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Mining landscapes of the Gauteng City-Region

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GCRO RESEARCH REPORT
NO. 07

MINING LANDSCAPES

OF THE GAUTENG CITY-REGION

JANUARY 2018

Edited by
Kerry Bobbins and Guy Trangoš
Contributions by
Potsiso Phasha, Siân Butcher and Janet Munakamwe

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MINING LANDSCAPES OF THE GAUTENG CITY-REGION

JANUARY 2018
ISBN: 978-0-620-74637-3
Written by: Kerry Bobbins and Guy Trangoš, with contributions from Potsiso Phasha, Siân Butcher and Janet Munakamwe
Design: Breinstorm Brand Architects
Cover Image: Potsiso Phasha

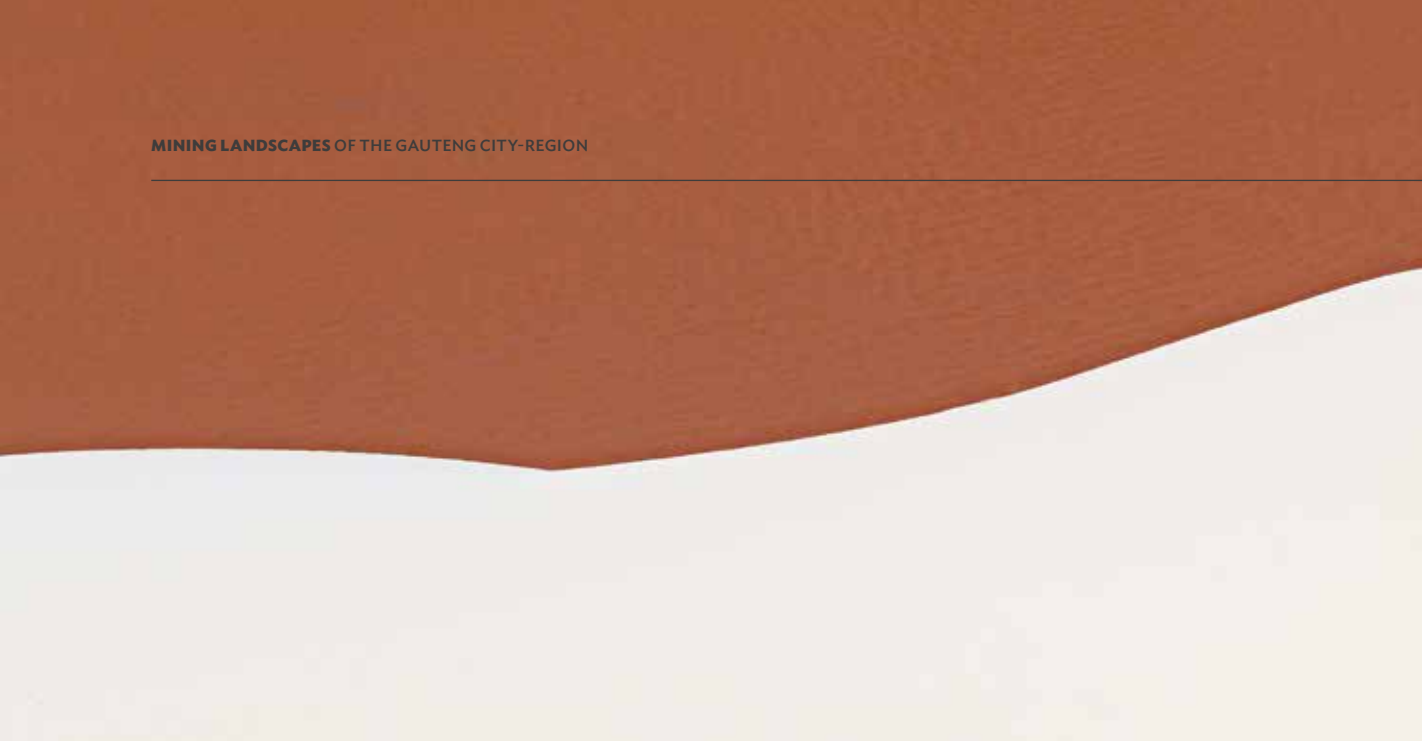
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Published by the Gauteng City-Region Observatory (GCRO), a partnership of the University of Johannesburg, the University of the Witwatersrand, Johannesburg, the Gauteng Provincial Government and organised local government in Gauteng (SALGA).

Mining Landscapes of the Gauteng City-Region

ACKNOWLEDGMENTS:

The editors of this report would like to acknowledge the assistance and significant work of all its contributors, including Potsiso Phasha, Siân Butcher and Janet Munakamwe. We would also like to thank Dr Richard Ballard and Graeme Gotz for their editorial guidance.

This document is the product of extensive research over the period 2013-2015, and as such we would like to thank those individuals and organisations that assisted us along the way. These include the Gauteng Department of Agricultural and Rural Development (GDARD), Mariette Liefferink (Federation for a Sustainable Environment), Ingrid Watson (Centre for Sustainability in Mining and Industry), Dr Hannah Le Roux (University of the Witwatersrand School of Architecture and Planning), Tahira Toffa, Prof Tracy-Lynn Humby (University of the Witwatersrand School of Law) and the Department of Environment and Infrastructure Services at the City of Johannesburg.



Photograph by Potsiso Phasha

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Photograph by Clive Hassall



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1. Mining landscapes of the GCR

An introduction

GUY TRANGOŠ AND KERRY BOBBINS

Context

Early processes

The landscapes of the Gauteng City-Region (GCR) can be traced back to about 3 000 million years ago when a depression in the earth formed an inland sea. Rivers flowing through the area drained into the depression and deposited sediment which would later become one of the largest deposits of mineral wealth on Earth.

The millennia that followed saw the formation of the well-known ridges, rivers and mountains of the region. These rolling landscapes provided the substrate for the origin of humankind and the unique set of anthropological developments that unfolded in the area. The deep histories of the region seem subordinate to its fast-moving and constructed economic stature. As a forgotten counterpart of its past, the landscape bears the marks of humankind and its obsessions.

The landscapes are laden with an assortment of minerals with vast economic value. Deep below the earth's surface, various strata of soil and rock intersect with gold, silver, platinum group minerals and diamonds. Other resources such as coal, uranium oxide, sulphur, kimberlite, silica, dolomite and sand also lie below the surface. The mining of this rich geological substrate has accelerated South Africa's economic development, especially the extensive gold mining that has occurred and continues to take place along the Witwatersrand.

Gold production has made a marked impact on the city-region's natural landscapes and has played an influential role in the shaping of Johannesburg and other 'Rand towns'. After gold production peaked in 1970 (at 1 000 tonnes in that year), active mining declined incrementally owing to high production costs, such as the availability of labour, water and electricity, and unavoidable physical constraints. Due to the prolific impact of the Witwatersrand on the city-region's landscape through its economic and social drivers, this report places a particular focus on this region where the profit generated from gold has made its mark on South Africa and abroad. It has also left behind a legacy of mining waste in the form of waste dumps, slimes dams and other waste storage facilities, which continues to affect the development of the region.

While gold mining continues, other types of mining operations are now even more primary to the economy of the region. Coal deposits discovered in 1890 in Witbank (now known as eMalahleni) have also made a large contribution to the South African economy and are considered secondary to the city-region's gold exploits. Large-scale coal mines have transformed the landscape around eMalahleni into a critical coal-mining hub.

After the decline of gold production, the platinum industry has become the largest contributor to the South African mining sector. Platinum deposits intersect the city-region, with its largest source in Rustenburg. Active platinum mining continues to sustain the region's mining industries. These mining ventures, which produce their own mining waste legacies, will continue to alter the city-region's historic landscapes.



> **After the decline of gold production, the platinum industry has become the largest contributor to the South African mining sector.**

Photograph by Clive Hassall

Gold along the Witwatersrand

The word 'Witwatersrand' is an Afrikaans term that means 'the ridge of white waters'. The area was appropriately named after the range of low sedimentary hills that run in an east-west direction across the southern portion of the Gauteng province. The hills change in elevation from 1 700 m to 1 800 m above sea level.

The Witwatersrand mining belt is characterised by three mining areas called the 'West', 'Central' and 'East' Rand. These are only three sub-basins of the larger Witwatersrand Basin that extends across a further seven distinct gold mining areas. The spatial orientation of the Witwatersrand mining belt spans the length of the gold-bearing reef, running from Randfontein and Carletonville in the west to Springs located in the east. Along its extent, the gold-bearing reef intersects the vast urban expanses of the East and West Rand and Soweto.

The Witwatersrand goldfields attracted prospectors from around the world who transformed the natural landscape. Financed by capital from the then declining Kimberley diamond fields and other circuits of colonial capital in South Africa, mining on the Rand extracted significant wealth from the ground. The constant extraction of gold and waste products created a landscape characterised by large volumes of mining waste. These mine residue areas present challenges for the future development and spatial integration of the city-region.

To ensure the viability of mining activities, mines kept their operational costs artificially low. This allowed them to overcome many unpredictable challenges, such as extracting ore from deeper below the earth's surface. Achieved by squeezing out excess costs through irresponsible mining methods (in retrospect). The long-term mining costs were offset to third parties.

For many years, the wealth extracted from gold mining along the Witwatersrand boosted the South African economy. Now that the industry is in decline, remaining landscapes contain mounds of toxic mining waste. Many settlements in these landscapes remain intrinsically linked with historic gold mining while others have developed alternative economies beyond mining. An example is the City of Johannesburg, which has successfully reinvented itself as a manufacturing hub and centre for financial services (Harrison & Zack, 2012). Other smaller towns such as Blyvooruitzicht have been less able to develop economically beyond active mining.

Mine residue areas

Generally classified as mine residue areas, mining waste found in the Gauteng City-Region includes tailings disposal facilities, waste rock dumps, open-cast excavations and quarries, water storage facilities, tailings spillage sites, footprints left after the re-mining of tailings disposal facilities, and a mixture of other waste located within the boundaries of former mine properties (GDARD, 2012).

Key facts

- South Africa's gold resources are a product of its rich geological history that dates back 3.7 billion years.
- The Witwatersrand, situated in Gauteng province, has the largest source of gold found on earth. Between the period 1886 and 2002, it has produced more than 47 000 tonnes of gold.
- Revenue generated from mines along the Witwatersrand through employment and the development of support industries has been a significant driver of the economy for almost 130 years.
- Gold mining has been in decline in South Africa for many years. This is mainly the result of the difficulty in obtaining gold-bearing rock, as well as the high costs of extraction.

Source: GDACE (2008) and Strydom (n.d.)



Photograph by Potsiso Phasha

"These mining legacies remain imprinted on the cities, towns and urban nodes that together comprise the city-region and continue to influence its future development."

Mining's impact on the landscape: A synthesis

Resource extraction has fundamentally shaped the Gauteng City-Region throughout its existence. Not only has gold mining in particular been responsible for the formation of Johannesburg and its greater conurbation, it has spawned a war, set in motion great social divides, engaged exploitative labour practices, impacted the Highveld's natural ecosystems and produced great wealth for mining companies, banks and private individuals alike. These mining legacies remain imprinted on the cities, towns and urban nodes that together comprise the city-region and continue to influence its future development.

While the effects of mining on the wider city-region and its people are patent, the nuanced and evolving gold mining-related ecosystem that has rooted itself in the Witwatersrand over the last century is intricate and complex. A vast mining landscape is caused by and manifested in a series of disparate processes. These include: the abandoned mine areas that scatter its surface; the funding that built Johannesburg; earth tremors caused by the excavated cavities below the earth; silicosis, a preventable lung disease brought about by unsafe working conditions in the mines; toxic lakes caused by acidic water emanating from mining voids; and new micro-economic opportunities in the form of informal mining. All these features and consequences constitute a vast and extensive mining landscape. The monumental trail of gold-mining waste that extends from Brakpan in the east of the Witwatersrand to Westonaria in the west and intersects Johannesburg's inner city in the centre best exemplifies the city-region's oldest and most expansive mining landscape.

This report draws on the entwined complexity of this mining landscape as a conceptual device to highlight the need for a comprehensive and collaborative approach to manage the after-effects of the Witwatersrand's gold mining. While mining operations continue in parts of the West Rand, gold-mining activity close to urban areas has largely ceased. Despite this, the vast mining landscape is by no means static. Massive quantities of mine waste are

Photograph by Clive Hassall



processed constantly for their relatively minute gold content, which continually reshapes the superficial layers of this landscape. Abandoned mining areas are mined informally for scrap metal and informal miners open up old shafts to seek new sites for gold mining. In addition, dust clouds cause adverse health effects in surrounding communities; old mining towns fall into decline as mining work ends; and the city-region's precious metals continue to be sold on global markets.

The colossal processes that have constituted this mining landscape play out in a variety of ways. Through time, the legacies of historical mining practices continue to influence society and the way natural ecosystems function in the city-region in the present day. In particular, the abandonment and mis-management of these legacies continue to compound their negative impact.

The spatialisation of mining across the Witwatersrand has affected the social structure of the city-region by underpinning an unequal socio-economic geography. On the one hand, the economic effects of mining and the divisive labour system it initiated have built Johannesburg. On the other hand, this has condemned a vast majority of the city's inhabitants to second-tier lives on the urban periphery with access to inferior land, services and opportunities. The subsequent relaxation of capital controls after the political transition in 1994 meant that much of the mining capital flowed out of South Africa. As a result, gold mining no longer remains as a source of wealth for investment elsewhere in the domestic economy.

Providing a unique contribution to the literature on mining and mining waste in the city-region, this report and its associated research deconstruct the mining landscape by focusing on some of the key components of its development, namely its urban, environmental, social and economic characteristics. While accounts are often told from the viewpoint of specific disciplines (such as history, geography and sociology), this report aims to present an integrated account of the mining waste landscapes found along the Witwatersrand.



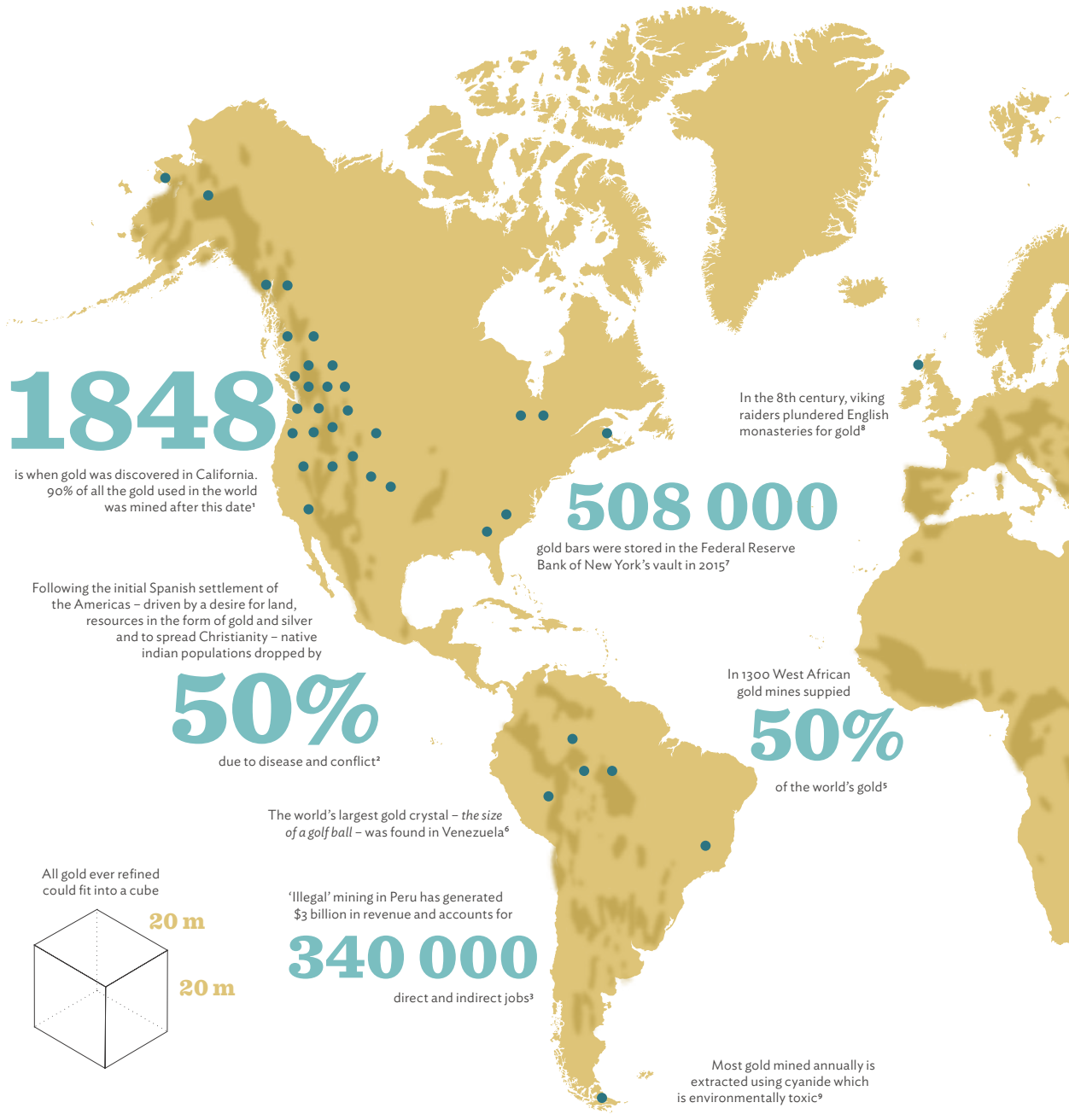
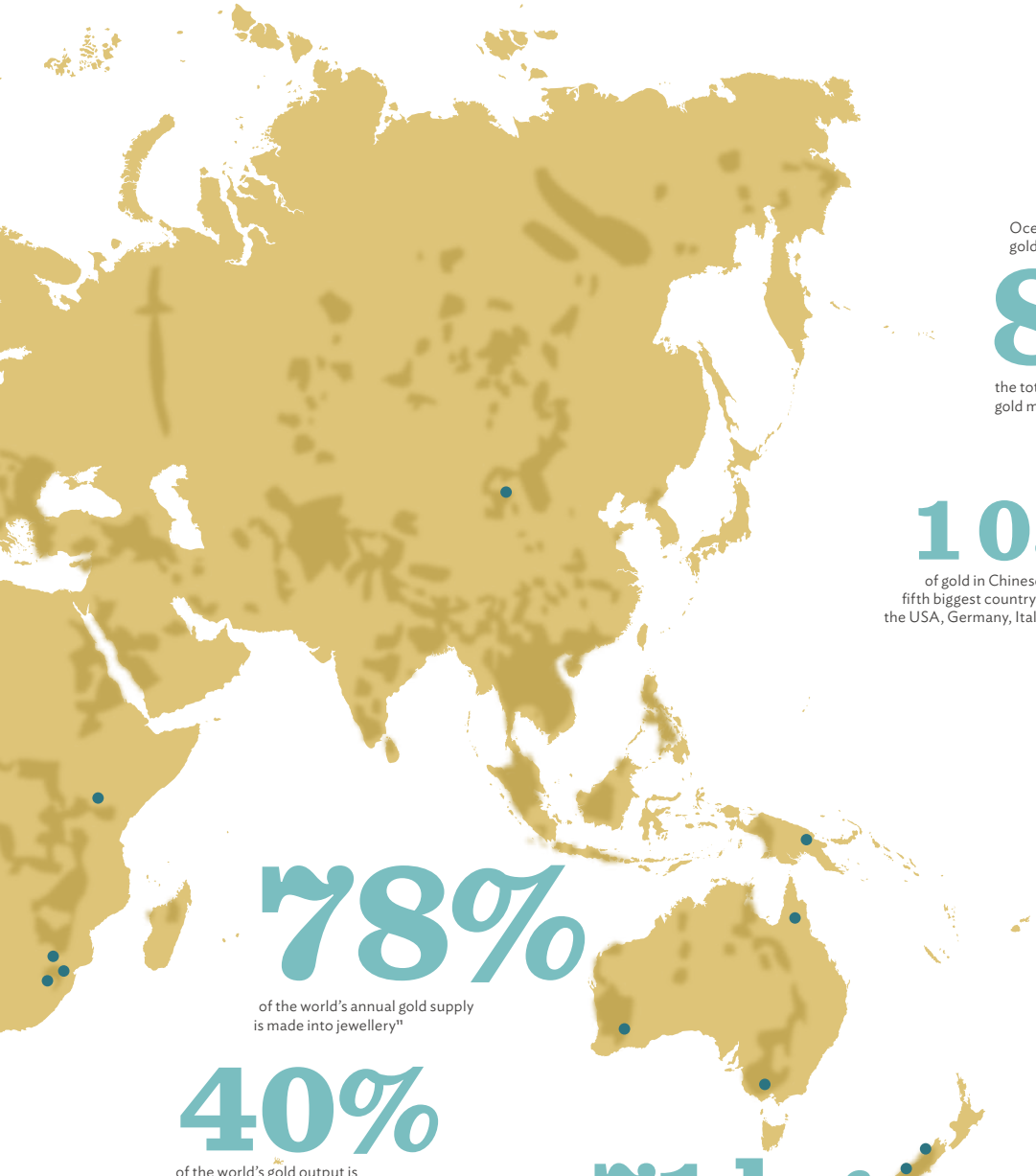


Figure 1: A world shaped by gold-mining.

SOURCES: [1] American Museum of Natural History, n.d.; [2] Than, 2011; [3] Rey Mallén, 2013, [4] CMI Gold and Silver, n.d.; [5] U.S. Global Investors, n.d.; [6] Lallanilla, 2014; [7] Federal Reserve Bank of New York, n.d.; [8] Local Histories, n.d.; [9] Mine Engineer, n.d.; [10] Escape Here, n.d.; [11] Geology.com, n.d.; [12] Geoterrics.com, n.d. Map: Gold Rush, n.d.

● = post-1848 gold rush

Mercator-projected map of the world with alluvial gold deposits overlaid



Oceans contain
gold reserves totalling

8X

the total quantity of
gold mined to date[1]

1 054 T

of gold in Chinese reserves make it the
fifth biggest country reserve holder after
the USA, Germany, Italy and France[10]

78%

of the world's annual gold supply
is made into jewellery[11]

40%

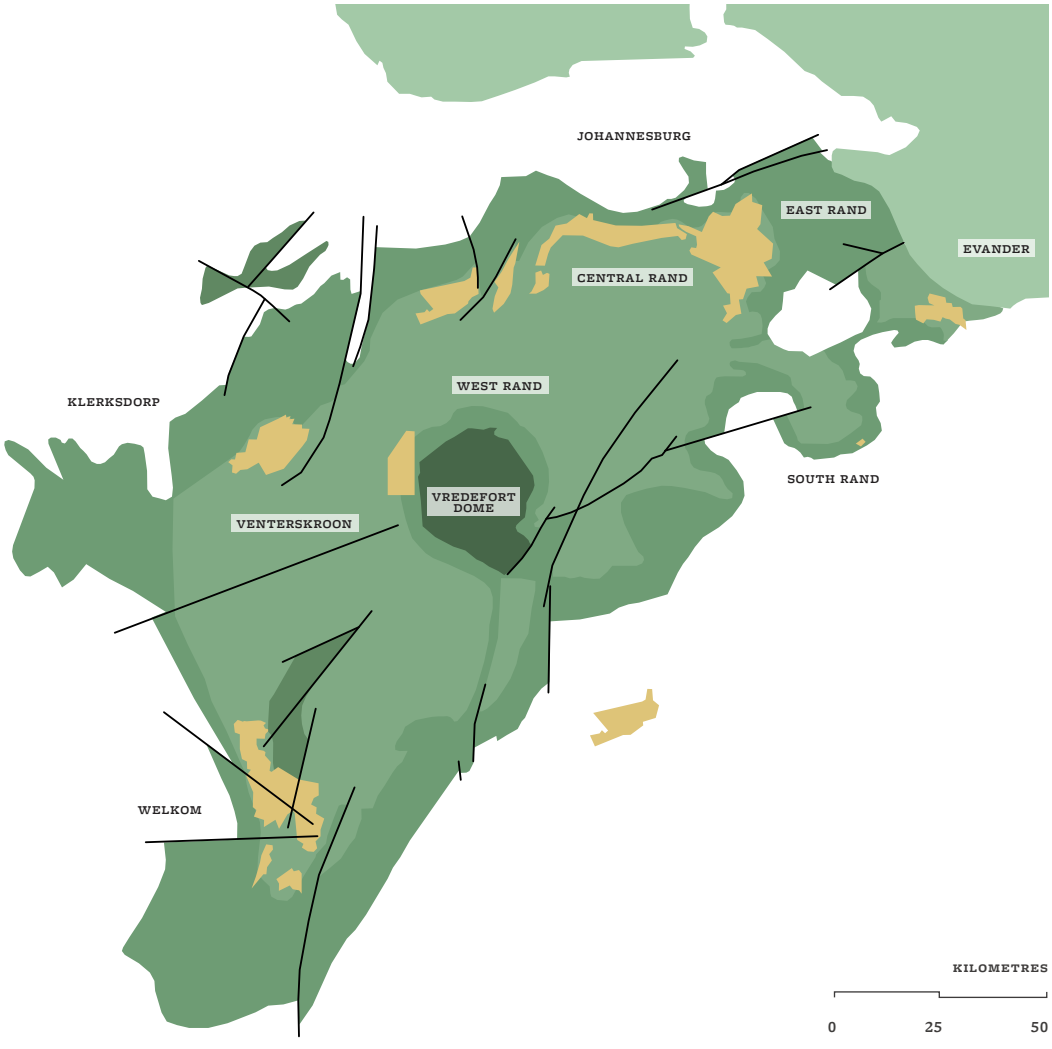
of the world's gold output is
from the Witwatersrand[4]

71 kg

of gold was extracted from the largest nugget ever
discovered, mined in Victoria, Australia in 1869[12]

Figure 2: The Witwatersrand Goldfield is located across the West Rand, Central Rand and East Rand.

SOURCES: 1 GDACE, 2008; 2 Cram101, 2012; 3 Everything Explained Today, n.d. Map: After Sibanye Gold, n.d.



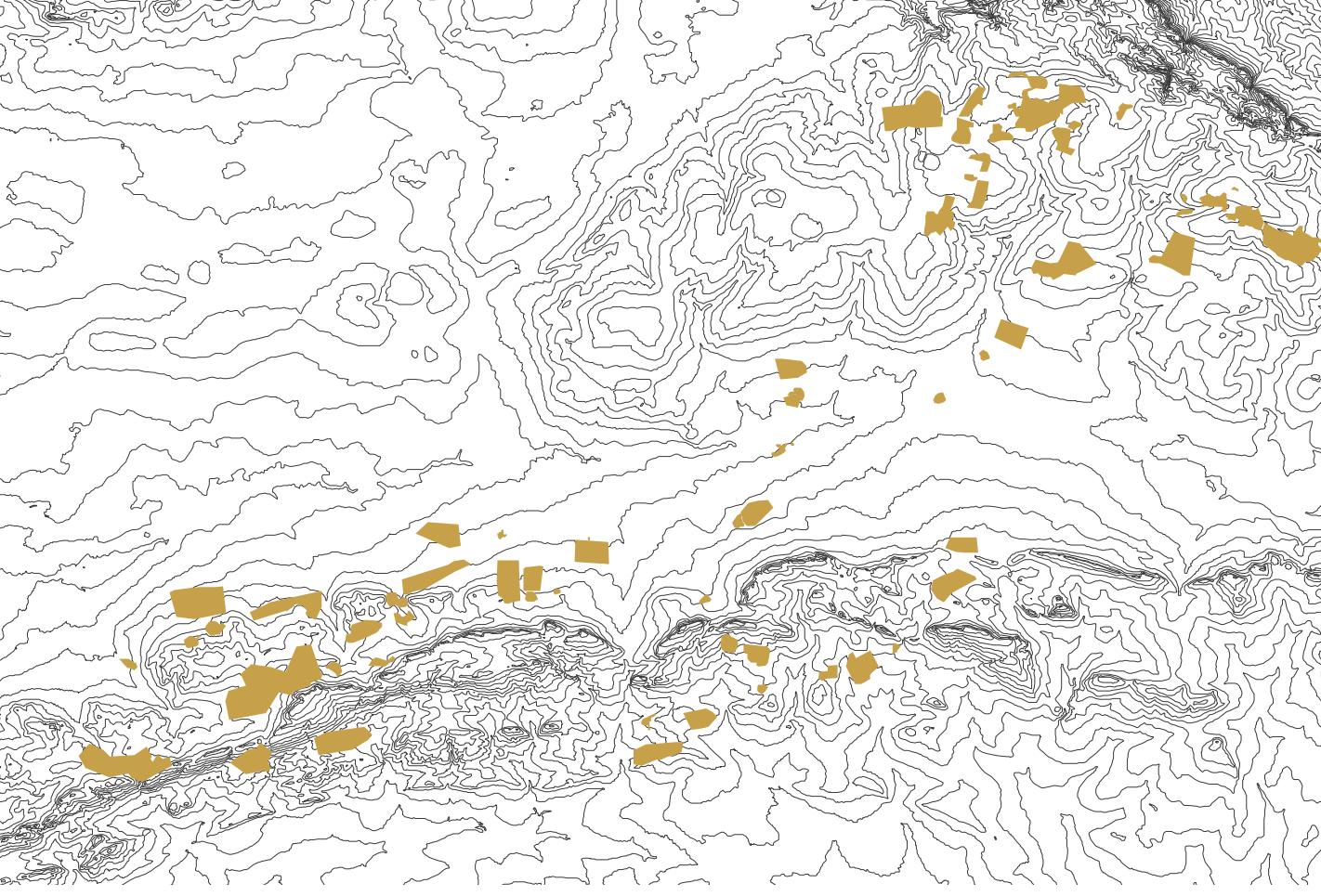
Fault line
Central Rand Group
Vredefort Dome
Bushveld Igneous Complex
West Rand Group
Goldfield



Photograph by Clive Hassall

Urban

Due to the adjacency of mining activity and urban development along the Witwatersrand, many urban areas have developed around pockets of mine waste or mine residue areas. These developments interface awkwardly with mine dumps and other mine waste, particularly in Johannesburg (Figure 3). Farther afield, extensions of the gold seam along the Witwatersrand to the east and west of Johannesburg intersect a very different urban-mining legacy. While Johannesburg continues to be one of the major economic engines of the country, these edge zones often contain distressed mining towns that have struggled to reinvent themselves (Box 4). The marked socio-economic impacts of the decline of the mining industry most directly affect communities that once drew their incomes from gold mining. While there are national policies directed at revitalising distressed mining settlements, somewhat broader questions arise around how these settlements and towns can re-purpose their economies to support the communities that remain in these discarded landscapes. In some distressed mining settlements, various skilled mine workers have turned to informal mining practices as a source of revenue. With no clear centralised social interventions developed after the mining activity, these skilled mine workers take part in opportunistic activities to mine gold in unregulated environments and markets, completely at their own risk.



This legacy has also stunted the development of a spatially integrated and socially inclusive city-region. Apartheid capitalised on this landscape by using dumps as buffers between human settlements. Mine waste was used as a means for the purposeful separation of races (Bremner, 2010). These geographies, superimposed onto the landscape during apartheid, remain as dividing lines in society and create challenges for the spatial integration and redevelopment required to build an inclusive city-region.

That being said, however, the location of mine waste could also be considered an opportunity, particularly in Johannesburg. Mine waste is well located and in close proximity to the inner city, which makes it well suited for development. Development in these areas could drastically shape the spatial form of the city-region in the future. Vast amounts of funding and expertise have already gone into the planning of alternative futures for mining waste sites. Multi-sectorial research approaches for engaging both theory and practice are critical for developing more sustainable futures for the mines and all those who live in the city-region.

Environment

Appreciating changes in the mining landscape requires an understanding of the economic, political and social relations that have brought about environmental change (Swyngedouw & Heynen, 2003). Creating a landscape of barren and unsafe spaces, mine waste affects common environmental resources such as air and water. As such, the trans-boundary nature of mine waste contamination along the Witwatersrand presents ongoing risks to humans and to the environment. Most notably, mine waste affects the quality and quantity of the region's potable water, which currently sustains the largest concentration of people in South Africa. When certain minerals present in mine waste encounter water and oxygen, they create acid water that is high in sulphates known as

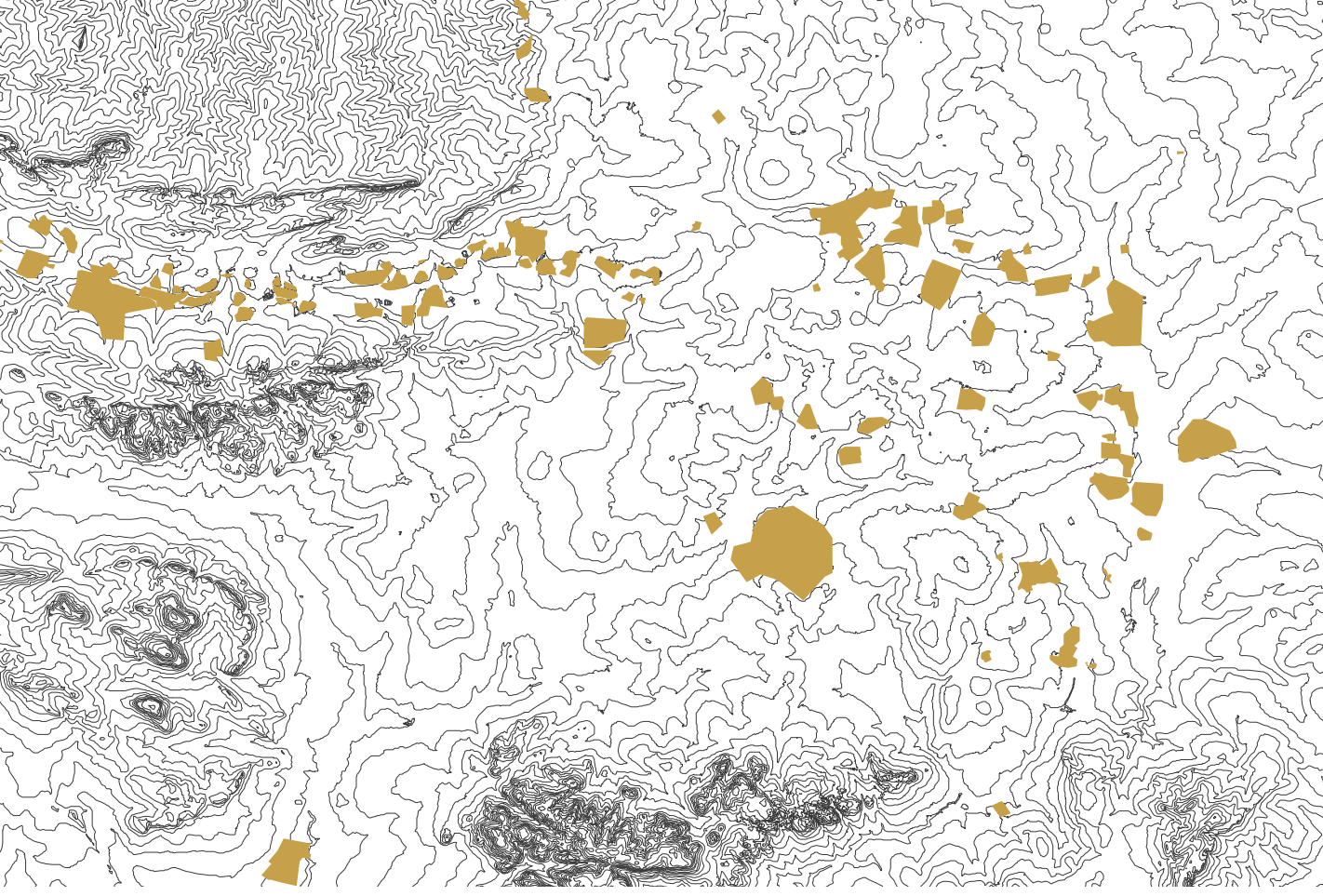


Figure 3: An overview of mine residue areas found along the Witwatersrand which have now become a feature of the Highveld landscape.

SOURCES: GDARD Mine Residue Areas, 2012; 20m contour.

acid mine drainage. The surfacing of acid mine drainage decant in the West Rand (in 2002) demonstrates the limited capabilities of the Witwatersrand's hydrological and ecological systems to buffer the effects of mine contamination. Understanding the true value of these natural services is essential to appreciate and manage the Witwatersrand's ecosystems and to harness long-term benefits for the water sector.

Social

Mine residue areas constitute large sections of waste land in Merafong City, Westonaria, Randfontein, Johannesburg and Ekurhuleni. Communities live unaware of both the short- and long-term effects of mining waste on their health and immediate environment. Used for fishing, bathing, watering crops and playing, contaminated mine water and the landscapes that they have created become an intrinsic part of the lives of those who live beside a mine dump. Often located close to impoverished communities, the legacy of mine waste contamination continues to disrupt the lives of the financially vulnerable who have less capacity to offset the effects of mining waste on their health and wellbeing than their more privileged compatriots. Moreover, these communities are also often located on unstable ground such as dolomitic land. As a result, they can be doubly or triply burdened by these environmental factors.

Economic

Present day gold-mining ventures include the reprocessing of tailing dumps and other mine waste (on former mining land) to expand the profits of a now expired extraction process. Herein lies tension in national departmental agendas. On the one hand, mine waste is seen to be a resource by the Department of Mineral Resources since fragments of gold remain in the expired waste. On the other hand, the Department of Water and Sanitation and the Department of Environmental Affairs regard this as the leftovers of a bygone gold-mining industry (DEA, DMR, Chamber of Mines, South African Mining and Biodiversity Forum and SANBI, 2013).

Re-processing ventures, undertaken mainly by the private sector and by individuals who informally work these landscapes, have created intersecting economies that stimulate the growth of large- and small-scale economies in the city-region. At the local level, informal mining and metal scavengers on the mine tailings have generated micro-economies around mine waste and, in doing so, support families and generate livelihoods. These informal economies need to be better understood and managed to develop more sustainable mining processes that truly bolster the entire mining lifecycle.

Overview

This report collates a series of in-depth pieces on key historical and contemporary processes, features and consequences that constitute the GCR's vast mining landscapes. The pieces are not divided into thematic sections bound by distinctive disciplinary conforms – urban, environmental, social and economic. Instead they highlight and elaborate a variety of overlapping and interconnected considerations that conceptually represent significant aspects of the landscape.

Chapter 2 interrogates the historical processes that have led to the divided urban form we see and experience today. It uses the conceptual devices of 'landscapes of pleasure' and 'landscapes of production' to examine the genesis and evolution of key urban divisions.

Chapter 3 investigates the legacy of mining waste on the region's natural ecosystems. It analyses inconsistencies between policy and practice in the management of the three major mining basins of the Witwatersrand, and explores ways to address the legacies of many years of environmental mismanagement.

Chapter 4 is a photo essay that viscerally illustrates some of the environmental impacts of mining, including acid mine drainage, on the West Rand areas of Gauteng.

Chapter 5 further investigates abandoned mining areas, looking specifically at the lasting health impacts experienced by communities situated close to abandoned mining areas. It considers the environmental justice concerns associated with the spatial location of settlements and mining waste, and also touches on the health challenges faced by former mine workers.

Chapters 6 and 7 examine new prospects for the city-region's mining waste sites through two ethnographic photo essays, capturing the complexity and hardship of, first, illegal mining and, second, the scavenging for old metal waste on abandoned mine dumps.

Finally, Chapter 8 examines prospects for the GCR's mining landscapes in more detail through an analysis of government and corporate rehabilitation programmes, as well as design exercises that imagine new and innovative futures for mining waste.

Across these chapters this report seeks to highlight the need for sustained, collaborative and innovative approaches to unshackle the towns and cities of the Witwatersrand from their gold-mining inheritance. As a significant portion of Gauteng's relatively small landmass, the region's mining landscapes hold significant potential for repairing social divisions, cultivating natural assets, and remedying the destructive health and environmental effects of a century of mining activity.

Ngoba … sewuthi

Because … you now say

BY B.W. VILAKAZI

Ngoba ngimamatheka njalo,
Ngikhombisa nokwenama,
Ngihlabelela ngephimbo,
Nom'ungifak'emgodini
Ngaphansi kwezinganeko
Zamatsh'aluhlaz'omhlaba-
Sewuthi nginjengensika
Yon'engezwa nabuhlungu.
Because I always smile
And even look happy,
Singing at the top of my voice,
Even when you push me into a hole
Under those mysterious
Blue/green stones of the earth -
You then say that I am like a pole/post
That can't feel any pain
Ngob'umlomo wam'uhleka,
Namehl'am'ebheke phansi;
Ngifingqe ngabek'idolo,
Nezinwele sezimpofu
Zigcwel'uthuli lomgwaqo,
Ngipheth'ipiki ngesandla,
Neyemb'elingenamhlane-
Sewuthi nginjengedwala
Lon'elingakwaz'ukufa.
Because I laugh with my mouth,
And my eyes are cast down;
My trousers rolled above the knee,
My hair like ochre
matted with the dust of the road,
My hand holding a pick,
Although my shirt is backless;
You say that I am like a rock
That doesn't know even [the
pains of] death.
Ngoba njalo ngakusihlwa
Sengigumul'iketango
Lomsebenz'onzim' emini,
Ngihlangana nabakithi
Siyogadlela ngendlamu,
Singoma ngamadala
Asikizelis'igazi,
Kuphele nokukhathala-
Sewuthi ngiyisilwane
Esifa kuzalw'esinye.
Because normally in the evenings
I let loose of the chains
Of the daily heavy work,
And meeting people of my kind
We dance with newly-found energy
And sing our traditional songs
That stir up our blood
And chase away our weariness;
You say that I am an animal
Which, should it die, it's
readily replaced.
Ngoba ngiwumgquphane,
Ngibulawa ukungazi,
Ngingaqondi namithetho,
Kodwa ngizwa ingiphanga;
Nendlu yami ngiyibeke
Ngaphansi kweziwa zetshe;
Utshani buyindlu yami,
Isaka liyisivatho –
Sewuthi ngiyisiduli,
Kanginalo nonyembezi
Olucons' enhliziyweni
Luwel'ezandleni'ezinhle
Zamadloz'abuka konke.
Because I am a simple dupe
Destroyed by the price of ignorance;
As I don't understand any laws,
But can only feel when they hurt me;
Because I make my home
Under a rocky krantz;
And cover it with grass thatch,
And myself with sack-cloth;
You think that I am a deaf-mute
That I have not a tear
That may fall from my heart
On those beautiful hands
Of my ancestors who see everything.

(*Source:* Zondi & Canonici, 2005)



Photograph by Clive Hassall



2. Making the mining city

Investigating Johannesburg's dual urban landscapes of production and pleasure

GUY TRANGOŠ

Introduction

The long-term impacts of mining activity are integrated deeply into the landscapes they affect. This is because mining is a deeply disruptive process resulting in its various social, environmental and economic consequences reverberating into the future. On the Witwatersrand, the dividends of mining constructed South Africa's largest, most populous and economically active city, Johannesburg. While the city would not exist without the revenue generated from mining activity, paradoxically, it was this revenue, and the process of its extraction that shaped the deeply polarised city that continues to endure today. The scale and importance of mining on the Witwatersrand for the South African economy has been considerable and, undoubtedly, mining capital has played a direct hand in influencing and shaping its urban development and growth.

The scope and focus of this research does not intend to interpret the complex web of mining effects on urban settlement on the Witwatersrand in its entirety. Instead, glimpses into key historical moments build a series of narratives, each grappling with a historical process and a modern day corollary. These analyses are not chronological or linear, but devolve into the conceptual framework of landscape, which recognises the past-present dichotomy as anachronistic, entangled and entropic. As Judin explains, "[u]nder evolving historical realities, the country and the city take on new material meanings, expressing the diverging interests and imaginations of our social bodies. Johannesburg and its furthest reaches remain bound together today in a seamless spatial dependency, challenging notions of permanence and change" (2008: 124).

The presence of historical ghosts or traces of memory in Johannesburg are profound. Only having emerged in 1886, the life of the city is brief, its growth explosive, and its vertical urban layering thin and intermittent when compared to older cities. While mining in what is today the City of Johannesburg municipality has ceased, its effects continue to define the urban landscape, despite other contemporary economic engines having replaced it.

Gold on the Witwatersrand

The Witwatersrand, also known as the Rand or the Ridge, is a 56 km rocky outcrop that extends in an east-west direction across the central Gauteng City-Region. It forms the northern edge of a large inland plateau known as the Highveld, which rises dramatically in height from sea level on its eastern edge, about 400 km from Johannesburg. The Witwatersrand ridge today forms a divide between Johannesburg's northern suburbs and inner city.

Historically, mining near the Witwatersrand occurred long before George Harrison's 1886 'discovery' of gold. The Sotho-Tswana people had already established various small settlements near the present site of Johannesburg (Huffman, 2010), but mining did not take place on a scale that could be carried by the capital networks of an industrialising world.

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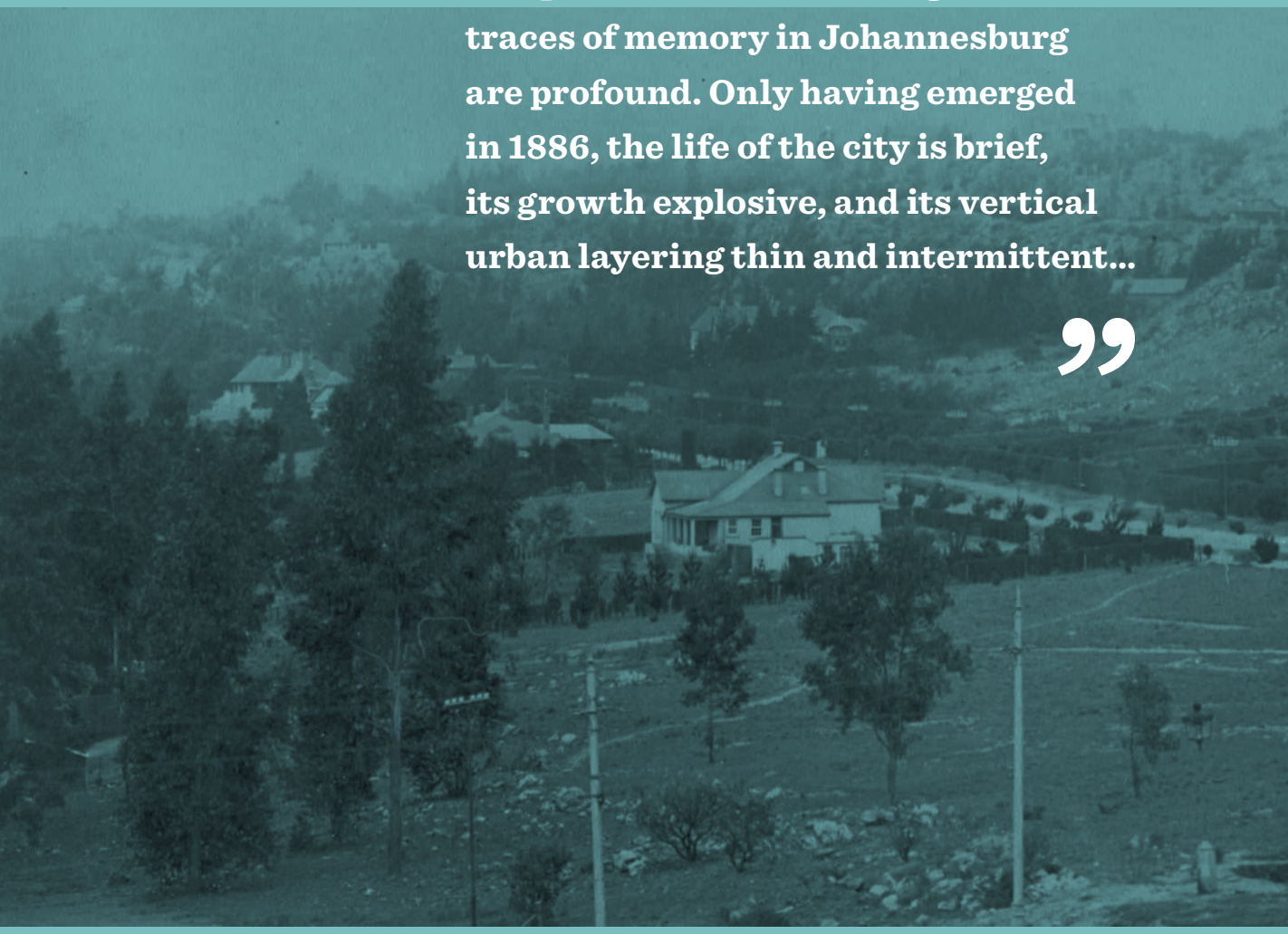
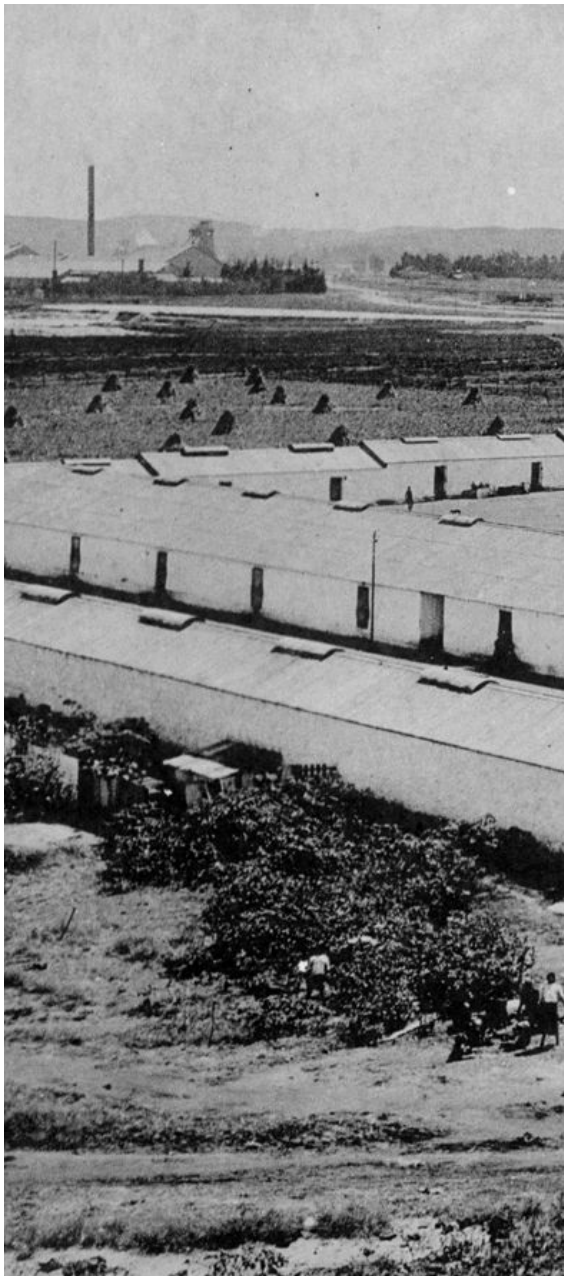


Image: Museum Africa Photo Archive



Before the opportune 1886 discovery of gold in Johannesburg, the diamond mines in Kimberley (less than 500 km away) functioned as a 'training school for millionaires' (Rosenthal, 1970: 47). The significant capital generated on the Witwatersrand was, in turn, able to fund increasingly extensive and deeper mining activities.

Before the onset of mining activities, the open grasslands and rocky outcrops of the Witwatersrand were divided into large farm portions. Fortuitously, the gold-bearing reef was adjacent to a large unoccupied plot of land that was not farmed because it was far from water sources. This uitvalgrond or surplus land was divided into stands by the government of the autonomous Zuid-Afrikaansche Republiek (ZAR) as a way to structure the settlement of Johannesburg into an orderly grid and benefit from leasehold property revenues (Beavon, 2004). Speculative subdivisions of farmland into city blocks adjacent to the new Johannesburg also occurred. The new mines were therefore awash with investors and space to expand, sustained by a burgeoning mining town capable of supporting a rapidly growing population and workforce (Figure 4 – Figure 8).

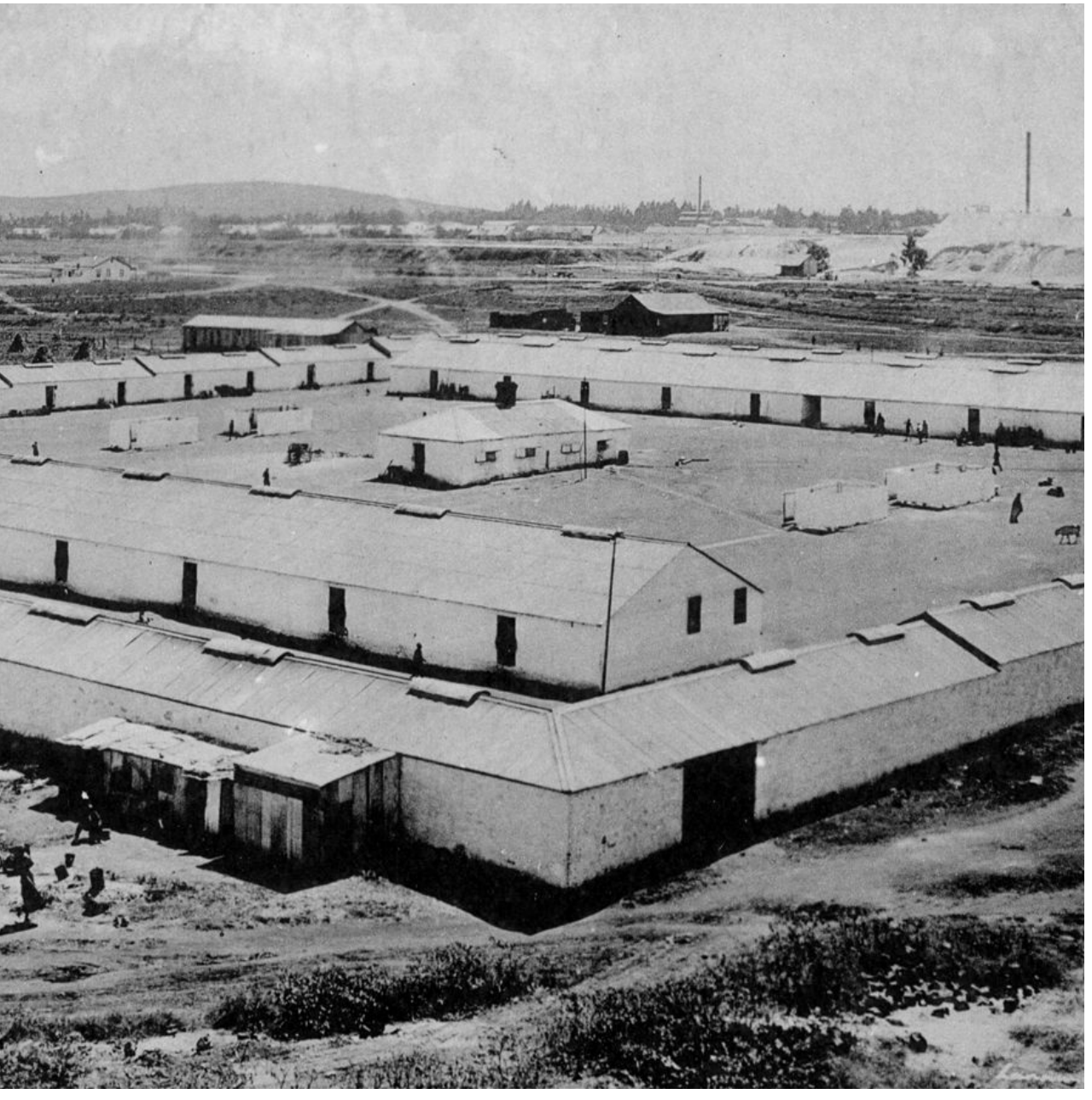


FIGURE 4: Mine workers' hostel at Geldenhuis Deep mine, c. 1904 (Image: University of the Witwatersrand Historical Papers Archive).



FIGURE 5: Cyanide and battery works at Geldenhuis Deep mine, c. 1904 (Image: University of the Witwatersrand Historical Papers Archive).

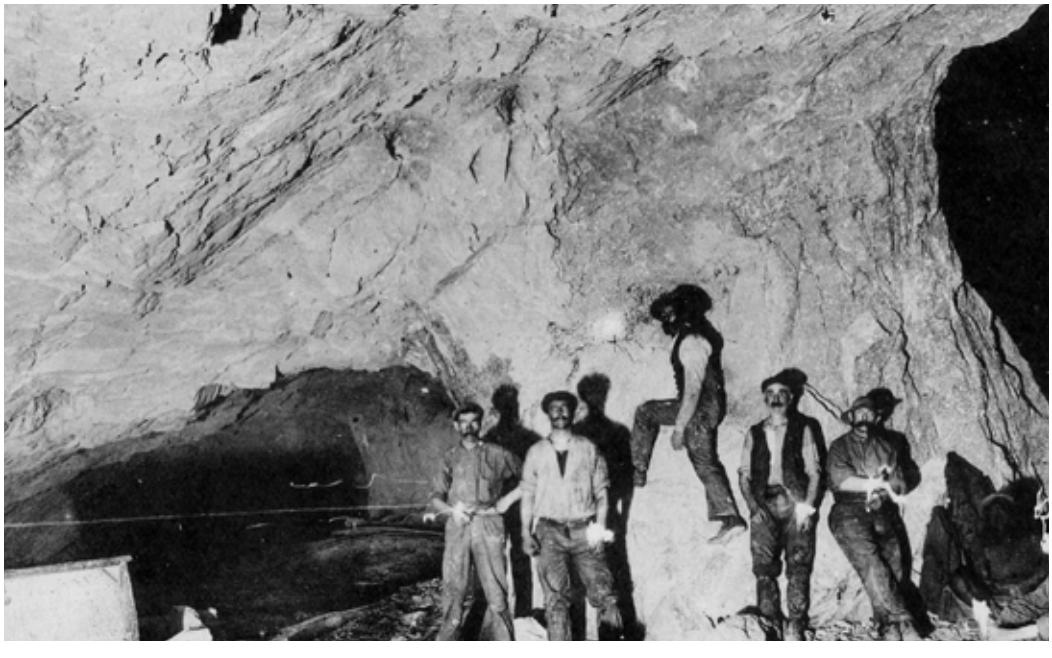


FIGURE 6: Underground pillar and tunnel at Geldenhuis Deep mine, c. 1904 (Image: University of the Witwatersrand Historical Papers Archive).

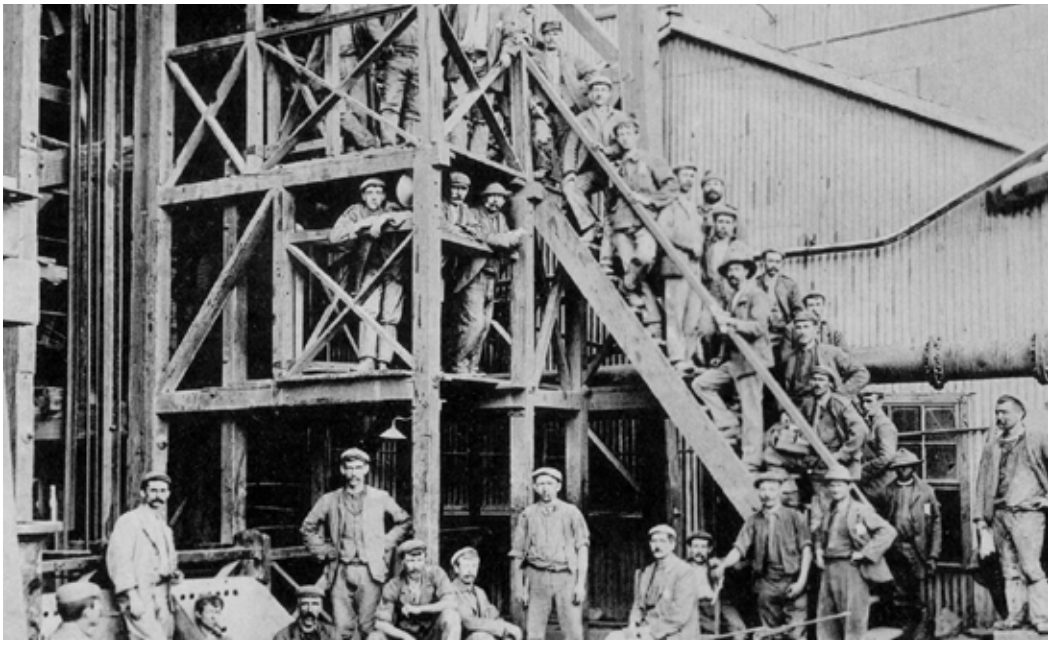


FIGURE 7: Miners entering the shaft at Geldenhuis Deep mine, c. 1904 (Image: University of the Witwatersrand Historical Papers Archive).



FIGURE 8: Miners at Geldenhuis Deep mine, c. 1904 (Image: University of the Witwatersrand Historical Papers Archive).

As is so often characteristic of global cities built on processes of extraction, the relationships between the urban and natural landscapes remain complex and fraught. Johannesburg developed across the open Highveld grassland – a landscape comparable to the Argentine pampas or the Siberian steppes in its scale and rootedness in the culture and identity of early settlers (Petterson, 1951: 211). Black and white herdsmen used its rolling hills, flat plain and rocky outcrops successively as they sought out new grazing for their herds of cattle and sheep (1951: 211). A barely visible stretch of rocky quartzite that ran in an east-west band across the open landscape marked the surface of the gold reef. After the discovery of gold, this would become Commissioner Street and Main Reef Road. Market Street (now known as Albertina Sisulu Road), four blocks north, became a primary trade link on which the market was situated (Figure 9).

The expansion of mining activities and the growth of Johannesburg and other towns along the Witwatersrand led to the indiscriminate use of the Highveld landscape for the large-scale depositing of mine-waste, and for fulfilling the needs of human settlement. This often occurred at the cost of natural ecosystems. As surface mining began to deplete, the mines moved south, east and west in line with the dip of the underground gold-bearing reef. Their impact extended across the landscape while their shafts plunged deeper underground.

Few cities in the world are located in such close proximity to mining waste as Johannesburg. The constant presence of the city's mining waste landscape has become an idiosyncratic feature of Johannesburg. While the large city has sprawled across the Highveld grasslands, it is the mounds of white and yellow dust, the lakes and dams of red water heavy with metals, and the deceptively bright blue – but toxic – water that have most destructively reshaped the landscape. As this text demonstrates, mining and its waste have aggressively shaped Johannesburg's complex urban and natural landscapes (Figure 10) (as platinum mining continues to do to the north-west of the city, Box 1). These effects are intrinsically spatial and their three-dimensional relationships are thus important. The conceptual devices of strata, landscapes and fields allow a useful reading into these interactions.





FIGURE 9: Market Street in Johannesburg (Image: University of the Witwatersrand Historical Papers Archive).

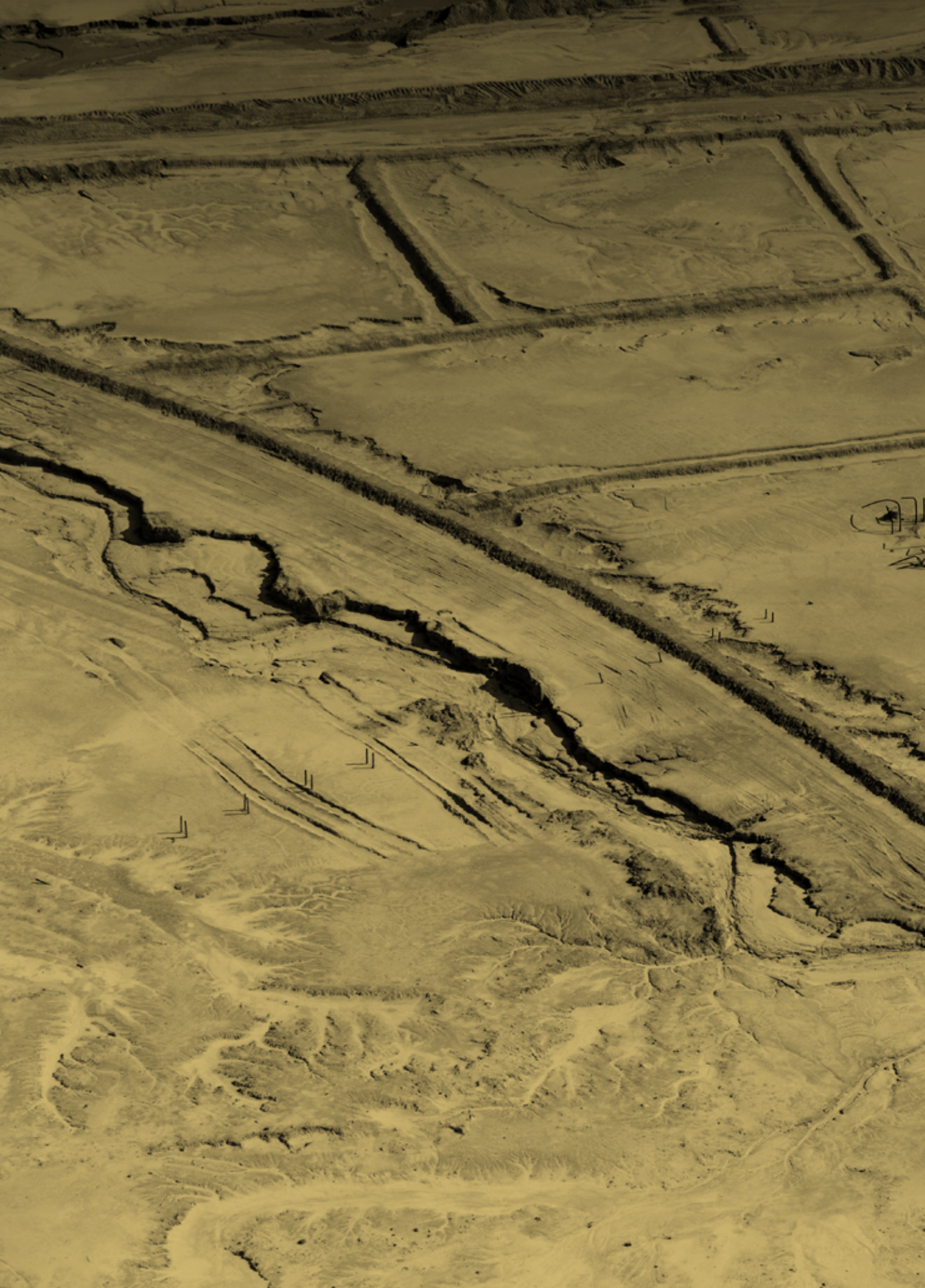




FIGURE 10: Sand dump at City Deep mine.

Photograph by Clive Hassall

Box 1: Platinum mining

GUY TRANGOŠ

While the life cycle implications of gold-mining activity in Johannesburg continue to be felt decades after mining ceased, platinum mining to the north of the city-region is in its relative infancy. Modern mines and improved socio-economic rights upheld by a democratic constitution should result in improved mining practice. Unfortunately the entanglement of power and capital, resultant labour exploitation and the conduit of resource wealth extraction – as established under the British Empire – remain largely in play, as was highlighted by the mine worker protests and the tragic massacre of strikers at Marikana.

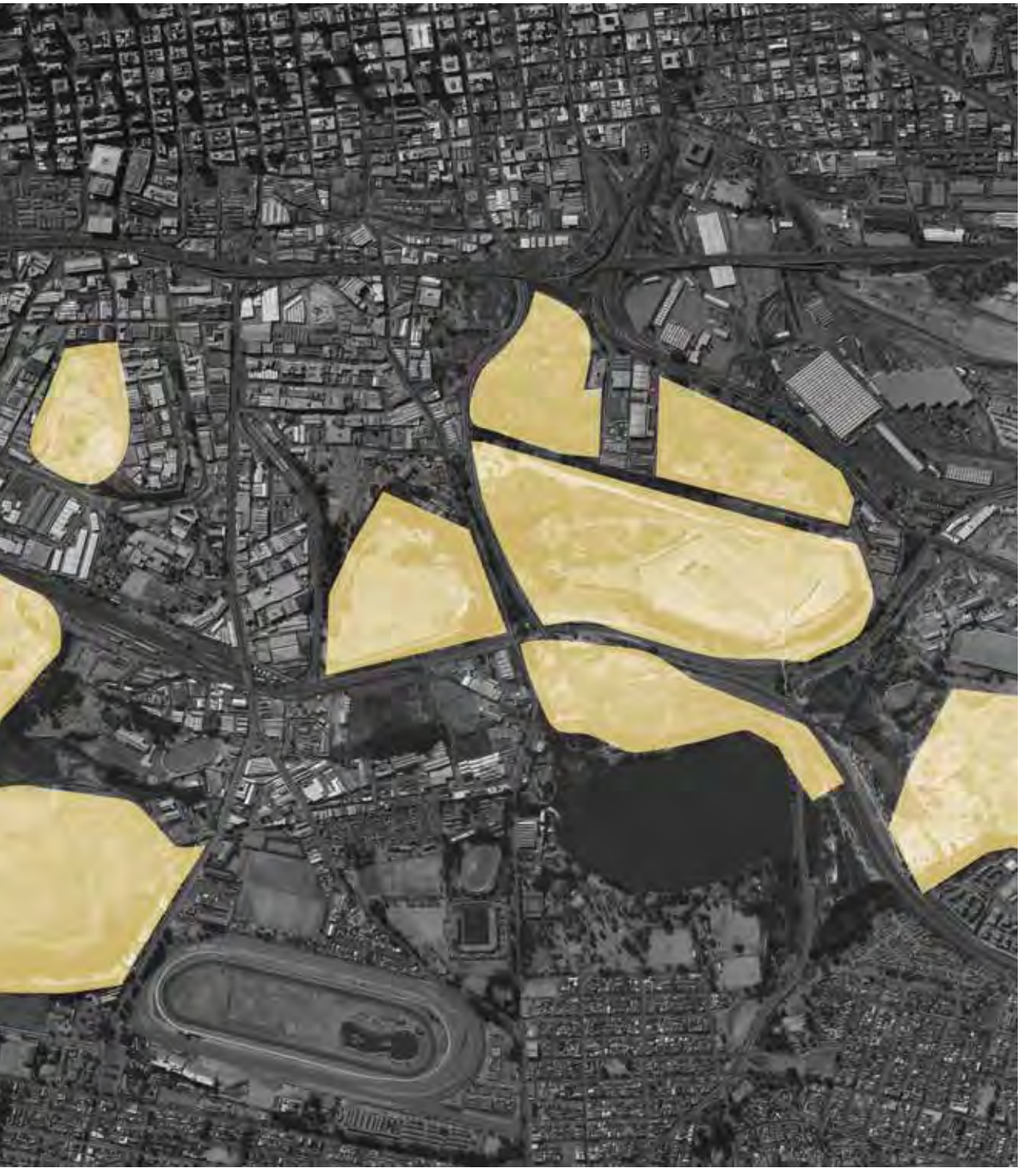
Marikana Massacre

The Marikana Massacre aggressively brought to light the steep inequalities that remain on South African mines. On 16 August 2012, the South African Police Service (Plaut, 2012) shot dead 34 striking platinum miners. Improved underground working conditions and the call for a living wage of R12 500 were the primary demands of the striking workers (Marinovich, 2012). London-based platinum mining company, Lonmin (London Mining), owns the Marikana Platinum Mine. Implicated in influencing the decision to end the strike at all costs was former National Union of Mineworkers (NUM) leader, Cyril Ramaphosa (Munusamy, 2012). The North West Provincial Commissioner, General Zukiswa Mbombo, stated on the morning of the massacre that, "Today we are ending this matter" (Bruce, 2012: 7), triggering what has been described as the largest and deadliest action by South African police against civilians since the Sharpeville massacre on 21 March 1960 and the end of apartheid.

Societies cannot remain defined by their capacity for production, nor can they continue to be shaped by the effects of largely white, colonial capital. Instead, it is important for more revenue produced by the capital networks of the city to be channelled into social and environmental investments to overcome the legacies of the city's past, and new legacies being created through the mining of the city-region's new gold.



FIGURE 11: An aerial photograph of Johannesburg, south of the inner city, detailing mine residue areas and their intersection with the city's built fabric.
DATASET: GDARD Mine Residue Areas, 2012. Image: NGI, 2012.



Strata, landscapes and fields

Beneath parts of Johannesburg exists a cavernous network of disused mining shafts and tunnels. Their reach is deep and extensive. Old mines dock themselves to the narrow diagonally descending gold seam under the city through a multi-tiered and interlocking network of shafts and passages. Today these are lost to the modern experience of the city. Rising ground water and rock falls have made navigating the dark tunnels nearly impossible. Their equipment, signage, stopes and machinery are sealed in time, degrading slowly or entirely destroyed. Seismic rumbles echo through these underground voids as the earth heaves.

Venturing in a southerly direction on the major M1 arterial, the city's form morphs from a landscape of old tree-lined suburbia shaped by the wealthy mining masters, to a vertical concrete city and the old central business district (CBD) (Figure 11). The inner city stands in striking contrast to the remnants of mining interspersed with light industry, manufacturing and warehousing businesses, a number of 'southern suburbs' and a few remaining mine heads, mining sheds, old winder houses and Gold Reef City (see 'Landscapes of pleasure'), much obscured by tall blue gums and scattered grasses.

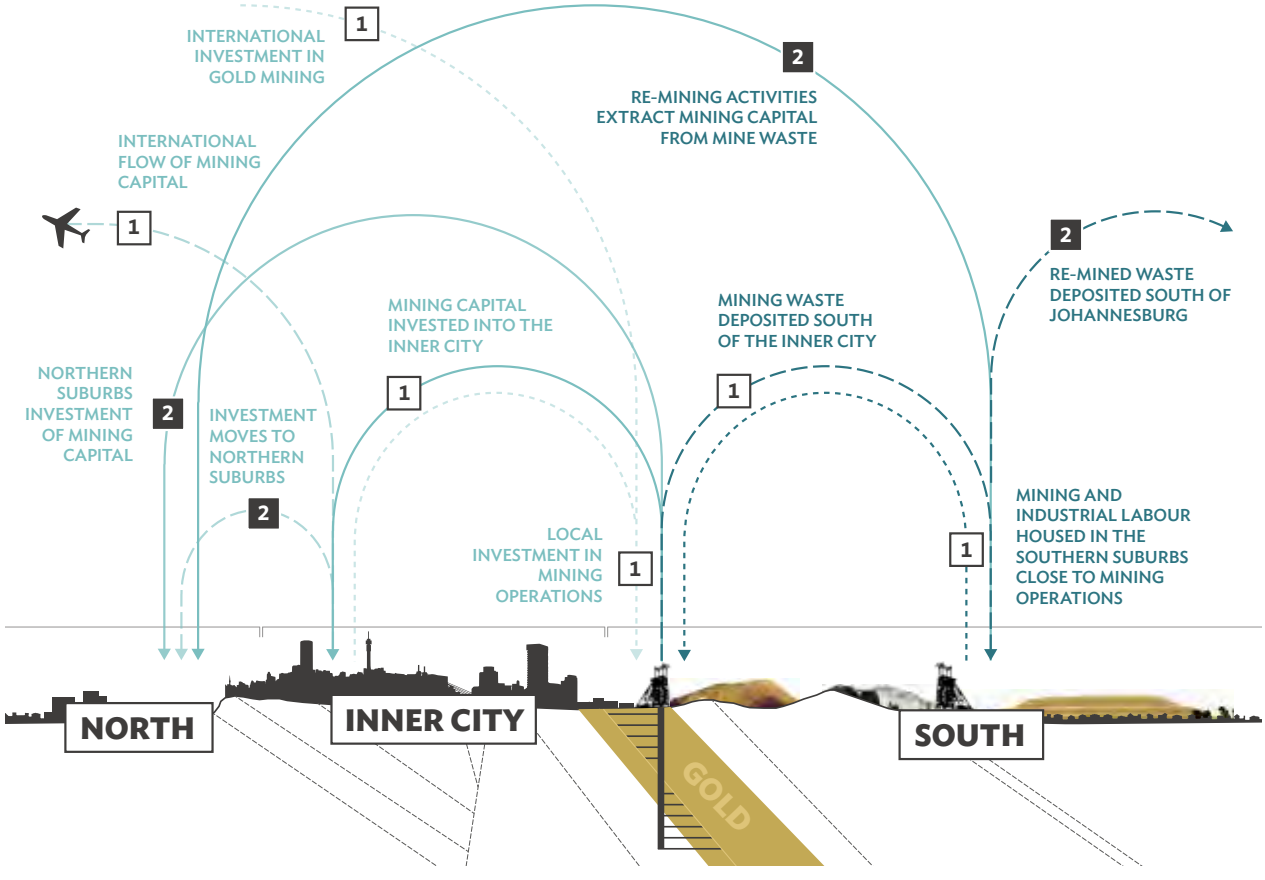
Strata of diverse ecosystems, both natural and constructed, enmesh the built urban skin on the surface of the city and bind it to a surrounding natural network of flora, fauna, soil, water and air. These essential infrastructures and resources support life in the city, but are constantly threatened by the products of urban lifestyles, industry and mining. For example, the deep vertical punctures left underground by mining activity have opened up these precious and protected strata to contamination from the surface and, in the case of acid mine drainage, contamination of the surface from the underground.

The urban stretches outwards as suburbia creeps north and south of the city-region's broad east-west gold mining arc. Economic nodes, not older than fifty years, rupture these suburban landscapes. Tall modern buildings cluster, usually around shopping centres such as Sandton City, Eastgate and Rosebank, as beacons of the 1980s and 1990s inner city economic flight, a process of disinvestment that occurred as inner city building stock became older, roads became more congested, and office parks and shopping nodes became desirable typologies.

On the periphery, the built urban landscape thins further; buildings are smaller and less frequent, with little previous human settlement. Open landscapes entangle with increasingly scattered suburbs. Sidewalks degrade into well-trodden strips of uneven earth. Streetlights become less common and agrarian functions more overt. On the periphery of the city-region, many areas of intense density suddenly emerge. Places such as Diepsloot, KwaThema, Katlehong, Ga-Rankuwa, Kagiso and Orange Farm are located away from social, cultural and economic centres and are dependent on various forms of unreliable public transport. Residents of these satellite suburbs are not only poorer but also spatially disadvantaged.

The city-region's numerous landscapes often overlap with each other. They fray at the edges, blur into one another and at times never touch. They have different sectional depths, be they layers of concrete, asphalt and glass in the urban; soil, plants

Figure 12: Johannesburg – divided by numerous historical and contemporary gold mining-related forces into northern landscapes of pleasure and southern landscapes of production.



and geology in the natural; grass, planting and trees in the suburban; or masses of rock, earth and water in the subterranean. They also contain varying, less visible layers, such as cultural rootedness, economic activity, social integration, socio-economic tension and political engagement.

The complex strata that collectively create the contemporary city-region are rooted in equally complex historical layers. These can be buried or exposed by time, be hidden beneath the lengthy accrual of history, be destroyed or preserved for future generations.

Two prominent urban landscapes have emerged through Johannesburg's history, one north of the mining belt and one south. These are the result of successive economic policies, colonialism and apartheid. Originally divided on racial lines, these unequal landscapes are socio-economically distinct (as demonstrated in Figure 12).

Dual landscapes

The spatial divide between the north and south of the city that remains entrenched in Johannesburg is intrinsically linked to a marked differentiation on the Witwatersrand between 'landscapes of production' and 'landscapes of pleasure'. While the gold-bearing seam and allied industries were located to the south of the city, those residents settling to the north at the turn of the 20th century chose to reside away from the mines, on the Parktown and Westcliff Ridge, which offered better quality air and dramatic views of the open Highveld below. The concentration of wealth and capital to the north of the mines allowed for the creation of a suburban utopia replete with mansions, manicured gardens, parks and a fixed social order congenial to the interests of elites. This was a landscape of pleasure, high society, wealth, sun and air. To the south, due to the spatialisation of geological wealth, components of the same natural landscape were sacrificed to gold mining and characterised by dust, disease, exploitative labour practices, profit and environmental degradation. This can be conceptualised as a landscape of production (Figure 12).

Analysing these dual landscapes allows for a useful comparison – a largely virgin landscape carved by the effects of mining in opposing ways has resulted in the socio-spatial structure by which the city grew and expanded. Over time, this created an entrenched land-use legacy. A conceptual device for this research, the notion of 'pleasure' and 'productive' landscapes is used to capture two examples that construct useful insights into processes that were ignited by mining and continue to affect Johannesburg.

Despite these contrasting halves of the city being positioned in this chapter as binaries, they are of course rich, diverse and complex. For example, pleasure undoubtedly occurs and is constructed in the south through investments into property, shopping complexes and recreational facilities, among others. The south also harbours tertiary economic activity in particular areas, such as Glenvista, Glenanda and Ormonde, and significant forms of capitalist consumption in its various nodes. The north is equally diverse, containing its own sites of production in the form of warehousing and light industry in Wynberg, Strydom Park and Marlboro for example, but also more localised forms of production, clearly evident in informal economic activity, home industries and backyard businesses.

Production occurs on multiple scales and can be broadly interpreted to include a number of activities, economies and processes. Similarly, pleasure is an elusive term that also operates on a variety of scales and meanings. Importantly, these processes are temporal and – in both cases – as some primary economic activities have run dry, these have been repurposed for tertiary economic activities, including consumption and pleasure. In this chapter, these two conceptual devices offer a simplification of the most common historical processes that have shaped urban form in these two halves of Johannesburg.

Figure 13 explores the contrasts inherent in the single landscape, presenting two worlds entwined in one another but distinct, divided and vastly different in terms of economic access.

The following section on 'Landscapes of pleasure' includes an analysis of the early settlement of the Ridge and how mining capital and the imperial elite shaped a Highveld landscape into the image of a British heartland. In so doing, they set up stark socio-economic spatial divides that still resound in the city today. In addition, the section interprets Gold Reef City, the mining-museum turned theme park, exploring how the park's mining history now threatens its future.

The 'Landscapes of production' section interrogates the effects of mining capital on urbanisation, along with an analysis of the historical and continued effects of mining waste on the lives of those living and working close to these toxic landscapes. Complex health and environmental challenges result from the mismanagement and abandonment of mining waste.

The two sections each provide an angle on the diverse effects and influences of mining activity and mining capital on the social, natural and urban landscapes they confront. Reinterpreting the true life cycle of mining activity demonstrates the immense externalities of a relatively brief period of extracting gold – a natural element without significant utilitarian value that has enchanted humanity for millennia.



FIGURE 13: Socio-spatial contrasts in the mining city produced by global networks of capitalism and colonialism.

"Analysing these dual landscapes allows for a useful comparison – a largely virgin landscape carved by the effects of mining in opposing ways has resulted in the socio-spatial structure by which the city grew and expanded."



Landscapes of pleasure

A view from the Ridge

Edward Said interprets the manipulation of the landscape as being central to the colonial project: "At the most visible level there was the physical transformation of the imperial realm, whether through what Alfred Crosby calls 'ecological imperialism,' the reshaping of the physical environment, or administrative, architectural and institutional feats such as the building of colonial cities [...]" (1993: 109). In 1896, only 15% of Johannesburg's inhabitants were citizens of the ZAR, the only one of two independent Boer Republics in which gold was found. The rest of its residents came from all over the world (Foster, 1996: 96). Most had come to Johannesburg with the intention of generating wealth from the burgeoning mining town, resulting in an atmosphere of excess – to the point where, in 1896, Johannesburg was described by English observer William Butler as "Monte Carlo on top of Sodom and Gomorrah" (Kruger, 2013: 2).

This section explores the mechanisms employed by the colonial elite to create a suburban landscape in the image of a traditional British townscape to counteract the rough and tumble city. As will be shown, however, this process has wrought lasting effects on Johannesburg's socio-spatial landscape. Starting with the British invasion of the ZAR during the Second Anglo-Boer War, Johannesburg saw substantial change.

The rich gold deposits found in Johannesburg were one of the major reasons for the Second Anglo-Boer War, which saw the British invading the Boer Republics with the intention of taking control of the gold mines. Once the British had succeeded in annexing the ZAR, Lord Milner was installed as the Transvaal Colony's first High Commissioner. Imbued by a vision to turn South Africa into a "union of civilized spirits mothered by Britannia, nursed, and nurtured by the benevolent spirits of Europe", Milner set about a period of reconstruction (Foster, 1996: 97). According to Foster, Milner's sweeping changes included the reorganisation of local and regional governance, new human settlement schemes, and the creation of new cultural images to cement orderliness and civility.

A central part of Milner's plans to anglicise the Transvaal was the re-creation of English towns on the Highveld (Parnell, 1993). This vision was trumpeted by most of his supporters, including the architect Sir Herbert Baker who lectured on the desirability of low urban density (Parnell, 1993). As a result, Johannesburg was reimagined as a global space of empire where, as in the rest of the British-occupied colonial world, imperial influence aggressively seeped into metropolitan culture and the 'minutiae of daily life' (Said, 1993: 108).



Photograph by Clive Hassall

On the Parktown and Westcliff Ridge resided a tight-knit community of Rand Lords, artists and wealthy European immigrants, many of whom identified themselves as temporary residents or the 'British overseas' (Foster, 1996). Their houses oriented northwards to benefit climatically from this aspect (Figure 14). As Foster suggests, the long gaze northwards also aligns with mining magnate and imperialist Cecil John Rhodes' dreams of colonial expansion to Cairo and Europe beyond (1996). After all, the Ridge is the highest point on the Witwatersrand where "[...] there is little in the way of human scale elements to relate to, a part of Africa in which the peculiar rolling quality of the topography has the effect of depressing the visual horizon" (Foster, 1996: 107). Once occupied by the manors of Johannesburg's ruling and colonial elite, the Ridge came to represent power, wealth, imperial dominion, territorial control and economic exploitation. The extensive planting of pavement trees and the establishment of leisurely parks to the north of the city cemented these new landscapes of wealth built in the image of a bucolic imperial idyll.

Between 1901 and 1910, Johannesburg saw substantial suburban growth northwards. Fifty-three new suburbs were established and the city's residential fabric then accounted for 41% of the municipal area (Beavon, 2004). Suburbs with names drawn from imperial references such as Killarney (a town in County Kerry, Ireland), Dunkeld (a market town in Perth and Kinross, Scotland), Norwood and Brixton (suburbs in south London), Kensington (a suburb in west London) and Yeoville (after Yeovil in Somerset, England) were connected by streets with names similarly imported, such as Oxford Road, Queen Street and London Road. In 1906, construction began on two electric tramlines that connected these northern suburbs to the city in the south (Beavon, 2004).

Integral to suburban expansion was the development of key institutions that were essential to anglicising the Transvaal. Examples of these in Johannesburg include the Country Club Johannesburg, established in 1906 (Figure 15), King Edward VII School (1902), Roedean School (1903 – designed by Sir Herbert Baker) and the Johannesburg, Art Gallery (1915 – designed by Sir Edwin Lutyens). Baker and Lutyens had built prolifically throughout the British Empire, replicating grand expressions of imperial dominion and order through architecture shaped by regional classical revivals. Their talents were put to use in Johannesburg with Baker particular setting the architectural standard through which the empire would expand its 'civilisation' in South Africa. Architecture, suburban expansion, the prolific planting of exotic trees, and suburban names taken from British and Irish cities and towns together created what was then described as the "largest and most densely populated European city in Africa" (Bremner, 2010: 174) (see Box 2 for an extract from a 1904 article detailing the growth of Johannesburg in relation to mining output).



FIGURE 14: The early northwards expansion of Parktown – in the background is the Parktown Ridge peppered with Rand Lord mansions, c. 1908 (Image: Museum Africa Photo Archive).

Icons of the empire remain strongly embedded in society as touchstones of history, grandeur and civilisation for the city's wealthier and largely English-speaking residents. The symbolic destruction of many mansions on the Ridge by the apartheid government in order to construct the Johannesburg College of Education (now the University of the Witwatersrand Education Campus) and the Johannesburg General Hospital (now Charlotte Maxeke Johannesburg Academic Hospital) removed symbols of British capital and imperialism, but many such mansions remain. Properties in Parktown and Westcliff have retained their status as some of the most expensive in the city, with the 'Park' suburbs, just beyond, remaining highly desirable. The roadside planting and establishment of public spaces, religious institutions and highly regarded schools by the British administration remain appealing features of these wealthy suburbs today.

Modern development in the city continues in the same pattern as that set up by the original English colonialists and mining magnates, seen planning future operations in Figure 16. Development on the northern periphery of Johannesburg (as Parktown and Westcliff were placed, over 100 years ago) continues in the form of elite enclaves of wealth detaching themselves from the social realities of the city to the south. These landscapes are developed, as David Harvey (1993: 12) describes, to the 'market provision of constructed authenticity'. They are often fashioned as constructed environs in the image of pleasurable nature. New suburban estates are frequently gated



FIGURE 15: The Country Club Johannesburg, c. 1920s (Image: University of the Witwatersrand Historical Papers Archive).

enclaves, protected by tall walls and on-site security. From golf and eco-estates, to security estates and equestrian estates, their production perpetuates landscapes of escape and fantasy. This unequal and socially and environmentally unsustainable form of development reinforces social inequality, as did its original urban form on the Ridge.

As wealth pools in northern Johannesburg enclaves, the productive landscapes to the south remain largely unaddressed by government structures and underinvested in by corporate structures. While much post-apartheid rebuilding focus has been placed on Soweto, other significant southern industrial nodes and residential areas lack improvement. The very mining engine that propelled Johannesburg forward, supported the extraction of mineral wealth, and generated the income that fuelled the northward expansion of the city, today remains ignored and isolated by the distant landscapes of pleasure with their northwards gaze away from the inner city and mining landscape.

"Modern development in the city continues in the same pattern as that set up by the original English colonialists and mining magnates."

Box 2: The Rand – what is it, how it is worked, and at what profit

AN EXTRACT FROM AN ARTICLE PUBLISHED IN THE WEST GIPPSLAND GAZETTE (WARRAGUL: VICTORIA) ON 21 JUNE 1904

(Source: The West Gippsland Gazette, 1904).

"Twenty-five years ago the Witwatersrand was merely a stretch of undulating veldt, occupied sparsely by homesteads. Now it is the centre of an immense population, all engaged, directly, or indirectly, in the removal of gold deposits ... It was in 1886 that the goldfields were proclaimed, and Johannesburg founded. The germ of this city consisted merely of a hamlet, with a few shanties. Ten years later, the population had exceeded 100,000, and Lord Milner has expressed the belief that someday the figure will reach 5,000,000! Before the war broke out, the number of inhabitants was between 120,000 and 130,000. Stately buildings, palatial offices, native hovels, and wooden stores are all overlooked by the dismantled fort built by the Boers.

The distinguishing feature of this gold field is the evenness with which the metal is distributed throughout what are called 'the blankets'. Each ton of ore yields about £2, and, in 1899, the production exceeded £15,000,000. It was almost exactly one-quarter the world's output of gold for that year. Perhaps for the first time in its history, gold mining was reduced to an exact industry, in which it is impossible to gauge to a nicety what will be the yield, and what the profit on a given cubical content of soil. It is obviously in the interest of the capitalist to reduce his wages bill, and so increase his margin for dividend. Humanly speaking, there are no risks. The Witwatersrand can be worked at a profit till the Witwatersrand has given up its treasures. Then Johannesburg will vanish as rapidly as Johannesburg sprang into existence and fame ..."



Photograph by Clive Hassall

THE RAND

WHAT IT IS.

HOW IT IS WORKED.

AND AT WHAT PROFIT.

Twenty-five years ago the Witwatersrand was merely a stretch of undulating veldt, occupied sparsely by homesteads. Now it is the centre of an immense population, all engaged, directly, or indirectly, in the removal of gold deposits. More than this, the Rand has become the battleground upon which must be fought anew the issue between Slavery and Liberty under the Union Jack. The eyes of an Empire are watching a struggle for which there has been no parallel since the American Civil War.

It was in 1886 that the goldfields were proclaimed, and Johannesburg founded. The germ of this city consisted merely of a hamlet, with a few shanties. Ten years later the population had exceeded 100,000, and Lord Milner has expressed the belief that some day the figure will reach 5,000,000! Before the war broke out, the number of inhabitants was between 120,000 and 130,000. Stately buildings, palatial offices, native hovels, and wooden stores are all overlooked by the dismantled fort built by the Boers.

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The workable gold is estimated at L600,000,000. If the rate of exploitation remained as in 1899, before the outbreak of war, then Johannesburg would enjoy 30 years of life—no more. It is the object of the Randlords and of Lord Milner to hasten the doom of the city, by hurrying the extraction of gold. Thus it is hoped to increase the share of spoil which accrues to the capitalist by reducing the share which falls to the worker. Hence the call for Chinese labor.

The gentlemen in whose interests Chinese laborers are to be recruited are, as will be seen from a selection of their names, patriotic Britons. In the following list—not, we fear, complete—the numerals represent the directorships or other offices held by the person referred to.

R. W. Schumacher (20), C. S. Goldmann (13), E. Birkenruth (12), C. Rube (20), S. Neumann (7), E. B. Mocatta (2), Julius Friedlander (4), L. Wagner (10), L. Reyersbach (12), W. G. Izard (5), H. Strakosch 5), Camillo Cerruti (9), G. Sons (2), Marquis d'Hautpoul (4), Edward Jacobs (2), S. F. Cohen (2), H. Zoeppritz (6), L. Sartoris (3), S. B. Joel (2), P. Dreyfus (2), A. Goerz and Co. (2), A. Reyersbach (3), J. Freudenthal (4), W. Dettelbach (4), J. W. S. Langermann (2), C. Mahau (7), Charles Marx (5), T. Matesdorf (2), L. Albu (4), G. Albu (6), J. Berlein (4), H. D. Solomon (4), A. Brakhan (5), A. H Marker (4), F. Francois (2), H. Pasteur, Arnold Friedlander, L. Suto, P. A. Molteno, Anton Dunkels, A. C. Bilbe, Julius Weil, Isaac Lewis, A. Epler, J. M. Egner, A. Beit, H. Graumann, A. Benjamin, F. Voelklein, R. B. Baredorf, A. E. Steinthal, E. Herman, B. Weiser, Cte. de Ferrieres, H. Fournel, T. M. Phillevitz, M. J. Rikoff, R. Ailiami, F. T. Gervers, A. Lambrechts, M. A. Braunstein, A. Wagner, P. Buisson, B. Kitzinger, F. Eckstein, C. R. Kehler, J. Koster.

These are the Englishmen who represent British opinion to Lord Milner. We have done our best to spell the names correctly, and are glad that it is unnecessary for the purposes of this article to pronounce them.

With these gentlemen are associated many distinguished members of the governing classes, as, for instances,

Hon. Lionel Phillips, Sir George Farrar, Sir J. P. Fitzpatrick, Sir Charles Euan Smith, K.C.B.; Vice-Admiral Sir A. H. Markham, K.C.B.; the Hon. A. G. Brand, M.P. (the only Liberal in the House of Commons who has voted for Chinese slavery); the Earl of Verulam; Lord Harris, G.C.S.I., G.C.I.E.; the Earl of Chesterfield; and doubtless others whose names have escaped us.

The "Stock Exchange Official Intelligence" for 1904 has just been published, possibly with a view to assist the Hyde Park demonstration. We say this because this useful book of reference for the first time gives a list of crushings and profits for the 54 mines on the Rand during the various months of 1903.

An analysis of the figures shows that 2875 stamps were running in January, 1903, but that this number had risen to 4295 in December, 1903—an increase of assistance of Chinese laborers.

During 1903 the gold extracted amounted to 2,963,751 oz, with a value of about L12,000,000.

Upon this turnover the profit works out at four and a half millions. It is upon this profit that the Randlords starve.

To show how the turnover is increasing, we may mention that in the seven months' workings of 1901 the gold extracted was 239,000 oz. In 1892, it was tracted was 239,000 oz. In 1892, it was 1,700,000 oz. In 1903 it was 2,964,000; while at the present rate—on the assumption that there will be no further acceleration—the output for 1904 will be 3,370,000 oz.

Let us see what these figures mean in dividends. Mr Mackarness has given in our columns a table, which we repeat:—

The Crown Reef from 1893 to 1903 paid an average annual dividend of 126 1-9 p.c. Its L1 shares stand to-day at L16.

The Ferreira from 1891 to 1903, 179 1-10 p.c. Its L1 shares stand to-day at L19.

The Wemmer from 1895 to 1903, 122 p.c. Its L1 shares stand to-day at L10.

The Meyer and Charlton from 1892 to 1903, 46½ p.c. Its L1 shares stand to-day at L5.

The New Primrose from 1891 to 1903, 26½ p.c. Its L1 shares stand to-day at L2 14-16.

The Robinson Gold Mining from 1893 to 1903, 10 7-10 p.c. Its L5 shares stand to-day at L3⅝.

The Langlaagte Estate from 1891 to 1903, 31 1-9 p.c. Its L1 shares stand to-day at L3⅝.

The Jubilee from 1891 to 1903, 76½ p.c. Its L1 shares stand to-day at L3⅜.

The Henry Nourse from 1896 to 1903, 66 5-6 p.c. Its L1 shares stand to-day at L8¼.

The Geldenhuis Deep from 1897 to 1903, 42 p.c. Its L1 shares stand to-day at L10.

The May Consolidated from 1895 to 1903, 20 p.c. Its L1 shares stand to-day at L2 14-16.

The City and Suburban from 1896 to 1903, 10 p.c. Its L4 shares stand to-day at L7 6-16.

The Angelo from 1893 to 1903, 26 2-3 p.c. Its L1 shares stand to-day at L6⅝.

The Rose Deep from 1898 to 1903, 37½ p.c. Its L1 shares stand to-day at L7½.

Last year the Bonanza paid 165 per cent. The Crown Reef paid 125 per cent. The Village Main Reef paid 29 per cent. The Geldenhuis paid 25 per cent. The Wemmer paid 125 per cent., and the Ferreira paid 100 per cent. Apparently these dividends are not high enough.

Usually British investors are satisfied when they receive their capital back over and over again in the course of a year or two. But the British citizens of the Rand appear to be exceptions.—P.W.W., in the "Daily News."



FIGURE 16: Chairman of Central Mining, Sir Clive Baillieu, visiting a Barlow Rand mine in 1952 (Image: University of the Witwatersrand Historical Papers Archive).

Gold Reef City

In the southern suburbs of Johannesburg, in the centre of the mining belt, exists the strange assemblage of a reconstructed mining village, theme park, casino, theatre and the Apartheid Museum. Seemingly disjointed from an urban Johannesburg and squeezed into a bend in a freeway, the Gold Reef City complex is an anomaly in this nondescript warehousing and office estate landscape. Emblematic of the repurposing of Johannesburg's historical sites of production into places of pleasure, entertainment and leisure, Gold Reef City is also a fantasy landscape that reconstructs a history of production through tourism and consumption, but remains threatened by the very real history it so fictionalises.

It is here that visitors come to experience the city's mining history. Gold Reef City was constructed in the late 1970s around the mothballed Crown Mines Shaft 14 (Figure 17). Comprised of a series of underground shafts which penetrated the underlying geological strata to reach the deep gold-bearing reef, Shaft 14 plunged to a depth of 3 293 m and was one of the deepest mines on the Witwatersrand. Doubtless it is a fitting site for a reconstructed mining village that includes corrugated Victorian houses, an 18 m working mine model, alluvial panning, a gold-pour demonstration and guided tours to depths of 220 m into the mine.

The mining landscape forms a physical divide between the south of Johannesburg and the historical inner city and the northern suburbs. While roads traverse the north-south divide, the landscape of reprocessed mine-dumps, blank veld, blue gum trees and toxic, yellow soil inhibits true north-south integration.



FIGURE 17: An aerial view of Gold Reef City's mining museum (Image: Nolween).

"The case of Gold Reef City demonstrates that a city built on exploitative social and environmental processes, most evident in the gold mines, results in a city of potent social divides."

As a premier tourist destination for residents, students and visitors, Gold Reef City has flourished. The theme park component of the complex has expanded and the rides have become taller and faster. At the end of 2013, minor mention was made in the press of the temporary closure, and relocation to a shallower 75 m, of the underground working mine museum and tour. In a twist of fate, Gold Reef City's original attraction, which has a declining role in the modern park, now threatens both the complex and its context.

The well-reported phenomenon of acid mine drainage has found an easy route to the surface in the form of Shaft 14. The ground water, made acidic through interactions with iron pyrites exposed by mining, is rising at a steady rate. At the time of Shaft 14's temporary closure, the level of the acidic water was close to the level of the underground museum and threatened its safe use (Blaine, 2013). (For more on acid mine drainage, see Chapter 2). In order to mitigate the rise of acid mine drainage in the Central Basin, pumping facilities are currently under construction near Germiston in the East Rand.

Underground strata, much like surface landscapes, function as integrated ecosystems. Flows of water, processes of sedimentation and seismic movements bring them alive. Mining disrupts these ecosystems and the deeply wrought underground world of the mine, so forgotten in the daily experience of Johannesburg, reminds the city of its caustic past.

Gold Reef City is steeped in nostalgia for a time of brave capitalist pioneers and strong proud miners, strung together in their quest for wealth, success and fame – much like the adornments of its faux, corrugated iron mining village. It interprets Johannesburg's early history as a Victorian mining wonderland, where miners gumboot dance or don traditional Zulu regalia to entertain the elite – a position to which the visitor is naturally elevated – while the 'wealthy' drink in bars, count gold bars and mint money. It characterises a manufactured landscape of urban pleasure, not too unlike that of the Ridge or early Johannesburg where deep social divides and racial segregation were part of creating a 'civilised city'. While early Johannesburg may have been as tumultuous as the theme park's rides, Gold Reef City is a simulacrum that represents a hyper-real version of history; a point where a history of colonialism is presented, but dressed in Wild West references that celebrate the entrepreneurial and unyielding spirit of the early white miner. The sequence is almost absurd, and now seems to be unmasked by the fact that the fictitious mining village is threatened by the very real mining by-product of acid mine drainage, caused largely by the industrialists it so celebrates.

This irony highlights the interconnectedness between 'landscapes of production' and those of pleasure. The case of Gold Reef City demonstrates that a city built on exploitative social and environmental processes, most evident in the gold mines, results in a city of potent social divides. Glossing over the city's history with thin facades might allow a short-term escape, but ignores the complex social and environmental effects that it replicates and deepens.

Landscapes of production

Mining capital and urbanisation

The northwards suburban expansion that cemented Johannesburg's division is entwined in the city's mining history. Milner's policies of suburban expansion, enabled both by mining capital and imperial health policy at the beginning of the 20th century, were rooted in an inherently racial vision of developing Johannesburg into an image of Western European urbanism. This section investigates how policy that sought to segregate the city evolved, through an analysis of the role of capital and colonialism in shaping urban policy. It further interprets the results of exploitative processes that have shaped a history of contest and sacrifice that remains etched into these productive landscapes.

While increases in mining activity resulted in a demand for low-cost labour on the mines (Kennedy, 1980; Johnstone, 1976), the parallel project of city building also attracted and coerced rural black labour to Johannesburg to work for white capital (Figure 18). The exploitative sourcing of low-cost black labour was thus central to capitalism's endless "addiction to geographical expansion" (Harvey, 2001: 24), fuelled by wealth accumulated from mining profits. Kennedy describes the "stresses and strains of urbanism" as being characterised by "a landless black and white peasantry squatting on the fringes of a vast inland city, sharing more than they cared to admit" (1980: 3).

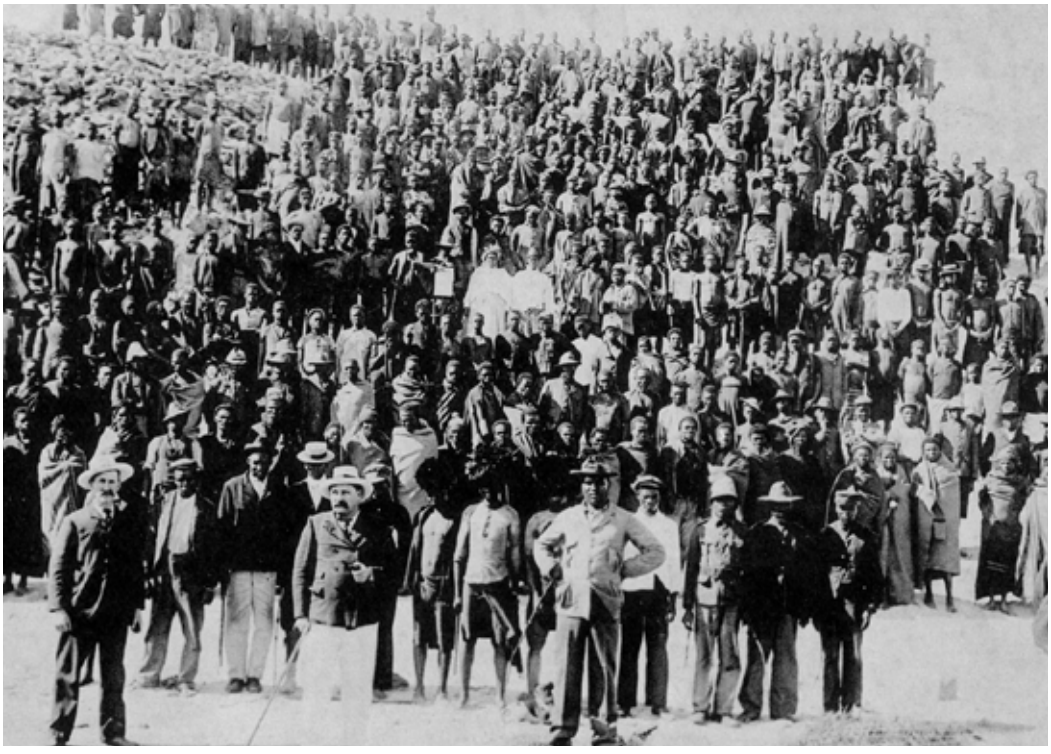
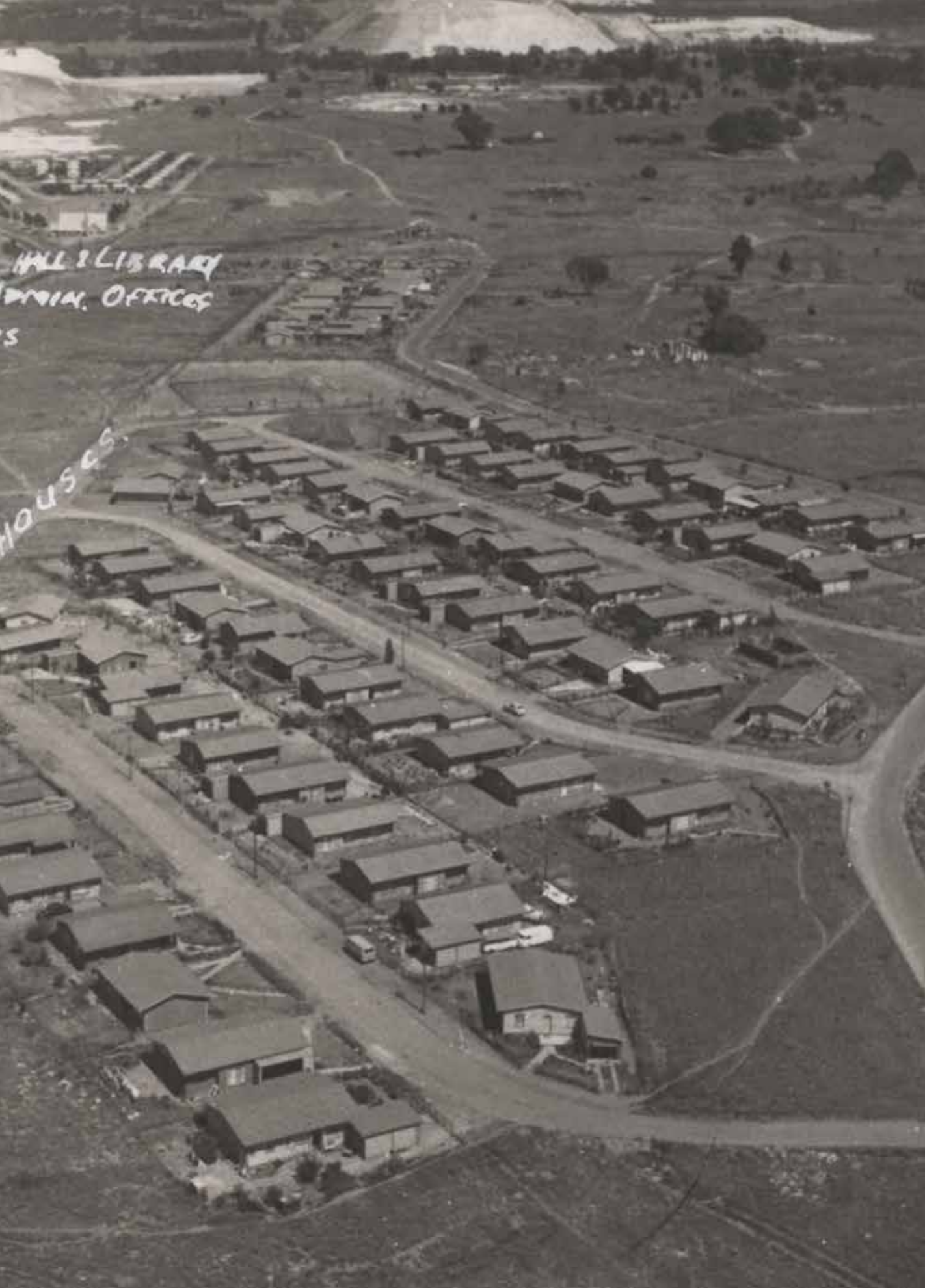


FIGURE 18: Mine workers at Geldenhuis Deep mine, c. 1904 (Image: University of the Witwatersrand Historical Papers Archive).



FIGURE 19: The establishment of Riverlea and Soweto adjacent to mine residue areas, c. 1960s
(Image: University of the Witwatersrand Historical Papers Archive)


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While the challenges and social frictions of increased urbanisation were profound, it is evident that true colonial town planning standards were never intended to apply to black residents (Parnell, 1993). At the start of his term as Administrator of the Transvaal Colony, Milner appointed Dr Charles Porter as Johannesburg's first Medical Officer of Health. As described by Parnell, his role in "extending municipal control of urban affairs [...] ensuring conditions conducive to permanent European immigrant settlement" was central, as was his unwavering dedication to implementing the British model of town planning in South Africa (1993: 476). Porter's perspective on shaping the city was not unique. As Judin stated, "Johannesburg has, since its extraction out of a gold reef, been generated as a reaction to fears of the distant country. For white authorities, defending the city meant defending order and modernity, the values and ideas of a metropolitan centre over those of an undeveloped rim" (2008: 123).

Parnell elaborates how Porter, impassioned by a racist and imperialist outlook on the colony, systematically ensured that black residents were not allowed to live in urban areas due to a perceived inability for them to cope with the health and social hazards of the city. In addition, he believed that the poor (of all races) were incapable of 'even passable cleanliness' (1993: 479)(Box 3).

Porter's views on removing black people from the 'white' city were supported by civil servants, white labour and mining capitalists (Parnell, 1993). Porter called for rebuilding on cheaper, peripheral land, housing the urban poor in "cheap dwellings with gardens" (Parnell, 1993: 481). This thinking can be contrasted with the assimilationist approach in the metropolis, where Britain's 1890 Housing and Working Classes Act progressively required that slum clearances were followed by in-situ rebuilds. Porter therefore assisted in establishing Johannesburg's basic and divided urban structure in the name of health and sanitation and, more destructively, in embedding racist planning as a norm. Njoh (2007) describes Porter's actions as being central to the colonial project of developing dual 'civic' and 'ethnic' cities, or our landscapes of pleasure and production.

With the path of segregation chosen, racial tensions swelled between the black and 'poor white' populations of Johannesburg. Increases in mining activity led to increases in urban migration. The social and psychological effects of bringing black and white mine workers into a system of severe social alienation and segregation in the form of the compound and location systems, and in an environment of danger, death and disease, were profound. A jostling for black mining jobs by unskilled white labour resulted in a number of racially fuelled strikes and protests. This discontent lead to the establishment of the Urban Areas Bill of 1923 which, after World War I, was discussed in the light of two proposals.

Photograph by Clive Hassall



Box 3: Legislating division

GUY TRANGOŠ

The Godley Committee recommended the repeal of pass laws and the establishment of 'native villages' in urban areas. In opposition, the Stallard Commission presented a scenario where "Natives [...] should only be permitted within municipal areas in so far and for so long as their presence is demanded by the wants of the white population" (Beavon, 2004: 96). Stallard's recommendations received increased public support owing to hardened white perceptions and prejudices, the 1914 white rebellion and the 1922 miners' strike for increased segregation in the mines and urban areas.

The Urban Areas Act, based on Stallard's recommendations and incorporating a few aspects of Godley's proposals, was passed in 1923. The Act entrenched a class system that allowed black mine workers to be exploited for decades onwards. Black mine workers were legally not allowed to unionise, had no annual leave, no provident pension funds, minimal workplace disability payouts in comparison to white labour, and no housing allowances. They were also spatially marginalised in the mining hostel system. While the Urban Areas Act further marginalised Johannesburg's black population, it was the continued economic ostracism of Afrikaners on the Rand by the English elite that spawned a powerful Afrikaner nationalist movement. Key mining-related moments that led to the National Party taking power in 1948 and the implementation of apartheid, include:

- Milner's policies of anglicising the Transvaal as a means to quash the Afrikaner in the Transvaal, following the Anglo-Boer War, in order to ensure the continued imperial dominance of Britain and its absolute control over mining capital on the Rand.
- The inseparability of mining wealth and imperial dominion over the Afrikaner and black resident on the Rand.
- Race-based employment on the mines. Prime Minister Jan Smuts's brutal clampdown on the Rand Revolt can be understood as a core factor that prevented his re-election.



The entanglement of mining capital in the investment decisions that led to Johannesburg's decentralised growth is not surprising. Mining capital founded the city, ensured its growth and expansion, and embedded socio-economic and class divisions – these remain the major beneficiaries and obstacles to its reform. The spatial repercussions of these divisions are evident in the development and planning of Soweto (Figure 19). As Johnstone notes, the "racial system [in the gold mining industry] may be most adequately explained as a class system – as a system of class instruments . . . generated and determined in its specific forms and its specific nature and functions, by the specific system of production and class structure of which it formed part" (Johnstone, 1976: 4).

In business, the strong link established between the United Kingdom and Johannesburg remained an important conduit of capital (Figure 12). By the mid-1980s, the corporate structure of Anglo American was representative of the deep social divisions set up at the dawn of Johannesburg. High achievers at Anglo American were largely Oxford-educated, benefitting from the prestigious Rhodes Scholarship set up by mining magnate Cecil John Rhodes (Butler, 2011). Mine managers were largely Afrikaans and had worked their way up through the ranks, while mine labour was almost entirely black, uneducated and underpaid.

Today South Africa is the United Kingdom's largest trade partner in Africa, with ties between the two nations strengthened by the colonial externalities of shared ancestry, sports, language and culture. Many large UK and South African firms are dual listed on both the Johannesburg and London Stock Exchanges, such as SAB Miller, Anglo American, Lonmin, Old Mutual and Investec. Adams reported that, in 2012, just over three quarters of the CEOs of all listed South African companies were white. Top CEOs earned annual packages of between R25 million and R41 million. The axis of privilege, honed from continued access to top education, business networks and invaluable guidance that allowed mining, industrial and financial capital to remain in the successive hands of white CEOs, is significant. This contributes to the creation of new landscapes of pleasure through the development of wealthy residential golf estates, shopping and entertainment complexes, and to the expansion of existing investments like these. Despite apartheid sanctions and trade restrictions limiting the scope of South African firms to invest internationally, at the level of executive management post-apartheid corporate structures are not vastly different from those of the Witwatersrand's original mining houses, albeit with a modicum of black and female representation.

Johannesburg's urban and largely suburban identity also remains oriented to a western image of the city, as was promoted under the governorship of Milner, and in the apartheid boom period of the 1960s and early 1970s. Today it could be argued that a globalised urban culture and aesthetic dominates global cities in a way that colonial planning law might once have, with global capital dictating what investor-friendly cities should look like. In doing so, it provokes a homogenisation of the streets, public spaces and buildings across the world. This section demonstrates that it is necessary for Johannesburg to break with forms of city-making that serve to continue to exploit its landscape and people. It needs to turn instead to approaches that promote human development, integration and access to opportunity.

Waste

"As an invisible line of mining concessions along an inclined reef, followed by a strip of mines with labour compounds, the landscape of Johannesburg was always more of a threat than a promise to those in the country" (Judin, 2008: 126). Many mine residue areas are currently undergoing re-mining activities that extract fragments of gold from waste soil. The landscape of waste is thus constantly changing; mine residue areas grow dramatically taller in places and completely disappear in others. Valuable land adjacent to urban centres has opened up, but remains in need of rehabilitation before any urban development can take place. Despite the physical properties of the landscape, the extensive belt of mine residue areas that stretches across the Witwatersrand from east

to west is a sinister monument to the externalised costs of mining profits. Another example of these externalised costs is the continued adverse health effects of mining on miners and of mine waste on the communities adjacent to it, during and long after mining operations.

In 1907, the first large-scale miners' strike took place on the Witwatersrand. Sparked by dangerous underground mining conditions and the hazardous effects of the lung disease miner's phthisis (an outdated medical term for anthracosis or pneumoconiosis), the strike highlighted how little mining safety and the wider effects of mining activity on humans were a priority to mining companies.

As Kippen (1995) demonstrated, this phenomenon was not only felt in South Africa, but also affected gold miners in Australia into the 1960s where 'Friendly Societies' picked up the cost for the treatment and rehabilitation of miners. On the Witwatersrand, mining houses set about compensating labourers who fell ill from mining-related disease, but compensation and rehabilitation for white miners proved to be higher than that allocated for black miners (see Chapter 3). In addition, while in 1916 the Miners' Phthisis Prevention Committee released a number of recommendations aimed at halting the spread of tuberculosis on the mines, few changes were implemented (McCulloch, 2012). Although the control of fine dust particles underground is now a priority in mine safety, the control of dust from mine residue areas offers a substantial dilemma (see Chapter 3).



FIGURE 20: The establishment of Riverlea adjacent to mine residue areas, c. 1960s
(Image: University of the Witwatersrand Historical Papers Archive).



SOUTH AFRICA'S OWNERLESS AND DERELICT MINES

Extract from the 'Gauteng City-Region Observatory Acid Mine Drainage and its Governance' occasional paper (Bobbins, 2015):

Mining waste is a particular challenge in light of so-called 'ownerless and derelict mines'. The Department of Mineral Resources has compiled a ranked database of ownerless and derelict mines which, abandoned by their previous owners, have become the responsibility of the state.

The ranking is based on the degree of environmental risk that the mines pose to both the environment and nearby communities as a result of mine residue areas. A total of 6 152 ownerless and derelict mines have been identified in South Africa (DMR, 2010). In 2011, the financial implication of ownerless and derelict mines was estimated to be R30 billion (DMR, 2010 and WWF, 2012).

FIGURE 21 (LEFT): Riverlea, before re-mining started on this mine residue area – the line represents the thin boundary between the mine residue area and the suburb (Image: Google Earth, 2012).

After DRD Gold started re-mining operations on the large mine dump adjacent to the Johannesburg suburb of Riverlea, clouds of fine mining dust penetrated the houses of this community (Figure 20 and 21). Respiratory-related health complaints increased and residents became generally unhappy with the quality of their air and environment. When faced with health claims, DRD Gold stated that the onus was on residents to prove that their conditions were a result of mining activity from the mine since the levels of dust produced by the mine were within legal limits (Kings, 2013). In similar cases in Kagiso and Tudor Shaft on the West Rand, communities and non-governmental organisations (NGOs) have opposed the mining-related environmental challenges facing them (SA News, 2014; Lob, 2012). The effects of mine waste on communities and the environment also stem from the continued decay of mine residue areas designated 'abandoned' or ownerless.

Princess Dump is an old and abandoned gold tailings storage facility located in Roodepoort in the west of Johannesburg, adjacent to the community of Davidsonville. The site is neither closed nor rehabilitated by municipal officials, as required by South African law. As a result, the erosion of the mine has serious ramifications for its surroundings. Concerns about the dump include exposed stopes susceptible to wind and water erosion, unmanaged runoff and seepage from the dump into the surrounding community and wetland, and the continued dumping of metals and other waste on the site due to its derelict nature (Ngigi, 2009).

In Kagiso, a large satellite suburb of Krugersdorp on the West Rand, there has been growing civic strife and protest regarding the mining activities of Mintails in very close proximity to residents' houses. It is well reported that the mine residue areas of the West Rand have not been well managed. Re-mining has opened up old dumps creating immense dust, while acid mine drainage decant has caused significant damage to natural water systems. Many people live in dangerously close proximity to the hazards of the region. In Kagiso, reports of cracking walls, broken windows and an increase in health complaints saw an urgent interdict brought to the South Gauteng High Court by the Gauteng Provincial Government against active mining near the new suburb (Ngobeni, 2014 and *Times Live*, 2014). A ruling in favour of the residents was granted and mining activity was halted. Further preliminary investigations have concluded that the mining company was operating in contravention of its mining licence (SA News, 2014).

To be discussed further in Chapters 2 and 3, these case studies demonstrate the continued negative environmental and social externalities brought about by mining activity on the Witwatersrand. In particular, they highlight the often-destructive effects of ownerless, abandoned and neglected mine residue areas and re-mining activities. Much like the underground network of mine tunnels, it is essential that surface dumps and slimes dams be well managed or natural forces will continue to destroy these new impermanent strata to the further detriment of the productive landscape.

It is critical, therefore, for residents, the city and mining companies to recognise and acknowledge the impacts of mine residue areas. Residents also need to be made aware that mining landscapes are not natural and mine residue areas can be toxic to their health. The mine residue areas offer opportunities for urban reimagining as new beneficial spaces for the city's residents. Importantly, however, the city needs to be sensitive to the dangers of mine residue areas and better improve capacity to manage them. As constructed landscapes, vast and complex 'landscapes of production' naturally conflict with environmental and social sensibilities and are always being challenged. Consequently, they cannot be ignored or remain abandoned.

"...the desire for rare and precious metals and their associate networks of colonial and later global capital, has built Johannesburg with one hand and impaired the city with the other."

Conclusion

The social, economic, environmental and spatial repercussions of mining in Johannesburg continue to echo across the landscape. Multiple negative externalities have been created by narrow profit margins and the exploitative labour and environmental factors that resulted. The role and influence of mining capital in shaping society along racial divides in the city's early years and later along distinct economic lines, together with apartheid planning, wrought Johannesburg's urban form. Mining residue areas distorted the natural landscape, forming immense barriers to spatial integration, while their mismanagement has led to environmental disaster in many areas.

Understanding the strata of the landscape acknowledges the complex three-dimensional urban ecologies that have formed in and around Johannesburg during its history. From the extraction of mineral resources beneath the surface to the discarding of mine waste on the surface, and from the investment of mining capital in the city-region's economic centres to the decline of mining towns, mining activities continue to reshape the city-region's form – physically, socially and economically.

'Landscapes of pleasure' demonstrated an interrogation of the image of the city, or the type of city imagined by early colonial settlers. The settlement of mining magnates along with the imperial elite on the city's northern Ridge and their conceptualisation of the rocky outcrop as a zone of empire on the Highveld, fixed the northwards pooling of wealth as a permanent spatial feature of Johannesburg's natural and social landscape. As Foster (1996: 96) states, "[...] it seems fair to say that from the outset Johannesburg was the one city in the sub-continent where the alliance of territorial control and economic exploitation, which lay at the heart of European imperialism, was most explicitly realised." While pleasure denotes a conceptual device for reading the forces that shaped Johannesburg's north, it by no means attempts to indicate that pleasure was the primary ambition of colonial settlers, or not present in the lives of everyone else.

This contrast plays out in the pleasure world of Gold Reef City, which ironically represents a modern image of the historical city, distorted by nostalgia and located in a landscape of historical production. Here, the complex and extremely exploitative nature of capital on the Witwatersrand and the mines is denied representation. This clean, linear and embellished site, however, is threatened by the real environmental challenge of acid mine drainage.

Both case studies present interesting parallels. A world of privilege and embedded wealth, settlements on the Ridge radically altered Johannesburg's natural landscape into an image of European urbanism. The extensive planting of exotic trees denied a future relationship of the city to its natural or original



Photograph by Clive Hassall

landscape. As a result, the wealth of Johannesburg's residents can be read from space by the density and age of their roadside trees. The case of Gold Reef City, however, demonstrates the inverse. A landscape scarred by mining waste, post-mining activity and allied industrial activity that is also clearly visible from space, it monumentalises the role of mining capital, again denying the relationship of the city to its natural or original landscape.

'Landscapes of production' saw the destructive social and environmental aspects of mining analysed through two case studies. The first identified how colonial and mining interests shaped the original patterns of racial segregation in Johannesburg; the second explored the ongoing challenges that mining waste poses to human settlement in the city. The notion of 'productive landscapes' in this section allowed a contrast to be drawn between constructive and destructive forces that influence the city. Building a city structured on inequality and segregation expanded the urban fabric, but impeded the city's full integration and the optimum functioning of its diverse social and economic networks. Similarly, by-products from processes of capital extraction from the gold mines, while heralded as building the city, have a continued damaging and adverse effect on the health, wellbeing and socio-economic success of those residents living near the mining belt. These comparisons allow a productive understanding of landscapes as complex processes that, unlike slower natural processes, are able to churn, destroy and create at varying degrees and at different moments in time (Box 4).

The products of South Africa's mines were drawn from its natural landscapes at major human and environmental cost. The Witwatersrand's gold continues to fill treasury vaults all over the word, to adorn jewellery boxes and probably plug a number of teeth. As presented in this text, the desire for rare and precious metals and their associate networks of colonial and later global capital, has built Johannesburg with one hand and impaired the city with the other. Residents, government officials and the private sector need to counter a reliance on comfortable 'business as usual' practices that embed the processes that have wrought social, economic and environmental harm on the city. Instead, new socially equitable, connected landscapes need to be forged that, unlike mining, can create steady opportunity for all, while improving and repairing the societies and environments in which people live.

Box 4: Gauteng's boomtowns are losing their lustre

KERRY BOBBINS

Once considered prosperous urban centres, former mining boomtowns along the Witwatersrand have started to lose their lustre. This is largely due to a decline in mining profits from the 1970s onwards, which has left a lasting mark on the economic prosperity of former mining towns (ANC, 2015; Zuma, 2015). Diminishing gold mining profits along the Witwatersrand are largely a result of the increasing costs of extracting and amalgamating gold from continuously deeper depths below the earth's surface.

The residents of former mining towns such as Blyvooruitzicht have experienced socio-economic distress as a result of the decline in mining profits. Forming the primary economy of this settlement, gold production was driven by the profits of the nearby Blyvooruitzicht Gold Mine and few employment opportunities remained after mining ceased. Behind the tired facades left behind, little opportunity lingered. The dwindling prospects make life tough for those who stay on.

The following excerpt from a media article written by Sipho Kings on Blyvooruitzicht provides an account of the realities of distressed mining towns along the Witwatersrand and the dire socio-economic circumstances that remain long after the gold-mining profits have dried up.

The town of Blyvooruitzicht is covered in dark-green grass dotted with patches of purple from the jacaranda trees. Nature is growing over the rusted remnants of mining, reclaiming the sludge pipes that run across the town from the slimes dams to the mines.

The area looks desolate – an abandoned town that was once prosperous. It's huge mine hospital is eerily silent, its long corridors punctured by rays of sunlight coming through smashed windows…

Streaks of rust run down the corrugated iron walls of mine buildings, and the cement walls of the lift shafts are dulled with age. There are few signs of life, but there are people here. Standing at his gate with his blue bicycle, Klaas Madisha (46) says he worked at the mine for nearly three decades. He knows the exact day he started – June 5 1985. He lost his job in August when the mine went into liquidation and its 1 500 workers were left to fend for themselves. They now live in continued uncertainty. The homes they live in – Madisha's is part of a small neighbourhood built next to the mine in the 1940s – are owned by the mine, so they could be evicted by a new buyer – if one is found.

Photograph by Clive Hassall



His family has gone back to Zebetiela in Limpopo; his four children are now the responsibility of their grandparents. "It is Christmas now so we must buy our children clothes for school next year, and presents. But we can't now, and the children have gone back home."

"We didn't have the power to stop them [the owners of the mine]. Who are we? We are just workers." He is calm when he says it, rarely showing enough energy to lift his arms to gesticulate. What he wants is information so he can decide what to do next. Community meetings were held before the closure, but nothing has happened since.

Near his house, Alfred Letsoalo is digging into the dark red and brown earth to plant spinach. Like most of the other plots, the garden is newly planted as locals try to supplement their food supply ...

"The mine closing is very bad news for the community." He is looking after his son's house while he is away; both generations lost their jobs at the mine. His two granddaughters follow him everywhere. "You can't leave children alone. They must come with you everywhere because there is no morality in this country now," he says, resting his arms on the faded white fence as one of the children runs away from a chicken, screaming.

The 65-year-old began working at the mine in the 1970s and says that at least now he can claim a pension after losing his job. His son does not have this safety net. "I am worried about my son. Unemployment is not good for people. And now we have a whole community where people are not occupied."

Novusile Mantyi says her husband came here from the Eastern Cape because of the gold. "There was no work at home, so we came here and it was good. There was work and we made a family."

Her once cream-coloured home is now dull and fading. The roof is a mix of its original red and rust. There is more rust than paint. "The mine disappeared for no reason. Everything was fine and my children had a future; now that is gone."

... But the energy has already gone from Blyvooruitzicht. In the potholed streets, filled with water from recent rains, people walk slowly. During the day, they sit and chat under the jacarandas. The only people working are at spaza shops. "We are just tired here," says Madisha outside his home.

(*Source:* Kings, 2013)





Photograph by Clive Hassall



3. The hidden legacies of gold

The delayed impacts of gold mining on the environment

KERRY BOBBINS

Introduction

Along the Witwatersrand, South Africa's foremost gold-mining region, mining practices have been unrestrained for much of their duration. From 1886 when gold was first discovered until the emergence of mining legislation (such as the Minerals Act in 1991), significant environmental degradation has taken place.

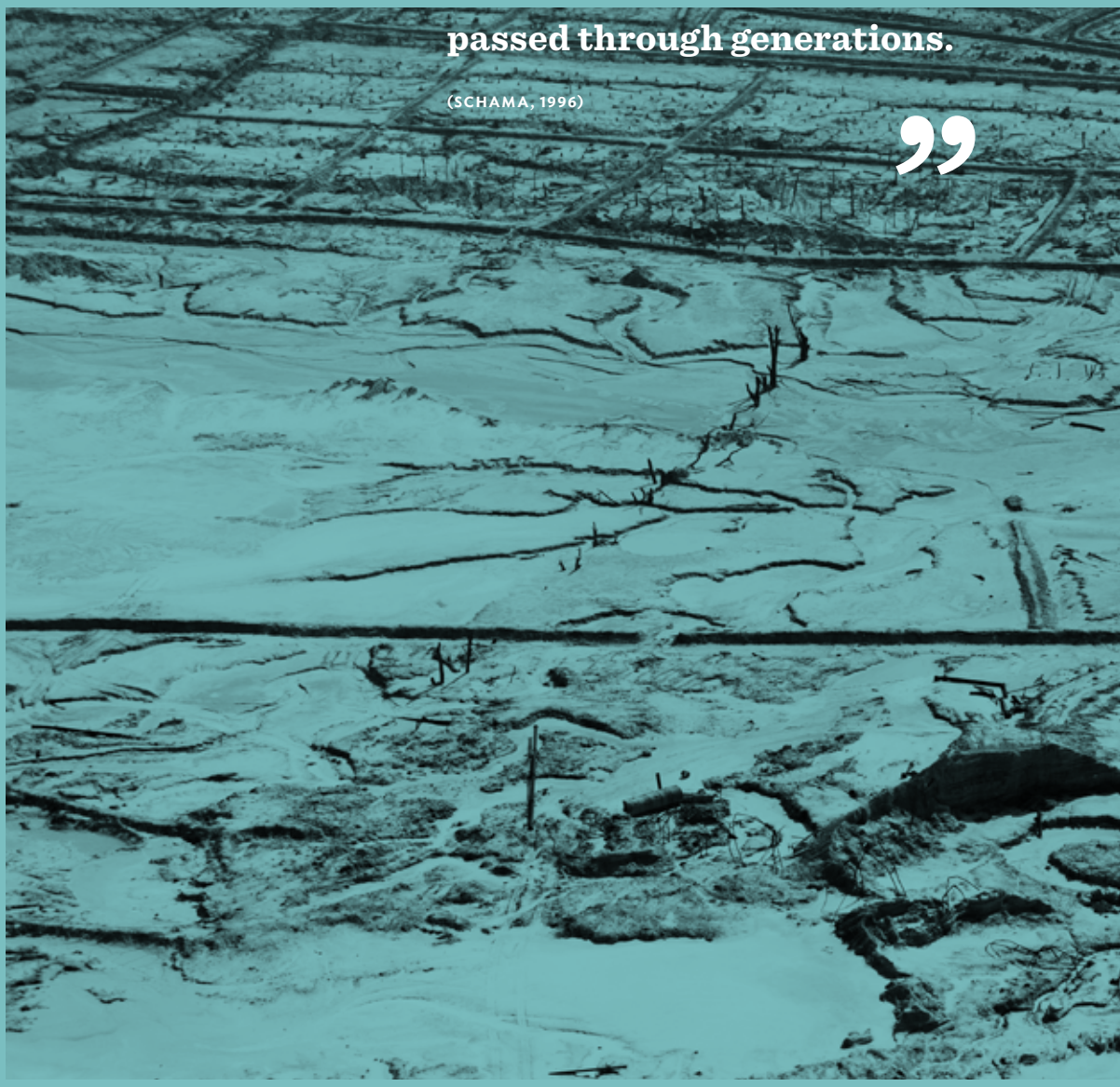
This degradation includes the large hollow spaces or mining basins found below the earth's surface and the colossal deposits of mining waste found above it. The legacy of mining also manifests as a series of slimes dams and waste dumps that trace the length of the gold seam. Mining waste intercepts the natural landscapes of the Witwatersrand and impacts on the health of its natural resources and intricate ecological networks. The presence of acid mine drainage (Box 5), which is acidic water created when minerals found in mining waste come into contact with water and oxygen, has reduced the quality of potable water in Gauteng. It has also left a lasting mark on the environment, particularly after it was allowed to flow from the mining basin onto the surface, or to decant, in the West Rand during 2002.

Addressing the Witwatersrand's mine waste legacy is a primary step towards remedying the negative effects of a bygone gold-mining era on the environment. While there has been a dramatic shift in mining policy and practice over the last 20 years, significant obstacles to addressing mining waste remain. The main reason is that much of the gold-mining waste deposited along the Witwatersrand predates formal environmental legislation and thus falls outside the legal obligations of current mining practice. In addition, a considerable amount of mining waste along the Witwatersrand is also deemed ownerless and derelict, where mines were not sufficiently closed and the owner cannot be traced. In these instances abandoned mines and their associated mining waste have become the responsibility of the state (PMG, 2010). According to a figure calculated in 2011, the financial implication of ownerless and derelict mines in South Africa is estimated to be over R30 billion (DMR, 2010 and WWF, 2012).

In order to build better environmental legacies for the future, new environmental opportunities need to be developed to reimagine mining waste landscapes of the city-region. This research can provide a basis from which to make informed decisions and facilitate meaningful collaborations around the transformation of abandoned mining waste (also explored in Chapter 5). These opportunities can also align with future human settlement and planning visions for the city-region, such as the City of Johannesburg's Corridors of Freedom project (Box 14).

This chapter explores the hidden environmental legacies of the Witwatersrand's bygone gold-mining era. It uses a spatial study on the proximity of mining waste to land cover (natural and constructed) and contextualises the impacts of mining waste on the environment. Using the theoretical concepts of ownership and value, the uneven responsibilities

> **All landscapes are a reflection of a common thread of human obsession passed through generations.**
>
> (SCHAMA, 1996)



Photograph by Clive Hassall

(between the state and landowners) around mining waste are revealed. Limited responsibility over historic mining waste and current legislation in respect of the environment has allowed for a series of risk trade-offs to occur in decision-making processes that pertain to the environment, economy and society. These are explored in more detail towards the end of the chapter by considering what is required to undertake more informed decision-making around the impacts of mining waste on the environment. The chapter concludes with an account of the availability of environmental data in the city-region and the opportunities for addressing mining waste in the future.

The lasting reminders of gold

Mine waste contaminates the physical environment of the Witwatersrand and is responsible for some of the region's most costly environmental challenges (Madihlaba, 2002; Oelofse et al., 2007; Coetzee et al., 2004). This is largely due to mining waste containing heavy metals and other toxic elements that were not removed from mined ore before being discarded in mining waste dumps or slimes dams. As a result, mining waste is often highly toxic and, if not maintained correctly, can pollute the surrounding environment through two primary pathways – air and water.

The Gauteng Department of Agricultural and Rural Development identifies the primary environmental concerns associated with gold-mining waste as dust, water pollution and soil contamination (GDARD, 2012). Dust poses a severe health risk to humans and can lead to lung chemical toxicity when inhaled, especially when containing uranium. The element uranium is naturally radioactive and its presence in mining waste can result in the increased radioactivity of the surrounding environment (Coetzee et al., 2004). The Gauteng Department of Agricultural and Rural Development reports that dust emanating from mining waste significantly undermines the credibility of the mining industry and its role as a responsible corporate citizen; this is explored in more detail in Chapter 3 (GDARD, 2012).

The Witwatersrand's natural hydrological network and rainfall patterns influence the movement of contaminated mining waste across the landscape. This is due to the intricate hydrological networks of the Witwatersrand and the frequency and magnitude of rainfall events, which typically peak during the summer months when mining waste is likely to be most dry.

The transfer of contaminated water has the largest impact on hydrological features that lie downstream of mining waste, such as wetlands and rivers (GDACE, 2008). Evidence suggests that the contamination of streams by mining waste can lead to acid mine drainage which severely affects the potable water supply of the city-region, contributing to some of the most costly forms of environmental damage (Oelofse et al., 2007).

Soil contamination occurs when mining waste pollutes the surface layers of the soil, such as the topsoil, near mining waste footprints (GDACE, 2008). This creates significant environmental challenges since topsoil is organically rich and facilitates biogenic activity, which sustains plant and animal life. Contaminated soil can have adverse effects on plants, animals and people (GDARD, 2012), especially when it is used as the substrate to grow food (in the form of vegetables) or to graze livestock.

“Mine waste contaminates the physical environment of the Witwatersrand and is responsible for some of the region’s most costly environmental challenges.”



Photograph by Mijas, España

Box 5: Acid mine drainage – the environmental and socio-economic impacts of a decade of gold mining

EXTRACT FROM THE GAUTENG CITY-REGION OBSERVATORY 'ACID MINE DRAINAGE AND ITS GOVERNANCE' OCCASIONAL PAPER (BOBBINS, 2015)

Acid mine drainage is neither a new phenomenon, nor is it exclusively found in the Gauteng City-Region. It occurs when iron pyrite or 'fool's gold' found in mined rock oxidises (becomes exposed to oxygen) in underground mining shafts or near mining waste. When exposed to water, iron pyrite creates run-off that is high in sulphates (McCarthy, 2010). This contaminated runoff is hazardous to humans and the environment.

Acid mine drainage is found internationally in Australia, Canada, the United States of America and Germany, and locally in the Klerksdorp, Orkney, Stilfontein, Hartbeespoort and Evander gold-mining areas, O'Kiep copper district, and other parts of the Free State, Mpumalanga and KwaZulu-Natal (DWA, 2010).

Acid mine drainage is particularly problematic along the former Witwatersrand goldfields due to the inter-connectivity of the mining voids, the scale of the gold-mining operations that took place along the Rand, and the proximity of mines in relation to available water and urban areas (DWA, 2010). McCarthy (2010) recognises the region's geomorphology, climate, and the distribution of iron pyrite deposits as further contributing to the occurrence of acid mine drainage.

The decant of acid mine drainage is said to have occurred from as early as 1996 (Khumalo, 2011), but it was not until 2002 that government first recognised it as a pressing issue. The immediate acid mine drainage crisis began with a flood event that occurred on the West Rand of Gauteng in 2002, when acid water from the Western Basin (WB) started decanting on the surface (Khumalo, 2011).

Since this decant in 2002, a flurry of news articles have highlighted the threat of acid mine water and its likely effects on human health, the environment, water quality, municipal infrastructure and building foundations in the Johannesburg Central Business District (CBD). These reports have fuelled anxieties around when and where decant will take place and who will be affected by acid mine drainage. In response to these concerns, government – through the Department of Water and Sanitation – has introduced a set of immediate and short- and long-term interventions to overcome decant in the West Rand.

The Department of Water and Sanitation acknowledges that acid mine drainage is a much larger issue to manage than simply pumping and pre-treating acid mine water in old mine shafts to neutralise the acidity and remove heavy metals. While works are in place in the Western Basin and Central Basin, and at an advanced stage of construction in the Eastern Basin, a range of issues remains unresolved.



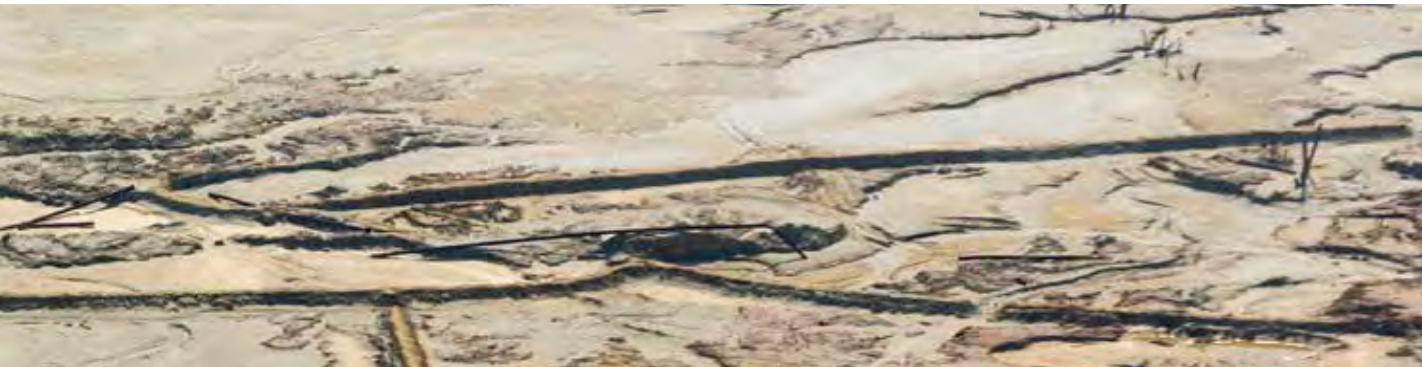
The pumping and treatment processes introduced through the immediate and short-term solution only neutralise the high acidity of acid mine drainage and address the metals (notably iron) carried in the water. This partially treated acid mine drainage is then discharged into natural watercourses still heavily laden with salt, which is raising saline levels, especially in the Vaal River System. Without some form of desalination as part of the treatment of acid mine drainage, this problem can only be addressed at present through the dilution of acid mine drainage-affected watercourses, in particular through the release of more water from the Vaal Dam. Excessive dilution requirements over the medium to long term are therefore raising concerns over water security in the finely-tuned Vaal water supply system.

In addition to the considerable environmental concerns about acid mine drainage decant and its impact on the hydrological networks of the Witwatersrand, acid mine drainage has manifested as a socio-economic issue.

In a presentation made by TCTA at the Rand Water Tariff Consultation Meeting on 22 October 2014 (TCTA, 2014), some of the outstanding budgetary requirements for acid mine drainage were revealed. It was indicated that the expected capital costs of the acid mine drainage short-term works (at completion) would be R2.3 billion, followed by the long-term works at R 7.9 billion (TCTA, 2014). It was also indicated that there is currently a deficit in the contribution of funds from the fiscus to deal with the costs associated with acid mine drainage (short- and long-term works) (TCTA, 2014).

That being said, there is mention of approval on the use of the Lesotho Highlands Water Project funding mechanism for acid mine drainage mitigation measures in the Department of Water and Sanitation and National Treasury presentations (dated 22 April 2014), backed by a government guarantee. This may refer to the fact that TCTA, as the agency that implements the two phases of the Lesotho Highlands Water Project (LHWP), has the capacity to raise considerable debt finance for capital works and to recoup their cost through the Capital Unit Cost (CUC) component of the Vaal River Raw Bulk Water tariff. In its presentation to the Rand Water tariff consultation session on 22 October 2014, TCTA highlighted an "Inter-Ministerial decision ... that the Vaal River System tariff will be a contributor to the cost recovery of the acid mine drainage project" (TCTA, 2014). The Vaal River System tariff is in effect the raw water price that the Rand Water Board must pay to the national Department of Water and Sanitation for what it abstracts for purification and distribution, as bulk water, mainly to municipalities. Municipalities in turn pay Rand Water a bulk water tariff. They recover this cost by selling water to domestic and business consumers, with local water tariffs set annually by each municipality. An increase in the raw water tariff has a knock-on effect through the bulk water and then the municipal water tariffs. Ultimately, ordinary consumers end up carrying the cost.

Photograph by Clive Hassall



The proximity of mine waste to urban land cover and green space

In 2003 the Gauteng Department of Agriculture, Conservation and Environment (GDACE), now the Gauteng Department of Agricultural and Rural Development (GDARD), developed a set of buffer zones to demarcate safe distances for development around mine residue areas in places where developments may result in harmful effects on human health and wellbeing. Buffers were established to support development projects at the local level, where decisions around the provision of housing are made (GDARD, 2009). It should be noted that these buffer zones are guidelines and, as a result, cannot be enforced under South African law (GDARD, 2009).

Two buffers were devised, namely a best-case scenario which denotes land within a 1 000 m zone around mining waste and a worst-case scenario which denotes land within a 500 m zone around mining waste (GDARD, 2003; GDARD, 2009). To provide some context in terms of these buffer distances, dust levels are generally acceptable 500 m away from mining waste, provided there are adequate mining waste practices in place. Beyond a distance of 1 000 m, dust from mining areas cannot be detected (GDARD, 2003; GDARD, 2009).

Using these buffers, a detailed spatial study was compiled to determine land cover classes that fell within the best- and worst-case buffers respectively. To do this, a 500 m (shown in red) and 1 000 m buffer (shown in white) was allocated around all mining waste areas (or mine residue areas) found along the Witwatersrand (Figure 22). This allowed for an analysis of land cover that were likely to be contaminated by mining waste. By isolating land cover categories that fell within the best- and worst-case buffers, the exact area of each of the land cover classes could be calculated. This enabled the total area of each land cover class that fell within the buffers to be determined.

The spatial study established that large portions of the Witwatersrand's green networks, including large proportions of natural and constructed land cover, fell within the buffer areas – with the worst-case scenario buffer at 67% and the best-case scenario buffer at 72% (Table 1). This also included parts of the urban form and fabric. A map of the buffers shows that 21% of the urban form fell within the worst-case buffer (500 m) and 23% fell within the best-case buffer (1 000 m). The close proximity of Gauteng's natural and constructed land cover and urban fabric indicated that large portions of this land might be susceptible to contamination through the effects of wind and water. In particular, natural networks such as planted and natural grasslands, trees (indigenous and non-indigenous), degraded natural vegetation, water bodies and rivers that lie in close proximity to mine waste were at risk.

While spatial analysis provides useful information on the location and proximity of mining waste to different types of land cover along the Witwatersrand, it does not cover all of the impacts of mine waste on the environment. Together with published studies on the environmental effects of mine waste, the following sections present some of the environmental impacts of mining waste in each of the Witwatersrand's mining basins (Figure 22).



Table 1: The total percentage of land cover located within the worst- and best-case buffers of mine residue areas attributed to gold mining.

DATASET: GTI, 2012; GDARD, 2012

Land cover category	Land cover features	500 m buffer		1 000 m buffer	
		Total area (km²)	% total land cover	Total area (km²)	% total land cover
Natural green space	Trees (indigenous and non-natural), degraded natural vegetation, bushland, water, wetlands, planted and natural grassland and bare rock and soil	344	72	598	67
Constructed green space	Sports fields, school grounds, cultivated land and golf courses	34	7	91	10
Urban form and fabric	New developments, buildings, industrial, residential, township, open, rail and roads	101	21	202	23

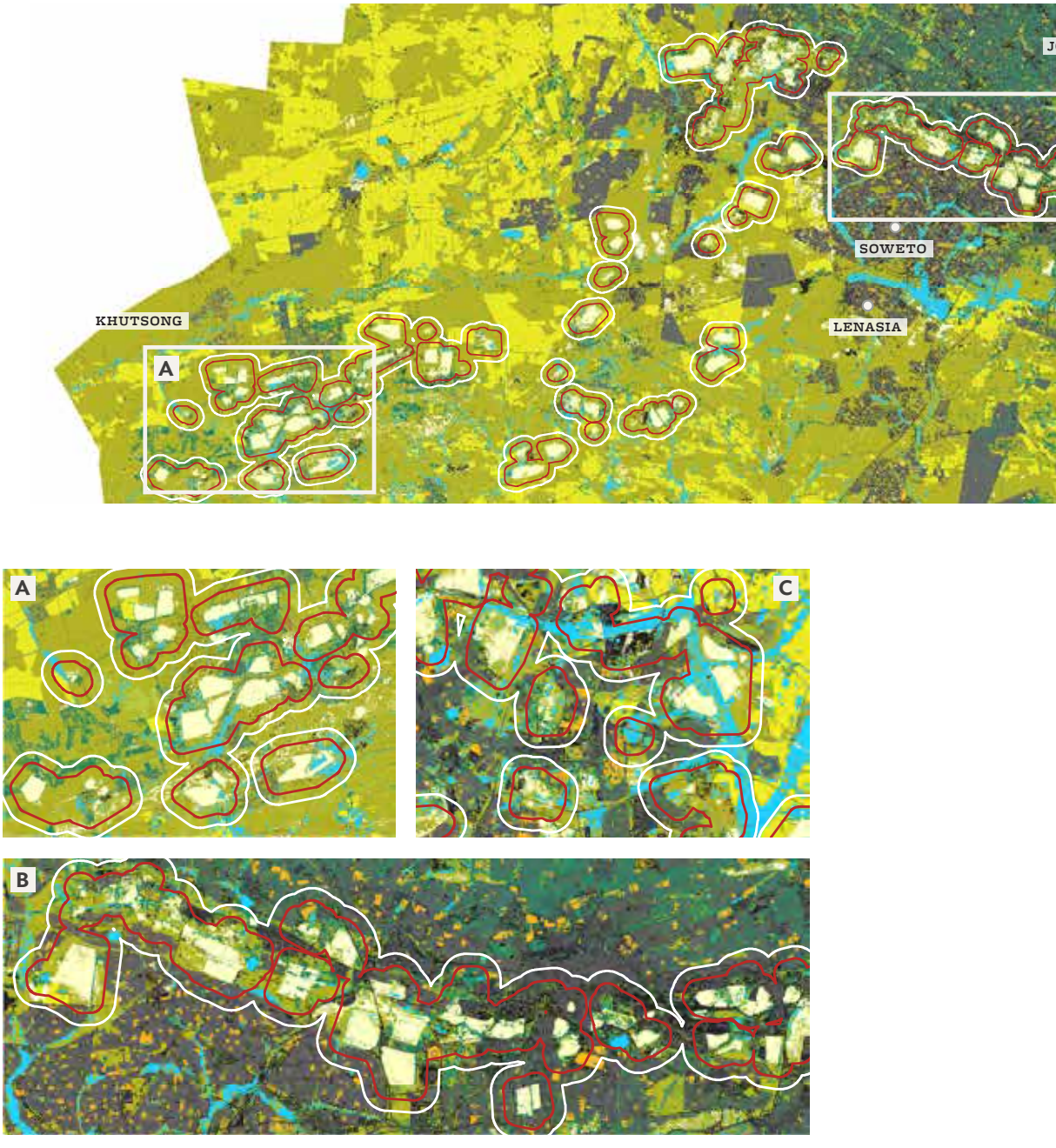
"The spatial study established that large portions of the Witwatersrand's green networks, including large proportions of natural and constructed land cover, fell within the buffer areas..."

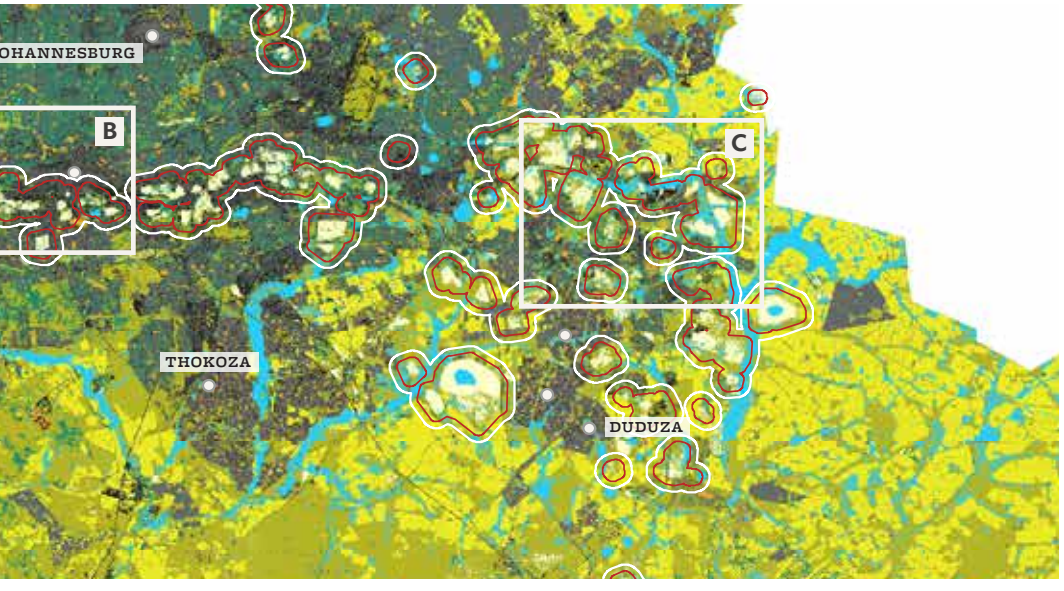
Photograph by Clive Hassall



Figure 22: Land cover that falls within a 500 m and 1 000 m buffer of gold-related mine residue areas along the Witwatersrand, Gauteng.

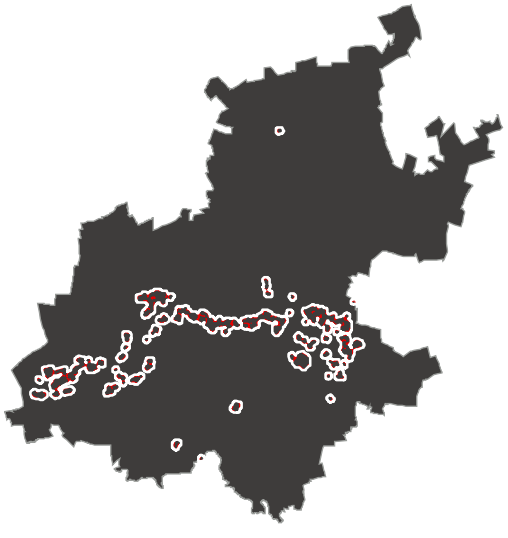
DATASETS: GTI 2.5 m land cover, 2012; GDARD Mine Residue Areas, 2012.





KILOMETRES

0 25 50



- 500 m buffer around mine waste
- 1 000 m buffer around mine waste
- Mine residue areas
- Urban fabric: New developments and buildings (industrial, residential, township, rail and road networks)
- Recreational areas
- Bushland, planted and natural grassland
- Trees (indigenous and non-natural)
- Degraded natural vegetation
- Cultivated land
- Bare rock and soil
- Water bodies and rivers
- Open space

Figure 23: The lasting impact of acid mine drainage decant in the West Rand. These pictures (taken on 9 September 2013) show the hardening of the top soil where acid mine drainage decant took place.

Photographs by Kerry Bobbins





West Rand

As demonstrated in Figure 22A, mine residue areas are located in close proximity to water resources in the western basin and are commonly found beside natural water such as rivers, springs and wetlands. When exposed to mine waste, this natural water is likely to become contaminated. This can include the formation of acid mine drainage, which has a low pH, high electrical conductivity and elevated concentrations of aluminium, manganese and toxic heavy metals (Oelofse et al., 2007). The presence of acid mine drainage in a hydrological network degrades soil quality due to its high concentration of heavy metals, which severely affects agricultural production and both aquatic and terrestrial fauna (Oelofse et al., 2007). Of more concern, however, are its impacts on the city-region's potable water resources (Oelofse et al., 2007).

Government interventions have prevented further acid mine drainage decant in the West Rand through pumping and purification activities, but a lasting set of adverse environmental impacts remain. An example of this is the hardening or crusting over of the topsoil, found on sites where decant took place in 2002 (Figure 23). The hardening of the landscape prevents ecological and biogenic functioning (Photo Essay 1). Another example is Robinson Dam, which has become polluted because of the mismanagement of mine waste (Rand Water, n.d.) (Photo Essay 1). The dam was used as a storage pond for acid mine drainage decant in the West Rand from 2002; as a result, the water now has a pH of 2.2 which is similar to the acidity of vinegar. Today, Robinson Dam is a highly toxic environment that no longer supports life. West Rand environment officials have reported environmental fears associated with the interventions developed by national government in response to acid mine drainage (Official, 2014), (see Box 5). These interventions, designed by a team of experts in the fields of mining and water management, have created a set of unintended environmental concerns. These are due mainly to the release of pre-treated acid mine water into the hydrological network, and the location of pumping and water treatment sites along the Witwatersrand which have led to localised instances of pollution. In some cases, private landowners not only have to deal with the lingering impacts of acid mine drainage decant, but also the environmental consequences of selected acid mine drainage interventions.

Central Rand

Mining waste located in the central basin, or the central portion of the Witwatersrand, is mainly characterised by mine tailing dams (or tailings dumps), which intersect grassland areas and the urban fabric (Figure 22B). As Rosner and Van Schalkwyk (2000) explain, this has led to the unintended localised contamination of topsoil.

Instances of poor management and the neglect of waste facilities (Mphephu, 2003) have made mining waste more vulnerable to the effects of wind and water erosion. The increased likelihood of mining waste mobility means that the impacts of contaminated mining waste can extend far beyond the boundaries of the original mining waste footprint. Oguntoke et al. (2013) report that dust originating from mine waste impairs visibility and can settle on fabrics, buildings, vehicles and water tanks found along the Central Rand. The reprocessing of sand and slime tailings into finer materials (as part of the gold recovery process) can worsen this effect (Oguntoke et al., 2013). The increased presence of dust particles in the air reduces the ambient air quality, while locations downwind of mining sites can experience higher dust concentrations than those upwind, usually during the spring months (Oguntoke et al., 2013).

Communities located close to tailings storage facilities along the central portion of the Rand are concerned about the frequent exposure to airborne particulate matter that originates from mining waste (Wright et al., 2012; Oguntoke et al., 2013). This has been flagged in the news and by non-governmental organisations such as the Centre for Environmental Rights and the South African Human Rights Commission (Centre for Environmental Rights, 2009; Kings, 2014; Love, 2015; Stassen, 2015). In addition to airborne pollution, mining waste is also likely to include increased levels of mercury. Mercury was used in the gold-production process to amalgamate gold along the Central Rand. It was not removed from processed ore before it was discarded as waste (GDACE, 2008), therefore mining waste tailings and underlying soils are likely to be contaminated by mercury. This creates major concerns around the spread and settling of particulate matter.

That being said, however, after mining activity ceased in the central basin during the mid-seventies, improved environmental legislation led to a number of mining waste reclamation projects that have enhanced the environmental condition of this section of the Witwatersrand (Box 6). This is due to the increased encouragement of mining companies to reclaim and manage their tailings dams in order to limit their impacts on the environment (Mphephu, 2003) (also see Chapter 3). Reclamation projects generally aim to extract a profit from the selling of rehabilitated mining land (see Chapter 5).

East Rand

Much of the mining waste found in the eastern basin or East Rand – largely in the form of rock piles, sand, tailings dumps and underground dumps – intersects natural water bodies (Roychoudhury & Starke, 2006) (Figure 22C). One example is the Blesbokspruit. As a Ramsar-certified wetland of international importance, it is under threat owing to increased metal deposits (or metal loading) caused by mining (Roychoudhury & Starke, 2006). Ramsar wetlands have significant natural value and are earmarked for protection under an intergovernmental agreement.

Along with mine waste contamination, the Blesbokspruit is also polluted by effluent from human settlements and industrial areas upstream (Roychoudhury & Starke, 2006). The poor water quality of the Blesbokspruit is likely to affect freshwater resources in the area on a long-term basis (Roychoudhury & Starke, 2006). Once introduced into aquatic environments, contaminants accumulate in sediments located at the bottom of water bodies and form metal-rich deposits (Roychoudhury & Starke, 2006). This severely impairs normal ecological functioning.

Inconsistencies between environmental policy and practice

Great inconsistencies exist within the management of mine residue areas. For example the Department of Mineral Resources regards mine waste as a resource, while environmental entities such as the Department of Environmental Affairs and the Department of Water Affairs (Kardas-Nelson, 2010) see it as a by-product of active mining. In some instances, this has created a 'blame game' around who the rightful mine waste owners are and how mining waste will be managed (Kardas-Nelson, 2010).



Photograph by Potsiso Phasha

Mining is regulated primarily through the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002), administered by the Department of Mineral Resources. Three separate spheres of government, namely the national, provincial and local, manage the environmental functions contained in this Act with the Department of Environmental Affairs taking the lead (WESSA, 2013). However, the Environmental Impact Assessments (impact studies informed by experts and participatory planning) required by mining fall under the responsibility of the Department of Mineral Resources with concurrent authorisation required from the Department of Environmental Affairs (WESSA, 2013).

The Wildlife and Environment Society of South Africa (2013) reports that the environmental considerations for mining, articulated in the Minerals and Petroleum Resources Development Act (Act No. 28 of 2002), are lower than those standards set for other sections of the Environmental Impact Assessment regulations under the National Environmental Management Act No. 107 of 1998 (NEMA) (WESSA, 2013). In some instances, mining companies develop their own Environment Management Plans (plans devised to map out measures for protecting the environment) and prescribing their own solutions for managing adverse environmental impacts. Mining companies can also be exempt from completing Environment Management Plans and little enforcement occurs to ensure that these plans are in fact completed (Madihlaba, 2002).

Box 6: Environmental policy and mining practice

KERRY BOBBINS

South Africa's transition to a democracy in 1994 presented an opportunity to change its historic mining philosophy into one that is more sustainable. The adoption of South Africa's new Constitution and the Mineral and Petroleum Resources Development Act in 2002 signified a shift in the way that natural resources are planned and included in national policy.

The National Department of Environmental Affairs is largely responsible for coordinating the activities of the National Department of Mineral Resources, the National Nuclear Regulator and the Department of Water Affairs around mining oversight and legislative enforcement (GDARD, 2012). At present, eight separate common laws and Acts that loosely inform a legislative framework guide the activities of these bodies. This framework incorporates a key focus on sustainability through the concepts of integrated environmental management and by considering the economic, social and environmental costs accrued during the life cycle of a mine. Noteworthy Acts that inform this sustainability focus include the Environmental Management Act (1998), the National Water Act (1998), and the Mineral and Petroleum Resources Development Act (2002).

The governance of mining waste at a national level is fragmented owing to the use of a loosely bound legislative framework and the role of various national departments in its administration and management. This further translates into the inconsistent enforcement of national legislation. As a result, the concept of sustainability does not often run full circle in terms of regulating and managing mining practices in South Africa.

At a provincial level, all spheres of government are responsible for the administration of legislation and regulations around mine residue areas along the Witwatersrand. This includes over thirteen national and nine provincial departments and institutions (GDARD, 2012). In particular, the Gauteng Premier has initiated work on mine residue areas which has been directed through the Gauteng Department of Agricultural and Rural Development (GDARD). Provincial interventions include the drafting of a report on the reclamation of mine residue areas for development processes (1999) and a strategy for mine residue areas for Gauteng (2012).

The mine residue area strategy aims to quantify mine residues through a technical review. The first phase of this project was completed in 2012. However, the broader five-year programme that underpins this approach was not completed in its entirety owing mainly to a lack of political interest. Additional attempts by provincial government to create an acid mine drainage/mine residue areas action committee have also failed for the same reason.

Local-level government experiences the immediate effects of mine residue areas on society and the environment. Most often, however, municipal departments do not have the necessary capacity and budget to intervene in the localised effects of mining waste on the environment (GDARD, 2012).

Tracing the legislative barriers from national to local government, it is evident that the weak capacity and legal standing of provincial and local departments limits the prospects for a co-ordinated response to mining waste along the Witwatersrand (Taviv, 2013). In order to address these barriers effectively, distinct government roles and responsibilities should be developed, including how government regulates and enforces existing environmental legislation.

"It is clear that the debates about the environment and sustainable development also need to be taken out of the 'green ghetto' of the strong environmental lobby in South Africa, and become part of the lexicon of the media, politicians, business, and ordinary citizens."

(PATEL, 2009)

Risk trade-offs

A series of risk trade-offs exist in addressing the environmental impacts of the Witwatersrand's mining waste landscapes. These trade-offs are informed by ideologies that are deeply rooted in the ownership and value of the Witwatersrand's natural resources and minerals. In his book entitled 'The Global Casino', Middleton (2013) explains the ownership and value of resources. While his explanation does not focus on Gauteng, it does describe how the ownership and value of resources are a key cause of imbalances between humans and nature. He argues that environmental resources under common ownership are more likely to be exploited or abused (Middleton, 2013). By contrast, resources that are individually owned are more likely to be managed and valued to ensure they are protected or conserved.

Using Middleton's (2013) insights, an interesting comparison can be drawn between individual and common ownership of mineral resources in South Africa. At present, there is an awkward arrangement of laws and constitutional rights to land and minerals in South Africa that has allowed for the exploitation of mineral wealth at the expense of the environment (Box 7). According to the Mineral and Mining Policy Green Paper, the state is the owner of mineral rights on surveyed public and private land (South African Government, 1998). This leaves landowners with limited rights to minerals found in their own soil (Van der Schyff, 2012). In this instance, while land can be privately owned, the mineral resources it harbours are considered a 'common' resource. This split in ownership creates an uncomfortable divide in the interests and valuation of the environment. While private landowners may be concerned about the long-term impacts of mining on the environment, this tends to fall out of their control as state-facilitated mining processes use or even exploit the mineral and other environmental resources, such as clean air, water and soil. This makes it easier for the state to undervalue these environmental resources, leading to unlawful contamination and overuse. This outcome, observed across mining waste landscapes throughout the world, can be understood through Hardin's (1968) notion of the tragedy of the commons. Here, individual mine owners profit from mining but feel no compulsion to shoulder some of the indirect costs. These costs are externalised and become the responsibility of society.

As mentioned previously, public systems to inform environmental decision-making are guided by expert and participatory perspectives on landscape planning in South Africa. As a result, the outcomes of decision-making tend to be unjust and unbalanced due to the wide range of perspectives that can be included in the decision-making process (Patel, 2009). Patel (2009) argues that current environmental decision-making processes are dominated by the roles and values of the environmental practitioner, often at the cost of local communities and the public (Box 7). In other words, the enforcement of environmental legislation meets basic requirements in terms of South Africa's legal system, but does not ensure the sufficient functioning of ecological systems.

Prioritising the economy over natural wealth, such as intact grasslands, functional waterways and other environmental phenomena, creates an increasingly fragmented natural landscape which is not able to provide the essential natural goods or ecosystem

services to support a living landscape. The goods and services provided by nature can counterbalance the effects of mine waste and help to offset the impacts of mining on society. Phytoremediation projects, or projects that use plants locally or in the surrounding environment to reduce the presence of toxic contaminates, can provide cost-effective and more resilient alternatives to offset the burdens of traditional approaches to treating mine waste (Dye & Weiersbye, 2010; Doley & Audet, 2013).

The relationship between all participants – the state, society, individuals and the environment as a whole – needs to be considered as part of mainstream planning and thinking (Patel, 2009) to address the risk trade-offs. By intervening in the broader political context in which environmental justice and concerns are positioned, more informed environmental decision-making can take place (Patel, 2009). Part of addressing risk trade-offs includes understanding how waste landscape legacies are perceived and addressed through national legislation and local management. This can be done by measuring, monitoring and evaluating the impacts of mining on the environment, and understanding how to make short-term changes that directly focus on the environment.

Photograph by Clive Hassall



Box 7: Framing environmental agendas in South Africa

KERRY BOBBINS

"Environmental planning of waste disposal by the South African gold mining industry in the past, although legal and recommended by government at the time, has since been proven to be environmentally unsound" (DEA, 2012: 19).

Khan (1999) and McDonald (2002) suggest that early environmental movements in South Africa were regarded as early conservation organisations focused on preserving endangered fauna and flora and on reviving neglected social objectives. The first scientific institutions were established during this period to conduct research on the political economy and imperialism (Van Eeden et al., 2009). The outputs of these studies were used to support the mining position; they did not place value on society or the health of the environment. Noteworthy contributions were made in 1902 in the fields of geology, geography, engineering and the environment, but these related primarily to enhancing the mining position and gold extraction (Van Eeden et al., 2009).

From 1970 onwards, research investigated the presence of elements and heavy metals in mine tailings, mine dumps and slimes dams in South Africa, with a particular focus on the contamination of water by heavy metals – a realisation that gained popularity (Van Eeden et al., 2009). This was used to generate a set of observations on hazardous mining materials, such as sand heaps and slimes dams, and how these affected ecological systems (Van Eeden et al., 2009). Findings were supported by technical environmental reports (produced during the 1970s and 1980s), which stimulated further research on soil, water management, pollution control and the presence of dolomite (Steyn, 2000). While the rapid output on the effects of active mining on the environment produced significant scientific findings, these findings did not flag the need to take action in terms of the effect of mine waste on the environment and broader environmental contamination. In the words of Van Eeden et al. (2009: 43), "history simply continued to repeat itself with no serious learning curve and remediation efforts on the horizon."

Environmental movements became politicised and grew in support from 1948 to 1990 (Khan, 1999). During this time, South Africa's environmental agenda had become interwoven around the promotion and preservation of basic human rights. Providing a platform for the discussion of South Africa's political agendas from the 1980s onwards, environmental movements were used as vehicles to promote the rights to a safe and healthy environment. These sentiments became increasingly widespread given the growing trend that poor people and people of colour were increasingly living in toxic environments (Khan, 2002).

Issues of the environment, racial discrimination and institutionalised poverty became interwoven and created a platform for the fight for human rights in South Africa (Khan, 1999). Fuelled by socio-political changes that were taking place at the time, the concept of the 'environment' and 'human rights' were melded as a common anti-apartheid agenda that flourished among poor communities (Khan, 2002). The right to a healthy environment became an integral part of civil rights programmes, as did an increased awareness of the effect of environmental problems on communities (Khan, 1999). This allowed for a shift towards more decentralised environmental governance regimes and the increased involvement of poor communities in environmental matters. Environmental organisations began to demonstrate their acceptance of the need for a

more broad-based appeal and socially-responsive orientation to ensure clean, safe and healthy environments for all (Khan, 1999). Through non-profit organisations (NGOs) such as Earthlife Africa and the Federation for a Sustainable Environment (FSE), the full effects of environmental impacts on society were considered. At the Earthlife Africa conference held in 1992, two key ideas informed the anthropogenic focus of the environment in South Africa. The first was the placement of people at the centre of relationships between the environment, society, the economy and politics. The second was the understanding that environmental justice needs to be achieved through power relations and the fair distribution of costs and benefits (Patel, 2009).

During the early 1990s, the South African government began to reconceptualise its approach towards the environment and re-examined the need for reform in the mining sector in relation to the environment. These sentiments also began to form across race and class groups in South Africa (Humby 2013). This also included the Minerals Act (50 of 1991), which recognised the need for land rehabilitation during and after mining operations (Madihlaba, 2002). The policy was extended in 1993 to ensure that each new mine completed an Environmental Management Programme Report before mining activities commenced. The intention of the report was to compel mining companies to outline all the possible environmental impacts of their mining operations (Madihlaba, 2002). The inclusion of a constitutional right to the environment in 1993 and 1996 provided an opportunity to cement environmental rights with an environmental justice agenda (Humby, 2013). Here, pollution and ecological degradation could be prevented through 'reasonable legislative and other measures' to secure ecologically sustainable developments and the sustainable use of resources (Humby, 2013: 74). In the period of policy reform after 1994, an explicit commitment to reversing the injustices of the past was translated into environmental law and policy (Patel, 2009). The vision of national environmental policy included a growing awareness of understanding environmental issues; an increased participation in environmental management at all levels of society; clear action plans for government to address environmental problems; and compliance with standards, monitoring and reporting (DWAF, 1996).

In particular, the development of the National Environmental Management Act (NEMA) of 1998 has played an influential role in shaping the environmental justice agenda of South Africa. This Act sets the tone for sustainable development in the environmental sphere, and outlines the norms and standards for achieving integrated environmental management (Swart, 2003). Furthermore, it frames the responsibility for duty of care in terms of environmental contamination through the 'polluter pays' principle, which enforces the remediation of environmental damage by the polluting individual and/or entity (Swart, 2003).

By the late 1990s, the relationship between environmental justice and environmental human rights was synergetic. In the words of Humby (2013: 43): "... from a legal perspective the discourse of environmental rights has been infused with a discourse of environmental justice that not only references the need for fair allocation of environmental hazards, but also emphasises the need for meeting basic needs through equitable access to natural resources and promoting a culture of inclusivity and engagement in environmental decision-making."



Information on the effects of mine waste on the environment

Data on the impacts of mining waste on the environment is typically located in research repositories and databases owned by private mining houses and the government. The fragmented nature of available scientific research poses a significant challenge for quantifying the exact degree and location of the impacts and, importantly, how they are understood in Gauteng. During a SWOT (strengths, weaknesses, opportunities and threats) analysis of the associated provincial governance structures required to manage mine waste, it was established that insufficient monitoring networks have resulted in a general lack of data on environmental concerns caused by air quality and surface and ground water contamination (GDARD, 2012). Sutton and Weiersbye (2008) reported that, given the sheer number of mine residue areas and the volume of mine waste, collecting conventional data for risk assessment is costly and time-consuming.

Research on the availability of studies that map out the effects of mine waste on the environment found that work commissioned by private funders and mining companies is often not available for public scrutiny. Where data is available – generally that created by academic and research institutions – the scope and focus of the findings are limited to one or two particular project goals. Here, data and findings cannot always be scaled up or blended with other research to inform an integrated study at a regional level. While articles written by academics and research institutes present factual evidence on the impacts of mine waste on the environment in scientific terms, they do not extend their research findings to include the political context within which the research is positioned. This contributes to fragmented research efforts on the effects of mining waste on the environment.

Studies have tried to classify mining-related environmental concerns using broad-based satellite imagery and remote sensing (see studies by Sutton & Weiersbye, 2008 and Chevrel et al., 2005). While these programmes aim to present an overview of the impacts of mining waste on the Witwatersrand's mining landscape – such as determining land cover type and the presence of mine waste and of mine-related effluence, they are insufficient in detailing the severity and effect of mine waste on the environment at a local level.

Restrictions on access to information are also commonplace. Much of the research that has been conducted serves to enhance the interests of mining companies and to monitor the impacts of individual mines for legislative purposes. In this regard, the public, academic organisations and private institutions may be unaware of the true nature



Photograph by Clive Hassall

of environmental threats associated with mining waste legacies. With this in mind, it is important to consider how stakeholders, including the public, have developed their own perceptions of mine waste and its impact on the environment.

The Promotion of Access to Information Act (PAIA) Act 2 of 2000 creates a mechanism for the public to access information held by state departments. The Act supports the enshrined constitutional right for access to information held by a public or private body (DMR, 2012). Despite providing a necessary platform for the public to request and acquire information, it has been reported that 65% of all requests for information were refused and 54% of requests went unanswered during the period July 2012 to August 2013 (PAIA Civil Society Network, 2013). In the PAIA Civil Society Network Shadow report, the Department of Mineral Resources received the most PAIA requests out of all public bodies (PAIA Civil Society Network, 2013). A follow-up report entitled 'Unlock the doors', compiled by the Centre for Environmental Rights, stated that the compliance of the Department of Mineral Resources with PAIA was consistently poor between mid-2010 and early 2012. During this time, the Department of Mineral Resources is reported to have been unable and reluctant to comply with PAIA. It appeared to be protecting the proprietary and financial interests of mining companies, to the exclusion of the interests of communities and government (Centre for Environmental Rights, 2012). The Centre for Environmental Rights, which repeatedly submitted requests for mining-related information to the Department's Gauteng regional offices, confirmed this.

To date, there have been very few precedent-setting court cases that favour the environment over people and companies. Communities and civil society organisations such as the South African Human Rights Commission, the Federation for a Sustainable Environment and the Centre for Environmental Rights have challenged environmental decisions made by government. This suggests that the current approach to managing mine waste, in particular with regard to ownerless and derelict mines, does not uphold the rights of humans and the environment, strongly indicating a lack of good environmental governance (Feris, 2010).

Addressing environmental mining waste legacies of the Witwatersrand

Towards adressing the environmental challenges associated with mine waste, Aubertin and Bussiere (2001) offer some insight into reconceptualising the way in which mine waste is created and how it can be

stored. Sorting and recycling can reduce a significant amount of non-mineral waste. Various stability models for stockpiles, such as tailings dumps, can be created to reduce the generation and runoff of acid mine drainage (Aubertin & Bussiere, 2001). Tang and Watkins (2011) identify possibilities for the use of acid mine drainage to meet South Africa's growing demand for water. More specifically, this initiative has the potential to bring together "seemingly disparate players in the region, [to] provide solutions for the future development of the 'Ridge of White Waters'" (Tang & Watkins, 2011).

In mitigating the effects of mine waste on the environment, the interconnected set of natural and constructed ecological systems, green spaces and other landscape features known as green infrastructure presents an opportunity to offset the immediate environmental impacts of mining waste on the environment. This will ensure a focus on the mining landscape rather than on individual mining waste features. Existing research on the use of trees along the Witwatersrand gold fields, for example, suggests that trees are already being used to prevent the seepage of contaminated water into the surrounding land, water courses and groundwater through phytoremediation (Dye & Weiersbye, 2010). It is also believed that trees planted in seepage pathways can increase evapotranspiration. Through hydraulic control and sequestration, trees can reduce the overall spread of contaminants (Dye & Weiersbye, 2010). This research indicates that there is already scientific backing for using natural and constructed ecological systems to curb the effects of mining waste on the environment. Greater investment and research could extend this backing to enhance the use of green infrastructure in mainstream mining waste management practices.

'Towards informing a green infrastructure approach', a recent paper by Houdet and Chikozho (2015), highlights ways to assess and include natural ecosystem services provided by the environment into the mining lifecycle. This paper posits that the value of environmental services can be harnessed through valuation studies, informed by a range of stakeholders, existing policies, laws, etc. Further opportunities for improving mining landscapes by creating new environmental and social values will be explored in more detail in Chapter 5.

Conclusion

The Witwatersrand's abandoned mine waste areas have had an adverse effect on the city-region's natural environment. As dangerous and sterile monuments to mining, mine residue areas affect the functioning of local environments and pose threats to air and water quality (GDARD, 2012). Strung together, these features create large-scale environmental effects that upset the functioning and future sustainability of the Witwatersrand.

This is because much of the mining waste was created at a time when formal legislation was not in place to govern the environmental and social impacts of mining. Despite the fact that South Africa's post-apartheid constitution has since included clauses detailing environmental rights and the human right to live in a clean environment, tracking the implementation of these rights in respect of historic mining waste has been difficult.

The power dynamics that have emerged around mining waste have led to a set of risk trade-offs, which typically sees development taking place at the cost of the environment. Since the true value of intact ecosystems is often only acknowledged once they are lost, rehabilitating the mining landscape with the environment in mind is of utmost importance. Where possible this should be supported by sufficient data and environmental standards.

In 2014, there was notification that the public protector will look into the water pollution caused by mining companies. This may be a promising start to exposing the liabilities of over a century of mining waste which may initiate more coordinated action (Crowley, 2014).



Photograph by Clive Hassall



Photograph by Clive Hassall



4. Photo Essay 1

A visit to the West Rand: Environmental impacts of acid mine drainage

KERRY BOBBINS

The West Rand's mining landscapes present a stark picture of the lasting environmental effects of over a century of gold mining. Strewn with different types of gold-mining waste, such as tailings and slimes dams, the landscape severely impairs the functioning of the ecological systems that occur here.

Poorly managed and monitored tailings dams on the West Rand contain elevated levels of radioactive heavy metals. These contaminants are transported through the landscape via wind and water. Most notably, water bodies linked with the Wonderfonteinspruit, a tributary of the Vaal River, have become contaminated as a result (Liefferink, 2013a).

Widely acknowledged as the site of acid mine drainage decant in 2002 (Box 5), the natural landscapes of the West Rand have become tarnished by the long-term effects of this acidic water on the environment. This is observable through a series of hardened-over surfaces, polluted water bodies and radioactive dust. Although these impacts are not always visible in the mining waste landscapes of the West Rand, they pose an ever-present threat to the Witwatersrand's potable water supply.

These landscapes also affect the health and well-being of communities, such as residents of the Tudor Shaft informal settlement, who live in close proximity to mine waste. Here, mining waste poses a significant threat to flora and fauna since contaminates found in mine waste accumulate in tissues of living organisms. This forms part of a retained ecological legacy that impacts on other living organisms further up the food chain.



CRUSTING OF THE SOIL

Since the acid mine drainage (AMD) decant took place in 2002, surfaces exposed to acid water have hardened. This hardening acts as a form of armouring and prevents normal biogenic activity from taking place in the surface layers of the soil.

Image: Potsiso Phasha



TOXIC WATERWAYS

A sign demarcates waterways around Lancaster Dam that are contaminated by mine waste and are considered toxic to human health. There is regular human traffic across this area.

Image: Potsiso Phasha



NO LIFE AT LANCASTER DAM

The re-mining of historic tailings in the West Rand has led to the contamination of Lancaster Dam. The presence of uranium has made the dams and wetland radioactive. As a result, there are few signs of plants and wildlife.

Image: Potsiso Phasha



FOOTPRINT RESIDUES

A brick manufacturing plant is located beside uraniferous mine tailings. It is estimated that 30% of all the bricks manufactured within the footprint of this former tailings dump contain uranium (Liefferink, 2013b).

Image: Potsiso Phasha



NEW LIFE TO OLD TAILINGS

Technologies for mineral extraction and the increasing price of gold have encouraged the retrieval of fractions of gold from mine dumps. As a result, some dumps have vanished from the Gauteng landscape (Tang & Watkins, 2011).

Image: Kerry Bobbins





REWORKING HISTORIC MINE WASTE

Retrieving fractions of gold from existing mine waste dumps through reprocessing activities leads to the suspension of dust particles in the air (Liefferink, 2013b). These dust particles can be deposited in the lungs of humans where they can remain for many years (Liefferink, 2013b).

Image: Potsiso Phasha



RADIATION ON THE RAND

Acid mine drainage that was discharged into Robinson Lake in 2002 has turned it into a high radiation zone. At a pH of 2.6, the uranium levels are reported to be 40 000 times higher than healthy standards (Liefferink, 2013b).

Image: Potsiso Phasha



CONTAMINATION OF SURROUNDING FLORA

As a result of natural bioaccumulation processes, contaminates found in the air and soil are stored in the tissues of plants and animals. The high levels of heavy metals and uranium in the area affect a tree located beside the Robinson Dam. These bulbous growths on the leaves of trees are said to be a result of mine waste contamination beside the dam.

Image: Potsiso Phasha



FINDING A FINAL RESTING PLACE

The West Wits Pit as shown here is the resting place for sludge, or the by-product of pre-treated acid mine drainage water pumped from the Witwatersrand mining voids. This pit is unlined and the long-term effect of contaminates leaching from this mining waste retention pond is not yet known.

Image: Kerry Bobbins



5. Human health implications of abandoned mine waste

KERRY BOBBINS

Introduction

Settlements along the Witwatersrand are severely affected by contaminates present in abandoned mining waste. This is largely the result of natural processes such as rain and wind that carry contaminated mining waste from its source and deposit it in the surrounding environment. As explained in Chapter 1, a unique characteristic of the Witwatersrand is the close proximity of mine waste to human settlements. In some instances, such as Ormonde, suburbs encircle old mines (Harrison & Zack, 2014). This phenomenon is different to many other mining landscapes across the globe, where mining waste is typically located on the periphery of urban areas. The Witwatersrand's complex urban form is firmly rooted in the early origins of Johannesburg and the continued presence of historic mining waste remains hazardous to the health and wellbeing of society.

Human exposure to contaminated mining waste along the Witwatersrand has resulted in significant health concerns, such as asthma, bronchitis and pneumonia (Plumlee & Morman, 2011). Communities most at risk reside beside former mining properties, or where mining waste is being re-worked (the re-processing of mining waste to extract fragments of remaining gold). This includes informal settlements that have developed along parts of the mining landscape (as depicted in Tang & Watkins, 2011). Various news agencies have reported on the health implications of human proximity to mining waste. In Zones 7 and 11 of Meadowlands in Soweto, for example, schoolchildren have worn raincoats to protect themselves from dust storms that result in mine dust being deposited across the landscape (*Mail & Guardian*, 1997). In Riverlea, residents use oxygen tanks to manage respiratory health problems attributed to suspended dust from mine waste tailings (Kings, 2013; Balch, 2015). These accounts of the effects of mining waste on society paint a grim picture of the lingering after-effects of active gold mining. The sentiment portrayed by these accounts, however, has not yet generated sufficient momentum to change the way that abandoned mining waste is managed along the Witwatersrand. This is particularly challenging due to numerous sites of abandoned mining waste that predate the era of formal mining legislation.

Civil society organisations such as the Federation for a Sustainable Environment, the South African Human Rights Commission and the Centre for the Environment undertake advocacy work on the impacts of mining waste on society. The case of the Tudor Shaft informal settlement in Mogale City is a prime example of this. The settlement is located on land contaminated by mining waste and is exposed to radioactive dust that emanates from a nearby mine dump (identified as radioactive by the National Nuclear Regulator). Over time, this dust has affected the health of many Tudor Shaft residents (Liefferink, 2012). To uphold the basic human rights of residents, a litigation battle ensued – driven by civil society organisations with the help of the media – to protect the rights of individuals living in the settlement. Litigation continued for many years before it resulted in the relocation of residents who lived in a portion of the Tudor Shaft settlement.

> **Settlements along the Witwatersrand are severely affected by contaminates present in abandoned mining waste. This is largely the result of natural processes such as rain and wind that carry contaminated mining waste from its source and deposit it in the surrounding environment.**



Photograph by Potsiso Phasha



The long forgotten underground mine workings also conceal their own spectres. The consequences of silicosis, a preventable lung disease caused by excessive exposure to silica in underground mine workings, have left a lasting mark on the health of former mine workers in South Africa. This is due to the notorious migrant labour system that attracted mine workers from across the country to work on the gold mines. The poor health of former mine workers renders them unable to work and support their families.

Limited space for urban development along the Witwatersrand, particularly in Johannesburg, has placed increasing pressure on the need to develop land along the mining belt. This trend continues to place individuals at risk of the effects of mining waste (Bremner, 2010).

Using the concept of environmental justice, two case studies – one on the health implications for residents living in the Tudor Shaft informal settlement and the other on the lasting health impact of silicosis – introduce instances where the preservation of human health in respect of mining has resulted in litigation efforts. The use (or non-use) of contaminated tracts of land that remain within the mining waste footprint along the Witwatersrand for informal or low-cost housing will also be explored, in particular the ways in which the location of these settlements may place its residents in unsafe environments.

These investigations by no means offer a finite reading of the socio-economic spatiality of Johannesburg, but provide a lens through which to examine the formation of urban division through mining practice.

Implications of historic mine waste on human health

Communities that live in close proximity to mining waste or mine reprocessing sites are often at risk of mining waste contamination. This is due to the increased likelihood of direct contact with mining waste via inhalation, ingestion, and skin and eye contact (Plumlee & Morman, 2011). In Gauteng, a large proportion of the population lives beside abandoned mining waste. This is most noticeable in Johannesburg, particularly in the south, and on the West Rand (straddling the Johannesburg–Randfontein boundary) where high population densities – above 6 261 people per km^2 – exist beside mining waste (Figure 24, and Box 8).

The source of mining waste contamination, the mode of contamination – through soil, air and water – and the point of exposure all contribute to, and define, the type of contamination and its effect on human health (Plumlee & Morman, 2011). Gold mining waste along the Witwatersrand (such as tailings dams) contains heavy metals (copper, zinc, lead and arsenic) and other toxic substances such as cyanide



Photograph by Clive Hassall

and uranium due to former ore-processing activities (Rosner & Van Schalkwyk, 2000). The presence of uranium also places humans at risk of exposure to radioactivity (see the case study on the Tudor Shaft informal settlement) (Oelofse et al., 2007; Winde, 2009; DWE, 2012). The mobility of contaminates can differ according to environmental variables such as rainfall, wind and geographical relief as well as the type of mining waste. Therefore, the effects of mining waste can vary from site to site.

The effects of mining waste on humans often manifest as non-communicable diseases such as respiratory conditions – bronchopneumonia, pneumonia and lower respiratory tract infections, neurological conditions, cardiovascular concerns and kidney damage (Wright et al., 2014). Other effects include sickness through the consumption of food and water that have been contaminated by mining waste (Oelofse et al., 2007; Winde, 2009; DWE, 2012). These effects are non-infectious and non-transmissible and, as such, the ailments caused by mining waste are often difficult to prove and diagnose. For these reasons, the human health implications of mining waste are generally not attributed to specific mining activities and a causal relationship between mining waste and human health cannot be assumed.

That being said, however, it is well established that Gauteng experiences poor air quality due to small air particles (particulate matter) between 2.5 and 10 micrometres in diameter. The Gauteng State of the Environment Report indicates that the amount of small air particles suspended in the atmosphere is generally increasing in the Witwatersrand over time, with the occurrence of particles greater than 10 micrometres exceeding the Gauteng Province Air Quality Objective (GPG, 2011). In Johannesburg, poor air quality is attributed to mining operations, which contribute to increasing dust emissions and particulate matter (CoJ, 2008). It is reported that "the contribution to air pollution from mine dumps is a serious and ongoing concern for many residents" owing to the toxic chemicals that it may carry – lead, sodium dichromate, mercury, zinc and copper (CoJ, 2008: 181).

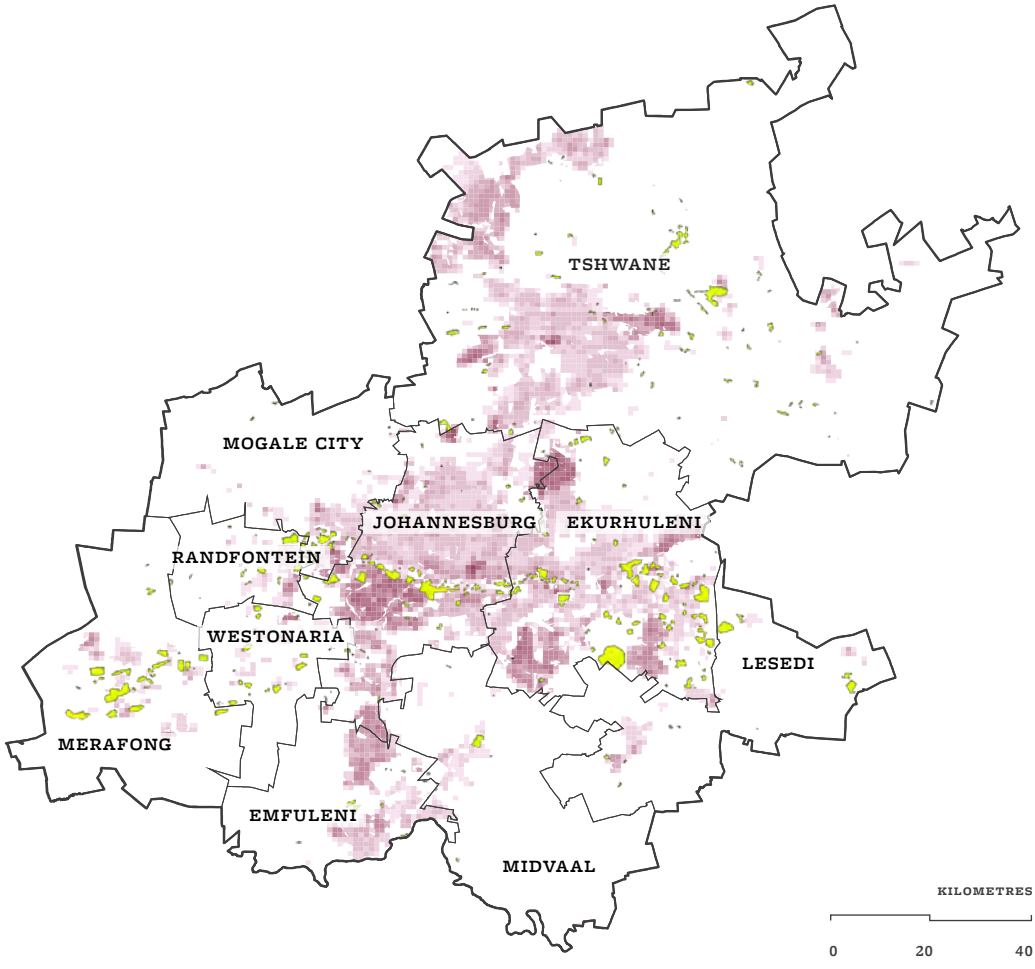
It is worth mentioning that the Gauteng Department of Health and Social Development has identified respiratory-related diseases as some of the top illnesses diagnosed on admission to hospitals in Gauteng, some of which may be attributed to mining dust. In 2012, respiratory conditions accounted for 18.4% of all diagnoses on admission to hospitals. (GDHSD, 2010). In this same year, 104 000 men in Gauteng (542 000 in South Africa) and 152 000 women in Gauteng (684 000 in South Africa) were diagnosed with chronic asthma.



Photograph by Clive Hassall

Figure 24: Location of Gauteng's population in relation to gold-mining waste.

DATASETS: GDARD, 2012; Lightstone DemProKey X, 2010



Mine residue areas associated with gold mining

200 - 563	3 037 - 4 838	10 142 - 14 059	41 289 - 66 909
564 - 1 670	4 839 - 7 167	14 060 - 22 388	
1 671 - 3 036	7 168 - 10 141	22 389 - 41 288	

Box 8: Perceptions of mines and mining waste across Gauteng

KERRY BOBBINS

While scientific studies related to the environmental and social impacts of mine waste have been conducted from as early as the 1970s, knowledge about the perception of mines and the economy and the perceived threat of mine waste on society remains scarce. This box presents some of the findings of the Gauteng City-Region Observatory's Quality of Life Survey III, which depicts the perceptions held by respondents across the Gauteng City-Region. The Quality of Life Survey is a biannual survey run by the Gauteng City-Region Observatory; it includes a host of socio-economic questions that relate to the quality of life in the Gauteng City-Region. In 2013, the survey interviewed 27 490 respondents across Gauteng's 508 wards – 30 respondents were interviewed in each ward.

In the survey respondents were asked whether or not they agreed with the statement 'mines drive the economy and, if they damage the environment, it is a price worth paying'. The results show that 54% of all respondents in Gauteng answered that they agreed or strongly agreed. Only 22% of respondents disagreed or strongly disagreed (Figure 25).

In a similar survey question statement, 'mining waste poses a threat to my community', a staggering 47% of all respondents answered that they agreed or strongly agreed with this statement. This means that almost half of the survey respondents believe that mining waste poses a threat to their community. A mapping of this data along with mine areas in the Gauteng province reveals an interesting link between the perception of mine waste and mining and its spatial location. The map records the percentage of respondents who agreed or strongly agreed with this statement in each ward.

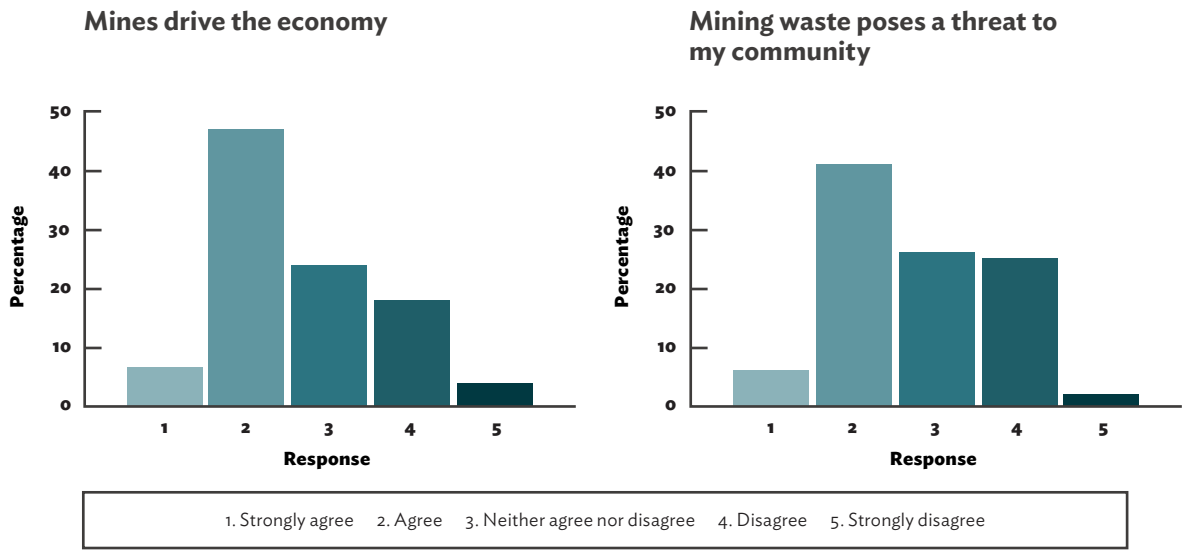
Figure 26 shows that the wards where 46–94% of respondents agreed with the statement, 'mining waste poses a threat to my community' fell in areas where mining waste associated with gold mining was present. In Carletonville, Krugersdorp and Soweto, for example, 74–94% of all respondents indicated that mine waste poses a significant threat to their community.

Gold mining areas are located close to higher residential densities because urban settlement historically developed around gold mines. Other existing and planned mining areas located close to residential communities are also seen as a threat. For example, new coal mining activity planned near Heidelberg in Lesedi has been perceived to threaten the livelihoods associated with agriculture in the area. Similarly residents of western Tshwane see platinum, vanadium and ferrochrome mines in North West Province on the border of Tshwane as a threat to their communities.

These results indicate that mining areas are perceived by their neighbouring communities to create environments that adversely affect their lives. Many residents in the region are unaffected by mining and its waste, and view its consequences as a 'price worth paying'. However there are also many communities adjacent to the waste landscape and mining activity (often communities with lower incomes) who are severely burdened by it.

Figure 25: Frequency graphs for Quality of Life Survey III questions: a) mines drive the economy, and b) mining waste poses a threat to my community. Percentages calculated for the 'agree' category include merged survey responses for 'strongly agree' and 'agree', while the 'disagree' category includes merged survey responses recorded for 'strongly disagree' and 'disagree'.

DATASET: GCRO QoL III, 2013

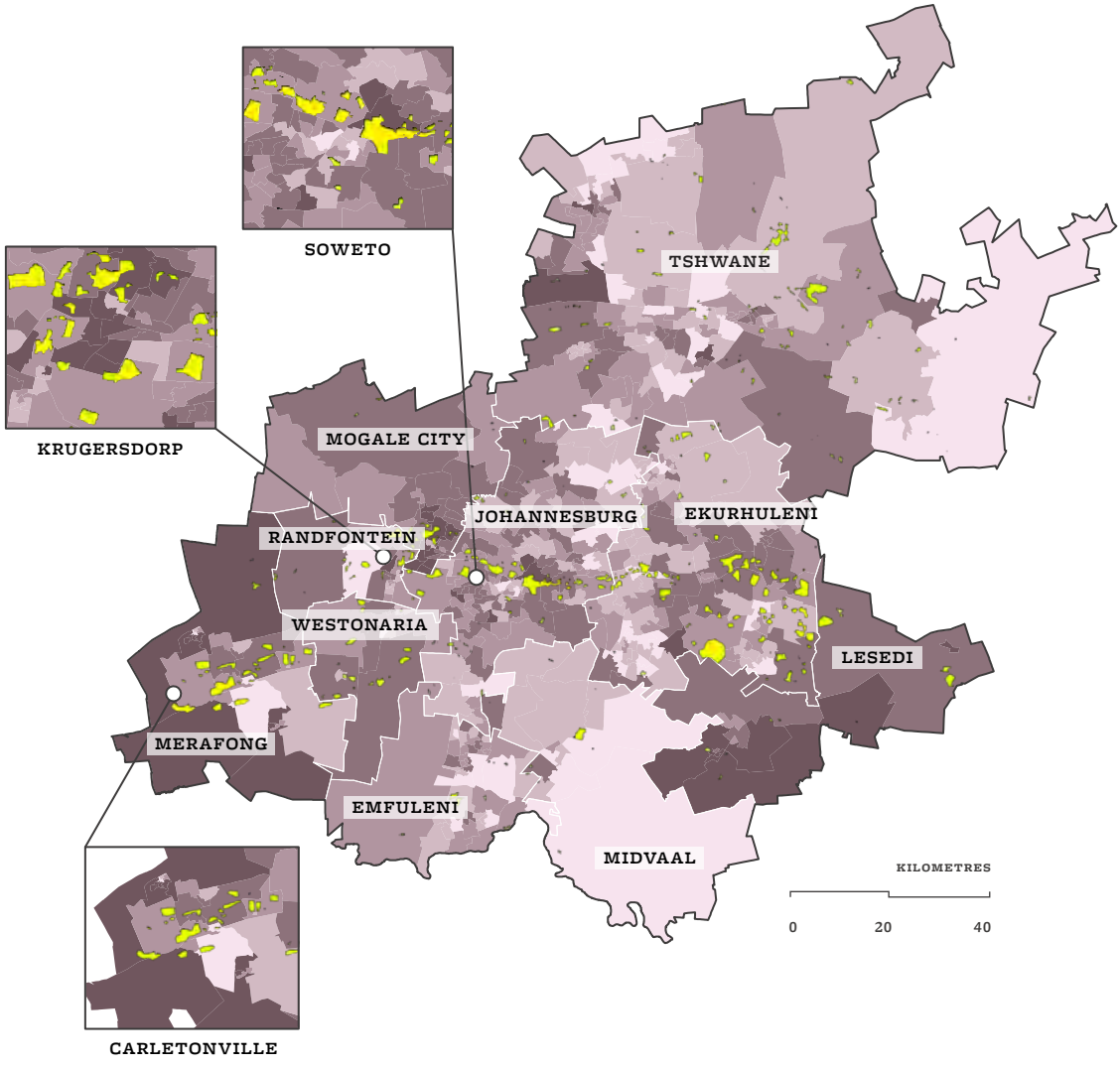


Photograph by Clive Hassall



Figure 26: Spatial representation of the Quality of Life Survey III question on whether mining waste poses a threat to the respondents' community. Areas shaded in purple indicate the percentage of respondents in each ward who agree ('strongly agree' and 'agree') with this statement.

DATASETS: GDARD, 2012; GCRO QoL III, 2013



Mine residue areas

Combined classes: Strongly agree and Agree (%)

0 - 30 | 31 - 45 | 46 - 57 | 58 - 73 | 74 - 94

An environmental justice concern

In South Africa, issues pertaining to the health of society are often considered through the lens of environmental justice. This focus is largely a result of the emergence of environmental justice movements during the late 1990s, which has encouraged the creation and preservation of environments to support healthy communities (Box 7).

The two case studies that follow illustrate some of the environmental justice concerns related to the impact of mines and mining waste on communities. One discusses the Tudor Shaft informal settlement and another the socio-economic impacts of silicosis. These studies present a set of incongruences that have emerged around the management of historic mine waste, the enforcement of national legislation, and the preservation of basic human rights. In both these case studies, litigation was used as an effective tool.

The ground we walk on: Tudor Shaft informal settlement

The Tudor Shaft informal settlement originated after families were relocated there in 1995 and 1996 by government (Humby, 2013). By 2012, the settlement was reported to have 454 informal structures, housing approximately 1 800 people (Humby, 2013). The settlement was positioned in close contact with mine waste contaminated by uranium. Residents were thus subjected to carcinogenic materials, heavy metals and radioactive uranium (SERI, 2013). While the existence of uranium in this area was suspected from as early as 1967, studies to investigate the issue were only commissioned from the late 1990s onwards (Humby, 2013). In 2000, a Water Research Commission study revealed that significant amounts of uranium were entering the hydrological system due to mine waste. This proved to be particularly problematic for communities living in informal settlements since they have a greater reliance on natural hydrological systems.

An antagonistic relationship emerged between academic experts and the National Nuclear Regulator after studies suggested a higher than normal concentration of uranium in the settlement (*Sowetan*, 2012). The National Nuclear Regulator alleged that the studies were not scientifically robust and that further research was necessary (Humby, 2013). In 2011 the Federation for a Sustainable Environment (FSE) – a civil rights organisation – together with the National Nuclear Regulator, developed an advocacy campaign on the radiological risk and hazard affecting communities in the West Rand around the Wonderfontein area (Liefferink, 2012). At this point the media began covering the story and, in response to media pressure (*Mail & Guardian*, 2013), the National Nuclear Regulator and the Department of Water and Sanitation, previously known as the Department of Water Affairs and Forestry (DWAF), appointed a specialist task team to prepare a remediation action plan. The plan outlined the radiological risk and the necessary conditions to overcome it (Humby, 2013). However, little action was stipulated by the plan and the FSE continued to create awareness around the risks associated with uranium. The National Nuclear Regulator affirmed their position that there was no imminent danger, after conceding that the recent environmental survey showed elevated levels of uranium (Humby, 2013).

Shortly after this, the National Nuclear Regulator and Mogale City, the municipality within whose jurisdiction this settlement falls, relocated 17 families (Humby, 2013). It is reported that these families had not been consulted and they generally did not want to move. In September 2011, Mogale City, as the owner of the land on which the settlement is situated, was issued a directive by the Department of Environmental Affairs to take measures to rectify environmental degradation (Humby, 2013). Mogale City consulted with the National Nuclear Regulator and revealed that the best way to address the directive would be to remove the mine tailings dump (Humby, 2013). An agreement with the mining company Mintails formalised cooperation around the removal of the dump (Liefferink, 2012). However, this led to greater challenges since the removal of the dust liberated radioactive dust into the air, posing a significant health threat to the informal settlement (Humby, 2013).

Reflecting on this case study, two considerations become evident. The first relates to the inadequate implementation of South Africa's laws and constitution that has prevented the development of equitable



HUMAN RIGHTS AND THE ENVIRONMENT

Section 24 of the Bill of Rights in the Draft Final Constitution (1) of the Republic of South Africa guarantees environmental rights for the people of South Africa. It states that:

"... Everyone has the right:
(a) to an environment that is not harmful to their health or well-being; and
(b) to have the environment protected for the benefit of present and future generations, (i) through reasonable legislative and other measures that 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 ..."

(The Bill of Rights of the Constitution of the Republic of South Africa, 1996)

processes for affirming human rights. This has been exacerbated by poor stakeholder co-ordination, poor regulation enforcement and poor use of national legislation. The second relates to the absence of members of the Tudor Shaft settlement in decisions made around their health and relocation to another part of the Witwatersrand (Humby, 2013). Described as being 'conspicuous in their absence' by Humby (2013: 101), the residents of Tudor Shaft were positioned as receptors of the media, civil society, government scrutiny and action. While action was taken in 2011 to relocate some of the families living in this area, it does raise a red flag in terms of preserving basic human rights in relation to historic mining waste and unresolved governance concerns.

Additional evidence suggests that other settlements, such as Bull Brand, Soul City, Baghdad and an RDP settlement close to the Tudor Shaft informal settlement, may need to be relocated due to similar mining waste contamination concerns (Mcleod, 2011).

Silicosis

The negative health impacts of mining waste on humans are not limited to communities living close to mines. Exposing a grisly side of the mining industry, many men who worked in the gold mines (some for longer than 30 years) now suffer from silicosis, a preventable lung disease that is caused by exposure to silica dust while working in the mines.

The main symptoms of silicosis are a persistent cough, shortness of breath, weakness and tiredness (NHS, n.d.). These symptoms might only manifest many years after exposure to silica dust in the gold mines. As the conditions become worse, simple activities such as walking or climbing stairs become difficult (NHS, n.d.). Silicosis also wields hidden gender impacts. In a two-part documentary, the *Mail & Guardian* presents some of the gender justice challenges that have emerged in remote parts of the country due to silicosis and further illustrates the socio-economic implications of gold mining, which run far deeper than those evident in Gauteng (*Mail & Guardian*, n.d.).

Workers released from the mines often receive little or no compensation. In many cases, it is the primary household breadwinner who falls ill and cannot continue to work. Wives and children take on the duties of supporting the sick and sourcing other means to support their families. In the words of Nokubonga Nkosi, the wife of an ex-Witwatersrand miner: "We are not surviving at all. My husband is sick. We have no money and no food." She continues, "He is working on the mines for 30 years [and] at the end of the day, they don't care about him" (*Mail & Guardian*, n.d.). Primrose Yaka, whose husband also suffers from silicosis, now runs a local shop to make enough money to support her family (*Mail & Guardian*, n.d.).

Recently, 200 members of the Treatment Action Campaign (TAC) picketed outside the high court in support of what may become South Africa's first class action suit against the gold-mining industry (Thamela, 2015). An update on the Treatment Action Campaign website indicates that the silicosis hearings are ongoing (TAC, 2015). At a hearing held on 12 October 2015, applicants requested to continue the case as a class action to allow for the rights of many silicosis victims to be decided by a single application (TAC, 2015). Mining houses refuted this. The Treatment Action Campaign continues to urge mining houses to co-operate in order to ensure adequate compensation for tuberculosis victims (TAC, 2015).

These case studies highlight broader concerns around the way in which mining landscape legacies will play out in the years to come. At present it appears that neither one actor, nor one group of actors, has come forward to take on the socio-economic liabilities of the bygone mining era. In addition, the very system used to regulate and enforce legislation that governs mining activity needs to be addressed. There is also a need to develop clear strategies to remedy historic mine waste, which demands a co-ordinated effort by government in participation with mining companies, civil society organisations and the public.

These case studies can be interpreted through the concept of environmental racism, for example the discriminatory pollution patterns described by Pulido et al. (1996) in Los Angeles in the United States where Chicano/Latino communities were exposed to poor air quality due to local relations of race, class and space. This presents a compelling comparison with the historic locations of black communities on land adjacent to mining waste during apartheid.

"The drive for the development of land beside the mining belt emerged from political pressure to build low-cost housing in Johannesburg."

The notion of environmental racism also applies in the case study on silicosis, where mines benefitted from the apartheid migrant labour system, employing cheap black labour and allowing workers to perform their working duties in unsafe environments (TAC, 2015). In both case studies, silicosis victims are non-white and poor, which prevents them from seeking out sufficient medical treatment (as in the case of Chicano/Latino communities in Los Angeles).

Land and people

The apartheid spatial legacy, which has been enhanced in South Africa's democracy through the Reconstruction and Development Programme (RDP), has seen the racialised location of black people on dangerous peripheral ground or in areas that cannot support them (Manungufala et al., 2005). The example of Soweto in Johannesburg will be used here to illustrate some of the complexities of developing land beside the former mining belt and how this may be placing individuals at risk of mining waste contamination.

Two major formal spatial developments took place in Soweto between 1990 and 2000. This included "the development of 'less formal townships' on the mining belt to the north-west of Soweto and the second was the initiation of the Baralink Regeneration Project" (Harrison & Harrison, 2014: 299). The drive for the development of land beside the mining belt emerged from political pressure to build low-cost housing in Johannesburg (Harrison & Harrison, 2014: 299). Land littered with slimes dams and mine dumps was selected for development by the City Council. The development of land in the mining footprint allowed the profits of post-active mining to continue along the Witwatersrand.

In addition, a number of township areas were developed during this period to the north-west of Soweto which intersect the mining belt – Bram Fischerville, Thulani, Slovoville, Matholesville, Tshepisong and Lerato Village. It was widely known that these settlements had "a lower level of servicing than other townships and housed a very poor population" (Harrison & Harrison, 2014: 299).

A shift in the business focus of mining companies from active mining to property development has allowed derelict land beside mining waste, or on areas of land that have been reclaimed from mining waste, to be developed. Considered to be a "significant force in the expansion of the south", the land in the



Photograph by Clive Hassall

south of Johannesburg formerly used by eight mining companies that all closed in the late 1970s was earmarked for development. (Harrison & Zack, 2014: 278). Johannesburg's significant housing need has meant that much of this land is allocated to public and private housing (Box 9).

Manungufala et al., (2005) and Tang and Watkins (2011) explain that land beside mine waste continues to be earmarked for low-cost housing and hosts numerous informal settlements. A recent study by Kneen et al. (2015: 9) reports that "continued human encroachments into marginal lands pose a growing risk of human health consequences" as a result of the "surge in residential dwellings" next to mining waste. This study was supported by the analysis of aerial photographs, satellite imagery and national census data (Kneen et al., 2015). The location of settlements enhances the negative effects of mining waste on human health (Kneen et al., 2015). Instead of forging a new legacy ensuring the location of individuals and communities in a safe and healthy environment, this approach expands a legacy of inequality where economically marginalised individuals are further impeded by the contaminated environments in which they live. Where tracts of land remain undeveloped, informal settlements (and other types of temporary settlement such as Tudor Shaft) may emerge. Planning authorities do not control this type of settlement. While municipalities attempt to prevent the development of informal dwellings on contaminated land, it is not a sure way to stop the settlement of people on this land (Box 9).

Box 9: Post-apartheid public and public–private housing investment

SIÂN BUTCHER

The most notorious form of housing connected to mining land is that of mine hostels – dormitories for mine workers run under prison-like conditions by mining companies for most of the 20th century. The Mining Charter of 2003 made the 'humanisation' of this hostel housing an important part of transformation within the mining sector. Since many of Gauteng's gold-mining companies (and hostel 'owners') have long gone, hostel upgrading has generally become the responsibility of municipal housing departments. In Johannesburg, for example, JOSCHO has been redeveloping the City Deep hostels since 2005. Other hostels, like that at Rand Leases, remain untouched.

But the state has also been involved in other kinds of residential developments on land connected to mining, although not necessarily mined. For example, the Riverlea extensions of the early 1990s were one of the City of Johannesburg's first such projects. Built before national legislation set minimum distances for development around mine dumps, Riverlea's proximity to the dumps has been an endless source of health-related ailments for residents (Smallhorne, 2012). More recently, following the mid-2000s Breaking New Ground housing policy and the Housing Indaba, we have seen the rise of large-scale, public-private integrated development in pockets of the 'mining belt'. Pennyville in New Canada was one of the first. Formally launched in 2008, it was built by the City of Johannesburg's Department of Housing and a private company – the Pennyville Zamimpilo Relocation Pty Ltd. Calgro M3 was also a major player. Pennyville's 2 800 'housing opportunities' of various kinds were aimed at re-housing the Zamimpilo informal settlement through a land exchange.

Close by, in what used to be the City of Roodepoort's Florida, next to the Rand Leases hostel and informal settlement (the subject of a 2011 High Court eviction case), the Fleurhof mega project has extended the Pennyville model. The joint venture between the National Department of Human Settlements, City of Johannesburg, Gauteng Partnership Fund, First National Bank, land owners and developers Calgro M3 and International Housing Solutions private equity group broke ground at Fleurhof in 2009. With a R2.8 billion phased budget, it will eventually provide 8 000 housing opportunities – from RDP apartments to social rentals to private rentals and fully bonded houses.

In both Pennyville and Fleurhof, the land was not seen as needing any rehabilitation prior to construction. At other sites, the expense of rehabilitating contaminated or undermined land has meant that public housing has not been built on such land. In fact, municipalities are trying to remove many informal settlers who have made their homes on these mine residue areas. There are ethical debates about the level of risk in living on mine residue areas. A mid-2000s study found that a sample group was willing to take such risks in return for proximity to the city (Simons & Aly, 2008). The City of Ekurhuleni embarked on a feasibility study into the possibility of residential development on their extensive mining-affected land.

Conclusion

Physical processes such as wind and water flows disperse mining waste into the surrounding environment (Oguntoke et al., 2013). This places communities residing close to mining waste at risk of poor health (Box 10). Health concerns brought about by mining waste manifest as non-communicable diseases, including respiratory and neurological conditions and kidney damage (Wright et al., 2014). As some of these health concerns can only be treated symptomatically, it makes it difficult to trace mining waste contaminant and it is often not possible to prove that individual mines are the cause of human health concerns.

The impacts of mine waste on communities and human health have resulted in a series of environment justice concerns. The exploration of two case studies – the Tudor Shaft informal settlement and silicosis – indicate instances of environmental injustice due to the violation of basic human rights and limited democratic accountability (McDonald, 2002). As presented here, it is apparent that no one actor or group of actors will take responsibility for health and social concerns that remain after active mining ceases. Buck-passing among various actors, including government and industry, appears to be commonplace (Humby, 2013). Towards challenging these injustices, South Africa's first class action suit was lodged against the gold-mining industry in 2015, appealing for compensation for former mine workers suffering from silicosis. These sufferers, much like the Witwatersrand's mining waste, seem to have been abandoned by mining companies (Thamela, 2015). The main argument of the suit will need to dissect the incongruences that exist between abandoned mining waste (a feature not bound by formal legislation until the 1990s) and its implications for human health both now and in the future.

The continued development of formal low-cost housing and the informal settlement of individuals along the mining belt have sustained the environmentally unjust legacies of mining. While land where formal development takes place meets national standards for the rehabilitation of mining waste, the location in which such developments are positioned may remain nestled among mining waste footprints. The dire need for housing, in Johannesburg in particular, means that open tracts of land between mining waste sites are being occupied by informal settlements due to their close proximity to the inner city. Individuals who live in these areas are often doubly or triply burdened: they are poor; they are forced to settle on unsafe or unstable land in inadequate housing; and they have limited access to basic services such as social, health and educational facilities.

The city-region's legacy of mining waste will continue to affect its social, economic and environmental characteristics. The impacts of mining waste will be felt on both a local and regional scale – ranging from increased health impacts to rising pollution and deteriorating air quality. Interventions driven by the public and public sectors, policy-makers and planners need to address these legacies collectively to ensure sufficient rehabilitation and management measures are followed. These interventions can be designed to contribute to broader processes of transformation, where mine residue areas can be converted into productive spaces that enhance the future development of the city-region.

Photograph by Clive Hassall



Box 10: Mine waste, income and settlement vulnerability

KERRY BOBBINS

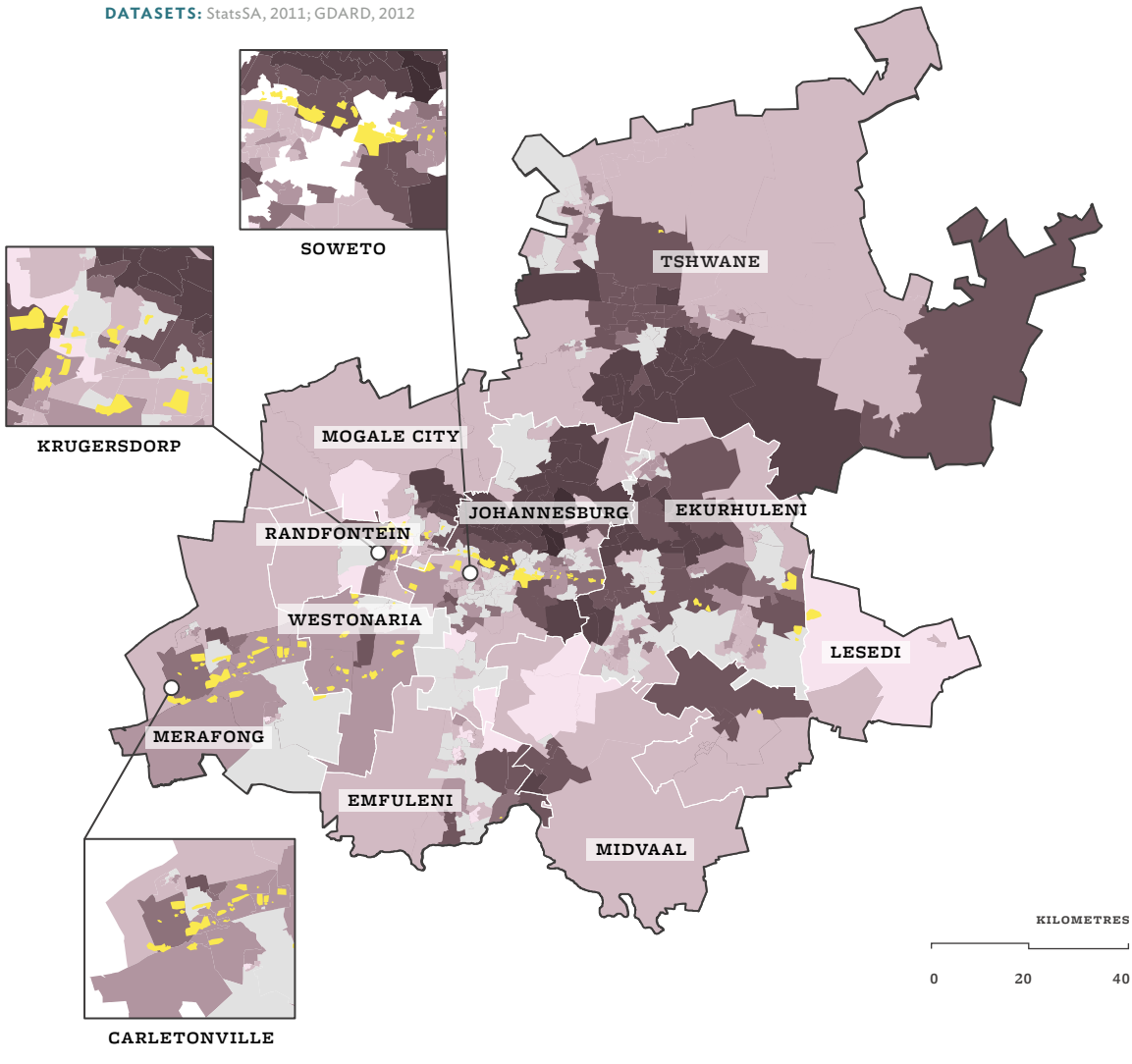
Communities located beside mine waste are likely to be more vulnerable to toxins and contaminates if they have a low household income. Based on the cyclical relationship between poor health and low incomes, which has been proven in studies by Feinstein (1993) and Cameron and Williams (2009), communities with limited incomes to develop good health in turn further limit their income (by missing days at work, their inability to work due to sickness, etc.). Applied to the Gauteng City-Region, community adjacency to mine waste may well exacerbate links between low annual incomes and poor health because these communities have limited resources to offset the effects of mine waste on their health or to relocate to another part of the region.

Data on average annual household income from the Statistics South Africa Census 2011 allowed for the testing of the spatial location of low annual household incomes in the Gauteng City-Region. Census data – opened in a statistical software package – allowed the number of households in each ward (only in Gauteng) to be listed according to their annual income category (see Figure 27 for a list of categories). The most commonly occurring household income category per ward indicated the frequent annual income earned across households in a particular ward; it did not represent an average. Mapping household income and mining waste indicates the location of low household income in relation to sites of possible contamination.

The map in Figure 27 shows that low annual household incomes typically fall beside mining waste. Low annual household incomes near Soweto, Krugersdorp and Carletonville indicate areas where the cyclical nature of low income may affect poor health. Limited access to resources may in turn place further challenges in view of breaking this cycle. Interestingly, wards directly beside mining waste have a lower annual income per annum than those found further afield. Figure 27 indicates this, with wards directly beside mine waste having a common annual income between R0 and R38 200, and wards further afield showing incomes between R19 600 and R1 1228 800 per annum.

Figure 27: Gold-mining waste divides Gauteng above and below the mining belt. Areas with a lower annual income per ward are observed to fall below the mining belt.

DATASETS: StatsSA, 2011; GDARD, 2012





Photograph by Clive Hassall



6. Photo Essay 2

Processing illegal gold

JANET MUNAKAMWE

Ethnographic studies indicate that partaking in informal mining activities is a desperate and dangerous socio-economic strategy for survival. This photo essay provides a general overview of the surface workplace for illegal gold miners (or zama-zamas) in Johannesburg and the methods used to process gold.

Informal gold miners work in teams according to tribal, ethnic or national delineations. Field data completed on this photo essay indicates that there are very few South Africans (approximately 2%) involved in illegal gold mining. This is because many South African households rely on government social grants, which reduces the need for individuals to seek out opportunities associated with informal gold mining. South Africans called 'Joburgers' typically run small peripheral businesses, such as 'amakitchen' (catering for the zama-zama), shebeens (unlicensed establishments selling alcohol), and shops selling fruits, vegetables, clothes and other products.

Many of the women involved in informal mining activities mentioned that they could not afford to send their children to local childcare facilities due to the irregular nature of their earnings. They earn between R70 and R100 per day for work done from as early as 05:00 to midday, although some work until 14:00. In summer it is difficult to work later because of the scorching sun. Winter allows workers to toil longer hours due to the reduced heat, and they are able to manage the cold by using warm clothing and blankets. The worst time to engage in this type of work is during the summer rainy season.



STEP 1: BREAKING DOWN GOLD-BEARING ROCK

This tool is one of the major artisanal tools used by zama-zamas, popularly known as 'hamura' (hammer). The miners use it underground to extract the gold-rich rock. On the surface, it is used at the very first stage of processing to break rock before pounding it. Also, hammers might be used in conflicts between miners, workers and the police if and when they occur.

Image: Alexia Webster



STEP 2: 'KUKUYA' – GRINDING

Women employed by zama-zamas often work with babies on their backs. The women grind ('kukuya') the crushed rock into 'ash-like' fine sand. The majority of these women suffer from chest pains and other health concerns because of exposure to sand with no protective gear to cover their mouths. Owing to the health and safety risks attached to their work, many prefer to work hard for a short period and use their earnings as 'capital' to start small businesses such as informal restaurants called 'shisa nyama', where they braai and sell meat. These are the main eating places for zama-zamas.

Image: Alexia Webster





STEP 3: GATHERING – 'VHOVHO'

Sometimes 'crushers' who pound gold-rich rock into fine particles are paid in the form of sand tribute or 'vhovho', which is the term used to describe sand that is rich in gold particles. Crushing rock is a laborious process; however, it yields more income than the daily rate (between R70 and R100 per day).

Here we see a woman gathering 'vhovho'. Every particle or grain on the grinding rock is collected because it could contain traces of gold. Nothing is wasted.

Image: Alexia Webster



STEP 4: DRAINAGE PROCESS

A makeshift drainage system – using a carpeted incline and water – allows for the separation of gold and sand. Gold particles (encased in impurities) remain on the carpeted surface (as they are denser than water) after they have been washed with water. The gold particles are then collected for purification and the remaining water and sand by-products are discarded.

Image: Alexia Webster



STEP 5: SEPARATING OF SAND AND GOLD PARTICLES

To purify gold, a mixture of water, gold and mercury is used. Impure gold is placed in a bucket of water and mixed with mercury to form 'amalgam gold' (or a lump of gold). Mercury is used to amalgamate very small gold particles, leaving behind any remaining impurities.

The amalgam gold is sold on to buyers according to a daily price. This price can fluctuate between R350 and R380 per gram, depending on demand and supply (prices calculated at the time of study).

Image: Alexia Webster



STEP 6: THE SIGNIFICANCE AND CRIMINALITY OF MERCURY

Mercury plays a central role in the processing of gold and formal mines usually supply it. This indicates a link between formal and informal mining. In fact, some informal workers claim that their activities are directly sustained by some formal institutions and mining companies. A small tube (50 ml) costs around R500. Without this metal, gold cannot be extracted. Dark marks on the hands of zama-zamas bear testimony to the use of this highly toxic metal.

Mercury is a controlled substance. If miners are found in possession of mercury, they can be arrested.

Image: Alexia Webster



STEP 7: AMALGAM GOLD

This is amalgam gold that is ready for smelting in a furnace at an informal 'plant'. Gold from South African mines is referred to as 'reef' and is usually 89% pure. The purer the gold, the more it weighs on the gold scale, and the higher the market price. Gold can be as pure as 99%, but cannot exceed this. As it solidifies, gold gathers impurities from the air and therefore loses the 100% purity.

Image: Alexia Webster







Box 11: Informal gold-mining activities in the Witwatersrand

KERRY BOBBINS

In 2013 the Chamber of Mines estimated that approximately 30 000 individuals have taken part in illegal mining activities over the last ten years (Whittles, 2015). Revenue collected from informal mining activities over this period equates to approximately R5 billion (Whittles, 2015).

Available literature does not detail the reasons individuals take up mining activities, but it is clear from the emerging set of outputs that the ability to work and earn an income is a driving factor (Steyn, 2012; Love, 2015; Whittles, 2015). In a *Mail & Guardian* article published in 2012 on illegal miners, it is stated that miners can earn up to R300 for every gram of gold concentrate extracted from the ground and approximately R1 000 per day (Steyn, 2012). Steyn (2012) reports that 'for them it is worth it' and, in light of the limited availability of jobs in the gold mining sector along the Rand, indeed it is.

The decline of gold mining along the Rand has led to the discharge of many skilled mine workers into the job market, once mines had closed after the 1970s. Workers may resort to informal mining activities to support their livelihoods. Informal miners include internal and external migrants (with mining or other skills) who flock to the Rand in search of economic opportunities (Love, 2015; Whittles, 2015).

Informal mining activities such as those outlined here are illegal and, as such, are not informed by policy frameworks and legislation (Love, 2015). This means that informal gold mining along the Rand is not a regulated activity and exposure to harmful contaminates in mining waste can affect human health and the surrounding environment. Informal mining activities, therefore, come with a set of risks and hazards associated with exposure to (or direct contact with) contaminated mining waste, or due to injury while extracting gold. The risk of injury is high as miners often do not have proper access to safety gear and they mine gold in areas that are difficult to access (such as human-made underground tunnels).

The social structures that govern Gauteng's seemingly abandoned mine waste are complex. There are increasing accounts of violence over mining waste along the Witwatersrand, for example the killing of fifteen illegal miners over three days at Grootvlei mine in Springs in September 2015 (eNCA, 2015; Hartleb, 2015). It has been reported that the emerging 'industry', now colloquially named zama-zama mining, is largely unknown and under-researched (Whittles, 2015).

A recent report by the South African Human Rights Commission on the issues and challenges of unregulated artisanal underground and surface mining activities in South Africa points out that greater research is required to understand the links between artisanal and small-scale mining activities, society, environment and the economy (Love, 2015).

Photograph by Potsiso Phasha

7. Photo Essay 3

Scavenger economies of the mine dumps

POTSISO PHASHA

"I work here and whatever I make is for my house back home. I will never stay here – I am here for work alone. Life is hard. But you must never suffer as long as you still have your hands; that's what my father taught me. He taught me you must work hard to have your own things."

TOFARA, A ZIMBABWEAN NATIONAL WHO WORKS ON THE MINE DUMPS.

In 1886, a prospector digging in the ground in an area just west of what is now Johannesburg discovered gold. His discovery led to the establishment of the world's greatest goldfield, the Witwatersrand, a reef stretching some 55 km in an east-west direction (Harrison & Zack, 2012; Mphephu, 2003).

As more and more mining activity took place on the Witwatersrand, its physical landscape began to change. A number of mine tailings began to define the landscape – a result of mining operations during which large volumes of ore were mined and brought to the surface where it was crushed and gold extracted (Mphephu, 2003). The pale mine tailings have since become 'permanent' features of our landscape. According to Mphephu (2003), there are over 250 mine tailings covering an area of 44 000 hectares. At the time of their establishment, mine tailings – commonly referred to as 'the mine dumps' – contained fine traces of gold that could not be extracted. With advances in mining technologies and increasing gold prices, however, the tailings have – over the last two decades – been reprocessed to recover the gold still in them.

Today the region's physical landscape is once again in a state of transition due to this reprocessing. The reworking, in which mining machinery reshuffles the mine dumps, has resulted in an unusual scavenger sub-economy. Every day, from dawn to very late in the evening, groups consisting only of men intensively and illicitly work the polluted soil of these pale landscapes in search of scrap metals – leftover fragments of old mine operations that have either surfaced through the mechanical reshuffling or are manually dug up. This is best seen on the mine dumps on the eastern edge of Johannesburg along Heidelberg and Rosettenville roads, the focus of this photo essay. As the scrap metals surfacing in one site become depleted, the men move on to other areas, often resorting to manual excavation in order to maintain their livelihoods.



The intensity of this scavenger sub-economy is intriguing. On the one hand, it is very different from what is conventionally understood and valued as an 'urban economy' by city-planners. On the other hand, it is worth asking whether this economy, although largely invisible, is any different from the early prospecting activities – where opportunity-seekers dug in the ground for scraps of gold a century ago in the same area – that were the very foundations of the city-region we have today.

This photo essay follows a group of men in the Rosettenville and Booysens areas of Johannesburg, who make a living through 'scavenging' for scraps of metal on old mine dumps. It places them in the context of the strange and distorted mining landscapes they inhabit, and reveals some of the key dynamics of their activities, from the moment of unearthing left-over metal shards to when these are sold to scrapyards in the nearby Johannesburg central business district. Ultimately, the essay portrays the workings of an invisible but vibrant economy on the region's mine dumps – seemingly dead spaces typically overlooked as mere waste ground.



The mine dump off Rosettenville Road south-east of the Johannesburg inner city is interesting because of its 'dual' nature. It is formed from mining waste dug up from underground, as well as from construction rubble that has been dumped there. Both layers contain traces of metals. Its dual nature is reflected in the fact that a mining company is currently re-mining it for gold, and a group of men is searching it for metal waste. Both are now reshaping the landscape.



Working in these landscapes has dangers, the biggest being the fact that the ground becomes more unstable the more excavating the men do. With no proper mining tools, their work creates cliffs that regularly collapse. This particular area in the photograph has a large concentration of steel, but the cliff now has a crack and rock chips off a number of times a day. Most of the men now fear digging here. The instability of this landscape is further aggravated by rain. "Water is dangerous because it goes between the cracks and makes the ground loose," says Ronny, one of the men who works on the mine dump every day.



Most of the men dig very close to the edge of the hill. Although dangerous, digging here has some advantages. The biggest one is that boulders and undesired rubble can be thrown off the dump with ease and so do not need to be carried away. This facilitates faster digging, which implies that more money can be made in a day. Working further from the edge means the process of digging is hampered by all the rubble that is unearthed and left lying around, covering other potential areas for digging. Working on the edge is also advantageous because, when it is time to leave at the end of the day, the metals are easily thrown off the cliff to the bottom where they can be collected again and carried away. This enables the men to climb down the hill without an excess load.



The mine dump undergoes physical change every day. With various metals – ranging from steel (heavy, light, stainless) to aluminium, copper, brass and lead – being extracted, a series of 'caves' remain. These indicate to the other men where the dump has been dug before. The steep gradient of the landscape prevents them from digging too deep as more and more cliffs and caves are created, in turn increasing the danger of working these spaces. Hence the men constantly move around to dig in new spots.

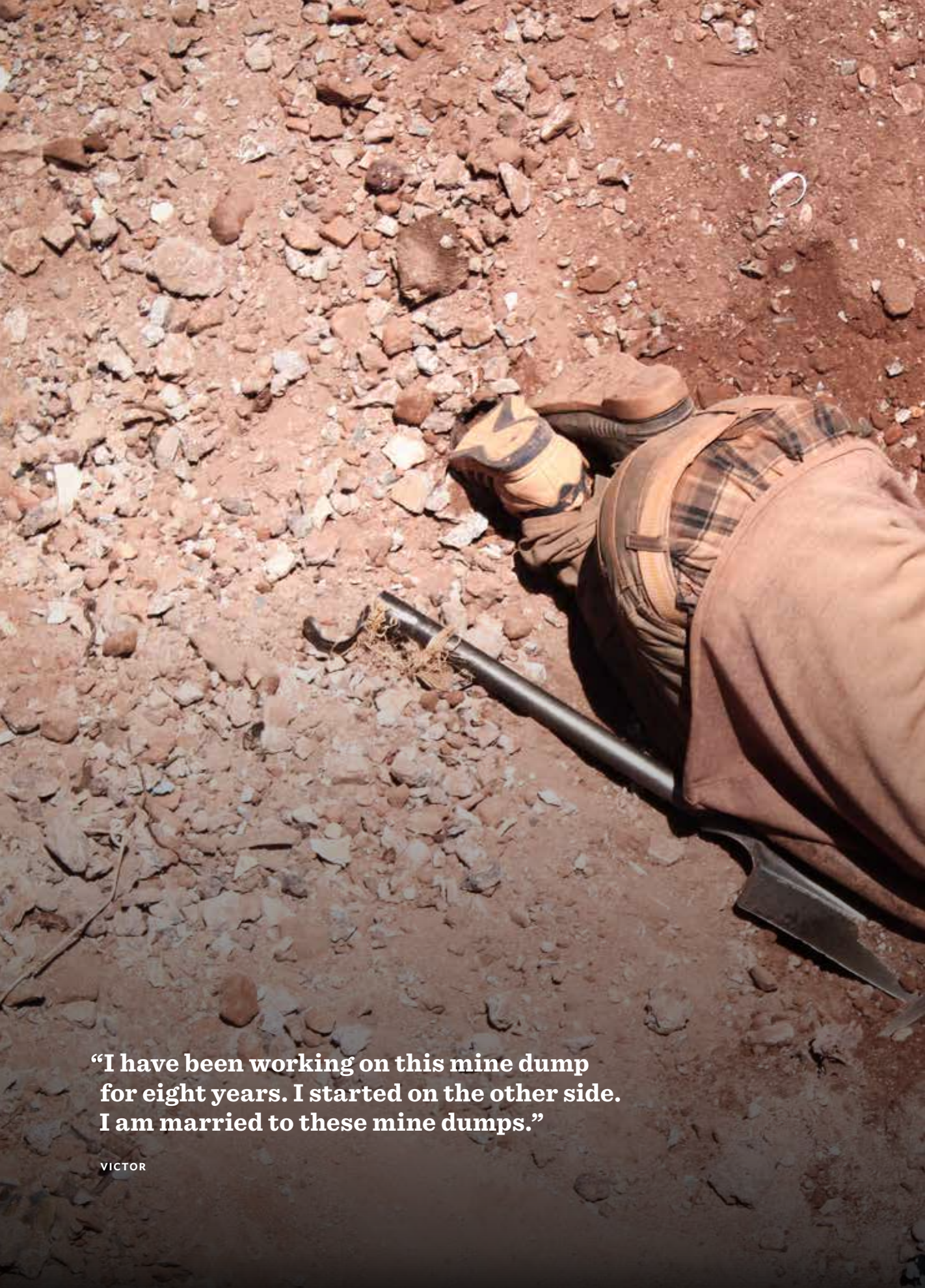


Ronny walks back from fetching water and buying cigarettes from an informal trader not far from the mine dump. Whenever one of the men leaves the dump to go to buy something, the other men give him their money to buy for them as well. Sometimes they go all the way into the Johannesburg CBD to buy bread to eat over lunch. This interaction demonstrates a mutual relationship between two different informal economies – street trading and 'illegal' mining, but also the ability of these economies to bleed into the formal economy.



Most of the men on the mine dumps are Zimbabwean. Ronny talks about how working on the mine dumps is a real job for him, the same way people go to work in offices every day. As such, he has developed a strong work ethic and sense of discipline. "South Africans do not like these kinds of jobs because they are laborious. You have to work very hard. They prefer better jobs, white-collar jobs at the office. Because they have an ID, they can access more things like applying for loans," says Ronny.

"I have to save and take everything back to Zimbabwe. Every time I go home, I take everything I own. When I come back, I start from scratch."



“I have been working on this mine dump for eight years. I started on the other side. I am married to these mine dumps.”

VICTOR







Victor, along with the other men, speaks of another gang of men that operates on the mine dumps. Their mission is to acquire as much of the steel being unearthed by the mining machinery as possible, with as little work as possible. They follow the machinery as it moves around reshuffling the mine dump, assuming 'ownership' of that part of the dump, and everything that the mining machinery brings to the surface. The gang comprises about 20 men, who are feared for not hesitating to use violence to secure any of the metals the machines unearth. They are not interested in doing any manual work and, as such, 'appropriate' the big mining machines to work for them. In instances where very little steel is brought to the surface, the gang is also known to rob the other men of the scrap metals they have found, claiming these were dug from an area that 'belonged' to them. This reveals a criminal economy living off an 'illegal' economy that also feeds an informal trader economy. While some of the interactions in the space where these different kinds of economies exist are defined by mutual gain, others are driven by individual benefit. The result in the latter case often has life-threatening consequences for those actors with lesser power.

Digging on the mine dump is a gamble. There are no guarantees that metals will be found on any given day. On this day, after many hours of digging, brothers Tofara and Ronny had only recovered a few strands of steel. Late in the afternoon, they moved to another spot to start digging. Since it was already late and they were frustrated, they decided to spend the night on the mine dump digging. "If I had a lot of money, I wouldn't be here. If you were to give me money today, I'd go straight to Zimbabwe. I was last there two months ago. I love Zimbabwe. I have my own land there. It is huge. I have cattle on it, and my younger brothers and cousins take care of them. I also love our president. Not 'like'; I love him! He gives his people land. Which other president will do that?" says Ronny.



After the metals are thrown down the mine dump, they are gathered into a bag and prepared to be sold on the same day. The heavy load is carried for a few metres to the road where a small truck comes to pick the men up. The men have a good relationship with a scrap dealer in the CBD and he offers them transport from the mine dump at no charge.



Although the men are here for the same thing, with no guarantees of success, there is no form of competition between them. They work together, eat together and share their tools. They also respect each other's workspace. In instances where one is not done digging in a particular spot, he is allowed a chance to continue in the same spot the following day. 'Mdala', in the picture, spent yesterday relaxing in the city's parks in the CBD, and today continues where he left off. He says he came back to dig as he had run out of money.



Ronny digs in his pocket to see how much copper he has accumulated. Of all the metals, copper is the most precious due to its high retail price. When recovered, it is immediately put away, normally in the pocket, to ensure that it is not forgotten on the mine dump at the end of the day.



The scrap dealers to whom the men sell complain when copper is still covered with a plastic casing, and often reject it on this basis. So, the process of trading the scrap metal involves a phase where it is cleaned on site to ensure that dealers do not reject it or offer a lower rate. The men burn the copper wires to melt off the casing and expose the copper wires inside. Each metal has its own retail price. Copper, in the picture, has the highest value – it is sold at a rate of between R48 and R50 per kilogram. Brass is R25/kg; stainless steel R8/kg; lead R7/kg; heavy steel, which is the most prominent of all the excavations, is sold at R2.50/kg while light steel trades at R1.60. The men are very aware of what is valuable and what is not – and how to treat the most valuable. Copper is the ultimate prize.



At the end of the day, the men make a quick cell phone call to their scrapyard owner and, within ten minutes his truck stops beside the mine dump. The metals are weighed and the men are paid immediately. Immediate access to cash means they are able to attend to daily bills such as food. Tofara talks about how, as a Zimbabwean, the cash payment arrangement is perfect for him as it requires no paperwork. Transactions are started and concluded within minutes. Being able to sell the metals on the same day saves the men money because they do not have to pay for any storage costs. All their scrap metal is now in somebody else's hands to store at their cost.



The Booysens mine dump, a few kilometres west of the Rosettenville Road dump, is relatively flat with a lot of vegetation. After some digging, the landscape begins to take on a different form. As it was mined shortly after gold was discovered in Johannesburg, heaps of underground soil define the terrain, marking the depths of the digging. The mounds of unearthed material reveal a series of past movements over the landscape and the traces of decisions made on it. They speak to the men of where and how deep to dig before moving on. The pursuit of opportunity is made visible through the day-to-day changes in the landscape. In the distance, the tall buildings of the Johannesburg CBD – a city built from these same kinds of excavations a century ago – can just be seen.



In the same way as copper goes through fire to get cleaned before it is sold, steel needs to be cleaned by knocking off the hardened bits of soil covering it. The pieces have been underground for a long time and are in a process of decomposition. Tlou, pictured here, talks about how these metals – when they were disposed of by the mines – were coated with chemicals that increased their rate of decomposition. The bucket on the right in the picture contains heavy steel that now looks like rock. Once it is crushed, the rust falls off and the steel inside is recovered.



“I don’t want to do this anymore, man. I want to do other things, I just need money to start. R2 000 would be okay to start. I want to buy things and sell to people. It is almost Christmas time now, people are going back home (to Zimbabwe) and they will be looking to buy clothes and toys and stuff. I must make money, my man.”

RONNY DESCRIBES THE PIPE HE IS CUTTING IN THE PICTURE AS HIS MEAL FOR TONIGHT AND FOR LUNCH TOMORROW.





◀ Ike and Ronny discovered this long pipe together one day while walking from the Booysens mine dump. From the road they saw a brown steel pipe jutting out from the earth, and discovered it was much longer than they thought. They do not know how long it is exactly, but judging by its thickness, diameter, and the current length of the furrow, it is estimated to weigh around two tons, which would be worth around R5 000.

▲ A municipal waste dump borders the Booysens mine dump. This dump has another group of men who also scavenge for recyclables such as plastic and glass. Like the gangs on the Rosettenville Road mine dump, they are known to be a violent group that views the municipal waste dump as a space for them alone. They are strongly territorial – anybody who goes up the waste dump risks their life as the group understands strangers to be there to take their 'money', referring to the actual waste. While some informal economies gel with ease, others within the same informal economic space are strongly repellent to each other due to the struggle to maximize waste, or money.



To some of the men, the mine dump has become more than a place of extraction. It is their home. They pay no rent, and they can work for much longer hours. This tunnel is on the Booysens mine dump. It links the municipal waste dump and the mine dump, and some of the men use it for shelter. "One guy discovered it. It was a small hole and he started to dig that hole more to see what was inside it. He found there were drums, steel drums, maybe about 80 of them. He did not tell anyone. Every day he would come here, take a few drums and go to sell them at the scrap yard. He didn't have to dig anymore. The other guys started to wonder what was happening and where this guy was getting the drums, because he would take like three each day and, in 30 minutes, he was gone, gone home. So they followed him and found the drums. From then, everyone began to take them and sell as well. And now it's a place where people sleep," explains Ronny.

"It's not too old. It was found last year towards the end of the year, like around this time. About eight people sleep in here every night."





It is much easier to dig during the rainy season. Some advantages of digging in the rainy season include the fact that the ground is softer and there is no dust. However, there are also disadvantages. The soil is much heavier to lift with a shovel, and rain is also a disruption to the workflow and productivity. If it rains for a day or two in a row, there will be no food to eat. The mine dump is empty and no one is working because all the holes that have been dug are filled with water, making it risky to walk around because it isn't clear which is a puddle and which goes deeper. But the rainy season does present an opportunity to store some metals, if they are in small quantities. Small but heavy pieces of steel are wrapped in plastic and placed at the bottom of the water-filled holes, making them easier to access the following day when the water level has subsided.





The mine dumps are liminal environments. The popular perception that they are dead spaces makes them attractive to criminal elements. Copper wires, often stolen, are sometimes stripped and prepared for sale here. Not many people interact with these places, making them a safe haven for activities that people would not do openly in other more accessible parts of the city.





While the process of unearthing scrap metal from the dump is itself laborious, the logistics of how these metals reach the market is equally so. At the Rosettenville Road dump, the scrapyard owner comes to collect the men and their metals. In Booysens, however, they have to transport the metals themselves, over a distance of close to three kilometres. While it is good to make the largest discoveries on the mine dumps, this comes at a cost. When the men have a fortunate day on the dump, unearthing a lot of metals, they may make more than one trip to the scrapyard to ensure that the finds do not over-accumulate, making it harder to transport them at the end of the day. The costs of transporting the metals come in various forms, ranging from physical and mental exhaustion to possible physical injury if a large piece of metal falls on a leg, for example, or someone accidentally rolls down the mine dump – as Tofara has done in the past. In some instances, the discovery is a single, heavy piece of steel. Such finds immediately escalate the costs.

Large finds not only require more manpower to lift and move, they call for moving equipment – often makeshift trolleys. These have to be sound and, in this precarious economy, this is seldom the case due to financial constraints. The trolleys are always shared, making them more vulnerable to damage. They also have a plastic base that bends under heavy loads, immediately reducing their mobility and requiring more force to push and pull. This is a great challenge, especially on the gravel road from the mine dump. The moment it reaches the street, less manpower is required, although it still rolls with the base touching the ground. Ultimately, all costs end up being financial. The strength required could result in physical injury; the digging itself could lead to health problems – as it has with Paul, who now has pneumonia – and the trolley also needs maintenance.




FOR SALE
TRG407 GP



One of the men who used to work the mine dumps has been given a job as a scrapyard assistant. As soon as scrap metals arrive, he cuts up all ties and weighs them and pays out. He is the 'face' of the shop. The owner only appears in cases of large sales that require large amounts of cash. On this particular day, for example, a group of men come in with over R4 000 worth of copper. In these instances, the shop assistant calls the owner to bring more cash to complete the transaction. The owner must always have cash to pay for incoming scrap. When scrap fills up at his shop, he quickly arranges transport to take it to a smelter in town in order to always have adequate liquid cash.

In order to remain competitive and to secure clients, the scrapyard owner says he sometimes organises braais for the men and, every day, he arranges soap and water for them to wash their hands. He needs to show signs of appreciation to the men because there are many other scrapyards around and he could easily lose them as clients. This is particularly so due to the fact that the trading process is not always a smooth one. Some tensions often emerge between the buyer and seller as both parties are aware that the other will try to maximise gains. Sometimes the seller has not cleaned the steel properly and it is still covered with other solids, or the copper wires are still covered with plastic. The buyer could easily offer a lower price, or claim that some steel is actually hardened solid and reject it. Both sides play this game of weight: the seller may try to attach additional weight to his metals by not cleaning them properly, while the scrap dealer might offer a



much lower rate claiming he is also offered a lower price when he sells poorly cleaned material for smelting.

In the end, an agreement is reached and final payouts are calculated. The calculator is a powerful symbol because it brings formal order into this scavenger economy. From sunrise to sunset there are no formal processes that govern the way scrap metals are extracted from the earth, although there are many hidden social codes and boundaries. The calculator stands as a tool of governance, an important link between the formal and informal economies. It subjects the men to another world of rules and logic, a numerical system that makes the thrown-away metal fragments they collect on the dead spaces of the mine dumps materially significant. This desk in the scrap shop also suggests a sense of authority – a station where matters are resolved and important things documented. The calculator establishes the domain of order. From this point on, the metals make their way into the formal economy.

**Names have been changed to protect the identity of each individual.*

8. Future mining landscapes

GUY TRANGOŠ AND KERRY BOBBINS

Introduction

Developing new visions for the Gauteng City-Region's mining landscapes will allow these *terrain vague*, in their numerous states of reprocessing or neglect, an active role in the redevelopment and growth of the city-region (Figure 28). Planning, conceptualising and imagining these spaces anew, however, are highly politicised acts, often ruled by vested interests and power imbalances. As Henri Lefebvre explained, "(Social) space is a (social) product [...] the space thus produced also serves as a tool of thought and action; that, in addition to being a means of production, it is also a means of control and hence of domination, of power" (1991: 26). The continued ownership of depleted mining land by the mining companies whose actions once so radically shaped the physical and social fabric of the city is an exemplar of this control. The vision of the landowner then drives the re-imagining of the mining landscape; while advocacy groups and government organisations attempt to foster new approaches, the landscape remains in ruin. Much mining land has also been abandoned by its owners and has become the responsibility of the state. This chapter explores the challenges of existing governmental programmes and details the importance of multi-disciplinary and multi-scalar collaboration as necessary for the successful reimagining of the mining landscape.

> **Planning, conceptualising and imagining these spaces anew, however, are highly politicised acts, often ruled by vested interests and power imbalances.**



Photograph by Potsiso Phasha

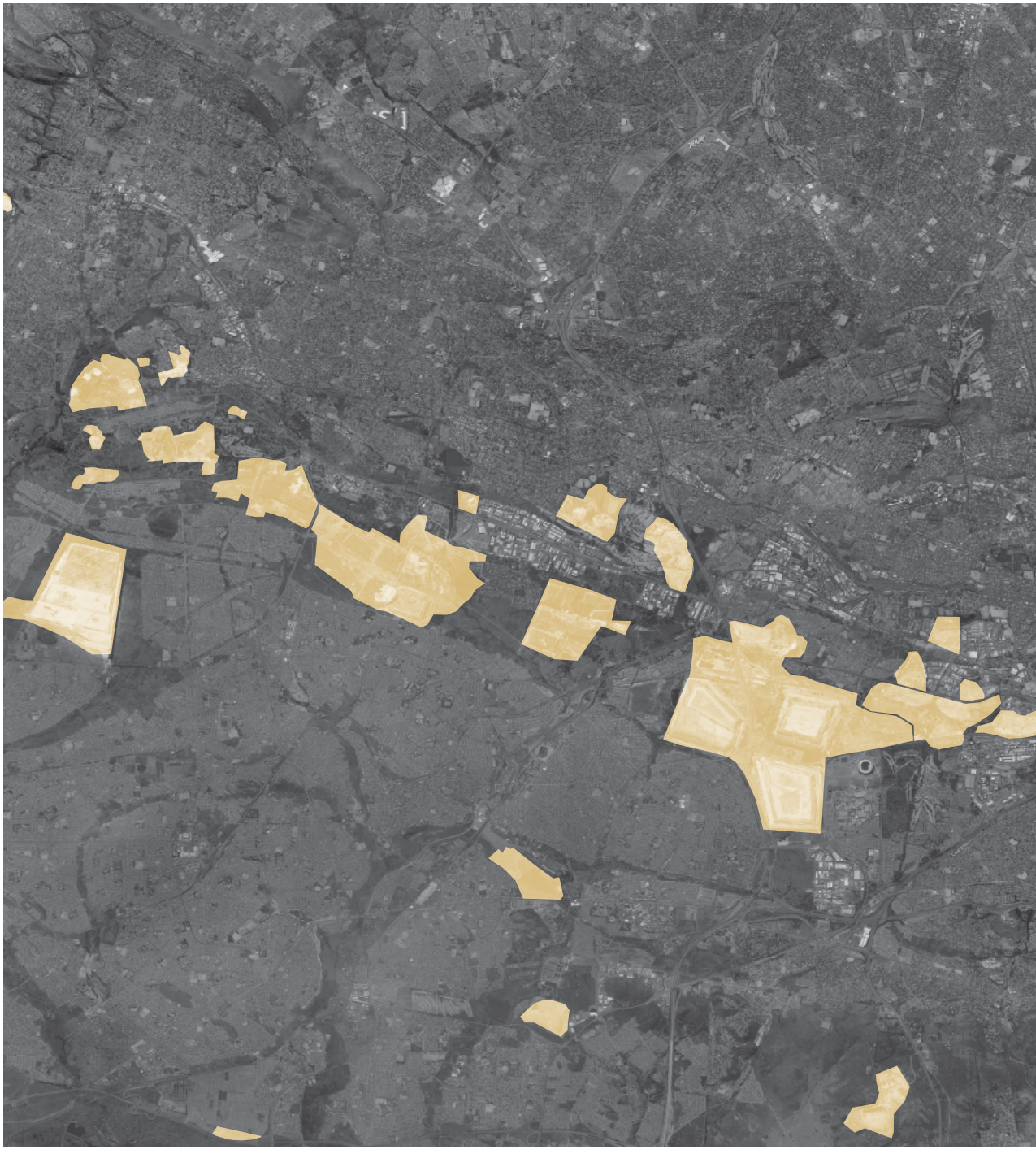
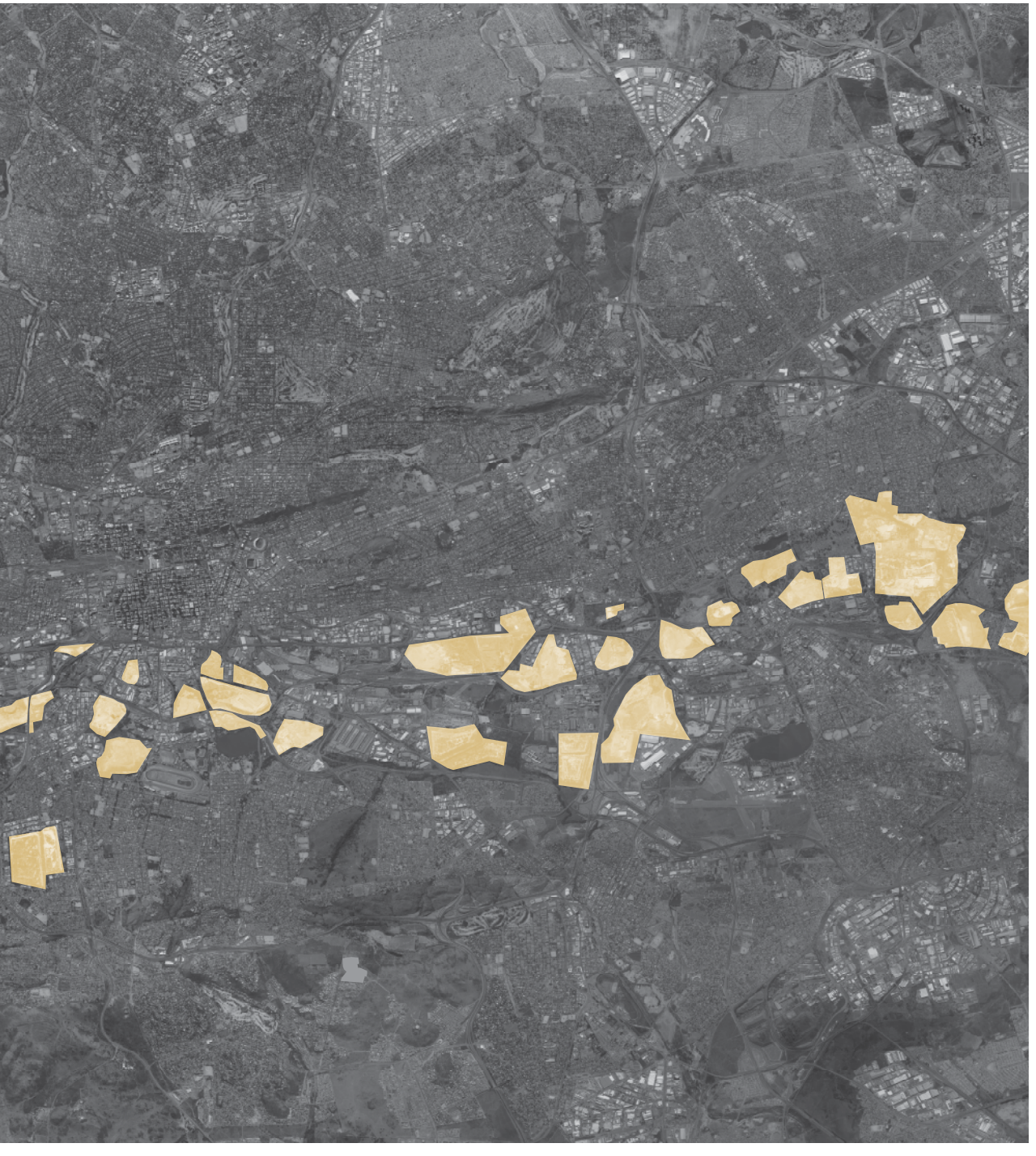


FIGURE 28: Johannesburg's mining waste (Image: GDARD Mine Residue Areas, 2012; NGI, 2012).



Existing programmes

National government

As mentioned earlier in this report, abandoned mining waste has become the responsibility of the state (PMG, 2010). In terms of addressing its responsibilities towards ownerless mining waste, the Department of Mineral Resources has adopted a programme to rehabilitate its collection of ownerless and derelict mines. However, due to the sheer number of these mines in South Africa, efforts made by the state to rehabilitate mines have been slow. For example, while six mines were allocated funds during 2011/12 for rehabilitation (DNT, 2011), only three were successfully rehabilitated (DNT, 2015). This increased to 13 rehabilitated mines in 2012/13 and 28 in 2013/14 (DNT, 2015).

In the Department of Mineral Resources Annual Performance Plan for 2013/14, the Department announced an internal programme in which thirty mining rehabilitation projects (to address ownerless and derelict mines) had been prioritised. In this same report, it mentioned that additional funding would be allocated to this programme between the years 2014/15 and 2017/18 as a way to prioritise rehabilitation activities and to meet government obligations towards addressing mining waste. These funds would allow for at least fifty ownerless and derelict mines to be rehabilitated per year (DNT, 2015).

It is noteworthy that management and oversight are complicated by divided interests within the Department of Mineral Resources, which is responsible for all aspects of the mining industry, namely its regulation, enforcement and promotion. This conflict in the Department provides little incentive to rehabilitate ownerless or abandoned mine residue areas or to mitigate their environmental impacts, despite new funding avenues.

Provincial government

In 2012 the Gauteng Department of Agricultural and Rural Development (GDARD) completed a study on mine residue areas entitled 'Gauteng mine residue areas strategy' (GDARD, 2012). This study recognised that the effects of mine waste on the health of citizens has legal implications for both provincial and local government – both can be held criminally responsible for failing to respond to their duty of care under South African law (GDARD, 2012). The study further detailed a rehabilitation strategy for Gauteng's mining waste as a means to reduce the risks posed to human health through the relocation of informal settlements adjacent to mining waste.

The Gauteng Department of Agricultural and Rural Development study (2012) also outlines three economically viable reclamation projects that would serve to create new land uses along the Witwatersrand. These include conservation and heritage approaches to enhance water resource protection and eco- and geo-tourism (in Mogale City); commercial and industrial re-development to stimulate economic activity and enhance property values (in Ekurhuleni); and urban and urban-rural agricultural development to foster sustainable livelihoods (in Johannesburg). While phase 1 of this project – which aimed to identify and characterise mine residues through a technical review – was achieved, there has been limited follow up on its findings. Attempts by provincial government to create an area action committee (for the management of mining waste and acid mine drainage) have also failed due to a lack of interest by national government and limited resources.

That being said, however, there are a number of smaller projects taking place in the city-region at a municipal level which aim to redevelop mining land across the province. One example is Project Hloekisa (Box 12).

Box 12: Project Hloekisa/Project Clean-up

SIÂN BUTCHER

The recovery of residual gold from mine dumps has not solved the problem of mine waste. Although a fair amount of land has been released from under old dumps that have gone through recovery in the re-mining of an old dump, 'new' waste is produced.

Increasing environmental regulation since the 1990s has led to various attempts to control remaining dumps and their toxic dust through greening (phytoremediation). From the early 2000s, however, the consolidation of re-mined tailings into a limited number of 'super dumps' has been prioritised.

In Johannesburg, this priority has been given the name 'Project Hloekisa'. It entails cooperation between various gold recovery companies, different landowners and multiple government agencies to jointly channel waste to the Nasrec and Ergo super dumps. Apparently this consolidation has the potential to release some 16 000 hectares of land. As such, the City is literally 'manufacturing real estate' as a DRDGold GM put it (Jacobsen, 2007). But it is uncertain how far along this Project Hloekisa has come. It has needed to depend on vast resources of energy and water for the tailings recovery, huge tracts of pipeline to the 'super dumps', and a sufficiently high gold price to buoy the lot.

Photograph by Clive Hassall



"Mining waste removal offers great possibilities for reconnecting the socially and economically fragmented city and for addressing the various socio-economic vulnerabilities that underpin Gauteng's unequal society."

New landscapes

Despite the legislative and managerial challenges that impede the sustainable rehabilitation of mine residue areas, they continue to offer immense opportunity for radical and innovative reconceptualisation. In turn, this could significantly address the city-region's complex mining legacies. This would include remedying their environmentally destructive nature, while creating new environmental, social and economic assets in the region. In order to achieve this, a break needs to occur from traditional sentiment that treats mining landscapes as wastelands, warranting mediocre remediation at best and often complete neglect. Instead, these landscapes can and should form part of the public imagination as spaces of considerable prospect, where new opportunities, natural landscapes and urban environments can be created.

Some mining companies, in search of new profits, have begun to remove their own spatial legacies from the daily-lived experience of the city by reprocessing mining waste (Box 12), or positioning themselves to benefit from the possibility of continued mining along the mining belt in the future (Box 13). The reprocessing of mining waste has resulted in the disappearance of once familiar landmarks, such as the 'mine dump' on which the popular Top Star Drive-In used to be located. Where mining waste once divided cities and communities, the new landscapes created through these processes present immense value to spatial transformation in Gauteng. Mining waste removal offers great possibilities for reconnecting the socially and economically fragmented city and for addressing the various socio-economic vulnerabilities that underpin Gauteng's unequal society. Similarly, unprocessed mine residue areas – and even those without prospects for reprocessing – hold immense possibility for the city-region as viable and functioning landscapes.

Reconceptualising Gauteng's mining landscapes, however, requires a number of important interventions. First, mining companies – and the state in the case of abandoned mining land – cannot remain the sole planners of their properties since these landscapes contain enormous promise for the city-region and cannot be left to the whim of property owners or managers alone. Municipalities and the Gauteng government should ensure that both reprocessed land and mine residue areas are redeveloped in line with local and provincial development frameworks, and that the needs of neighbouring communities and the greater city-region are realised. Second, it is essential that these landscapes not be left solely to market forces to determine their development. Instead, provision must be made for the creation of social and environmental assets, such as natural parks with rehabilitated waterways; productive landscapes bounding with employment and economic opportunities; transport infrastructure to connect distant neighbourhoods to urban centres; and mixed-use and mixed-income housing in prime locations.

These basic examples should be considered and planned in highly innovative and collective ways to ensure that they enrich the region, creating the economic opportunity the province so desperately requires, while rebalancing mining's environmentally destructive processes and providing new social assets.



Photograph by Clive Hassall

Box 13: A (limited) return to deep-level mining?

SIÂN BUTCHER

From the 1970s, the deep-level extraction of gold from Gauteng's mines became increasingly expensive. The decreasing price of gold, combined with the rising costs of ever-deeper shafts and lower grades of ore, saw the margins narrowing. The Mining Rights Act of 1967 allowed mines to consider other sources of profit, such as developing their surface landholdings, which had been prohibited before. New technologies for re-mining gold tailings from dumps developed in the 1980s and provided additional revenue streams, assisted once again by a high gold price. Underground gold production dropped dramatically, despite the fact that the Witwatersrand basin is still thought to contain 45% of the world's known gold reserves (Viljoen in Toffa, 2012).

In the first decade of the 21st century, soaring gold prices (increasing by 600% between 2001 and 2011) and new technology for extracting gold from lower-grade ore made the return to ultra-deep mining a possibility (Bryceson & Mackinnon, 2012). In Johannesburg, under the new mining rights and regulations of the Minerals and Petroleum Resources Development Act (Act No. 28 of 2002) and the Department of Mineral Resources, a mining and exploration company called Central Rand Gold (CRG) gained the rights to mine a wide area of the central Witwatersrand. CRG describes itself as 'bringing commercial gold mining back' to the city. But, since it began extraction in 2009, CRG has struggled to meet its estimates. Its share price collapsed in 2011, only to be rescued by a 2013 bailout from a Chinese private equity group (Brendan, 2013). Recently CRG partnered with another Chinese company to upgrade its infrastructure (Interactive Investor, 2014). As such, some analysts are sceptical about the feasibility of future deep-level gold mining.

However, private landowners along the mining belt have not abandoned the possibility of a return to mining. In the past, they made certain they could maintain access to shafts through flexible forms of land development, such as container yards and parking lots that could be reversed if the need arose. If such a mining future materialises and CRG exploits its rights more fully, it could potentially affect the spatial plans of the City of Johannesburg, especially in terms of the Department of Mineral Resources and the regulations of the National Nuclear Regulator that guide development near mining operations.

Box 14: Corridors of Freedom – re-stitching our city to create a new future

SIÂN BUTCHER

In his 2013 State of the City address, Johannesburg's Mayor Councilor Parks Tau announced the launch of 'a new spatial vision' – the 'Corridors of Freedom'. The Corridors of Freedom had two overt goals: one, to transform the apartheid spatialities that have pushed black and poor households to the periphery of Johannesburg's economic and social opportunities; and, two, to reduce the number of private cars on the road to lower congestion and carbon emissions, increasing sustainability. Under tight timeframes, Corridors of Freedom targeted a handful of key transit arteries. The City undertook to pour significant capital funding (R17.3 billion to start) into transport infrastructure in the hopes of kick-starting mixed-use, high-density development around these arteries (Cox, 2013).

In August 2016, local government elections saw the ANC lose political power in Johannesburg, and a coalition of the Democratic Alliance (DA) and Economic Freedom Fighters (EFF) take over. The new coalition government dispensed with the name 'Corridors of Freedom', but continued with a commitment to develop these Transit Oriented Development (TOD) Corridors.

In the medium-term plan for the Corridors of Freedom the 'mining belt' was designated as the final corridor to be prioritised. There are few public details about what this corridor would involve. In a public meeting in October 2013, then Member of the Mayoral Committee of Planning Roslynn Greeff said they had decided to develop the mining belt because 'it is an apartheid spatial barrier'. However, only certain kinds of land use are possible on it – in the maps disseminated it was marked off for 'industrial' use.

The global engineering firm Aurecon was given the contract to lead the infrastructural development, as well as community engagement, for Corridors of Freedom. The community was informed of the plans (post-design) to varying degrees. Responses ranged from a defensive NIMBYism ('Not In My Back Yard') in the suburbs around the Empire Road and Louis Botha Avenue corridors; concern about overinvestment in certain Soweto nodes to the exclusion of others; worries about gentrification and how this would increase accommodation costs in Turffontein; and general criticism of the lack of consultation, the hasty framework planning, and the lack of attention to the additional bulk services required.

Corridor planning is nothing new to post-apartheid Johannesburg's spatial visions. Since the early 1990s, the mining belt has appeared in city spatial development frameworks as an 'east-west' development corridor – although more present on paper than on the ground. What has seemed different about these TOD corridors has been strong political will and commitment of a large public budget, successful branding (if not communication), and an emphasis on attracting private-sector capital to these re-valued spaces (Property24, 2013).



Collective visions

In pondering new approaches to re-imagining the future of the region's mining landscapes, it is important to consider how multiple voices should be heard. Gauteng's residents need to continue to lobby, not only for the acceptable remediation of mine residue areas, but to participate in the decision-making processes that will help shape the environments that affect them. This is made clear in the Tudor Shaft informal settlement case study, where local members of the settlement were unaware of the ill effects of mine waste on their health. Similarly, different professions have a role in working collaboratively to develop the city-region in a sustainable and inclusionary way.

In order to take part in the planning and reconceptualisation of mining areas, it is important for all stakeholders and residents to consider diverse spatial imaginaries and multiple future scenarios for the mining landscape. These varied approaches should inspire a sense of what is possible in the minds of government officials, professionals and the public alike, allowing the stasis in the spatial imaginary to be challenged and overcome through new and innovative alternatives.

In February 2014, students from the University of the Witwatersrand's Master of Urban Design Programme and the Katholieke Universiteit Leuven's Research Unit in Urbanism and Architecture presented an exhibition on collaborative imaginings of the West Rand mining belt. The research followed a two-week field trip in the affected areas from which projects were developed. These were based on investigations of specific themes: water, soil, infrastructure, and the urban form and fabric. The results of the student projects offer keen insights into processes of remediation, twinned with innovative approaches to landscape design. These are featured here in Figures 29, 30 and 31. Developed using combined experiences of the various environments, these future visions provide new ways of considering the tracts of land left behind after a century of active mining. These projects present an opportunity to re-imagine and reshape the city to include the needs of both society and the environment. Serving as a vision for implementation, these ideas can benefit the uptake of more focused technical considerations to support more equitable landscape solutions.

The University of the Witwatersrand and Katholieke Universiteit Leuven students demonstrate that it should not only be government or mining companies that shape the mining belt. Innovation can stem from advanced land-use approaches, scientific processes, new institutions and an active engagement with a landscape that is so often represented as being without potential and beyond the scope of intervention.

Photograph by Christina Culwick



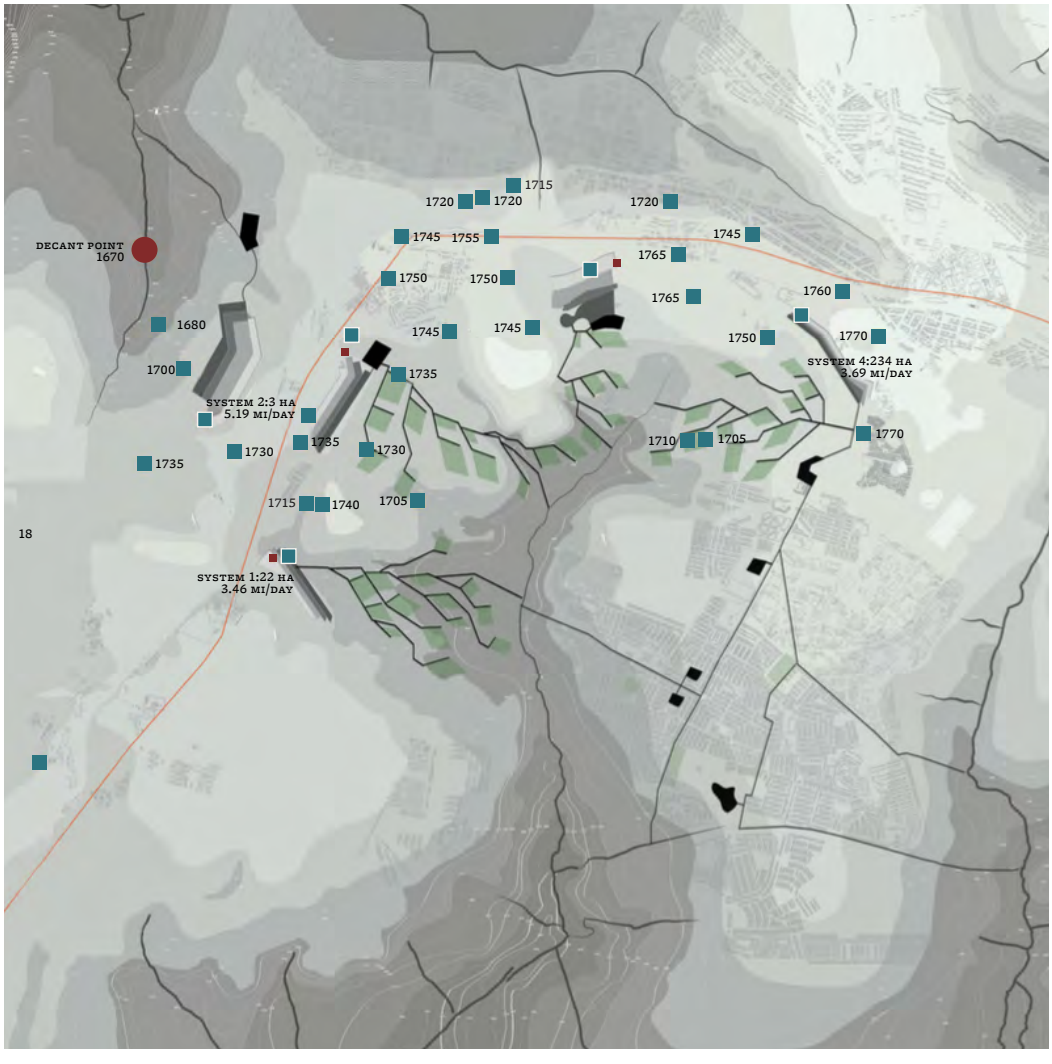


FIGURE 29: Processing mining water and improving the landscape: "... acid mine drainage can be pumped through several shafts to avoid decant in the natural water system. A four-step wetland system can treat the water through passive and natural processes. By keeping the water as high up in the topography as possible, it can be reused to irrigate agricultural production, water ponds for wildlife, and urban agriculture in Kagiso by using just gravity. The vast amounts of water – av. 27 ml/day, min. 10 ml/day in dry season, max. 60 ml/day in rain season – can be kept in the West Rand to produce agricultural products that have a high added value on the market, thus producing high economic return" (Image: Mining Belt Studio, 2014: 19).

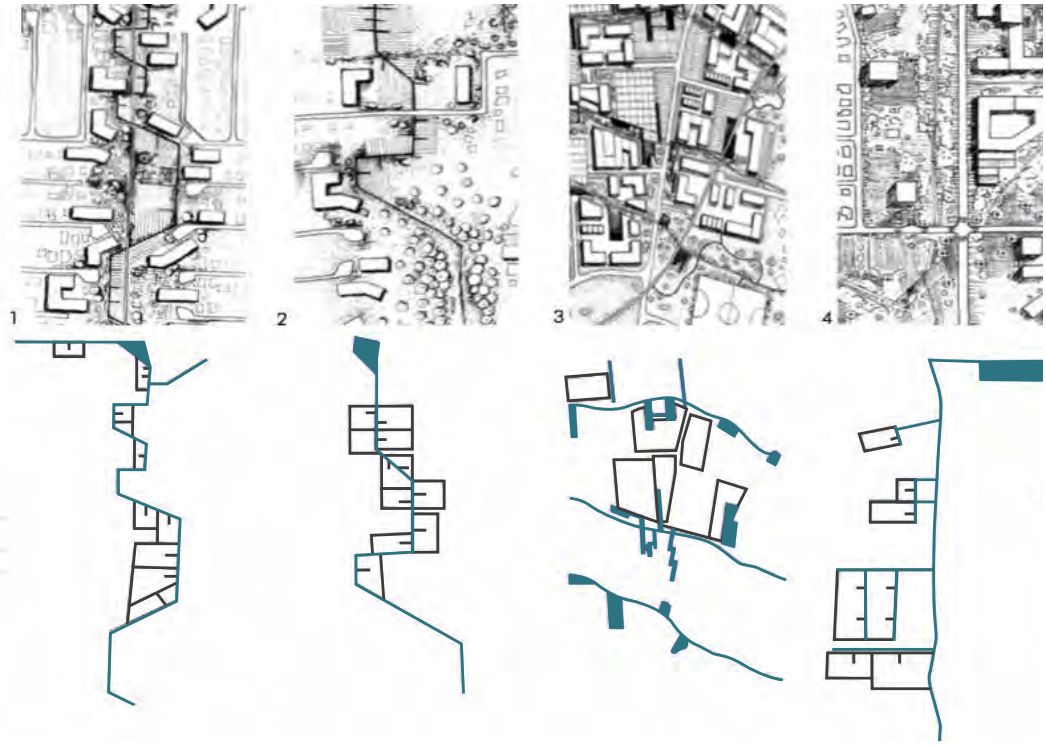


FIGURE 30: Changing settlements adjacent to mining through improved access to water: "The clean water reserves offer an opportunity to provide Kagiso with what it was historically deprived of. Built on the higher ridge with the rivers as buffer spaces, Kagiso never had the same access to water as Krugersdorp. The easternmost wetland system can allow a network of canals, aqueducts and ponds to penetrate Kagiso. The water can become the regenerator of the urban tissue. The enormous amounts of water going through the neighbourhood are a potential source for the local population to hook their watering cans to. If several join together, they can organise their open space together and optimise the agricultural production. This also allows them to transform their built footprint and building height, creating additional economic support" (Image: Mining Belt Studio, 2014: 20).

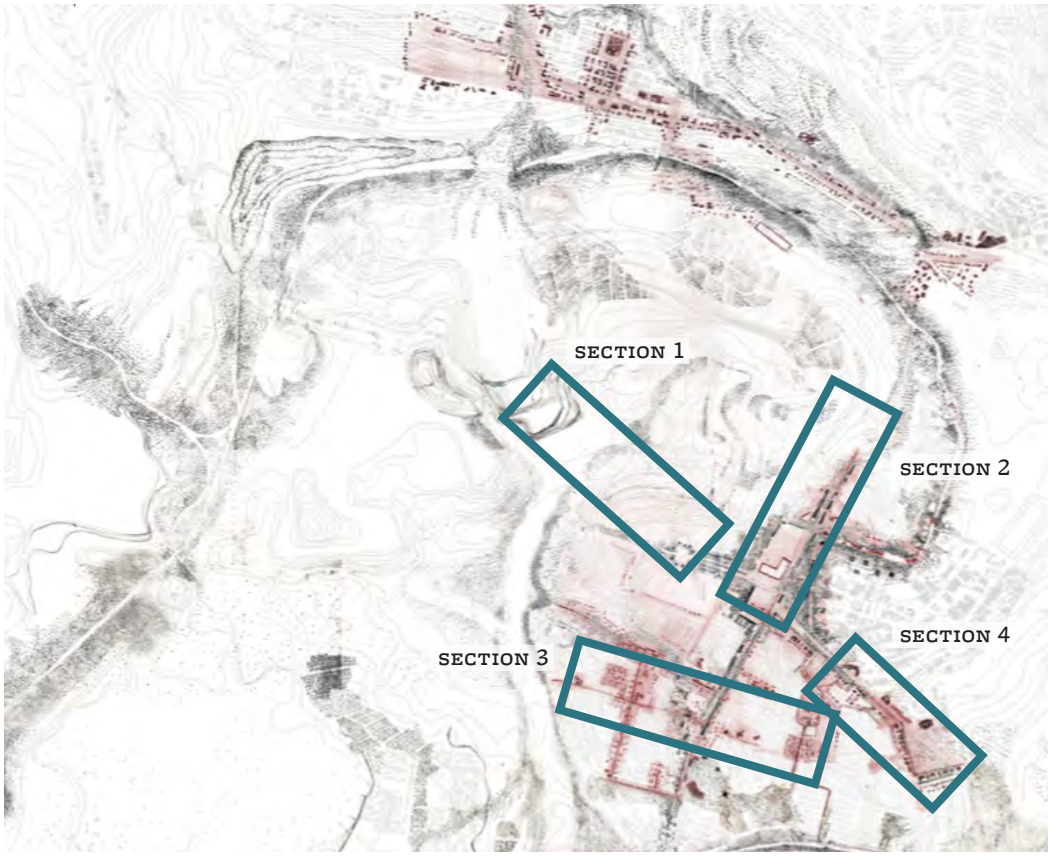


FIGURE 31: Reprocessing the waste landscape: "The vocation of the West Rand lies in the unique conditions of its mining activities. Instead of fighting the forces of the mining companies, they are embraced and operationalised in such a way that they immediately benefit the local population, the mining company and the environment. The large amounts of soil and water allow a drastic transformation of the landscape to make it fit for agricultural (clean and highly irrigated soil) and wildlife (constructing topographically varied wet and dry habitats) futures. The landscape – water, soils, vegetation, animals – is now also penetrating the most interiorised urban tissues, leading it to improved and sustainable living qualities" (Image: Mining Belt Studio, 2014: 22).

Integrated futures

This report presents the impetus for the diverse components of Gauteng's current and future mining landscapes to be understood as a connected landscape of systems, stratas and fields. From artisanal mining, to acid mine drainage and distressed mining towns, the legacy of mining in Gauteng has a variety of expressions, all emerging from the same interconnected history. All will need to be considered as an integrated landscape in order for innovative future considerations and plans to have maximum effect (Box 14).

The historical narrative posits that Gauteng's mining landscapes were integral to the development of Johannesburg. This is certain because, first, settlement followed mining activity; second, mining residues are enormous and physically disrupt and define the urban landscape; third, authorities used mining landscapes to reinforce segregated urban structures which themselves were based on the racially exploitative form of South Africa's economic growth; fourth, the revenues from mining funded the construction of the city, including the more affluent north and working class south; and, fifth, mining spawned further economic activity, including industry and – increasingly – services. Importantly, the effect of mining on segregating and weakening the social, economic and environmental fabric of the city places it as a central force in the formation of the socially and economically divided city we experience today.

The lasting environmental legacies of mining in Gauteng are complex, with their adverse effects on entire river systems, ecologies and human settlements. Here again, a comprehensive approach to tackling mine residue areas and processes, such as acid mine drainage decant, requires a holistic and integrated vision that transcends into the future and includes innovative remediation processes that lead to functional urban assets along the mining belt.

In imagining a future for the mining landscapes of Gauteng, it is essential for all actors to be identified and included, for more voices to be heard, for new collaborative processes to shape visions, and for multidisciplinary approaches to the remediation, structuring and development of the mining belt land. The mining landscape holds unparalleled opportunity for the Gauteng City-Region to increase residential densities close to major centres, to provide much needed green space for growing cities, and to create active and productive landscapes for forms of agriculture, environmental education and the expansion of conservation efforts. As such, work on the mining landscape cannot remain under-resourced by government, unfunded by mine owners and forgotten by the public. Existing programmes such as the Corridors of Freedom project in Johannesburg offer an impetus for the inclusion of all stakeholders in the re-imagining of tracts of land occupied by volumes of mine waste. However, without the inclusion of all voices to shape a common future and integrated experiences of the environment, projects such as these are at serious risk of falling flat. The mining landscapes of the future need to recapture the imagination of all stakeholders in the city-region and to reset the legacies bequeathed on it by creating sites of positive change, spatial transformation and future accomplishment.



Photograph by Clive Hassall





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Photograph by Potsiso Phasha



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