TYGERKLOOF MINING PTY LTD – TYGERKLOOF MINING

Final Environmental Management Programme

DMR ref: LP30/5/1/2/2/10093MR

Location: Portion 5 of the farm Tygerkloof 354 KQ, Thabazimbi Local Municipality, Limpopo

August 2015

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Abbreviations

ABA	Acid base Accounting
AIA	Archaeological impact assessment
ARF	Areal reduction factors
BID	Background information document
CA	Competent authority
CARA	Conservation Of Agricultural Resources Act, No 43 of1983
C	Carbon
Ca	Calcium

CBA	Critical Biodiversity Area
Cl	Chlorine
CO	Carbon dioxide
CO_2	Carbon monoxide
DEA	Department of Environmental Affairs
DME	Department of Minerals and Energy
DMR	Department of Mineral Resources
DWA/S	Department of Water Affairs (Department of Water and Sanitation)
EAP	Environmental assessment practitioner
E. coli	*Escherichia coli*
EC	Electrical conductivity
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMP	Environmental management plan
ESA	Early Stone Age
ESR	Environmental scoping report
FOE	Frequency of exceedance
GN	Government notice
HCO_3	Bicarbonate
HIA	Heritage Impact Assessment
HRA	Heritage Resources Act No 25 of 1999
IA	Iron Age
I&APs	Interested and affected parties
IWWMP	Integrated water and waste management plan
IWULA	Integrated water use licence application
K	Potassium
LED	Local economic development
LEDET	Limpopo Department of Economic Development, Environment and Tourism
LIA	Late Iron Age
LSA	Late Stone Age
mamsl	Metres above mean sea level
MAP	Mean annual precipitation
mbs	Metres below surface
Mg	Magnesium
MM5	Mesoscale Model 5
MPRDA	Minerals and Petroleum Resources Development Act, No 28 of 2002
MSA	Middle Stone Age
MWP	Mining works programme
Na	Sodium
NEMA	National Environmental Management Act, No 107 of 1998
NEMBA	National Environmental Management: Biodiversity Act, No 10 of 2004
NEMWA	National Environmental Management: Waste Act, No 59 of 2008
NO_2	Nitrogen dioxide

NO_3	Nitrate
NWA	National Water Act, No 36 of 1998
P	Phosphorous
PPP	Public participation process
RAM	Rhino Andalusite Mine
RWDs	Return water dams
SACNASP	South African Council for Natural Scientific Professions
SAHRA	South African Heritage Resources Agency
SANS	South African National Standard
SDF	Standard design flood
SDM	Sustainable Development through Mining Programme
SLP	Social and labour plan
SO_2	Sulphur dioxide
SO_4	Sulphate
SWMP	Stormwater management plan
TDS	Total dissolved solids
TIOM	Thabazimbi Iron Ore Mine
TLM	Thabazimbi Local Municipality
TSP	Total Suspended Particulates
TWQG	Target Water Quality Guidelines
WBPA	Waterberg/Bojanala Priority Area network
WDM	Waterberg District Municipality
WRDs	Waste rock dumps
WUL	Water use licence

Executive summary

Applicant

BECS Environmental has been appointed by Tygerkloof Mining (Pty) Ltd to apply for an environmental authorisation, a mining right, and an integrated water use licence (IWULA) for the proposed extension of quarries and associated haul road in the Thabazimbi area. Rhino Andalusite Mine (RAM) is an already existing mine, covering Portion 1 and the Remaining Extent of the farm Buffelsfontein 353 KQ, and Portion 3 of the farm Grootfontein 352 KQ. This mine has been operating under a mining licence, with mining right number74MR, for more than 25 years. Tygerkloof Mining is a proposed new mine, adjacent to this already existing RAM, but will entail the extension of the already existing quarries and haul road from RAM area into Tygerkloof Mining area, on portion 5 of the farm Tygerkloof 354 KQ, Thabazimbi Local Municipality (TLM), Limpopo. Tygerkloof Mining and RAM fall under the management of Imerys Refractory Minerals, a member of the Imerys Group.

Background and project description

The RAM was originally the Timeball Andalusite Mine. RAM mines an andalusite ore body, developed along the strike of an alumina-rich shale band at the base of an ironstone ridge, in the foothills of the Witfontein Mountain Range. The ore body is being mined by means of open quarry methods. The existing mine has 7 open quarries, tailings dams, waste rock dumps (WRDs), overburden dumps, processing plants, return water dams (RWDs), workshops, store rooms, mine buildings, a network of internal roads, and one haul road.

The Tygerkloof Mining extension will include an open quarry with overburden adjacent to the quarry, as well as a haul road to transport ore form the quarry to the existing RAM. The quarry will be approximately 115.9ha. The overburden will cover and area of approximately 142.2ha. The already existing haul road will be extended at a width of approximately 12m, and a length of 3.5km, adjacent to the quarry. Portion 5 of the farm Tygerkloof 354 KQ is approximately 594ha, therefore 44% of the total area will be disturbed for mining activities.

Legal requirements

Three different processes are conducted simultaneously to obtain all the necessary authorisations for the Tygerkloof Mining operations. These three processes are the environmental authorisation in terms of the National Environmental Management Act, No 107 of 1998 (NEMA), as amended (in terms of 2010 regulations), a mining right application in terms of the Minerals and Petroleum Resources Development Act, No 28 of 2002 (MPRDA), as amended (in terms of 2004 regulations), and a water use license (WUL) in terms of the National Water Act, No 36 of 1998 (NWA), as amended.

Introduction

Authorisation processes

Three different processes are conducted simultaneously to obtain all the necessary authorisations for the Tygerkloof Mining operations:

EIA process in terms of NEMA

An Environmental Impact Assessment Report (EIAR) which forms part of the EIA process in terms of the NEMA. The LEDET is the CA.

The application form was submitted in August 2014. LEDET accepted the application form but requested that this form be amended and re-submitted with the Environmental scoping report (ESR) in terms of NEMA. This amendment included change in project title and description of activities. LEDET sent a letter on 9 January 2015 whereby they indicated, due to the new EIA Regulations, the final EIAR must be submitted by end May 2015. The ESR in terms of NEMA was submitted on 2 March 2015, with the amended application form. A site visit, with LEDET, was conducted on 19 March 2015. All comments from the LEDET officials are included in the EIAR as well as this EMP.

An extension was requested to submit the EIAR. This was done due to the fact that certain specialist reports were not finished on/or before end April 2105. The registered Interested and affected parties (I&APs) must have 30 days to peruse the draft EIAR with all specialist reports. The draft EIAR with all final specialist reports were presented to the registered I&APs in May 2015, therefore allowing for a period of 30 days to peruse and comment. The final EIAR was submitted to LEDET on 30 June 2015, and a final site visit was held on 21 July 2015. **The mine was granted an environmental authorisation for the EIA on 31 July 2015.**

Refer to Addendum 5B for LEDET's acknowledgement of receipt of the EIA application form; Addendum 5C for a letter from LEDET indicating the change in EIA regulations and hence the updated timeframe to submit the EIAR to LEDET; Addendum 5D for LEDET's acceptance of the ESR in terms of NEMA; Addendum 5E for a letter from LEDET granting extension of the submission of the EIAR to end June 2015; Addendum 5F for LEDET's acknowledgement of receipt of the final EIAR; and Addendum 5G for LEDET's acceptance of the EIAR in terms of NEMA. **Refer to Addendum 5H for the Environmental Authorisation.**

EMP process in terms of MPRDA

This EMP forms part of a mining right application process, which is followed in terms of the MPRDA. The Limpopo Department of Mineral Resources (DMR) is the CA. the mining right application was accepted by DMR on 28 November 2014. This acceptance was amended on 3 December 2014 to indicate the correct dates for submission of the ESR and EMP. The ESR in terms of MPRDA was submitted to DMR on 15 January 2015 DMR accepted this ESR on 25 March 2015 with a set of conditions. The EMP must include:

- Studies with regard to noise, dust, waste and water pollution, as well as the management measures of these impacts. These specialist reports must be appended to the EMP.
- All issues and concerns raised by I&APs must be addressed.
- The closure objectives must be clearly described.

Further on this letter requested that the provisions of the NWA be met, in terms of the IWULA process, as well as the provisions of the NEMA, Conservation of Agricultural Resources Act, No 43 of1983 (CARA), and South African Heritage Resources Agency (SAHRA). Proof of the WULA submitted to DWS will be send as soon as this is done.

All specialists' studies, including noise, dust, waste and water (geohydrological report, a stormwater management plan (SWMP), as well as waste management) are included and appended to this EMP. A complete public participation process (PPP) was undertaken as part of this process. Refer to paragraphs 11-13 of section 1 (EIA) for the PPP as well as Addendum 4 for all proof of documentation. The end land use as well as residual impacts, closure objectives and a rehabilitation plan are included in paragraph 1 of section 2 (EMP) of this EMP.

All provisions of the CARA are included in the Ecological Specialist report, and therefore included in this EMP. The ESR in terms of NEMA and MPRDA was uploaded onto SAHRA website on 14 January 2015. The EIA in terms of NEMA was uploaded onto SAHRA website on 1 June 2015. The EMP in terms of MPRDA was uploaded on 16 July 2015. Please note, the information in the EIAR and EMP is similar.

Refer to Addendum 5I for DMR's acknowledgement of receipt of the mining right application form and Addendum 5J for the amendment of this acceptance; Addendum 5K for DMR's acceptance of the ESR in terms of MPRDA; Addendum 5L for proof of ESR uploaded onto SAHRA website; and Addendum 5M for proof of EIAR and EMP uploaded onto SAHRA website.

IWULA process in terms of NWA

An IWULA process is followed in terms of the NWA. North West Department of Water Affairs (Department of Water and Sanitation) (DWA/S) regional offices is the CA. This IWULA will be submitted before mid-August.

Details of the applicant and landowner

Refer to Table 1 below for a description of the applicant, Figure 1 for an organogram of the applicant, and Table 2 for a description of the landowner of the proposed site.

Table 1: Description of the applicant

Project applicant	Tygerkloof Mining Pty Ltd
Trading name	Tygerkloof Mining
Contact person	Hendrik Jones

Physical address	Farm Grootfontein Makoppa, Turn Off on the R510, Thabazimbi, 0380
Postal address	Private bag X 329, Thabazimbi, 0380
Telephone number	014-784-0660
Facsimile number	014-784-0669
E-mail address	hendrik.jones@imerys.com

Table 2: Description of the landowner

Proposed farm name and portion	Portion 5 of the farm Tygerkloof 354 KQ
Coordinates of proposed project	24˚ 43' 35"S; 27˚ 13' 58"E
Landowner	Rhino Andalusite Mine
Contact person	Hendrik Jones
Physical address	Farm Grootfontein Makoppa, Turn Off on the R510, Thabazimbi, 0380
Postal address	Private bag X 329, Thabazimbi, 0380
Telephone number	014-784-0660
Facsimile number	014-784-0669
E-mail address	hendrik.jones@imerys.com

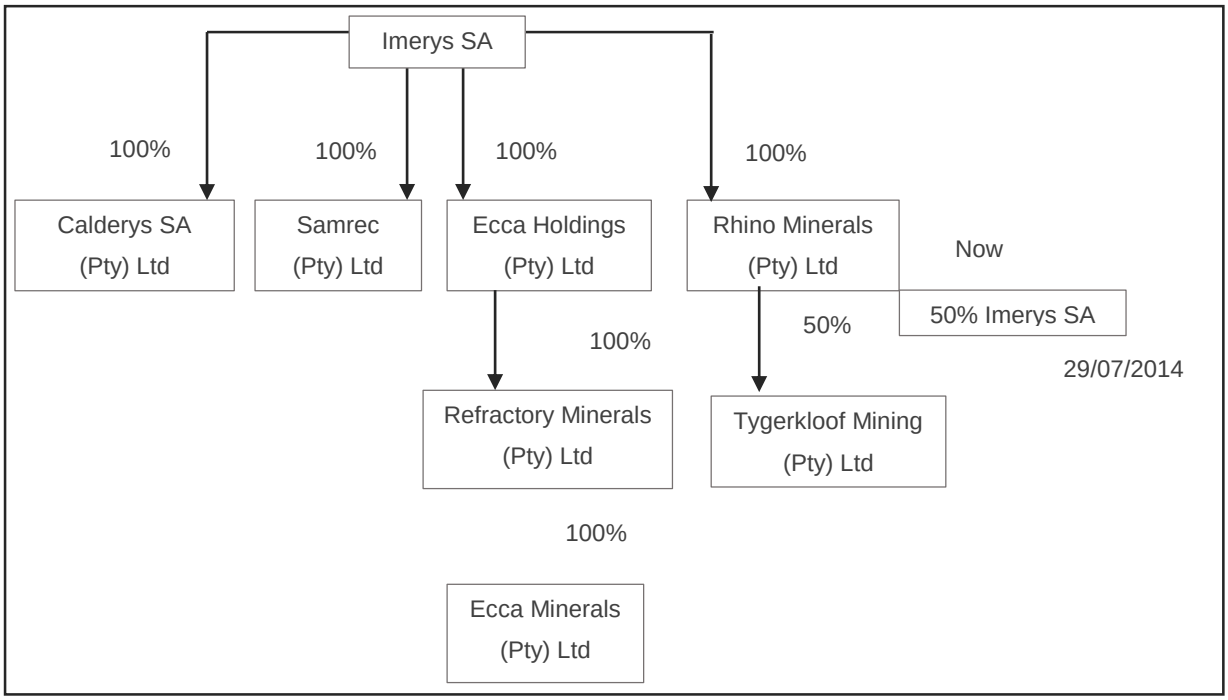


Figure 1: Tygerkloof Mining & Rhino Andalusite Mine organogram

Details and expertise of the environmental assessment practitioner

BECS Environmental was appointed as an independent consultant to meet the requirements as set out in regulation 17 of the EIA Regulations, 2010. Refer below to a description of the EAP, and refer to Addendum 2 for a detailed CV of the EAP.

Table 3: Description of the environmental assessment practitioner

Name of company	BECS Environmental
Postal address	PO Box 72960, Lynnwood Ridge, 0040
Telephone number	012 361 9970
Cell phone number	072 191 6074
Facsimile number	012 361 0645
E-mail address	salome@becsenv.co.za
Name of responsible EAP	Salome Beeslaar
Expertise of EAP	B.Sc Environmental Science (UP), B.Sc Honours Geography (UP), M.Sc Geography (UP), Professional Scientist (Environmental Science)

SECTION 1

ENVIRONMENTAL IMPACT ASSESSMENT

REGULATION 50 (a).

1. Description of the baseline environment

1.1 Concise description of the environment on site relative to the environment in the surrounding area

The environmental background description is a based on the descriptions of the specialist studies.

1.1.1 General locality description

The proposed mine is located in the TLM, within the Waterberg District Municipality (WDM), in the south-western part of the Limpopo Province in the Savannah Biome. It is situated near the Pilanesberg National Park. This area is mainly applied for agriculture although platinum, iron and andalusite is also mined in the area. The proposed mine is located on the south-eastern slope of the foothills of the Witfonteinrand Mountain Range and is situated approximately 110km from Rustenburg and 15km south-west of Thabazimbi. It is linked to the R510 Road via a dirt road which leads to Makoppa. Refer to Figure 33 in Paragraph 2 of Section 1 (EIA).

1.1.1.1 Land claims

A letter was received on 14 November 2014 whereby the Office of the Regional Land Claims Commissioner: Limpopo confirmed that there is currently no information available with regards to land claims on portion 5 of the farm Tygerkloof 354 KQ. Refer to Addendum 5A.

1.1.2 Geology

Information for section was obtained from the Mining Works Programme (MWP) (Samrec, 2014). The area is underlain by a succession of steeply dipping shale and quartzite of the Timeball Hill Formation (Pretoria Group) of the Transvaal Sequence. To the north, these sediments are bounded by a banded ironstone formation beyond which the dolomite succession (Malmani Subgroup) of the Transvaal

Sequence occurs. The Timeball Hill shale and quartzite are bounded to the south by the mafic rocks of the Marginal Zone of the Bushveld Complex. The andalusite ore body is developed along strike within the alumina rich shale band developed at the base of the banded ironstone ridge.

A number of north-west striking faults intersect the ore body in places. These faults frequently form the saddles within the ridge. A narrow diabase dyke has intruded in a similar orientation to the faults. Available geological maps show that a diabase sill occurs immediately south of the mining activities. The sill is conformable to the steeply dipping (55° towards the south-east) shale bands.

1.1.3 Climate

Information for this section was obtained from 'Information in support of application for rectification of existing mine residue disposal' (Shangoni Management Services, 2011) & 'Air Quality Specialist Report for the Proposed Tygerkloof Mine, Thabazimbi, Limpopo Province' (Airshed Planning Professionals, 2015).

1.1.3.1 Rainfall

According to the MM5 data set, annual rainfall is estimated at 455 mm. Precipitation peaks during the summer months and lowest during the winter months (Figure 2). This assessment included the mitigating effect of rainfall on dust from unpaved roads. The US EPA estimates emissions reduction efficiency from the number of days per year that rainfall exceeds 0.254 mm. According to the MM5 data an average of 26 days per year receive rainfall in excess of 0.254mm/day.

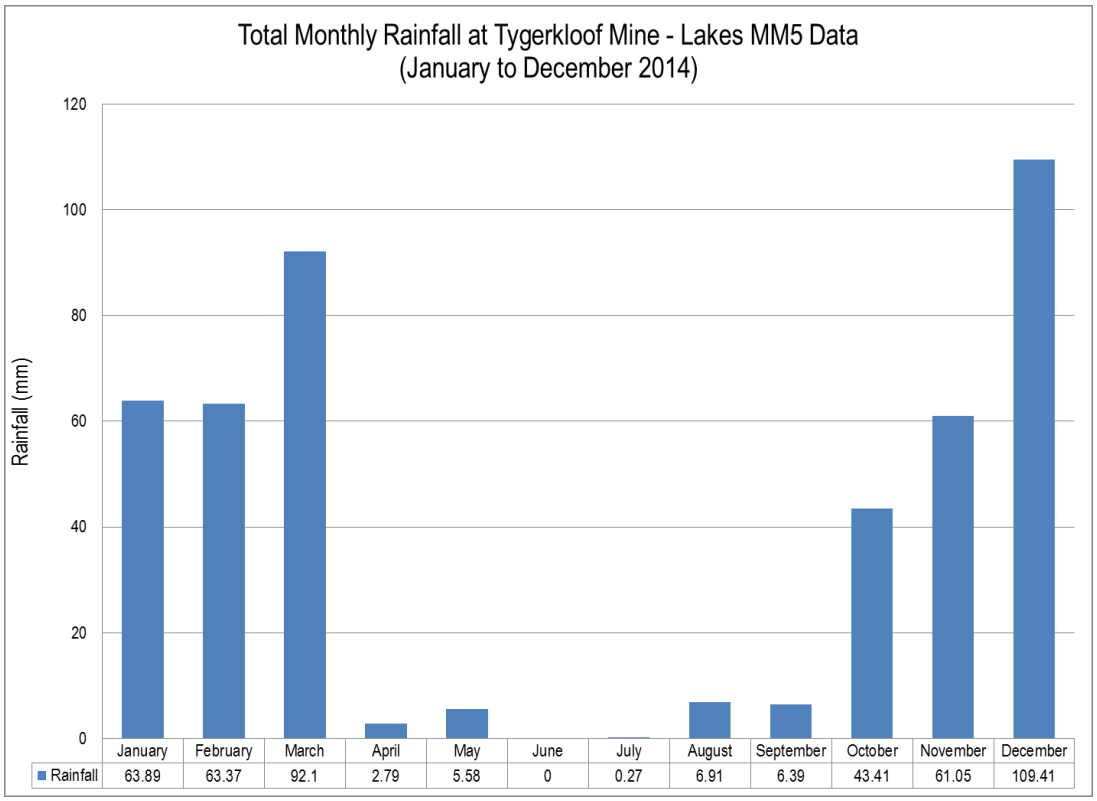


Figure 2: Monthly rainfall and relative humidity (MM5 data, 2014)

1.1.3.2 Temperatures

Diurnal and average monthly temperature trends are presented in Figure 3. Monthly mean, maximum and minimum temperatures are given in Table 4. Temperatures ranged between 1.5°C and 32.9°C. During the day, temperatures increase to reach maximum at around 15:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 04:00 i.e. just before sunrise.

Table 4: Monthly temperature summary (MM5 Data, 2014)

Monthly Minimum, Maximum and Average Temperatures (°C) MM5 Data (2014)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Minimum	17.5	17.1	15.9	9.9	6.7	2.8	1.5	3.5	7.3	9.7	12.8	17.0
Average	25.4	24.6	22.9	19.0	16.4	12.6	12.0	15.2	19.5	21.4	23.6	24.7
Maximum	32.9	31.4	30.5	27.8	25.3	23.9	21.4	26.2	29.3	32.2	31.7	32.5

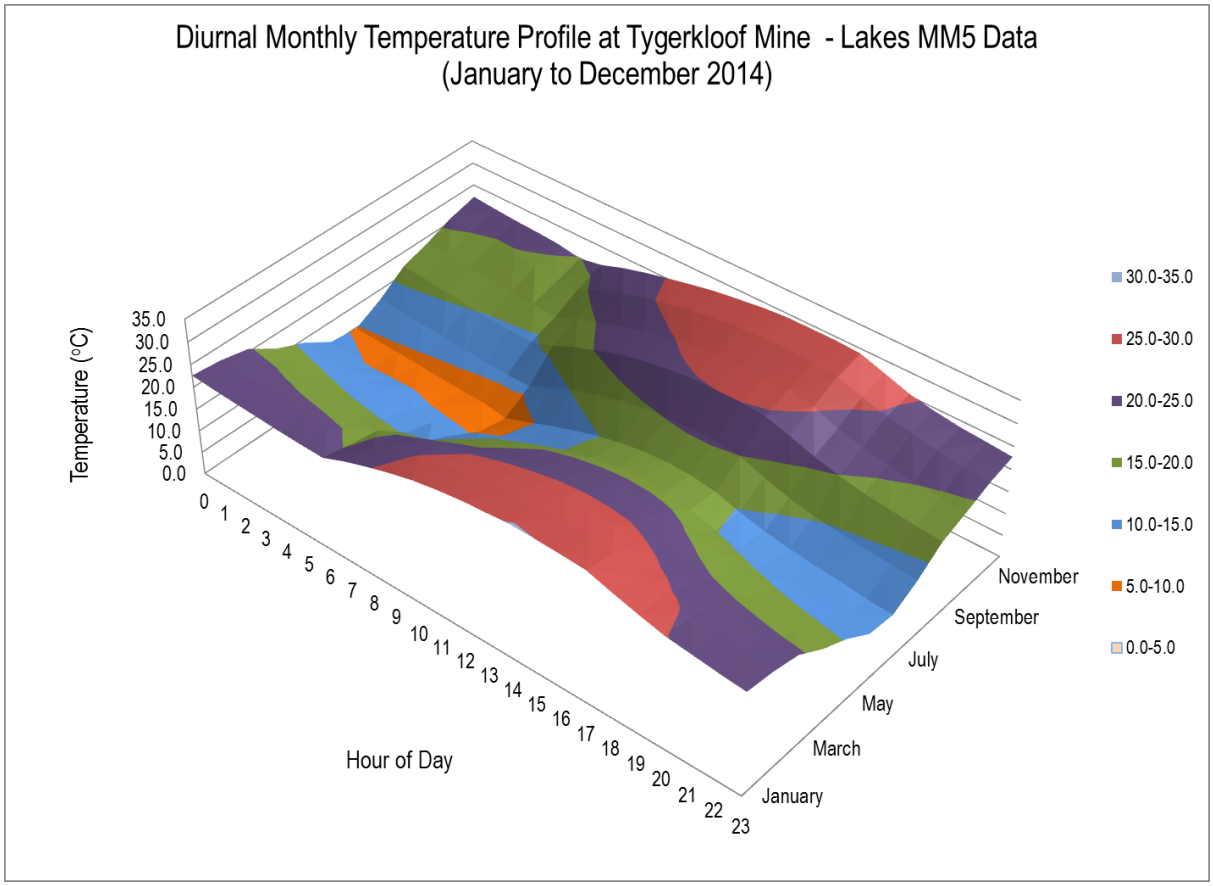


Figure 3: Diurnal temperature profile (MM5 Data, 2014)

1.1.3.3 Wind direction and speed

The wind roses comprise 16 spokes, which represent the **directions from which** winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind **speeds**; the yellow area, for example, representing winds in between 4m/s and 5m/s. The dotted circles provide information regarding the **frequency** of occurrence of wind speed and direction

categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1m/s are also indicated.

The period wind field and diurnal variability in the wind field are shown in Figure 4 while the seasonal variations are shown in Figure 5. During the January to December 2014 period, the wind field was dominated by winds from the north and north-northwest, with an average wind speed of 3.0m/s. The strongest winds (more than 6m/s) were also from the north and north-northwest and occurred mostly during the day (06:00 to 18:00). Calm conditions occurred 14.12% of the time. A distinct increase in winds from the south occurred at night (18:00 to 06:00).

Seasonally, the wind flow pattern conforms to the period average wind flow pattern. The seasonal wind field shows considerable seasonal differences in the wind fields. During autumn and winter the dominant winds are from the north-northwest, while in spring and summer, the northerly winds dominate.

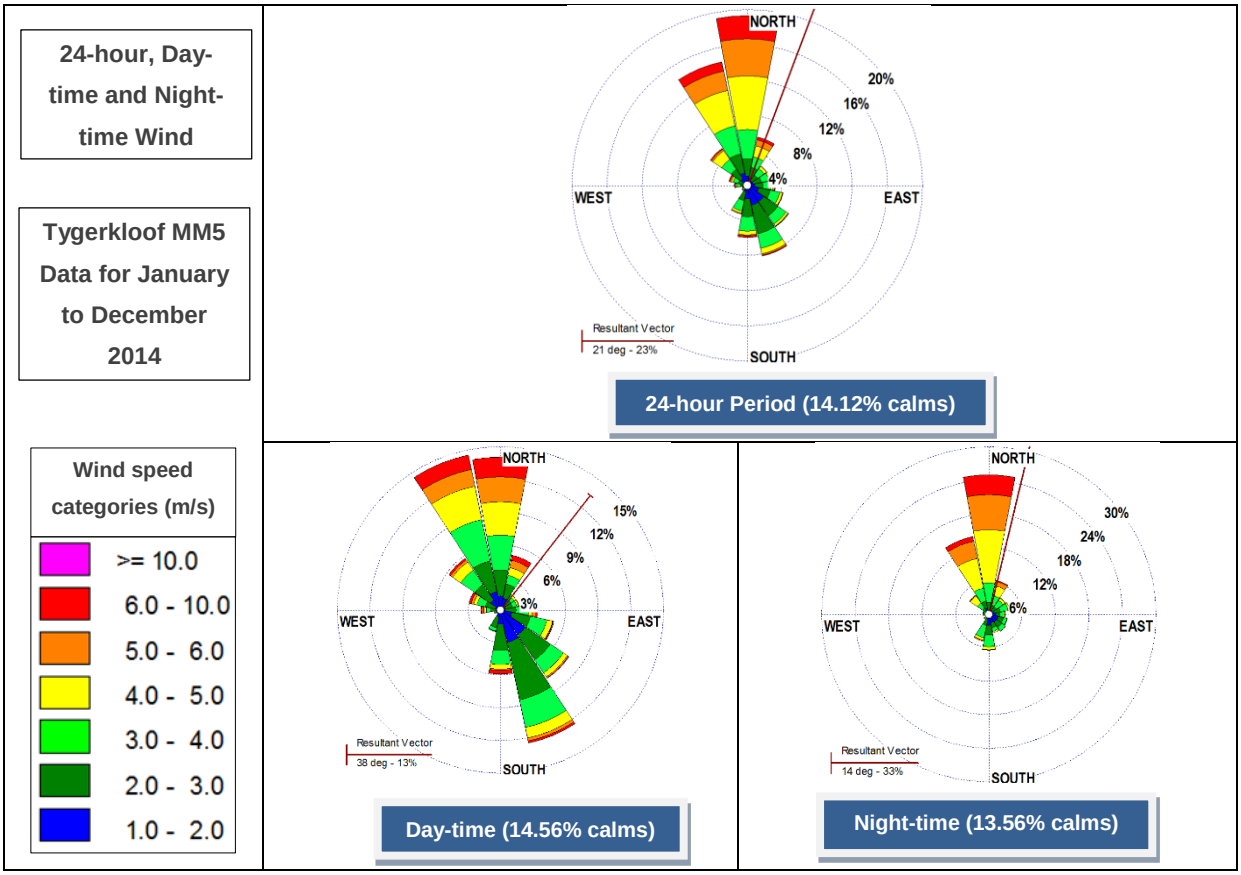


Figure 4: Period, day- and night-time wind roses (MM5 Data, January to December 2014)

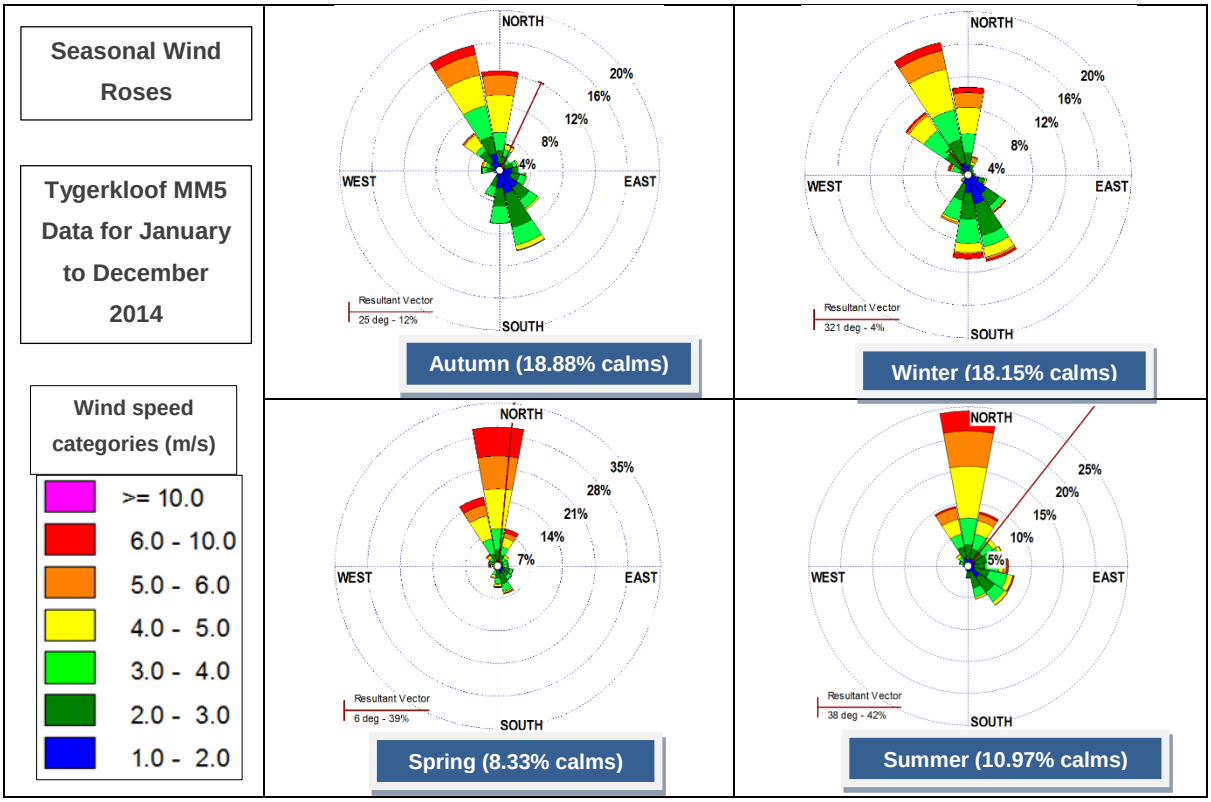


Figure 5: Seasonal wind roses (MM5 Data, January to December 2014)

1.1.3.4 Evaporation

The monthly evaporation for Thabazimbi is not available. The monthly evaporation for Swartklip Rustenburg Platinum Mine, about 80 km from Thabazimbi, is given in Table 5 below.

Table 5: Mean monthly evaporation

MONTH	SYMONS PAN (mm)	"A" PAN (mm)
January	183	219
February	156	186
March	145	173
April	118	141
May	98	117
June	77	98
July	83	115
August	114	167
September	156	208
October	192	256
November	191	248
December	200	247

1.1.3.5 Incidence of extreme climatic conditions

The incidence of hail varies from light to severe hailstorms, although the latter are very rare. Frost occurs in the low-lying areas of Thabazimbi. Strong winds occur sporadically, mainly from the south, and blow at a mean speed of 4.7 to 6.4m/s.

1.1.4 Topography

Information for this section was obtained from 'Information in support of application for rectification of existing mine residue disposal' (Shangoni Management Services, 2011); and 'Report on geohydrological investigation as part of the EIA, environmental management plan (EMP) and IWULA (Groundwater Complete, 2015).

The site falls within a low mountainous terrain morphological unit. The northern part of the site is a mountainous area, namely the Witfonteinrand range. The site slopes from the range into a southern direction. Surface elevations vary from approximately 1,040 to 1,340 meters above mean sea level (mamsl).

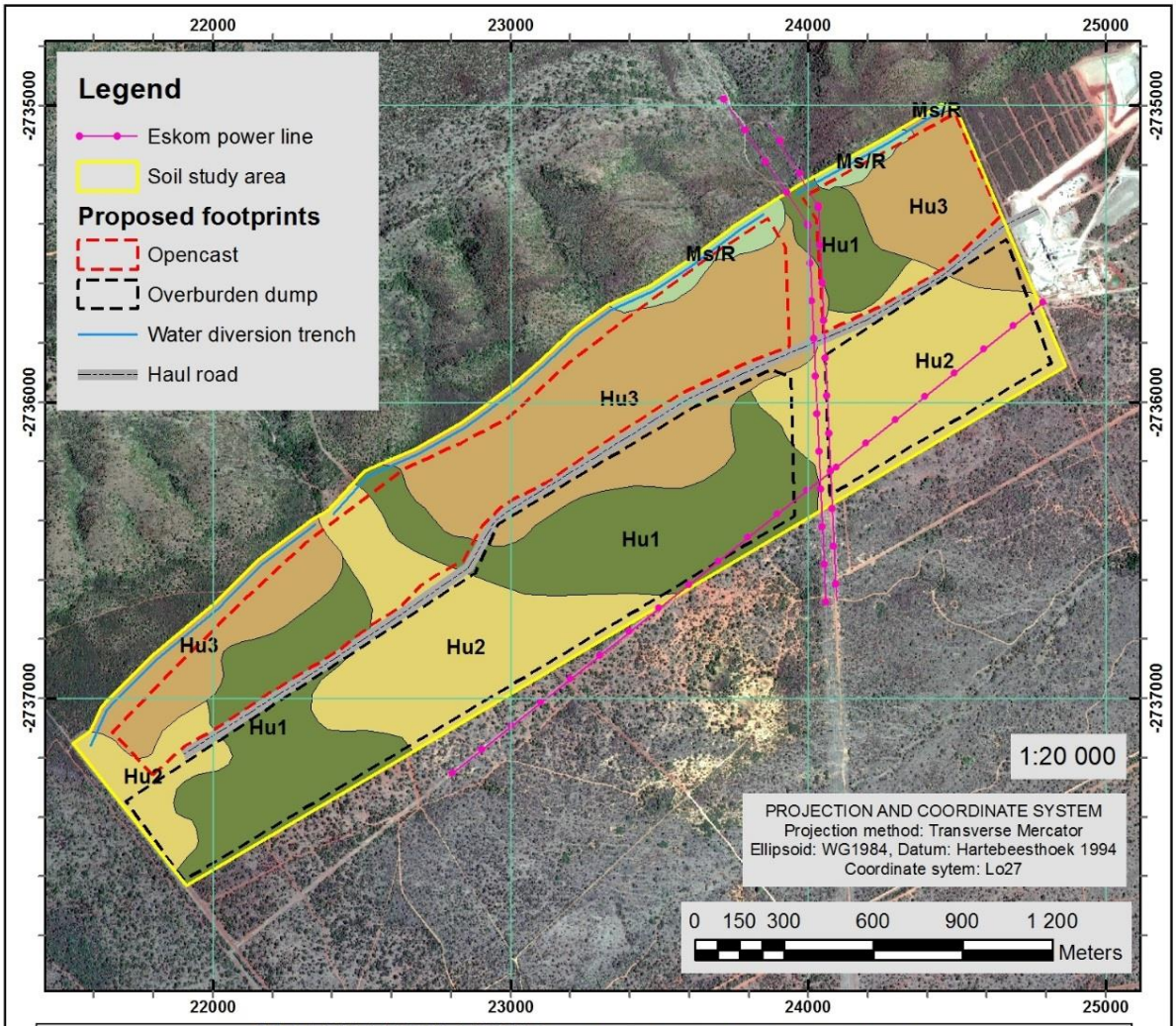
1.1.5 Soil

Information for this section was obtained from the 'Soil Study Report' (Gudani Consulting, 2015).

1.1.5.1 Soil types within the proposed quarry and overburden dump footprints

A total of 4 homogeneous soil units, based on dominant soil form, effective soil depth, internal drainage, terrain unit and slope percentage were identified during field observations and were symbolised as Hu1, Hu2, Hu3 and Ms/R. The homogeneous units are referred to as soil types and are shown in Figure 6 which contains an abbreviated soil legend. A comprehensive soil legend is provided in Table 6 which described the soils in terms of the following aspects:

- Dominant soil forms and families and subdominant soil forms;
- The estimated clay content of the A and B or E or G-horizons;
- A broad description of the dominant soil form and terrain in terms of the effective soil depth, internal drainage, soil colour, soil texture class, terrain unit and average slope percentage range;
- A description of the soil horizon sequences;
- The derived erodibility class and dry land crop production potential;
- The land capability and wetland zone classification; and
- The area and percentage comprised by each soil type.



ABBREVIATED SOIL LEGEND (for full legend refer to Table 2 of the soil report)

Soil Type Code	Dominant & subdominant Soil Form and Family	Summarized description of soil type and terrain	Land Capability	Wetland zone	Area (ha)	Area (%)
Hu1	***Hutton 2100**; Kimberley 1100, Plooysburg 1000	Moderately deep to deep (700-1200 mm), red, well-drained, sandy loam soils situated on gentle footslopes (1-4% slopes) with no surface stones or rock.	Arable	Terrestrial	88.39	28.40
Hu2	***Hutton 2100**; Kimberley 1100, Plooysburg 1000	Shallow (300-600 mm), red, well-drained, sandy loam soils situated on gentle footslopes (1-5% slopes) with no surface stones or rock.	Grazing	Terrestrial	101.61	32.64
Hu3	***Hutton 2100**; Glenrosa 1211	Very shallow (100-200 mm), red, well-drained, sandy loam soils situated on gentle to moderate midslopes (4-10% slopes) with little (less than 1%) surface stones or rock.	Grazing	Terrestrial	113.41	36.44
Ms/R	***Mispah 1100**; Glenrosa 1211, rock	Steep rocky midslopes (12-40% slopes) with the surface covered by 60-80% stone and rock in a complex association with very shallow (50-100 mm), reddish brown, sandy loam soils.	Wilderness	Terrestrial	7.88	2.53
* Dominant soil form and family				Total	311.29	100.0

Figure 6: Detailed soil map of the proposed open pit and overburden dump areas

Table 6: Detailed soil legend – proposed open pit and overburden dump footprints

Soil legend										
Soil Type Code	Dominant & subdominant Soil Form and Family	% Clay per horizon A, E, G, B	Summarised Description of Dominant Soil Forms in terms of effective depth, soil colour, soil texture and terrain unit	Description of soil horizon sequences of dominant soil forms	Erodibility	Dry land crop production potential	Land Capability	Wetland zone	Area (ha)	Area (%)
Hu1	*Hutton 2100; Kimberley 1100, Plooysburg 1000	A: 15-20 B: 15-20	Moderately deep to deep (700-1200 mm), red, well-drained, sandy loam soils situated on gentle footslopes (1-4% slopes) with no surface stones or rock.	Brownish red, sandy loam, Orthic A-horizons, underlain by red, sandy loam, apedal B-horizons underlain by highly weathered fractured rock	Low	Moderate	Arable	Terrestrial	88.39	28.40
Hu2	*Hutton 2100; Kimberley 1100, Plooysburg 1000	A: 15-20 B: 15-20	Shallow (300-600 mm), red, well-drained, sandy loam soils situated on gentle footslopes (1-5% slopes) with no surface stones or rock.	Brownish red, sandy loam, Orthic A-horizons, underlain by red, sandy loam, apedal B-horizons underlain by highly weathered fractured rock	Low	Low-moderate	Grazing	Terrestrial	101.61	32.64
Hu3	*Hutton 2100; Glenrosa 1211	A: 15-20	Very shallow (100-200 mm), red, well-drained, sandy loam soils situated on gentle to moderate midslopes (4-10% slopes) with little (less than 1%) surface stones or rock.	Brownish red, sandy loam, Orthic A-horizons, underlain by a gravely/stony red, sandy loam, apedal B-horizon containing more than 60% gravel and stones.	Low to moderate	Low	Grazing	Terrestrial	113.41	36.44
Ms/R	*Mispah 1100; Glenrosa 1211, rock	A: 15-20	Steep rocky midslopes (12-40% slopes) with the surface covered by 60-80% stone and rock in a complex association with very shallow (50-100 mm), reddish brown, sandy loam soils.	Reddish brown, sandy loam, Orthic A-horizons, underlain by solid hard rock or fractured rock.	High	Very low to none	Wilderness	Terrestrial	7.88	2.53
* Dominant soil form and family			Total						311.29	100.01

1.1.5.2 Soil chemistry

The positions of the soil sampling points are shown on Figure 6 (Gudani Consulting, 2015) as yellow dots and the coordinates are included in Appendix D (Gudani Consulting, 2015), Table D1.

A sample of the A-horizon of the dominant soil types was taken at 4 localities and the analytical results are shown in Table 7. The averages of the cations, potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na) as well as phosphorus (P), pH and resistance were calculated and highlighted in green.

Table 7: Soil chemical analyses

Samp Point	**Soil Form**	**Hor**	**Depth**	**K**	**Ca**	**Mg**	**Na**	***Titr.Acid**	***Acid saturat.**	**R_S (resistance)**	**P (Bray1) mg/kg**	**pH (H_2O)**
				mg/kg	mg/kg	mg/kg	mg/kg					
				Ammonium acetate				cmol(+)/kg	%	ohm		
Sampling points in cultivated land												
E8	Hu2100	A	0-250	74	598	62	0.6	0		2830	7.3	5.94
J9	Hu2100	A	0-250	49	681	83	0.77	0		3190	6.4	5.68
L13	Hu2100	A	0-250	55	488	58	0.53	0.05	1.6113	2100	6.8	5.49
Q20	Hu2100	A	0-250	68	409	55	0.42	0.15	5.3239	1790	8.1	5.4
Averages				61.5	544	64.5	0.58	0.05	1.73	2478	7.2	5.62
*Analyses done when pH is below 5.5												

1.1.5.2.1 Soil fertility status

The averages of the cations (K, Ca, Mg and Na), P, pH and resistance were compared to general fertility guidelines in Table 8. The average concentration of K, Ca, Mg is moderate-low which reflects the general natural soil fertility status. The low average Na concentration of 0.58 mg/kg indicates an absence of sodic soil conditions and the high resistance indicates an absence of saline soil conditions. The average pH value of 5.6 reflects acid soil conditions which indicate a moderate leached status and correlates with the moderate-low status of base cations. The average P value of 7.2 is low and indicates the general low P status of uncultivated land in the majority of South Africa.

Table 8: Soil fertility compared to broad fertility guidelines

Element or measurement	**Guidelines (mg/kg)**						**Fertility rating**	
	Low			**High**			**Average (mg/kg)**	**Rating**
K	<40			>250			61.5	Moderate-low
Ca	<200			>3000			544	Moderate-low
Mg	<50			>300			64.5	Moderate-low
Na	<50			>200			0.58	Low
P	<8			>35			7.2	Low
Resistance (R_S)	<200			>300			2478	High
pH(H_2O)	Very acid	Acid	Slightly acid	neutral	Slightly alkaline	Alkaline		

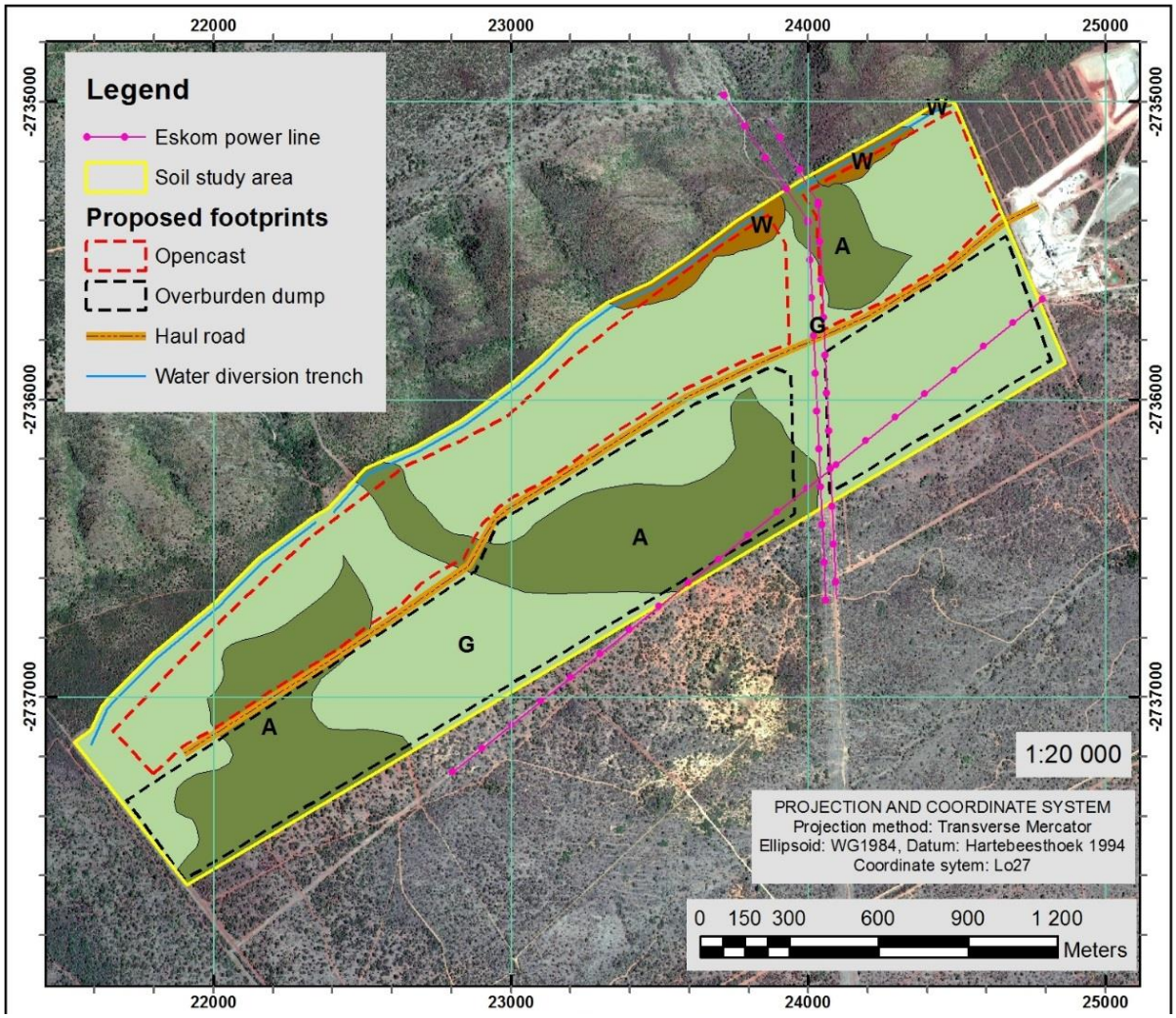
Element or measurement	Guidelines (mg/kg)						Fertility rating	
	Low			High			Average (mg/kg)	Rating
	<4	5-5.9	6-6.7	6.8-7.2	7.3-8	>8	5.62	Acid

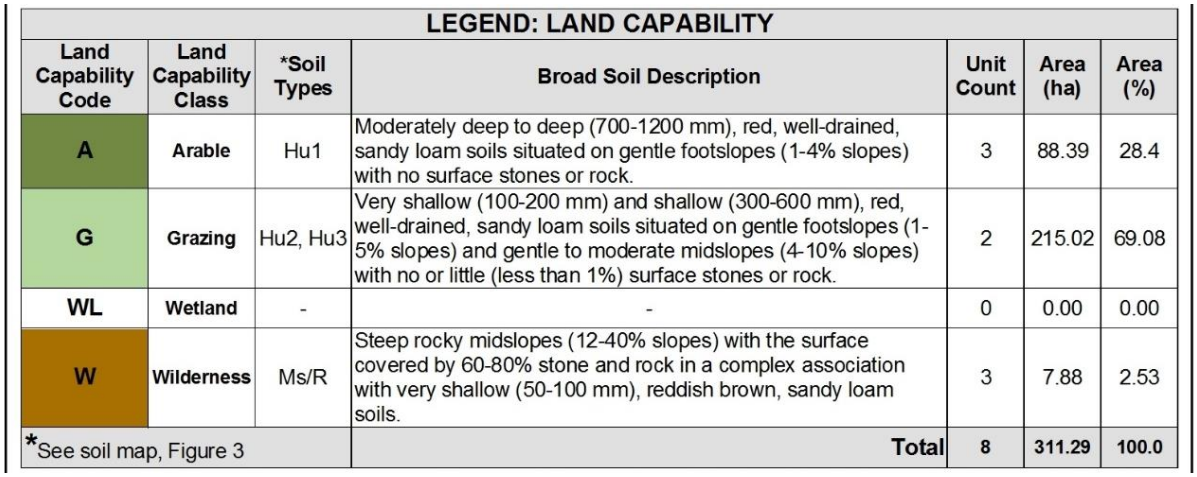
1.1.6 Land capability

Information for this section was obtained from the 'Soil Study Report' (Gudani Consulting, 2015).

1.1.6.1 Land capability of the proposed open pit and overburden dump footprints

The location and extent of land capability classes within the proposed quarry and overburden dump footprints are shown in Figure 7. The land capability of the proposed quarry and overburden dump footprints are summarised in Table 9 which shows the soil types grouped into each land capability class, a broad description of the soil group, the number of units per land capability class, and the area and percentage comprised by each land capability class.





LEGEND: LAND CAPABILITY						
Land Capability Code	Land Capability Class	*Soil Types	Broad Soil Description	Unit Count	Area (ha)	Area (%)
A	Arable	Hu1	Moderately deep to deep (700-1200 mm), red, well-drained, sandy loam soils situated on gentle footslopes (1-4% slopes) with no surface stones or rock.	3	88.39	28.4
G	Grazing	Hu2, Hu3	Very shallow (100-200 mm) and shallow (300-600 mm), red, well-drained, sandy loam soils situated on gentle footslopes (1-5% slopes) and gentle to moderate midslopes (4-10% slopes) with no or little (less than 1%) surface stones or rock.	2	215.02	69.08
WL	Wetland	-	-	0	0.00	0.00
W	Wilderness	Ms/R	Steep rocky midslopes (12-40% slopes) with the surface covered by 60-80% stone and rock in a complex association with very shallow (50-100 mm), reddish brown, sandy loam soils.	3	7.88	2.53
*See soil map, Figure 3			Total	8	311.29	100.0

Figure 7: Land capability map of the proposed open pit and overburden dump footprints

Table 9: Land capability classes – proposed open pit and overburden dump footprints

Land Capability Code	Land Capability Class	*Soil Types	Broad Soil Description	Unit Count	Area (ha)	Area (%)
A	Arable	Hu1	Moderately deep to deep (700-1200 mm), red, well-drained, sandy loam soils situated on gentle footslopes (1-4% slopes) with no surface stones or rock.	3	88.39	28.4
G	Grazing	Hu2, Hu3	Very shallow (100-200 mm) and shallow (300-600 mm), red, well-drained, sandy loam soils situated on gentle footslopes (1-5% slopes) and gentle to moderate midslopes (4-10% slopes) with no or little (less than 1%) surface stones or rock.	2	215.02	69.08
WL	Wetland	-	-	0	0.00	0.00
W	Wilderness	Ms/R	Steep rocky midslopes (12-40% slopes) with the surface covered by 60-80% stone and rock in a complex association with very shallow (50-100 mm), reddish brown, sandy loam soils.	3	7.88	2.53
			Total	8	311.29	100.01

1.1.6.2 Wetland and riparian delineation

Land capability was assessed in categories of arable land, grazing land, wetlands/riparian zones and wilderness land. Wetlands and riparian zones were therefore delineated as part of the soil and land capability assessment based on soil properties. Auger observations were made systematically towards possible wetland zones in order to locate the point where soil properties reflect signs of wetness within 500mm from the surface or where soil, topography or vegetation indicate the boundary of the riparian zone.

No soil types were found in the area that reflects properties related to temporary, seasonal or permanent wetland zones. (See Appendix C of the specialist report for details on soil properties related to wetland zones).

1.1.6.3 Derived dry land crop production potential and long term potential yields

The derived dry land crop production potential and potential crop yields (based on soil properties) of soil types within the proposed open pit area are summarised in Table 10. These soil qualities were rated as high, moderate and low with classifications in-between these.

Table 10: Derived dry land crop potential and long term potential yields

Soil Type (Code)	Dry land crop production potential class	Potential long term yields for maize (t/ha/a)	Grazing capacity for cattle (ha/lsu)
Hu1	Moderate	2-4	10-12
Hu2	Low-moderate	2-3	
Hu3	Low	Not suitable	
Ms/R	Very low to none	Not suitable	

1.1.7 Vegetation

Information for this section was obtained from the 'Ecological Evaluation for the Tygerkloof Mine Report' (Pachnoda Consulting cc, 2015).

1.1.7.1 Regional vegetation description

The proposed site corresponds to the Savanna Biome and more particularly to the Central Bushveld Bioregion as defined by Mucina & Rutherford (2006). It comprehends two ecological types known as the (1) Waterberg Mountain Bushveld and (2) Dwaalboom Thornveld (Mucina & Rutherford, 2006) (Figure 5 of report – Pachnoda, 2015).

1. Waterberg Mountain Bushveld

This vegetation type is predominantly confined to the northern section of the proposed site, and is restricted to the Waterberg Mountains including a number of outlier hills and ridges of the Vlieëpoortberge and Boshofsberge near Thabazimbi. The floristic composition is complex and varies between *Faurea saligna – Protea caffra* bushveld on the high slopes, grading into mixed *Diplorhynchus condylocarpon* woodland on the mid and foot slopes while *Burkea africana – Terminalia sericea* savanna occurs on the low-lying valleys and areas of deep sand.

This unit is not threatened since more than 9% is formally conserved within the Marakele National Park and Moepel Nature Reserve. However, more than 3% of this woodland type is transformed by cultivation.

2. Dwaalboom Thornveld

This vegetation type is restricted to the southern section of the study site and occurs on the flats north of the Dwarsberge and ridges associated with the Crocodile River. However, it is centred near the Dwaalboom area but also extends eastward and north of Pilanesberg to Northam. The floristic and structural attributes of Dwaalboom Thornveld is fairly homogenous and consists of low to medium high microphyllous bushveld that is dominated by taxa of the genus *Vachellia* and *Senegalia* (=*Acacia*). The herbaceous layer is dominated by graminoid taxa as opposed to forb species.

However, fine-scale phytosociological differences do occur and is driven by the clay content of the soil. For example, *Vachellia tortilis* and *V. nilotica* tend to dominate soils with a clay content of 21% or less, while the vegetation appears stunted (<1m) and sparse on soils containing more than 55% clay. The latter is dominated by *V. tenuispina*. On the other hand, *Acacia erubescens* dominates sandy soils.

This unit is not threatened since more than 6% is formally conserved within the Madikwe Game Reserve. Nearly 14% of this woodland type is transformed by cultivation and bush encroachment due to overgrazing by cattle.

1.1.7.2 Limpopo Conservation Plan

According to the Limpopo Conservation Plan Version 2 (Desmet *et al*., 2013), it is evident that the proposed site is classified as part of a "CBA 2". A CBA 2 is an area that is "optimal' (as opposed to "irreplaceable") for achieving provincial conservation targets, and represent areas where there are spatial options for achieving targets.

CBA 2 areas should be maintained in a natural state with little to no net loss of biodiversity. Therefore, any current land use activity should not be intensified and should be managed in a way to minimise the impact on threatened species or ecological processes. Compatible land-use include current agricultural practices, intensive and extensive livestock production, game ranching and ecotourism as long as the current ecological integrity of the area is maintained. *However the following land-use practices is incompatible: Urban and residential development, business, industrial and mining development and linear infrastructure.* Nevertheless, some of these activities could be allowed following a detailed impact assessment and the identification of alternative areas to meet the CBA network targets.

1.1.7.3 Vegetation units

The dominant vegetation composition and structure on the study site comprises of five major communities simulated by environmental drivers such as the presence of outcrops and topography, slope, past disturbance regimes and proximity to drainage lines (Figure 8 of this report, & Figure 11 & 12 and Appendix 1 of the specialist report (Pachnoda Consulting cc, 2015)):

1. Dense to open *Dichrostachys cinerea* - *Peltophorum africanum* thicket and woodland on low lying plains:
   a. Dense short *Dichrostachys cinerea – Panicum maximum* thicket;
   b. Open *Peltophorum africanum – Dombeya rotundifolia* woodland; and
   c. Short *Dichrostachys cinerea – Combretum zeyheri* shrub on recently disturbed land.
2. *Senegalia caffra* - *Chrysophyllum serrulata* mountain bushveld on rocky, shallow soils:
   a. Open mixed *Combretum zeyheri – Diheteropogon amplectens* savannoid grassland; and
   b. Mixed *Senegalia caffra – Chrysophyllum serrulata* mountain bushveld.
3. Dense *Berchemia zeyheri – Acalypha glabrata* riparian woodland along drainage lines and ravines.

In general, *Dichrostachys cinerea* subsp. *africana*, *Combretum zeyheri, Combretum molle*, *Peltophorum africanum, Senegalia caffra, Chrysophyllum serrulata, Combretum apiculatum* and *Ximenia americana* were the dominant taxa observed.

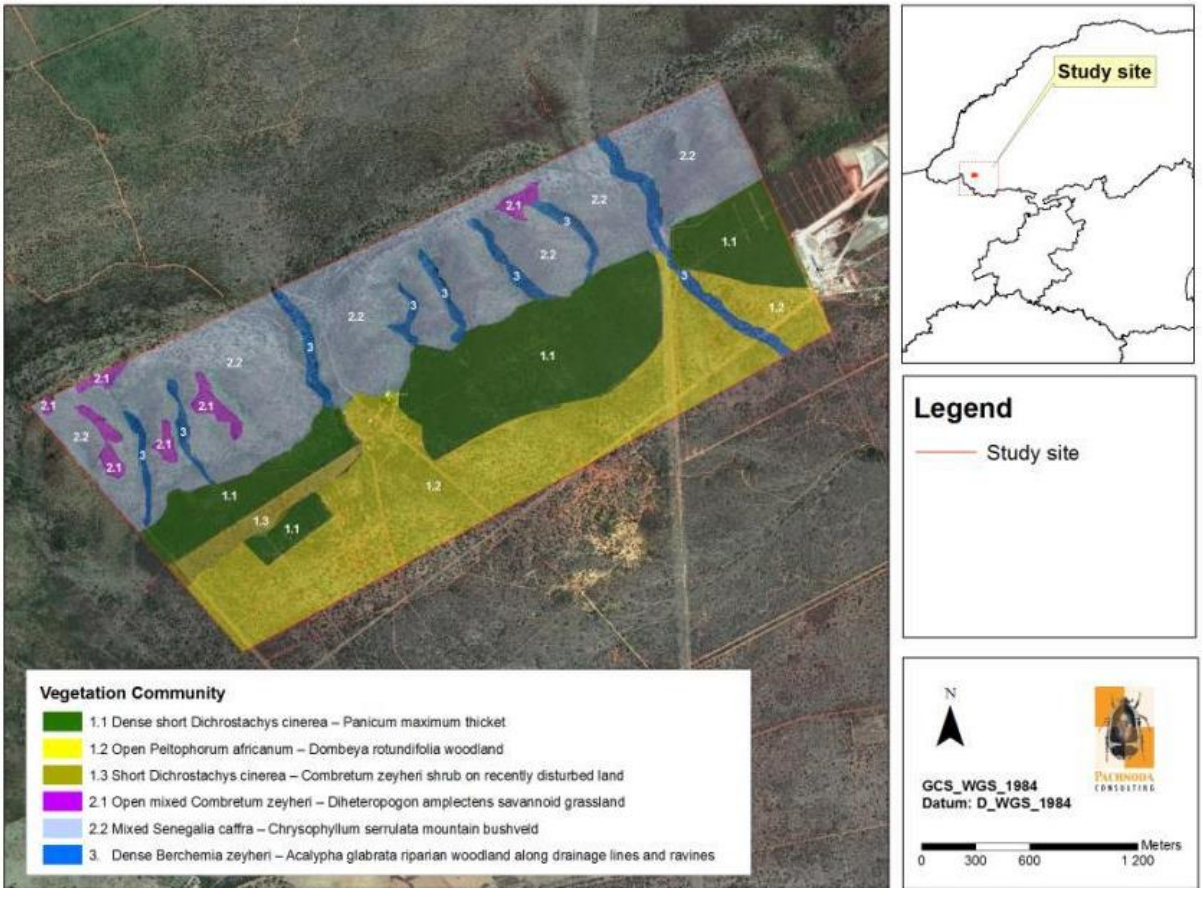


Figure 8: A map illustrating the vegetation units identified on the proposed study site

The surface area (size) of each vegetation community is summarised in Table 11. Refer to Figure 13 of the specialist report (Pachnoda Consulting cc, 2015) for diversity comparisons between the different floristic units/communities. It is evident from the rarefaction curves that high floral diversities are maintained by units showing little evidence of severe disturbances (mountain bushveld, savannoid

grassland and open woodland) while those subjected to past transformation events tend to maintain low diversities (thickets). In addition, the species richness on the mountain bushveld was the highest as evidenced by the elevated rarefaction curves in comparison to the other communities (Figure 13 of the specialist report (Pachnoda Consulting cc, 2015)).

Table 11: The surface area (ha) of each defined vegetation unit in relation to the proposed study site

Major Vegetation Community	**Area (ha)**	**%**
1. Dense to open *Dichrostachys cinerea - Peltophorum africanum* thicket and woodland on low lying plains	315.47	53.37%
2. *Senegalia caffra - Chrysophyllum serrulata* mountain bushveld on rocky, shallow soils	246.00	41.61%
3. Dense *Berchemia zeyheri – Acalypha glabrata* riparian woodland along drainage lines and ravines	29.69	5.02%
Vegetation Sub-community	**Area (ha)**	**%**
1.1. Dense short *Dichrostachys cinerea – Panicum maximum* thicket	138.96	23.51%
1.2. Open *Peltophorum africanum – Dombeya rotundifolia* woodland	164.00	27.74%
1.3. Short *Dichrostachys cinerea – Combretum zeyheri* shrub on recently disturbed land	12.51	2.12%
2.1. Open mixed *Combretum zeyheri – Diheteropogon amplectens* savannoid grassland	12.92	2.19%
2.2. Mixed *Senegalia caffra – Chrysophyllum serrulata* mountain bushveld	233.08	39.43%
Total*:*	591.16	100.00

1.1.7.3.1 Dense to open Dichrostachys cinerea - Peltophorum africanum thicket and woodland on low lying plains

1. Dense short *Dichrostachys cinerea – Panicum maximum* thicket

This community covers approximately 24% of the total surface of the proposed area where it is confined to the foot slopes of the nearby mountain ranges on the northern part of the site, and is almost entirely dominated by a short, dense canopy of *Dichrostachys cinerea* subsp. *africana* (*c*. 4-5m) (Figure 14 of the specialist report (Pachnoda Consulting cc, 2015)). The entire unit is reminiscent of past disturbances, presumably caused by severe overgrazing and incompatible wildlife management principles, which resulted in widespread bush encroachment of microphyllous thicket.

Apart from a monotonous woody canopy of *D. cinerea*, was the basal layer poor in species richness. Noteworthy graminoids include shade tolerant taxa such as *Panicum maximum* and annual grasses such as *Aristida adscensionis*. The forb layer is poorly defined and consists mainly of *Melhania acuminata*.

The conservation importance of this community is *low*. It is species poor and of low importance to game or livestock grazing owing to the absence of a well-defined graminoid layer. Species of conservation concern were rare and consist of scattered individuals (low densities) of the nationally

protected tree *Sclerocarya birrea subsp. africana* (Marula) which persists as relict canopy constituents.

2. Open *Peltophorum africanum – Dombeya rotundifolia woodland*

This community covers approximately 28% of the total surface of the study site where it is confined to relatively flat areas on Hutton soils. It is described as a moderately tall woodland (*c*. 6-8m) with an open canopy dominated by *Peltophorum africanum, Dombeya rotundifolia, Vachellia nigrescens, V. burkei, Ziziphus mucronata* and *Combretum zeyheri* (Figure 15 of the specialist report (Pachnoda Consulting cc, 2015)). The graminoid layer is poorly defined and overgrazed owing to the highly palatability of the composition.

The shrub layer is low and in places fairly dense, thereby leading to characteristic "bush clumping" and provides protection against browsing to palatable taxa. Noteworthy shrubs include *Grewia flavescens* and *G. flava*, while typical graminoids include *Eragrostis rigidior, E. lehmanniana, Aristida adscensionis* and *Heteropogon contortus*.

The conservation importance of this community is *moderate*. It is species rich and sustains many tree species that are nationally protected including *Elaeodendron transvaalense* that is Near Threatened. The high palatability of the species composition, high floristic richness and rehabilitation potential of the unit makes it a valuable component for game ranching.

3. Short *Dichrostachys cinerea – Combretum zeyheri* shrub on recently disturbed land

This community covers a small section of the study site (approximately 2%) where it is confined to flat areas that were recently cleared of vegetation. It is described as a short dense scrubland (*c*. 1-2m) dominated by pioneer taxa with a high tendency to become bush encroachers at an advanced successional stage, in particular *Dichrostachys cinerea* (Figure 16 (Pachnoda Consulting cc, 2015)). It is an early successional stage which will at a later stage conform to *Dichrostachys cinerea – Panicum maximum* thicket.

The canopy layer is poorly defined and comprised of relic tree species such as *Combretum zeyheri*, *Peltophorum africanum* and *Ximenia americana* which were prior to disturbance regimes constituents of an open *Peltophorum africanum – Dombeya rotundifolia* woodland. The graminoid layer is characterised by secondary taxa such as *Eragrostis trichophora, E. rigidior, E barbinodis* and *Aristida adscensionis*.

The conservation importance of this community is *low*. It is reminiscent of a transformed and transient woodland and nearly impenetrable. Although the floristic richness was high, most of these species are pioneers or opportunistic taxa which flourish during disturbances. However, it should be emphasised that the dead trees provide potential breeding habitat for cavity-nesting bird species.

1.1.7.3.2 *Senegalia caffra - Chrysophyllum serrulata* mountain bushveld on rocky, shallow soils

1. Open mixed *Combretum zeyheri – Diheteropogon amplectens* savannoid grassland

This community is confined to the open rocky slopes and ridges on the northern section of the study site (Figure 17 (Pachnoda Consulting cc, 2015)) and covers approximately 2% of the total surface area. The stunted structure of the canopy layer and surface extent of the graminoid cover are regulated by fires and environmental extremities induced by aspect and soil conditions (e.g. soil nutrition, texture and leaching). It is considered unique to the region with more than 50% of its composition, especially the graminoid composition being absent from typical "bushveld" units. In addition, it supports a high richness of primary graminoid species.

The graminoid layer is earmarked by a well-defined primary composition of 'decreaser' grass taxa such as *Loudetia flavida, Trachypogon spicatus, Diheteropogon amplectens* and *Andropogon schirensis*. It is rich in forb taxa, not only at a species level, but is also owing to a high diversity of plant families pertaining to the Asteraceae (*Helichrysum spp., Athrixia elata*), Crassulaceae and Fabaceae (e.g. *Indigofera* and *Tephrosia*). The increased diversity of plant taxa is encouraged by the high spatial heterogeneity provided by the numerous outcrops and rock promontories. These provide stable microclimatic conditions for the colonisation of "shade-tolerant" pteridophytes (e.g. *Cheilanthes pentagona*). Other noteworthy woody species pertaining to this unit include *Englerophytum magalismontanum, Faurea saligna*, *Burkea africana, Combretum zeyheri* and *Ochna pulchra*.

The conservation importance of this community is *high and undisputable*. It sustains a graminoid composition of primary (pristine) ecological condition while also supporting many provincially protected geophytic taxa.

2. Mixed *Senegalia caffra – Chrysophyllum serrulata* mountain bushveld

This community is widespread and prominent on the rocky hills that occur on the northern section of the study site (*c*. 39% of the total surface area), and conforms to an open woody canopy (*c*. 5-8m) dominated by *Senegalia caffra, Combretum apiculatum, C. molle* and *Kirkia wilmsii.* In addition, the herbaceous layer is rich in 'decreaser' grass taxa and is dominated by *Setaria lindenbergiana, Chrysophyllum serrulata* along with taxa of the genus Enneapogon (Figure 18 (Pachnoda Consulting cc, 2015)). Subtle differences in the dominant basal composition are apparent along ill-defined drainage lines as evidenced by an over-dominance of *Panicum deustum.*

This woodland is common on steep slopes of 30° or more, and forms a distinct eco-tone or transitional community between the savannoid grasslands on rocky slopes and the lower-lying open woodland. Therefore, its composition is often shared with both of these floristic units.

The conservation importance of this community is *high*. It sustains a floristic composition indicative of a primary (pristine) ecological condition while also supporting many provincially protected geophytic

taxa. In addition, part of its composition includes range-restricted taxa such as *Erythrophysa transvaalense* (a Central bushveld endemic) and regional rarities such as *Calodendron capense*.

1.1.7.3.3 Dense *Berchemia zeyheri – Acalypha glabrata* riparian woodland along drainage lines and ravines

This community is restricted to the various drainage lines ad ravines on the study site, and conforms to a tall, closed-canopy woodland with a poorly defined graminoid layer (Figure 19 (Pachnoda Consulting cc, 2015)). Typical canopy constituents include *Spirostachys africana, Berchemia zeyheri, Ficus burkei* and *Strychnos usambarensis,* and noteworthy shade-tolerant species such as *Barleria obtusa, Acalypha glabrata* and *Calpurnia aurea.*

The conservation importance of this community is *high*. The floristic composition shows strong biogeographic affinities with azonal forest groups such as the Northern Afrotemperate Forests of the Waterberg, Magaliesberg and Suikerbosrand (Mucina & Rutherford, 2006) based on the eminent dominance of *Calpurnia aurea*, *Isoglossa grantii*, *Chaetachme aristata* and *S. usambarensis*. In addition, it is the only vegetation unit that supports the provincially protected tree *Spirostachys africana* (Tamboti). The linear configuration of this unit facilitate ecological connectivity with other units, while it also act as important dispersal corridors for fauna taxa, thereby maintaining genetic cohesion among populations of the same species.

1.1.7.4 Threatened, near threatened and declining plant taxa

Only one near threatened and one declining species were recorded on the study (see Table 4 (Pachnoda Consulting cc, 2015)). *The near-threatened Elaeodendron transvaalense (Transvaal Saffron) is a small tree which were observed in low densities in the open Peltophorum africanum – Dombeya rotundifolia* woodland (see Figures 9 below, and Figure 21 (Pachnoda Consulting cc, 2015)). This species is a very popular species used for muthi (sensu Raimondo *et al*., 2009). The other taxon includes the declining *Boophone disticha* which is observed in low numbers from the mixed *Senegalia caffra – Chrysophyllum serrulata* mountain bushveld and is also expected to be present in the open mixed Combretum zeyheri – *Diheteropogon amplectens* savannoid grassland (see Figures 9 of this report and Figure 21 (Pachnoda Consulting cc, 2015)). It is highly valued for its medicinal properties.

1.1.7.5 Protected plant species

Five plant species were observed and listed as protected (Table 5 (Pachnoda Consulting cc, 2015)) under Schedule 12 of the Limpopo Environmental Management Act (No 7 of 2003) during the respective survey period. It is evident from Table 5 (Pachnoda Consulting cc, 2015) that the majority of protected plant species are localised and restricted to the mixed S*enegalia caffra – Chrysophyllum serrulata* mountain bushveld.

A permit is required to remove or disturb a protected plant. It is recommended that protected plants in danger of becoming destroyed during any of the planned mining activities be removed prior to the commencement of construction activities and translocated to suitable habitat, or used during the rehabilitation phase.

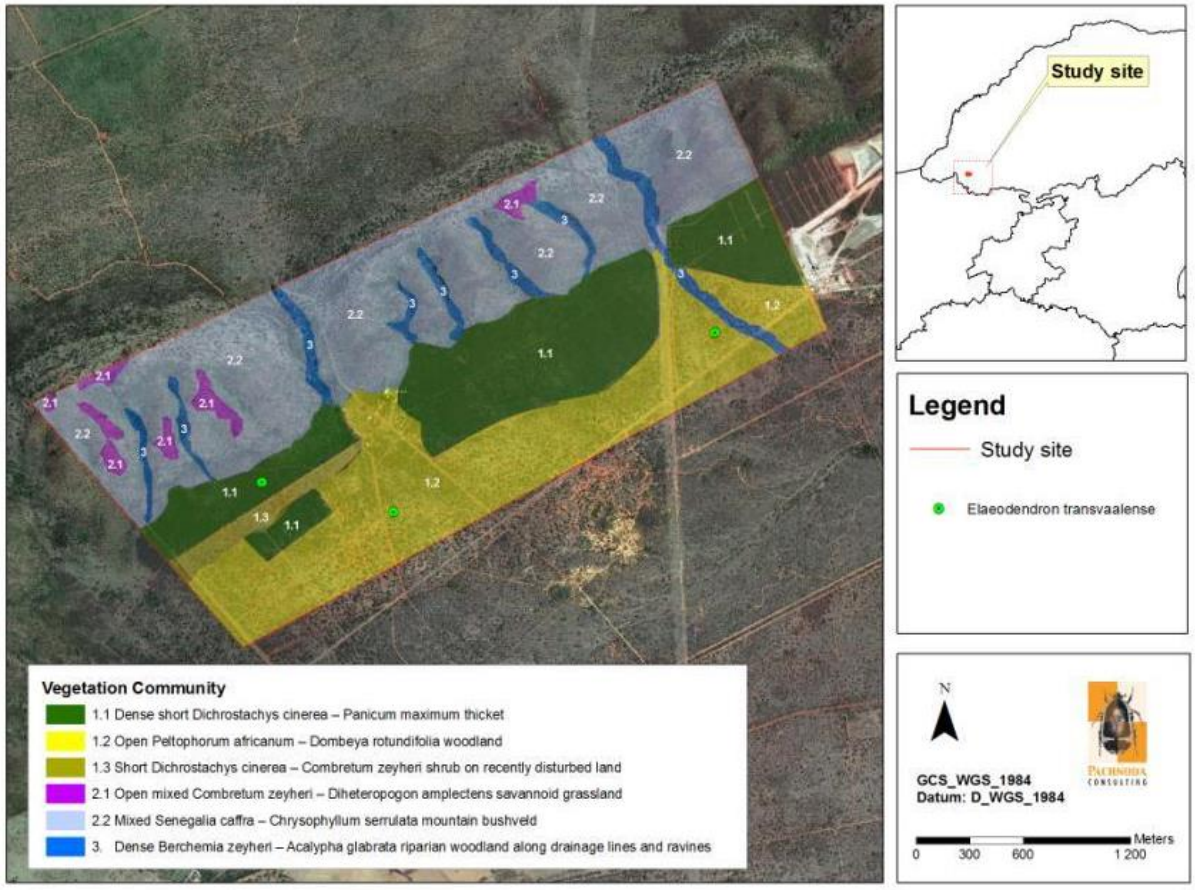


Figure 9: The approximate spatial distribution of observed near threatened plant taxa on the study site

1.1.7.6 Protected tree species

Five tree species (Table 6 (Pachnoda Consulting cc, 2015)) appear on Schedule A of the national list of protected tree species as promulgated by the National Forests Act, 1998 (No 84 of 1998). The main reasons for this list are to provide strict protection to certain species while others require control over harvesting and utilisation. In most instances these species occur widely and are not threatened (not Red Data listed), but should be considered during the project based on their legal status.

In terms of the National Forests Act of 1998, a licence should be granted by the Department of Forestry (or a delegated authority) prior to the removal, damage or destruction of any individual. Therefore, such activities (as mentioned above) should be directed to the responsible Forestry official in each province or area.

It is unavoidable that a number of individuals are likely to become lost or removed during the proposed mining phase (if permission is granted). Even though they are regionally well distributed, effort should be put in place to conserve at least examples of tall canopy constituents represented by *Vachellia erioloba* and *Combretum imberbe*.

1.1.7.7 Medicinal plant species

Although most of these plant species are regionally widespread and abundant, some are declining and should be envisaged as priority conservation entities. Table 12 lists those species considered to be of economical or cultural value (according to Van Wyk *et al*., 1997; Pooley, 1998).

Table 12: A list of medicinal species observed on the study site (according to Van Wyk *et al*., 1997; Pooley, 1998). Important (heavily utilised) species are highlighted in grey

Species Identified within Van Wyk *et al*. (1997)		
Species	Parts used	Treatment
Vachellia karroo	Bark, leaves & gum	Stomach ailments such as diarrhoea and dysentery. Bark, gum & leaves used as an astringent for colds and conjunctivitis.
Sclerocarya birrea subsp. *caffra*	Bark and fruit	Treatment of various ailments, including malaria. Fruit rich in Vitamin C.
Dicoma anomala	Leaves	Used to treat fever.
Elaeodendron transvaalense	Bark	Used for stomach cramps, diarrhoea and fever.
Gomphocarpus tomentosus	Leaves	Treatment of headaches, tuberculosis and general body aches.
Helichrysum spp.	Leaves & stems	Treatment of coughs, colds, fever, infections and menstrual pain.
Heteropyxis natalensis	Leaves	Treatment of colds.
Jatropha zeyheri	Rhizomes	Treatment of fever and wounds.
Terminalia sericea	Roots	An infusion is made to treat pneumonia and wounds.
Vernonia oligocephala	Leaves and twigs	Used to treat abdominal pain and colic.
Euclea undulata	Roots	Used as a remedy for headaches and toothaches.
Pellaea calomelanos	Leaves and rhizomes	Treatment of colds and asthma.
Xerophyta retinervis	Stems	Used to treat asthma.
Ziziphus mucronata	Roots, leaves and bark	Treatment of respiratory ailments.

Species Identified within Pooley (1998)	
Species	Treatment
Boophone disticha	Treatment of pain, wounds and used as a narcotic.
Schizocarphus nervosus	Treatment of rheumatic fever and dysentery.
Scadoxus puniceus	Used to treat coughs, poultices, headaches and stomach ailments.

Species Identified within Van Wyk *et al*. (1997)		
Species	Parts used	Treatment
Commelina africana		Used for a wide variety of ailments including fevers, fits, heart complaints and bladder infections.

1.1.7.8 Endemic and near-endemic taxa

According to Mucina & Rutherford (2006), taxa such as *Grewia rogersii, Pachystigma triflorum* and *Oxygonum dregeanum* subsp. *canescens* var. *pilosum* are endemic to the Waterberg Mountain Bushveld. These species are likely to occur (in particular *G. rogersii*) on areas of rocky soils (in particular the mixed *Senegalia caffra – Chrysophyllum serrulata* mountain bushveld) although not confirmed during the site visits.

The Central Bushveld Endemic, *Erythrophysa transvaalensis* was recorded from the northern aspects of mixed *Senegalia caffra – Chrysophyllum serrulata* mountain bushveld (see Figure 22 (Pachnoda Consulting cc, 2015) and Figure 10).

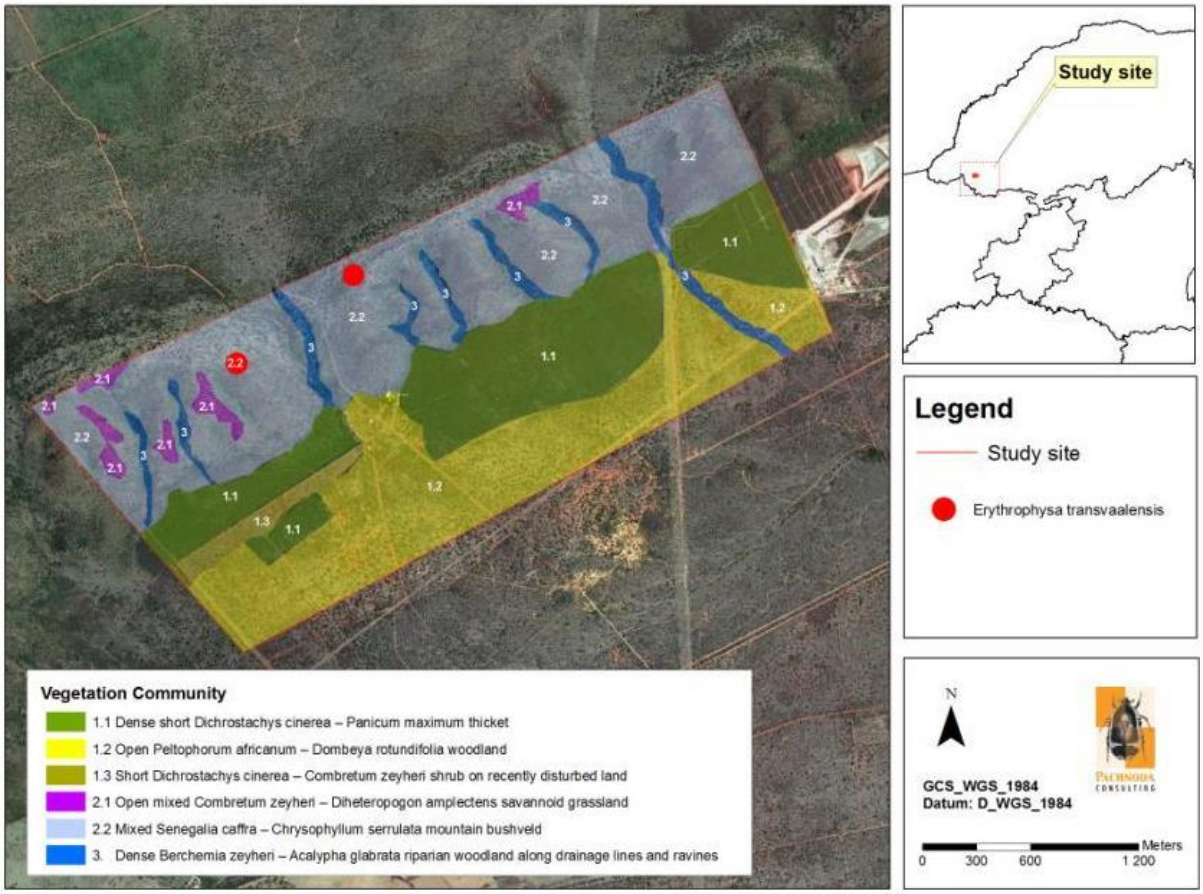


Figure 10: The approximate distribution of the central bushveld endemic, *Erythrophysa transvaalensis* on the study site

1.1.7.9 Declared weeds and invader plants

In general, the natural vegetation units on the site were relatively free of alien and invasive plant taxa. However, observed minor ruderal weed species include *Tagetes minuta, Schkuhria pinnata, Pupalia lappacea* and *Zinnia peruviana*. These species are all annuals (they completely die off during the dry season) and are of temporary nature.

1.1.7.10 Ecological condition and succession

An analysis of the ecological status of each floristic community revealed that the mountain bushveld and savannoid grassland seres on ridges (open mixed *Combretum zeyheri – Diheteropogon amplectens* savannoid grassland and mixed *Senegalia caffra – Chrysophyllum serrulata* mountain bushveld) are characterised by a high percentage of Decreaser grass species (see Figure 24 (Pachnoda Consulting cc, 2015)). *These two units are represented by late-succession compositions, and share a species-rich graminoid layer when compared to the other communities.*

Nevertheless, the highly transformed units dominated by *Dichrostachys cinerea* shrub and thickets are earmarked by low levels of utilisation (grazing) as evidenced by the high cover of Increaser 1 grasses. The low levels of utilisation is best explained by the density of the woody layer which makes it difficult for livestock and large grazing taxa to access the graminoid layer.

The open woodland unit (open *Peltophorum africanum – Dombeya rotundifolia* woodland) is characterised by high levels of grazing by game as evidenced by the high cover of Increaser 2 grasses.

An analysis of the ecological succession showed that both the mountain bushveld and savannoid grassland units are dominated by late-successional (primary or “near-climax”) taxa (see Figure 25 (Pachnoda Consulting cc, 2015)).

In summary, the open mixed *Combretum zeyheri – Diheteropogon amplectens* savannoid grassland and mixed *Senegalia caffra – Chrysophyllum serrulata* mountain bushveld consist of primary compositions.

1.1.7.11 Ecological Sensitivity

<u>Areas of high ecological sensitivity</u>

The following habitat units and floristic communities are considered to be of high ecological sensitivity (Figure 11):

- Open mixed *Combretum zeyheri – Diheteropogon amplectens* savannoid grassland;
- Mixed *Senegalia caffra – Chrysophyllum serrulata* mountain bushveld; and
- Dense *Berchemia zeyheri – Acalypha glabrata* riparian woodland along drainage lines and ravines

These units are of high sensitivity based on the following arguments:

- The mountain bushveld and savannoid grassland units show high floristic richness when compared to the other units. More than 80% of the species composition is composed of late-successional taxa. In addition, more than 35 % of the floristic composition is composed of decreaser grasses;
- The mountain bushveld and savannoid grassland units provide habitat for declining and near-threatened plant species;
- The mountain bushveld unit overlaps with the home range of the regionally vulnerable Verreaux's Eagle (*Aquila verreauxii*) and globally near threatened Brown Hyaena (*Parahyaena brunnea*);
- The mountain bushveld and savannoid grassland units provide potential habitat for two near threatened lizard species and five reptile taxa endemic to the Waterberg region;
- The mountain bushveld is part of a ca. 110km ridge corridor extending in the west from the Noupoort mountains, eastwards past the Rookpoort Mountains to the Hoekberg Mountains near Modimolle. It forms an extensive and important regional dispersal corridor for fauna in the landscape while also providing resilience towards climate change; and
- The riparian woodland units are located along drainage lines of linear configuration and facilitate animal dispersal and ecological connectivity. It also provides refuge for avifaunal taxa with high affinities towards forest and closed-canopy (mesic) habitat types.

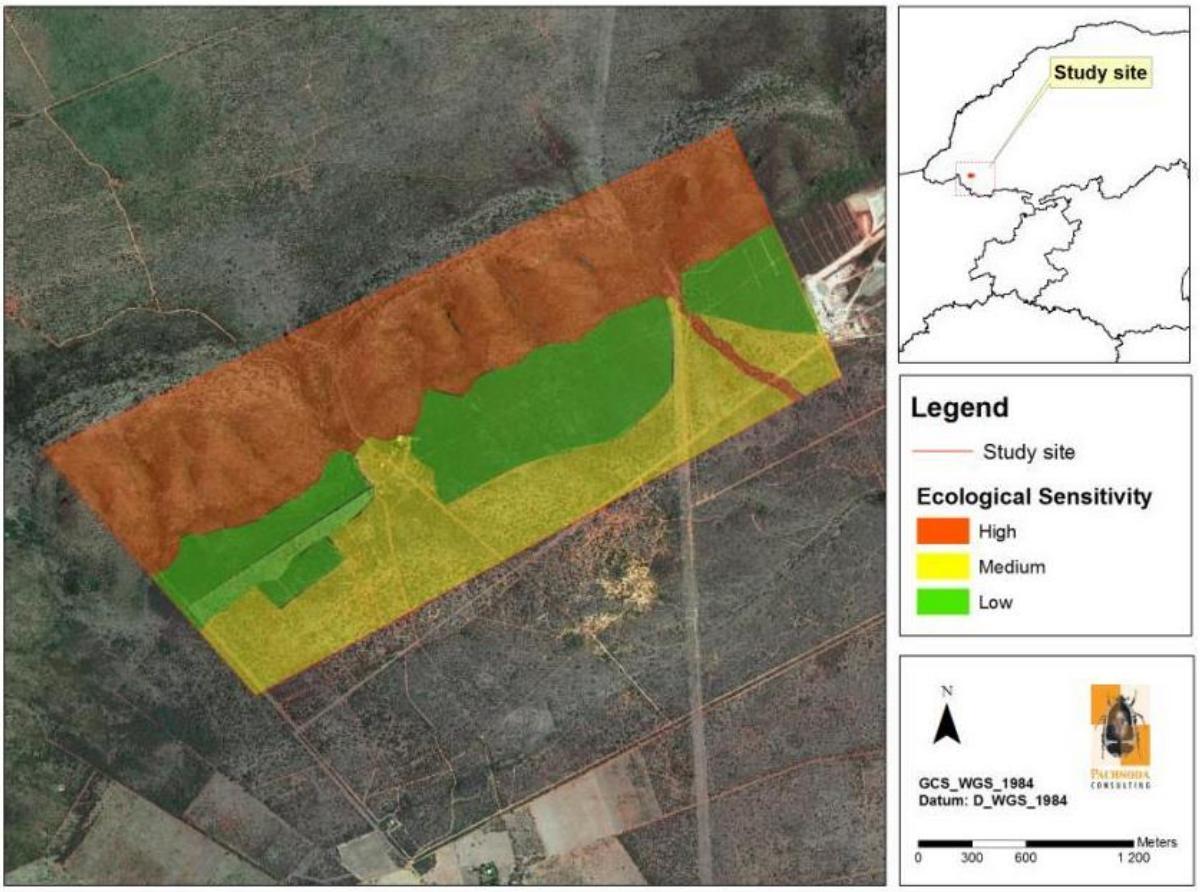


Figure 11: Ecological sensitivity map

Areas of medium ecological sensitivity

The following habitat types and floristic communities are considered to be of medium ecological sensitivity (Figure 11):

Open *Peltophorum africanum – Dombeya rotundifolia* woodland.

These units are of medium sensitivity based on the following arguments:

- The open woodland provides habitat for a high diversity of taxa with widespread distributions;
- The open woodland provides habitat for a number of national protected tree species including one near-threatened tree species (*Elaeodendron transvaalensis*);
- Over 60% of the graminoid composition is composed of secondary grasses which are indicative of inappropriate grazing regime and stocking rates.

Areas of low ecological sensitivity

The following habitat types and floristic assemblages are considered to be of low ecological sensitivity (Figure 11):

Dense short *Dichrostachys cinerea – Panicum maximum* thicket; and

Short *Dichrostachys cinerea – Combretum zeyheri* shrub on recently disturbed land

These units are of low sensitivity based on the following arguments:

- These units hold floristic compositions consisting of typical pioneer species and bush encroacher taxa;
- Both units are transformed either through the clearing of vegetation or severe overgrazing;
- Overall species richness is low when compared to the other units.

1.1.8 Animal life

Information for this section was obtained from the 'Ecological Evaluation for the Tygerkloof Mine Report' (Pachnoda Consulting cc, 2015).

1.1.8.1 Mammals

A total of 65 mammal species could occur on the proposed site (excluding bats and introduced game; Appendix 2 (Pachnoda Consulting cc, 2015)) of which 25 species (38%) were confirmed during the survey period (Table 13 of this report & Figure 26 (Pachnoda Consulting cc, 2015)). In addition, four species are probably uncommon to absent on the study site owing to the absence of suitable habitat. Nevertheless, among those confirmed were seven antelope species, five rodents, one canine (jackal), one feline (cats), one hyaenid, two leporids (hares), one mustellid, aardvark, two suids (pigs), one hyrax (dassie) and three primates.

Bats (Chiroptera) are a highly specialised group of mammals and requires specialised equipment and ultra-sonic recorders/detectors to survey them. Therefore this group was omitted from the study. However, approximately 16 species could utilise the study site, of which six are regionally near

threatened, one data deficient and one being vulnerable. It is possible that some of these taxa (especially the genus Rhinolophus) could roost in rock fissures and caves provided by the dolomite outcrops in the mountain bushveld. In addition, the riparian woodland should be considered as an important foraging habitat for many of the smaller insectivorous taxa.

Table 13: An inventory of mammalian taxa observed on study site during the site visit (23 - 27 February 2015)

Scientific Name	Vernacular Name	Observation Indicators	Observed Habitat
Aepyceros melampus	Impala	Visual sightings	Very common and widespread, mainly confined to the open woodland.
Micaelamys namaquensis	Namaqua Rock Mouse	Trapped	Widespread on outcrops
Canis mesomelas	Black-backed Jackal	Spoor & vocalisations	Widespread, although inconspicuous.
Cercopithecus pygerythrus	Vervet Monkey	Visual sightings	Widespread.
Cryptomys hottentotus	African Mole-rat	Soil heaps	Widespread.
Civettictis civetta	African Civet	Spoor (old)	Inconsicuous.
Galago moholi	Southern Lesser Galago	Visual sightings	Widespread.
Hystrix africaeaustralis	Cape Porcupine	Visual sightings and camera trapped	Widespread, all habitat types.
Lepus saxatilis	Shrub Hare	Droppings & Visual sightings	Widespread, mainly on flat topographies.
Mastomys coucha/natalensis	Multimammate Mouse	Trapped	Mainly confined to open woodland.
Oreotragus transvaalensis	Transvaal Klipspringer	Visual sightings	Restricted to mountain bushveld and savannoid grassland.
Orycteropus afer	Aardvark	Burrows & camera trapped.	Confined to low-lying areas on sandy substrate.
Panthera pardus	Leopard	Spoor (old)	Probably roaming over entire study site.
Papio cyanocephalus ursinus	Savanna Baboon	Droppings & visual sightings	Widespread, all habitat units
Parahyaena brunnea	Brown Hyaena	Spoor & camera trapped	All vegetation units.
Paraxerus cepapi	Tree Squirrel	Visual sightings	Widespread.
Phacochoerus africanus	Common Warthog	Visual sightings & spoor	Widespread, mainly confined to the low-lying areas.
Potamochoerus larvatus	Bushpig	Spoor & diggings	Restricted to riparian woodland.
Procavia capensis	Rock Hyrax	Visual sightings.	Outcrops.

Scientific Name	Vernacular Name	Observation Indicators	Observed Habitat
Pronolagus randensis	Jameson's Red Rock Rabbit	Droppings	Mountain bushveld and savannoid grassland.
Raphicerus campestris	Steenbok	Visual sightings & spoor.	Widespread on low-lying areas.
Redunca fulvorufula	Southern Mountain Reedbuck	Visual sightings	Confined to mountain bushveld and savannoid grassland.
Strepsiceros zambesiensis	Zambezi Kudu	Visual sightings, spoor & droppings	Widespread.
Sylvicapra grimmia	Common Duiker	Spoor, droppings & visual sightings	Widespread, all areas.
Tragelaphus sylvaticus	Bushbuck	Visual sightings.	Widespread, prevalent along the drainage lines.

Mammal taxa of conservation concern

The proposed area provides habitat for a variety of threatened and near-threatened taxa, of which two species were confirmed during the surveys. Based on the large variety of habitat types available, the study site is likely to sustain two globally near-threatened species (according to the IUCN, 2014), as well as one regionally threatened and four near-threatened species (see Appendix 2 (Pachnoda Consulting cc, 2015)) (according to Friedmann & Daly, 2004).

A brief annotated account is provided below for those species that could occur on the study site:

Brown Hyaena (*Parahyaena brunnea*)

The Brown Hyaena is listed as near threatened on the global IUCN Red List (Wiesel *et al*., 2008) since it requires extensive areas (sometimes in excess of 1,000km²) to maintain a viable population, especially where inter-specific competition for resources is fierce between other predator taxa. Such massive home ranges often coincide with livestock and agricultural areas where they are heavily persecuted by farmers. Therefore, persecution and the loss of habitat due to agricultural intensification are some of the primary threats faced by this species.

The numerical abundance of this species on the study area remains unclear, although anecdotal observations show that it is widespread in the area. It was recorded from both the mountain bushveld and the open woodland (based on spoor tracking and camera trapping). The territory of a young adult coincides with the study site and it is considered sedentary on the site since.

Leopard (*Panthera pardus*)

The Leopard, although a widespread and adaptable species, is listed as near threatened on the global IUCN Red List (Henschel *et al*., 2008). The global population estimate for *P. pardus* is non-existent or very unreliable, which is responsible for its placement in the "near-threatened" category. Furthermore, increased competition for space along with frequent human encounters (near farming communities) has seriously reduced the number of global subpopulations.

The presence of ridges and topographic complexity on the northern part of the study site (shelter), dense vegetation (shelter) and a generous availability of prey (it is catholic in its diet, taking prey from small invertebrates to large antelopes, including Kudu) prompted the definite occurrence of this species on the study site. It was confirmed on the site based on old spoor, although the landowner has confirmed its presence.

Honey Badger (*Mellivora capensis*)

The Honey Badger is listed as least concern on the global IUCN Red List although Friedmann and Daly (2004) have listed it as near-threatened.

Honey Badgers are widespread and generally very catholic in their habitat requirements. They are predominately nocturnal, solitary, and generally very unobtrusive in behaviour (Skinner & Chimimba, 2005). It is tolerant to modified habitat types and personal observations from the central Mpumalanga Highveld have shown that it can persist on areas dominated by agricultural activities (camera trapping, pers. obs.). This species is likely to be present and can occur almost anywhere due to its unobtrusiveness.

The regional conservation status of *M. capensis* is currently under revision, although supporting evidence suggests that it will be downgraded from near-threatened to least concern (pers. comm., M. Child of EWT).

South African Hedgehog (*Atelerix frontalis*)

The South African Hedgehog is listed as least concern on the global IUCN Red List although Friedmann and Daly (2004) have listed it as near threatened. This species occurs in a wide variety of habitat types, which makes prediction regarding its habitat requirements very difficult. However, illegal hunting, habitat transformation to make way for agricultural land, and hard-surfaced infrastructure (e.g. road mortalities) are probably the main reasons for its decline.

It is highly adapted to urban environments and frequently encountered in urban gardens (Skinner & Smithers, 1990) and will readily adapt to new development, if emphases is placed on preserving the natural function of the respective vegetation units while minimising the unnecessary use of exotic plant species and roads. It is considered a resident on the study site based on the widespread

occurrence of suitable habitat (c. dry and rocky structure provided mountain bushveld and savannoid grassland).

Serval (*Leptailurus serval*)

The Serval is listed as least concern" on the global IUCN Red List although Friedmann and Daly (2004) have listed it as near threatened.

Servals show a wide distribution range, although they are limited by their obligate preference for surface water. Therefore, they are always found near water and in areas with sufficient shelter such as tall grass (Skinner & Smithers, 1990) with an abundance of suitable prey – mainly Murid rodents (e.g. genera *Mastomys*, *Mus* and *Otomys*).

This species is a specialised rodent hunter, and appears to be tolerant towards agricultural activities and adapts readily to abandoned cultivation and secondary growth as long as they are not persecuted or persistently disturbed (in Wilson & Mittermeier, 2009). However, it is considered to be an uncommon to rare resident on the study site as explained by the absence of optimal habitat (moist grassland) and low density of rodent prey (pers. obs.).

The regional conservation status of *L. serval* is currently under revision, although supporting evidence suggests that it will be downgraded from near threatened to least concern (pers. comm., M. Child of EWT).

Data Deficient Taxa

All shrew species (genera *Crocidura*), the Short-snouted Elephant-shrew (*Elephantulus brachyrhynchus*), the Single-striped Mouse (*Lemniscomys rosalia*), Rock Dormouse (*Graphiurus platyops*) and the Bushveld Gerbil (*Tatera leucogaster*) are "Data Deficient" and likely to occur on the proposed site. Most of these species are perceived to be relatively widespread and abundant, but current modifications of suitable habitats and the paucity of scientific information on meta-population demographics place these species under the "Data Deficient" category. Many of these species could potentially associate with the tributaries while the Single-striped Mouse and Elephant-shrew could occur on grassy patches associated with the savannoid grassland units. The genus *Tatera* often colonises disturbed areas and are likely to occur within sandy areas dominated by secondary arid bushveld.

The regional conservation status of these taxa is currently under revision, and supporting evidence suggests that many will be downgraded to least concern (pers. comm., M. Child of EWT).

The vulnerable Ground Pangolin (*Manis temminckii*) is not discussed since there is very little known about its life-history and distributions. It is mainly encountered in well managed game farms.

Biodiversity value and ecological considerations

- The geographic position of the study site (located between a number of game farms) is responsible for a high diversity of angulate taxa, which attract species pertaining to higher trophic guilds (e.g. Leopard). However, poor management principles and intensive grazing on low-lying areas of the study site (southern parts) were responsible for a low primary prey production (e.g. rodentia) which explains the ominous absence of meso- and small carnivores (e.g. jackal, badgers, mongoose) on the study site;
- The topographical complexity and the “sense of wilderness” on the northern parts of the study site are responsible for the occurrence of two globally near-threatened scavenger-predator species, namely Leopard (*Panthera pardus*) and Brown Hyaena (*Parahyaena brunnea*);
- The absence of perennial surface water and inundated habitat (e.g. moist grassland and dams) is responsible for the absence of many "wetland-associated" taxa such the Marsh Mongoose (*Atilax paludinosus*), Cape Clawless Otter (*Aonyx capensis*) and *Otomys* spp.

1.1.8.2 Avifauna

Species richness and composition

According to the South African Bird Atlas Project, 169 bird species have been recorded from the proposed region of which 163 species were recorded during SABAP2 (2427CA Kaaldraai; Harrison *et al*., 1997) and 29 species during SABAP2 (pentad 2440_2710). This equates to 17.5% of the approximate 967 species listed for the southern African subregion. In addition, the SABAP2 database recorded on 29 species (www.sabap2.adu.org.za) in the area, which is significantly lower than the SABAP1 database. The SABAP2 statistic was obtained from one pentad grid representing a single ad hoc submission. However, the current survey produced 152 species (see Appendix 3 (Pachnoda Consulting cc, 2015)) despite the poor richness documented during the respective atlas periods along with 17 species not recorded during the current survey (Table 9 (Pachnoda Consulting cc, 2015)). The atlas data clearly illustrates the poor coverage in the area by citizen scientists. On a national scale, the species richness on the study area is considered to be very low (see Figure 27) (Pachnoda Consulting cc, 2015).

The observed totals are well within the limit (>50%) of the number of species likely to occur, and provide a realistic indication of the thoroughness and general coverage of the study site. The area was poorly represented by biome-restricted (see Table 14) and endemic bird species. Despite the poor richness of endemic species, the area accommodates species with local distribution patterns in the region (e.g. out of range distributions). These species are primarily restricted to closed-canopy environments and are confined to the forested habitat pertaining to the dense *Berchemia zeyheri – Acalypha glabrata* riparian woodland along drainage lines and ravines (e.g. Collared Sunbird *Hedydipna collaris* and Yellow-bellied Greenbul *Chlorocichla flaviventris*).

Table 14: Biome-restricted species (Barnes, 1998) observed on the study site

Species	Kalahari-Highveld	Zambezian
Burchell's Starling	X	
Kalahari Scrub-robin	X	
White-bellied Sunbird		X
White-throated Robin-chat		X
Kurrichane Thrush		X

An analysis of bird data generated from the point counts showed that the Cape turtle Dove (*Streptopelia capicola*), Dark-capped Bulbul (*Pycnonotus tricolor*), Laughing Dove (*Spilopelia senegalensis*), Chin-spot Batis (*Batis molitor*) and White-browed Scrub-robin (*Erythropygia leucophrys*) are dominant in the area (Table 15 summarises the 10 typical species observed on the study site). These species are widespread and consist of (1) granivorous taxa (doves) and (2) insectivorous species that co-occur in nutrient-poor systems pertaining to the mountain bushveld and savannoid grassland units.

Table 15: The dominant bird species recorded on the study site.

Species	Average Abundance	Consistency	% Contribution
Cape Turtle Dove	0.94	0.76	23.65
Dark-capped Bulbul	0.81	0.51	14.16
Laughing Dove	0.59	0.54	11.57
Chinspot Batis	0.72	0.35	6.78
White-browed Scrub-robin	0.44	0.39	6.43
White-bellied Sunbird	0.44	0.34	4.54
Black-headed Oriole	0.28	0.2	3.05
Cinnamon-breasted Rock Bunting	0.41	0.23	2.85
Yellow-fronted Tinkerbird	0.34	0.25	2.82
African Grey Hornbill	0.41	0.2	2.14

Bird taxa of conservation concern

Table 16 provides an overview of bird species of “special conservation concern” recorded in the proposed area, as well as those previously recorded in the area based on their known distribution range and the presence of suitable habitat. According to Table 16, ten (10) species could occur on the study site, of which only three were confirmed during the survey. The confirmed species include the globally threatened White-backed Vulture (*Gyps africanus*) and Cape Vulture (*G. coprotheres*) and the regionally threatened Verreaux's Eagle (*Aquila verreauxii*) (Taylor, in press).

Table 16: Bird species of "special conservation concern" that could utilise the study site based on their known distribution range and the presence of suitable habitat. Species highlighted in grey were confirmed on the study site. Red list categories according to the IUCN (2014)* and Taylor (in press)**

Species	Global Conservation Status*	National Conservation Status**	Recorded during SABAP1	Recorded during SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
Aquila rapax (Tawny Eagle)	-	Endangered	No	No	Lowveld and Kalahari savanna, especially game farming areas and reserves.	Regarded as a highly irregular foraging visitor on the study site.
Aquila verreauxii (Verreaux's' Eagle)	-	Vulnerable	No	No	Mountainous areas or areas with prominent outcrops with a high prey base (e.g. hyrax)	Confirmed, a regular foraging visitor.
Ardeotis kori (Kori Bustard)	Near-threatened	Near-threatened	Yes	No	Open savannoid woodland on flat areas and fallow land located in the Savanna.	An irregular foraging visitor.
Coracias garrulous (European Roller)	Near-threatened	Near-threatened	Yes	No	Open woodland and bushveld.	A fairly common to uncommon -non-breeding (summer) visitor to the open woodland and recently disturbed vegetation units. It is not threatened in South Africa.
Falco biarmicus (Lanner Falcon)	-	Vulnerable	Yes	No	Varied, but prefers to breed in mountainous areas.	A fairly regular foraging visitor. The study site provides breeding habitat (e.g. mountain bushveld).
Gyps africanus (White-backed Vulture)	Endangered	Endangered	Yes	No	Breeds on tall, flat-topped trees. Mainly restricted to large rural or game farming areas.	An irregular (non-breeding) foraging visitor on the study site.
Gyps coprotheres (Cape Vulture)	Vulnerable	Vulnerable	Yes	No	Varied but breeds on steep south or east facing cliffs.	A regular foraging visitor to the study site (regularly observed soaring overhead) from the

Species	Global Conservation Status*	National Conservation Status**	Recorded during SABAP1	Recorded during SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
						breeding colony at Kransberg. The study site does not provide breeding habitat.
Polemaetus bellicosus (Martial Eagle)	Near-threatened	Endangered	Yes	No	Varied, from open karroid shrub to lowland savanna.	An irregular foraging visitor on the study area.
Leptoptilos crumeniferus (Marabou Stork)	-	Near threatened	No	No	Varied, from savanna to wetlands, pans and floodplains – dependant of game farming areas	Vagrant to the study site. However, a common foraging visitor to a nearby vulture restaurant operated by the Thabazimbi Iron Ore Mine (TIOM)
Torgos tracheliotus (Lappet-faced Vulture)	Vulnerable	Endangered	No	No	Restricted to large game farming districts. More inclined towards the Lowveld and Kalahari Thornveld.	A highly irregular foraging visitor. More often observed at nearby vulture restaurant at the TIOM

A brief annotated account is provided below for those species with a high probability to occur on the study site:

Vultures

These include two scavenging birds of prey (African White-backed Vulture *Gyps africanus* and Cape Vulture *Gyps coprotheres*). The two Gyps species include large bodied taxa with large home ranges, and their occurrence is determined by the presence of mammalian carcasses which are often highly unpredictable and patchy. The latter explains why these birds are often highly transient in any particular area, depending on the availability of food. However, these species are often observed soaring overhead and attracted to a nearby vulture restaurant that is managed by the TIOM.

Lanner Falcon (*Falco biarmicus*)

F. biarmicus is currently classified as regionally “Vulnerable” (Taylor, 2014). *F. biarmicus* breeds mainly in mountainous areas and prefers deep ravines and sheer cliffs for nesting purposes. Although fairly common within its distribution range with approximately 1,400 pairs in the eastern part of South Africa (Tarboton & Allen, 1984), it is at risk due to persistent loss of open habitat to make way for agricultural land.

Although not observed during the survey period, *F. biarmicus* is predicted to be a fairly regular foraging visitor, and possibly overlooked breeding resident. The outcrops on the eastern part of the study site (in the vicinity of the overhead power line servitude) provide suitable breeding and roosting habitat for this species.

Verreaux's Eagle (Aquila verreauxii)

Previous published conservation assessments of the iconic Verreaux's Eagle (*A. verreauxii*) have found that the global population is stable. However, the national population is suspected to have declined tremendously during the past 12 years, with less than 10,000 adult individuals present in South Africa. Therefore, according to current population trends, *A. verreauxii* should be placed in the "Vulnerable" category (Taylor, in press).

The study site overlaps with the home range of a sedentary pair of *A. verreauxii*. It is considered as a regular foraging visitor to the mountain bushveld and savannoid grassland seres on the northern section of the study site.

European Roller (*Coracias garrulus*)

The European Roller (*Coracias garrulus*) is regarded as a fairly common non-breeding (summer) visitor to the open *Peltophorum africanum – Dombeya rotundifolia* woodland, and short *Dichrostachys cinerea – Combretum zeyheri* shrub on recently disturbed land. However, this species is fairly unspecialised on its wintering (non-breeding) grounds, where it is prevalent in open woodland habitat. It is currently listed as near threatened (BirdLife International, 2012) owing to direct persecution while on migration over the Mediterranean (especially Oman) and Gujarat in India (del Hoyo et. al., 2001). It is also threatened by habitat loss, since large tracts of suitable breeding habitat are converted to agricultural monocultures. It is not considered to be threatened in its wintering habitat.

Biodiversity value and ecological considerations

- The study site supports a high diversity of bird species representing 90% of the regional richness (on a QDS and pentad level);
- The avifaunal community on the study site is not unique and poorly represented by South African endemics and biome-restricted species. The dominant composition is widespread in the region;
- The mountain bushveld and savannoid grassland on the northern section of the study site provide optimal foraging habitat for the Vulnerable Verreaux's Eagle (*A. verreauxii*). The study site overlaps with the home range of a pair of Verreaux's Eagle (*A. verreauxii*) that often utilises the area during hunting bouts;
- The riparian woodland along the various drainage lines support a bird composition of local interest that is commonly associated with forested or closed-canopy habitat types (e.g.

Collared Sunbird *Hedydipna collaris*, Yellow-bellied Greenbul *Chlorocichla flaviventris* and African Firefinch *Lagonosticta rubricata*);

- The dead trees located on the short *Dichrostachys cinerea – Combretum zeyheri* shrub on recently disturbed land provides ephemeral breeding habitat for many obligate hole-nesting bird species (e.g. starlings, woodpeckers, barbets, rollers and Southern Grey-headed Sparrows Passer diffuses), including the Red-billed Oxpecker (*Buphagus erythrorhynchus*); and
- The ridges contained within the mountain bushveld (especially on the eastern section of the study site) provide ideal nesting habitat for Falconiiform taxa (e.g. Lanner Falcon, *Falco biarmicus*) and foraging habitat for charismatic birds of prey species (Verreaux's Eagle, *Aquila verreauxii*).

1.1.8.3 Amphibians

Fifteen (15) frog species are expected to occur on the study site (Appendix 4 (Pachnoda Consulting cc, 2015)) of which 10 were recorded from the QDS grids that overlap with the study site (2427CA). However, one species are peripheral to the study area (*Poyntonophrynus vertebralis*) and is believed to be sporadic on the study site. However, the lack of any perennial surface water on the study site and the poor water-retention potential of many of the observed depressions will discourage amphibian diversity or even occurrence on the site. Most of these species listed under Appendix 4 (Pachnoda Consulting cc, 2015) will only be detected during high precipitation events and will most likely only utilise the drainage lines and wetland-features (e.g. small dams) during dispersal.

Biodiversity value and ecological considerations

According to Minter *et al*. (2004), the amphibian richness on the study area is moderate (c. 11-20 species) with a very low prevalence of endemic species (c. 1-3 species). The study site is not considered as an important area for amphibian diversity.

The expected frog species breed mostly in temporary water bodies and inundated (moist/wet) grassland, and these features were respectively rare and absent on the study site.

Red listed, "near-threatened" and "data deficient" species

No threatened or near-threatened frog species are likely to be present (Appendix 4 (Pachnoda Consulting cc, 2015)) (Minter *et al.,* 2004).

Reptiles

Seventeen taxa (comprising of four snakes, eight lizards, three geckos, one tortoise and one terrapin) (Table 17) have been recorded from the QDG 2427CA which corresponds to the proposed site (Bates *et al*., 2014). However, this inventory is by no means comprehensive and many more species are likely to be present. Of the 17 species recorded in the area, eight were confirmed (Table 17).

According to the habitat diversity present, the study region is known to support between 12 - 14 reptile species with no endemic species to South Africa (Bates *et al*., 2014).

Results showed that the exposed rock crevices and promontories of the mountain bushveld and savannoid grassland have the potential to provide high richness values when compared to the other habitat units and critical important habitat for rupicolous taxa.

Table 17: An inventory of reptile species confirmed from QDG cell 2427CA, their probability of occurrence and presence of suitable habitat on the study site

Family	Scientific Name	Common name	Probability of occurrence
Agamidae	*Acanthocercus atricollis*	Southern Tree Agama	Confirmed
Atractaspididae	*Atractaspis bibronii*	Bibron's Stiletto Snake	High, likely to occur
Colubridae	*Dispholidus typus*	Boomslang	High, likely to occur
Colubridae	*Psammophis subtaeniatus*	Western Yellow-bellied Sand Snake	Confirmed
Cordylidae	*Cordylus jonesii*	Jones' Girdled Lizard	Could occur
Elapidae	*Naja annulifera*	Snouted Cobra	High, likely to occur
Gekkonidae	*Hemidactylus mabouia*	Common Tropical House Gecko	High, likely to occur
Gekkonidae	*Homopholis wahlbergii*	Wahlberg's Velvet Gecko	High, likely to occur
Gekkonidae	*Lygodactylus capensis*	Common Dwarf Gecko	Confirmed
Gerrhosauridae	*Gerrhosaurus flavigularis*	Yellow-throated Plated Lizard	Confirmed
Pelomedusidae	*Pelusios sinuatus*	Serrated Hinged Terrapin	Low
Scincidae	*Trachylepis capensis*	Cape Skink	High, likely to occur
Scincidae	*Trachylepis punctatissima*	Speckled Rock Skink	Confirmed
Scincidae	*Trachylepis striata*	Striped Skink	Confirmed
Scincidae	*Trachylepis varia*	Variable Skink	Confirmed
Testudinidae	*Stigmochelys pardalis*	Leopard Tortoise	Confirmed
Varanidae	*Varanus albigularis*	Rock Monitor	High, likely to occur

Species of conservation concern and endemic taxa

A number of local endemics (Waterberg endemics) show distribution ranges peripheral to the study site and could be present on the mountain bushveld and savannoid grassland units. These include *Lygodatylus waterbergensis* (Waterberg Dwarf Gecko), *Pseudocordylus transvaalensis* (Northern Crag Lizard), *Smaug breyeri* (Waterberg Girdled Lizard), *Platysaurus minor* (Waterberg Flat Lizard) and *Xenocalamus bicolor australis* (Waterberg Quill-snouted snake) (Figure 28 (Pachnoda Consulting cc, 2015)).

According to a recent conservation assessment (see Bates *et al*., 2014), both *L. waterbergensis* and *P. transvaalensis* are classified as near threatened taxa.

It is therefore highly recommended that a herpetofauna specialist investigation be commissioned should the proposed development and activities overspill onto the mountain bushveld and savannoid grassland units with particular emphasis on establishing the status of these taxa on the site.

1.1.8.4 Invertebrates

Diurnal butterlfies

Fifteen (15) diurnal butterfly species is known to occur in the QDG 2427CA that is sympatric to the proposed site (Table 18). However, this list is incomplete and an additional 16 species were confirmed during the respective site visit (Table 19). None of the species are threatened or near-threatened.

Table 18: A list of butterfly species recorded on QDG 2427CA (Mecenero *et al*., 2013)

Family	Genus	Species	Subspecies	Common name	Conservation Status	Occurrence
Lycaenidae	*Anthene*	*amarah*	*amarah*	Black striped hairtail	Least Concern	Confirmed
Lycaenidae	*Axiocerses*	*amanga*	*amanga*	Bush scarlet	Least Concern	High
Lycaenidae	*Axiocerses*	*tjoane*	*tjoane*	Eastern scarlet	Least Concern	High
Lycaenidae	*Azanus*	*jesous*		Topaz babul blue	Least Concern	Confirmed
Lycaenidae	*Eicochrysops*	*messapus*	*mahallakoaena*	Cupreous blue	Least Concern	Confirmed
Lycaenidae	*Hypolycaena*	*philippus*	*philippus*	Purplebrown hairstreak	Least Concern	High
Lycaenidae	*Oraidium*	*barberae*		Dwarf blue	Least Concern	Probable
Lycaenidae	*Tarucus*	*sybaris*	*sybaris*	Dotted blue	Least Concern	Confirmed
Lycaenidae	*Tuxentius*	*calice*		White pie	Least Concern	High
Lycaenidae	*Tuxentius*	*melaena*	*melaena*	Black pie	Least Concern	Confirmed
Lycaenidae	*Virachola*	*dinochares*		Apricot playboy	Least Concern	High
Nymphalidae	*Byblia*	*ilithyia*		Spotted joker	Least Concern	Confirmed
Nymphalidae	*Charaxes*	*phaeus*		Demon charaxes	Least Concern	Confirmed
Nymphalidae	*Junonia*	*hierta*	*cebrene*	Yellow pansy	Least Concern	Confirmed
Nymphalidae	*Junonia*	*oenone*	*oenone*	Blue pansy	Least Concern	Confirmed

Table 19: A list of butterfly species observed on the study site apart from those recorded by Mecenero *et al.,* 2013

Family	Genus & species	Common Name	Distribution
Lycaenidae	*Lampides boeticus*	Long-tailed Blue	Widespread & common
Lycaenidae	*Leptotes babaulti*	Babault's Blue	Widespread & common
Lycaenidae	*Zizula hylax*	Gaika Blue	Widespread & common
Nymphalidae	*Stygionympha wichgrafi wichgrafi*	Wichgraf's Hillside Brown	Mountain bushveld
Nymphalidae	*Charaxes achaemenes achaemenes*	Bushveld Charaxes	Mountain bushveld
Nymphalidae	*Danaus chrysippus orientis*	African Monarch	Widespread & common

Family	Genus & species	Common Name	Distribution
Nymphalidae	*Hypolimnas misippus*	Common Diadem	Widespread & common
Nymphalidae	*Hamanumida daedalus*	Guineafowl Butterfly	Very common
Nymphalidae	*Acraea neobule neobule*	Wandering Donkey Acraea	Widespread & common
Nymphalidae	*Vanessa cardui*	Painted Lady	Widespread & common
Pieridae	*Catopsillia florella*	African Migrant	Widespread & common
Pieridae	*Eurema brigitta brigitta*	Broad-bordered grass yellow	Widespread & common
Pieridae	*Teracolus eris eris*	Banded Gold Tip	Widespread & common
Pieridae	*Pinacopteryx eriphia eriphia*	Zebra White	Widespread & common
Pieridae	*Mylothris agathina agathina*	Common Dotted Border	Localised to well-wooded ravines and mountain bushveld
Papilionidae	*Papilio demodocus demodocus*	Citrus Swallowtail	Fairly common & widespread

Scorpion taxa

The majority of scorpion taxa are substrate specialists and are therefore good indicators of environmental change. These species are so-called stenotopic based on their high habitat specificity. Table 20 (and Figure 29 (Pachnoda Consulting cc, 2015)) lists those species observed and expected to occur on the study site. *Uroplectes carinatus* and *U. vittatus* were the two prominent (dominant) taxa on the study site.

Table 20: A list of scorpion taxa expected to be present on the study site

Family	Species	Status
Buthidae	*Parabuthus mossambicensis*	Expected, possibly widespread on low-lying areas
	Parabuthus transvaalicus	Widespread and common from rocky areas.
	Uroplectes carinatus	Widespread and common.
	Uroplectes planimanus	Expected to occur on rocky areas.
	Uroplectes olivaceus	Expected to occur on low-lying areas.
	Uroplectes triangulifer	Widespread, most areas.
	Uroplectes vittatus	Widespread and arboreal
Liochelidae	*Hadogenes troglodytes*	Occurs under exfoliating rock - not recorded but expected to occur.
	Opistacanthus asper	Uncommon, an arboreal species
Scorpionidae	*Opistophthalmus glabrifrons*	Expected.
	Opistophthalmus carinatus	Expected.

Mygalomorph (baboon) spiders

The baboon spider *Augacephalus junodi* was observed on the site (Figure 30 (Pachnoda Consulting cc, 2015)). This species are stenotopic and once mature, it loses the ability to construct burrows (the rastellum on their chelicerae is lost). Therefore, once a burrow is constricted, they remain (mainly the females) in this burrow for the rest of their lives, making them especially vulnerable towards habitat destruction. It is considered to be widespread on the study site although it is present in low densities (therefore easily overlooked). Only two burrows were observed during the survey period from mountain bushveld and open *Peltophorum africanum – Dombeya rotundifolia* woodland.

Augacephalus junodi is protected under Schedule 10 of the Limpopo Environmental Management Act No 7 of 2003.

Odonata (dragonflies & damselflies)

Only four dragonfly (Anisoptera) taxa were observed (Table 21). These species were only observed from a small reservoir that is used to provide drinking water to game. Nevertheless, the observed taxa are all "sweepstake" and opportunistic species and are able to rapidly colonise ephemeral resources when available (mainly to reproduce). These taxa are widespread, and based on the cumulative dragonfly biotic index (DBI), the ecological integrity of "wetland-associated" features on the study site are compromised and of low importance.

Table 21: A list of observed dragonfly taxa and associated dragonfly biotic index

Family	Species	DBI
Libellulidae	*Pantala flavescens*	0
Libellulidae	*Trithemis arteriosa*	0
Libellulidae	*Trithemis kirbyi*	0
Libellulidae	*Tramea bassilaris*	0
	Total:	0

1.1.9 Surface water

1.1.9.1 General description

Information for this section was obtained from ‘Information in support of application for rectification of existing mine residue disposal’ (Shangoni Management Services, 2011) & ‘Storm water management plan’ (Rational Environmental, 2015).

The proposed operation is located in the Limpopo catchment, Bierspruit Sub-catchment a part of the Crocodile Catchment, in the quaternary catchment area A2. The operation is located in the Crocodile (West) and Marico Water Management Area. Surface water draining from the site mostly takes place in the form of overland flow collecting in the network of non-perennials originating on the site. The non-perennials drain into the Bierspruit to the south of RAM, which in turn flows into the Crocodile River situated north-east from the site. Most of the runoff is diverted away from the quarries by means of trenches.

1.1.9.2 Rainfall depths and peak flows

The design rainfall depths are estimated for different return periods and durations at the weather station Thabazimbi (0587697 A), 11km North East of the site.

Table 22: Design rainfall depths at Thabazimbi

Duration (days)	Return period (years)						
	2	5	10	20	50	100	200
1	54	73	87	102	122	138	155
2	67	91	108	125	148	166	185
3	78	105	124	142	167	187	206
4	83	112	132	151	177	196	217
5	88	119	139	159	185	205	225
6	92	123	144	164	190	210	230
7	98	132	154	175	203	223	244

Flood peaks are calculated for the upstream catchments to determine the peak volume of water that will pass the site in the event of a rain event at different return periods. The flood peak is the maximum rate of inflow that can be expected from accumulated runoff in the catchment area. The alternative rational method is used to calculate the expected runoff during different flood return periods. Verification of the results is done by means of the unit hydrograph and standard design flood (SDF) method. The Utility Program for Drainage, based on the SANRAL manual was used to model flood peaks.

Table 23: Quarry 3 Drain catchment flood peaks

Return period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m^3/s)
1:2	0.58	22.67	100.00	39.40	0.75	34.6	1.014
1:5	0.58	38.25	100.00	66.47	0.80	36.9	1.825
1:10	0.58	50.03	100.00	86.94	0.85	39.2	2.536
1:20	0.58	61.82	100.00	107.42	0.90	41.5	3.318
1:50	0.58	77.40	100.00	134.48	0.95	43.8	4.385
1:100	0.58	89.18	100.00	154.96	1.00	46.1	5.318

Table 24: Quarry 7 Drain catchment flood peaks

Return period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m^3/s)
1:2	0.45	20.85	100.00	46.60	0.75	34.6	0.850
1:5	0.45	35.18	100.00	78.62	0.80	36.9	1.530
1:10	0.45	46.02	100.00	102.83	0.85	39.2	2.127
1:20	0.45	56.86	100.00	127.05	0.90	41.5	2.782

Return period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m^3/s)
1:50	0.45	71.18	100.00	159.07	0.95	43.8	3.677
1:100	0.45	82.02	100.00	183.28	1.00	46.1	4.459

1.1.9.3 Normal flow during dry weather

The normal dry weather flow in the affected water course is gentle.

1.1.9.4 Surface water quality

Various surface water quality results for two points – RA2 & RA3 - are given in Figure 12 to 19 below. RA2 is downstream water outside RAM, after it is mixed with the run-off water from RAM. RA3 is water upstream outside RAM before is mixed with the run-off water from the plant. RA3 is therefore a good indication of the baseline water qualities and a comparison between RA3 and RA2 indicates the impact of the existing mine activities (including plant activities) on the surface water quality. Water qualities are measured against both the South African National Standard (SANS 241-2011) as well as the Target Water Quality Guidelines (TWQG). Water qualities measured are pH, sulphates (SO_4), chlorides, total dissolved solids (TDS), nitrates (NO_3), *Escherichia coli* (*E. coli*), and total coliform bacteria.

1.1.9.4.1 Chemical analysis

<u>pH:</u>

According to Figure 12 below, all water qualities are within the pH limits for both the TWQG as well as the SANS 241-2011.

<u>Chloride:</u>

According to the TWQG, water with chloride levels less than 100mg/l has no aesthetic or health effects, whereby water with levels between 100mg/l and 200mg/l has no aesthetic or health effects, but a possible increase in the corrosion rate in domestic appliances. Water with levels between 200mg/l and 600mg/l has a distinctly salty taste, but no health effects, with a likelihood of noticeable increase in corrosion rates in domestic appliances. According to Figure 13 below, both the surface water qualities upstream and downstream of RAM show high levels of chloride. Water in 2009 had chloride levels below 100mg/l. The water upstream, which is not yet impacted by RAM activities, show higher levels of chloride than the water impacted by RAM activities.

<u>Sulphate:</u>

According to Figure 14 below, all water qualities are below the SO_4 limits for both the TWQG as well as the SANS 241-2011.

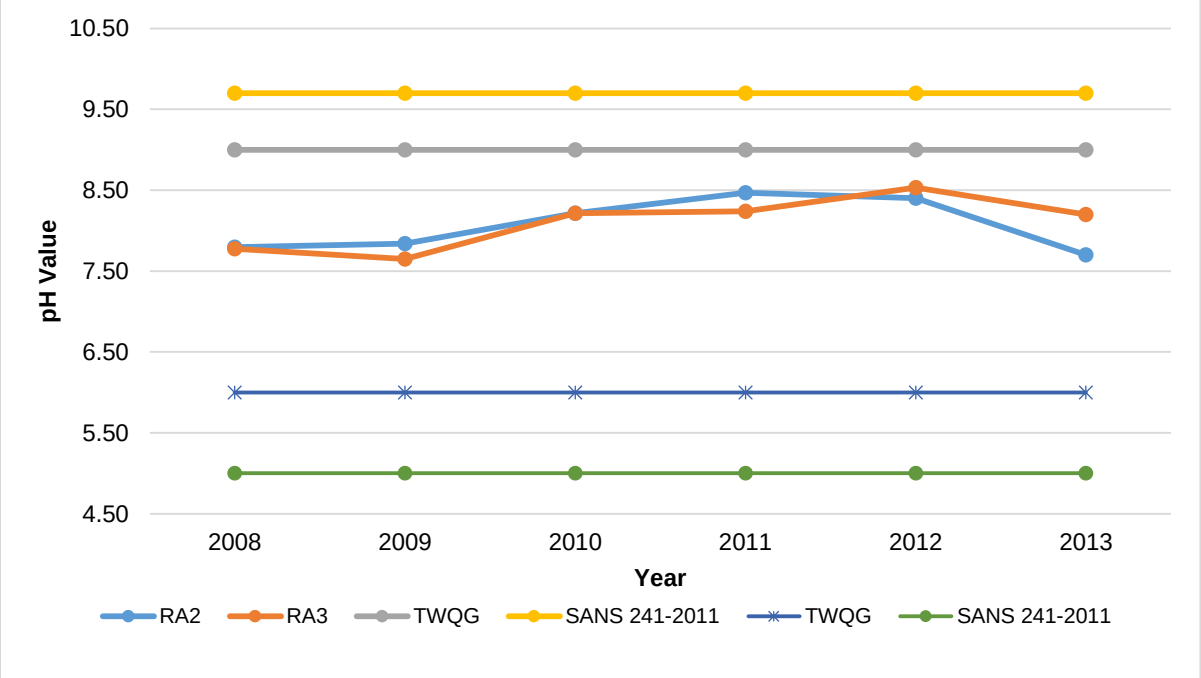


Figure 12: pH results of surface water for the years 2008 to 2013

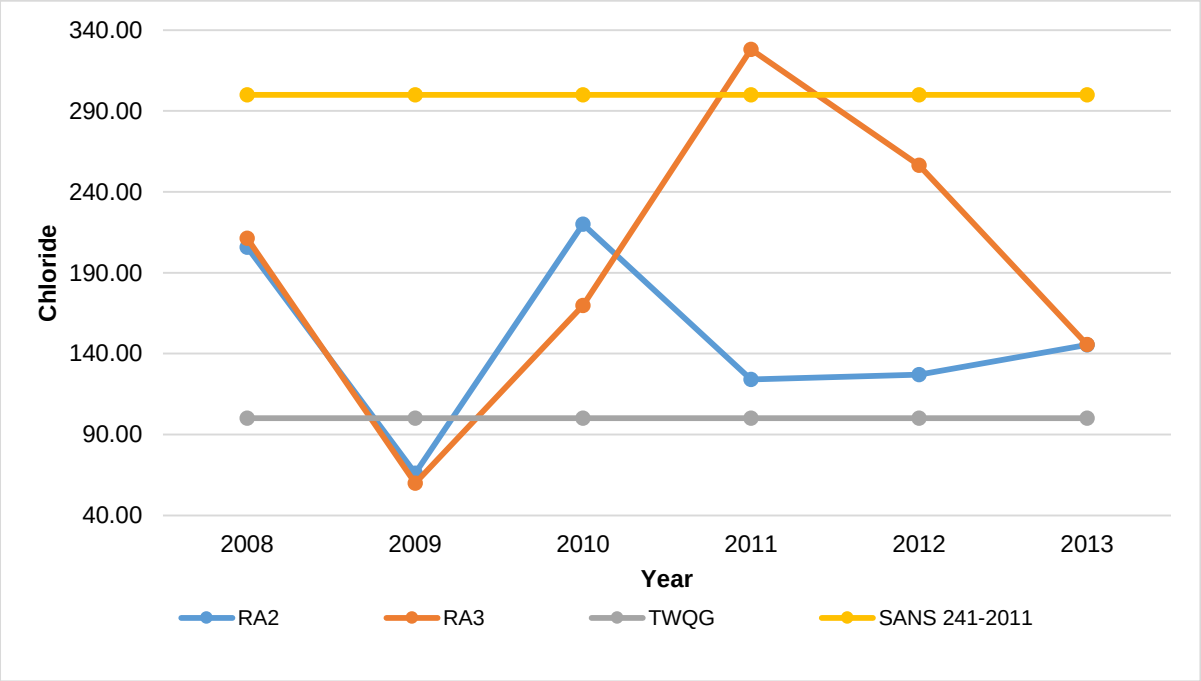


Figure 13: Chloride results of surface water for the years 2008 to 2013

Total dissolved solids or electrical conductivity:

According to the TWQG (1996):

'The TDS is a measure of the amount of various inorganic salts dissolved in water. The TDS concentration is directly proportional to the electrical conductivity (EC) of water. Since EC is much easier to measure than TDS, it is routinely used as an estimate of the TDS concentration.'

RAM measures the EC of the surface water qualities. The TWQG limits indicates TDS levels, therefore only the SANS 241-2011 limits are used. According to Figure 14 below the downstream water in 2010 is above the SANS 241-2011 limits, and the upstream water in 2011 is above these limits.

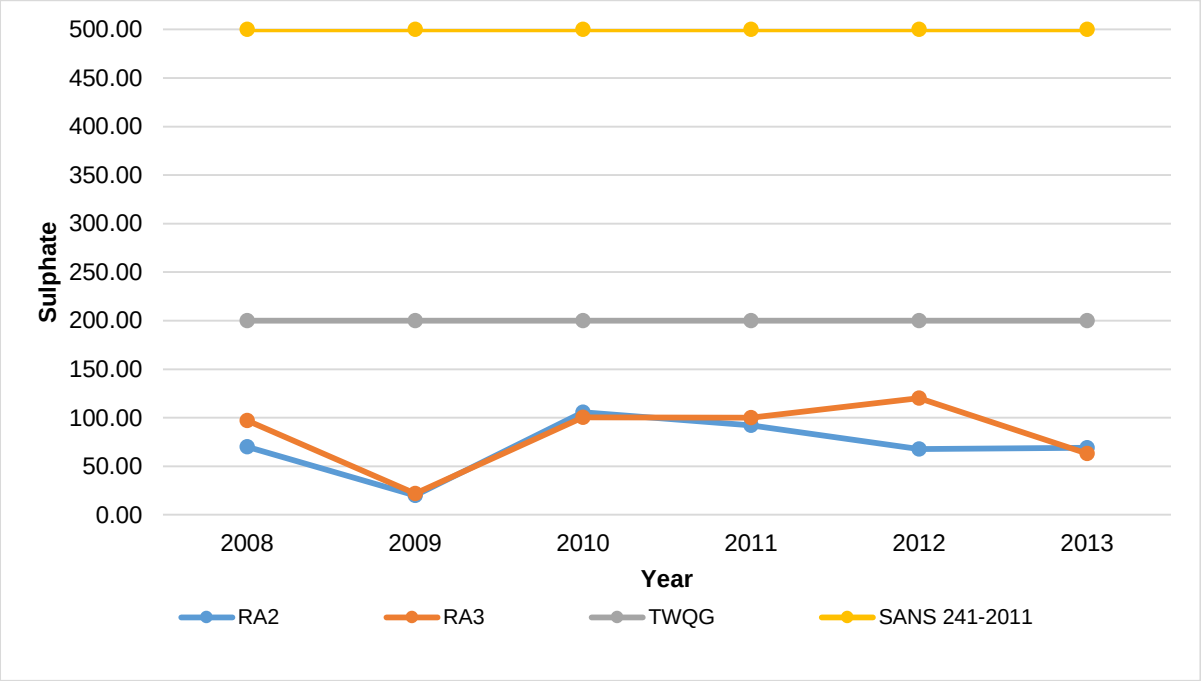


Figure 14: Sulphate results of surface water for the years 2008 to 2013

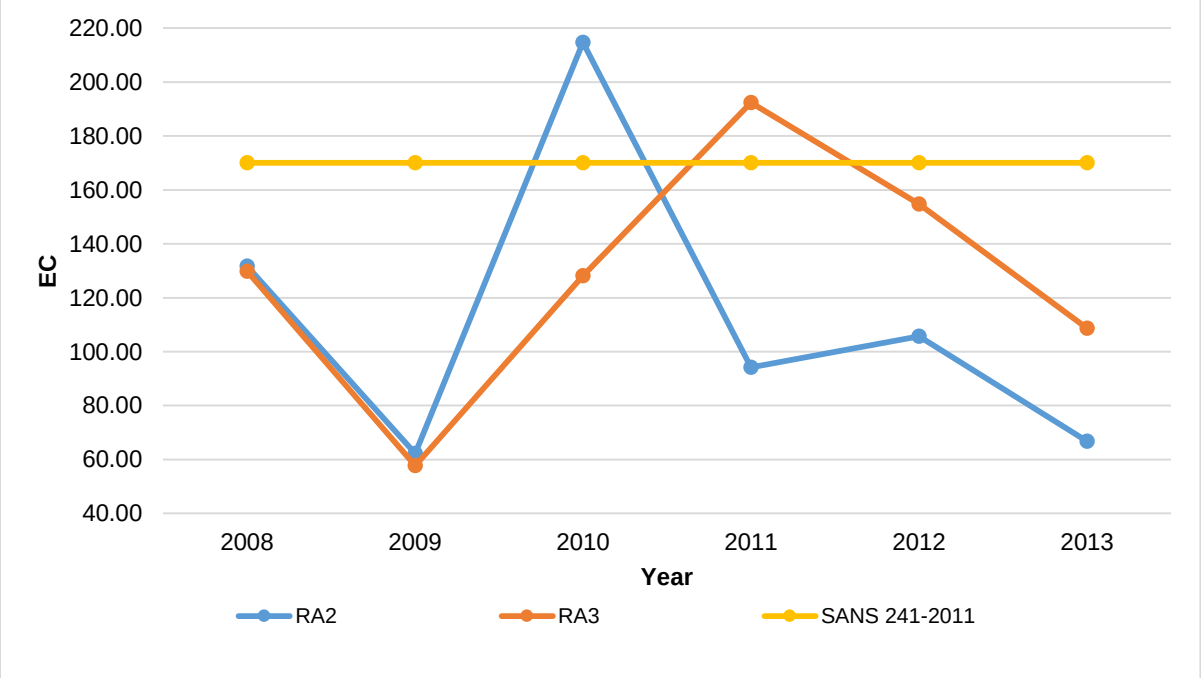


Figure 15: EC results of surface water for the years 2008 to 2013

Nitrates:

According to Figure 16 below the downstream water in 2011 is above both the TWQG and SANS 241-2011 limits, and the upstream water in 2012 is above the TWQG limits. High levels of NO_3 lead to the following effects (TWQG, 1996):

'Upon absorption, nitrite combines with the oxygen-carrying red blood pigment, haemoglobin, to form methaemoglobin, which is incapable of carrying oxygen. This condition is termed methaemoglobinaemia. The reaction of nitrite with haemoglobin can be particularly hazardous in infants under three months of age and is compounded when the intake of Vitamin C is inadequate.'

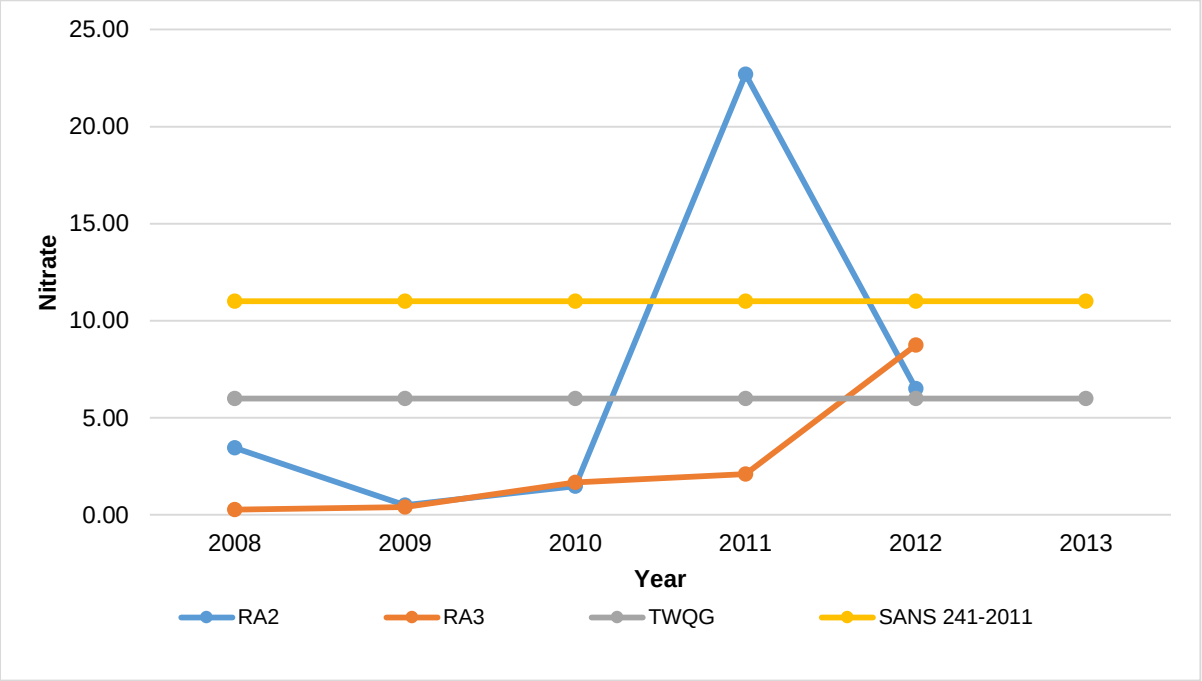


Figure 16: Nitrate results of surface water for the years 2008 to 2013

1.1.9.4.2 Bacteriological analysis

E. coli:

According to Figure 17 below, *E. coli* levels downstream of RAM were very high. Also refer to Figure 18 which indicates only downstream levels. These levels also exceeded the limits throughout the sampling period.

Total coliform bacteria:

According to Figure 19 below, Total coliform levels downstream and upstream of RAM were very high.

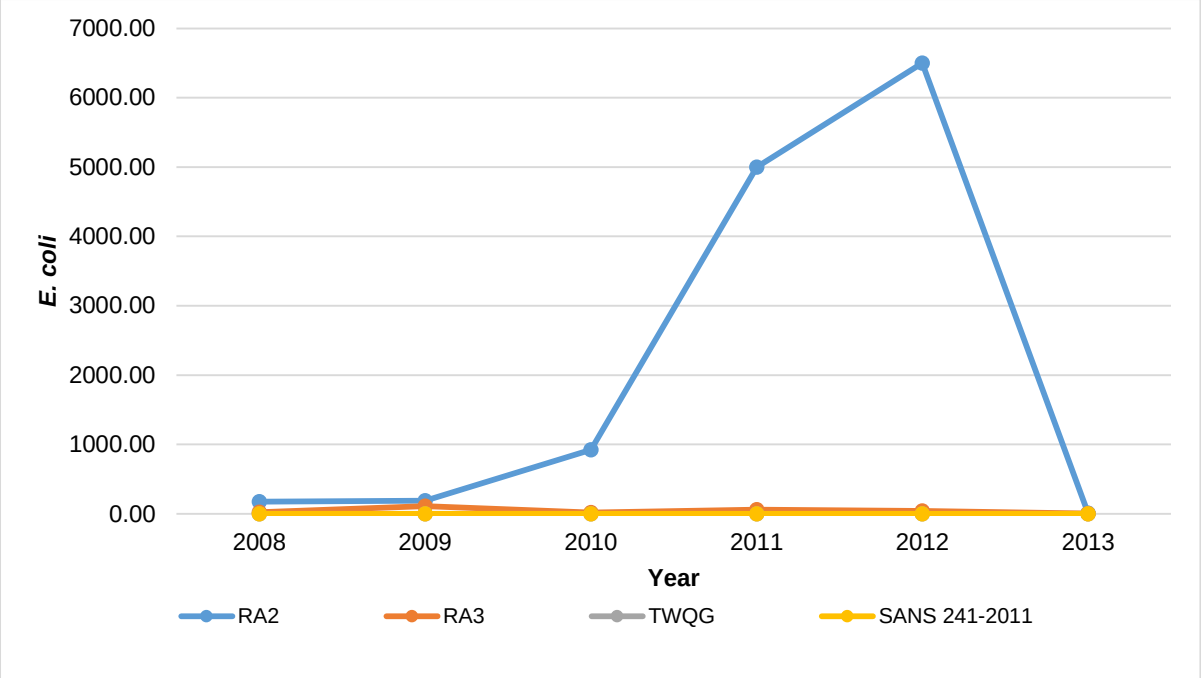


Figure 17: *E. coli* results of surface water for the years 2008 to 2013

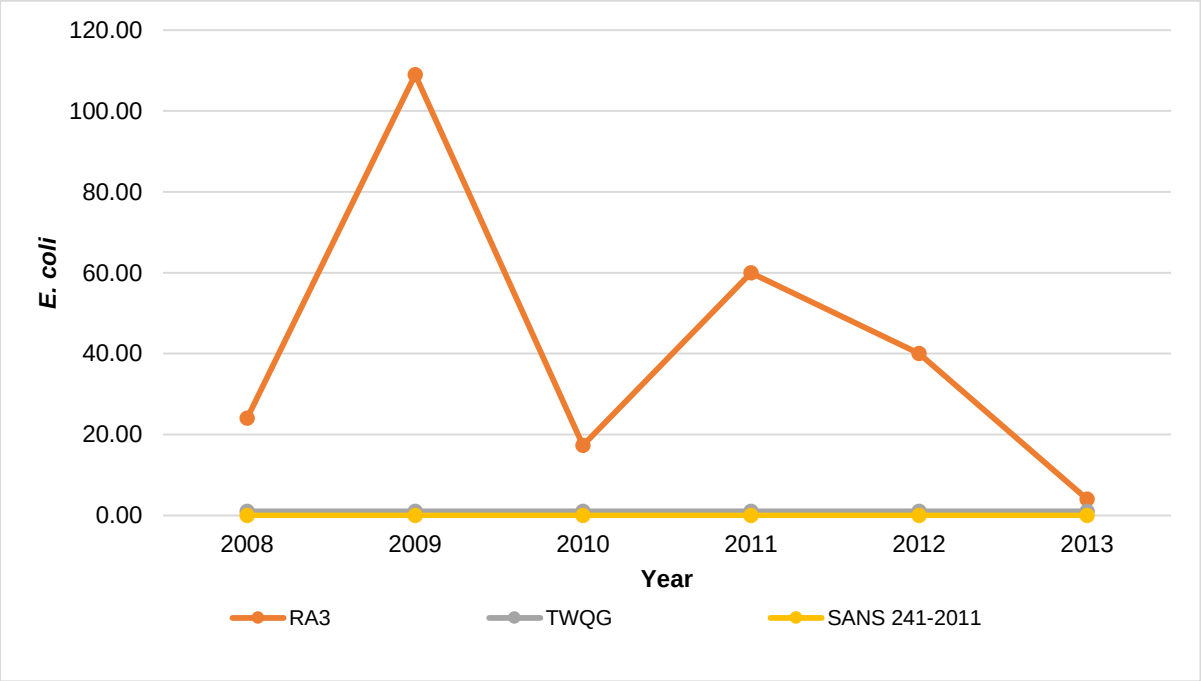


Figure 18: *E. coli* results of upstream surface water for the years 2008 to 2013

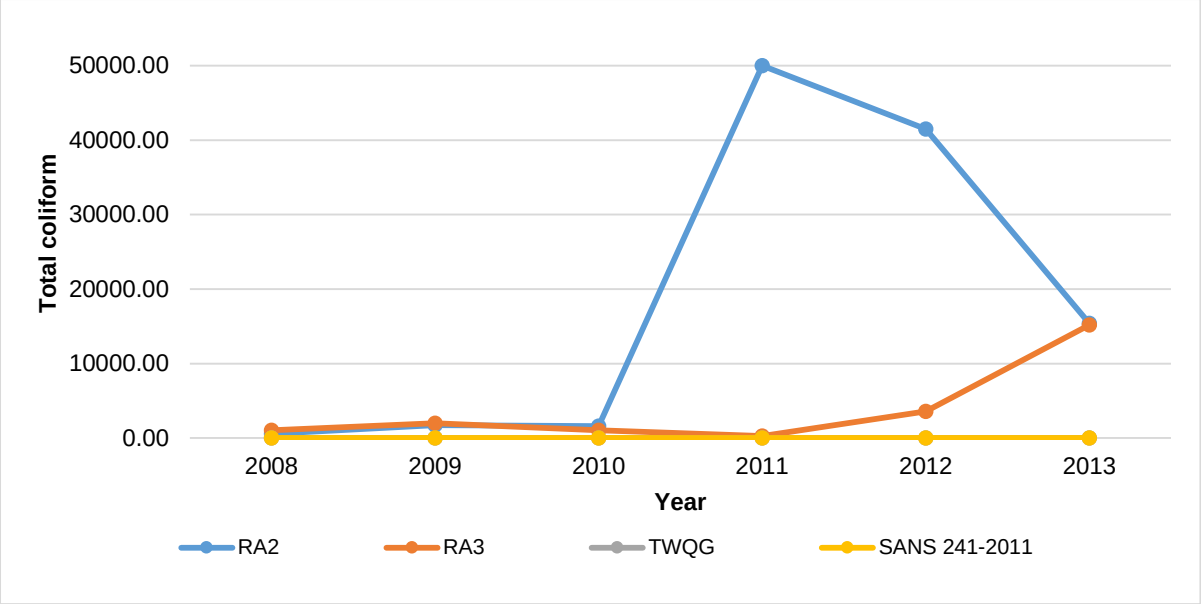


Figure 19: Total coliform results of surface water for the years 2008 to 2013

1.1.9.5 Water authority

The relevant water authority in this instance is the DWS – Lower Crocodile (West) and Marico (Hartbeespoort) regional office.

1.1.9.6 Wetlands

According to both the Ecological study (Pachnoda Consulting cc, 2015) and the Soil, Land Use and Land Capability study (Gudani Consulting, 2015) there are no wetlands on the proposed site.

1.1.9.7 Water use

Surface water use in the area is mainly for agricultural purposes, with little domestic use. Agricultural water uses include both irrigation and livestock watering.

1.1.10 Groundwater

Information for this section was obtained from the 'Report on geohydrological investigation as part of the EIA, EMP and IWULA (Groundwater Complete, 2015).

1.1.10.1 Hydrocensus/user survey

A hydrocensus and groundwater user survey was conducted by Aquatico Scientific within radius of up to 10km around the project area. A total of 32 boreholes were located during the hydrocensus/user survey and their positions are indicated in Figure 7 (Groundwater Complete, 2015). Summaries of the findings are provided in Figure 8 (Groundwater Complete, 2015) and Table 25, while the complete hydrocensus report is provided in Appendix A (Groundwater Complete, 2015). Nearly half of all boreholes located are used for domestic purposes, game and livestock watering and irrigation.

Table 25: Results of hydrocensus/user surveys

Locality	Farmer/Owner	Farm	Coordinates		Static water level (m)	Depth (m)	Sampled	Use
			South	East				
Aquatico Hydrocensus								
BH1	Rhino Mine	-	-24.70767	27.26000	31.5	80	Yes	Dust suppression
BH2	Rhino Mine	-	-24.70749	27.25978	34.3	51	Yes	Dust suppression
BH3	Rhino Mine	-	-24.70773	27.25939	31.9	50	No	Dust suppression
BH4	Rhino Mine	-	-24.70868	27.25988	-	-	Yes	Dust suppression
BH5	Rhino Mine	-	-24.70900	27.25993	25.0	87	Yes	Dust suppression
BH6	Rhino Mine	-	-24.69452	27.30581	29.0	100	Yes	Plant process water
BH7	Rhino Mine	-	-24.66944	27.30597	30.0	80	Yes	Plant process water
BH8	Rhino Mine	-	-24.67261	27.31564	10.1	43	Yes	Plant process water
BH9	Rhino Mine	-	-24.67328	27.31632	10.1	15	Yes	Plant process water
BH10	Rhino Mine	-	-24.67355	27.31666	15.6	25	Yes	Plant process water
BH11	Rhino Mine	-	-24.67355	27.31666	9.4	15	Yes	Plant process water
BH12	Rhino Mine	-	-24.67495	27.31642	-	-	Yes	Plant process water
BH13	Rhino Mine	-	-24.67495	27.31642	9.1	10	Yes	Plant process water
Bokkie1	Bokkie Bronkhorst	Roodedam	-24.71127	27.32606	17.0	44	Yes	None
FerdieBotha1	Ferdie Botha	Tygerkloof 1	-24.72327	27.23783	37.8	40	Yes	None
FerdieBotha2	Ferdie Botha	Tygerkloof 1	-24.73134	27.22120	19.2	45	Yes	None
JohanVenter1	Johan Venter	Roodedam 4	-24.70894	27.29749	50.3	80	Yes	Domestic/livestock/irrigation
KobusMuller1	Kobus Muller	Roodedam 12 & 14	-24.71369	27.31340	-	100	Yes	Domestic/livestock/irrigation
KobusMuller2	Kobus Muller	Roodedam 12 & 14	-24.71369	27.31340	-	96	Yes	Domestic/livestock/irrigation
KobusMuller3	Kobus Muller	Roodedam 12 & 14	-24.71369	27.31340	70.0	80	Yes	Domestic/livestock/irrigation
Leadwood1	Victor Selvadi	Leadwood	-24.75627	27.21675	-	-	Yes	Domestic/livestock
Leadwood2	Victor Selvadi	Leadwood	-24.75848	27.20250	36.8	100	Yes	None
Leadwood3	Victor Selvadi	Leadwood	-24.76588	27.24796	27.2	65	Yes	Game water
Leadwood4	Victor Selvadi	Leadwood	-24.71642	27.23171	-	-	Yes	Game water

Locality	Farmer/Owner	Farm	Coordinates		Static water level (m)	Depth (m)	Sampled	Use
			South	East				
Leadwood5	Victor Selvadi	Leadwood	-24.72755	27.19343	-	-	Yes	Game water
RheederRanch1	Jan Rheeder	Grootfontein	-24.66656	27.31263	20.1	44	Yes	Game water
RheederRanch2	Jan Rheeder	Grootfontein	-24.66978	27.30704	39.4	100	Yes	None
RheederRanch3	Jan Rheeder	Grootfontein	-24.66928	27.29041	59.5	75	Yes	Game water
RheederRanch4	Jan Rheeder	Grootfontein	-24.68159	27.27847	-	-	Yes	Game water
ScottDenton1	Scott Denton	Hartbeeskopje	-24.75275	27.22900	-	-	Yes	Domestic
ScottDenton2	Scott Denton	Hartbeeskopje	-24.74992	27.24731	-	-	Yes	Livestock
StephanSchoeman1	Stephan Schoeman	Maroelasfontein	-24.76277	27.20533	31.0	60	Yes	None

Note: Coordinates – WGS84

1.1.10.2 Aquifer delineation

Because the main aquifer is a fractured rock type and fractures could assume any geometry and orientation, the physical boundary or 'end' of the aquifer is very difficult to specify or quantify. Aquifer boundary conditions that are generally considered during the delineation process are described below:

- No-flow boundaries are groundwater divides (topographically high or low areas/lines) across which no groundwater flow is possible.
- Constant head boundaries are positions or areas where the groundwater level is fixed at a certain elevation and does not change (perennial rivers/streams or dams/pans).

Topographic highs (no-flow boundary) and the perennial Bierspruit (constant head boundary) were used to roughly delineate the aquifer system underlying the project area (Figure 20). The aquifer was estimated to cover an area of approximately 420km².

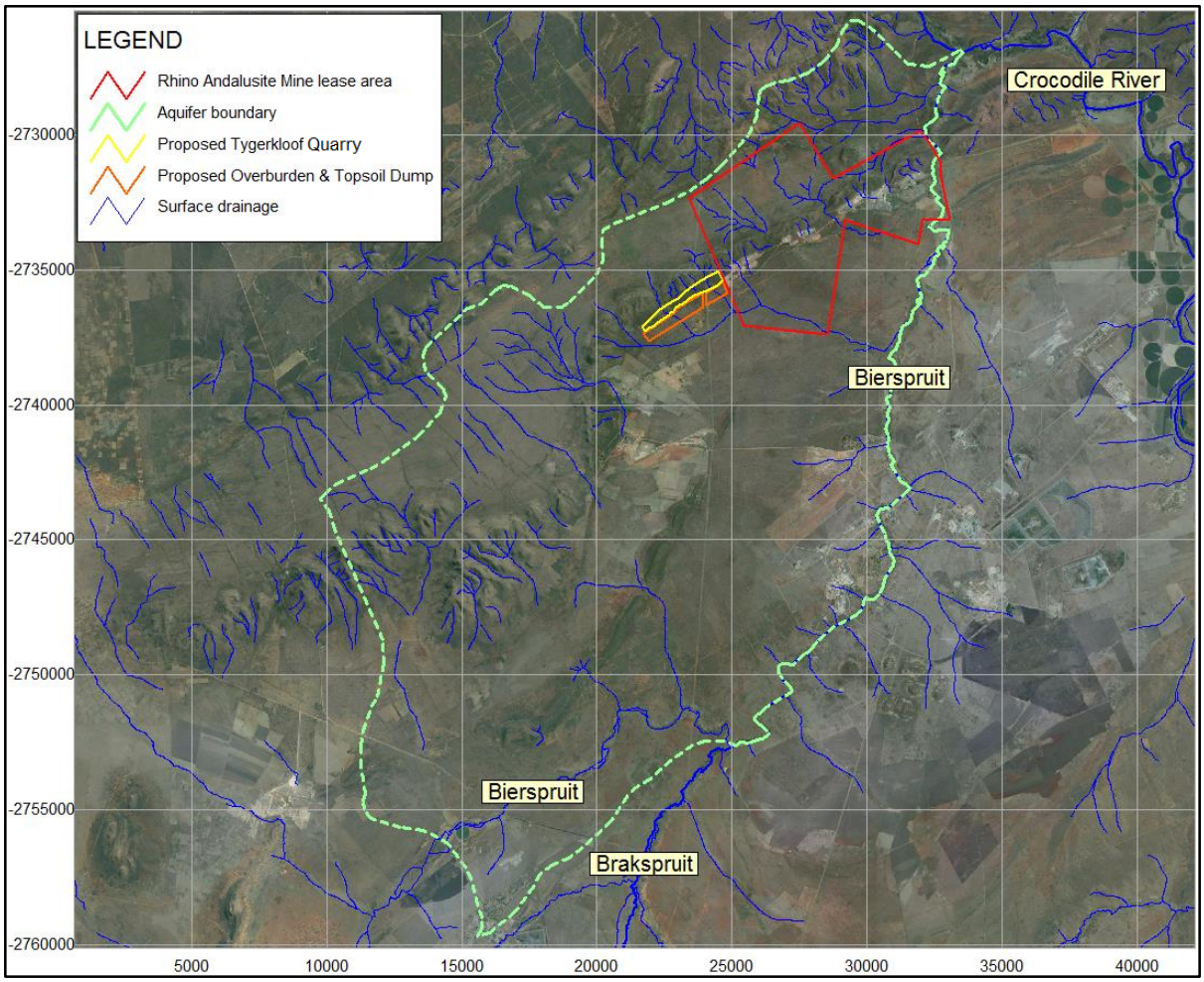


Figure 20: Aquifer delineation for project area

1.1.10.3 Groundwater level depth

Groundwater levels in the project area are available from monitoring boreholes and surrounding groundwater user boreholes that were located during the hydrocensus survey. A thematic groundwater level map of the entire project area is provided in Figure 23. These water levels are essential as they were used in the generation of static groundwater level elevations with the use of the Bayesian interpolation method (Figure 24).

Regional static groundwater levels around the project area generally vary between ±9m and 70m below surface (Figure 22). Some of the deeper groundwater levels measured during the hydrocensus surveys are the result of groundwater abstraction. Due to the generally low aquifer transmissivities the pumping causes deep drawdown of the groundwater levels/piezometric heads and depression cones form that are deep, but very limited in lateral extent.

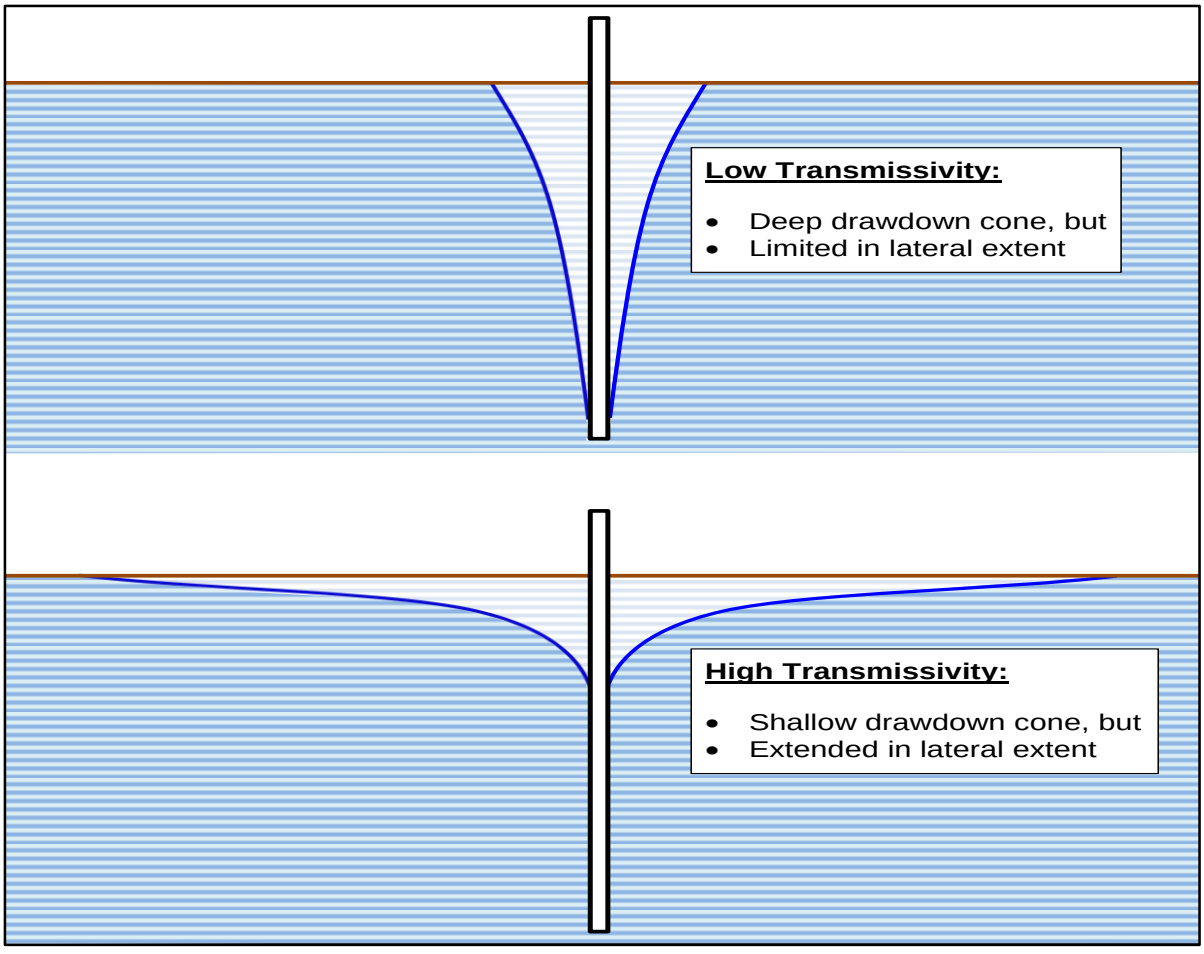


Figure 21: Effect of aquifer transmissivity on depression cone

The static groundwater elevation contour map provided in Figure 24 was constructed through the utilisation of the Bayesian interpolation technique. The Bayesian interpolation technique utilises the natural relationship that exists between the surface topography and the depth-to-groundwater level to estimate groundwater levels in areas where borehole data is scarce.

Because impacts on the natural groundwater level already exist due to groundwater abstraction for domestic and irrigation purposes, only boreholes where the linear correlation between borehole collar elevation and groundwater level elevation exists were used in the interpolation. The pre-mining static groundwater contours presented in Figure 24 therefore represent conditions without impacts from sources or actions other than natural conditions.

A graph of borehole collar elevation versus groundwater level elevation is presented in Figure 22 where the linear correlation of approximately 99% can be seen. It should be noted that groundwater levels from some boreholes were discarded because impacts from groundwater abstraction destroys the natural groundwater-topography relationship.

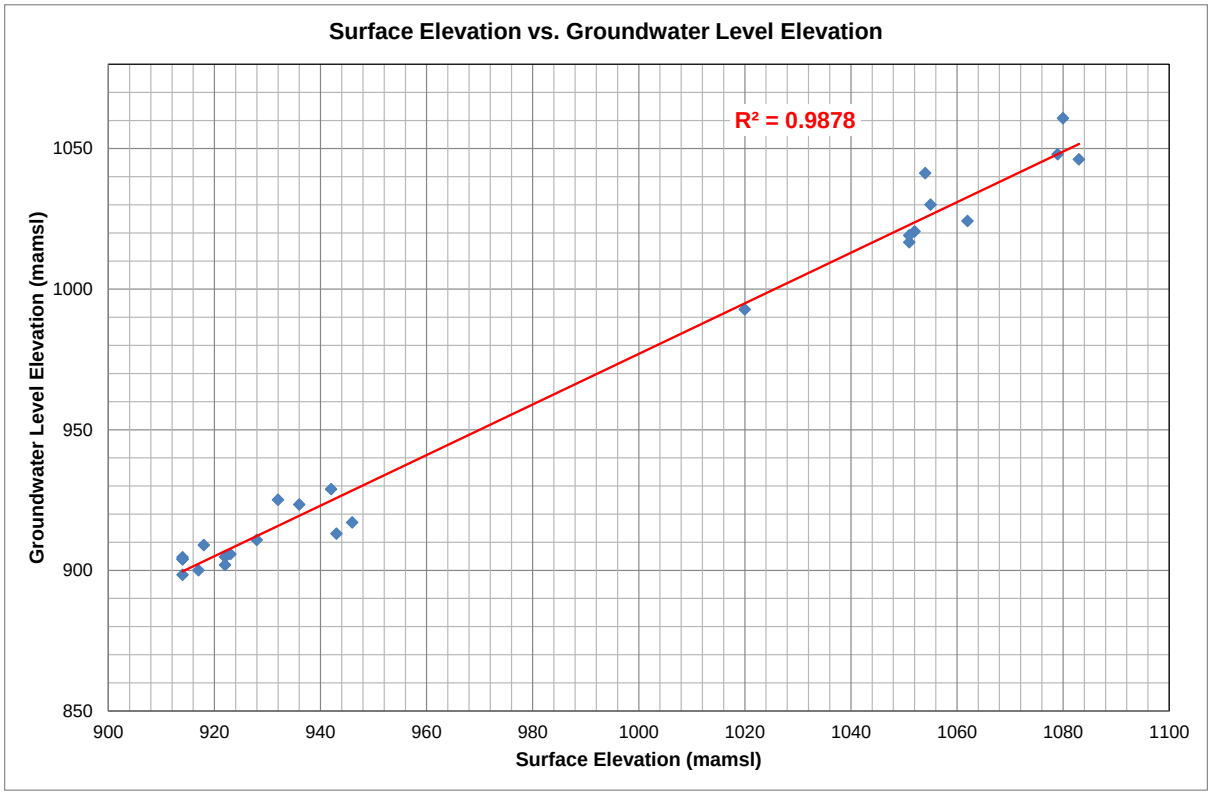


Figure 22: Relationship between surface and groundwater level elevation

The highest static water level elevation within the immediate vicinity of the project area is approximately 1,360mamsl and occurs in the topographically higher region of the Witfonteinrand Mountain range. The lowest static water level elevation where no impact from abstraction occurs is at approximately 880mamsl in the northern down gradient direction. Groundwater flow directions within the project area are also indicated in Figure 24 with the use of blue arrows.

Seen in the light of water level differences because of mining, pumping and recharge effects, filtering and processing of water levels is required to remove water levels considered anomalous high or low. **The final interpolated potentiometric surface of the water levels is thus bound to contain local**

over- or under estimations of the actual water levels but it will be representative of the general regional trend of the static groundwater level.

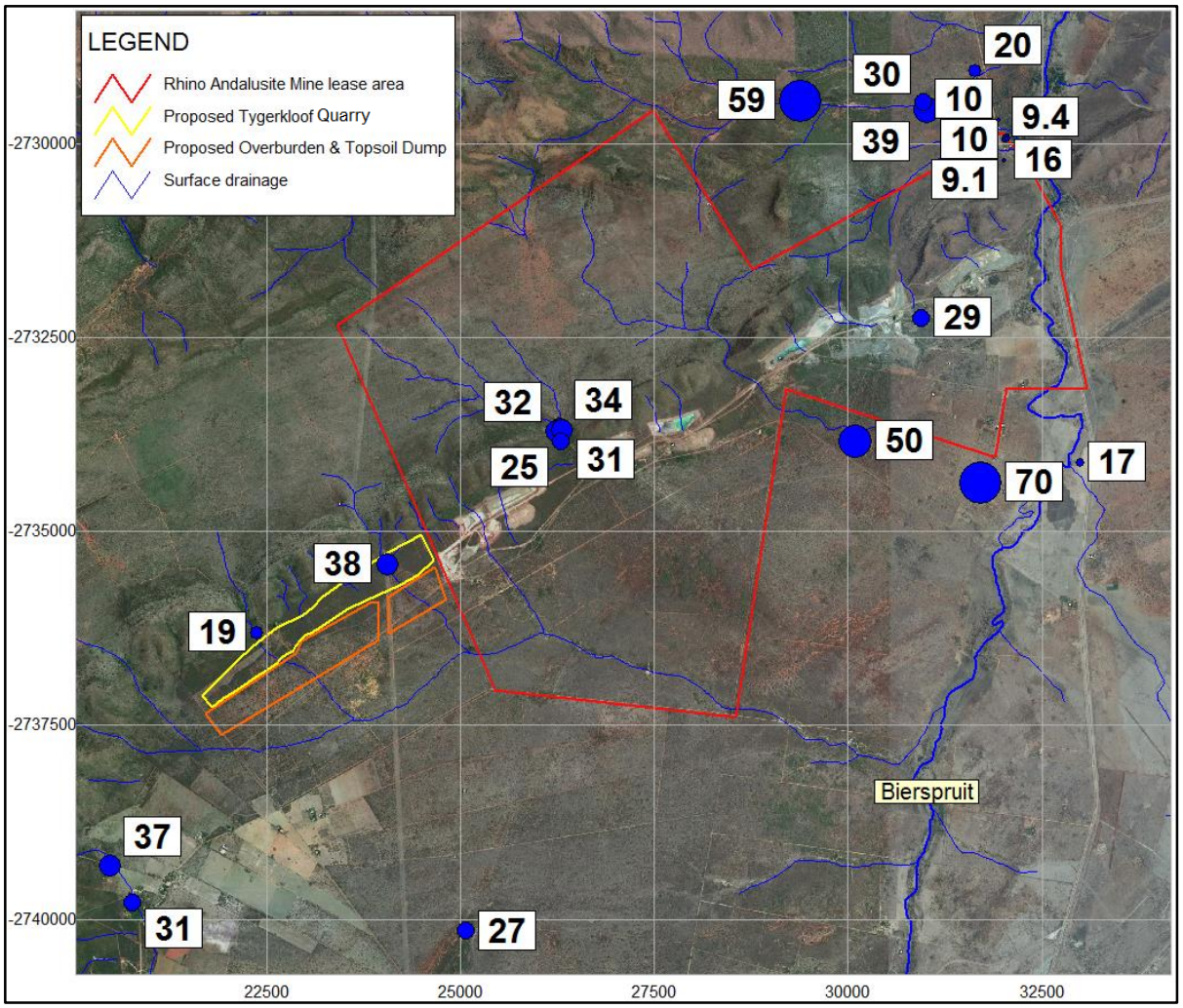


Figure 23: Thematic map of groundwater level depths (mbs)

Notes: - The numbers in the above figure indicate the groundwater level depth below surface in meters,

- The blue circles represent the positions of the user/monitoring boreholes,

- The size of the blue circles is directly proportional to the groundwater level depth, hence the largest circle represents the deepest water level.

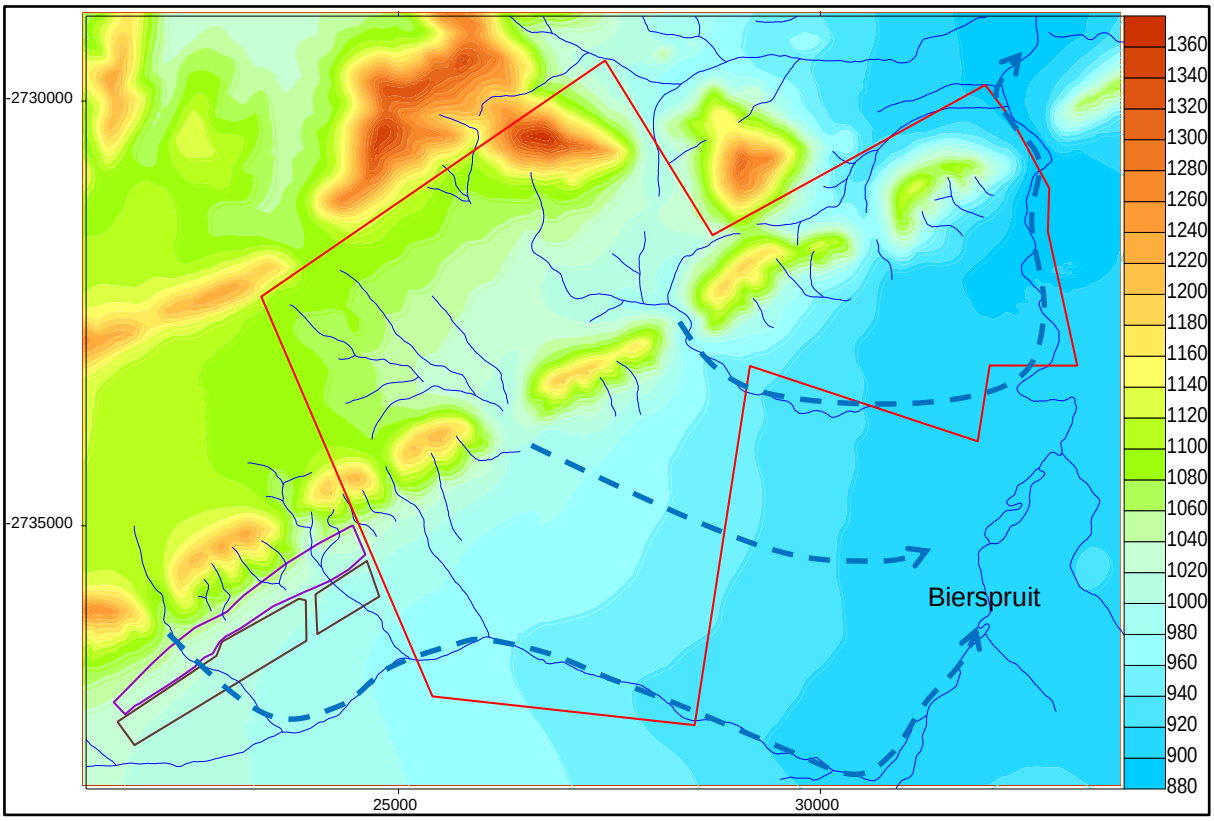


Figure 24: Bayesian interpolated groundwater elevation contour map of the project area (mamsl)

1.1.10.4 Groundwater flow directions, gradients and velocities

Contours of the static water levels or piezometric heads in and around the project area are indicated in Figure 24. Path lines or flow lines of groundwater particles are lines perpendicular to the contours, as indicated with arrows. Flow occurs faster where contours are closer together and gradient are thus steeper.

On the relatively steeper sloping hillocks where groundwater gradients are higher, groundwater seepage rates are correspondingly higher. Seepage rates on the other hand are much lower in the flat plateaus and valley bottoms.

Average groundwater gradients were calculated with the above formula from the water level elevation data (Figure 24. By substituting the hydraulic head difference over lateral distance a hydraulic gradient of approximately 2% east/south-eastwards was calculated for the proposed Tygerkloof Quarry mining area.

The pre-mining static groundwater contours are presented in Figure 24 and represent conditions without impacts from sources or actions other than natural conditions. Groundwater flow gradients were used to calculate the rate of groundwater movement (the so-called 'Darcy flux') within the potentially impacted areas and the results are provided below in Table 26.

Table 26: Direction and rate of groundwater movement in the project area

Groundwater flow direction	Groundwater flow gradient	Groundwater flow velocity (m/d)	Groundwater flow velocity (m/y)
East/South-East	3%	0.01	3.65

Notes: Flow velocity (Darcy Flux) calculations were done by assuming an average aquifer porosity of 6% and hydraulic conductivity of 0.02m/d.

1.1.10.5 Aquifer types

For the purpose of this study an aquifer is defined as a geological formation or group of formations that can yield groundwater in economically useable quantities. Aquifer classification according to the Parsons Classification system is summarised in Table 2 (Groundwater Complete, 2015).

The **first aquifer** is a shallow, **semi-confined or unconfined aquifer** that occurs in the transitional soil and **weathered bedrock zone** or sub-outcrop horizon. Drilling in the project area indicated the presence of significant scree deposits, which are restricted to the lower lying areas. Yields in this aquifer are generally low (less than 0.5l/s) and the aquifer is usually not fit for supplying groundwater on a sustainable basis. Consideration of the shallow aquifer system becomes important during seepage estimations from pollution sources to receiving groundwater and surface water systems. The shallow weathered zone aquifer plays the most important role in mass transport simulations from process and mine induced contamination sources because the lateral seepage component in the shallow weathered aquifer often dominates the flow. **According to the Parsons Classification system, this aquifer is usually regarded as a minor- and in some cases a non-aquifer system.**

Due to the mainly lateral flow and sometimes phreatic nature of the weathered zone aquifer, it is usually only affected by opencast mining or by high extraction or shallow underground mining where subsidence occurs and the entire roof strata above the mined area is destroyed. Where mining becomes deeper the weathered zone aquifer is usually affected to a very limited extent. The shallow aquifer system is not developed in the mountainous areas where the proposed opencast mining is planned to take place.

The **second, main aquifer system** is the deeper **secondary fractured rock aquifer** that is hosted within the sedimentary rocks of the Transvaal Supergroup. Groundwater yields, although more heterogeneous, can be higher. This aquifer system usually displays semi-confined or confined characteristics with piezometric heads often significantly higher than the water-bearing fracture position. Fractures may occur in any of the co-existing host rocks due to different tectonic, structural and genetic processes. Drilling results indicated an absence of significant water yielding fractures within the secondary fractured rock aquifer. **According to the Parsons Classification system, the aquifer could be regarded as a minor aquifer system, but also a sole aquifer system in some cases where groundwater is the only source of domestic water.**

Notable is the fact that **no significant blow yields** were recorded in the secondary fractured rock aquifer.

If the dip of the strata is considered, the Malmani Sub-group dolomite of the Chuniespoort Group outcrops to the north of the project area. Dolomite is capable of forming major aquifers, especially where widespread karst formation occurred. However, groundwater studies conducted for the adjacent RAM found no signs of significant karst development within the immediate vicinity of the project area – the dolomite is estimated to underlie the proposed Tygerkloof Quarry at a depth of approximately 4,500 meters below surface.

In spite of relatively low blow-out yields, pump tests were performed on 2 boreholes in the immediate vicinity of the proposed quarry in order to obtain representative aquifer parameters for the project area. These pump tests were performed using a low yield (± 0.3 l/s) pump with the main aim of determining the transmissivity and storage characteristics of the solid geological formation – the so-called aquifer matrix. These low rate pump tests are performed instead of the more commonly used slug tests because of the much improved accuracy obtained with the pump tests, resulting in much more reliable aquifer parameters calculated from the tests. The tests results are provided in Table 27.

1.1.10.6 Aquifer transmissivity and storativity

Constant rate pump tests were performed on two boreholes and their positions are indicated in Figure 15 (Groundwater Complete, 2015). A short summary of the pump tests are also provided in Table 27.

Data collected from the pump tests were used to determine aquifer parameters such as transmissivity and storativity for both the matrix- and fracture flow stages.

Table 27: Summary of pump tests

BH	**BH depth**	**Static WL**	**Pump duration**	**Pump rate**	**Drawdown**	**Recovery**
Unit	***m***	***mamsl***	***min***	***l/s***	***m***	***%***
FerdieBotha2	97	19.1	48	0.30	25.0	28% @ 50 min
TKBH02	47	33.6	19	0.35	10.3	66% @ 35 min

Aquifer transmissivity is defined as a measure of the amount of water that could be transmitted horizontally through a unit width of aquifer by the full-saturated thickness of the aquifer under a hydraulic gradient of 1. Transmissivity is the product of the aquifer thickness and the hydraulic conductivity of the aquifer, usually expressed as m^2/day ($Length^2$/Time).

Storativity (or the storage coefficient) is the volume of water that a permeable unit will absorb or expel from storage per unit surface area per unit change in piezometric head. Storativity (a dimensionless quantity) cannot be measured with a high degree of accuracy in slug tests or even in conventional pumping tests. It has been calculated by numerous different methods with the results published

widely and a value of 0.002 to 0.01 is taken as representative for the proposed mining area. The storage coefficient values calculated from the pump tests proved to be in this order of magnitude.

The pump test data was analysed with the AQTESOLV Professional software package, which offers a wide range of mathematical equations/solutions for the calculation of aquifer parameters. The time-water level data collected during the constant rate pump test is plotted on a log-linear graph. A straight line can then be fitted to the different flow stages on the graph (process known as curve matching) and the aquifer transmissivity and storativity is calculated in accordance with the preselected analytical equation. All aquifer parameters provided in this report were calculated with the *Cooper-Jacob (1946)* equation.

Examples of curve matching are provided in Figures 16 and 17 (Groundwater Complete, 2015), which illustrate aquifer parameters calculated for both the matrix- and fracture flow stages. It is important to note that the Cooper-Jacob approximation algorithm for pump test analysis was designed for pump tests interpretation in a primary porosity aquifer environment with the following assumptions:

- The aquifer is a homogeneous medium,
- Of infinite extent,
- No recharge is considered, and
- An observation borehole is used for water level recording at a distance from the pumped borehole.

Although few of these assumptions apply at the project area, the method could still be used as long as the assumptions and 'shortcomings' are recognized and taken into account. It is for this reason that not one straight line is fitted but two different lines are fitted for the fracture and matrix flow periods respectively.

Because aquifer hydraulic parameters (like most geological parameters) usually display a log-normal distribution it is an accepted approach to calculate the harmonic or geometric mean in preference to the arithmetic mean. A generally accepted approach for calculating a representative hydraulic conductivity for an aquifer is to take the average of the harmonic and geometric means. This methodology could however not be followed due to an insufficient amount of data and only averages have been calculated and are provided in Table 28.

It follows that the average transmissivity of the **aquifer matrix** (between fracture zones) in the project area is approximately **0.4m^2/d**, which translates to an average **hydraulic conductivity** of ± **0.02m/d**. The average transmissivity of **fractures** in the area is ± **2.9m^2/d**, translating to an average **hydraulic conductivity of 0.15m/d**.

The extremely heterogeneous nature of the fractured rock aquifer regime may however cause significant variations in aquifer transmissivity/storativity within relatively short distances, which makes

it difficult to determine representative values over large areas. The data distribution of only two boreholes over the project area is far from ideal and aquifer parameters provided in Table 28 below cannot be considered representative of the wider project area. The values obtained, however, are precisely in line with literature values and what we know from experience in the aquifer(s) developed in this shale rock environment.

Table 28: Aquifer parameters calculated from pump tests

BH	Tf	Tm	Sf	Sm
FerdieBotha2	2.7	0.2	0.04	0.18
TKBH02	3.0	0.6	0.05	0.16
Average:	2.85	0.40	0.045	0.170

Note: Tf: - Fracture transmissivity (m^2/d); Tm – Matrix transmissivity (m^2/d); Sf – Fracture storativity/storage coefficient (dimensionless quantity); Sm – Matrix storativity/storage coefficient (dimensionless quantity).

1.1.10.7 Aquifer recharge and discharge rates

According to Figure 18 (Groundwater Complete, 2015) the mean annual recharge to the aquifer underlying the project area varies between approximately 8mm to 20mm, which based on an average rainfall of approximately 650mm/a (Figure 3 (Groundwater Complete, 2015)) translates to a recharge percentage varying between 1% and 3%.

Where outcrop occurs, the effective recharge percentage can be slightly higher while in low-lying topographies where discharge generally occurs and thicker sediment deposition, the effective recharge will be lower or even zero. Based on this estimate, the mean annual recharge to the aquifer regime as defined in Figure 9 (Groundwater Complete, 2015) should vary between ±3.3Mm^3 & 8.3Mm^3.

1.1.10.8 Groundwater quality conditions

Groundwater quality data is available for two groups of boreholes, namely user boreholes and purposed drilled monitoring boreholes for the adjacent RAM. Refer to the specialist report for methodology used to assess groundwater quality.

1.1.10.8.1 Groundwater quality evaluation for user boreholes

Water quality information is available for a total of 17 user boreholes and their positions are indicated below in Figure 25. The results of the chemical analyses are provided in Table 29.

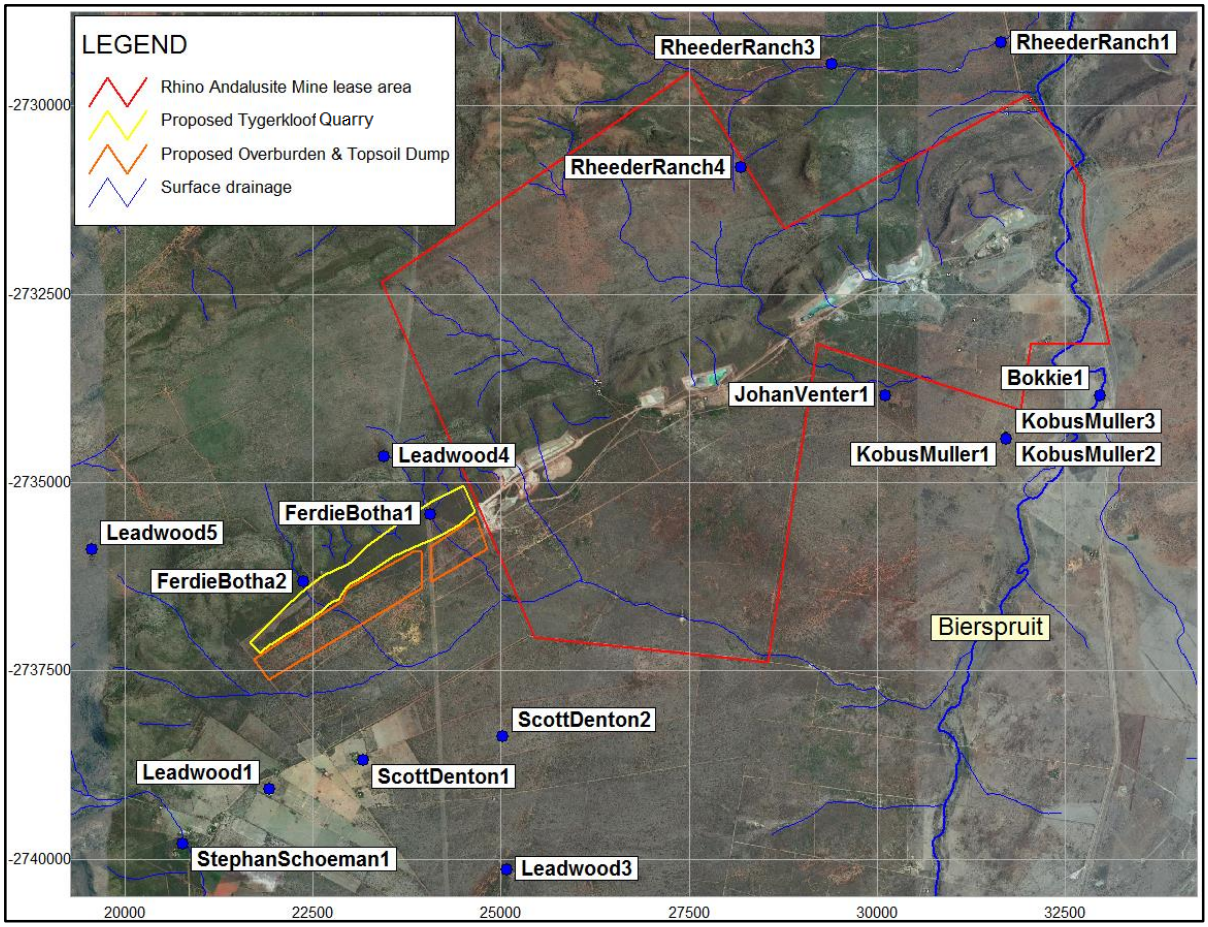


Figure 25: Positions of user boreholes used in groundwater quality assessment

Five chemical parameters (TDS, SO_4, NO_3, Chlorine (Cl) and pH) were chosen from the full list of analytes as indicators of the specific type of contamination expected to occur at the proposed mining operations. Although only the five parameters will be discussed, all inorganic parameters will be assessed and anomalies will be discussed.

The **TDS** content of groundwater is a good indicator of the overall quality conditions, as it provides a measurement of the total amount/weight of salts that are present in solution. An increase in TDS will therefore also indicate an increase in the total inorganic content of the groundwater. Groundwater TDS concentrations measured in user boreholes vary between ±80mg/l & 850mg/l, which are well below the permissible SANS value of 1,200mg/l (Table 3 (Groundwater Complete, 2015)). A positive linear correlation generally exists between groundwater salinity and aquifer residence time and because gravity dictates that groundwater moves from higher to lower hydraulic gradients, overall higher salinities are generally measured in the lower lying areas and valley bottoms.

This phenomenon may explain the overall higher salinities measured in user boreholes Bokkie1, KobusMuller1 and KobusMuller2, which are located at lower surface elevations close to the Bierspruit.

The SO_4 content of groundwater measured within the user boreholes vary from below the detection limit of 0.04mg/l to approximately 50mg/l, which are well below the permissible SANS value of 500mg/l and representative of ambient conditions. SO_4 contamination is more often than not associated with the oxidation of sulphide bearing minerals (in particular pyrite).

No Acid Base Accounting (ABA) tests were conducted for the purpose of this study. However, ABA test results were obtained for the adjacent RAM, which shows that the rock material contains very low concentrations of sulphur and is non-acid forming (Geohydrological Study for Rhino Minerals – Rhino Andalusite Mine, 2010). Since the RAM and proposed Tygerkloof Quarry are located within the exact same geological environment, similarly low concentrations of sulphur are expected for the project area and no significant acid formation should occur.

The groundwater pH conditions are more or less neutral with values ranging between 7.1 and 8.5. The neutral pH conditions restrict the mobilisation of metals, which are also sensitive to groundwater redox conditions.

Groundwater NO_3 concentrations measured in the majority of boreholes are below the permissible SANS value of 11mg/l (Table 329. Exceptions do however occur as a NO_3 concentration of 16mg/l was measured in user borehole ScottDenton1, which exceeds the permissible SANS value for drinking water (Table 3 (Groundwater Complete, 2015)). Borehole LeadWood1 displayed a concentration of approximately 7mg/l, which despite being below the SANS guideline value, exceeds the ambient concentration of ±1.0mg/l. The once-off analyses do not allow for accurate source identification, however the NO_3 contamination affecting the abovementioned two boreholes is likely to originate from quarry latrines and/or feedlots.

User boreholes displayed groundwater chloride concentrations varying from less than 10mg/l to approximately 230mg/l, which are below the permissible SANS value of 300mg/l. Similar to the groundwater TDS content, overall higher chloride concentrations were measured in user boreholes Bokkie1, KobusMuller1 and KobusMuller2, which are likely to be caused by natural occurring ion exchange reactions as the groundwater moves through the aquifer host rock (Table 29).

According to the Expanded Durov diagram (Figures 18 (Groundwater Complete, 2015)) the user boreholes are dominated by fresh, clean, relatively young groundwater that has started to undergo mineralisation with especially Mg ion exchange. The groundwater is therefore dominated by Mg cations, while bicarbonate (HCO_3) alkalinity dominates the anion content.

Table 29: Concentrations in indicator chemical parameters for user boreholes

Locality	pH	EC mS/m	TDS mg/l	Alk mg/l	Cl mg/l	SO_4 mg/l	NO_3 mg/l	NH_4 mg/l	PO_4 mg/l
Rheeder Ranch1	7.6	72.7	380.0	348.0	25.5	2.8	0.7	0.04	0.06
Rheeder Ranch3	7.1	13.6	76.0	71.3	4.6	1.2	0.4	0.03	0.07
Rheeder Ranch4	8.2	73.3	384.0	379.0	21.8	2.1	0.3	0.28	0.05
Kobus Muller1	8.0	139.0	770.0	529.0	136.0	51.5	0.2	0.02	0.04
Kobus Muller2	7.8	137.0	750.0	504.0	134.0	52.7	0.3	0.03	0.04
Kobus Muller3	7.9	98.8	551.0	486.0	40.8	12.2	0.6	0.01	0.04
Johan Venter1	8.5	88.8	490.0	487.0	20.0	7.2	0.5	0.07	0.04
Bokkie1	7.6	165.0	847.0	481.0	234.0	27.4	4.1	0.03	0.13
Ferdie Botha1	7.4	61.7	324.0	273.0	30.7	13.0	0.2	0.46	0.04
Ferdie Botha2	7.4	78.2	427.0	428.0	9.1	4.4	0.5	0.36	0.04
Leadwood1	8.0	87.2	497.0	475.0	12.5	<0.04	6.9	0.03	0.04
Leadwood3	8.3	62.5	329.0	324.0	10.1	0.3	3.4	0.02	0.04
Leadwood4	7.8	71.5	395.0	403.0	6.9	1.2	0.4	0.02	0.04
Leadwood5	8.0	77.4	407.0	372.0	13.5	18.0	2.1	0.01	0.04
Scott Denton1	8.0	111.0	637.0	528.0	28.4	12.3	15.9	0.02	0.04
Scott Denton2	8.4	74.2	427.0	450.0	7.2	<0.04	0.2	0.14	0.04
Stephan Schoeman1	7.9	91.4	521.0	534.0	10.5	5.1	0.5	0.01	0.04

Locality	F mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Al mg/l	Fe mg/l	Mn mg/l	Thard mg/l
Rheeder Ranch1	0.3	61.8	54.0	18.3	1.7	<0.003	<0.003	<0.001	376.0
Rheeder Ranch3	0.1	8.6	8.8	7.2	0.3	<0.003	<0.003	<0.001	58.0
Rheeder Ranch4	0.2	42.3	70.6	11.4	3.0	<0.003	<0.003	<0.001	397.0
Kobus Muller1	0.2	88.0	80.4	85.6	4.8	<0.003	<0.003	<0.001	551.0
Kobus Muller2	0.3	91.6	84.3	75.5	3.4	<0.003	<0.003	<0.001	576.0
Kobus Muller3	0.4	60.4	54.9	80.1	3.2	<0.003	<0.003	<0.001	377.0
Johan Venter1	0.3	57.6	86.6	17.5	0.7	<0.003	<0.003	<0.001	500.0
Bokkie1	0.5	66.3	143.0	61.5	2.7	<0.003	<0.003	0.0	754.0
Ferdie Botha1	0.4	55.2	39.5	14.4	3.4	<0.003	<0.003	0.2	300.0

Locality	F mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Al mg/l	Fe mg/l	Mn mg/l	Thard mg/l
Ferdie Botha2	0.2	84.1	58.7	5.6	1.1	<0.003	<0.003	0.8	452.0
Leadwood1	0.2	74.6	79.6	7.8	1.3	<0.003	<0.003	<0.001	514.0
Leadwood3	0.2	33.1	67.0	5.8	0.3	<0.003	<0.003	<0.001	358.0
Leadwood4	0.2	81.3	54.0	2.6	0.8	<0.003	<0.003	<0.001	425.0
Leadwood5	0.2	60.0	71.6	5.6	1.7	<0.003	<0.003	<0.001	445.0
Scott Denton1	0.3	92.5	89.2	20.8	1.0	<0.003	<0.003	<0.001	598.0
Scott Denton2	0.2	56.7	62.3	23.2	2.0	<0.003	<0.003	<0.001	398.0
Stephan Schoeman1	0.3	103.0	69.6	4.1	0.5	<0.003	<0.003	<0.001	544.0

Note: Values shaded with red are those that exceed the SANS guideline values for drinking water

1.1.10.8.2 Groundwater quality evaluation for mine monitoring boreholes

Groundwater quality information is available for a total of 12 monitoring boreholes from the adjacent RAM and their positions are indicated below in Figure 26. The results of the chemical analyses are provided in Table 30.

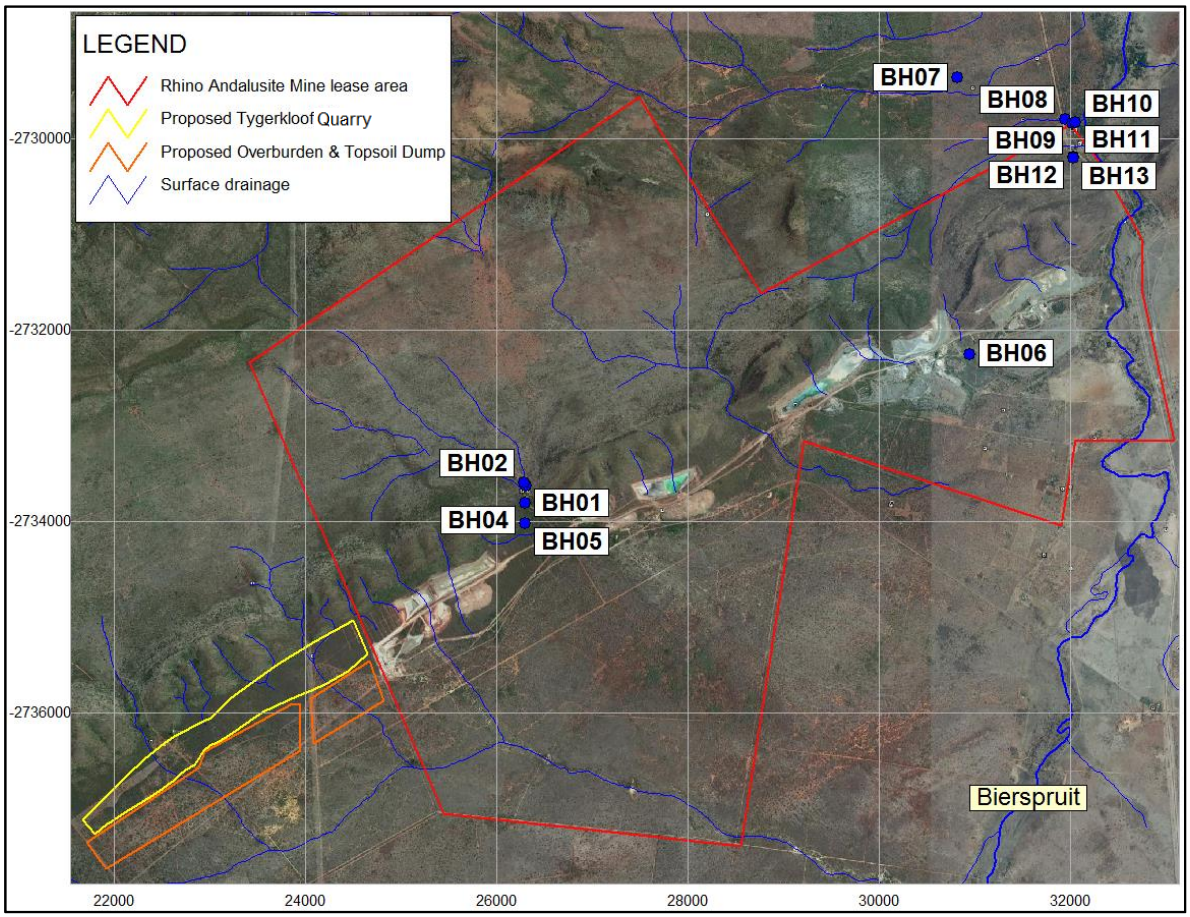


Figure 26: Positions of mine monitoring boreholes used in groundwater quality assessment

Groundwater TDS concentrations measured in mine monitoring boreholes vary between approximately 430mg/l and 1,130mg/l, which are below the permissible SANS value of 1,200mg/l. Overall higher concentrations were measured in monitoring boreholes BH06 and BH07, however no reasonable explanation can be provided given the limited amount of data available.

Groundwater SO_4 concentrations of less than 10mg/l were measured in the majority of monitoring boreholes, therefore representing natural, unaffected groundwater quality conditions. However, overall higher concentrations were again measured in monitoring boreholes BH06 and BH07, which displayed concentrations of approximately 160mg/l and 150mg/l respectively. These concentrations are still well below the permissible SANS level of 500mg/l, however they do exceed the ambient concentration of approximately 6mg/l.

The groundwater pH conditions are more or less neutral with values ranging between 7.3 and 8.2, which are well within recommended SANS ranges for drinking water purposes.

The mine monitoring boreholes displayed groundwater NO_3 concentrations varying between approximately 0.5mg/l and 0.8mg/l, which are well below the permissible SANS value of 11mg/l. A slightly higher concentration of ± 2.1mg/l was measured in BH04, however no reasonable explanation can be provided for this anomaly at this point in time.

Groundwater chloride concentrations measured in the majority of monitoring boreholes vary from less than 10mg/l to approximately 140mg/l, which are below the permissible SANS value of 300mg/l. However, boreholes BH06 and BH07 displayed concentrations of ± 33mg/l and 360mg/l respectively, therefore exceeding the permissible SANS value for drinking water purposes (Table 5 (Groundwater Complete, 2015)). The once-off sampling data is insufficient and does not provide any reasonable explanation for this phenomenon.

According to the Expanded Durov diagram (Figure 20 (Groundwater Complete, 2015)) the mine monitoring boreholes are dominated by two main types of groundwater:

- Fresh, clean, relatively young groundwater that has started to undergo mineralisation with especially Mg ion exchange. The groundwater is therefore dominated by Mg cations, while HCO_3 alkalinity dominates the anion content.
- Groundwater that is usually a mix of different types – either clean water from fields 1 and 2 that has undergone SO_4 and NaCl mixing/contamination or old stagnant NaCl dominated water that has mixed with clean water. The groundwater is consequently dominated by Mg cations and SO_4 anions.

The plot position of boreholes BH06 and BH07 in field 5 of the EDD represents groundwater that is affected by an unknown source of SO_4 contamination. Both boreholes also displayed elevated salinities in comparison to the other boreholes, which also suggest localised impacts on groundwater quality.

Table 30: Concentrations in indicator chemical parameters for mine monitoring boreholes

Locality	pH	EC mS/m	TDS mg/l	Alk mg/l	Cl mg/l	SO_4 mg/l	NO_3 mg/l	NH_4 mg/l	PO_4 mg/l
BH01	7.5	79.8	442.0	448.0	7.0	2.8	0.6	0.027	0.041
BH02	7.6	79.8	439.0	443.0	7.2	2.8	0.8	0.034	0.038
BH04	7.5	84.3	452.0	424.0	16.3	4.1	2.1	0.026	0.038
BH05	8.2	77.9	427.0	410.0	15.9	3.7	0.7	0.025	0.038
BH06	7.6	197.0	1116.0	439.0	333.0	162.0	0.6	0.028	0.040
BH07	7.5	199.0	1126.0	449.0	357.0	149.0	0.7	0.019	0.040
BH08	7.5	121.0	642.0	472.0	110.0	6.3	0.6	0.021	0.038
BH09	7.5	120.0	621.0	426.0	119.0	5.5	0.6	0.018	0.037

Locality	pH	EC mS/m	TDS mg/l	Alk mg/l	Cl mg/l	SO_4 mg/l	NO_3 mg/l	NH_4 mg/l	PO_4 mg/l
BH10	7.5	125.0	638.0	398.0	141.0	6.0	0.6	0.021	0.038
BH11	7.5	94.0	505.0	467.0	30.4	2.6	0.6	0.065	0.038
BH12	7.5	104.0	569.0	473.0	67.4	4.3	0.5	0.024	0.038
BH13	7.6	109.0	578.0	449.0	86.3	5.0	0.5	0.128	0.039
TKBH01*	7.3	81.5	440.0	440.0	9.3	8.3	<0.392	0.08	0.01
TKBH02*	7.4	77.2	400.0	423.0	2.2	<0.957	<0.392	0.70	0.01

Locality	F mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Al mg/l	Fe mg/l	Mn mg/l	Thard mg/l
BH01	0.3	91.8	58.2	4.4	1.5	<0.003	<0.003	<0.001	469.0
BH02	0.3	90.9	58.5	4.4	1.5	<0.003	<0.003	<0.001	468.0
BH04	0.3	92.3	60.8	8.1	2.2	<0.003	<0.003	<0.001	481.0
BH05	0.4	83.7	55.1	11.8	3.0	<0.003	<0.003	<0.001	436.0
BH06	0.2	148.0	138.0	61.5	2.9	<0.003	<0.003	<0.001	939.0
BH07	0.3	163.0	146.0	31.7	2.3	<0.003	<0.003	<0.001	1009.0
BH08	0.4	99.3	66.2	65.6	4.4	<0.003	<0.003	<0.001	521.0
BH09	0.4	97.1	59.9	70.3	5.6	<0.003	<0.003	<0.001	489.0
BH10	0.4	95.9	56.3	86.9	6.3	<0.003	<0.003	<0.001	471.0
BH11	0.3	99.6	64.4	17.9	2.6	<0.003	<0.003	<0.001	514.0
BH12	0.3	99.1	62.7	40.8	3.6	<0.003	<0.003	<0.001	506.0
BH13	0.3	95.4	59.5	50.6	4.4	<0.003	<0.003	<0.001	483.0
TKBH01*	<0.496	83.1	54.2	13.0	2.9	<0.003	<0.003	<0.001	431.0
TKBH02*	<0.496	82.4	45.2	6.9	3.3	<0.003	<0.003	0.5	392.0

Note: Values shaded with red are those that exceed the SANS guideline values for drinking water.

* Purpose drilled source monitoring borehole.

1.1.11 Air quality

Information for this section was obtained from 'Air Quality Specialist Report for the Proposed Tygerkloof Mine, Thabazimbi, Limpopo Province' (Airshed Planning Professionals, 2015).

1.1.11.1 Sources of air pollution within the region

Neighbouring land-use in the surrounding of the proposed project comprises predominantly of farming and mining activities. These land-uses contribute to baseline pollutant concentrations via fugitive and process emissions, vehicle tailpipe emissions, household fuel combustion, biomass burning etc.

1.1.11.1.1 Mining sources

Existing mines located in this region include the TIOM, the Amandelbult Platinum Mine and the Cronimet Chrome Mine. Particulates represent the main pollutant of concern at mining operations, be it underground or opencast mining. The amount of dust emitted by these activities depends on the physical characteristics of the material, the way in which the material is handled and the weather conditions (e.g. high wind speeds, rainfall, etc.).

1.1.11.1.2 Unpaved and paved roads

Emissions from unpaved roads constitute a major source of emissions to the atmosphere in the South African context. When a vehicle travels on an unpaved road the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong turbulent air shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Dust emissions from unpaved roads vary in relation to the vehicle traffic and the silt loading on the roads.

Emission from paved roads are significantly less than those originating from unpaved roads, however they do contribute to the particulate load of the atmosphere. Particulate emissions occur whenever vehicles travel over a paved surface. The fugitive dust emissions are due to the re-suspension of loose material on the road surface.

1.1.11.1.3 Wind erosion of open areas

Windblown dust emanates from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the threshold velocity. This relates to gravity and the inter-particle cohesion that resists removal. Surface properties such as soil texture, soil moisture and vegetation cover influence the removal potential. Conversely, the friction velocity or wind shear at the surface is related to atmospheric flow conditions and surface aerodynamic properties. Thus, for particles to become airborne, its erosion potential has to be restored; that is, the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity. Every time a surface is disturbed, its erosion potential is restored (US EPA, 2004). Erodible surfaces may occur as a result of agriculture and/or grazing activities.

1.1.11.1.4 Vehicle Tailpipe Emissions

Emissions resulting from motor vehicles can be grouped into primary and secondary pollutants. While primary pollutants are emitted directly into the atmosphere, secondary pollutants form in the atmosphere as a result of chemical reactions. Significant primary pollutants emitted combustion engines include carbon dioxide (CO_2), carbon (C), sulphur dioxide (SO_2), oxides of nitrogen (mainly NO), particulates and lead. Secondary pollutants include Nitrogen dioxide ($NO_{2)}$, photochemical oxidants such as ozone, sulphur acid, sulphates, nitric acid, and nitrate aerosols (particulate matter). Vehicle type (i.e. model-year, fuel delivery system), fuel (i.e. oxygen content), operating (i.e. vehicle speed, load) and environmental parameters (i.e. altitude, humidity) influence vehicle emission rates.
Transport in the vicinity of the mine site is via trucks and private vehicles along the R510 and R511 provincial road, which are the main sources of vehicle tailpipe emissions.

1.1.11.1.5 Agriculture

Agriculture is a major land-use activity within the area surrounding the site. Particulate matter is the main pollutant of concern from agricultural activities as particulate emissions are derived from windblown dust, burning crop residue, and dust entrainment as a result of vehicles travelling along dirt

roads. In addition, pollen grains, mould spores and plant and insect parts from agricultural activities all contribute to the particulate load. Should chemicals be used for crop spraying, they would typically result in odiferous emissions. Crop residue burning is an additional source of particulate emissions and other toxins. Due to the small scale of farming activities these are regarded to have an insignificant cumulative impact.

1.1.11.1.6 Biomass and residential fuel burning

Aerosols, black C and hydrocarbons are associated with biomass burning. Burning crop residue may be a significant source of atmospheric emissions within the area. Also, domestic households are potentially one of the most important sources contributing to poor air quality within residential areas. Individual households are low volume emitters, but their cumulative impact is significant. It is likely that households within the local communities/settlements utilise coal, paraffin and /or wood for cooking and/or space heating purposes (mainly during winter). Pollutants arising from the combustion of wood include respirable particulates.

1.1.11.2 Measured ambient air quality

The site is located in a rural area currently affected by air pollution sources as described in the preceding section. Pollutants released include but are not limited to, fugitive $PM_{2.5}$, PM_{10} and Total Suspended Particulates (TSP) and gaseous pollutants as products of the combustion of petrol and diesel. Ambient monitoring data was obtained from the TIOM monitoring network as well as the Department of Environmental Affairs (DEA's) Thabazimbi monitoring station (Waterberg/Bojanala Priority Area network (WBPA)). The locations of these ambient monitoring locations are illustrated in Figure 27.

1.1.11.2.1 Thabazimbi Iron Ore Mine monitoring network

The TIOM monitoring network comprise 21 dustfall sampling buckets and a gravimetric PM_{10} and $PM_{2.5}$ sampler. Dustfall deposition results for the period July 2013 to August 2014 are presented in Figure 28. Monthly averages of daily PM_{10} and $PM_{2.5}$ concentrations for the period September 2011 to July 2013 and November 2012 to July 2013 respectively, are presented in Figure 29. Dustfall rates are generally low and below the residential and non-residential National Dust Control Regulations limits, except for D15 in September 2013 and D9 in November 2013. Daily PM_{10} and $PM_{2.5}$ concentrations do not exceed their respective standard over the monitoring period. Concentrations are generally low, exhibiting slight spatial or temporal variation throughout the monitoring period.

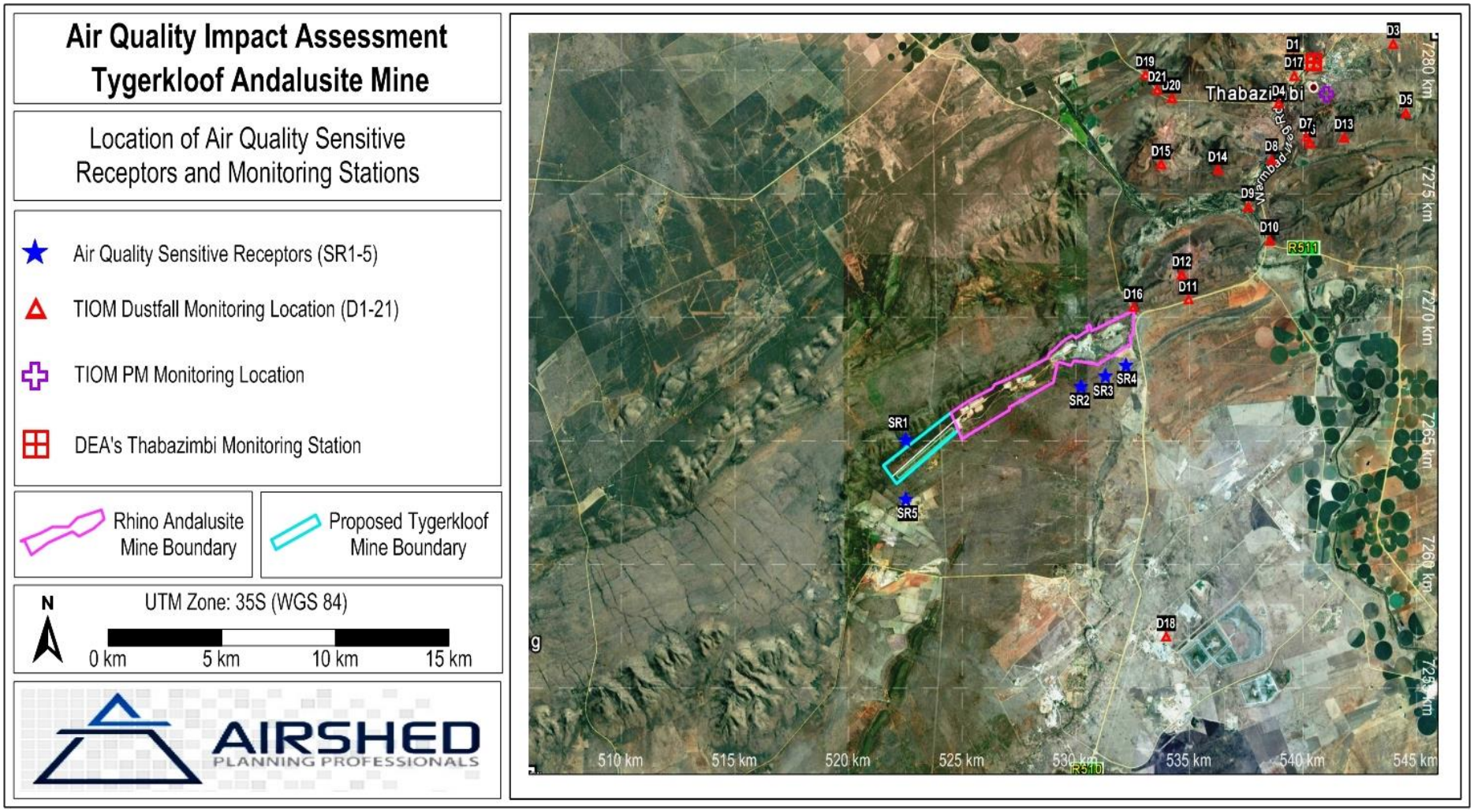


Figure 27: Location of air quality sensitive receptors and ambient monitoring stations in the vicinity of the project

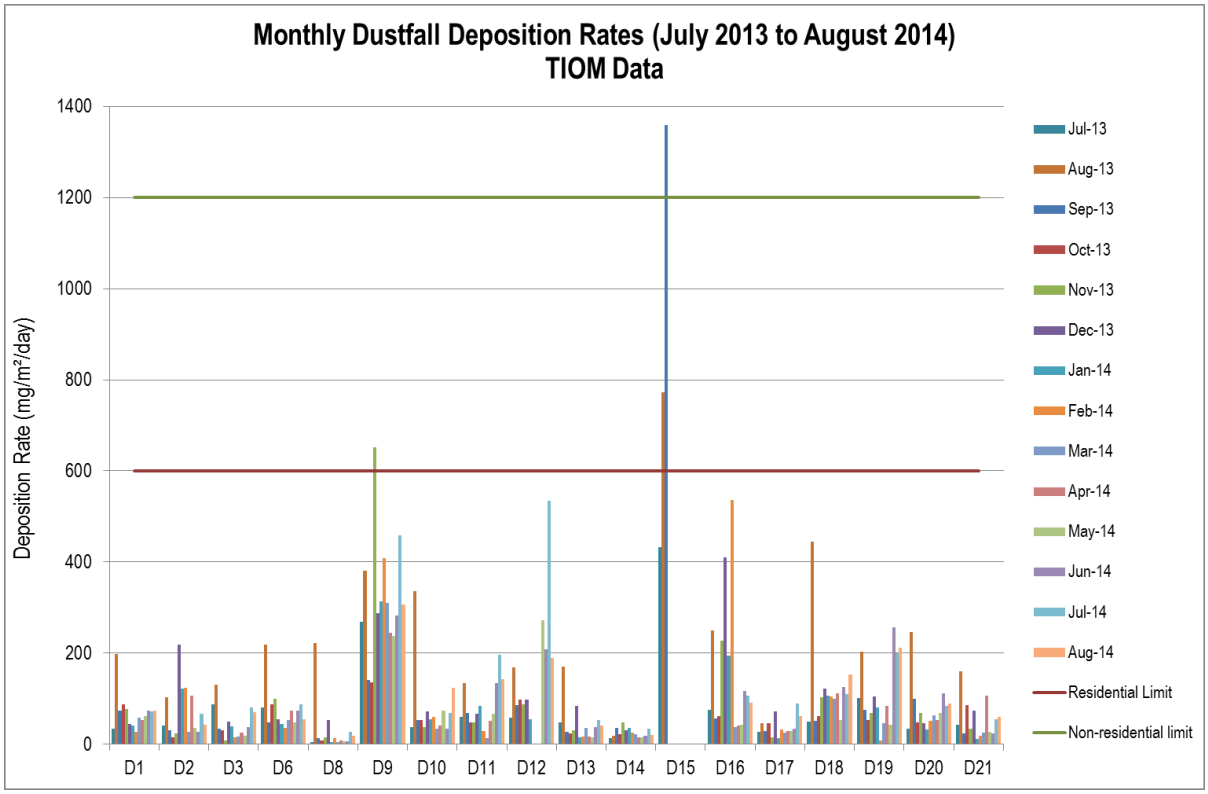


Figure 28: Monthly dustfall deposition rates (July 2013 to August 2014) TIOM monitoring station

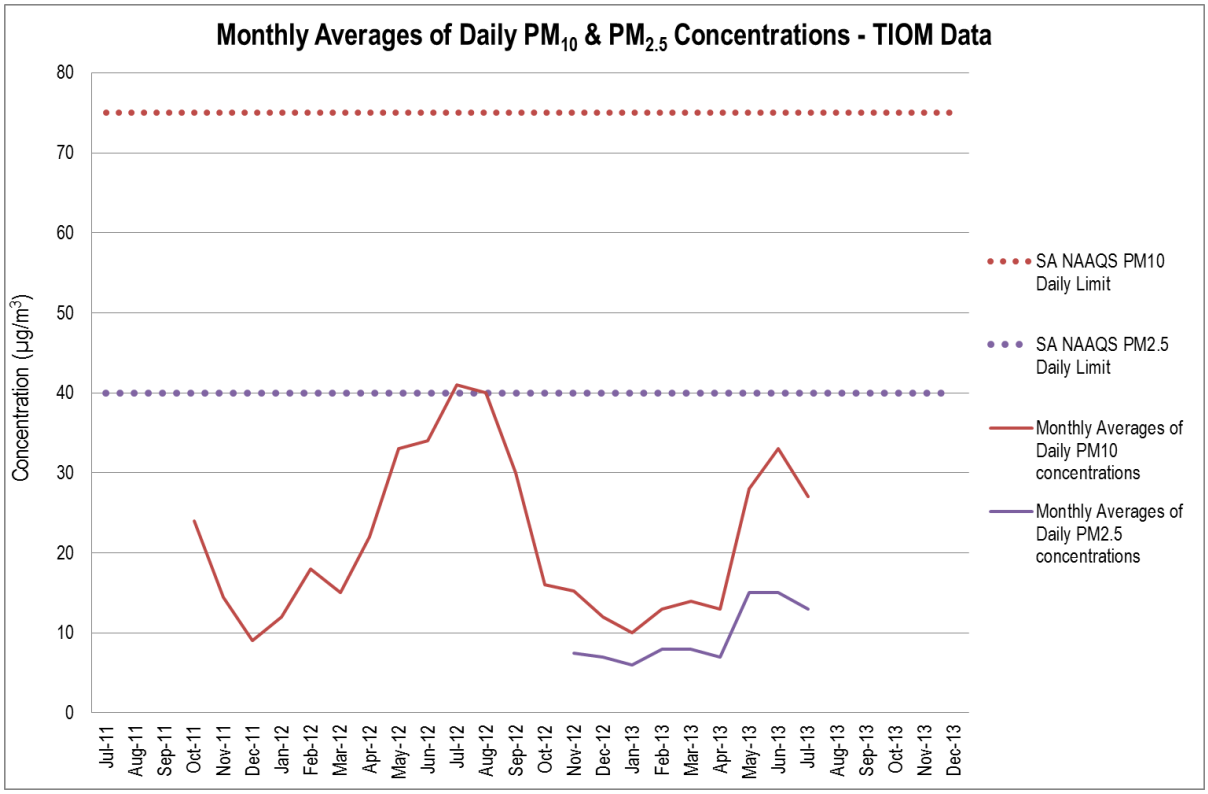


Figure 29: Monthly averages of daily PM_{10} & $PM_{2.5}$ concentrations - TIOM monitoring station

1.1.11.2.2 Thabazimbi monitoring station (DEA)

The DEA operates an ambient monitoring station in Thabazimbi as part of the WBPA. The station was commissioned in February 2013 and is located at the Regorogile Gateway Clinic, Shai drive (27.391605 E; -24.591058 S). The station was set up with the purpose of measuring residential emissions and emissions from mines located about 15-20km south of the station. The station measures most of the criteria pollutants including PM_{10} and $PM_{2.5}$ at varying intervals.

Analyses of data for the period 1st October 2012 to 20th April 2015 are presented in Figure 12, Figure 13, Figure 14 and Figure 15 (Airshed, 2015) for $PM_{2.5}$, PM_{10}, CO and NO_2 respectively. From these figures, it can be deduced that ambient concentration for CO does not exceed it standard at the Thabazimbi monitoring station.

Daily PM_{10} and $PM_{2.5}$ as well as hourly NO_2 concentrations exceed the National Ambient Air Quality Standards (South Africa) standard at varying frequencies across the period with irregular spikes in concentrations recorded mostly in the winter/spring months.

1.1.11.3 Air quality sensitive receptors

Sensitive receptors around the project site are shown in Figure 27. Thabazimbi town is located about 15km to the northeast of the project boundary. Nearby air quality sensitive receptors include informal settlements and residential houses situated within 100m to 1,000m of the project boundary.

1.1.12 Environmental noise

Information for this section was obtained from the 'Environmental Noise Impact Assessment Report' (Varicon cc, 2015).

The sound pressure levels were evaluated against the standards as specified in the SABS Code of Practice 0103 of 2008 (The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication) with reference to Code SABS 0328 of 2003 (Environmental Noise Impact Assessments). Refer to Table 31 below for the typical rating levels for ambient noise in districts.

Table 31: Typical rating levels for ambient noise in districts

Type of district	**Equivalent continuous rating level (LReq.T) for ambient noise**					
	Outdoors			**Indoors, with open windows**		
	Day- night	**Daytime**	**Night-time**	**Day- night**	**Daytime**	**Night-time**
(a) Rural districts	45	45	35	35	35	25
(b) Suburban with little road traffic	50	50	40	40	40	30
(c) Urban districts	55	55	45	45	45	35
(d) Urban districts with some workshops, business premises and with main roads.	60	60	50	50	50	40

Type of district	Equivalent continuous rating level (LReq.T) for ambient noise					
	Outdoors			Indoors, with open windows		
	Day- night	Daytime	Night-time	Day- night	Daytime	Night-time
(e) Central business districts	65	65	55	55	55	45
(f) Industrial districts	70	70	60	60	60	50

Note: The values given are A-weighted sound pressure levels and include corrections for tonal character and impulsiveness of the noise

The day-time weather conditions were dry and sunny and very hot temperatures with a slight breeze blowing. The night time weather conditions presented warm weather with clear skies and a light breeze blowing. Refer to Table 32 below for the environmental conditions present during the survey periods.

Table 32: Environmental conditions during the survey periods

Time	Wind speed	Wind direction	Humidity	Air temperature
10:00 – 14:00 (Day-time)	Mild breeze blowing	North-Westerly Direction	20%	29,5 0C – 40,0 0C
20:00 – 23:00 (Night-time)	Mild breeze blowing	North-Westerly Direction	15%	27,5 0C – 34,0 0C

In general, daytime results indicated normal background noise, caused by slight wind through the grass, wild animals, and birds. Night-time results indicated sounds of crickets, frogs and other night-time animals such as jackals with slight wind blowing through the grass. Noise results closer to the existing plant indicated a slight rise in results, however; these results were still below the typical rating for SABS 0103, Category D limitations (urban districts with some workshops, business premises and with main roads). Refer to Table 33 below for the results from the survey.

Table 33: Noise levels at various sampling locations

Measuring positions	Approximate co-ordinates	Ambient noise (dB(A))						Remarks
		Day-time Levels (outdoors)			Night-time Levels (outdoors)			
		Average Results	Typical Rating (SABS 0103) (Category D)	Excess ∆LReq,T (dBA)	Average Results	Typical Rating (SABS 0103) (Category D)	Excess ∆LReq,T (dBA)	
Position A: Middle section of the proposed new mine area. West of the existing quarry area.	24º44'12.94"S 27º13'23.46"E	32.8	60	+27.2	28.0	50	+22.0	Daytime: - Normal background noise, caused by slight wind through the grass, wild animals, birds. Night-time: –Night-time sounds of crickets, frogs and other night time animals such as jackals. Slight wind blowing through the grass.
Position B: Southern corner of the proposed new mining area. South-West of the existing quarry area.	24º44'41.60"S 27º13'06.10"E	27.4	60	+32.6	26.8	50	+23.2	Daytime: - Normal background noise, caused by slight wind through the grass, wild animals, birds. Night-time: –Night-time sounds of crickets, frogs and other night time animals such as jackals. Slight wind blowing through the grass.
Position C: Western corner of the proposed new mining area. West of the existing quarry area.	24º44'20.10"S 27º12'47.12"E	27.2	60	+32.8	26.4	50	+23.6	Daytime: - Normal background noise, caused by slight wind through the grass, wild animals, birds. Night-time: –Night-time sounds of crickets, frogs and other night time animals such as jackals. Slight wind blowing through the grass.
Position D: Moving quarter way upwards on the Northern side of the proposed new mining area. Close to the farmer's residence.	24º43'57.30"S 27º13'21.81"E	29.2	60	+30.8	28.7	50	+21.3	Daytime: - Normal background noise, caused by slight wind through the grass, wild animals, birds. Night-time: –Night-time sounds of crickets, frogs and other night time animals such as jackals. Slight wind blowing through the grass.
Position E: Moving upwards on the	24º43'42.65"S 27º13'47.92"E	33.4	60	+27.2	30.0	50	+22.0	Daytime: - Normal background noise, caused by slight wind through the grass, wild animals, birds.

Measuring positions	Approximate co-ordinates	Ambient noise (dB(A))						Remarks
		Day-time Levels (outdoors)			Night-time Levels (outdoors)			
		Average Results	Typical Rating (SABS 0103) (Category D)	Excess ΔLReq,T (dBA)	Average Results	Typical Rating (SABS 0103) (Category D)	Excess ΔLReq,T (dBA)	
northern side towards the existing quarry area.								Night-time: –Night-time sounds of crickets, frogs and other night time animals such as jackals. Slight wind blowing through the grass.
Position F: Entrance gate into the proposed new mining area towards the eastern corner. Closer to the existing quarry.	24º43'50.86"S 27º14'15.36"E	33.9	60	+26.1	27.8	50	+22.2	Daytime: - Normal background noise, caused by slight wind through the grass, wild animals, birds. Night-time: –Night-time sounds of crickets, frogs and other night time animals such as jackals. Slight wind blowing through the grass.
Position G: Moving up in the dirt road against the main fence towards the northern corner of the proposed new area.	24º43'26.45"S 27º14'17.29"E	34.4	60	+25.6	28.4	50	+21.6	Daytime: - Normal background noise, caused by slight wind through the grass, wild animals, birds. Night-time: –Night-time sounds of crickets, frogs and other night time animals such as jackals. Slight wind blowing through the grass.
Position H: The top north corner of the proposed mine, adjacent of Plant 5 of the existing quarry.	24º43'15.78"S 27º13'21.81"E	38.2	60	+21.8	29.7	50	+20.3	Daytime: - Normal background noise, caused by slight wind through the grass, wild animals, birds. Closer to the production plant Night-time: –Night-time sounds of crickets, frogs and other night time animals such as jackals. Slight wind blowing through the grass. Closer to the production plant.
Position I: The bottom south-eastern corner of the proposed mine,	24º43'31.94"S 27º14'42.29"E	40.2	60	+19.8	31.7	50	+18.3	Daytime: - Normal background noise, caused by slight wind through the grass, wild animals, birds. Closer to the production plant

Measuring positions	Approximate co-ordinates	Ambient noise (dB(A))						Remarks
		Day-time Levels (outdoors)			Night-time Levels (outdoors)			
		Average Results	Typical Rating (SABS 0103) (Category D)	Excess ΔLReq,T (dBA)	Average Results	Typical Rating (SABS 0103) (Category D)	Excess ΔLReq,T (dBA)	
adjacent of Plant 5 of the existing quarry.								Night-time: –Night-time sounds of crickets, frogs and other night time animals such as jackals. Slight wind blowing through the grass. Closer to the production plant.

1.1.13 Visual aspects

The site is directly adjacent the R510 Road from Rustenburg to Ellisras (Lephalale). Mining activities of the current mine (RAM) are visible from the R510. There are also other mines in the area which impact on the visual aspect of the area.

1.1.14 Sensitive landscapes

Refer to Figure 30 for a sensitive landscape map. Sensitive landscapes include ecological sensitive areas, the Bushveld saffron, as well as heritage & cultural resources on and surrounding the site. The Tygerkloof Mining layout plan was adjusted to prevent damage to any of these sensitive features. A 50m buffer was included to remain outside of the high ecological sensitivity area, and 100m buffers around the Blue saffron identified on site as well as the drainage line. Tygerkloof Mining is allowed to mine under the Eskom power lines, but no overburden may be placed under these lines.

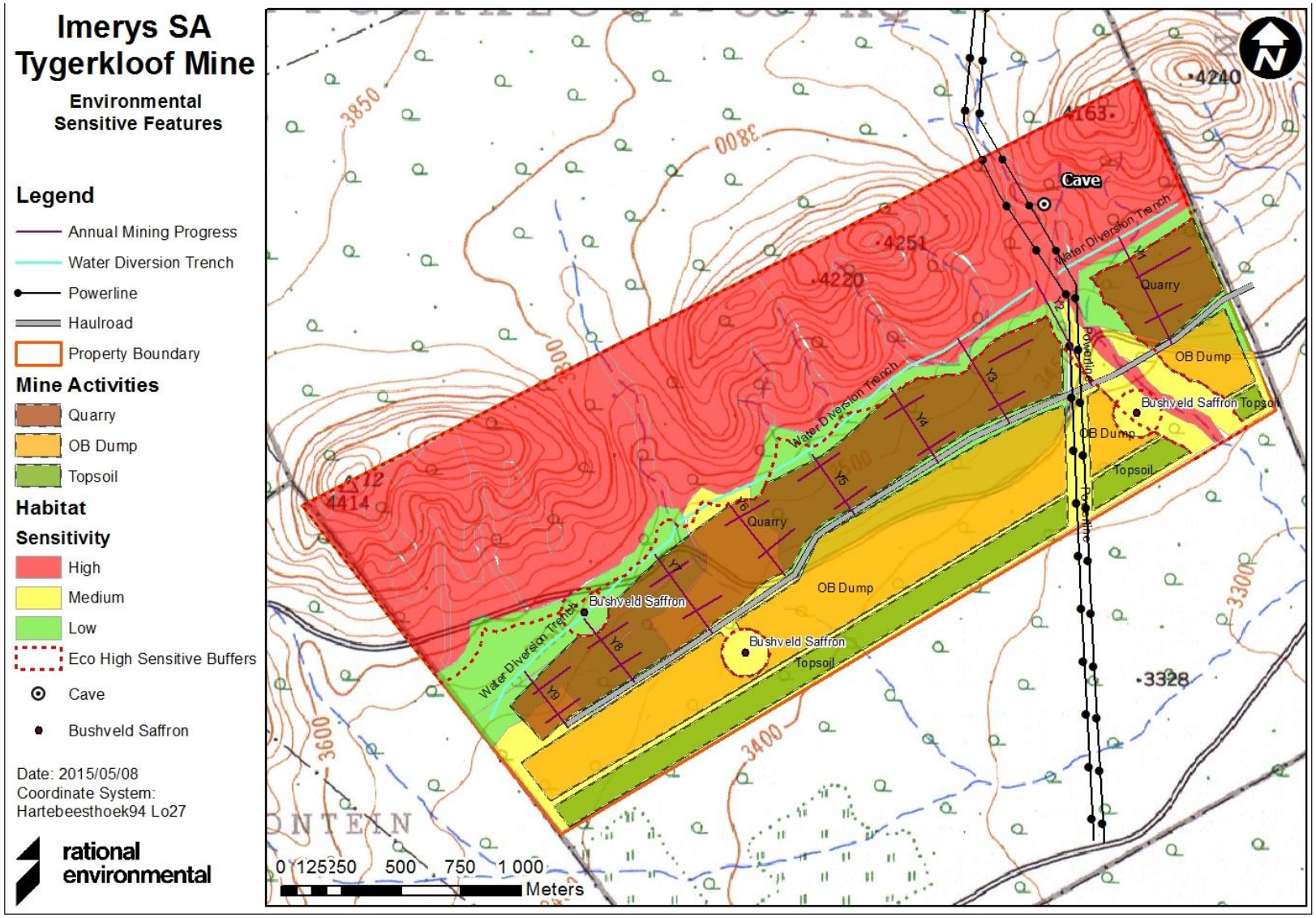


Figure 30: Map indicating environmental sensitive features

1.2 Concise description of each of the existing environmental aspects both on the site applied for and in the surrounding area which may require protection or remediation

All environmental aspects must be protected from the mine's impacts, however below is a list of important aspects to be protected:

- Soil quantity;
- Surrounding land capability;
- All natural vegetation and ecological sensitive areas;
- All animal life;
- Groundwater and surface water quality and quantity; and
- Air quality.

The potential significance of impacts on the above-mentioned environmental components has been rated in the risk assessment section.

1.3 Concise description of the specific land uses, cultural and heritage aspects and infrastructure on the site and neighbouring properties/farms in respect of which the potential exists for the socio-economic conditions of other parties to be affected by the proposed mining operation

1.3.1 Land use and existing infrastructure

Information for this section was obtained from the 'Soil Study Report' (Gudani Consulting, 2015).

The localities and extents of pre-mining land uses within the proposed quarry and overburden dump footprints are shown in Figure 5 (Gudani Consulting, 2015) and are summarised in Table 34.

Table 34: Pre-mining land uses – proposed open pit and overburden dump areas

Land Use Code	Pre-mining Land Use	Unit Count	Area (ha)	Area (%)
G	Grazing - formerly used for cattle, currently used for game farming	1	310.38	99.71
F	Farmstead	1	0.91	0.29
TOTAL		2	311.29	100.0

1.3.2 Cultural and heritage resources

Information for this section was obtained from the 'Phase I Cultural heritage resources impact assessment (African Heritage Consultants CC, 2015).

1.3.2.1 Background to the archaeological and history of the area

Resources, and in particular the mineral resources (Küsel 1998), in what is now known as the Thabazimbi region have been extensively utilised by prehistoric and historic groups. The greater region has several important Stone Age localities with deep occupation deposits and importantly, a widespread occurrence of open-air sites.

The shelter site of Olieboomspoort near Lephalale show a succession from the Earlier, Middle and Later Stone Ages (ESA, MSA and LSA) and up to historic times (van der Ryst 2006). Early Iron Age localities such as Diamant are particular important. At this locality in the western Waterberg the Early Iron Age facies of Diamant was first identified at the eponymous locality (Huffman 1990). This site has also delivered the earliest evidence for glass trade beads and domesticated dogs in the Limpopo Province (van der Ryst 2006).

The movement of African farmers into this region is documented by their ceramics and settlements (Huffman 2007b). The later occupations of agropastoralists groups are complex (Schapera 1942, 1965; Breutz 1953, 1989; Bergh 1998). The accounts of early travellers provide important data on the fauna, flora and inhabitants of the Waterberg. The observations of travellers, missionaries and hunters who traversed the region throughout the 18th and the 19th centuries constitute a source of implicit ethnography on the late presence of hunting and gathering groups, the African farmers and inmoving colonists (Baines 1872, 1877; Smith 1836; Schlömann 1896; Wallis [Baines] 1946; Burke [Mauch's journals] 1969). The region is also rich in rock art (Eastwood and Eastwood 2006).

Heritage resources

Huffman (2004, 2006a, 2007a, 2009a) in surveys for Rhino Minerals Andalusite Mine on the Farm Buffelsfontein 353 KQ recorded an Early Iron Age village on red colluvial/alluvial deposits and several grainbins. The LIA homesteads contained several burnt houses. He ascribed the burning to a severe drought (Huffman 2009b). He also noted MSA lithics but not of any significance. In a subsequent archaeological impact assessment (AIA) no settlements were recorded but isolated fragments of pottery and slag suggest a buried occupation (Huffman 2009a).

Van Schalkwyk (2007) in an assessment for cultural heritage resources on sections of the farms Amandelbult 383KQ and Elandsfontein 386KQ in the Thabazimbi District recorded surface MSA and LSA lithics. He also noted two possible EIA sites whereas most of the others that were identified are from the Late Iron Age/early Historical period, the latter features assigned Medium significance. A buffer zone is already in place following on previous recommendations on Iron Age remains within this general area (Van Schalkwyk 1994, 2001, 2003, 2004; Van Schalkwyk *et al*. 2004).

Coetzee (2008) in a report for the PPC expansion project recorded only a small Stone Age lithic scatter from the prehistoric period. However, 10 historical houses from the 1930s to 1940s have been documented as well as several graves. He provides a synthesis of the Stone Age and Iron Age (IA)

sequences. In the latter the different settlement phases of the Early Iron Age are defined, namely Happy Rest, Diamant and Eiland. The Late Iron Age (LIA) sequence is much more complex, with numerous groups moving into the region. The mainly stone-walled settlements are also more visible. Based on ethnographic accounts (Schapera 1942, 1965; Breutz 1953, 1989; Bergh 1998) he provides an overview of the ethnographic sequence of groups who occupied the region, such as the Bakgatla baga Kgafela, and the Batlokwa ba Kgosi and provides detail on the trust farms occupied. In the greater region Dreyer (2011) in an assessment for proposed chrome mining developments found no heritage remains at Hartbeestkopje 367KQ, Schilpadnest 385KQ and Moddergat 389KQ, in the Northam District but recorded historical material at Zwartkop 369KQ.

At Boikarabelo excavations of an extensive grainbin-site and surface collections of around 12 IA settlements demonstrated Tswana settlement sequences that include a probable early Moloko (probably Icon) facies and at least one site had been identified to the Letsibogo facies. The relative age of the sites were therefore inferred to range from the late 17th to late 18th centuries (Digby Wells Environmental 2011).

A heritage impact assessment (HIA) for the proposed development of the Kambaku Private School on the farm Vlakplaats 137 KQ yielded no evidence for heritage resources (Hutten 2012). Hutten (2013a, 2013b, 2013c) in several assessments for solar developments noted that there was an absence of heritage resources on the farms Liverpool and Aapiesdraai near Koedoeskop, whereas a historic structure, outside the developments, was recorded at Grootkuil. Coetzee (2014) in an assessment for the Marakele Park on the northern edge of the Waterberg Plateau similarly found no heritage resources. The area is some distance from Thabazimbi. However the Waterberg region abounds in heritage and archaeological resources and forms part of the broader study region.

Van Vollenhoven in an HIA for the proposed development of a limestone mine on Portion 1 of the farm Nooitgedacht 136 JQ, Portion 1 of the farm Buffelskraal 545 KQ and Portions 3, 4, 5, 6 and the Remainder of Krokodilkraal 545 KQ in the Thabazimbi District reported that no heritage resources have been identified and that the surveyed properties have been used for cattle farming and extensive agriculture. In a draft ESR for the proposed township on Portion 20 and 22 of the farm Theunispan 293 LQ, Portion 1-4 and a portion of the remainder of the Farm Grootdoorn 292 LQ, portion 3 of the Farm Steenbokpan 295 seven heritage sites of significance or value were identified within the area proposed for the development of the Steenbokpan Extension 3 Township. These comprise five informal cemeteries, all on portions of Grootdoorn and two historic structures of the Harmse family homestead (Ila 2014; PGS 2014).

In an extension of a mining licence for clay extraction on the farm Nooitgedacht 436 JR Portion 25 an informal cemetery with 15 graves was identified (African Heritage Consultants 2013). African Heritage Consultants (2011, 2014) in a Phase 1 AIA identified numerous stone-walled enclosures, a pre-

colonial mine, graves, and historic structures that include a weir and bridge at the Sondagsriver. A Phase 2 mitigation was recommended.

The ESR on heritage for Project Infinity Sishen Iron Ore Thabazimbi Mine (Shangoni Management Services 2013) noted that MSA lithics were present in an area with sheet erosion. The Mine has in the past encouraged research on the IA stone-walled enclosures on their property, and further research is supported. Mitigation of historical buildings, including the Du Randt Homestead, was also addressed. The proposed mining on Wachsteenbietjesdraai 350 KQ and Kwaggashoek 345 KQ is in close proximity from the Mostert Tunnel Cave south of Thabazimbi that has significant geological formations. Appropriate mitigation measures will be recommended (PGS 2012).

Gatkop Cave on the farm Randstephane 455 KQ ESE of Thabazimbi was also investigated. The locality lies within an area with rich iron ore deposits that are currently being explored by Aquila Resources in view of future extraction. It is an important heritage resource of high cultural significance that is still being used for ritual ceremonies and constitutes a contentious issue in view of the developments. This locality also has potentially high palaeontological heritage significance (Almond 2013). Madimatle Mountain at Donkerpoort 448 KQ and Gatkop Cave on Randstephane 455 KQ hold significant spiritual, ancestral and cultural heritage importance to the local community, local traditional healers, local traditional leaders, persons that practice and belong to certain African Christian denominations (van Vuuren 2014; SAHRA Statement of Significance, accessed SAHRIS 11 February 2015). Acting on the recommendations SAHRA has appointed an anthropologist who compiled a report on the significance of this locality (van Vuuren 2014). Mademathle/Mletse Mountain and the Gatkop caves described as the Remainder of the Farm Randstephne 455 KQ and the Remainder of the Farm Donkerpoort 448 KQ have now been nominated as a Provincial Heritage Site (SAHRA 2014; SAHRIS database accessed February 2015).

1.3.2.2 Description of the site

North western section

The north western section is thick sickle bush (*Dichrostachys cinerea*). The dense growth of sickle bush is an indication of over grazing and utilisation. In this area archaeological sites should be present but will only be found if the area is cleared of sickle bush. When the mine cleans the area for mining an archaeologist should be present to identify possible archaeological sites.

Eastern section

According to the farmer who uses the area for game farming, there is no heritage resource on the eastern part of the site. No heritage resource were observed.

West of the northern section – not on proposed footprint

Just west of the northern section of the development area is a large rock shelter. The floor of this shelter has a good archaeological deposit with Late Stone Age and Iron Age material present

(Madikwe Facies). At the roof of the shelter small stalactites' are forming. On the floor is a single very large stalagmite. See photographs and map on pages 22 & 25 (African Heritage Consultants CC, 2015).

North of the site – not on the proposed footprint

To the north of the development site on the farm Buffelsfontein 353 KQ is an ancient mine recorded by Küsel US (2003) at S24° 42' 40.5" & E27° 16' 00.9". At that stage Küsel informed SAHRA that the proposed mining activities would possibly damage the ancient mine. The mining company undertook to fence the area in and to install instruments to monitor shock waves from blasting. The entrance to the mine has collapsed probable because of blasting. Rainwater also now runs into the underground section of the ancient mine - see photographs below and maps on pages 22, 23 & 24 (African Heritage Consultants CC, 2015).

Roger Summons who has made a detail study of the ancient mining in Zimbabwe could find not a single complete mine as all the mines were destroyed by modern mining.

The ancient mine and surroundings were investigated by Prof Tom Huffman (2006) when the mine requested a second opinion after the author's original report. Huffman found a number of Early Sotho (Tswana) settlements at the foot of the mountain on Buffelsfontein and Tygerkloof as well as two iron smelting sites. He identified the pottery as Madikwe facies of the Moloko cluster. He had the sites dated which gave a date of 1485 -1615.

As far as the ancient mine is concerned he came to the conclusion that red ochre was mined. Unfortunately he did not investigate the mine itself. The author and his team entered the mine during our current visit and found no red ochre inside.

Huffman (2006) came to the conclusion that the settlements and the mine are interrelated. Huffman also suggested that the mine should be investigated. This is strongly supported as this mine is probably the most complete ancient mine in Southern Africa found up to date.

1.3.3 Regional socio-economic aspects

Information for this section was obtained from the 'Integrated Development Plan' (Thabazimbi Local Municipality, 2013), and 'Integrated Development Plan' (Waterberg District Municipality, 2013)

1.3.3.1 Demographics

Limpopo is the fifth most populated province at 5.4 million. Population increased in WDM from 604,936 in 2001 to 679,336 in 2011. Population increased in TLM from 65,533 in 2001 to 85,234 in 2011. Refer to Table 35 below for population, age and gender structure. The majority of population is aged below 35 years. TLM experienced fast population growth for the period between 2001 and 2011. Majority of population is age between 15 and 64 with males in the majority.

Table 35: Population, age and gender structure

Age structure						Gender ration		Population growth (% p.a.)	
<15		15-65		>65		Males per 100 females			
2001	2011	2001	2011	2001	2011	2001	2011	1996-2001	2001-2011
26.0	21.1	71.5	76.4	2.5	2.4	114.0	141.1	1.71	2.63

Source: Statssa, Census 2011

Refer to Table 36 below for population group and sex structure. According to these results, Blacks are in the majority, followed by whites. There are more male blacks than female blacks.

Table 36: Population group and sex structure

Population group	1996			2001			2011		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Blacks	29,984	17,15	46,999	28,935	24,940	53,875	42,773	29,072	71,845
Whites	6,415	5,886	12,281	5,810	5,540	11,350	6,420	5,889	12,309
Coloured	136	115	251	151	122	274	310	217	527
Indians/Asian	19	8	26	19	15	34	130	75	205
TOTAL	36,554	23,024	59,578	34,915	30,617	65,532	49,633	35,253	84,886

Source: Statssa, Census 2011

Refer to Table 37 below for the dependency ratio for 1996, 2001 and 2011. Dependency ratios provide insights in to the burden born by those who are in working age group (15 -64) years to support those aged 0 -14 and 65+ years. Dependency ratio has been declining over time.

Table 37: Dependency ratio for 1996, 2001 and 2011

	1996	2001	2011
0 - 14	14,451	17,062	18,014
15 - 64	42,225	46,835	65,153
65+	1,894	1,637	2,067
Dependency Ratio	38.7	39.9	30.8

Source: Statssa, Census 2011

Refer to Table 38 below for the distribution of the population aged between 5 and 24 years by school attendance, and sex for 1996, 2001 and 2011

Table 38: Distribution of the population aged between 5 and 24 years by school attendance, and sex for 1996, 2001and 2011

	1996			2001			2011		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
Attending	4,901	4,567	9,468	5,425	5,139	10,563	6,462	6,091	12,554
Not Attending	3,933	3,505	7,438	5,109	5,399	10,507	5,570	4,465	10,035
TOTAL	8,834	8,072	16,906	10,533	10,537	21,070	12,032	10,556	22,589

Source: Statssa, Census 2011

Refer to Table 39 below for the household demographics.

Table 39: Household demographics

Household		**Household dynamics**			
2001	2011	2001	2011	2001	2011
20,734	25,080	2.9	3.4	29.4	24.7

Source: Statssa, Census 2011

1.3.3.2 Basic services

Refer to Table 40 below for distribution of households using electricity for lighting, heating, cooking, Table 41 for distribution of households by access to piped water, Table 42 for distribution of households by type of refuse removal, and Table 43 for distribution of households by type of toilet facility

Table 40: Distribution of households using electricity for lighting, heating, cooking

Lighting			**Cooking**			**Heating**		
1996	2001	2011	1996	2001	2011	1996	2001	2011
7,819	10,039	19,269	6,664	7,985	18,332	6,668	8,010	17,062

Source: Statssa, Census 2011

Table 41: Distribution of households by access to piped water

Piped (tap) water inside dwelling yard			**Piped (tap) water on communal stand**			**No access to piped (tap) water**		
1996	2001	2011	1996	2001	2011	1996	2001	2011
9,521	11,782	17,863	1,686	8,705	5,668	3,603	247	1,550

Source: Statssa, Census 2011

Table 42: Distribution of households by type of refuse removal

Removed by local authority/ Private company			**Communal Refuse dump**			**No rubbish disposal**		
1996	2001	2011	1996	2001	2011	1996	2001	2011
5,788	7,727	15,609	8,189	10,844	7,756	627	2,164	1,381

Source: Statssa, Census 2011

Table 43: Distribution of households by type of toilet facility

Flush/ Chemical toilet			**Pit toilet**			**Bucket latrine**			**No toilets**		
1996	2001	2011	1996	2001	2011	1996	2001	2011	1996	2001	2011
7,563	9,796	17,211	5,307	5,630	5,51	67	88	189	1,877	5,220	1,585

Source: Statssa, Census 2011

TLM is designated as Water Services Authority and Water Service Provider. TLM has appointed Water lab for a period of 1 year for sampling on clear water quality monitoring. The challenge is that the Service provider withheld the test result due to Municipality cash flow problem. Water Services Development Plan and Draft Water and Sanitation Bulk Infrastructure are in place.

Thabazimbi, Regorogile and Northam currently have a quota of 9Ml per day from Magalies board. Regorogile and Thabazimbi have additional supply from seven boreholes. The boreholes are located at Group 5, 12 and TIOM. Rooiberg and Leeupoort/Raphuti currently source their water from local boreholes. Schilpadnest water is also supplied from three working boreholes without any chlorination facilities.

Thabazimbi and Regorogile are using water borne sewer system. The existing water treatment plant caters for Thabazimbi town including Regorogile and Ipelegeng. The current capacity of the plant is 28 litres per second but the average daily flow is about 60 litres per second. The current sanitation system in Northam is 60% water borne and 40% septic tank. Leeupoort is septic tank. The Municipality empties the septic tanks for all the residents regularly and discharges the sewerage into the existing oxidation pounds. The outfall sewer has been partially constructed in Northam and the project is still outstanding. The municipality does not provide bulk water to the mines within its area of jurisdiction

1.3.3.3 Employment and income

Refer to Table 44 for the labour market demographics, Table 45 for the distribution of the population aged between 15 and 64 years by employment status for 1996, 2001 and 2011, and Table 46 for households by monthly income category. Majority of household earn between R3,201 – R6,400.

Table 44: Labour market demographics

Unemployment rate		Labour market		Education age 20+				Matric	
		Youth Unemployment Rate 15 – 24 years		No Schooling		Higher Education			
2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
21.0	20.6	31.0	26.9	17.5	8.8	16.0	26.6	4.3	7.6

Source: Statssa, Census 2011

Table 45: Distribution of the population aged between 15 and 64 years by employment status for 1996, 2001 and 2011

Employed			Unemployed			Unemployed Rate		
1996	2001	2011	1996	2001	2011	1996	2001	2011
28,712	26,903	29,605	2,540	7,143	7,304	8.1	21.0	19.8

Source: Statssa, Census 2011

Table 46: Households by monthly income category

Income category	Household
No income	3,518
R1 – R400	686
R401 – R800	1,027
R801 – R1,600	3,165
R1,601 – R3,200	4,048
R3,201 – R6,400	5,021
R6,401 – R12,800	3,517
R12,801 – R25,600	2,474
R25,601 – R51,200	1,160
R51,201 – R102,400	313
R102,401 – R204,800	105
R204,801 or more	45

Source: Statssa, Census 2011

1.3.3.4 Settlement patterns

There are four urban settlements in TLM area:

- Thabazimbi/ Regorogile: Main hub of the Municipal area. It has a well-established business and industrial area with sizable residential developments. It provides the majority of services to the rest of the municipal area.
- Northam: The second largest town in the Thabazimbi Municipal area. It has a well-established business sector (albeit smaller than Thabazimbi) and caters for the residents of the Northam town, as well as for the wider faming and mining areas.
- Rooiberg: A small rural town that originated as a mining town. Today no more mining activities take place and the town is mostly inhabited by residents involved in local businesses, which is primarily tourist and property related, as well as by retired citizens. A Low Cost Housing project

has been approved by the former Department of Housing and provision was made for ± 200 new houses. The farms that are located in and around Rooiberg also accommodate farm workers.

- Dwaalboom: A small town also referred to a mining town with the focal point being the PPC mine. Dwaalboom residents reside in the surrounding farm areas or in PPC houses. It has a various supporting social and business amenities. Thabazimbi provides key specialised services. The farms that are located in and around Dwaalboom also accommodate farm workers.

Other predominantly rural settlements in the Thabazimbi Municipal area are; Leeupoort, Kromdraai, Koedoeskop, Makoppa and Sentrum. These smaller settlements are mostly rural residential in character with ancillary small-scale businesses. (Rural areas are defined as: the sparsely populated areas in which people farm or depend on natural resources, including the villages and small towns that are dispersed through these areas. (Rural Development Framework, 1997)):

- Leeupoort (including Raphuti Stad): so-called “Holiday Township”, but proclaimed as a formal public township. It has specific eco-life style natural living areas. The township is characterised by gravel roads, borehole water, septic tanks with limited boundary fences around dwelling houses and game is roaming freely within the confines of Leeupoort. In respect of Raphuti (a.k.a. Leeupoort Vakansiedorp Extension 7) 100 government subsidies have been approved by the Department of Health but no houses have yet been built.
- Kromdraai: A grouping of “agricultural holdings” and has a distinct rural character. Some businesses, guest houses and lodges are found in this settlement but residents are dependent on Thabazimbi or Bela-Bela for primary services. There are a number of farm workers working and staying in this area.
- Koedoeskop: A small rural settlement with a small number of residents. It provides a low level commercial service to the farming community in the area. The surrounding area is mostly agricultural and utilised for irrigation farming. There are a number of farm workers working and staying in this area.
- Makoppa: This settlement is characterised as a typical farming community with predominant agricultural land uses including a large number of game farms. It provides a low level commercial service to the farming community in the area. There are a number of farm workers working and staying in this area.
- Sentrum: This settlement is a small-scale rural settlement with a small number of residents. It is totally dependent on Thabazimbi for basic and primary services. The area is mostly known for game and cattle farming. There are a number of farm workers working and staying in this area.

Thabazimbi is characterised by a number of informal settlements. The following table describe the various informal settlements:

- Schilpadnest “Smash block”: Located close to Amandelbult (mine area). Settlement is reaching alarming proportions as no formal infrastructure service are in place. Many efforts have been made by in the past by different authorities to resettle the people or to formalise the area for residential purposes but without success.

- Jabulani: Located close to Northam Platinum Mines on the farm Elandskuil. No infrastructure services. Municipality supply's water by truck. The settlement is growing on a constant basis. Inhabitants are most likely local mine workers and farm workers from the nearby farms.
- Rooiberg: Located south-east of Rooiberg Town. Land is affected by undermining and the Municipality should as a matter of urgency relocate the people staying here. The DMR has already notified the Municipality in writing that it is not safe for people to stay on this property.
- Raphuti village: Located at Leeupoort Township. A formal township application has already been launched, i.e. Leeupoort Vakansiedorp Extension 7 to formalise this area, but proclamation has been drawn out for a number of years. The Provincial Government granted 100 subsidies in favour of this project but no houses have yet been built.
- Donkerpoort Informal: Thabazimbi: Located in Thabazimbi on a part of the Remainder of the farm Donkerpoort 344 KQ, on entering Thabazimbi Town. This settlement is close to a stormwater channel running from Regorogile which could pose danger during high floods and rainy seasons.
- Regorogile Informal: Located in Regorogile Extension 3 & on parts of the farm Rosseauspoort 319-KQ and Apiesdoorn, 316-KQ. This settlement is partly located within an ESKOM servitude area and should be relocated. The remaining area could be formalised into a proper residential township.
- Dwaalboom Informal: Located in the Dwaalboom area on Portion 7 of the farm Dwaalboom, 217-KP. Approx. 10 new units have also been built on Portion 3, Dwaalboom, 217-KQ, and all southwest of the Road D2707.
- Skierlik: Located on the farm Groenvley, 87-KQ in Sentrum next to a school property owned by the Department of Public Works. No infrastructure services. The settlement is growing on a constant basis. Inhabitants are most likely people that were retrenched from nearby farms and other homeless people in the area.
- Northam Illegal Occupants: In Northam Extension 7 people are illegally occupying the houses in this township area.

Another informal settlement affecting Thabazimbi, although it is not situated within the Thabazimbi borders is Thulamashwana. This settlement is on the border between Limpopo and North-West Province on the Anglo mining land. Anglo wishes to relocate these people into Thabazimbi Municipality to a location that is more suitable. For this reason Thulamashwana will be highlighted in the Thabazimbi Housing Strategy. Various formal Mining settlements are also found within the municipal area, i.e. Setaria, Swartklip and Amandelbult.

1.3.3.5 Local economic development

The WDM is one of the major mining regions within South Africa of which platinum, iron ore, coal and diamonds are mined. The District is also home to a world renowned Biosphere Reserve. The Waterberg Biosphere reserve is an area of 414,000ha and includes various ingenious fauna and flora. The fertile soil has also lead to a competitive advantage in the agricultural sector and opportunities within this sector still needs to be used to its full potential. The area has variety of natural resources

has the potential to create countless opportunities for the local population to encourage entrepreneurship and economic development.

The Limpopo Employment Growth and Development Strategy identifies the Waterberg District within the meat production, coal, energy and petrochemicals, platinum, tourism cluster. Depicting the local economy of the municipal area based on the local economic development (LED) Strategy of the municipality, the Waterberg has both comparative and competitive advantages in agriculture, mining and tourism. The tourism comparative advantage is almost evenly distributed in all the six local municipalities.

Mining:

The mining industry in the municipal area contributes to the economic development of the District and Province. Waterberg area is the largest production area of platinum in the Province. Mining of coal and petroleum development in Lephalale has increased demand for the commodity for electricity generation. The coal resource in the Waterberg field is estimated at 76 billion tons, which is more than 40% of the national coal reserve. There is also mining of cement and iron in the municipal area.

The Waterberg area host 70% platinum reserves in Limpopo Province followed by the Sekhukhune District. The platinum mining activity is found in Mokgalakwena and Thabazimbi.

Amandabult and Union section in Thabazimbi have 130 million tons of proven ore reserves between them and the current mining rate is approximately 6 million tons per year between them. Potgieterus Platinum has proven reserves of 280 million tons and its current extraction rate is 57 million tons per year. The municipal area still has the potential of expanding mining activities; currently PPRust Mine is to further expand production to an additional 230,000 ounce of platinum. The TIOM in Thabazimbi is reaching its lifespan while the existence of the town is dominated by mining activities and government services.

The construction of Medupi Power station, the expansion of Grootegeluk and petrochemical production facility will require expansion of accommodation both the mix of single and family units in Lephalale and adjacent municipalities. The development has an impact also on municipal services; including infrastructure and social services.

Agriculture:

Waterberg District contributes almost 30% of the Limpopo Province agricultural activity, agriculture contributes over 4% of the District GGP and it employs around 21% of the labour force of the District. Although named the Waterberg the district is actually classified as a semi-arid area with poor water resources. For crop farmers there have been dramatic changes in many commodity prices leading to changes in cropping patterns. Crops such as cotton, tobacco, maize and sorghum have been badly affected by low international prices and over production and plantings have been reduced

significantly, often with negative financial and employment implications. Alternative crops like sunflower, wheat, soya beans, groundnuts and paprika are all internationally traded commodities and thus sensitive to the rand/dollar exchange rate.

These crops therefore are limited substitutes. Lucerne appears to have some potential, especially with the movement towards game ranching, although demand is sensitive to seasonal conditions. Potato production also has some potential although entry is constrained by high input costs. In general there is little cropping that takes place without some form of irrigation. With demand on water resources increasing consistently crop farmers are going to have to examine their returns on the use of water in future.

The cattle and game industry is undergoing significant transformation. Lead by water constraints, areas previously under dry land and irrigation are being consolidated and converted for extensive livestock production. Similarly other former cultivated land and livestock grazing is being converted to game ranching and eco-tourism. Even within the game ranching industry owners are diversifying into lodges and eco-tourism. This general trend has been encouraged by the establishment and development of the Waterberg Biosphere. This trend is expected to continue.

Tourism:

The Waterberg District host internationally renowned tourist attractions that can be used as draw cards to attract more tourists in the area:

- Waterberg Biosphere Reserve- received its international status in March 2001 and now forms part of the World Network of biosphere reserves, registered with UNESCO. The Waterberg Biosphere Reserve is the first " savannah" biosphere reserve registered in Southern Africa;
- The Makapan Valley World Heritage Site - is a site for one of the most dramatic incidents in the long and fascinating local history near Mokopane town in the Mogalakwena Local municipality. This cooking pot reached a boiling point between the Voortrekkers and the local Ndebeles. The Voortrekkers, which by the 1850s were already well established as far as Schoemansdal near Soutpansberg, used the local area as a thoroughfare. The Makapan Valley was declared as one of the first National Heritage Sites of the new united nation-an act supported by all local communities. In fact, current Chief Mokopane made contributions towards the development of the site as a cultural shrine and tourism icon. The application for the World Heritage Status has been approved by UNESCO.
- Nylsvley Wetland- is a registered Ramsar site (Ramsar is the international convention for the protection of wetlands). More than 400 bird species have been recorded on the 16 000ha wetland extending some 70km between the towns of Modimolle and Mokopane. The heart of the Nylsvley wetland is in the Nylsvley Nature Reserve with five modern bird hides providing perfect view and photo opportunities.
- Marakele National Park – located in the northeast of Thabazimbi, this park is undoubtedly one of the greatest wilderness areas of South Africa. The park has become a „place of sanctuary" for an

impressive variety of wildlife due to its location in the transitional zone between the dry wester and moister eastern regions of South Africa.

- Hot Spring Water- the strong mineral springs with a flow of 220,000l of water per hour with a temperature of 52 degrees Celsius gave rise to the establishment of Bela-Bela (Warmbaths). The town`s progress was to a large extent due to the hot water and their healing qualities. The water from the springs is rich with NaCl, calcium-carbonate and other salts are, amongst others, beneficial to persons suffering from rheumatic ailments. About 400 000 people visit the beautiful swimming baths of the springs annually, mainly during winter months when the climate is pleasant.

1.4 Annotated map showing the spatial locality and aerial extent of all environmental, cultural/heritage, infrastructure and land use features identified on site and on the neighbouring properties and farms

Refer to Figure 30 for an annotated map showing the spatial locality and aerial extent of all environmental, cultural/heritage, infrastructure and land use features identified on site and on the neighbouring properties and farms.

1.5 Confirmation that supporting documents in the form of specialist studies are attached as appendices

Refer to addendum 3 (specialist studies) for all specialist studies attached to this EMP.

2. The proposed mining operation

2.1 The mineral to be mined

Tygerkloof Mining will recover andalusite (aluminum silicate) from an andalusite-bearing alumina-rich shale band at the base of an ironstone ridge, in the foothills of the Witfontein Mountain Range.

2.2 The mining method to be employed

2.2.1 Description of the existing mine

2.2.1.1 Locality of existing mine and property description

The existing mine (RAM) is located on Portion 1 and the Remaining Extent of the farm Buffelsfontein 353 KQ, and Portion 3 of the farm Grootfontein 352 KQ. RAM is located on the south-eastern slope of the foothills of the Witfonteinrand Mountain Range and is situated approximately 109km from Rustenburg and 15km south-west of Thabazimbi Town. RAM is linked to the R510 Road via a dirt road which leads to Makoppa. Refer to Figure 31 for a locality of the already existing mine.

2.2.1.2 Description of existing activities

The ore body is being mined by means of open quarry methods. Mining activity is currently taking place at Quarry 9. Quarries 1 to 5 have been mined out and are currently being used for disposal of

fine tailings, with future rehabilitation in mind. Area 6 (future quarry 6) will not be opened as a result of extensive faulting and weathering of the mother rock in this area. Quarries 7 and 8 is mined out, and currently being filled with tailings. Quarry 9 is the current active quarry. If blasting is needed the area is drilled to a depth of 10m. This is carried out using a self-propelled pneumatic percussion drill. 115mmØ holes are drilled in softer ore on a 4m x 4m pattern. In hard ore 115mmØ holes are also drilled to a 3.5m x 3.5m pattern. The holes are charged with explosives. The explosive is HEF 100 re-pumpable emulsion. This is used with 12m Nonel EZ Dets, 1 x 150g Pentolite booster per hole, connected by 4m trunk lines. A single 6-D detonator and 1.2 m safety fuse initiate the blast. Topsoil is loaded by back-actors onto trucks that, in turn dump the topsoil at the designated topsoil dump. The remaining overburden is removed along with “contact” ore (weathered ore) to designated waste (overburden) dumps. The overburden is dumped within 1km of each quarry on the opposite of the haul road. The dumps vary in size depending on the depth mined as well as the quality of ore found in the quarry and the topography of the area. Any in-quarry waste or low-grade ore is also removed to these dumps. Dust is suppressed by using potable water at a rate of 2,000l per shift. Ore is extracted by means of back-actors. Benches are typically 5m wide and 10m high. Similar technology Trucks used to haul ore are Bell B40D ADT. Primary waste is removed by 10m³ tipper trucks. The Hitachi 650 excavators are applied for loading and offloading operations. Bell 2208 and Bell 1706 loaders are applied in the operation as loaders.

There are eight overburden dumps on the site. The overburden was dumped within 1km of each quarry on the opposite of the haul road. Dumps vary in size depending on the depth that was mined as well as the quality of ore found in the quarry and the topography of the area. There are 5 WRDs located on site. These WRDs consist of coarse rock that does not contain any andalusite constituents and was removed during the processing of ore. The WRDs are concentrated in close proximity to the processing plants. One primary WRD is located opposite Quarry 9. Depending on quality, this WRD may be reworked in the future. There are three old tailings dams that are no longer in use. All new tailings are directly backfilled.

Processing of the ore may be divided into three main stages as outlined below:

Crushing and screening

The Run of Mine ore is screened prior to crushing and the majority of material, owing to its friability is passed as undersize which bypasses the crusher. The screen oversize is crushed after which it passes into the washing plant together with the undersize. The de-sliming process upgrades andalusite content in comparison to the Run of Mine concentration of between 4.5 to 30%.

Heavy Medium Separation

Cyclones are used in conjunction with a ferrosilicon medium. Density control is automated in order to keep tight control of the critical density required for andalusite separation.

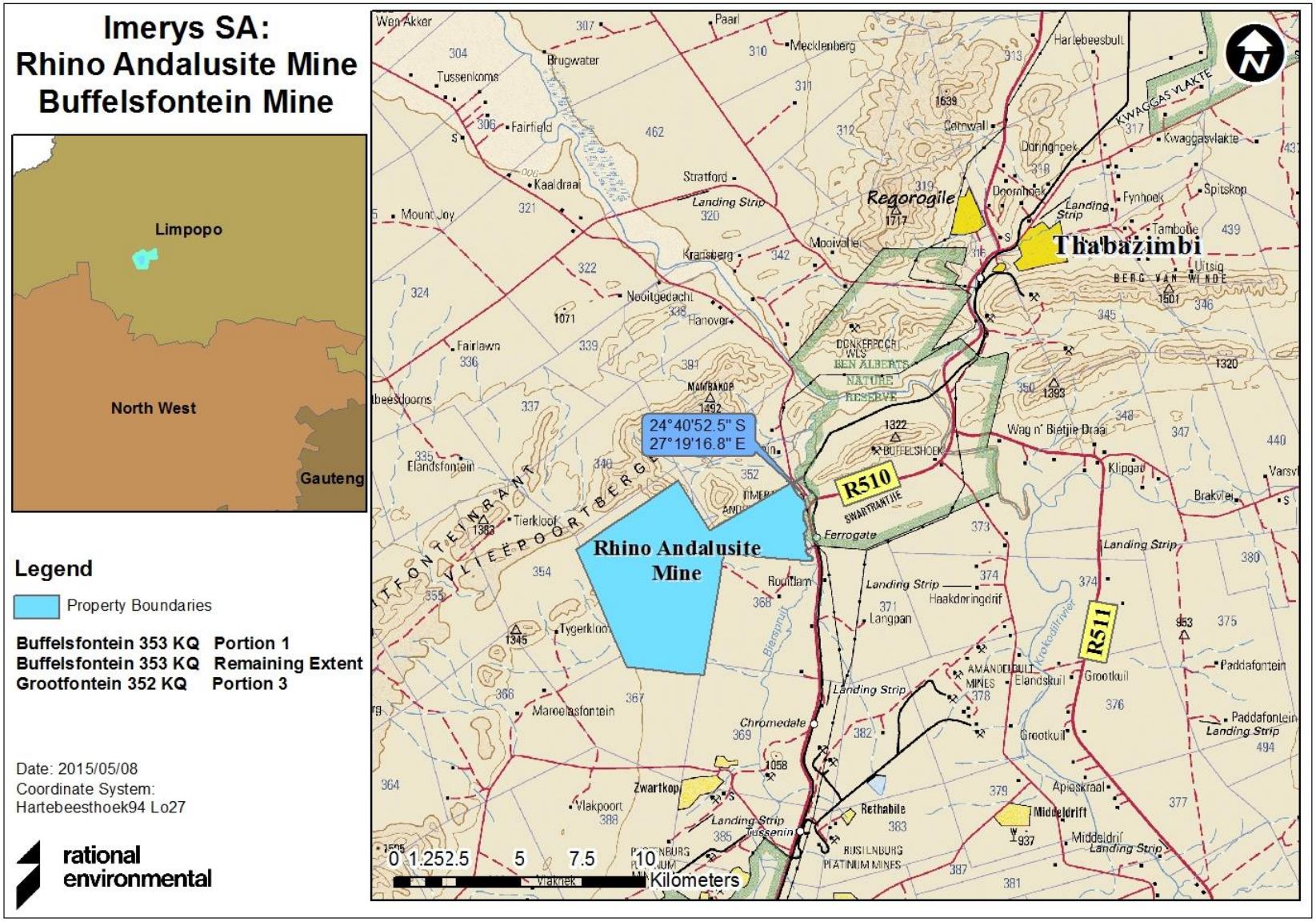


Figure 31: Locality map of already existing RAM (map attached as Addendum 1B) taken from Shangoni Management Services, 2011

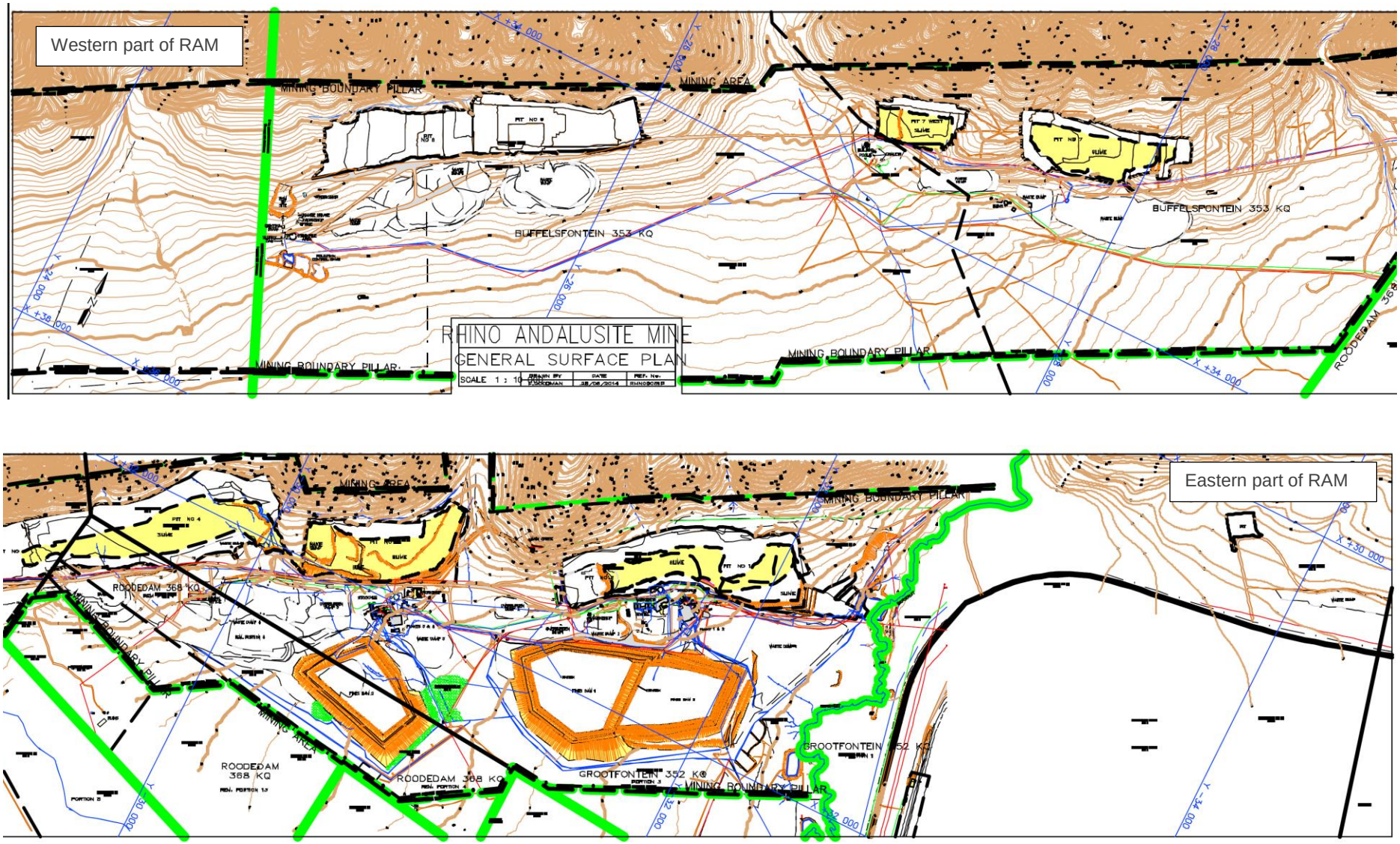


Figure 32: Site layout plan of already existing RAM, this plan has been divided into two parts for easier interpretation (plan attached as Addendum 1D)

Drying and magnetic separation

A rotary drier is used to dry the andalusite, which is then screened into various size grades. The different size fractions are then passed over magnetic rollers to remove iron-rich impurities. Process water from the plants are recycled and stored in three worked out quarries. Existing buildings include workshops, store rooms and mining buildings. No explosives are stored on the mine. The mine has various internal dirt roads as well as one haul road used to transport material from the open quarries.

2.2.2 Description of the proposed new mine

2.2.2.1 Locality of proposed new mine and property description

The proposed location of Tygerkloof Mining is on portion 5 of the farm Tygerkloof 354 KQ. This site is adjacent, to the west of the already existing RAM. This mine is linked to the R510 Road via the dirt road adjacent to RAM, which leads to Makoppa. Portion 5 of the farm Tygerkloof 354 KQ is approximately 594ha in size. Refer to Figure 33 for a locality map of the proposed new mine. The approximate coordinates of the proposed mine are as follow:

24˚ 43' 35"S; 27˚ 13' 58"E

The proposed mine will be located south, of the south-eastern slope of the foothills of the Witfonteinrand Mountain.

2.2.2.2 Description and design of proposed new activities

The proposed new activities include the mining of andalusite in an open quarry over a timeframe of 10 years. The mining method used is open cast rip and doze operation. Topsoil is loaded by back-actor and dumped at the designated topsoil dump. The remaining overburden is removed along with “contact” ore (weathered ore) to designated waste dumps. Any in-quarry waste or low-grade ore is also removed to these dumps. Drilling is carried out using a self-propelled pneumatic percussion drill. 102mm Ø holes are drilled in softer ore on a 4m X 4m pattern. In hard ore 102mm Ø holes are also drilled to a 3.5m X 3.5m pattern. All holes are drilled to a depth of 10m. Dust is suppressed by making use of air cyclones on the drill-rig. Hydraulic back-actors with 4.1m3 and 5m3 buckets load onto dump trucks for hauling and dumping at the process plant. Benches are typically 5m wide and 10m high. The quarry will be approximately 115.9ha. Overburden from the mining operations will be stored adjacent to the quarry on the southern side of the open quarry. The overburden will cover and area of approximately 142.2ha. This overburden will be backfilled into the quarry as part of concurrent rehabilitation, commencing after 2018. The already existing haul road from RAM will be extended at a width of approximately 12m, and a length of 3.5km, adjacent to the quarry, between the open quarry and the overburden. No new buildings or any other associated infrastructure will be constructed. All processing activities will take place on the already existing RAM site.

The initial design for the proposed Tygerkloof Mining is illustrated in Figure 34. In the event of any changes in designs, it will be incorporated into the EIAR, however, this is not envisaged.

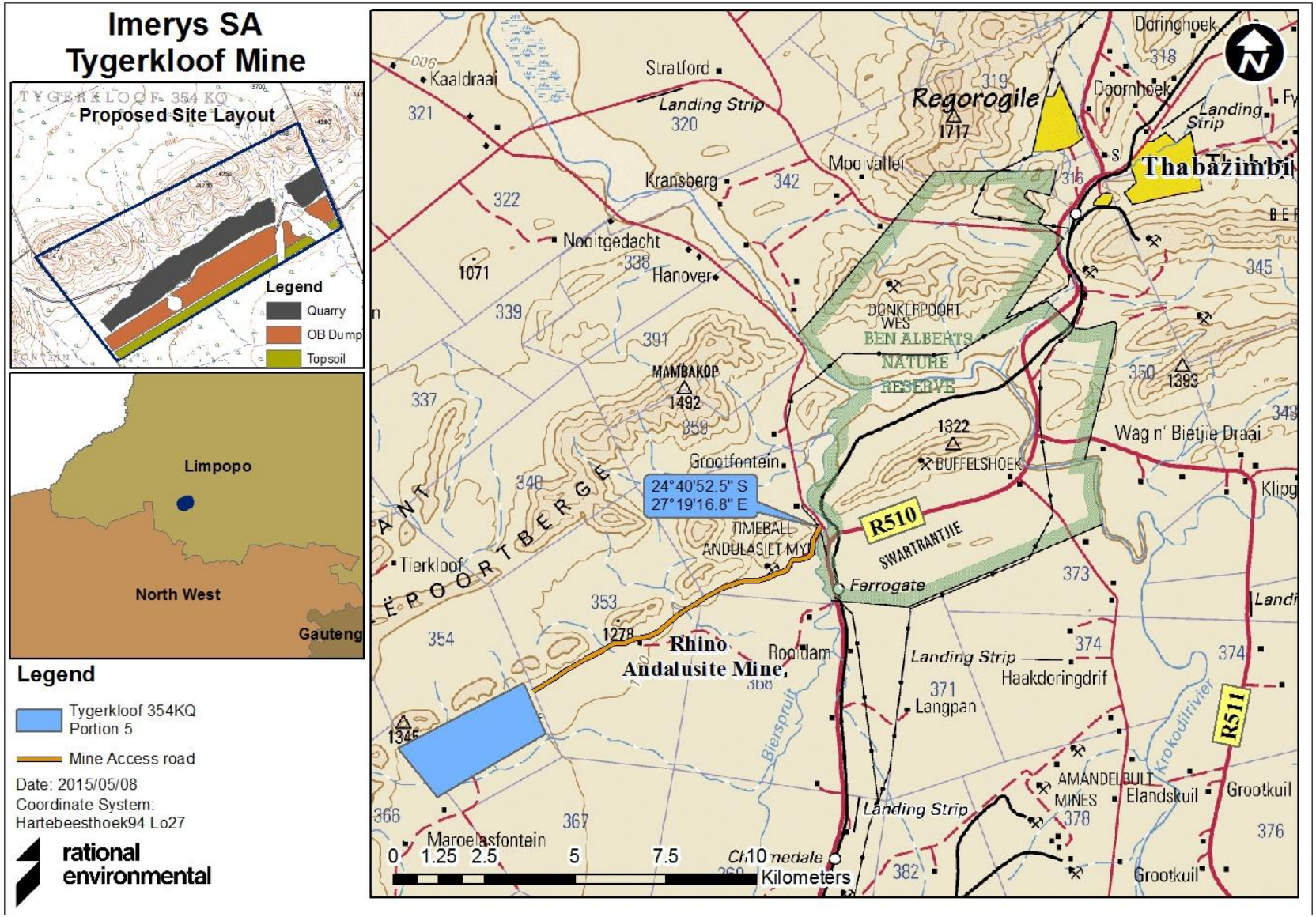


Figure 33: Locality map of Tygerkloof Mining (map attached as Addendum 1A)

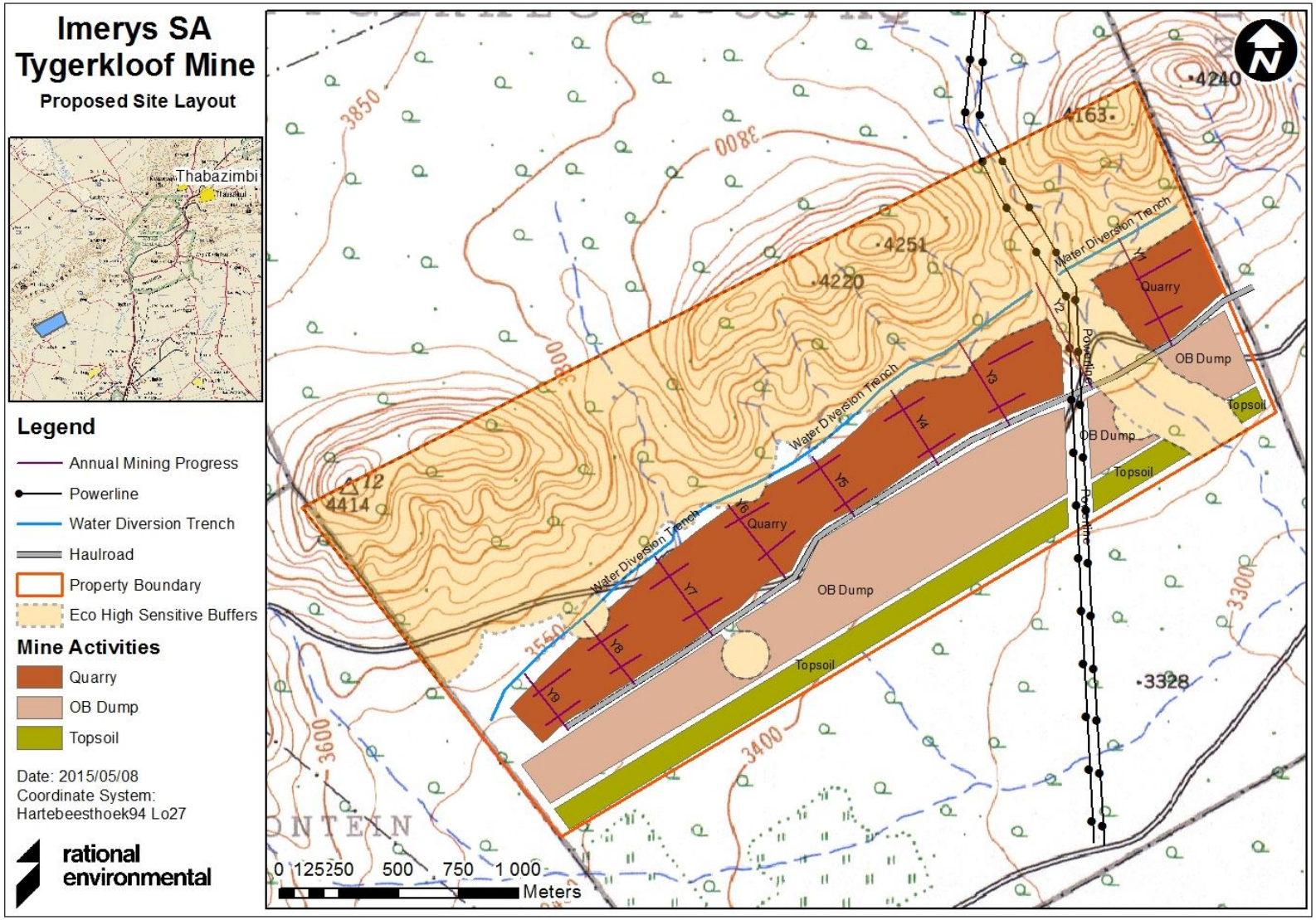


Figure 34: Site layout plan for Tygerkloof Mining (plan attached as Addendum 1C). The plan will be amended to adjust quarries 1-5, however, this will not influence the layout or any other features.

2.2.3 Reserves and resources

The drilling pattern for the different resource classes are as follows:

Inferred: 100mx200m

Indicated: 50mx100m

Measured: 50mx50m

Only measured resources with mining layouts, production plans and where the material have been proved economical by beneficiating material from drilling campaigns are seen as proven reserves. Figure 35 indicates the areas with the borehole localities and resource and reserve classification areas for Tygerkloof.

2.2.4 Planned production rate

The forecasted production is based on 70Kt of andalusite product per annum.

2.2.5 Planned life of mine

Based on the current levels of reserves, operations on the farm Tygerkloof are expected to continue at current production rates until the year 2030.

2.3 List of the main mining actions, activities, or processes, such as, but not limited to, access roads, shafts, pits, workshops and stores, processing plant, residue deposition sites, topsoil storage sites, stockpiles, waste dumps, access roads dams, and any other basic mine design features

Refer to Paragraph 2.2.2 of Section 1 (EIA) above for a complete description of the mining activities and associated activities.

2.4 Plan showing the location and aerial extent of the aforesaid main mining actions, activities, or processes as required to calculate the financial provision in accordance with the Department's published guideline. (Reg. 51 (b) (v))

Refer to Figure 34 above for the site layout plan.

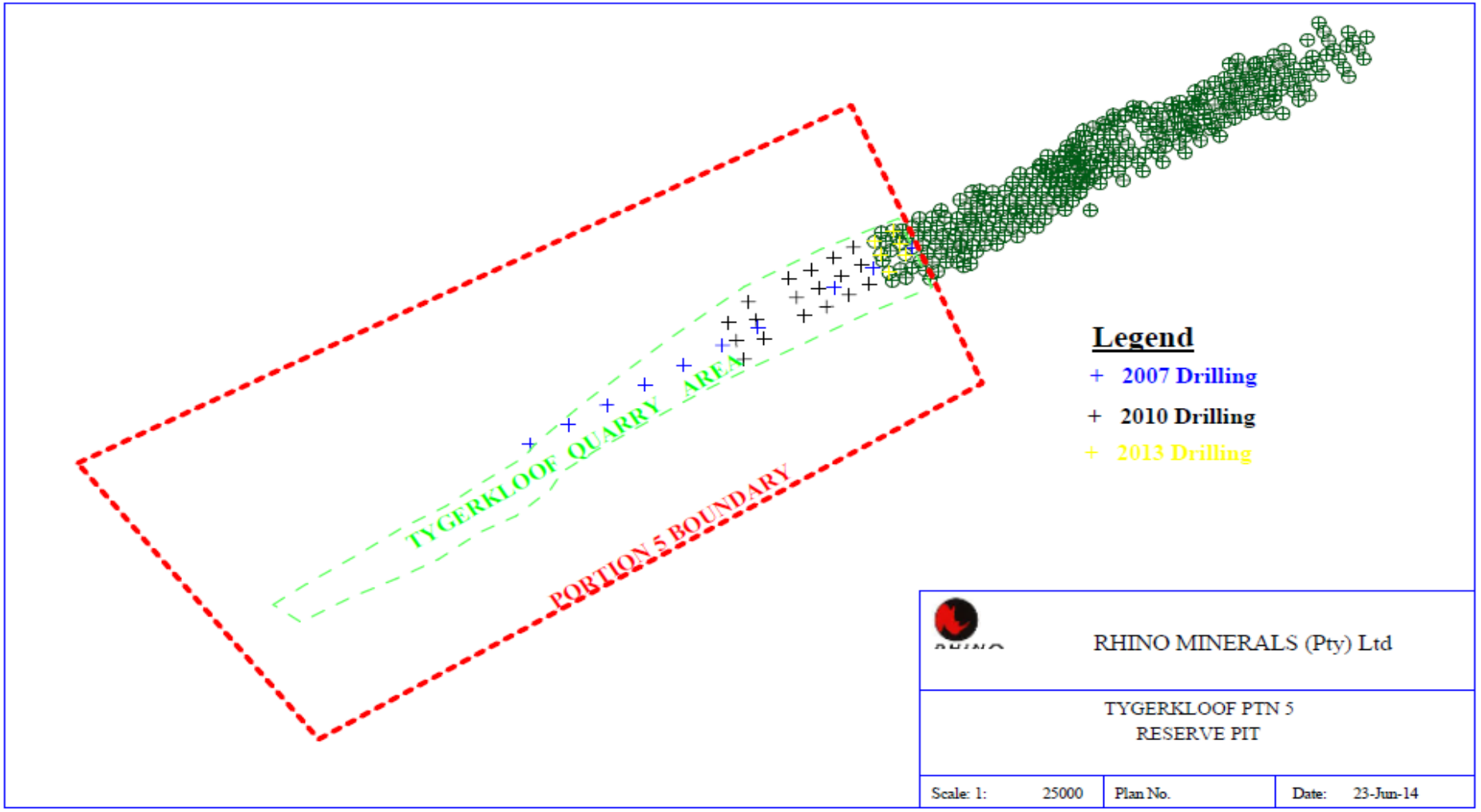


Figure 35: Borehole localities on Tygerkloof 354KQ. The GREEN block indicates the reserves of Tygerkloof 354KQ

2.5 Listed activities (in terms of the NEMA EIA regulations) which will be occurring within the proposed project

Refer below for Table 47 below, indicating the listed activities in terms of the NEMA which are being applied for, as well as the relevant government notice (GN) and a description of the activity.

Table 47: Listed activities in terms of the NEMA which are being applied for

Relevant notice	Activity No	Activity	Description
GN R. 544, 18 June 2010	26	Any process or activity identified in terms of section 53(1) of the National Environmental Management: Biodiversity Act, No 10 of 2004 (NEMBA).	Activities 12, 13, 14 & 19 under GN 546 are triggered.
GN R. 544, 18 June 2010	47	The widening of a road by more than 6m, or the lengthening of a road by more than 1km (ii) where no reserve exists, where the existing road is wider than 8m excluding widening or lengthening occurring inside urban areas.	The haul road will be extended approximately 3.5km. This road has a width of 12m.
GN R. 545, 18 June 2010	5	The construction of facilities or infrastructure for any process or activity which requires a permit or license in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent and which is not identified in GN 544 of 2010 or included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, No 59 of 2008 (NEMWA) in which case that Act will apply.	Overburden from the mining operations will be stored adjacent to the quarry. This will trigger a section 21g WULA under the NWA.
GN R. 546, 18 June 2010	12	The clearance of an area of 300m² or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation. (b) In Free State, Limpopo and Mpumalanga provinces: (iv) Outside urban areas, in: (ee) Critical biodiversity areas (CBAs) as identified in systematic biodiversity plans adopted by the CA or in bioregional plans	The quarries will be extended over a period of ten years and will be concurrently backfilled and rehabilitated. The total area of disturbance will be 115.9ha for the quarries. A total area of 142.2ha overburden will be temporarily stored adjacent to the quarries. This will also be concurrently backfilled.
GN R. 546, 18 June 2010	13	The clearance of an area of 1ha or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation, except where such removal of vegetation is required for:	The quarries will be extended over a period of ten years and will be concurrently backfilled and rehabilitated. The total area of disturbance will be 115.9ha for the

Relevant notice	Activity No	Activity	Description
		(1) the undertaking of a process or activity included in the list of waste management activities published in terms of section 19 of the NEMWA, in which case the activity is regarded to be excluded from this list. (2) the undertaking of a linear activity falling below the thresholds mentioned in Listing Notice 1 in terms of GN 544 of 2010 (a) CBAs and ecological support areas as identified in systematic biodiversity plans adopted by the CA.	quarries. A total area of 142.2ha overburden will be temporarily stored adjacent to the quarries. This will also be concurrently backfilled.
GN R. 546, 18 June 2010	14	The clearance of an area of 5ha or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation, except where such removal of vegetation is required for: (1) purposes of agriculture or afforestation inside areas identified in spatial instruments adopted by the CA for agriculture or afforestation purposes; (2) the undertaking of a process or activity included in the list of waste management activities published in terms of section 19 of the NEMWA in which case the activity is regarded to be excluded from this list; (3) the undertaking of a linear activity falling below the thresholds in Notice 544 of 2010. (a) In Eastern Cape, Free State, KwaZulu-Natal, Gauteng, Limpopo, Mpumalanga, Northern Cape, Northwest and Western Cape: (i). All areas outside urban areas.	The quarries will be extended over a period of ten years and will be concurrently backfilled and rehabilitated. The total area of disturbance will be 115.9ha for the quarries. A total area of 142.2ha overburden will be temporarily stored adjacent to the quarries. This will also be concurrently backfilled.
GN R. 546, 18 June 2010	19	The widening of a road by more than 4m, or the lengthening of a road by more than 1km. (a) In Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga and Northern Cape provinces: (ii) Outside urban areas, in: (ee) CBAs as identified in systematic biodiversity plans adopted by the CA or in bioregional plans.	The road will be extended with approximately 3.5km at a width of 12m.

2.6 Indication of the phases (construction, operational, decommissioning) and estimated time frames in relation to the implementation of these actions, activities or processes and infrastructure

2.6.1 Implementation

The current mine operation at Rhino Andalusite Mine have been operating for over 25 years. Tygerkloof is the western point of the ore-body. Therefore no start-up capital will be required as the mining and beneficiation will be done with the current infrastructure available at Rhino Andalusite Mine. As soon as the mining right is approved access roads and other required infrastructure will be put into place as required on operational costs.

2.6.2 Operational phase

The forecasted production is based on 70Kt of andalusite product per annum. The production rate is based on half the current plant capacity at Rhino Andalusite Mine. The plant capacity was designed on andalusite sales forecast drawn-up in the past.

2.6.3 Decommissioning phase

Based on the current levels of reserves, operations on the farm Tygerkloof are expected to continue at current production rates until the year 2030. The plant and mine will only be decommissioned in 2034, which is the current life-of-mine for Rhino Andalusite. If the resources available on Tygerkloof are viable the mining right will be extended as and when required.

2.6.4 Estimated life of mine

Assuming an 'average' (may differ from year to year due to in situ grades and yield variations) consumption of 70Kt andalusite per annum until the current reserve runs out, the expected life of mine is 15 years (this timeline excludes the possible future transfer from resources to reserves).

2.7 Confirmation if any other relevant information is attached as appendices

Refer to addendum 3 (specialist studies) for all specialist studies attached to this EMP.

3. The potential impacts

3.1 List of the potential impacts, on environmental aspects separately in respect of each of the aforesaid main mining actions, activities, processes, and activities listed in the NEMA EIA regulations (include all the items to be included in the list referred to in the concomitant section of the guideline posted on the official website of the Department)

Refer to Paragraph 7 of Section 1 (EIA) for a complete risk assessment which includes all impacts. Below is a summary of the key findings of the environmental impact assessment.

3.1.1 Soil, land use and land capability

The impact on soil, land capability, and land use is inevitable. Some management measures can be implemented to reduce the impact, however, the focus is on adequate rehabilitation measures to mitigate these impacts.

3.1.2 Ecological

The impact on loss and clearing of vegetation communities and loss of floristic diversity, which goes hand in hand with fauna displacement, are high, but can be managed if the correct buffer zones are implemented. The location alternative for overburden placement is north of the quarry, thereby overlapping with sensitive mountain Bushveld and should be avoided. Areas with *low ecological value* is considered to be more feasible for the proposed activities although the standard mitigation measures as listed above are applicable. Areas with *medium ecological sensitivity* is likewise feasible, although on condition that a functional open space network/corridor be set aside to provide *in situ* protection of near threatened tree taxa and aged (or significant clusters) of protected trees. A pre-construction screening (or "walk-through") of the habitat is recommended to identify areas with floristic taxa of 'conservation concern' (e.g. near threatened taxa) and to advice on the spatial configuration of the open space network. The rationale of the network is to provide protection to low-lying biodiversity and the seed bank and to facilitate post-mining rehabilitation through increased immigration and dispersal of fauna and floristic propagules.

The proposed mining application and activities will result in the loss and clearing of vegetation and faunal habitat types. When the “preferred mine layout” is superimposed (Figure 32 (Pachnoda, 2015)) over the ecological sensitivities of the respective habitat types it is evident that the proposed quarry coincides vegetation units of low (*Dichrostachys* thicket) to medium (open woodland) sensitivities. On the other hand, the proposed placement of the discard dumps correspond mainly to vegetation units of medium sensitivities. However, one of the dumps is proposed to be placed north of the quarry and will contravene onto habitat with low to high (mountain bushveld) ecological sensitivities.

A "location alternative" is also suggested, whereby all the discard dumps are placed north of the quarry, thereby overlapping with sensitive mountain bushveld. However, this alternative is not ecological feasible and should be avoided.

According to the proposed mine layout (Figure 32 (Pachnoda, 2015)), a number of impacts are anticipated during the mining activities, especially when corresponding to the various vegetation units on the study site. A three-step approach should be used when such detrimental activities are likely to correspond to ecologically sensitive areas. These steps are of cardinal importance when planning mining activities, and should form an integral part of the decision-making process:

1. Avoidance: avoid or prevent the ecological impact from happening.

Avoidance measures are the first prize during any ecological planning. Examples will include not to mine at all and to avoid disturbing areas that are considered to be of high ecological sensitivity such as the mountain bushveld and savannoid grassland units.

2. Mitigate: minimise the ecological impact

Where avoidance is not possible, the impact on the ecological environment should be minimised by a suite of mitigation measures, for example by concentrating the mining activities on areas of low ecological sensitivity.

3. Compensate: provide an equivalent amount of ecological improvement in the region of the impact to balance the impact where it cannot be avoided or mitigated

Compensation (synonymous to offsets) is a last resort and implies an improvement in the area that is normally larger than the affected or impacted area. In addition, compensation measures should be applied in close proximity to where the proposed impact is likely to occur. Improvement should only happen in areas where similar ecological conditions prevail as to the impacted area (e.g. “a like for like or better” scenario). Typical examples of compensation include: the proclamation of conservation areas larger than the impacted area, the restoration of altered habitat (through proper scientific conduct), the establishment of appropriate corridors and stepping stones to enhance animal movement and the enhancement of habitat that will facilitate the re-colonisation of rare and threatened species that used to occur naturally in the impacted area.

More often, these proposals demand long-term monitoring and management which makes them less feasible over time. The same argument applies for mitigation effort. Proper and effective mitigation structures call for proper planning during the design phase, which is often associated with immense engineering cost. However, if cost is not a stumble block, this could open a new era of ecological design which will bring a whole new meaning to the word "ecology" and not just merely a way to "cloud" issues which appears to be "good" to the spectator, although its intrinsic function is often worthless/useless.

The region is not characterised by aggressive alien vegetation therefore the impact on declared aliens are medium and could be lowered by proper management.

All other impacts on fauna can be properly managed.

3.1.3 Groundwater

Topsoil and overburden material are mostly inert, therefore no significant impacts on groundwater quality conditions are envisaged. Local groundwater levels are expected to remain unaffected by the planned opencast mining activities since the quarry floor is planned to remain largely above the local groundwater level.

Potential sources of contamination

Based on the fact that the rock material underlying the project area is inert and poses no risk for acid mine drainage, the conclusion is drawn that neither the proposed quarry nor its overburden dump are considered to be meaningful sources of groundwater contamination.

Potential pathways for contamination

In order for contamination to reach and eventually affect a receptor/s, it needs to travel along a preferred pathway. The effectiveness of a pathway to conduit contamination is determined by three main factors, namely:

- Hydraulic conductivity of pathway,
- Groundwater hydraulic gradient, and
- Area through which flow occurs.

All three abovementioned factors have a linear relationship with the flow of contamination through a preferred pathway, meaning an increase in any one of the three will lead to an increase in flow.

The following potential pathways were identified in the project area:

Unsaturated zone

Soil development along the mountainous regions is virtually non-existing with the unsaturated zone mainly being composed of scree and weathered rock. The unsaturated zone in the flatter and lower lying topographies is however composed of red, stony soils with a high base status and moderate water holding capability (Tygerkloof Mining & Rhino Andalusite Mine: Final Environmental Scoping Report, 2015). Underneath the soils the unsaturated zone is characterised by weathered or fresh rock and scree originating from the mountain. The unsaturated zone impacts on the aquifer in terms of both groundwater quality and quantity.

The permeability and thickness of the unsaturated zone are some of the main factors determining the infiltration rate, the amount of runoff and consequently the effective recharge percentage of rainfall to the aquifer.

The type of material forming the unsaturated zone as well as the permeability and texture will significantly influence the mass transport of surface contamination to the underlying aquifer(s). Factors like ion exchange, retardation, bio-degradation and dispersion all play a role in the unsaturated zone.

The thickness of the unsaturated zone was determined by subtracting the pre-mining static water levels in the project area from the topography. Water level measurements in boreholes of users in the area as well as in purpose drilled monitoring boreholes showed that the depth to water level, and thus the unsaturated zone, generally varies between ± 9 and 70 meters below surface.

Geological structures

Geological structures, typically north-west striking faults, are known to intersect the andalusite ore body at numerous locations. Intrusive dykes are also known to occur within the project area and may also act as sufficient pathways for contamination. The crystalline nature of an igneous dyke is characteristic of an aquiclude, however rapid cooling of its sides during intrusion into the cold Transvaal rocks lead to the formation of highly transmissive fracture zones.

Potential receptors of contamination

A receptor of groundwater contamination usually occurs in the form of a groundwater user that relies on groundwater for domestic, irrigation or livestock watering purposes. Surface water features (stream, river, dam, etc.) that rely on groundwater base flow for the sustainment of the aquatic environment are also considered to be important receptors.

Numerous groundwater users were located during the user survey and their positions relative to the proposed Tygerkloof mining activities are indicated in Figure 7 (Groundwater Complete, 2015). A near-perennial water course namely the Bierspruit is also located directly east of the project area (Figure 2 (Groundwater Complete, 2015)).

Please note that due to the low sulphur content and relatively inert nature of the Transvaal Supergroup rocks underlying the project area, no significant groundwater quality impacts are envisaged and receptors will remain unaffected.

3.1.4 Air quality

Construction and closure phase are typically less than emissions during the operational phase. The significance rating of the construction closure phase is expected to be *'low'* for all PM and gaseous pollutants assessed. Sources of emission quantified included crushing and screening, material handling, vehicles travelling on unpaved roads, windblown dust from the stockpiles, vehicle exhaust and drying.

A distinction was made between 2 operational phase scenarios in order to distinguish emissions from the existing RAM operations **(scenario A)** and the proposed Tygerkloof Mine operations **(scenario B)**.

The main findings of the assessment are as follow:

The receiving environment:

- The area is dominated by winds from the north and north-northwest. Long term air quality impacts are therefore expected to be the most significant to the south and south east of the project area.

- Ambient air pollutant levels in the project area are currently affected by the following sources of emission; mining to southwest and north, vehicles tail-pipe emissions, open areas exposed to the wind, charcoal making and biomass burning.
- Thabazimbi is situated about 15km northeast of the project area. Nearby air quality sensitive receptors include informal settlements and residential houses situated within 100m to 1,000m of the project boundary.

Impact of the proposed Project:

- Construction and closure phases:
    - Construction and closure phase emissions were not quantified, since, as for all open-quarry mining operations, they are typically less than emissions during the operational phase. This is expected of construction and closure phase activities due to their temporary nature, and the likelihood that these activities will not occur concurrently at all portions of the site. The significance rating of the construction closure phase is expected to be 'low' for all PM and gaseous pollutants assessed.
- Operational phase:
    - Sources of emission quantified included crushing and screening, material handling, vehicles travelling on unpaved roads, windblown dust from the stockpiles, vehicle exhaust and drying.
    - Operational phase PM emissions ($PM_{2.5}$, PM_{10} and TSP) and gaseous emissions (CO, NO_x, and VOC) were quantified and utilized in simulations.
    - Simulated annual average off-site $PM_{2.5}$ GLCs (for scenario A and B) were below the standard. The 4-day per year frequency of exceedance (FOE) of the daily SA NAAQS was exceeded for about 200 to 300 m to the north and south of the proposed project boundary, but not at any of the sensitive receptors.
    - At nearby AQSRs (SR1 and SR 5), both long and short term impacts were not expected to exceed at the initial stage of the Tygerkloof Mine. However, as mining progresses across the pit, impacts are expected to exceed limit values at SR1 and probably at SR5. $PM_{2.5}$ impact due to existing RAM emissions is not expected to exceed the standard at any of the sensitive receptors for the remaining life of the mine.
    - The significance rating of $PM_{2.5}$ impact is expected to be *'low'* for scenario A and B.
    - Simulated annual average PM_{10} GLCs (for scenario A and B) exceed the standard outside the RAM and Tygerkloof boundary at a distance between 200 and 500 m. The 4-day per year FOE of the daily SA NAAQS was exceeded for about 1 to 2 km north and south of the proposed project boundary, but not at any of the sensitive receptors.
    - At nearby AQSRs (SR1 and SR 5), long term impact is not expected to exceed the standard at the initial stage of the Tygerkloof Mine, while short term impact is expected to exceed limit values at SR5. As mining progresses across the pit, both short and long term impacts are expected to exceed at SR1 and SR5. PM_{10} impact

due to existing RAM emissions is not expected to exceed the standards at any of the sensitive receptors for the remaining life of the mine.

- The significance rating of PM_{10} impact is expected to be *'medium'* for scenario A and B.
- The simulated maximum daily dustfall deposition rate due to operational phase did not exceed the NDCR non-residential standard (1,200mg/m^2-day) outside the boundaries of the RAM and Tygerkloof boundary for both scenario A and B. The residential limit (600 mg/m^2-day) is exceeded outside the boundaries but not at the sensitive receptors.
- As mining progresses across the pit, impacts due to Tygerkloof mine are expected to exceed the residential limit at SR1 and probably at SR5.
- The significance rating of TSP nuisance effect is expected to be *'low'* for scenario A and B.
- Simulated annual average NO_2 GLCs (for scenario A and B) were below the standard outside the RAM and Tygerkloof boundary. The 88-hour per year FOE of the hourly SA NAAQS was exceeded for about 200 to 500 m to the north and south of the RAM and Tygerkloof boundary, but not at any of the sensitive receptors.
- At nearby AQSRs (SR1 and SR 5), both long and short term impacts are not expected to exceed at the initial stage of the Tygerkloof Mine. However, as mining progresses across the pit, impacts are expected to exceed at SR1 and probably at SR5. NO_2 Impact due to existing RAM emission is not expected to exceed the standards at any of the sensitive receptors for the remaining life of the mine.
- The significance rating of NO_2 impact is expected to be *'medium'* for scenario A and B.
- CO and SO_2 impacts were not simulated due to insignificant emission rates. The impacts due to CO and SO_2 emissions are expected to be insignificant, as is typical of similar processes. The significance rating of CO and SO_2 impacts is expected to be *'low'* for scenario A and B.
- Simulated VOCs impact were insignificant and far below the adopted TCEQ guideline. The significance rating of VOCs impact is expected to be *'low'* for scenario A and B.

Recommendations are as follow:

To ensure the lowest possible impact on nearby sensitive receptors and the environment, it is recommended that the air quality management plan as set out in the specialist be adopted. The recommended management plan includes:

- The mitigation of sources of major emission;
- The management of associated air quality impacts; and
- Ambient air quality monitoring.

- Given that ambient air quality data is not available for the area, it is recommended that continuous dustfall, PM_{10}, $PM_{2.5}$ and NO_2 monitoring be conducted as part of the project's air quality management plan. This should be undertaken until the air quality trends become apparent.
- The locations of the monitoring exercise should include sensitive receptors (especially SR1 and SR5). This will ensure adequate planning and management intervention at these receptors should long term exceedance of the regulatory standards and guidelines occur.

3.1.5 Environmental noise

All measurements were conducted as part of the initial baseline measurements to compare disturbance levels of any future mining or any other activities on this site. All noise levels measured were below the prescribed requirements as referred to under 3.1. As this is a baseline survey and no mining activities are conducted on the proposed site yet, the measured results are very low and form a solid base for any future measurements and the evaluation of any activities that could increase the noise levels Some of the measurements were taken close to the existing Plant 5 and the readings were below the statutory requirements.

From an environmental perspective, there are no residents or settlements in close proximity of the operations that could be affected.

3.1.6 Surface water

The design of this SWMP is aligned with DWS's best practice guidelines to contain activities that may have a detrimental impact on the natural water environment, while providing controlled diversion of clean runoff to continue downstream. Successful implementation of the plan will reduce the risk of injury to staff or damage to property during a flood event. The storm water control will divert upstream runoff from the mountain catchment area away from site, while all runoff on site will be retained in pollution control dams and decommissioned quarries. It remains the responsibility of the mine management to conduct regular inspections to prevent erosion along diversion berms and cleaning of trenches and pollution control dams to maintain its capacity. First priority should be given to construct the outstanding trenches upstream of the quarry and divert clean runoff from the workings. This also applies for the proposed Tygerkloof quarry.

3.1.7 Geology

Disturbance of the geology is unavoidable. The removal of ore is the core activity of any mining operation.

3.1.8 Visual aspect

The area has various visual impacts form already existing mines, including RAM. This impact is also unavoidable, but with adequate rehabilitation, this impact will be managed.

3.2 List of all potential cumulative environmental impacts

3.2.1 Soil, land use and land capability

The proposed mine is surrounded by various other mines in the area as well as other land uses in the area, which could lead to cumulative impacts on the soil, land capability and land uses of the area

3.2.2 Ecological assessment

The proposed mine is surrounded by various other mines in the area as well as other land uses in the area, which could lead to cumulative impacts on the ecological aspects of the area. However, the high ecological sensitive area is to the north of the quarry. Land use in this area is mostly wilderness due to the slope of the area.

3.2.3 Groundwater

Pollution from the proposed mine and the existing RAM could lead to a cumulative impact on the groundwater resource. These two mines will be managed as a unit. An integrated water and waste management plan (IWWMP) is currently being compiled for both these mines.

3.2.4 Air quality

Due to the small scale of farming activities these are regarded to have an insignificant cumulative impact. Domestic households are potentially one of the most important sources contributing to poor air quality within residential areas. Individual households are low volume emitters, but their cumulative impact is significant. Cumulative pollutant concentrations and dustfall rates as a result of the project in addition to pre-development air pollution levels could not be determined at this stage.

3.2.5 Environmental noise

Noise levels could be accumulative between the existing quarry and the new quarry when in operation, but the levels should remain below the statutory requirements.

3.2.6 Heritage impact assessment

There are various heritage resources in the area as described in Paragraph 1.3.2 of Section 1 (EIA). These heritage resources were identified as part of EIA studies and are therefore managed in accordance to these HIAs. The cumulative impact on heritage resources are therefore not severe.

3.2.7 Surface water

Surface water run-off from the adjacent mine is also decreased to prevent dirty water from leaving the area. The new proposed mine will increase the amount of water lost to the surface water catchment.

3.2.8 Geology

The proposed mine is an extension of the already existing quarry, and therefore removal of ore.

3.2.9 Visual aspect

The proposed mine is an extension of the already existing quarry, and therefore and extension of the already existing visual impact on the area.

3.2.10 Socio-economic

No new jobs will be created; however, the extension of the quarry into the new mine will ensure ongoing employment of the already employed personnel in the area.

3.3 State specifically whether or not there is a risk of acid mine drainage or potential groundwater contamination associated with the mineral to be mined. (If such a risk is associated with the mineral to be mined provide a summary of the findings and recommendations of a specialist geo-hydrological report in that regard)

ABA test results were obtained for the adjacent RAM, which shows that the rock material contains very low concentrations of sulphur and is non-acid forming (Geohydrological Study for Rhino Minerals – Rhino Andalusite Mine, 2010). Andalusite mining at RAM has been ongoing for a few decades in exactly the same manner and in the same geological and geochemical environment as proposed for the Tygerkloof Quarry. After all this time and exposure to water and oxygen of the exposed ore and waste rock, the groundwater and quarry water qualities do not indicate any acid forming tendencies. The andalusite, shale and banded iron formation are chemically inert and do not form poor quality leachate.

Since the RAM and proposed Tygerkloof Quarry are located within the exact same geological environment, similarly low concentrations of sulphur are expected for the project area and no significant acid formation should occur. No ABA tests were thus conducted for the purpose of this study.

REGULATION 50 (b)

4. The alternative land use or developments that may be affected

4.1 Concise description of the alternative land use of the area in which the mine is proposed to operate

Portion 5 of Tygerkloof is currently leased, by the applicant, to a farmer, who uses the area for grazing.

4.1.1 Alternatives to the property on which or location where it is proposed to undertake the activity

RAM is the landowner of Portion 5 of the farm Tygerkloof 354 KQ, which is situated adjacent to Portion 1 and the Remaining Extent of the farm Buffelsfontein 353 KQ, also owned by RAM. Prospecting was done on this property whereby it was estimated that the underlying geology contains

andalusite which can be economically mined. It is therefore **not possible** to propose an alternative to the property or location for this proposed activity.

4.1.2 Alternatives to the type of activity to be undertaken

The reason for this application is to obtain all the necessary authorisation, including a mining right to mine the andalusite reserve on the proposed site. **No** other activity alternatives are therefore proposed.

4.1.3 Alternatives to the design or layout of the activity

The proposed open quarries must be designed in such a way that the reserve can be optimally mined. The proposed haul road extension will be an extension of the already existing haul road and will be located in such a way that the ore can be optimally removed from the open quarry and transported to RAM. There will therefore be no location alternative proposed for the open quarry or the haul road.

The preferred location for the overburden is south of the open quarry, with one overburden dump placed north of the open quarry. The location alternative is to place all the overburden on the northern side of the open quarry. Refer to Figure 36 for the alternative layout of Tygerkloof Mining.

4.1.4 Alternatives to the technology to be used and operational aspect in the activity

Mining is currently taking place at RAM. This technology and operation method used, has been used for a number of years and has been proven to be best practice for this type of mining and area. Therefore, **no** technology or operational alternatives are proposed.

4.1.2 The option of not implementing the activity

The potential impact of the preferred project option on environmental and socio-economic attributes identified during the assessment phase is evaluated against the potential impact of the 'option of not implementing the activity' on the same attributes. The summary of this assessment is provided in Table 48 below, whereby -1 is negative, +1 is positive and 0 is 'no impact'. These impacts are based on the assumption that management measures will be put into place. This table will be updated after completion of the specialist studies.

Table 48: Proposed mining activities versus option of not implementing the activity

Attribute	Development Option	No-go Option
Geology	-1	0
Change in topography	-1	0
Soil fertility	0	0
Loss of topsoil	0	0
Soil erosion	0	0
Change in land capability	-1	0
Loss of vegetation	-1	0

Attribute	Development Option	No-go Option
Loss of animal habitat	-1	0
Loss of surface water quantity	-1	0
Change in surface water quality	0	0
Loss in groundwater quantity*	0	0
Change in groundwater quality	-1	0
Dust generation	-1	0
Noise generation	-1	0
Change in visual aspects	-1	0
Loss of cultural and heritage resources**	0	0
Land use	+1	0
Employment	+1	0
Skills development	+1	0
Local and national economy	+1	0
Traffic	-1	0

* According to the mine, the quarry will not extend into the water table, therefore groundwater will not be removed. ** It is currently unknown whether there are any resources on the proposed site.

4.2 List and description of all the main features and infrastructure related to the alternative land uses or developments

The preferred location for the overburden is south of the open quarry, with one overburden dump placed north of the open quarry. The location alternative is to place all the overburden on the northern side of the open quarry.

4.3 Plan showing the location and aerial extent of the aforesaid main features of the alternative land use and infrastructure related to alternative land developments identified during scoping

Refer to Figure 36 below.

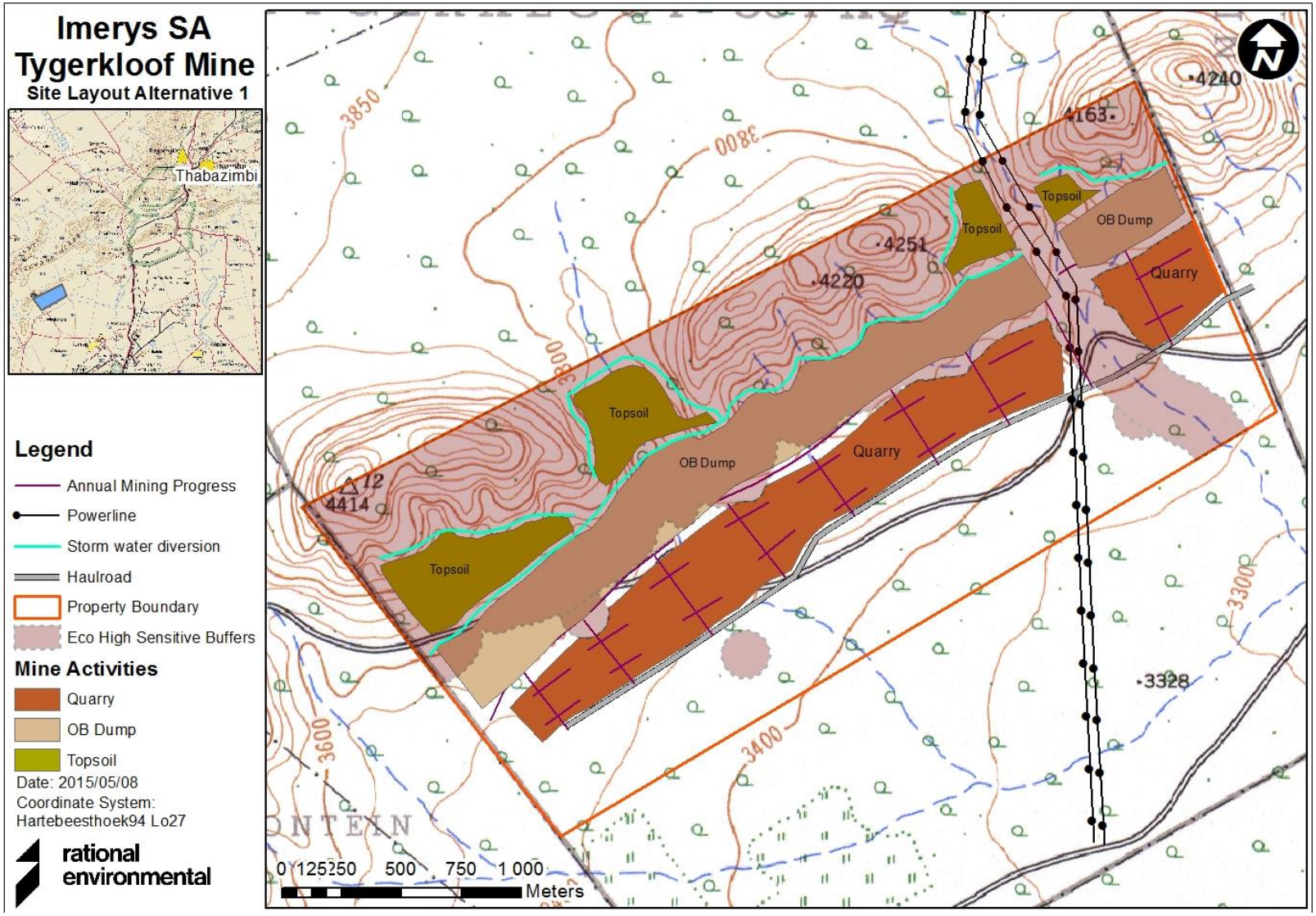


Figure 36: Alternative layout of Tygerkloof Mining

5. The potential impacts of the alternative land use or development

5.1 List of the potential impacts of each of the aforesaid main features and infrastructure related to the alternative land use or development and related listed activities

Refer to Table 49 below for the advantages and disadvantages of the proposed location versus the alternative location of overburden.

Table 49: Advantages and disadvantages of the proposed location versus the alternative location of overburden

Preferred overburden locality	**Alternative overburden locality**
Advantage or disadvantage	**Advantage or disadvantage**
A water diversion trench will be constructed on the northern side of the open quarry. This trench will divert clean water from the mountain area, away from the open quarry as well as the overburden on the southern side of this open quarry.	This water diversion trench will have to be constructed further north, into the mountain area. This alternative is not recommended due to the difficulty and high risk associated with controlling storm water runoff along the steep slopes of the mountain.
The haul road will be extended to be located between the open quarry to the north and the overburden to the south. Therefore the haul road will be in close proximity to the open quarry as well as the overburden.	The haul road will not be in close proximity to the overburden, and therefore the road must be extended even further than the proposed 3.5km.
The overburden will be placed on an area that, has a low to moderate ecological sensitivity.	According to the results from the ecological study, areas identified with *high ecological sensitivity* (open mixed *Combretum zeyheri – Diheteropogon amplectens* savannoid grassland, mixed *Senegalia caffra – Chrysophyllum serrulata* mountain bushveld and dense *Berchemia zeyheri – Acalypha glabrata* riparian woodland along drainage lines and ravines) should be perceived as sensitive habitat and developmental activities should refrain from these areas. The location alternative will coincide with this highly sensitive area.

5.2 Description of all potential cumulative impacts of the main features and infrastructure related to the identified alternative land uses or developments

Refer to Paragraph 3.2 of Section 1 (EIA).

REGULATION 50 (c)

6. Identification of potential social and cultural impacts.

6.1 List of potential impacts of the proposed mining operation on the socioeconomic conditions of other parties' land use activities

No additional jobs will be created. This new mine right will ensure extension of mining activities and extension of the current employment on the mine.

6.2 Description of the cultural aspect that will potentially be affected, and describe the potential impact on such cultural aspect

Refer to Paragraph 6.3 of Section 1 (EIA) below.

6.3 Description of heritage features and the potential impact on such heritage feature

There are no resources identified on the proposed site. However, sites in the area should be access controlled. The proposed site must be inspected prior to disturbance for any resources not identified during the study.

Rock Shelter

This is a sensitive site which may contain important archaeology material and is next to the proposed new mining site. For this reason it needs a proper Heritage Management Plan to safeguard it from vandalism and a 50m buffer area around the site.

Ancient Mine on Buffelsfontein

The collapse of a section of the ancient mine was most probably the result of recent mining and blasting. This site urgently needs a Heritage Management Plan which should include measurements to prevent water entering the old shafts as well as a detail survey and mapping of the ancient mine and surface area in a phase II heritage investigation

6.4 Quantification of the impact on the socio-economic conditions of directly affected persons, as determined by the findings and recommendations of a specialist report in that regard

6.4.1 The amount of the quantified potential impact on property or infrastructural assets

Only one farm house will be removed from portion 5 of Tygerkloof. This farm house belongs to the applicant and therefore this is not an impact on the socio-economic component of the area.

6.4.2 State the amount of the quantified potential impact on commercial, economic or business activity which will be impacted upon as a result of the mining activity

It is not envisaged that the mine will have any impact on commercial, economic or business activities in the area.

6.4.3 The sum of the amounts, referred to in paragraphs 6.6.1 and 6.6.2 above

Not applicable, see above.

7. Assessment and evaluation of potential impacts

7.1 List of each potential impact identified in paragraphs 3 and 6 above

7.1.1 Preferred option

7.1.1.1 Soil, land use and land capability

Quarry establishment

Environmental component: Soil, land capability and land use

Activity: Removal of all topsoil at the quarry footprint in order to mine the underlying geological strata.

Nature: Stripping and stockpiling of topsoil will cause the natural soil horizon sequence to be disturbed and the A and B-horizons will be mixed. Possible stripping of lower quality subsoil together with high quality topsoil will result in a reduction of soil quality and subsequent land capability. Removal of all topsoil will cause all productive soil functions and subsequent land capability; all current and current possible land uses to cease completely at the quarry footprint.

Consequence: Removal of all topsoil will cause all productive soil functions at the quarry footprint in terms of a growth medium for plants and subsequent food and habitat for fauna and flora to cease completely. The mixing of soil horizons will cause a reduction in soil quality. Removal of the topsoil at the quarry footprint will cause the all existing land capability and land use in terms arable, grazing and wilderness potential to cease completely.

Impact phase: Impact will take place throughout construction to decommissioning phase until the quarry is backfilled, topsoil is replaced and succession of nature takes place over period of time.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	To lose all soil productivity on the 110ha quarry footprint is large. The total proposed quarry footprint is planned to be mined and cannot be reduced without reducing the planned production volumes.	3	3
Severity or destruction effect			
Large to very large	All topsoil will be removed and all productive soil functioning and subsequent land capability and land use in terms of arable, grazing or wilderness at the quarry footprint will cease completely. Soil horizons sequences and habitats which developed over many of years will be destroyed.	3	2
Extent			
Site specific	The impact will occur only at the quarry footprint where all topsoil will be	1	1

Description		Rating before management	Rating with management
	removed.		
Duration			
Throughout the life of the activity	The impact will remain throughout the life of the activity (construction to operational phase) and will be permanent if the quarry is not backfilled and the topsoil not replaced.	3	2
Probability			
Definite	All soil productivity will definitely cease and subsequent all land capability and land use will cease.	3	3
Reversibility			
Only reversible with management	Impact will be reversible to some extent if proper rehabilitation is done.	2	2
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	The impact is not avoidable. In order to mine all topsoil at the quarry footprint will have to be removed, and subsequent all productive soil functions at the quarry footprint will cease.	3	3
	Land capability and land use can be restored to some extent by replacing the topsoil.	2	2
Degree to which can be avoided			
Not avoidable with management measures	The impact is not avoidable. In order to mine all topsoil at the quarry footprint will have to be removed, and subsequent all productive soil functions at the quarry footprint will cease. The impact is not avoidable. Topsoil will have to be removed and subsequent all land capability and land use, in terms of arable land, grazing and wilderness will cease.	3	3
Significance			
High	Soil: High significance prior to management and moderate significance with management.	21	19
	Land capability and land use: High significance prior to management and moderate significance with management.	20	18
Environmental objective: To implement all soil management measures in order to conserve soil.			
Monitoring requirements: The site layout has been adjusted to include all topsoil stockpile areas stipulated by the specialist. The mine must ensure compliance to this map.			
Management:			

Description	Rating before management	Rating with management
• Management of the impact on soil lies in ensuring that the soil resource is removed and conserved in high quality status during the mining period until rehabilitation can be done. • The topsoil should be stripped at different depths per soil type and stored separate from underlying overburden material as shown in Figure 6 and Section 7 of the soil report. This will ensure that sufficient high quality soil is available during the decommissioning phase. • The topography should be reconstructed to such an extent that it is free-draining and topsoil should then be replaced at depths indicated in Figure 6 of the specialist report. • Proper rehabilitation of the soils at the quarry footprint will directly influences post-mining land capability and increase the tempo at which habitats can re-establish. • All management or mitigation measures applied on soil will directly influence post-mining land capability and land use.		
Roles and responsibility: Mine manager and surveyor		
Management timeframe: Construction until after rehabilitation.		
Environmental budget: • Stripping and stockpiling of soil - R357,000/year • Reconstruction of topography - Part of financial provision • Rehabilitation of topsoil - Part of financial provision • Backfilling of OB and trenches, etc. - - Part of financial provision		

Placement of overburden dumps

Environmental component: Soil, land capability and land use

Activity: Placement of overburden dumps and topsoil stockpiles on top of natural undisturbed soils.

Nature: Overburden material and topsoil will be placed in large quantities adjacent to the quarry on top of productive undisturbed soils.

Consequence: The overburden dumps and topsoil stockpiles will cause all productive soil functions, and all land capability and land uses in terms of arable land or grazing, to cease completely.

Impact phase: Impact will take place during the construction and operational phase until the dumps and stockpiles are removed and the footprints rehabilitated.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large to very large	Overburden dumps and topsoil stockpiles will cause productive soil functioning, land capability and land use to cease on 138ha.	3	2
Severity or destruction effect			
Large to very large	All productive soil functioning, land capability and land use underneath	3	2

Description		Rating before management	Rating with management
	the overburden dumps and topsoil stockpiles will cease completely.		
Extent			
Site specific	The impact will occur only at the footprint of overburden dumps and topsoil stockpiles.	1	1
Duration			
Throughout the life of the activity	The impact will occur during the construction and operational phase until the overburden dumps and topsoil stockpiles are removed	3	2
Probability			
Definite	Productive soil functioning, land capability, and land use will definitely cease underneath all overburden dumps and topsoil stockpiles.	3	3
Reversibility			
Only reversible with management	The impact can only be reversed by removal of the overburden dumps and topsoil stockpiles and rehabilitation of the footprints.	2	2
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	The overburden dumps and topsoil stockpiles will have to be removed to re-establish the original soil potential, land capability and land use.	2	1
Degree to which can be avoided			
Not avoidable with management measures	The impact is not avoidable but can be decreased with management.	3	2
Significance			
High	High significance prior to management and moderate significance with management.	20	15
Environmental objective: To implement all soil management measures in order to conserve soil.			
Monitoring requirements: The site layout has been adjusted to include all topsoil stockpile areas stipulated by the specialist. The mine must ensure compliance to this map.			
Management: • Management of the impact by overburden dumps and topsoil stockpiles lie in containing the size of the footprints as far as possible and by removing the dumps as soon as possible which might commence partly during the operational phase. • If the overburden dumps remain after the decommissioning phase it will result in an altered topography with much lower quality growth medium.			
Roles and responsibility: Mine manager and surveyor			
Management timeframe: Construction until after rehabilitation.			
Environmental budget: **Included in the budget above**			

Description	Rating before management	Rating with management
• Stripping and stockpiling of soil - R357,000/year • Reconstruction of topography - Part of financial provision • Rehabilitation of topsoil - Part of financial provision • Backfilling of OB and trenches, etc. - - Part of financial provision		

Water diversion trench

Environmental component: Soil, land capability and land use

Activity: Excavation of a water diversion trench.

Nature: Excavation of a water diversion trench implies removal of the topsoil and subsoil horizons and placing it adjacent to the trench. The natural soil horizon sequence will be disturbed and the A, B and C-horizons will be mixed which will result in a reduction in soil quality. All vegetation will also be removed and the current land use in terms of grazing for livestock or wildlife will cease.

Consequence: The removal of the soil horizons will cause all productive soil functions at the trench footprint in terms of a growth medium for plants and subsequent food and habitat for fauna and flora to cease completely. Land capability and land use in terms of arable, grazing or wilderness will cease.

Impact phase: Impact will take place during the construction and operational phase until the trench is backfilled and soil processes can re-establish over time.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	Soil productivity, land capability and land use will cease at the footprint of the 3.433km trench which will probably be fairly narrow. The trench can probably not be shortened to reduce the footprint and impact.	2	2
Severity or destruction effect			
Large to very large	The topsoil will be excavated and all productive soil functioning at the trench footprint will cease completely. Land capability at the trench footprint will cease completely. The vegetation will be removed and existing land uses at the trench footprint will cease completely.	3	2
Extent			
Site specific	The impact will occur only at the trench footprint	1	1
Duration			
Throughout the life of the activity	The impact will occur during the construction and operational phase and	3	2

Description		Rating before management	Rating with management
	until the trench is backfilled.		
Probability			
Definite	Productive soil functions, land capability, and current land uses, will definitely cease at the trench footprint.	3	3
Reversibility			
Only reversible with management	The impact will only be reversible to some extent if the excavated material is backfilled. Mixing of the soil's A, B and C-horizons will cause a reduction in soil quality and subsequent land capability which will remain after the trench is backfilled. Vegetation and subsequent land use will re-establish over a long period of time.	2	2
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	The soil productivity, land capability, and land use, can be re-established to some extent by when the trench is backfilled.	2	1
Degree to which can be avoided			
Not avoidable with management measures	The impact is not avoidable. A trench cannot be dug without causing all production soil functions to cease at the trench footprint. The trench will have to be dug to divert water out of the quarry.	3	2
Significance			
Moderate	Moderate significance prior to management and moderate significance with management.	19	15
Environmental objective: To implement all soil management measures in order to conserve soil.			
Monitoring requirements: The site layout has been adjusted to include the water trench, stipulated by the specialist. The mine must ensure compliance to this map.			
Management: • Management of the impact on soil lies in ensuring that the soil resource is conserved during the mining period until rehabilitation can be done. • Backfilling of the trenched will re-establish the soil functions over time.			
Roles and responsibility: Mine manager and surveyor			
Management timeframe: Construction until after rehabilitation.			
Environmental budget: **Included in the budget above** • Stripping and stockpiling of soil - R357,000/year • Reconstruction of topography - Part of financial provision			

Description	Rating before management	Rating with management
• Rehabilitation of topsoil - Part of financial provision • Backfilling of OB and trenches, etc. - - Part of financial provision		

Haul road

Environmental component: Soil, land capability and land use

Activity: Construction of a haul road on top of natural undisturbed soils.

Nature: Road building material will be placed and compacted on top of productive undisturbed soils.

Consequence: The road material will cause all productive soil functions at the road footprint in terms of a growth medium for plants and subsequent food and habitat for fauna and flora to cease completely. The haul road will cause all land capability at the road footprint in terms of arable land or grazing to cease completely.

Impact phase: Impact will take place during the construction and operational phase until the haul road is removed and the footprint rehabilitated.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	Productive soil functions will cease at the haul road footprint which covers 3.320km in distance and approximately 10-20m wide.	2	2
Severity or destruction effect			
Large to very large	All productive soil functioning and subsequent land capability and land use underneath the road building material will cease completely.	3	2
Extent			
Site specific	The impact will occur only at the haul road footprint	1	1
Duration			
Throughout the life of the activity	The impact will occur during the construction and operational phase until the haul road is removed and the footprint rehabilitated.	3	2
Probability			
Definite	Productive soil functions, land capability and current land use will definitely cease at the haul road footprint.	3	3
Reversibility			
Only reversible with management	The impact can only be reversed by removal of the haul road and	2	2

Description		Rating before management	Rating with management
	rehabilitation of the footprint.		
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	The soil resource is irreplaceably. The haul road will have to be removed to re-establish the original productive soil functions, land capability and land use.	2	1
Degree to which can be avoided			
Not avoidable with management measures	The impact is not avoidable. A haul road cannot be constructed without causing all productive soil functions to cease. A haul road has to be built to transport material to the plants. The impact may be decreased by containing the size of the haul road footprints as far as possible.	3	2
Significance			
Moderate	Medium significance prior to management and medium significance with management.	19	17
Environmental objective: To implement all soil management measures in order to conserve soil.			
Monitoring requirements: The site layout has been adjusted to include all haul roads, as stipulated by the specialist. The mine must ensure compliance to this map.			
Management: • Management of the impact by the haul road lies in containing the size of the haul road as far as possible and by removing the haul road as soon as possible. • If the haul road remains after the decommissioning phase it will cause a permanent impact on soils.			
Roles and responsibility: Mine manager and surveyor			
Management timeframe: Construction until after rehabilitation.			
Environmental budget: **Included in the budget above** • Stripping and stockpiling of soil - R357,000/year • Reconstruction of topography - Part of financial provision • Rehabilitation of topsoil - Part of financial provision • Backfilling of OB and trenches, etc. - - Part of financial provision			

7.1.1.2 Ecological assessment

The proposed quarry placement for the preferred option coincides with vegetation units of low (*Dichrostachys* thicket) to medium (open woodland) sensitivities and the proposed placement of the discard dumps correspond mainly to vegetation units of medium sensitivities. However, one of the dumps is proposed to be placed north of the opencast pit and will contravene onto habitat with low to high (mountain bushveld) ecological sensitivities.

Loss and clearing of vegetation communities

Environmental component: Vegetation communities

Activity: Construction and operation of the quarry; and construction and operation of discard dumps[1]

Nature: Mining operation and placement of discard dumps will clear areas of low to medium ecological sensitivities to construct a quarry

Consequence: Loss of floristic communities (affecting floristic richness, floristic structure, and ecological condition) and loss of declining, protected and near threatened plant taxa

Impact phase: Impact will take place during construction and operation

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The proposed area of quarry activities is approximately 115.9ha; the proposed area for the placement of the discard dumps is approximately 142.2ha	3	3
Severity or destruction effect			
Moderate	Loss of vegetation pertaining to areas with **low ecological sensitivity**	2	1
Large	Loss of vegetation pertaining to areas with **medium ecological sensitivity**	3	2
Extent			
Site specific	The impact will be specific to the site of the activity	1	1
Duration			
Permanent	The loss of vegetation is permanent	3	2
Probability			
Definite	The construction and mining activities is unavoidable - **low ecological sensitivity**	3	2
Definite	The construction and mining activities is unavoidable - **medium ecological sensitivity**	3	3
Reversibility			
Only reversible with management	Impact will only be reversible during intensive ecological restoration	2	1[2]

[1] Mining activities and placement of overburden has a similar impact assessment, therefore these two activities are grouped together in this report

Description		Rating before management	Rating with management
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	Impact will only be reversible during intensive ecological restoration - **low ecological sensitivity**	2	1
Resource irreplaceable, receptor highly sensitive	Restoration is potentially impossible to achieve pre-mining conditions without intense effort owing to expected partial loss of seed bank- **medium ecological sensitivity**	3	2
Degree to which can be avoided			
Somewhat avoidable with management measures	Impact avoidable with management measures (see below)	2	1
Significance			
Medium pre-management and low post-management	Areas of **low ecological sensitivity**	18	12
High pre-management and medium post-management	Areas of **medium ecological sensitivity**	20	15
Environmental objective: To implement all ecological management measures in order to prevent and/or management the loss of vegetation communities.			
Monitoring requirements: The site layout has been adjusted to include all buffer zones as stipulated by the specialist. The mine must ensure compliance to these buffer zones. Checks must be carried out at regular intervals to identify areas where erosion is occurring.			
Management: • The attached sensitivity map must be used as a decision tool to guide the layout design. Mining and construction activities should preferably be restricted to areas identified with *low* conservation importance. *Open cast mining on areas of high conservation importance should be avoided.* • Footprint areas must be scanned for protected and near threatened tree species during a walk-trough of the affected area prior to the construction/mining phase. It is recommended that these plants be identified and marked prior to the development in order to obtain the necessary permits from the relevant authority. • Where possible, large and aged specimens of protected trees (e.g. *Vachellia erioloba*) and *Elaeodendron transvaalensis* should be retained and buffered (see Figure 32 (Pachnoda, 2015) and the sensitivity map to follow this report). All buffered areas should form part of an open space network to promote movement of fauna when a high rate of natural disruption is expected and to conserve part of the seed bank diversity (essential for restoration). • Rehabilitation/restoration should make use of indigenous species, and preferably of species native to the study site and immediate surroundings. The species selected should strive to represent habitat types typical of the ecological landscape prior to construction. • Reinstate/rehabilitate as a continual process – this will maximise the viability of the natural seed bank and prevent the unnecessary loss of topsoil during storage. • Checks must be carried out at regular intervals to identify areas where erosion is occurring. Appropriate remedial action, including the rehabilitation of the eroded areas, and where			

[2] Rating changed from specialist report to be similar for quarry and overburden, description is similar

Description	Rating before management	Rating with management
necessary, the relocation of the roads causing the erosion, are to be undertaken.		
Roles and responsibility: Mine manager and surveyor		
Management timeframe: Construction until after rehabilitation.		
Environmental budget: • Walk-through of site prior to construction for protected and near threatened tree species – R12,000-00 once-off • Checks on erosion - In-house – no additional budget necessary • Re-vegetation - Part of financial provision		

Loss of floristic diversity and invasion by declared aliens

Environmental component: Floristic diversity

Activity: Construction and operation of the quarry; and construction and operation of discard dumps[3]

Nature: Invasive plants may establish due to surface area disturbance and also through future rehabilitation activities (e.g. seeding practices). This may lead to:

- Displacement of indigenous vegetation;
- Change in plant species composition;
- Change in vegetation composition and structure;
- Competition for sunlight will increase between indigenous and alien species;
- Loss of habitat and a change in biodiversity.

Consequence: Loss of floristic diversity and changes to the community composition (both fauna and flora).

Impact phase: Impact will take place during construction and operation

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The proposed area of quarry activities is approximately 115.9ha; the proposed area for the placement of the discard dumps is approximately 142.2ha	3	3
Severity or destruction effect			

[3] Mining activities and placement of overburden has a similar impact assessment, therefore these two activities are grouped together in this report

Description		Rating before management	Rating with management
Moderate	The region is not characterised by aggressive alien vegetation, thereby the impact is not expected to be highly severe.	2	1
Extent			
Area adjacent to site	The impact could spread beyond area of disturbance.	2	1
Duration			
Throughout life of activity	The impact is likely to persist during rehabilitation.	2	1
Probability			
Definite	It is expected that ruderal and annual weed will colonise the area along with opportunistic floristic taxa (resulting in a species poor community)	3	2
Reversibility			
Only reversible with management	Impact will only be reversible by means of active control and eradication programmes.	2	1
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	Impact will only be reversible by means of active control and eradication programmes	2	1
Degree to which can be avoided			
Avoidable with management measures	The impact can be avoided by means of active control and eradication programmes and follow-up control strategies	1	1
Significance			
Medium to low	Medium pre-management and low post-management	17	11
Environmental objective: To implement all ecological management measures in order to prevent and/or management the loss of vegetation communities.			
Monitoring requirements: Monitoring must be in accordance to the invasive plant eradication and control programme, which must still be drafted			
Management: • An alien and invasive plant eradication and control programme must be implemented along with a follow-up programme. The programme must be compiled by a qualified botanist/ecologist and the implementation thereof should be supervised by a qualified botanist/ecologist. • Priority should be given to eradicate aggressive species. • Method of removal, that will depend on category of identified species and seasonal period when recorded. • Any action taken to control and eradicate a listed invasive species shall be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment. • Future rehabilitation strategies must consider sensitivity of the flora/fauna within the area, and prevent the introduction of species that may compromise the existing habitat and/or promote			

Description	Rating before management	Rating with management
the establishment of invader plants (e.g. transporting of material to the study site including plant specimens/seedlings used during rehabilitation (see below). • Inspect all materials to be used during construction/operation for potential invader species before being transported to the construction/operational area.		
Roles and responsibility: Mine manager		
Management timeframe: Construction until after rehabilitation.		
Environmental budget: • Alien and invasive plant eradication and control programme - R30,000-00 and once off for the plan • Alien invasive implementation - The costs for implementation of the Alien and invasive plant eradication and control programme will be included in this eradication and control programme.		

Loss/displacement of fauna

Environmental component: Fauna

Activity: Construction and operation of the quarry; and construction and operation of discard dumps[4]

Nature: Mining operation and placement of discard dumps will clear areas of low to medium ecological sensitivities to construct a quarry.

Consequence: Loss of fauna richness during clearing of vegetation and loss of fossorial and stenotopic taxa with restricted dispersal abilities. The proposed construction (site clearing and earthworks) and operational (mining operations) activities go hand in hand with high ambient noise levels and the eventual displacement of animal taxa. Many of the larger terrestrial mammal and bird species will vacate these areas (including taxa of conservation concern).

Impact phase: Impact will take place during construction and operation

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The proposed area of quarry activities is approximately 115.9ha; the proposed area for the placement of the discard dumps is approximately 142.2ha	3	3
Severity or destruction effect			
Moderate	Loss of fauna pertaining to areas with **low ecological sensitivity**	2	1
Large	Loss of fauna pertaining to areas with **medium ecological sensitivity**	3	2
Extent			
Area adjacent to site	The impact will be specific to the site and the surrounding habitat.	2	2
Duration			

[4] Mining activities and placement of overburden has a similar impact assessment, therefore these two activities are grouped together in this report

Description		Rating before management	Rating with management
Permanent	The anticipated loss of habitat (vegetation) will result in the displacement of fauna.	3	2
Probability			
Definite	The construction and mining activities is unavoidable - **low ecological sensitivity**	3	2
Definite	The construction and mining activities is unavoidable - **medium ecological sensitivity**	3	3
Reversibility			
Only reversible with management	Impact will only be reversible during intensive ecological restoration (which is often difficult to achieve)	2	2
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	Impact will only be reversible during intensive ecological restoration and management - **low ecological sensitivity**	2	1
Resource irreplaceable, receptor highly sensitive	Restoration is potentially impossible to achieve pre-mining conditions without intense effort. It is expected that changes to the community structure will occur, with increased colonisation rates by opportunistic/transient taxa with widespread distribution ranges - **medium ecological sensitivity**	3	2
Degree to which can be avoided			
Somewhat avoidable with management measures	Impact avoidable with management measures (see below) although different taxa react/respond differently.	2	1
Significance			
Medium pre-management and low post-management	Areas of **low ecological sensitivity**	19	14
High pre-management and medium post-management	Areas of **medium ecological sensitivity**	21	17
Environmental objective: To implement all ecological management measures in order to prevent and/or management the loss of vegetation communities.			
Monitoring requirements: The site layout has been adjusted to include all buffer zones as stipulated by the specialist.			
Management: • The attached sensitivity map must be used as a decision tool to guide the layout design. Mining and construction activities should preferably be restricted to areas identified with *low*			

Description	Rating before management	Rating with management
conservation importance. *Open cast mining on areas of high conservation importance should be avoided.* • Rehabilitation/restoration should make use of indigenous plant species, and preferably of species native to the study site and immediate surroundings. The species selected should strive to represent habitat types typical of the ecological landscape prior to construction. • Reinstate/rehabilitate as a continual process – this will maximise the viability of the natural seed bank and prevent the unnecessary loss of topsoil during storage. • Checks must be carried out at regular intervals to identify areas where erosion is occurring. Appropriate remedial action, including the rehabilitation of the eroded areas, and where necessary, the relocation of the roads causing the erosion, are to be undertaken. • All labour or staff should be advised (induction) by means of environmental awareness training on the biodiversity importance of the area. • Intentional killing of any faunal species (in particular invertebrates and snakes) should be avoided by means of awareness programmes presented to the labour force. The labour force should be made aware of the conservation issues pertaining to the taxa occurring on the study site. Any person found deliberately harassing any animal in any way should face disciplinary measures, following the possible dismissal from the site. • All waste (if present) should be removed from the study site as soon as possible and should be appropriately covered to reduce the risk of colonisation by feral mammals or competitively superior bird species (e.g. Pied Crows *Corvus albus*).		
Roles and responsibility: Mine manager and surveyor		
Management timeframe: Construction until after rehabilitation.		
Environmental budget: • N/A		

Outside lighting and disorientation of nocturnal animals

Environmental component: Nocturnal animals

Activity: Construction and operation of the quarry

Nature: Outside lighting attracts nocturnal migrating birds and nocturnal invertebrates.

Consequence: Many nocturnal invertebrates and certain migratory bird species could be attracted to outside lighting, thereby disrupting natural dispersal and possible collision with infrastructure.

Impact phase: Impact will take place during construction and operation

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The proposed area of quarry activities is approximately 115.9ha	3	3
Severity or destruction effect			

Description		Rating before management	Rating with management
Moderate	Nocturnal invertebrates and certain migratory birds could become disoriented, displaced and could collide with mining infrastructure	2	1
Extent			
Area adjacent to site	The effect will depend on the light intensity but is expected to extend beyond site boundary (hundreds of metres)	2	1
Duration			
Throughout life of activity	Long-term and impact will last the life of the project.	2	1
Probability			
Definite	The impact is likely to occur, especially considering the proximity of natural habitat	3	2
Reversibility			
Only reversible with management	Effectively reversed by proper installation and planning	2	1
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	Not applicable and regarded as temporary (as long as the project is operational)	2	1
Degree to which can be avoided			
Avoidable with management measures	Impact avoidable with management measures (see below)	2	1
Significance			
Medium to low	Medium pre-management and low post-management	18	11
Environmental objective: To manage lighting on the mine			
Monitoring requirements: Continuous monitoring of lighting			
Management: • Minimise exterior lighting and implement operational strategies to reduce "spill light". Outside features should be illuminated by using "down-lighting" rather than "up-lighting. • If possible, outside lighting should be replaced with bulbs of longer wave lengths (550nm), for example low-pressure yellow Na vapour bulbs or yellow LEDs. • Where possible, outside lighting should not make use of fluorescent lights since these emit significant amounts of UV which will attract invertebrates. • Apply UV filters to high pressure mercury vapour lamps as an alternative to yellow Na lamps. • Limit haul traffic to daytime - most animals are nocturnal and the impact will be significantly reduced if night traffic is avoided.			
Roles and responsibility: Mine manager and surveyor			
Management timeframe: Construction until after rehabilitation.			
Environmental budget:			

Description	Rating before management	Rating with management
• Outside lighting should be replaced with bulbs of longer wave lengths (550nm); Apply UV filters to high pressure mercury vapour lamps as an alternative to yellow Na lamps - R70,000/year		

Haul traffic and displacement of fauna

Environmental component: Fauna

Activity: Operation of haul road

Nature: Haul road will lead to increased noise effect, thereby resulting in the displacement of wildlife.

Consequence: Haul traffic will lead to increased noise generation which will deter animals from utilising nearby resources. However, displacement of large-bodied animals which require large home ranges will lead to excessive competition between conspesific species, resulting in potential conflict with neighbouring species. Increased haul traffic noise and vibration will interfere with ability of ground-dwelling animals to detect potential predators or to escape predation.

Impact phase: Impact will take place during operation

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	The road is of linear configuration, thereby the impact is largely confined to the road reserve and immediate surroundings	2	2
Severity or destruction effect			
Large	The initial severity of the impact will be large. However, certain animals (especially some of the large ungulates) could become accustomed to the traffic.	3	2
Extent			
Area adjacent to site	The effect will impact on the area at the road and the area beyond road reserve.	2	1
Duration			
Throughout life of activity	Long-term and for the duration of the project.	2	1
Probability			
Definite	The impact is likely to occur, especially considering the proximity of natural habitat	3	2

Description		Rating before management	Rating with management
Reversibility			
Only reversible with management	Effectively reversed by proper management (see below)	2	1
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	Not applicable and regarded as temporary (as long as the project is operational).	2	2
Degree to which can be avoided			
Somewhat avoidable with management measures	Impact avoidable with management measures (see below)	2	1
Significance			
Medium pre-management and low post-management		18	12
Environmental objective: To manage any displacement of fauna			
Monitoring requirements: Continuous monitoring of road infrastructure			
Management: • Limit haul traffic to daytime - most animals are nocturnal and the impact will be significantly reduced if night traffic is avoided. • Limit the road network to areas with low ecological sensitivity and plan roads to cross the least number of different habitat types - this will limit the richness of taxa that could be affected by the impact. • Allow movement of animals during operation and increase the permeability of the road network. • Allow for movement of small-bodied (and slow-moving) taxa by incorporating underpasses, especially near areas where a high probability of animal dispersal is anticipated (e.g. near drainage lines). • All roadside stormwater structures should be designed so as to prevent amphibian, reptile and small mammal access. Ditches/trenches should have slopes of less than 45° rather than vertical sides.			
Roles and responsibility: Mine manager			
Management timeframe: Construction until after rehabilitation.			
Environmental budget: • N/A			

Haul road mortalities

Environmental component: Fauna

Activity: Operation of haul road

BECS Environmental

Nature: Haul traffic could lead to increased road mortalities.

Consequence: Increased traffic will result in animal collisions and road mortalities. The area is confined within a matrix of game farms with a high diversity of fauna. In addition, nocturnal animals are often blinded by the headlights of vehicles, thereby increasing the risk of road mortalities at night.

Impact phase: Impact will take place during operation

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	The road is of linear configuration, thereby the impact is largely confined to the road reserve and immediate surroundings	2	2
Severity or destruction effect			
Large	The majority of mammal taxa is nocturnal, thereby rendering the severity of the impact as potentially large	3	2
Extent			
Area adjacent to site	The effect will impact on the area at the road and the area beyond road reserve.	2	1
Duration			
Throughout life of activity	Long-term and for the duration of the project.	2	1
Probability			
Definite	The impact is likely to occur, especially considering the proximity of natural habitat	3	2
Reversibility			
Only reversible with management	The impact severity could be ameliorated by mitigation (see below)	2	1
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	Not applicable and regarded as temporary (as long as the project is operational).	2	2
Degree to which can be avoided			
Somewhat avoidable with management measures	Impact avoidable with management measures (see below)	2	1
Significance			
Medium pre-management and low post-management		18	12

Description	Rating before management	Rating with management
Environmental objective: To prevent haul road mortalities as far as possible		
Monitoring requirements: Refer to paragraph 15 of section1 (EIA)		
Management: • Limit haul traffic to daytime - most animals are nocturnal and the impact will be significantly reduced if night traffic is avoided. • Introduce road calming structures (e.g. humps) and enforce speed limit. • Monitor road kills and create a database of species killed to identify areas with a high frequency of mortalities. Re-enforce mitigation measures at these specific areas. • Allow movement of animals and increase the permeability of the road network (e.g. underpasses should be installed).		
Roles and responsibility: Mine manager		
Management timeframe: Construction until after rehabilitation.		
Environmental budget: • Introduce road calming structures (e.g. humps) and enforce speed limit - R5,000/year • Monitor road kills and create a database of species killed to identify areas with a high frequency of mortalities - In-house – no additional budget necessary.		

7.1.1.3 Groundwater

Development and utilisation of the topsoil and overburden dumps

Environmental Component: Groundwater

Activity: The development and utilisation of the topsoil and overburden dumps in tandem with the development and progression of the proposed quarry.

Nature: Topsoil and overburden material are mostly inert, therefore no significant impacts on groundwater quality conditions are envisaged.

Consequence: Groundwater pollution.

Impact Phase: Operational phase.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Small to very small	± 140 ha disturbed by overburden dump	1	1
Severity or destruction effect			
Very low to low	No significant quarry dewatering expected	1	1
Extent			
Site specific	No significant impact envisaged	1	1
Duration			

Description		Rating before management	Rating with management
Throughout life of activity	No significant impact envisaged	2	2
Probability			
Not probable	No significant impact envisaged	1	1
Reversibility			
Reversible	No significant impact envisaged	1	1
Irreplaceability of resources			
Resource replicable, receptor not sensitive	No significant impact envisaged	1	1
Degree to which can be avoided			
Avoidable with management measures	No significant impact envisaged	1	1
Significance			
Low	No significant impact envisaged	9	9
Environmental objective: To prevent contact of clean water and dirty water.			
Monitoring requirements: Continuous monitoring of groundwater quality is recommended throughout the life of mine. Refer to paragraph 15 of section1 (EIA)			
Management: • Clean surface water should not come into contact with dirty water and continuous monitoring of groundwater quality is recommended.			
Roles and responsibility: Mine manager			
Management timeframe: Construction until after rehabilitation.			
Environmental budget: • Construction of diversion trench for stormwater - R15,000/year • Continuous monitoring of groundwater quality - R25,000/year			

Development and progression of the quarry

Environmental Component: Groundwater

Activity: The progressive development of opencast mining cuts.

Nature: Local groundwater levels are expected to remain unaffected by the planned opencast mining activities since the quarry floor is planned to remain largely above the local groundwater level.

Consequence: Lowering of local groundwater level.

Impact Phase: Operational phase.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Small to very small	± 116 ha disturbed by proposed quarry	1	1
Severity or destruction effect			
Very low to low	Topsoil and overburden material are mostly inert	1	1
Extent			
Site specific	No significant impact envisaged	1	1
Duration			
Throughout life of activity	No significant impact envisaged	2	2
Probability			
Not probable	No significant impact envisaged	1	1
Reversibility			
Reversible	No significant impact envisaged	1	1
Irreplaceability of resources			
Resource replicable, receptor not sensitive	No significant impact envisaged	1	1
Degree to which can be avoided			
Avoidable with management measures	No significant impact envisaged	1	1
Significance			
Low	No significant impact envisaged	9	9
Environmental objective: To monitor groundwater quantity			
Monitoring requirements: Quarterly monitoring of groundwater levels is recommended throughout the life of mine. Refer to paragraph 15 of section1 (EIA)			
Management: • Quarterly monitoring of groundwater levels is recommended throughout the life of mine. • If the monitoring program indicates that nearby groundwater users are affected negatively by dewatering, the users need to be compensated for the loss.			
Roles and responsibility: Mine manager			
Management timeframe: Construction until after rehabilitation.			
Environmental budget: • Quarterly monitoring of groundwater levels is recommended - R75,000/year			

Extension of existing haul road

Environmental Component: Groundwater

BECS Environmental

Activity: The extension of the already existing haul road.

Nature: The extension of the haul road will cause a very small reduction in recharge to the underlying aquifer system due to the compaction of the surface of the road.

Consequence: Groundwater pollution and lowering of local groundwater recharge.

Impact Phase: Operational phase

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Small to very small	± 4 ha disturbed by proposed extension	1	1
Severity or destruction effect			
Very low to low	Material used in the construction is inert.	1	1
Extent			
Site specific	No significant impact envisaged	1	1
Duration			
Throughout life of activity	No significant impact envisaged	2	2
Probability			
Not probable	No significant impact envisaged	1	1
Reversibility			
Reversible	No significant impact envisaged	1	1
Irreplaceability of resources			
Resource replicable, receptor not sensitive	No significant impact envisaged	1	1
Degree to which can be avoided			
Avoidable with management measures	No significant impact envisaged	1	1
Significance			
Low	No significant impact envisaged	9	9
Environmental objective: To prevent spillages from vehicles and machinery			
Monitoring requirements: This will depend on the spill handing procedure			
Management: • Haul road should be kept free of potentially hazardous material by cleaning spillages, thereby reducing infiltration of contaminated water.			
Roles and responsibility: Mine manager			
Management timeframe: Construction until after rehabilitation.			

Description	Rating before management	Rating with management
Environmental budget: **Included in the budget above** • Continuous monitoring of groundwater quality - R25,000/year • Quarterly monitoring of groundwater levels is recommended - R75,000/year • Spill handling and waste management procedure - R5,000 once off		

7.1.1.4 Air quality

The impact assessment was conducted on various air pollutants, therefore the tables and corresponding information below, differ in format from the other environmental components.

Quantitative assessment of the significance of operational phase air quality impacts associated with PM and gaseous emissions

Activity	Impact	Quantity or size of disturbance	Severity or destruction effect	Extent	Duration	Probability	Reversibility	Irreplaceability of resources	Degree to which can be avoided	Significance
Operational phase – Scenario A and B	$PM_{2.5}$	1	1	2	2	2	2	2	1	13 (Low) [(a)]
	PM_{10}	2	2	2	2	2	2	2	2	16 (Medium) [(b)]
	NO_2	1	1	2	2	2	2	2	2	14 (Medium) [(c)]
	VOCs	1	1	1	2	2	2	2	1	12 (Low) [(d)]
	CO	1	1	1	2	2	2	2	1	12 (Low) [(d)]
	SO_2	1	1	1	2	2	2	2	1	12 (Low) [(d)]
	Dustfall (Nuisance effect)	1	1	1	2	2	2	2	1	12 (Low) [(d)]

Notes: Description of Significance Rating

[(a)] The proposed activities will contribute minimally to the pollutant baseline footprint in the area (low). Impacts will recede with recommended mitigations or when the activities cease.

[(b)] The proposed activities will contribute slightly significantly to the pollutant baseline footprint in the area (medium). Impacts will recede with recommended mitigations or when the activities cease.

[(c)] The proposed activities will contribute slightly significantly to the pollutant baseline footprint in the area (medium). Impacts will recede with recommended mitigations or when the activities cease.

[(d)] The proposed activities will contribute minimally to the pollutant baseline footprint in the area (low). Impacts will recede with recommended mitigations or when the activities cease.

Unpaved roads and crushing and screening were identified as the major contributor to PM emissions. The main dust generating factors on unpaved road surfaces include: Vehicle speeds; Number of wheels per vehicle; Traffic volumes; Particle size distribution of the aggregate; Compaction of the surface material; Surface moisture; and Climate.

Environmental objective:

The main objective of the proposed air quality management measures for the project is to ensure that operations result in ambient air concentrations (specifically PM2.5, PM10 and NO2) and dustfall rates that are within the relevant ambient air quality standards at Hotazel, Santoy and other off-site areas. In order to define site specific management objectives, the main sources of pollution need to be identified. Once the main sources have been identified, target control efficiencies for each source can be defined to ensure acceptable cumulative ground level concentrations.

Monitoring requirements: Refer to paragraph 15 of section1 (EIA)

Management measures:

- The mine must commit itself to adequate air quality management planning throughout the life of the proposed project. The air quality management plan provides options on the control of dust particles and gases at the main sources, while the monitoring network is designed to track the effectiveness of the mitigation measures.
- For the control of vehicle entrained dust it is recommended that water (at an application rate of 1litre/m2-hour), be applied in combination with addition of chemicals. Literature reports an emissions reduction efficiency of 80%.
- In minimising windblown dust from stockpile areas, water sprays should be used to keep surface material moist and wind breaks installed to reduce wind speeds over the area.
- Once a portion of the area has reached the end of its active life i.e. sides and certain surface areas, it should be rehabilitated. If this is done continually, a 75% or more reduction in emissions is anticipated.
- To ensure lower diesel exhaust emissions, equipment suppliers or contractors should be required to ensure compliance with appropriate emission standards for mining fleets.

Roles and responsibility: Mine manager

Management timeframe: Construction until after rehabilitation.

Environmental budget:

- Air quality monitoring – This will depend on costs of consultant to monitor air quality.
- Maintenance of all machinery and vehicles - R10,000,000/year
- Water down roads - R55,000/month
- Water sprays to keep surface material moist and wind breaks installed to reduce wind speeds over the area - Part of financial provision

Qualitative assessment of the significance of construction and closure phase air quality impacts associated with PM and gaseous emissions

Activity	Impact	Quantity or size of disturbance	Severity or destruction effect	Extent	Duration	Probability	Reversibility	Irreplaceability of resources	Degree to which can be avoided	Significance
Construction and closure phase – Scenario A and B	$PM_{2.5}$	1	1	1	1	2	1	2	1	10 (Low) [(a)]
	PM_{10}	1	1	2	1	2	1	2	1	11 (Low) [(a)]
	NO_2	1	1	1	1	2	1	2	1	10 (Low) [(a)]
	VOCs	1	1	1	1	2	1	2	1	10 (Low) [(a)]
	CO	1	1	1	1	2	1	2	1	10 (Low) [(a)]

	SO_2	1	1	1	1	2	1	2	1	10 (Low) [(a)]
	Dustfall (Nuisance effect)	1	1	1	1	2	1	2	1	10 (Low) [(a)]

Notes: Description of Significance Rating

[(a)] The proposed activities will contribute minimally to the pollutant baseline footprint in the area (low). Impacts will recede with recommended mitigations or when the activities cease.

Environmental budget: **Included in the budget above**

- Air quality monitoring – This will depend on costs of consultant to monitor air quality.
- Maintenance of all machinery and vehicles - R10,000,000/yea
- Water down roads - R55,000/month
- Water sprays to keep surface material moist and wind breaks installed to reduce wind speeds over the area - Part of financial provision

7.1.1.5 Environmental noise

Environmental component: Environmental noise

Activity: Mining activities and placement of overburden

Nature: Noise generation through mining activities and placement of overburden[5]

Consequence: Noise nuisance on environment and community

Impact phase: Impact can take place throughout construction to decommissioning phase

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Very small to small	Noise generation is small and will be limited to vehicle noise and mining activities. The reef is removed through pick and shovel en and blasting is only done when hard rock need to be removed to gain access to the ore body. Noise levels could be accumulative between the existing quarry and the new quarry when in operation, but the levels should remain below the statutory requirements.	1	1
Severity or destruction effect			
Moderate	From an environmental perspective, there are no residents or	2	1

[5] Mining activities and placement of overburden has a similar impact assessment, therefore these two activities are grouped together in this report.

Description		Rating before management	Rating with management
	settlements in close proximity of the operations that could be affected. Therefore the severity or destruction effect will not be physical, but could be more on a disturbance level which could result into an emotional or psychological level. The farmer that currently rents the farm from the mine, will vacate his residence when mining commence. From an occupational perspective, the mine and plant workers will be effected more seriously and this issue should be dealt with under the Mine Health and Safety Act.		
Extent			
Site specific	The noise generation will mainly be limited to the mining site, but will extent past the boundaries of the quarry area through the vehicles that travel in and out of the quarry.	1	1
Duration			
Throughout life of the activity	Noise generation will continue for the duration of the mining activities.	2	2
Probability			
Definite	All vehicles and mining processes are noise generation activities.	3	3
Reversibility			
During mining only reversible with management. Reversible once mining stops	Noise is an unwanted reality and will always exist with any mining activity. The severity and extent of damage as a result can be controlled and minimised very effectively through proper management and mitigation measures during the life of mine. The impact, however, will cease once mining stops.	2	1
Irreplaceability of resources			
Resource replicable, receptor not sensitive	From an environmental perspective, there are no human receptors that could be harmed through exposure to high noise levels. Therefore no resources are in danger of being damaged or lost.	1	1
Degree to which can be avoided			
Somewhat avoidable with management measures	There will always be noise but the intensity can very effectively be controlled through management and mitigation measures, therefore limiting the disturbance.	2	2
Significance			

Description		Rating before management	Rating with management
Medium to Low	Medium prior to management and mitigation Low with management and mitigation	14	12
Environmental objective: To manage noise nuisance on and around the mine			
Monitoring requirements: The mine monitors occupational noise. This monitoring must include environmental noise.			
Management: • All maintenance and operating of equipment should be done as per specifications of the OEM's. • Effective maintenance of the vehicle engines and exhaust systems. • Hearing conservation programme as per DMR guidelines on Noise Control, including zoning of high noise areas, such as vehicles for people working in close proximity of the vehicle engines while operating • The use of approved hearing protection devices for the personnel involved with the mining process. • Limit the use of noise generation activities or vehicles or appliances after 22:00. • From an occupational perspective the mining workers should be protected through standards and procedures and monitored as requires through Section 12 of the MHSA.			
Roles and responsibility: Mine manager, Safety and health manager			
Management timeframe: Construction until all activities have ceased			
Environmental budget: • PPE to all workers - In-house – no additional budget necessary			

7.1.1.6 Heritage impact assessment

Environmental component: Heritage resources

Activity: Any potential impacts including uncontrolled access to heritage resources or mining activities creeping into in buffer zones

Nature: Permanent and site specific including uncontrolled access to or disturbance of the identified buffer zones, spillage of material, stockpiling, traversing by services, spillage of silt from slimes dams (please note, not this is not part of the proposed Tygerkloof project, but a potential impact for the existing RAM), and flooding.

Consequence: In term of the Heritage Resources Act No 25 of 1999 (HRA) the following applies:

Structures

34. (1) No person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority.

Archaeology, palaeontology and meteorites

35.(4) No person may, without a permit issued by the responsible heritage resources authority—

a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

e) Burial grounds and graves

36.(3) No person may, without a permit issued by SAHRA or a provincial heritage resources authority—

a) destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;

b) destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or

c) bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) any excavation equipment, or any equipment which assists in the detection or recovery of metals.

Impact phase: Impact can take place throughout the project cycle, pre during and post

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	Heritage Resources are protected as indicated above	3	2
Severity or destruction effect			
Large	A risk cautious approach must be applied at all times, any disturbance or impact is regarded as significant	3	2
Extent			
Site specific	Site and locality specific[6]	1	1
Duration			

[6] This rating differs from the specialist report – the rating is incorrectly shown as 3 and 2 in the specialist report

Description		Rating before management	Rating with management
Permanent	Heritage resources are non-renewable and all impacts are permanent	3	2
Probability			
Probably	Highly likely, once people know of the resource they tend to want to visit it. Mining activities will likely impact on the resources without constant management[7]	2	2
Reversibility			
Irreversible (changed from 'permanent' in specialist report)	Once the resources are negatively impacted it is permanent	3	2
Irreplaceability of resources			
Resource is irreplaceable	Access to the site and buffer must be controlled	3	2
Degree to which can be avoided			
Somewhat avoidable with management measures	Impact avoidable with management measures, but must be monitored from time to time[8]	2	2
Significance			
High to medium	High significance prior to management, and medium significance with management[9].	20	15
Environmental objective: To prevent damage or destruction of any heritage resources.			
Monitoring requirements: Refer to paragraph 15 of section1 (EIA)			
Management: 1. General awareness • Heritage awareness must be included in normal site induction for all employees, contractors and visitors to the subject properties. This will ensure that the general level of heritage awareness is raised and that there is compliance with the act. • The sections of the HRA as highlighted above must be given to each visitor, contactor and employee or any other person acting on the sites or immediate surrounds. 2. General heritage management pointers • All actions on the property will be subject to the provisions of the HRA and any transgressions of the act will make the transgressor liable in terms of the act. • Archaeological deposits can occur below ground level. Should any archaeological artefacts or skeletal material be revealed in the area during construction activities, such activities should			

[7] This rating differs from the specialist report – the rating is incorrectly shown as 3 and 2 in the specialist report
[8] This rating differs from the specialist report – the rating is incorrectly shown as 3 and 2 in the specialist report
[9] Rating changed as indicated above – however, significance remains high and medium as sown in the specialist report

Description	Rating before management	Rating with management
be halted, and a university or museum notified in order for an investigation and evaluation of the find(s) to take place (cf. HRA). • Prior to the commencement of any work or action that will impact or effect a heritage resource, the relevant authorisation must be obtained from the SAHRA. • Where there is uncertainty with regard to the status of a heritage resource, object, place or artefact, or any legislative or other policy issue the SAHRA can be contacted for clarity: SAHRA, P.O. Box 2771, CAPE TOWN, 8000, Tel: (021) 465 2198, Fax: (021) 465 5789, Email: info@sahra.org.za 3. Specific heritage management pointers • The following Heritage Management Actions are required on site : • To protect the integrity of the heritage resources it is recommended that the works / mining area be demarcated to limit the footprint of the mining activities and limit creep of activities outside the impact area • During the stripping of topsoil from the mining area a suitably qualified professional must inspect the area for any potential archaeological or heritage resources • Should any archaeological or heritage resources be exposed during the mining activities all activities must be suspended to allow for an investigation by a suitably qualified professional.		
Roles and responsibility: Mine manager		
Management timeframe: Construction until after rehabilitation.		
Environmental budget: • Suitably qualified professional to inspect the area for any potential archaeological or heritage resources - This will be calculated, using the costs as per the heritage consultant for one day to come out to site.		

7.1.1.7 Surface water

Flooding risk

Activity: Development of quarry within drainage lines with the potential of flooding.

Nature: Damage to infrastructure and/or excessive inflow into open quarry.

Consequence: Financial/production loss and/or surface water contamination

Impact phase: Impact can take place throughout construction to decommissioning phase

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	Direct surface runoff of the area is affected	2	1
Severity or destruction effect			
Moderate	Flooding has the potential to cause severe damage to high walls, roads and other infrastructure that may be placed on site.	2	2

Description		Rating before management	Rating with management
Extent			
Site specific	Flooding of quarry and damage to infrastructure is limited to the direct site	1	1
Duration			
Temporary	Temporary impact	1	1
Probability			
Probably	The upstream catchment area will probably produce surface runoff with the potential to flood.	2	1
Reversibility			
Only reversible with management	Impact is reversible when repairs are made or dewatering takes place	2	1
Irreplaceability of resources			
Resource replicable, receptor not sensitive	Planned infrastructure very limited and easy to maintain. Flooding of quarry is easy to dewater and use in the process.	1	1
Degree to which can be avoided			
Avoidable with management measures	Impact avoidable with management measure.	2	1
Significance			
Low	Low to medium significance prior to management, and low significance with management	13	9
Environmental objective: To prevent excessive inflow into the open quarry			
Monitoring requirements: Refer to paragraph 15 of section1 (EIA)			
Management: Clean water berm • Clean runoff water from the mountain area should be diverted around the quarry with a trench along the north to prevent clean inflow into the quarry. Natural drainage line to the east coincides with a servitude from Eskom that provides a proposed 200m wide drainage area through the quarry footprint. • The size of the trench is recommended at 1.5m (width of an average excavator bucket) by 1m deep and vegetation growth should be encouraged, but limited to grass as trees and scrubs may create a blockage. A portion of the runoff should be diverted around the western side of the quarry. As the topography flattens below the quarry the drainage is mainly in an eastern direction where runoff will join with the eastern drainage line of the quarry before forming part of the Bierspruit. Storm water runoff diverted to west will have no impact on the property west of the mine as it can be considered upstream of the proposed diversion outfall. Culvert			

Description	Rating before management	Rating with management
• A culvert will be required where the haul road has to cross the drainage line. • Based on the estimated 1:50 year flood peaks along the drainage line it is anticipated that at least a 3m*2m high box culvert is required to sufficiently allow drainage past the proposed haul road. This can only be used as a reference as it is not based on detailed surveyed data. Refer to Table 7 of the SWMP for the slope and sizing parameters used. Runoff is expected to be at a high velocity and decent erosion control measures are necessary. General storm water management measures • Storm water control infrastructure within this document is design to withstand a 1:50 year flood event. In the event of runoff breaching infrastructure it is important to first ensure the safety of the people on site. • No affected water from the mine is allowed to spill into the clean water environment. This should be ensured through design as well as operational control measures.		
Roles and responsibility: Mine manager		
Management timeframe: Construction until after rehabilitation.		
Environmental budget: • Construction of diversion trench for stormwater - R15,000/year • Construction of culvert at haul road - R75,000		

Erosion and siltation risk

Activity: Concentration of accelerated runoff.

Nature: Erosion of steep slopes accompanied by siltation of downstream receiving environment.

Consequence: Loss of soil with reduced capacity downstream.

Impact phase: Impact can take place throughout construction to decommissioning phase

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	Erosion will be directly at drainage lines and exposed slopes, whereas the settling may impact a wider downstream area	2	1
Severity or destruction effect			
Large	Erosion usually has an escalating effect while the siltation downstream is often uncontrollable.	3	3
Extent			
Beyond the boundaries of adjacent area	The impact of erosion and siltation may extend far downstream.	3	2

Description		Rating before management	Rating with management
Duration			
Permanent	If not prevented or rehabilitated, erosion and siltation may remain after closure.	3	1
Probability			
Probably	If not managed there is a probability that erosion and subsequent siltation will take place.	2	1
Reversibility			
Only reversible with management	Impacts from erosion and siltation can be reversible with adequate rehabilitation.	2	1
Irreplaceability of resources			
Resource replicable, receptor not sensitive	Eroded soil can be replaced and capacity loss from siltation can be re-opened.	1	1
Degree to which can be avoided			
Avoidable with management measures	Careful design of slopes, channels and other storm water measures together with regular maintenance can avoid erosion and siltation.	2	1
Significance			
Medium	Medium significance prior to management, and low significance with management	18	11
Environmental objective: To prevent sedimentation of water resources			
Monitoring requirements: Refer to paragraph 15 of section1 (EIA)			
Management: • Active overburden and topsoil dumps should be defined with berms to prevent erosion runoff extending beyond the property boundaries. Dumps should be free draining and minimise runoff directly over the sides where erosion may be a high risk. • It is recommended that the protected species identified also be demarcated to prevent accidental encroachment into the 100m buffer recommended by the ecologist. • Regular inspections should be conducted on all channels, trenches, berms and pollution control dams to ensure function and capacity of infrastructure is maintained as well as maintenance where signs of erosion become evident. High risk erosion areas include all road and berms where surface water is concentrated into sheet flow. • Erosion prevention measures (e.g. grass, cement or rock) should be in place at all concentration points on the mine. These areas specifically include high velocity trenches and drains diverting clean runoff around the quarries.			
Roles and responsibility: Mine manager			
Management timeframe: Construction until after rehabilitation.			

Description	Rating before management	Rating with management
Environmental budget: • Construction of diversion trench for stormwater - R15,000/year • Checks on erosion - In-house – no additional budget necessary • Regular inspections - In-house – no additional budget necessary		

7.1.1.8 Geology

Loss of geology

Environmental component: Geology

Activity: Mining activities

Nature: Removal of ore

Consequence: Removal of ore will lead to the loss of geology.

Impact phase: Impact will take place during construction and operation, and will be permanent after mining has ceased

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The proposed area of quarry activities is approximately 115.9ha	3	3
Severity or destruction effect			
Low	Loss of geology will not impact any other environmental component	1	1
Extent			
Site specific	The impact will be specific to the site of the activity if management measures are implemented	2	1
Duration			
Permanent	The loss of geology is permanent	3	3
Probability			
Definite	The mining activities is unavoidable	3	3
Reversibility			
Not reversible	Impact will not be reversible	3	3
Irreplaceability of resources			
Resource is not a sensitive receptor	Geology is not a sensitive receptor	1	1

Description		Rating before management	Rating with management
Degree to which can be avoided			
Somewhat avoidable with management measures	Impact avoidable with management measures	2	2
Significance			
Medium	Medium pre-management and medium post-management	18	17
Environmental objective: To prevent unnecessary removal of ore.			
Monitoring requirements: Continual monitoring of mining plan			
Management: • Mining will take place according to the mining plan as approved by DMR.			
Roles and responsibility: Mine manager and surveyor			
Management timeframe: Construction to end of operational phase			
Environmental budget: • Mining plan - In-house – no additional budget necessary			

7.1.1.9 Visual aspect

Environmental component: Visual aspect

Activity: Mining activities

Nature: Removal of ore

Consequence: Removal of ore will lead to a change in topography, which will lead to a visual impact on the area. There are already visual impacts from the existing RAM and other mining activities in the area. This visual impact will only be visible from the R510 as well as adjacent forms to the south of the mine.

Impact phase: Impact will take place during construction and operation, and will be cease after rehabilitation

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The proposed area of quarry activities is approximately 115.9ha	3	3
Severity or destruction effect			
Low	The mining activities will be mostly visible to the R510. Due to the already existing mines in the area, this impact will not be severe.	1	1
Extent			

Description		Rating before management	Rating with management
Area adjacent to site	The quarry will be visible adjacent to the site	2	2
Duration			
Permanent - throughout life of activity	The impact will be permanent without management measures, but only throughout life of mine if management (rehabilitation) takes place.	3	2
Probability			
Definite	The mining activities is unavoidable	3	3
Reversibility			
Only reversible with management	Impact will be reversible if rehabilitation takes place	2	2
Irreplaceability of resources			
Resource is not a sensitive receptor	The visual aspect is not a sensitive receptor	1	1
Degree to which can be avoided			
Not avoidable with management measures	Impact will only cease once complete rehabilitation is finished.	3	2
Significance			
Medium	Medium pre-management and medium post-management	18	16
Environmental objective: To minimise the visual aspect as soon as possible.			
Monitoring requirements: Refer to paragraph 15 of section1 (EIA)			
Management: • The area will be concurrently rehabilitated (refer to paragraph 1.2.4 of section 2 (EMP)).			
Roles and responsibility: Mine manager			
Management timeframe: Construction until after rehabilitation.			
Environmental budget: • As part of financial provison			

7.1.1.10 Socio-economic

Environmental component: Socio-economic

Activity: Mining activities

Nature: Job creation

Consequence: The mine has a social and labour plan (SLP) as part of the mining right process. This plan indicates how the mine must implement human resources development plans, and social economic development plans. This SLP also indicates how the mine will manage down-scaling and retrenchment once mining cease.

Impact phase: Impact will take place during construction and operation, and will be cease after rehabilitation

This impact is of a positive. No impact rating is therefore done. This will be an extension of the existing process operation at RAM so no additional job will be created.

Management: The mine must ensure that the SLP is implemented

Roles and responsibility: Human resources

Environmental budget: Not applicable, part of human resources budget.

7.1.1.11 General

Soil and surface water pollution

Environmental component: Soil and surface water

Activity: Mining activities and placement of overburden; haul road operations

Nature: Hydrocarbon spillages from vehicles and machinery, waste generation.

Consequence: Pollution of soil and surface water resources.

Impact phase: Impact will take place during construction and operation, and will cease after rehabilitation.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The proposed area of quarry activities is approximately 115.9ha, the area of the overburden is 142.2ha, and the haul road is approximately 4ha.	3	3
Severity or destruction effect			
Low	The amount of hydrocarbon spillages form a vehicle or machinery, as well as waste generation will not be severe.	1	1
Extent			
Area adjacent to site	Water run-off from the area will impact the adjacent drainage lines.	2	1
Duration			

Description		Rating before management	Rating with management
Throughout life of activity	Water run-off will cease once the area is rehabilitated	2	1
Probability			
Probably	Without management measures, there will be probably of pollution.	2	1
Reversibility			
Reversible	The impact will be reversible with management measures.	1	1
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	The drainage lines are somewhat sensitive to hydrocarbon pollution	1	1
Degree to which can be avoided			
Avoidable with management measures	Impact avoidable with management measures	1	1
Significance			
Low	Low pre-management and low post-management	13	10
Environmental objective: To prevent spillages from vehicles and machinery			
Monitoring requirements: This will depend on the spill handing procedure			
Management: • The mine will compile and implement a spill handling procedure to contain any potential spillages form vehicles and machinery, and a waste management procedure to manage waste disposal. • The mine will adhere to the Water and Waste management as set out in the IWWMP.			
Roles and responsibility: Mine manager			
Management timeframe: Construction until after rehabilitation.			
Environmental budget: • Spill handling and waste management procedure - R5,000 once off			

Inadequate planning and design, not taking specialist studies and sensitive area into consideration

Impact	Objectives	Management measures	Responsible person
Impacts on various environmental components that could potentially have been avoided	To plan and design the proposed mine extension to such as degree that impacts are prevented and/or minimised and that the mine works towards rehabilitation after the life of mine has ceased.	Site selection must consider: • the recommendations of the specialist reports; • the environmental map which indicates sensitive areas	Mine manager and surveyor

Impact	Objectives	Management measures	Responsible person
Monitoring compliance and reporting: The site layout has been adjusted to include all buffer zones and 'no-go' areas as stipulated by the specialists. The mine must ensure compliance to these buffer zones and areas.			
Timeframe: Completed prior to construction phase			

7.1.2 Alternative option

Refer to the preferred option for comprehensive management options.

7.1.2.1 Soil, land use and land capability

There will be no difference on the soil, land use and land capability impact as assessed between the two overburden alternatives.

7.1.2.2 Ecological assessment

The proposed quarry placement for the alternative option coincides with vegetation units of low (*Dichrostachys* thicket) to medium (open woodland) sensitivities. The location alternative for overburden placement is north of the quarry, thereby overlapping with sensitive mountain bushveld. This section only indicates the alternative impact assessment for the placement of the discard dumps.

Loss and clearing of vegetation communities

Environmental component: Vegetation communities

Activity: Construction and operation of discard dumps

Nature: The placement of discard dumps coincide with habitat of low to high ecological sensitivities.

Consequence: Loss of floristic communities (affecting floristic richness, floristic structure, and ecological condition) and loss of declining, protected and near threatened plant taxa.

Impact phase: Impact will take place during construction and operation

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The proposed area for the placement of the discard dumps is approximately 142.2ha	3	3

Description		Rating before management	Rating with management
Severity or destruction effect			
Very Large	Loss of vegetation pertaining to areas with **high ecological sensitivity**	3	2
Large	Loss of vegetation pertaining to areas with **medium ecological sensitivity**	3	2
Moderate	Loss of vegetation pertaining to areas with **low ecological sensitivity**	2	1
Extent			
Site specific	The impact will be specific to the site of the activity	1	1
Duration			
Permanent	The loss of vegetation is permanent	3	2
Probability			
Definite	The construction and mining activities is unavoidable	3	3
Reversibility			
Irreversible	Impact is irreversible. The dominant floristic composition is highly specialised and given the leached nature of the soil types and a subsequent adaptation to a nutrient-poor system, recovery is likely to be near-impossible - **high ecological sensitivities**.	3	3
Only reversible with management	Impact will only be reversible intensive ecological restoration - **medium to low ecological sensitivities**.	2	2
Irreplaceability of resources			
Resource irreplaceable, receptor highly sensitive	Restoration is impossible to achieve pre-mining conditions without intense effort owing to loss of seed bank- **high ecological sensitivity**	3	3
Resource irreplaceable, receptor highly sensitive	Restoration is potentially impossible to achieve pre-mining conditions without intense effort owing to expected partial loss of seed bank- **medium ecological sensitivity**	3	2
Resource somewhat replaceable, receptor moderately sensitive	Impact will only be reversible during intensive ecological restoration - **low ecological sensitivity**	2	1
Degree to which can be avoided			
Not avoidable with management measures	**High ecological sensitivity**	3	3
Somewhat avoidable with management measures	Impact avoidable with management measures) - **low to medium ecological sensitivity**	2	1

Description		Rating before management	Rating with management
Significance			
High pre-management and high post-management	Areas of **high ecological sensitivity**	22	20
High pre-management and medium post-management	Areas of **medium ecological sensitivity**	20	16
Medium pre-management and low post-management	Areas of **low ecological sensitivity**	18	13
Management: • The attached sensitivity map must be used as a decision tool to guide the layout design. The placement of discard dumps should preferably be restricted to areas identified with *low* conservation importance. *Placement on areas of high conservation importance should be avoided.* • Footprint areas must be scanned for protected and near threatened tree species during a walk-trough of the affected area prior to the construction/mining phase. It is recommended that these plants be identified and marked prior to the development in order to obtain the necessary permits from the relevant authority. • Where possible, large and aged specimens of protected trees (e.g. *Vachellia erioloba*) and *Elaeodendron transvaalensis* should be retained and buffered (see Figure 32 (Pachnoda, 2015) and the sensitivity map to follow this report). All buffered areas should form part of an open space network to promote movement of fauna when a high rate of natural disruption is expected and to conserve part of the seed bank diversity (essential for restoration). • Rehabilitation/restoration should make use of indigenous species, and preferably of species native to the study site and immediate surroundings. The species selected should strive to represent habitat types typical of the ecological landscape prior to construction. • Checks must be carried out at regular intervals to identify areas where erosion is occurring. Appropriate remedial action, including the rehabilitation of the eroded areas, and where necessary, the relocation of the roads causing the erosion, are to be undertaken. • Excavated and stockpiled soil material are to be stored and bermed on the higher lying areas of the footprint area and not in any storm-water run-off channels or any other areas where it is likely to cause erosion, or where water would naturally accumulate.			

Loss of floristic diversity and invasion by declared aliens

Environmental component: Floristic diversity

Activity: Construction and operation of discard dumps

Nature: Invasive plants may establish due to surface area disturbance and also through future rehabilitation activities (e.g. seeding practices). This may lead to:

Displacement of indigenous vegetation; Change in plant species composition; Change in vegetation composition and structure; Competition for sunlight will increase between indigenous and alien species; and Loss of habitat and a change in biodiversity.

Consequence: Loss of floristic diversity and changes to the community composition (both fauna and flora).

Impact phase: Impact will take place during construction and operation

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The proposed area for the placement of the discard dumps is approximately 142.2ha	3	3
Severity or destruction effect			
Moderate	The region is not characterised by aggressive alien vegetation, thereby the impact is not expected to be highly severe.	2	1
Large	The impact is likely to be more severe on/adjacent to areas of **high ecological sensitivity**	3	2
Extent			
Area adjacent to site	The impact could spread beyond area of disturbance.	2	1
Duration			
Throughout life of activity	The impact is likely to persist during rehabilitation.	2	1
Probability			
Definite	It is expected that ruderal and annual weed will colonise the area along with opportunistic floristic taxa (resulting in a species poor community)	3	2
Reversibility			
Only reversible with management	Impact will only be reversible by means of active control and eradication programmes.	2	1
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	Impact will only be reversible by means of active control and eradication programmes	2	1
Degree to which can be avoided			
Avoidable with management measures	The impact can be avoided by means of active control and eradication programmes and follow-up control strategies	1	1
Significance			
Medium to low	Medium pre-management and low post-management	17	11
Medium pre-management and low post-management	Areas of **high ecological sensitivity**	18	12

Description	Rating before management	Rating with management
Management: • An alien and invasive plant eradication and control programme must be implemented along with a follow-up programme. The programme must be compiled by a qualified botanist/ecologist and the implementation thereof should be supervised by a qualified botanist/ecologist. • Priority should be given to eradicate aggressive species. • Method of removal, that will depend on category of identified species and seasonal period when recorded. • Any action taken to control and eradicate a listed invasive species shall be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment. • Future rehabilitation strategies must consider sensitivity of the flora/fauna within the area, and prevent the introduction of species that may compromise the existing habitat and/or promote the establishment of invader plants (e.g. transporting of material to the study site including plant specimens/seedlings used during rehabilitation (see below). • Inspect all materials to be used during construction/operation for potential invader species before being transported to the construction/operational area.		

Loss/displacement of fauna

Environmental component: Fauna

Activity: Construction and operation of discard dumps

Nature: Placement of discard dumps will clear areas of low to medium ecological sensitivities to construct a quarry.

Consequence: Loss of fauna richness during clearing of vegetation and loss of fossorial and stenotopic taxa with restricted dispersal abilities. The proposed construction (site clearing and earthworks) and operational (mining operations) activities go hand in hand with high ambient noise levels and the eventual displacement of animal taxa. Many of the larger terrestrial mammal and bird species will vacate these areas (including taxa of conservation concern).

Impact phase: Impact will take place during construction and operation

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The proposed area for the placement of the discard dumps is approximately 142.2ha	3	3
Severity or destruction effect			
Moderate	Loss of fauna pertaining to areas with **low ecological sensitivity**	2	1
Large	Loss of fauna pertaining to areas with **medium ecological sensitivity**	3	2
Very Large	Loss of fauna pertaining to areas with **high ecological sensitivity**	3	3
Extent			

Description		Rating before management	Rating with management
Area adjacent to site	The impact will be specific to the site and the surrounding habitat.	2	2
Duration			
Permanent	The anticipated loss of habitat (vegetation) will result in the displacement of fauna.	3	2
Probability			
Definite	The construction and mining activities is unavoidable - **low ecological sensitivity**	3	2
Definite	The construction and mining activities is unavoidable - **medium ecological sensitivity**	3	3
Definite	The construction and mining activities is unavoidable - **high ecological sensitivity**	3	3
Reversibility			
Only reversible with management	Impact will only be reversible during intensive ecological restoration (which is often difficult to achieve) - **low to medium ecological sensitivity**	2	2
Irreversible	Impact is considered irreversible when coinciding with areas of **high ecological sensitivity**	3	3
Irreplaceability of resources			
Resource somewhat replaceable, receptor moderately sensitive	Impact will only be reversible during intensive ecological restoration and management - **low ecological sensitivity**	2	1
Resource irreplaceable, receptor highly sensitive	Restoration is potentially impossible to achieve pre-mining conditions without intense effort. It is expected that changes to the community structure will occur, with increased colonisation rates by opportunistic/transient taxa with widespread distribution ranges - **medium ecological sensitivity**	3	2
Resource irreplaceable, receptor highly sensitive	Restoration is potentially impossible to achieve pre-mining conditions without intense effort. Areas providing optimal habitat for stenotopic taxa and/or taxa of conservation concern - **high ecological sensitivity**	3	3
Degree to which can be avoided			
Somewhat avoidable with management measures	Impact avoidable with management measures (see below) although different taxa react/respond differently.	2	1
Significance			
Medium pre-management and low post-management	Areas of **low ecological sensitivity**	19	14
High pre-management and medium post-management	Areas of **medium ecological sensitivity**	21	17
High pre-management and	Areas of **high ecological sensitivity**	22	20

Description		Rating before management	Rating with management
high post-management			
Management: • The attached sensitivity map must be used as a decision tool to guide the layout design. Mining and construction activities should preferably be restricted to areas identified with *low* conservation importance. *Open cast mining on areas of high conservation importance should be avoided.* • Rehabilitation/restoration should make use of indigenous plant species, and preferably of species native to the study site and immediate surroundings. The species selected should strive to represent habitat types typical of the ecological landscape prior to construction. • Reinstate/rehabilitate as a continual process – this will maximise the viability of the natural seed bank and prevent the unnecessary loss of topsoil during storage. • Checks must be carried out at regular intervals to identify areas where erosion is occurring. Appropriate remedial action, including the rehabilitation of the eroded areas, and where necessary, the relocation of the roads causing the erosion, are to be undertaken. • All labour or staff should be advised (induction) by means of environmental awareness training on the biodiversity importance of the area. • •Intentional killing of any faunal species (in particular invertebrates and snakes) should be avoided by means of awareness programmes presented to the labour force. The labour force should be made aware of the conservation issues pertaining to the taxa occurring on the study site. Any person found deliberately harassing any animal in any way should face disciplinary measures, following the possible dismissal from the site. • All waste (if present) should be removed from the study site as soon as possible and should be appropriately covered to reduce the risk of colonisation by feral mammals or competitively superior bird species (e.g. Pied Crows *Corvus albus*).			

7.1.2.3 Groundwater

There will be no difference on the groundwater impact as assessed between the two overburden alternatives.

7.1.2.4 Air quality

Qualitative assessment of the significance of operational phase air quality impacts associated with PM and gaseous emissions (alternative overburden dump location)

Activity	Impact	Quantity or size of disturbance	Severity or destruction effect	Extent	Duration	Probability	Reversibility	Irreplaceability of resources	Degree to which can be avoided	Significance
Operational phase – Scenario B	$PM_{2.5}$	1	1	2	2	2	2	2	1	13 (Low) [(a)]
	PM_{10}	2	2	2	2	2	2	2	2	16 (Medium) [(b)]
	NO_2	1	1	2	2	2	2	2	2	14 (Medium) [(c)]

	VOCs	1	1	1	2	2	2	2	1	12 (Low) [(d)]
	CO	1	1	1	2	2	2	2	1	12 (Low) [(d)]
	SO_2	1	1	1	2	2	2	2	1	12 (Low) [(d)]
	Dustfall (Nuisance effect)	1	1	1	2	2	2	2	1	12 (Low) [(d)]

Notes: Description of Significance Rating

[(a)] The proposed activities will contribute minimally to the pollutant baseline footprint in the area (low). Impacts will recede with recommended mitigations or when the activities cease.

[(b)] The proposed activities will contribute slightly significantly to the pollutant baseline footprint in the area (medium). Impacts will recede with recommended mitigations or when the activities cease.

[(c)] The proposed activities will contribute slightly significantly to the pollutant baseline footprint in the area (medium). Impacts will recede with recommended mitigations or when the activities cease.

[(d)] The proposed activities will contribute minimally to the pollutant baseline footprint in the area (low). Impacts will recede with recommended mitigations or when the activities cease.

Unpaved roads and crushing and screening were identified as the major contributor to PM emissions. The main dust generating factors on unpaved road surfaces include: Vehicle speeds; Number of wheels per vehicle; Traffic volumes; Particle size distribution of the aggregate; Compaction of the surface material; Surface moisture; and Climate.

Management measures:

- The mine must commit itself to adequate air quality management planning throughout the life of the proposed project. The air quality management plan provides options on the control of dust particles and gases at the main sources, while the monitoring network is designed to track the effectiveness of the mitigation measures.
- For the control of vehicle entrained dust it is recommended that water (at an application rate of 1litre/m2-hour), be applied in combination with addition of chemicals. Literature reports an emissions reduction efficiency of 80%.
- In minimising windblown dust from stockpile areas, water sprays should be used to keep surface material moist and wind breaks installed to reduce wind speeds over the area.
- Once a portion of the area has reached the end of its active life i.e. sides and certain surface areas, it should be rehabilitated. If this is done continually, a 75% or more reduction in emissions is anticipated.
- To ensure lower diesel exhaust emissions, equipment suppliers or contractors should be required to ensure compliance with appropriate emission standards for mining fleets.

7.1.2.5 Environmental noise

From an environmental perspective there will be no difference on the noise impact as assessed between the two overburden alternatives. There will be no residents or small holdings or informal settlements or factories in close proximity of the operations and there should be no significant difference in the noise levels generated while the overburden is located on either the northern side or the southern side of the quarry.

7.1.2.6 Heritage impact assessment

The impact assessment as indicated under Paragraph 7.1.1 of Section 1 (EIA) (preferred option) is done on resources that are on the mining area (including RAM) but not on the area of disturbance (quarry, overburden or haul road). This impact assessment are therefore not site specific and there will be no difference between the preferred option and the alternative.

7.1.2.7 Surface water

Erosion and siltation risk

Activity: Concentration of accelerated runoff.

Nature: Erosion of steep slopes accompanied by siltation of downstream receiving environment.

Consequence: Loss of soil with reduced capacity downstream.

Impact phase: Impact can take place throughout construction to decommissioning phase

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	Erosion will be directly at drainage lines and exposed slopes, whereas the settling may impact a wider downstream area. Stockpiles on steep slopes increase the size of potential erosion.	2	2
Severity or destruction effect			
Large	Erosion usually has an escalating effect while the siltation downstream is often uncontrollable.	3	3
Extent			
Beyond the boundaries of adjacent area	The impact of erosion and siltation may extend far downstream.	3	2
Duration			
Permanent	If not prevented or rehabilitated, erosion and siltation may remain after closure.	3	1
Probability			
Definite	Proposed stockpiles on the steep mountain slopes will definitely result in large scale erosion and siltation of overburden and topsoil dumps with no adequate measure to prevent erosion on these steep slopes.	3	3
Reversibility			

Description		Rating before management	Rating with management
Only reversible with management	Impacts from erosion and siltation can be reversible with adequate rehabilitation.	2	1
Irreplaceability of resources			
Resource replicable, receptor not sensitive	Eroded soil can be replaced and capacity loss from siltation can be re-opened.	1	1
Degree to which can be avoided			
Somewhat avoidable with management measures	It will be much more difficult to avoid erosion of stockpiles on the steep slopes, especially operational dumps	2	2
Significance			
Medium	Medium to high significance prior to management, and medium significance with management	19	15
Management: • In addition to management measures listed within Section 4.6 and 4.7 of the SWMP, stockpiling of overburden and topsoil on the steep mountain slopes north of the proposed pit will require special design. • These stockpiles will require contoured steps at least every 5m in elevation to control runoff. • Stability tests are also required on the material to determine the risk of landslides during heavy rainfall events. • This alternative is not recommended due to the difficulty and high risk associated with controlling storm water runoff along the steep slopes of the mountain.			

7.1.2.8 Geology

There will be no difference on the geological impact for the alternative.

7.1.2.9 Visual aspect

There will be no difference on the visual impact for the alternative.

7.1.2.10 Socio-economic

The positive impact will be similar for the alternative option.

7.2 Concomitant impact rating for each potential impact listed in paragraph 7.1 above in terms of its nature, extent, duration, probability and significance

According to the Information Series 5: Impact Significance of the Integrated Environmental Management Information Series (Department of Environmental Affairs and Tourism, 2002):
'The concept of significance is at the core of impact identification, prediction, evaluation and decision-making. Deciding whether a project is likely to cause significant environmental effects is central to the practice of EIA.'

Impact assessment is therefore based on the description of an impact, the significance of this impact, and how the impact can be managed. Impact assessment and management measures must be based on the requirements as set out in the relevant Regulations and guidelines of the National Environmental Management Act No 107 of 1998 (as amended), the Minerals and Petroleum Resources Development Act No 28 of 2002 (as amended), and the National Water Act No 36 of 1998 (as amended). All impacts identified as part of this process must be done using the criteria as set out below. Refer to the two examples below as well.

Please note, impact assessment must be conducted for both the preferred option as well as the alternative option. These options are as follow:
'The preferred location for the overburden is south of the open quarry, with one overburden dump placed north of the open quarry. The location alternative is to place all the overburden on the northern side of the open quarry.'

1. Nature: Description of the aspect of the activity;
2. Consequence: Result of aspect on the environment;
3. Extent;
4. Duration: Including during which phase (construction, operational, decommissioning) and whether temporary, throughout the life of the activity or permanent;
5. Probability;
6. Reversibility;
7. Irreplaceability of resources: Sensitivity of resources or environmental receptor; and
8. Degree to which can be avoided: This will include significance rating after management incorporated.
9. Significance: This is worst case scenario without any management measures. See below how significance is determined:

Description	Rating
Quantity or size of disturbance	
Very small to small	1
Moderate	2
Large to very large	3
Severity or destruction effect	

Description	Rating
Very low to low	1
Moderate	2
Large to very large	3
Extent	
Site specific	1
Area adjacent to site	2
Beyond the boundaries of adjacent area	3
Duration	
Temporary	1
Throughout life of activity	2
Permanent	3
Probability	
Not probably	1
Probably	2
Definite	3
Reversibility	
Reversible	1
Only reversible with management	2
Irreversible	3
Irreplaceability of resources	
Resource replicable, receptor not sensitive	1
Resource somewhat replaceable, receptor moderately sensitive	2
Resource irreplaceable, receptor highly sensitive	3
Degree to which can be avoided	
Avoidable with management measures	1
Somewhat avoidable with management measures	2
Not avoidable with management measures	3
Significance	
Low	8-13
Medium	14-19
High	20-24

7.3 Indication of the phases (construction, operational, decommissioning) and estimated time frames in relation to the potential impacts rated

Refer to Paragraph 7.1 of Section 1 (EIA) above for the phases and estimated time frames in relation to the potential impacts rated.

REGULATION 50 (d)

8. Identification of the alternative land uses which will be impacted upon

Refer to Paragraph 7.1.2 of Section 1 (EIA) above.

9. Listed results of a specialist comparative land use assessment

Refer to Paragraph 7.1.2 of Section 1 (EIA) above.

REGULATION 50 (e)

10. List of all the significant impacts as identified in the assessment conducted in terms of Regulation 50 (c)

Refer to Refer to Paragraph 7.1 of Section 1 (EIA) above for the phases and estimated time frames in relation to the potential impacts rated.

REGULATION 50 (f)

11. Identification of interested and affected parties

According to the Publication of Participation Guideline (NEMA), and I&AP is:

"(a) any person, group or persons or organisations interested in or affected by an activity, and (b) any organ of state that may have jurisdiction over any aspect of the activity".

This definition is more detailed in the Guideline for consultation with communities and I&APs (MPRDA):

"I&APs include, but are not limited to; (i) Host Communities, (ii) Landowners (Traditional and Title Deed owners), (iii) Traditional Authority, (iv) Land Claimants, (v) Lawful land occupier, (vi) The Department of Land Affairs, (vii) Any other person (including on adjacent and non-adjacent properties) whose socio-economic conditions may be directly affected by the proposed prospecting or mining operation (viii) The Local Municipality, (ix) The relevant Government Departments, agencies and institutions responsible for the various aspects of the environment and for infrastructure which may be affected by the proposed project."

This PPP was conducted to include the definitions of both the NEMA and MPRDA guidelines. RAM is the landowner of Portion 5 of the farm Tygerkloof 354 KQ, which is situated adjacent to Portion 1 and the Remaining Extent of the farm Buffelsfontein 353 KQ, also owned by RAM. Tygerkloof Mining and RAM fall under the management of Imerys Refractory Minerals, a member of the Imerys Group. The following I&APs were identified:

Table 50: Interested and affected parties identified

Historical disadvantaged communities
None identified
Landowner
RAM - RAM and Tygerkloof Mining form part of Imerys SA
Traditional authority
None identified
Land claimants
None confirmed by Office of the Regional Land Claims Commissioner: Limpopo
Lawful land occupier
Owner is RAM, no occupier currently on site.
Any other person whose socio-economic conditions may be directly affected by the proposed prospecting or mining operation
See list attached as Addendum 4A. This list indicates all persons that have registered as I&APs. Only registered I&APs will receive any further correspondence, including the EIAR and EMP.
Local municipality
Thabazimbi Local Municipality
Relevant government departments – Refer to Addendum 4B
Waterberg district Municipality
Ward Councillor – Ward 3
SAHRA
DWS
Department of Agriculture, Forestry and Fisheries
LEDET
Local Department of Environmental Affairs
DRDLA
DMR

12. The details of the engagement process

An advertisement was published in the local newspaper “Die Kwëvoël” on 12 December 2014. Refer to Addendum 4C for a copy and proof of this advertisement. Four site notices were placed at and around the site on 9 December 2014. One site notice was placed at the security gate of the mine, one site notice at the entrance road to the mine, and two site notices were placed at the Roodedam Farms, adjacent to the site. Refer to Addendum 4D for a copy and proof of the site notices placed. Also refer to Addendum 4D for a map indicating the location of these site notices.

Background information documents (BIDs) were distributed to all adjacent landowners, and stakeholders from 8-15 December 2014 via email or per hand delivery. Refer to Addendum 4E for a copy of the BID proof of BIDs emailed and proof of BIDs hand delivered.

A public and stakeholders meeting was held on 9 January 2015, 10h00, at the Leadwood Lodge, adjacent to the existing mine. Refer to Addendum 4F for the meeting presentation and for the attendance register. Only two I&APs attended the meeting. One I&AP asked for some clarification on the process. No comments or issues were raised during the meeting. An email were send to all I&APs and stakeholders, giving feedback on the meeting held. Refer to Addendum 4G for this feedback email. Emails were send to all registered I&APs to inform them about LEDET's letter regarding the EIA Regulations changes and new timeframes, as well as a step-by-step explanation on how to use Dropbox. Refer to Addendum 4G for these emails.

All specialist reports were uploaded and emails were send out to the I&APs to indicate this, and to send a link to the dropbox folder. Refer to Addendum 4H for these emails.

The draft ESR in terms of MPRDA was uploaded onto Dropbox on 12 January 2015. The draft ESR in terms of NEMA was uploaded on dropbox on 4 February 2015. The draft EIAR without all final specialist studies, was uploaded onto Dropbox on 30 April 2015 (this report was only in draft format and did not include the final Air Impact Assessment report, Soil, land capability and land use assessment report, Geohydrological report, or Stormwater management plan. The layout plans were also only in draft format), and the draft EIAR with all final specialist studies, was uploaded onto Dropbox on 29 May 2015. The EMP in terms of MPRDA was uploaded onto Dropbox on 8 June 2015. Refer to Addendum 4I wherein the I&APs and stakeholders were notified that these reports were uploaded onto Dropbox.

13. Details regarding the manner in which the issues raised were addressed

All comments and responses during the EIA, EMP, and WULA processes are included in a table and appended to this EMP as Addendum 4N. Below is a summary of all correspondence during the PPP.

Comment 1 – Land claims:

DRDLA send a response to our letter requesting any information on land claims. According to their letter, there are no land claims currently on the property. Refer to Addendum 5A for this letter.

Comments 2 – Registering I&APs:

Various parties requested to be registered as I&APs. These parties are indicated in Addendum 4A. Refer to Addendum 4J for communication regarding the registering of I&APs.

Comment 3 – Dropbox link

Mr. De Jager send an e-mail on 29 April, indicating he cannot access the dropbox folder which contains the ESR. This link was send again to Mr. De Jager. Refer to Addendum 4K for this communication.

Comment 4 - Andalusite Resources

Mr De Jager send an e-mail on 12 May 2015 with comments on the proposed new Tygerkloof Mine. The following concerns were raised:

Andalusite Resources have been granted a mining right on Re portion 1 Maroeloesfontein 366 KQ which boarders the area to the south where Tygerkloof Mining & Rhino Andalusite Mine now applies for a mining right. Andalusite Resources have two issues regarding the application:

- Rainfall / stormwater falling on the upstream of Tygerkloof Mine will be channelled' around the quarries. He enquired what the layout will consist of and how will Tygerkloof Mining ensure that the water does not result in a negative impact on the Andalusite Resources mining right area.
- He also enquired whether the mine considered the impact of MHSA Regulation 17.7 and 17.8 as well as 17.10(b).

A letter was send to Mr De Jager via email on 13 May 2015 stating the following:

- The mine will ensure that the cut-off trench divert the water into an easterly direction, by ensuring their levels in the channel is correct to allow for such flow. The stormwater management plan is currently being reviewed by myself as well as the mine. We will ensure this comment is included and addressed in the plan.

Please note: The stormwater plan has been amended to include this concern for Andalusite Resources. The stormwater management plan is attached as Addendum 3C to this EIA. The management measures are also incorporated into this EIA report.

- The mine will do a risk assessment and add it to the EIA and EMP that will be scrutinised by the CIOF.

Please note: This risk assessment is underway and will be send to Andalusite Resources prior to the final submission of this EIA report to LEDET as well as submission of the EMP to DMR.

- The mine will respect the 9m pillar boundary with Maroeloesfontein.

Refer to Addendum 4L for the correspondence between Mr De Jager and BECS Environmental.

Comment 5 – DMR:

An email was received from Ms M Sathekge of DMR on 12 May 2015. She enquired whether hard copies of the EIA report will be send to her. BECS environmental replied that a hard copy will be send as soon as the EIA report is finalised with all the specialist studies. All specialist studies wil be send on a CD because these studies will also be send along with the EMP as part of the MPRDA process. This EIAR was send to s Sathekge. Refer to Addendum 4M for the correspondence between Ms Sathekge and BECS Environmental.

REGULATION 50 (g)

14. The appropriate mitigatory measures for each significant impact of the proposed mining operation

14.1 Adequacy of predictive methods utilised

The mitigation measures as described this EMP have been used adequately by various mines and on various other sites.

14.2 Adequacy of underlying assumptions

The mitigation measures as described in this EMP was obtained from specialist studies and are adequate for the proposed activities.

14.3 Uncertainties in the information provided

Maps

The original site layout plan were based on the Clarke 1880 survey system and not the WGS system. This plan has been revised, however, the Eskom pillar may still be misplaced on the revised plan.

Ecology

In order to obtain a comprehensive understanding of the dynamics of the floristic and faunal communities on the study site, as well as the status of endemic, rare or threatened species in any area, ecological assessments should always consider investigations at different time scales (across seasons/years) and through replication. However, due to time constraints such long-term studies were not feasible. Please note that the inventories listed in the specialist report are not complete and is merely a reflection of the dominant taxa on the study site during instantaneous sampling. A complete inventory, irrespective of the taxon or group of taxa will only be achieved during long-term temporal sampling. The information as presented in the specialist report only has reference to the investigated mining right boundary and cannot be applied to any other area without prior investigation.

Groundwater

Only once-off groundwater quality samples were used to compile the geohydrological report. The groundwater quality analyses are therefore limited to these once-off results. The once-off sampling data is insufficient to explain any phenomena in the water qualities.

Air quality

- The quantification of sources of emission was restricted to the existing and proposed project. Background pollutant concentrations are not included.
- Routine emissions were estimated and simulated.
- In the absence of on-site surface meteorological data, use was made of modelled MM5 data for an on-site location.

- A minimum of 1 year is generally recommended for use in atmospheric dispersion modelling for air quality impact assessment purposes. The 2014 MM5 meteorological data was utilized in this study.
- The impact assessment was limited to airborne particulates (including TSP, PM10 and PM2.5) and gaseous pollutants from diesel engines, including CO, NOx, VOCs and SO2.
- Nitrogen monoxide (NO) emissions are rapidly converted in the atmosphere into the much more poisonous nitrogen dioxide (NO2) which is regulated by SA NAAQS. NO2 concentrations were calculated by the adoption of the Ambient Ratio Method (ARM) as stipulated by DEA (2014). The ARM assumes a wide area quasi-equilibrium state and multiply the Tier 1 empirical estimate NO by a ratio of NO2/NOx = 0.80. The ratio is recommended for South Africa as the conservative ration based on a review of ambient air quality monitoring data from the country.
- Construction and decommissioning phase impacts were not quantified. Impacts associated with this phase are highly variable and generally less significant than operational phase impacts. Mitigation and management measures recommended for the operational phase are however also applicable to the construction and closure phases.
- VOC emissions from diesel storage were not included. It is known to contribute minimally to total VOC emissions from mining operations

Heritage

The north western section of the site is thick sickle bush (*Dichrostachys cinerea*). It is so thick that walking through it is impossible. The dense growth of sickle bush is an indication of over grazing and utilisation. In this area archaeological sites should be present but will only be found if the area is cleared of sickle bush. When the mine cleans the area for mining an archaeologist should be present to identify possible archaeological sites.

Surface water

- Calculations assume uniform rainfall intensities throughout the duration of the storm over the entire catchment areas assessed.
- Storm water control recommendations are based on industry experience and best practice. Designs are based on capacity sizing and should be used as a guide in the preparation of the site.
- Contour elevation data used during the assessment is received from the Surveyor-general and the data is assumed to be accurate.
- This storm water management plan does not distinguish between existing or proposed measures and should be viewed as an operation document for the complete management of all storm water requirements.

REGULATION 50 (h)

15. Arrangements for monitoring and management of environmental impacts.

15.1 List of identified impacts which will require monitoring programmes

All identified impacts must be monitored to some extent.

15.2 Functional requirements for the said monitoring programmes

15.2.1 Soil, land capability, and land use

The manner in which soil stripping must take place, is indicated in paragraph 1.2.4 of Section2 (EMP). Soil stripping must be continuously monitored during the construction, operational en rehabilitation phases. Continuous monitoring to ensure mining takes place according to the mining plan will help to prevent over-utilisation of soil.

15.2.2 Ecology

Road kills must be monitored and a database crated of species killed to identify areas with a high frequency of mortalities. Continuous monitoring to ensure mining takes place according to the mining plan will help to prevent removal of sensitive species. Checks must be carried out at regular intervals to identify areas where erosion is occurring. Monitoring of alien and invasive vegetation will take place in accordance with the Alien Eradication programme to be compiled.

Biomonitoring: No natural water bodies are located on the property to conduct valuable biomonitoring. Drainage lines through the mining areas are non-perennial and does not sustain any aquatic life. The Bierspruit is the closest defined water drainage line. This is however also a non-perennial tributary and only has intermitted flow after heavy rains.

15.2.3 Groundwater

Groundwater samples will be collected from purpose drilled source monitoring boreholes around the project area on a quarterly basis. Water levels of these boreholes will also be determined on a quarterly basis when the sampling is done. Samples will be analysed for chemical and physical constituents normally associated with andalusite mining. These constituents are listed in Table 51.

Two source monitoring boreholes were drilled directly down gradient from the proposed quarry area. A third user borehole, namely FerdieBotha2 is recommended as an up gradient monitoring point. The positions of the three monitoring boreholes are indicated in Figure 37, while relevant information regarding the monitoring boreholes is also provided in Table 52. It must be mentioned that this monitoring schedule will be re-assessed by a qualified geohydrologist at a later stage in terms of stability of water levels and quality. Should the sampling program be changed, it should be done in consultation with the DWS.

Table 51: Summary of source monitoring boreholes

BH	South	East	Elevation (mamsl)	Depth (m)	SWL	Comments
TKBH01	-24.73383	27.23390	1031	47	38.9	New source monitoring borehole
TKBH02	-24.74094	27.22045	1052	47	33.6	New source monitoring borehole
FerdieBotha2	-24.73134	27.22120	1080	45	19.2	User borehole

Note: Coordinates – WGS84; mamsl – meters above mean sea level; SWL – static water level.

Table 52: Groundwater constituents for routine analysis

Monitoring	Variable
Quarterly*	EC, pH, TDS, total hardness, total alkalinity, Ca, Mg, Na, K, chloride, SO_4, fluoride, NO_3, iron, manganese, aluminium and turbidity.

Note: * Once trends are established, some of these constituents may be sampled less frequent, while others found to be problematic may be added as determined on consultation with the relevant role players, such as the DWS: Regional Office.

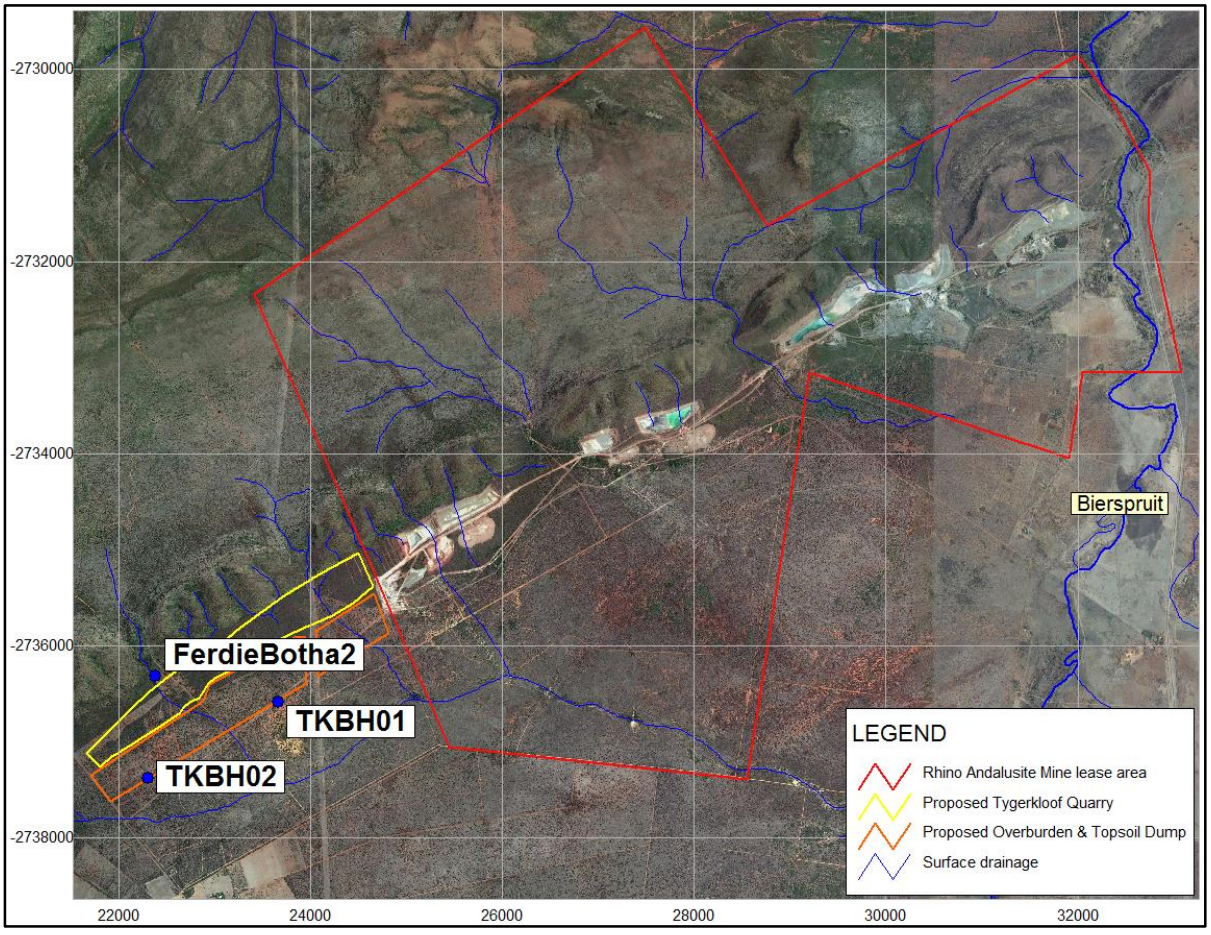


Figure 37: Positions of source monitoring boreholes

The following maintenance activities will be adhered to:

- Monitoring boreholes will be capped and locked at all times,
- Borehole depths will be measured quarterly and the boreholes will be blown out with compressed air, if required and
- Vegetation around the boreholes will be removed on a regular basis and the borehole casings painted, when necessary, to prevent excessive rust and degradation.

Reporting on groundwater quality conditions will be included in the annual report. The quarterly report will be an update of the database with time-series graphs and statistical analysis (average, maximum, minimum, 5 -, 50 – and 95 percentile values as well as linear performance). Data will also be presented in a map format to present a clear picture of the water quality situation. Laboratory results will be analysed against the target water quality guidelines for domestic use, the aquatic environment, livestock watering and irrigation (according to the South African National Standards for drinking water; *SANS 241:2011*). The strictest value between the target water quality objectives or objectives through a reserve determination will be used. In terms of flow, all water uses and discharges will be measured on an ongoing basis. The flows include:

Make-up water:

- Volumes of groundwater seepage into the opencast workings (not relevant to proposed Tygerkloof Quarry),
- Volumes of contaminated water used for dust suppression,
- An annual detailed evaluation report on the surface and groundwater quality will be prepared that will analyse the water quality situation in detail to investigate trends and non-compliance.

Data Management:

- Monitoring results will be entered into an electronic database as soon as results are available, and at no less than one quarterly interval, allowing:
- Data presentation in tabular format,
- Time-series graphs with comparison abilities,
- Statistical analysis (minimum, maximum, average, percentile values) in tabular format,
- Graphical presentation of statistics,
- Linear trend determination,
- Performance analysis in tabular format,
- Presentation of data, statistics and performance on diagrams and maps, and
- Comparison and compliance to the South African National Standards for drinking water *(SANS 241:2011)*.

As far as possible, the same monitoring points will be used from the construction phase through the operational and decommissioning phases to after mine closure to develop a long data record and enable trend analysis and recognition of progressive impacts with time.

15.2.4 Air quality

Performance Indicators:

Key performance indicators against which progress of implemented mitigation and management measures may be assessed form the basis for all effective environmental management practices. In the definition of key performance indicators careful attention is usually paid to ensure that progress towards their achievement is measurable, and that the targets set are achievable given available technology and experience.

Performance indicators are usually selected to reflect both the source of the emission directly (source monitoring) and the impact on the receiving environment (ambient air quality monitoring). Ensuring that no visible evidence of windblown dust exists represents an example of a source-based indicator, whereas maintaining off-site dustfall levels to below 600 mg/m²-day represents an impact- or receptor-based performance indicator. Except for vehicle/equipment emission testing, source monitoring at mining activities can be challenging due to the fugitive and wind-dependant nature of particulate emissions. The focus is therefore rather on receptor based performance indicators i.e. compliance with ambient air quality standards and dustfall regulations.

Source Monitoring

It is recommended that exhaust emissions testing be done on all mobile and stationary diesel combustion sources as part of equipment maintenance schedules.

Ambient Air Quality Monitoring

Ambient air quality monitoring can serve to meet various objectives, such as:

- Compliance monitoring;
- Validate dispersion model results;
- Use as input for health risk assessment;
- Assist in source apportionment;
- Temporal trend analysis;
- Spatial trend analysis;
- Source quantification; and,
- Tracking progress made by control measures.

Given that ambient air quality data is not available for the area, it is recommended that continuous (annual or seasonal) dustfall, PM_{10}, $PM_{2.5}$ and NO_2 monitoring be conducted as part of the project's air quality management plan. This should be undertaken until the air quality trends become apparent. The locations of the monitoring exercise should include sensitive receptors (especially (SR1 and SR5). This will ensure adequate planning and management intervention at these receptors should long term exceedance of the regulatory standards and guidelines occur.

Periodic inspections and audits

BECS Environmental

Periodic inspections and external audits are essential for progress measurement, evaluation and reporting purposes. It is recommended that site inspections and progress reporting be undertaken at regular intervals (at least quarterly), with annual environmental audits being conducted. Annual environmental audits should be continued at least until closure. Results from site inspections and monitoring efforts should be combined to determine progress against source- and receptor-based performance indicators. Progress should be reported to all I&APs, including authorities and persons affected by pollution.

The criteria to be taken into account in the inspections and audits must be made transparent by way of minimum requirement checklists included in the management plan. Corrective action or the implementation of contingency measures must be proposed to the stakeholder forum in the event that progress towards targets is indicated by the quarterly/annual reviews to be unsatisfactory.

15.2.5 Environmental noise

From an occupational perspective the mining workers should be protected through standards and procedures and monitored as requires through Section 12 of the MHSA. No environmental noise monitoring has been proposed by the specialist.

15.2.6 Heritage resources

The area must be inspected and monitored for any heritage resources prior to removal of vegetation and soil.

15.2.7 Surface water

Surface water quality sampling will be conducted on a quarterly basis. As part of the surface water monitoring programme the water quality of the upstream and downstream water environments will be assessed so as to establish the impact of the mining activities on the receiving environments.

In addition to the above, bacteriological testing (determining the plate count, Coliform Bacteria and Faecal Coliform Bacteria) will also be conducted on all water used for domestic purposes.

The water balance of RAM and the proposed site shall be updated on an annual basis. Surface water quality shall be monitored on a quarterly basis. This is currently ongoing on RAM and will be extended to the proposed new site. RAM is currently monitoring a number of variables. Any additional monitoring requirements from DWS will be implemented once the integrated water use licence is authorised.

The receiving rivers and streams have been included within the surface water monitoring programme of the mine and includes both upstream and downstream of the mining and processing plants at locations within the Bierspruit. It is imperative to note that the Bierspruit is a non-perennial stream, and that the frequency of such monitoring data is done during periods of rainfall with resultant flow in

the Spruit. The purpose of this monitoring is to identify any impact associated with the mining and processing plant activities on the receiving surface water environment.

15.2.8 Geology

Continuous monitoring to ensure mining takes place according to the mining plan will help to prevent over-exploitation of geology.

15.2.9 Visual aspect

Refer to monitoring of rehabilitation below.

15.2.10 Socio-economic

A senior manager will be accountable for the on-going monitoring and evaluation of the SLP and for the annual report.

15.2.11 Rehabilitation

A post-mining land capability assessment needs to be done progressively at all areas rehabilitated during the operational phase. The assessment should be executed by a soil specialist by means of auger observations at a grid spacing of 100 x 100 m. This is required to evaluate the rehabilitation procedures and to verify that the topsoil thickness is as specified. A final post-mining land capability map needs to be compiled and should be submitted for closure purposes.

15.2.12 Performance assessments, rehabilitation and financial provision

The EMP to be submitted to DMR will be a duplicate of this EIAR, compiled using DMR's template. The performance of the EMP will be assessed every two years, therefore the commitments in this EIAR will be assessed every two years. A financial provision will accompany the EMP which will be updated on an annual basis. This financial provision update wil be accompanied by a report on rehabilitation that has taken place.

Internal auditing on the general operation, maintenance and incident reporting should be conducted at least twice per week with monthly reporting to management. An incident register must be kept to report on all environmental incidents. Incidents with the potential to pollute clean water resources must be reported to regional DWS within 24hours followed by a remediation action plan. Annual update of the IWWMP includes a review on the adequacy and performance of the measures contained within this document. The IWWMP document is updated to address shortcoming in the operation of the mine. Compliance to the provisions of GN704 of 4 June, 1999 is to be evaluated every 2 years.

15.2.13 Waste

A waste disposal procedure must be put in place that includes an appendix containing a checklist for the main waste collection sites. This inspection has to be completed once per month to ensure clean

and efficient waste management. The main waste collection sites are the hazardous waste site at the contractor's yard, the waste collection points at the plants and offices, and the general waste collection area. Information in the checklist includes:

Waste storage area: Area clean, no flammable material with oil and diesel, oil reclamation system working

- Waste separated, placed into appropriate disposal skips/areas according to RAM standards
- Waste containers/ drums/ skips in good condition
- Hazardous waste containers / drums labelled
- Waste skips not overflowing
- Spill kit available for any accidental spillages
- Fire extinguisher available on/ near site.

As part of the monitoring programme the following will also be conducted:

- Volumes of all waste generated (Domestic and Hazardous Waste) and disposed of will be monitored and measured on a monthly basis and records kept,
- All contractors and disposal agents, premises and disposal sites will be inspected twice yearly to ensure that all environmental and legal requirements are adhered to, and
- Volumes of mine residue generated and disposed of by the mine will be monitored on a monthly basis and records kept.

15.3 Roles and responsibilities for the execution of the monitoring programmes

The mine manager must ensure all monitoring is conducted on the mine.

15.4 Time frames for monitoring and reporting.

Refer to Table 53 below for the timeframes.

Table 53: Timeframes for monitoring and reporting

Environmental component	Description	Timeframes
Soil, land capability, land use	Soil stripping	Continuously throughout LoM
Ecology	Road kills	Continuously as it takes place
	Alien vegetation	This depends on the recommendations of the alien eradication programme
Soil & ecology	Checks for erosion	Continuously throughout LoM
Groundwater	Groundwater levels	Quarterly
	Groundwater quality	Quarterly
Air quality	Dustfall	Quarterly
	PM_{10}, $PM_{2.5}$ and NO_2	Annually
Environmental noise	Only occupational noise	Not applicable

Environmental component	Description	Timeframes
Heritage resources	Heritage resources	Prior to removal of vegetation and soil
Surface water	Water balance update	Annually
	Surface water quality	Quarterly
Socio-economic	Monitoring of SLP	Continuous
Rehabilitation	Post-mining land capability assessment	Progressively at all areas rehabilitated during the operational phase
Various	Performance assessment	Every two years
	Maintenance on vehicles and machinery	To be confirmed
	Site inspections and progress reporting	Quarterly
	Compliance with mining plan	Continuously throughout LoM, starting prior to removal of any vegetation and/or soil
	Internal auditing on the general operation, maintenance and incident reporting	Twice per week with monthly reporting to management.
	Update of the IWWMP	Annually
	Compliance to the provisions of GN704 of 4 June, 1999	Every two years
Waste	Inspection of clean and efficient waste management	Monthly

REGULATION 50 (i)

16. Technical and supporting information

Refer to Addendum 3 (specialist studies) for all specialist studies attached to this EMP.

SECTION 2

ENVIRONMENTAL MANAGEMENT PROGRAMME

REGULATION 51 (A)

1. Description of environmental objectives and specific goals for mine closure

1.1 Environmental aspects that describe the pre-mining environment

Refer to Paragraph 1 of Section 1 (EIA), Regulation 50(a), 1 – Description of the baseline environment for a complete description of the pre-mining environment.

1.2 Measures required to contain or remedy any causes of pollution or degradation or the migration of pollutants, both for closure of the mine and post-closure

Refer to Paragraph 7.1 of Section 1 (EIA), for the decommissioning aspects, impacts and management measures.

1.2.1 End land use

Due to the nature of the mining activities and the accompanied residual impacts, the end land use will be similar to the land use prior to mining. The area will therefore be rehabilitated to an arable and grazing land use, with the exception of the wilderness areas on the mountain side.

1.2.2 Residual impacts

If adequate concurrent rehabilitation takes place, soil will be replaced, thereby reinstating the current land capability and land use. The visual impacts will also be mitigated, and surface water flow will be normal. Once mining has ceased, any dust pollution and environmental noise will also cease. No impacts from the mine will take place on heritage resources after closure. Implementation of the buffer zones will prevent the loss of highly ecological sensitive areas. Implementation of the buffer zones will prevent the loss of highly ecological sensitive areas. Mine closure will lead to retrenchment and loss of employment. This is being managed through the SLP.

<u>Groundwater level recovery, recharge rate and potential decant</u>

Groundwater levels are expected to remain unaffected by the proposed opencast mining activities since the quarry floor is planned to remain largely above the local groundwater level. Decant predictions in an opencast mining environment is affected by the following:

- The MAP,
- Recharge to the mine void, expressed as a percentage of the MAP. Recharge on the other hand is affected by:
    - The size of the surface area disturbed by mining activities,
    - The transmissivity of the backfill material,
    - Surface water runoff,

- The overall porosity of the rehabilitated quarry area,
- The groundwater contribution to water inflow, which is determined by the hydraulic properties of the surrounding undisturbed aquifer/s (not relevant to Tygerkloof Project since no interaction is expected between the proposed quarry and underlying groundwater).

The water gradient within a rehabilitated quarry is generally very close to being zero as a result of the high transmissivity of the backfill material. Decanting of a quarry is therefore most likely to occur wherever the quarry intersects the lowest surface elevation. The time it will take the proposed Tygerkloof Quarry to fill with water was calculated with the use of volume/recharge calculations and the results are provided in Table 54, while the most probable decant position is indicated in Figure 38.

The proposed Tygerkloof Quarry is expected to decant at an elevation of approximately 1,036mamsl and the decant position is indicated in Figure 38. The most probable time it will take the backfilled void to fill with water to the decant elevation was calculated to be in the order of 70 years after active mining has ceased (Table 54).

Decanting of a mine void generally occurs as a result of an excess volume of water that cannot be “absorbed” by the aquifer system. The excess water is generated by the increased recharge from surface due to the destruction of the aquifer structure.

An evaporation rate of approximately 2.6 Mm^3/y (Figure 5 (Groundwater Complete, 2015)) was calculated to occur from the surface of the backfilled quarry, which far exceeds the expected recharge volume of ± 90,260 m^3/y (Table 54). The backfilled quarry is expected to experience a net loss of water. The water level within the quarry is therefore unlikely to reach the surface, therefore decanting should not occur.

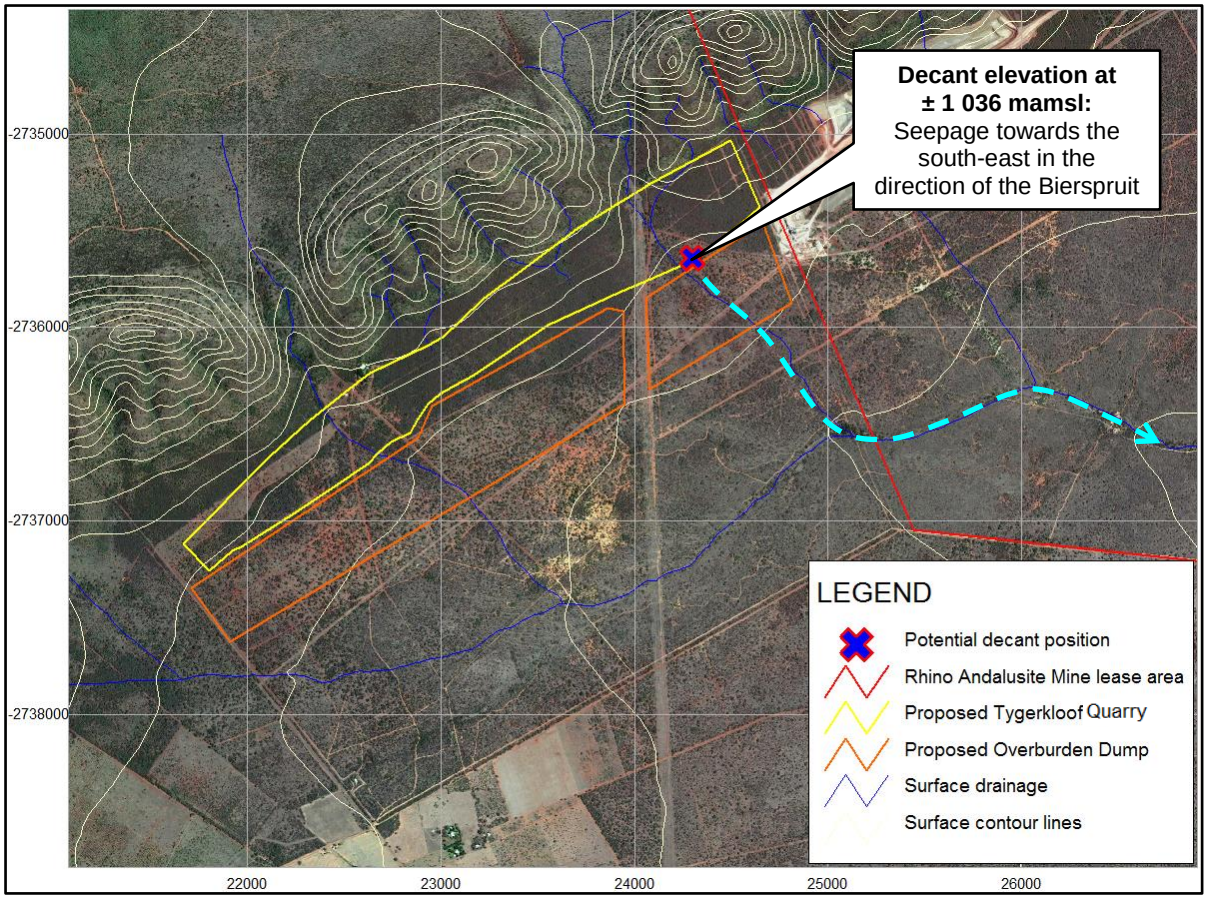


Figure 38: Potential decant position for the proposed Tygerkloof Quarry

Table 54: Time-to-fill calculations for the proposed Tygerkloof Quarry

General information		
Surface area	m^2	1,157,190
Decant elevation	mamsl	1,036
Total void volume	m^3	23,767,919
Mean annual precipitation	m/a	0.65
Backfilled void volume		
20% Porosity	m^3	4,753,584
25% Porosity	m^3	5,941,980
30% Porosity	m^3	7,130,376
Decant/Recharge rate		
10% Recharge	m^3/y	75,217
12% Recharge	m^3/y	90,261
14% Recharge	m^3/y	105,304
Time to fill		
Worst case scenario (20% Ø and 14% RCH)	Years	45
Most probable scenario (25% Ø and 12% RCH)	Years	66
Best case scenario (30% Ø and 10% RCH)	Years	95

Notes: Ø - Porosity,

RCH - Recharge

1.2.3 Closure objectives

Rehabilitation will aim to:

- Restore normal infiltration rates to areas where recharge were reduced due to surface compaction such as the haul roads,
- Restore normal infiltration rates in areas where recharge was increased (i.e. quarry area),
- Maximise clean runoff by ensuring disturbed surface areas are vegetated and sloped to be free draining.
- Replace topsoil and thereby the medium to restore land capability.
- Re-introduce indigenous vegetation into the area.

1.2.4 Rehabilitation process

1.2.4.1 Principles for stripping and stockpiling of topsoil

Stripping and stockpiling has an impact on soil, land capability and land use, but it is important to realise that the way this action is performed is also the first and one of the most important mitigation measures. The impact on soil, land capability and land use are mitigated by means of the rehabilitation process which commences with stripping and stockpiling of topsoil before mining takes place and is not a process that starts with replacing of topsoil after or during the mining operation. Rehabilitation and subsequent mitigation of soil, land capability and land use consists therefore of the following phases:

- Stripping and stockpiling of topsoil
- Backfill of open pits and levelling of spoil material to a free draining surface
- Replacing and levelling of topsoil and preparation of the surface
- Soil amelioration and re-vegetation

If the first phase of rehabilitation namely stripping and stockpiling of topsoil, is not done with the aim of reinstating post-mining land capability similar to pre-mining land capability, then successful rehabilitation will not be achieved and it will probably result in a serious deterioration from pre-mining to post-mining land capability.

In practice, even with optimal rehabilitation procedures applied, some deterioration from pre-mining to post-mining land capability is unavoidable. It is therefore crucial to follow the proposed rehabilitation procedures as far as possible in order to minimise degradation of soil characteristics and to re-establish the highest possible post-mining land capability.

The term topsoil refers to the A and B-horizons of the soil profile as defined in the Taxonomic Soil Classification system for South Africa. The A-horizon comprises the upper part (0-300 mm) of the soil profile and the B-horizon from 300 mm up to the stripping depth specified per soil type indicated in

Figure 39. The characteristics of soil horizons (A- and B-horizons) are further described in Appendix E in terms of soil stripping, stockpiling and replacing.

Stripping, stockpiling and replacing of topsoil has a very high impact on soil, land capability and land use, and the procedures followed during execution of these actions directly influence the post-mining land capability and consequently determine the degree of deterioration from pre-mining to post-mining land capability. They also directly determine the possible post-mining land uses.

During stripping and stockpiling the following principles should be aimed for:

- Prevent mixing of high quality topsoil (A and B-horizons) with low quality underlying material to ensure sufficient volumes of high quality soil for rehabilitation. The quality of soil earmarked for rehabilitation purposes significantly deteriorates when the high quality topsoil is mixed with the underlying poorer quality material (clay layers, calcrete, plinthite, weathered rock etc.). This results in significant deterioration in the quality of the soil's physical and chemical properties and a decline in the soil fertility necessary for re-vegetation. The deterioration in soil quality also significantly increases the susceptibility of rehabilitated soils for erosion and seal and crust formation.
- Separate stockpiling of different soil type groups to obtain the highest post-mining land capability. Topsoil quality or potential is not just limited to the grade of soil generally referred to as topsoil but can vary from very high to low due to various properties. Soil properties of different soil types can vary substantially e.g. high quality red and yellow well-drained soils and low quality grey poorly drained wetland soils can occur over very short distances in the same field. Mixing of different soil types result in rapid changes in soil properties and characteristics such as texture, infiltration rates and water holding capacity over short distances after replacement, which will definitely adversely affect the post-mining land capability.
- Separate stripping, stockpiling and replacing of soil horizons (A and B-horizon) in the original natural sequence to combat hardsetting and compaction, maintain soil fertility and conserve the natural seed source. The higher soil fertility of the A-horizon, especially P and C contents, declines significantly when it is mixed with the B-horizon, resulting in poorer re-vegetation success. It also increases the susceptibility to compaction and hard setting. The A-horizon also serves as a seed source which will enhance the re-establishing of natural species. The A and B-horizons should be stripped and stockpiled separately and replaced with the A-horizon overlying the B-horizon. Contrary to the general perception, separate stockpiling of different soil types and horizons does not have significant cost implications for the mine and only requires planning and continuing management.

The soil horizons and properties influencing stripping and stockpiling procedures are discussed in Appendix E of the soil specialist study (Gudani, 2015).

1.2.4.2 Handling of topsoil from construction to decommissioning phase

Handling of topsoil from construction to decommissioning phase should be based on the following principles. **However, some deviation of the principles may take place in order to accommodate the engineering design and requirements for each specific structure.**

1.2.4.2.1 Stripping and stockpiling of topsoil at open pit footprint

The soil types that should be stripped at different depth and stockpiled separate from the overburden material is shown in Figure 39. The Figure should be read together with Table 55.

The following guidelines for stripping and stockpiling procedures need to be aimed for:

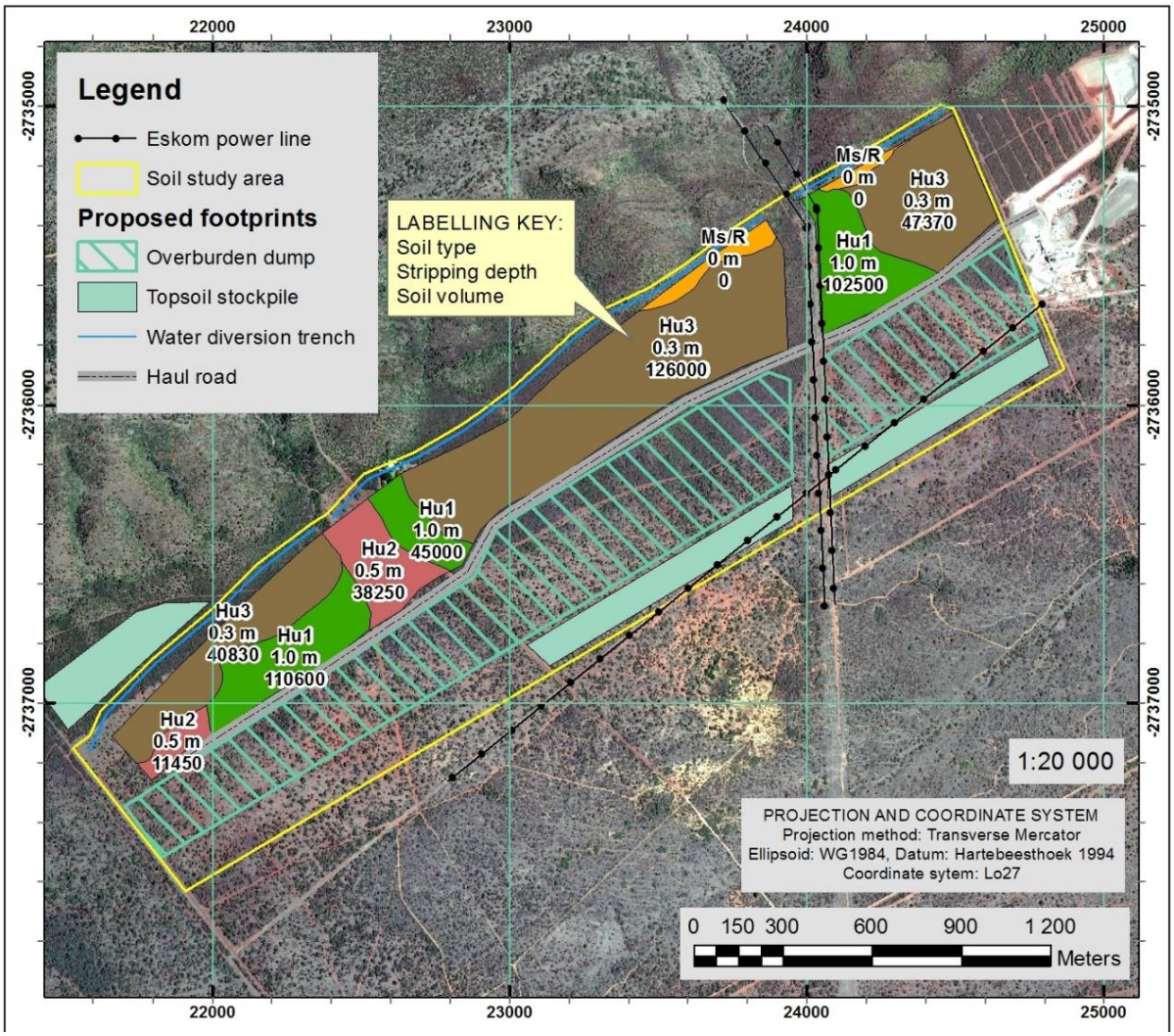
- Figure 39 and Table 55 show the soil types to be stripped at different depths in the proposed open pit area.
- The boundaries of the soil types that should be stripped at different depths, and stockpiled separately from the overburden dump, should be surveyed and staked by the mine surveyor before any soil stripping commences.
- Soils of soil type Hu1 is shown in green and should be stripped at a depth of 1 m. These are very high quality soils, containing no gravel or coarse fragments and occur on gentle footslopes and should be replaced on similar positions. Soils of soil type Hu2 is shown in dark pink and are similar than those of Hu1 but are shallower and should be stripped at a depth of 0.5 m. Soils of soil type Hu3 is shown in brown and should be stripped at a depth of 0.3 m. These soils are very gravely and occur on steeper foot and midslopes and should be replaced in similar positions.
- The size and height of the stockpiles will be determined by the soil volume as indicated in Figure 39 and Table 55 and no stockpile height restriction is proposed as long as the soil type are stripped at depths as specified in Figure 39 and Table 55.
- The most suitable stockpile positions should be determined by the mine planner based on the mining sequence plan and need to be surveyed and staked by the mine surveyor.

Table 55 forms part of Figure 39 and shows the stripping depths per soil type, the areas and percentages as well as the total soil volume per soil type. It also shows the post-mining land capability class and replacing depth (topsoil thickness)

Table 55: Soil stripping, stockpiling and replacing guideline

Legend: Pre-mining stripping depths, soil volumes, post-mining replacing depths and land capability									
	Pre-mining					**Post-mining**			
Soil Type	**No of units**	**Strip depth (m)**	**Area (ha)**	**Area (%)**	**Soil volume (m^3)**	**Replacing**			**Land capability**
						Depth (m)	**Area (ha)**	**Area (%)**	
Hu1	3	1.0	25.81	23.38	258,100	1.0	25.81	23.38	Arable

Legend: Pre-mining stripping depths, soil volumes, post-mining replacing depths and land capability									
	Pre-mining					Post-mining			
Soil Type	No of units	Strip depth (m)	Area (ha)	Area (%)	Soil volume (m^3)	Replacing			Land capability
						Depth (m)	Area (ha)	Area (%)	
Hu2	2	0.5	9.94	9.00	49,700	0.5	9.94	9.00	Grazing
Hu3	3	0.3	71.40	64.66	214,200	0.3	71.40	64.66	Grazing
Ms/R	2	0	3.27	2.96	0	0	3.27	2.96	Wilderness
Grand Total			110.42	100	6.23		110.42	100	



Legend: Pre-mining stripping depths, soil volumes, post-mining replacing depths and land capability									
	Pre-mining					Post-mining			
Soil Type	No of units	Strip depth (m)	Area (ha)	Area (%)	Soil volume (m^3)	Replacing			Land capability
						Depth (m)	Area (ha)	Area (%)	
Hu1	3	1.0	25.81	23.38	258100	1.0	25.81	23.38	Arable
Hu2	2	0.5	9.94	9.00	49700	0.5	9.94	9.00	Grazing
Hu3	3	0.3	71.40	64.66	214200	0.3	71.40	64.66	Grazing
Ms/R	2	0	3.27	2.96	0	0	3.27	2.96	Wilderness
Grand Total			110.42	100	522000		110.42	100	

Figure 39: Soil tripping and stockpiling guide map

1.2.4.2.2 Backfilling of open pit and levelling of material

Before topsoil can be replaced, the quarry should be backfilled to an elevation and topography which is free-draining and if possible ensure a continuation of the pre-mining surface drainage pattern. The backfilled surface should be surveyed by a surveyor in order to ensure that it has the correct elevation and slopes to be free draining. A non-free draining surface results in local depressions of periodically saturated zones and increased percolation which usually leads to localised subsidence of backfilled material. Slopes of the backfilled surface should therefore change gradually since abrupt changes in slope gradient increase the susceptibility for erosion initiation.

1.2.4.2.3 Replacing and levelling of stored topsoil and preparation of the surface

The backfilled surface should be covered with stockpiled topsoil. Care should be taken to tip enough soil per square unit to reinstate the total required post mining soil depth at once. Spreading of soil over far distances and repeated traversing of heavy mechanical equipment should be minimised in order to prevent compaction in the lower profile which is difficult to alleviate afterwards. The dumped soil heaps should thus only be levelled on top to reach the required soil thickness. Caterpillar-type tracked equipment is preferred for levelling of topsoil because these tracks cause less compaction. Bowl scrapers cause enormous compaction and should not be used.

The replaced topsoil thickness should be progressively monitored during replacement to verify if it is similar to the replacing depth provided in Table 55 and to prevent encountering shortages of topsoil.

1.2.4.2.4 Soil amelioration and re-vegetation

- The soil fertility status should be determined by soil chemical analysis after levelling (before seeding/re-vegetation).
- Soil amelioration should be done according soil analyses as recommended by a soil specialist, in order to correct the pH and nutrition status before re-vegetation.

- The footprint should be re-vegetated with a grass seed mixture of local grass and/or tree species. Rehabilitation/restoration should make use of indigenous species, and preferably of species native to the study site and immediate surroundings. The species selected should strive to represent habitat types typical of the ecological landscape prior to construction.
- Re-vegetation should be done as soon as possible and preferably in spring and early summer to stabilise the soil and prevent soil loss during the rainy season.
- Reinstate/rehabilitate as a continual process – this will maximise the viability of the natural seed bank and prevent the unnecessary loss of topsoil during storage.
- A short term fertiliser program should be based on the soil chemical status after the first year in order to maintain the fertility status for 2 to 3 years after rehabilitation until the area can be declared as self-sustaining.
- Checks must be carried out at regular intervals to identify areas where erosion is occurring. Appropriate remedial action, including the rehabilitation of the eroded areas, and where necessary, the relocation of the roads causing the erosion, are to be undertaken.

1.2.4.3 Post-mining land capability requirements

The post-mining land capability class will be determined mainly by the soil type and the thickness of the soil layer replaced on the backfilled surface. Other factors and characteristics that might influence the post-mining land capability are slope, erodibility, compaction and reduction of soil quality due to contamination of soils by subsoil, soft overburden or spoil material.

A post-mining land capability assessment needs to be done progressively at all areas rehabilitated during the operational phase. The assessment should be executed by a soil specialist by means of auger observations at a grid spacing of 100 x 100 m. This is required to evaluate the rehabilitation procedures and to verify that the topsoil thickness is as specified. A final post-mining land capability map needs to be compiled and should be submitted for closure purposes.

A post-mining soil depth and land capability evaluation by a soil specialist registered at the SACNASP in order to map the final post-mining land capability which will be used for final post-mining land uses and closure purposes.

2. Description of environmental objectives and specific goals for the management of identified environmental impacts emanating from the proposed mining operation

2.1 List of identified impacts which will require monitoring programmes

Refer to Paragraph 7 of Section 1 (EIA), for a complete description of the monitoring for the mine.

2.2 List of the source activities that are the cause of the impacts which require to be managed

Refer to Paragraph 7 of Section 1 (EIA), for a complete description of the source activities that are the cause of the impacts that require to be managed.

2.3 Management activities which, where applicable, will be conducted daily, weekly, monthly, quarterly, annually or periodically as the case may be in order to control any action, activity or process which causes pollution or environmental degradation

Refer to Paragraph 7 of Section 1 (EIA), for the management activities which, where applicable, will be conducted continuously, daily, weekly, monthly, quarterly, annually or periodically as the case may be in order to control any action, activity or process which causes pollution or environmental degradation.

2.4 The roles and responsibilities for the execution of the monitoring and management programmes

Refer to Paragraph 7 of Section 1 (EIA), for the roles and responsibilities for the execution of the monitoring and management programmes.

3. Description of environmental objectives and specific goals for the socio-economic conditions as identified in the social and labour plan

Refer to Paragraph 7 of Section 1 (EIA), for the description of environmental objectives and specific goals for the socio-economic conditions as identified in the SLP.

4. Description of environmental objectives and specific goals for historical and cultural aspects

Refer to Paragraph 7 of Section 1 (EIA), for the description of environmental objectives and specific goals for historical and cultural aspects.

REGULATION 51 (B) – OUTLINE OF THE IMPLEMENTATION PROGRAMME

5. The appropriate technical and management options chosen for each environmental impact, socio-economic condition and historical and cultural aspect in each phase of the mining

5.1 Actions, activities or processes, including any NEMA EIA Regulation listed activities, which cause pollution or environmental degradation

Refer to Paragraph 7.1 of Section 1 (EIA), for a complete description of the actions, activities or processes; including any NEMA EIA regulation listed activities, which cause pollution or environmental degradation.

5.2 Concomitant list of appropriate technical or management options chosen to modify, remedy, control or stop any action, activity, or process which will cause significant impacts on the environment, socio-economic conditions and historical and cultural aspects as identified

Refer to Paragraph 7.1 of Section 1 (EIA), for a concomitant list of appropriate technical or management options chosen to modify, remedy, control or stop any action, activity, or process which will cause significant impacts on the environment, socio-economic conditions and historical and cultural aspects as identified.

6. Action plans to achieve the objectives and specific goals contemplated in Regulation 50 (a)

- Where possible, large and aged specimens of protected trees (e.g. *Vachellia erioloba*) and *Elaeodendron transvaalensis* should be retained and buffered (see Figure 32 (Pachnoda, 2015) and the sensitivity map to follow this report). All buffered areas should form part of an open space network to promote movement of fauna when a high rate of natural disruption is expected and to conserve part of the seed bank diversity (essential for restoration).
  This must be done continuous throughout topsoil removal.
- An alien and invasive plant eradication and control programme must be implemented along with a follow-up programme. The programme must be compiled by a qualified botanist/ecologist and the implementation thereof should be supervised by a qualified botanist/ecologist.
  This will be compiled after submission of the EMP, in October 2015.
- The mine will compile and implement a spill handling procedure to contain any potential spillages form vehicles and machinery, and a waste management procedure to manage waste disposal.
  This will be compiled after submission of the EMP, in October 2015.
- A post-mining soil depth and land capability evaluation by a soil specialist registered at the South African Council for Natural Scientific Professions (SACNASP) in order to map the final

post-mining land capability which will be used for final post-mining land uses and closure purposes.

- Prior to final rehabilitation

7. Procedures for environmentally related emergencies and remediation

The mine has an emergency preparedness CoP. All environmentally related emergencies and remediation will be implemented according to this CoP.

8. Planned monitoring and environmental management programme performance assessment

8.1 Description of planned monitoring of the aspects of the environment which may be impacted upon

Refer to Paragraph 15 of Section 1 (EIA) for the planned monitoring of the aspects of the environment which may be impacted upon.

8.2 Provide a description as to how the implementation of the action plans contemplated in regulation 51 (b) (ii) as described will be monitored as described in paragraph 6 of the EMP will be monitored

An EMP Performance Assessment (EMP PA) will be conducted every two years (biennial basis), to monitor the effectiveness of the implementation of the commitments as contained in this document.

8.3 Frequency of proposed reporting for assessment purposes

According to section 55(2)(a) of the MPRDA, a Performance Assessment must be conducted every two years, therefore, the EMP Performance Assessments (EMP PA) for the mine shall be done every two years (biennially).

Refer to Paragraph 15 of Section 1 (EIA) for the planned time frames for monitoring.

9. Financial provision in relation to the execution of the environmental management programme

9.1 Plan showing the location and aerial extent of the aforesaid main mining actions, activities, or processes anticipated

Refer to Figure 34 for the site layout plan indicated the aforesaid main mining actions, activities, or processes anticipated.

9.2 Annual forecasted financial provision calculation

Refer below for the annual forecasted financial provision calculation. This forecasting is therefore only for year 1.

No	Description	Unit	A Quantity	B Master rate	C Multiplication factor	D Weighting factor	E=A*B*C*D Amount
3	Rehabilitation of access roads	m^2	4.2	R30.44	1	1.1	R140.65
6	Opencast rehabilitation including final voids and ramps	m^2	1.159	R173,174.97	0.52	1.1	R114,806.00
8(A)	Rehabilitation of overburden and spoils	ha	1.422	R118,912.29	1	1.1	R186,002.60
10	General surface rehabilitation	ha	2.5861495	R94,198.59	1	1.1	R267,972.80
14	2 to 3 years of maintenance and aftercare	ha	2.5861495	R1,253.59	1	1.1	R3,566.18
SUBTOTAL 1							R572,488.23
1	Weighting factor 2	(0%, 5% or 10%)					R 28,624.41
2	Preliminary and General	12,5% of subtotal 1					R71,561.03
3	Administration and supervision costs	6,0% of subtotal 1					R34,349.29
4	Engineering drawings and specifications	2,0% of subtotal 1					R11,449.76
5	Engineering and procurement of specialist work	2,5% of subtotal 1					R14,312.21
6	Development of closure plan	2,5% of subtotal 1					R14,312.21
8	Contingency	10,0% of subtotal 1					R57,248.82
SUBTOTAL 2							R231,857.73
Total							R804,345.96
VAT (14%)							R112,608.43
GRAND TOTAL (SUBTOTAL 1 + SUBTOTAL 2 + VAT)							**R916,954.40**

9.3 Confirmation of the amount that will be provided should the right be granted

An amount of R916,954.40, will be provided should the right be granted.

9.4 Method of providing financial provision contemplated in Regulation 53

This amount will be provided using a bank guarantee.

10. Environmental Awareness Plan (Section 39 (3) (c))

This section includes an environmental awareness plan describing the manner in which the applicant intends to inform his or her employees of any environmental risks which may result from their work and the manner in which the risks must be dealt with in order to avoid pollution or the degradation of the environment.

Environmental Awareness must be implemented by the mine in order to inform their employees and contractors of the environmental risk that may result from their work. This must be prior to any prospecting work done on site. Training must be given to all employees and contractors. Proof of all training provided must be kept on site. The training focuses on the following aspects:

- Explaining clearly what the environment is and what the environment consist of.
- Explain all activities that will take place on the site and the associated impacts.
- The mining personnel must be made aware of the mining plan with its buffers, the depth to which topsoil must be removed, and the location of the topsoil stockpiles and overburden placement.
- Explain all restrictions and prohibitions of removal of any vegetation other than that on site, off-road driving, poaching of animals, etc.
- Mining personnel must be made aware of the protected vegetation species that occur on site and the prohibition to remove them before the mine has a permit to do so.
- Mining personnel must be made aware how to identify any potential heritage resources on site.
- Visual aids such as pictures or photos can be used.

11. Attachment of specialist reports, technical and supporting information

Refer to addendum 3 (specialist studies) for all specialist studies attached to this EMP.

SECTION 39 (4) (a) (iii)

12. Capacity to manage and rehabilitate the environment

Refer to paragraph 7.1.1 of section 1 (EIA), for the breakdown of the environmental budget per impact. Below is a table which summarises the environmental budget as set out in paragraph 7.1.1 of section 1 (EIA).

Table 56: Summary of environmental budget

Description	Budget (indicate year, month, etc.)
Stripping and stockpiling of soil	R357,000 per year
Reconstruction of topography	Part of financial provision
Rehabilitation of topsoil	Part of financial provision
Backfilling of OB and trenches, etc.	Part of financial provision
Walk-through of site prior to construction for protected and near threatened tree species	R12,000
Checks on erosion	In-house – no additional budget necessary.
Re-vegetation	Part of financial provision
Alien and invasive plant eradication and control programme	R30,000-00 and once off for the plan
Alien invasive implementation	The costs for implementation of the Alien and invasive plant eradication and control programme will be included in this eradication and control programme.
Outside lighting should be replaced with bulbs of longer wave lengths (550nm); Apply UV filters to high pressure mercury vapour lamps as an alternative to yellow Na lamps	R70,000/year
Introduce road calming structures (e.g. humps) and enforce speed limit	R5,000/year
Monitor road kills and create a database of species killed to identify areas with a high frequency of mortalities	In-house – no additional budget necessary
Continuous monitoring of groundwater quality	R25,000/year
Quarterly monitoring of groundwater levels is recommended	R75,000/year
Maintenance of all machinery and vehicles	R10,000,000/year
Air quality monitoring	This will depend on costs of consultant to monitor air quality.
PPE to all workers	In-house – no additional budget necessary
During the stripping of topsoil from the mining area a suitably qualified professional must inspect the area for any potential archaeological or heritage resources	This will be calculated, using the costs as per the heritage consultant for one day to come out to site.
Spill handling and waste management procedure	R5,000 once off
For the control of vehicle entrained dust it is recommended that water (at an application rate of 1litre/m2-hour), be applied in combination with addition of chemicals	R55,000/month
In minimising windblown dust from stockpile areas, water sprays should be used to keep surface material moist and wind breaks installed to reduce wind speeds over the area	Part of financial provision
Construction of diversion trench for stormwater	R15,000/year

Description	Budget (indicate year, month, etc.)
Construction of culvert at haul road	R75,000

13. Undertaking

The EMP will, should it comply with the provisions of section 39 (4) (a) of the Act and the right be granted, be approved and become an obligation in terms of the right issued. As part of the proposed Environmental Management Programme, the applicant is required to provide an undertaking that it will be executed as approved and that the provisions of the Act and regulations thereto will be complied with.

14. Identification of the report

Herewith I, the person whose name and identity number is stated below, confirm that I am the person authorised to act as representative of the applicant in terms of the resolution submitted with the application, and confirm that the above report comprises EIA and EMP compiled in accordance with the guideline on the Departments official website and the directive in terms of sections 29 and 39 (5) in that regard.

Full Names and Surname	
Identity Number	
Designation	
Signature	

-END-

References

African Heritage Consultants CC. 2013: Cultural Heritage Resources Impact assessment for a proposed mining licence on the farm Nooitgedacht 436 JR Portion 25. Ecca Holdings (Pty) Ltd

African Heritage Consultants, 2015: Phase i Cultural Heritage Resources Impact Assessment for the proposed new Tygerkloof Mine an extension of the existing Rhino Andalusite Mine on portion 5 of the farm Tygerkloof 354 KQ Thabazimbi District Limpopo Province

Airshed Planning Professionals, 2015: Air Quality Specialist Report for the Proposed Tygerkloof Mine, Thabazimbi, Limpopo Province

Baines, T. 1872: From the Tati to Natal. *Cape Monthly Magazine* 4(19):28-34

Baines, T. 1877: *The gold regions of south eastern Africa.* London: Edward Stanford, Charing Cross

Barnes, K.N, 1998: The Important Bird Areas of southern Africa. BirdLife South Africa, Johannesburg.

Bates, M.F, Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. (eds), 2014: Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. Suricata 1. South African National Biodiversity Institute, Pretoria

BECS Environmental, 2015: Tygerkloof Mining Pty Ltd – Tygerkloof Mining & Rhino Andalusite Mine. Final Environmental Scoping Report

Bergh, J.S. 1999: *Geskiedenisatlas van Suid-Afrika: die vier noordelike provinsies*. Pretoria: J.L. van Schaik

BirdLife International 2012: *Coracias garrulus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. http://www.iucnredlist.org/

Breutz, P.-L. 1953a: *The tribes of Rustenburg and Pilanesberg Districts*. Pretoria: Government Printer

Breutz, P.-L. 1989: *History of the Batswana*. Ramsgate: Breutz

Burke, E.E. (Ed.). 1969: *The journals of Carl Mauch: his travels in the Transvaal and Rhodesia 1869-1872*. Transcribed from the original by E. Bernhard and translated by F.O. Bernhard. Salisbury: National Archives of Rhodesia

Coetzee, F.P. 2008: Cultural Heritage Survey of PPC Dwaalboom. For PPC

Coetzee, F.P. 2014: Cultural Heritage Assessment for the proposed Mara Trails Camp, on the Farm Jagtersrus 418 KQ, in the Marakele Park (Pty) Ltd, Section of the Marakele National Park, Limpopo Province. For: Nuleaf Planning and Environmental (Pty) Ltd. Nuleaf Planning and Environmental (Pty) Ltd

Cowherd, C., Muleski, G. E., & Kinsey, J. S., 1988: Control of Open Fugitive Dust Sources. United States Environmental Protection Agency.

Del Hoyo, J.; Collar, N. J.; Christie, D. A.; Elliott, A.; Fishpool, L. D. C, 2014: HBW and BirdLife International Illustrated Checklist of the Birds of the World. Lynx Edicions BirdLife International

Department of Environmental Affairs and Tourism, 2002: Information Series 5: Impact Significance of the Integrated Environmental Management Information Series

Department of Water Affairs and Forestry, 1996: Target Water Quality Guidelines

Desmet, P. G., Holness, S., Skowno, A. & Egan, V.T, 2013: *Limpopo Conservation Plan v.2: Technical Report*. Contract Number EDET/2216/2012. Report for Limpopo Department of Economic Development, Environment & Tourism (LEDET) by ECOSOL GIS

Digby Wells Environmental. 2011. Phase 2 Archaeological Impact Assessment mitigation for Boikarabelo Coal Mine (SAHRA Permit No. 80/11/07/015/51). For: Resgen South Africa (Pty) Ltd.

Dreyer, C. 2011. First Phase Archaeological and Heritage Assessment of the proposed chrome mining developments at Zwartkop 369KQ, Hartbeestkopje 367kq, Schilpadnest 385kq, Moddergat 389KQ, Northam District, North West Province.

Eastwood, E. and Eastwood, C. 2006: Capturing the spoor. An exploration of southern African rock art. Claremont: David Philip New Africa Books (Pty) Ltd.Hall, S.L. 1981. Iron Age sequence and settlement in the Rooiberg, Thabazimbi area. Unpublished MA Thesis. University of South Africa. Johannesburg

Flocchini, R. G., Cahill, T. A., Matsumura, R. T., Carvacho, O., & Lu, Z., 1994: Study of fugitive PM10 emissions for selected agricultural practices on selected agricultural soils. University of California.

Friedmann,Y. & Daly, B, 2004: *Red Data Book of the Mammals of South Africa: A Conservation Assessment*. CBSG South Africa, Conservation Breeding Specialist Group (SSC/IUCN), Endangered Wildlife Trust, South Africa

GeoPollution Technologies, 2010: Geohydrological study for Rhino Minerals (Pty) Ltd – Rhino Andalusite Mine

Groundwater Complete, 2015: Report on geohydrological investigation as part of the EIA, and EMP and IWULA

Gudani Consulting, 2015: Soil, land capability and land use assessment of the quarry and overburden dump footprints of Imerys Refractory Minerals 'Samrec's proposed Tygerkloof Mine situated on portions 1, 3 and the remaining extent 5of the farm Tygerkloof 354 KQ near Thabazimbi

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. (eds.), 1997: *The Atlas of Southern African Birds. Vol. 1 & 2*. BirdLife South Africa, Johannesburg

Henschel, P., Hunter, L., Breitenmoser, U., Purchase, N., Packer, C., Khorozyan, I., Bauer, H., Marker, L., Sogbohossou, E. & Breitenmoser-Wursten, C, 2008: Panthera pardus. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. http://www.iucnredlist.org/

Huffman, T.N. 1990. The Waterberg Research of Jan Aukema. *The South African Archaeological Bulletin* 45 :117 119

Huffman, T.N. 2004: Archaeological Assessment for the Rhino Andalusite Mine. Second Report. A final Phase 1 report prepared for Rhino Minerals. Johannesburg: Archaeological Resources Management

Huffman, T.N. 2006b. Maize grindstones, Madikwe pottery and ochre mining in precolonial South Africa. *Southern African Humanities* 18:51-70

Huffman, T.N. 2007a. Further reconnaissance for the Rhino Andalusite Mine, Thabazimbi, Limpopo Province. A Phase 1 report prepared for Rhino Minerals

Huffman, T.N. 2007b. Handbook to the Iron Age. Scotsville: University of KwaZulu-Natal Press

Huffman, T.N. 2009a: Archaeological Assessment for the Rhino Andalusite Mine, Thabazimbi. Third Report. A Phase I Report with Appendix prepared for Rhino Minerals. Johannesburg: Archaeological Resources Management

Huffman, T.N. 2009b: A cultural proxy for drought: ritual burning in the Iron Age of southern Africa. *Journal of Archaeological Science* 36: 991-1005

Hutten, M. 2012: HIA for the proposed development of the Kambaku Private School on the farm Vlakplaats 137 KQ, approximately 15 km north of Thabazimbi, Limpopo Province. Compiled for: Tekplan Environmental

Hutten, M. 2013a: HIA for the proposed solar park development on the farm Liverpool near Koedoeskop, Limpopo Province. Compiled for: Jonk Begin Omgewingsdienste

Hutten, M. 2013b: HIA for the proposed solar park development on the farm Grootkuil near Koedoeskop, Limpopo Province. Compiled for: Jonk Begin Omgewingsdienste

Hutten, M. 2013c: HIA for the proposed solar park development on the farm Aapieskruil near Koedoeskop, Limpopo Province. Compiled for: Jonk Begin Omgewingsdienste

Ila. 2014: Draft scoping report: proposed township on Portion 20 and 22 of the farm Theunispan 293 LQ, Portion 1-4 and a portion of the remainder of the Farm Grootdoorn 292 LQ, portion 3 of the Farm Steenbokpan 295, within Lephalale Municipality. For Flexilor Properties Pty Ltd T/A Steenbokpan Development Consortium

International Union for Conservation of Nature, 2014: http://www.iucnredlist.org/

Küsel, M.M. 1998: Prehistoriese mynbou, Hoofstuk 4:100-102. Met kaart 2.3.In Bergh, JS (red.) *Geskiedenisatlas van die noordelike streke* [History Atlas for the northern areas: Prehistoric mining]. Pretoria: Van Schaik

Mecenero, S, Ball, J.B., Edge, D.A., Hamer, M.L., Henning, G.A., Krüger, M., Pringle, E.L., Terblanche, R.F. & Williams, M.C. (eds.), 2013: Conservation assessment of butterflies of South Africa, Lesotho and Swaziland: Red list and atlas. Saftronics (Pty) Ltd., Johannesburg & Animal Demography Unit, Cape Town

Minter, L.R., Burger, M., Harrison, J.A., Braack, H.H., Bishop, P.J. & Kloepfer, D., 2004: Atlas and Red data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institution, Washington, D.C

Mucina, L. & Rutherford, M.C. (eds), 2006: The vegetation map of South Africa, Lesotho and Swaziland. *Strelitzia 19,* South African National Biodiversity Institute

NPI., 2012: Emission Estimation Technique Manual for Mining. Version 3. Australian Government Department of Sustainability, Environment, Water, Population and Communities.

Pachnoda Consulting CC, 2015: An ecological evaluation for the Tygerkloof Mine

PGS. 2012. Wachteenbietjesdraai 350 KQaAnd Kwaggashoek 345 KQ Heritage Impact Report on proposed mining activities of Project Phoenix

Pooley, E, 1998: A Field Guide to the Wild Flowers of KwaZulu-Natal and the Eastern Region. Natal Flora Publications Trust, Durban

Raimondo, D., Von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A. & Mayama, P.A. (eds), 2009: Red List of South African plants. *Strelitzia* 25. South African National Biodiversity Institute, Pretoria

Rural Development Framework, 1997

SAHRA. 2014: A statement of significance of Madimatle Mountain

Samrec, 2014: Mining Works Programme

Schapera, I. 1942a: A history of the BaKgatla baga Kgafêla. Cape Town: School of African Studies

Schapera, I. 1965: Praise-Poems of Tswana Chiefs. Oxford: Clarendon Press

Schlömann, H. 1896: Felszeichnungen der Buschmänner bei Pusompe in Nord-Transvaal, einer Cult-Stätte der jetzt dort ansässigen Massele. *Zeitschrift für Ethnologie* 28:220 221.Shangoni Management Services. 2013: Sishen Iron Ore Company (Pty) Ltd: Thabazimbi Mine – Project Infinity Final Scoping Report Under Nema, 1998

Shangoni Management Services, 2011: Environmental Management Programme for Rhino Andalusite Mine

Skinner, J.D. & Chimimba, C.T. (Revisers), 2005: Mammals of the Southern African Subregion. Cambridge University Press, London

Skinner, J.D. & Smithers, R.H.N., 1990: *The Mammals of the Southern African Subregion*. University of Pretoria, Pretoria, RSA

Smith, A. 1836: Report of the expedition for exploring Central Africa. *Journal of the Royal Geographic Society*, 362-413

Stevenson, T., 2004: Dust Suppression on Wyoming's Coal Min Haul Roads – Literature Review, Recommended Practices and Best Available Control Measures – A Manual.

Tarboton, W.R & Allen, D.G., 1984: The status and the conservation of birds of prey in the Transvaal. Transvaal Mus. Monograph 3

Taylor, M.R. (ed.) in press: The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg. In press

Thabazimbi Local Municipality, 2013: Integrated Development Plan

Thompson, R. J., & Visser, A. T., 2000: Integrated Asset Management Strategies for Unpaved Mine Haul Roads. University of Pretoria.

US EPA, 1996: Compilation of Air Pollution Factors (AP-42). United States Environmental Protection Agency.

US EPA, 2004: AERMOD: Description of Model Formulation. United States Environmental Protection Agency. Retrieved from United States Environmental Protection Agency: http://www.epa.gov/scram001

Varicon cc, 2015: Environmental Noise Impact Assessment Report

Van Schalkwyk, J.A. 1994: A survey of archaeological and cultural historical resources in the Amandelbult mining lease area. Unpublished report 94KH03. Pretoria: National Cultural History Museum

Van Schalkwyk, J.A. 2001: A survey of cultural resources in two development areas, Amandelbult, Northern Province. Unpublished report 2001KH13. Pretoria: National Cultural History Museum

Van Schalkwyk, J.A. 2003: A survey of archaeological sites for the Amandelbult Platinum Mine Seismic exploration program. Unpublished report 2003KH16. Pretoria: National Cultural History Museum

Van Schalkwyk, J.A. 2004: Heritage impact report for the Amandelbult electricity sub-transmission lines, Amandelbult Platinum Mine, Limpopo Province. Unpublished report 2004KH32. Pretoria: National Cultural History Museum

Van Schalkwyk, J. 2007: Survey of heritage resources in the location of the proposed Merensky Mining Project, Amandelbult Section, Rustenburg Platinum Mine, Limpopo Province. Prepared For WSP Environmental

Van Schalkwyk, J.A., Pelser, A.J. and Teichert, F. 2004: The surveying and mapping of archaeological sites on the farm Elandsfontein 386KQ, Amandelbult Platinum Mine, Thabazimbi district, Limpopo Province. Unpublished report 2004KH47. Pretoria: National Cultural History Museum

Van Vuuren, C.J. 2014: Cultural Heritage of the Madimatla Cave and surrounding area: An anthropological perspective

Van Wyk, B-E, Van Oudtshoorn, B & Gericke, N, 1997: Medicinal Plants of South Africa. Briza Publications, Pretoria

Van der Ryst, M.M. 2006: 'Seeking Shelter: Hunter-Gatherer-Fishers of Olieboomspoort, Limpopo, South Africa.' PhD diss., University of the Witwatersrand

Wallis, J.P.R. (Ed.) 1946: *The northern goldfields diaries of Thomas Baines Vol. III. Second journey 1871-1872*. London: Chatto and Windus

Waterberg District Municipality, 2013: Integrated Development Plan

Wiesel, I., Maude, G., Scott, D. & Mills, G., 2008: Hyaena brunnea. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. http://www.iucnredlist.org/

Wilson, D.E. & Mittermeier, R.A. (eds), 2011: Handbook of the mammals of the world. Vol 2. Hoofed Mammals. Lynx Editions, Barcelona

www.sabap2.adu.org.za