, increasing concerns around food and water security, the impacts of climate change, and the consequences of not addressing these, it feels justified to propose such prominence to this body. Chapter 9 institutions are independent, and subject only to the Constitution and the law, and are accountable to the National Assembly. Other organs of state are tasked to assist and protect these institutions to ensure the independence, impartiality, dignity and effectiveness, and no person or organ of state may interfere with the functioning of these institutions (RSA, 1996). In order to be effective in resource regions, there would be a need for regional representation addressing the specifics of that region, but functioning in accordance with the institutional requirements. For example, in South Africa there could be representation in each of the significant mining regions.

The proposed model is a significant shift from what is in currently in place in South Africa and many mining jurisdictions globally. Yet, as presented through the case study of the Free State goldfields, and supported by those presented in the literature review, the long term outcomes of mining are seldom positive for the local landscape. The mining industry on its own is not able to address this, and tweaking existing legislation will not significantly improve the situation. With a further layer of climate change, this will only get worse. A new way needs to be considered, one that can build

resilience in the landscape. As presented, the proposed model is deliberately general, focussing rather on purpose and outcomes. This is to allow for application across commodities and mining jurisdictions. The finer details of where it fits within existing institutions and how it interacts with legislation would need to be determined by the jurisdiction concerned. The key findings from this research, in particular the three emerging themes (that the application of landscape biography provides a comprehensive and nuanced spatiotemporal account of a region; which provides the evidence that mining does not act in isolation in driving landscape change in these areas; and that the consequences for resource regions are significant with existing measures to regulate these being inadequate), while identified from the Free State goldfields case study, are relevant to all mining regions in South Africa and beyond. The proposed model for the management of resource regions would likewise be applicable.

Chapter 11

11.Conclusion and recommendations

This research set out to achieve two broad aims. The first was to tell the story of the Free State goldfield through the lens of its landscape, its landscape biography. The Free State goldfields is a mining region that over 73 years, from 1945 to 2018, experienced the entire mining lifecycle, the boom and bust associated with mineral development and now, the consequences of mine closure. This has had a significant impact on the local economy, the residents of the region and the environment. Over six chapters (Chapter 4 to 9), each aligning to a particular timeframe, the development of this region is discussed, based initially on what was observed from maps and aerial photographs. What is visible on the maps and aerial photographs is the outcome of the interaction between society and the environment. A review of a wide range of literature and company reports provided an understanding for what was observed, or 'read' (Francivaglia, 1991). Long term residents of the Free State add a personal, human perspective to the landscape biography in chapter 9 and plans for the future of this landscape are reviewed. The drivers of landscape change are summarised and discussed in Chapter 10.

The outcome of this process is a comprehensive and nuanced spatiotemporal account of the Free State goldfields over an extended period of time, highlighting events, decisions and processes that shaped the landscape. The focus of this account is on mining, which catalysed the development of this region, and the consequent infrastructure and urban development. Other important drivers of change, that are included in the landscape biography, are political and legislative change, which was significant over the period under review, agriculture, which diminished but persists, and natural and spatial factors.

The second aim of this research was to demonstrate that a landscape biography is useful for the study of resource regions. A landscape biography considers long-term transformations of landscapes and recognises that this is a consequence of a complex interplay between social and economic development, culturally specific perceptions of the environment, histories of institutions and political formations and ecological dynamics (Plieninger et al., 2015). In order to develop the landscape biography of the Free State goldfields a number of different, disciplinary specific approaches were incorporated into this original idea of landscape biography. These include:

- Systems thinking and specifically the recognition that a landscape is a social-ecological system. This approach highlights that there are a number of variables interacting at different

scales, that there is positive and negative feedback between these, the interconnectedness of social and ecological systems and that the resulting system can be complex.

- Landscape change and the drivers of change. Driving forces are the factors that cause change to the landscape and are grouped according to type and origin. Based on this approach, five key drivers were identified as being active in the Free State goldfields over the study period and guided the research process.
- Cumulative impacts. These are particularly relevant in resource regions where there are numerous mining operations. Franks et al.'s (2013) conceptual framework for the cumulative dimensions of impacts informed the development of the conceptual framework for this research.
- Reliance on spatial data and mapping land uses. As described, spatial data formed the basis of the landscape biography and some basic land use maps were developed to illustrate these. There is an opportunity to further enhance the contribution of spatial data to a landscape biography, such as to quantify change, through the use of RS and GIS.
- Interviews: Incorporating the perspectives of local residents, especially those that have witnessed the changing landscape adds an extra component to the research. The approached used in this research can be expanded significantly. Further interrogation of the participants of their experiences may well have surfaced other issues of interest, for example what kind of politics emerged alongside the growth and eventual decline of mining, and the changes that went along with this. This presents an opportunity for further research.

Collectively these approaches informed the methodology applied in this research. This methodology has a number of benefits over others used to study mining landscapes. Firstly it extends over geographical and temporal scale, a 'snap-shot' at a particular time and place does not provide a full understanding of the issues. Closely related to this is the recognition that the landscape is dynamic and complex, an outcome of intertwined drivers of change. This allows the system to be managed through carefully selected interventions. Thirdly, the methodology facilitates an interdisciplinary approach, which is necessary to identify and understand the various drivers acting on a landscape. The application of the landscape biography to the Free State goldfields provided insights (the three themes discussed in section 10.2), and evidence for these, that would otherwise not have been visible.

There are limitations to this methodology. Because of the timeframes, geological extent and topics covered, it is time consuming, complex and needs a lot of investment in terms of expertise and

information. Ideally it should be conducted by an interdisciplinary team with knowledge and expertise on each of the key drivers, supported by skills in RS and GIS.

The three findings that emerged from this research are applicable to mining regions globally. As discussed in section 10.2, these are that the application of landscape biography provides a comprehensive and nuanced spatiotemporal account of a region, which, secondly, provides the evidence that mining does not act in isolation in driving landscape change in these areas, and thirdly that the consequences for resource regions are significant with existing measures to regulate these being inadequate. The latter two points talk to a mismatch between the forces shaping the landscape, which are intertwined, operate across the landscape, over various timeframes and may originate locally, nationally or globally, and the response. The response is local, fragmented and focussed on managing discrete activities.

The thesis concludes by proposing a model for the development of resilient resources regions. The model proposes a *buffer* to protect natural and spatial features and provide protection for the future. This *buffer* could take the form of a regional planning body with functions and authority to direct landscape change in a resource regions towards a virtuous cycle. Stemming from this, a recommendation is that the proposed model be further developed for implementation. Additional research should consider alternative forms that the *buffer* could take, how this could function within existing legal systems and governance structures, how it would be funded and which aspects of a landscape biography would be useful to inform this. In order to be most effective, the *buffer* would need to be tailored to the specific landscape, however a generic model would be applicable to resource regions globally. This would need to be developed. There is an urgent need to do things differently and change the current trajectory of mining landscape.

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Appendices

Appendix 1: Ethics clearance certificate

Appendix 2: Participant information sheet

Appendix 3: Consent form – informal

Appendix 4: Consent form – formal

Appendix 5: Interview guide – long-term residents

Appendix 1: Ethics clearance certificate

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Watson

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H16/04/22**
PROJECT TITLE	Modelling landscape change in the Free State Goldfields, and implications for the development of resource regions
INVESTIGATOR(S)	Ms I Watson
SCHOOL/DEPARTMENT	CSMI /
DATE CONSIDERED	22 April 2016
DECISION OF THE COMMITTEE	Approved unconditionally
EXPIRY DATE	09 May 2019

DATE 10 May 2016 **CHAIRPERSON** _____
(Professor J Knight)

cc: Supervisor : Dr S Merlo

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

_____ 12/05/2016
Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Appendix 2: Participant information sheet

Good day
My name is Ingrid Watson, working at the Centre for Sustainability in Mining and Industry at the University of the Witwatersrand. I am conducting a PhD research study that assesses the physical development of Free State gold fields between 1940 and the present. The aim of my research is to firstly map how the physical landscape has changed over this period, and secondly understand why this is and what the impacts are. I hope that the outcome of my research will lead to better planning in mining regions in the future.

In addition to mapping these changes, I would like to interview residents of the gold fields to better understand how the landscape has changed, when it changed and the impact that these changes have had. I am inviting you to be part of this study as you have resided in the area for a period of time and would have seen and experienced these changes.

If you agree to participate in this study, I would like to interview you, at a location and time convenient to yourself. The interview will take between 60 and 90 minutes. During the interview it may also be necessary to indicate locations on a map and/or point them out in the landscape. With your permission, the interview will be recorded and documented.

Your participation is entirely voluntary. You may refuse to answers questions about which you feel uncomfortable and you may withdraw from the study at any time. There are no penalties for doing this. Your name and personal details will be kept confidential and no identifying information will be included in the final research report.

You will not directly benefit from participating in this study and will not receive any payment.

This research has been approved by the Human Research Ethics Committee (Non-Medical) at the University (reference H16/04/22). The research will be written up as a PhD thesis and will be available online through the University. I will also write articles for publication in academic journals and present the findings at a sector conference.

You are welcome to contact me or my supervisors should you have any questions.

Thank you

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Supervisors: Dr Stefania Merlo, Stefania.merlo@wits.ac.za
Prof Daniel Limpitlaw, daniel@limpitlawconsulting.com

Appendix 3: Consent form – informal

DATE

As researcher, I, _____, confirm that I have read and explained the following to the participant, and that they have consented to participate.

This research is looking at the physical development of the Free State gold fields since 1940.

1. Your participation is voluntary and you have the right to end the interview at any point. You may also decline to answer specific questions.
2. You will not be paid for your participation.
3. Your participation involves being interviewed by a researcher.
4. The interview will last approximately 60-90 minutes and may be extended with your permission. Notes will be written during the interview. You **agree/disagree** to have the interview recorded.
5. Your identity will be kept confidential. Your name will not appear in a research report.
6. This study has been reviewed and approved by the Human Research Ethics Committee (Non-Medical) of the University of the Witwatersrand.

Researcher's name: _____

Researcher's signature: _____

Date: _____

Appendix 4: Consent form – formal

DATE

I, _____, consent to participate in the research project. I understand that this research is looking at the physical development of the Free State gold fields since 1940.

I understand that:

7. My participation is voluntary and that I have the right to end the interview at any point. I may also decline to answer specific questions.
8. I will not be paid for my participation.
9. My participation involves being interviewed by a researcher.
10. The interview will last approximately 60-90 minutes and may be extended with my permission. Notes will be written during the interview. I **agree/disagree** to have the interview recorded.
11. My identity will be kept confidential. My name will not appear in a research report.
12. This study has been reviewed and approved by the Human Research Ethics Committee (Non-Medical) of the University of the Witwatersrand.

Name: _____

Signature: _____

Date: _____

Appendix 5: Interview guide – long-term residents

Introduction and background information

1. How long have you lived in the Free State gold fields? Have you always lived in your present home? Where else have you lived?

2. If you weren't born here, why did you move to this area?

3. What has been you occupation(s) over the years?

Landscape change – what, when, how, by whom, examples?

4. Please describe the landscape – what does it look like? Are there any prominent or important features, what are these?

5. Tell me what it was like to grow up in this area? What did the area look like at that time?

6. How has the area (landscape) changed since then? Can you give me examples (include location and date or relate to specific events)? Can you show me (on a map or physically)?

7. Why do you think these changes have taken place? Who/what was responsible for making/causing these changes?

8. How have these changes to the landscape impacted you? Your business/occupation? Your community?

9. Is the landscape still changing? How? Can you give me examples? Who/what is driving this change?

10. What do you think the landscape will look like in the future? What do you hope it will look like?

You are involved in the mine closure and rehabilitation planning -

Do the mines have plans, what are the plan, how do these relate to other plans, do they only look at environmental aspects, who is implementing the plans, what monitoring is there, is there any regional coordination

Thank you.