mineral resources

Department:
Mineral Resources
REPUBLIC OF SOUTH AFRICA

FINAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT

And

ENVIRONMENTAL MANAGEMENT PROGRAMME REPORT

Waste Licence Application

SUBMITTED FOR ENVIRONMENTAL AUTHORISATIONS IN TERMS OF THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 AND THE NATIONAL ENVIRONMENTAL MANAGEMENT WASTE ACT, 2008 IN RESPECT OF LISTED ACTIVITIES THAT HAVE BEEN TRIGGERED BY APPLICATIONS IN TERMS OF THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002 (MPRDA) (AS AMENDED).

NAME OF APPLICANT: IMERYS REFRACTORY MINERALS SOUTH AFRICA, RHINO ANDALUSITE MINE
TEL NO: +27 14 784 0669
POSTAL ADDRESS: PO Box 8118, Centurion, 0046
PHYSICAL ADDRESS: Farm Grootfontein, Thabazimbi, 0380

FILE REFERENCE NUMBER SAMRAD: LP30/5/1/2/3/2/1/74 EM

October 2017

BECS environmental

PO Box 72960, Lynnwood Ridge, 0040;
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E-mail: salome@becsenv.co.za

1 IMPORTANT NOTICE

In terms of the Mineral and Petroleum Resources Development Act (Act 28 of 2002 as amended), the Minister must grant a prospecting or mining right if among others the mining "will not result in unacceptable pollution, ecological degradation or damage to the environment".

Unless an Environmental Authorisation can be granted following the evaluation of an Environmental Impact Assessment and an Environmental Management Programme report in terms of the National Environmental Management Act (Act 107 of 1998) (NEMA), it cannot be concluded that the said activities will not result in unacceptable pollution, ecological degradation or damage to the environment.

In terms of section 16(3)(b) of the EIA Regulations, 2014, any report submitted as part of an application must be prepared in a format that may be determined by the Competent Authority and in terms of section 17 (1) (c) the competent Authority must check whether the application has taken into account any minimum requirements applicable or instructions or guidance provided by the competent authority to the submission of applications.

It is therefore an instruction that the prescribed reports required in respect of applications for an environmental authorisation for listed activities triggered by an application for a right or a permit are submitted in the exact format of, and provide all the information required in terms of, this template. Furthermore, please be advised that failure to submit the information required in the format provided in this template will be regarded as a failure to meet the requirements of the Regulation and will lead to the Environmental Authorisation being refused.

It is furthermore an instruction that the Environmental Assessment Practitioner must process and interpret his/her research and analysis and use the findings thereof to compile the information required herein. (Unprocessed supporting information may be attached as appendices). The EAP must ensure that the information required is placed correctly in the relevant sections of the Report, in the order, and under the provided headings as set out below, and ensure that the report is not cluttered with uninterpreted information and that it unambiguously represents the interpretation of the applicant.

2 OBJECTIVES OF THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

The objective of the environmental impact assessment process is to, through a consultative process—

a. determine the policy and legislative context within which the activity is located and document how the proposed activity complies with and responds to the policy and legislative context;
b. describe the need and desirability of the proposed activity, including the need and desirability of the activity in the context of the preferred location;
c. identify the location of the development footprint within the preferred site based on an impact and risk assessment process inclusive of cumulative impacts and a ranking process of all the identified development footprint alternatives focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects of the environment;
d. determine the—-
    i. nature, significance, consequence, extent, duration and probability of the impacts occurring to inform identified preferred alternatives; and
    ii. degree to which these impacts—
        aa. can be reversed;
        bb. may cause irreplaceable loss of resources, and
        cc. can be avoided, managed or mitigated;
e. identify the most ideal location for the activity within the preferred site based on the lowest level of environmental sensitivity identified during the assessment;
f. identify, assess, and rank the impacts the activity will impose on the preferred location through the life of the activity;
g. identify suitable measures to manage, avoid or mitigate identified impacts; and
h. identify residual risks that need to be managed and monitored.

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ABBREVIATIONS

ABA	Acid Base Accounting
AIA	Archaeological impact assessment
AMD	Acid mine drainage
CoP	Code of Practice
DAFF	Department of Agriculture Forestry and Fisheries
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
DRDLA	Department of Rural Development and Land Affairs
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EDD	Expanded Durov diagram
EIA	Environmental Impact Assessment
EIA Regulations	Environmental Impact Assessment Regulations, GN 982 of 2014 i.t.o. the National Environmental Management Act No 107 of 1998
ESA	Early Stone Age
HIA	Heritage Impact Assessment
IA	Iron Age
I&APs	Interested and affected parties
IWUL	Integrated Water Use License
IWULA	Integrated Water Use License Application
LED	Local Economic Development
LIA	Late Iron Age
LSA	Late Stone Age
mamsl	Metres above mean sea level
MPRDA	Mineral and Petroleum Resources Development Act No 28 of 2002 (as amended)
MSA	Middle Stone Age
NEMA	National Environmental Management Act No 107 of 1998 (as amended)
NEMWA	National Environmental Management Waste Act 59 of 2009 (as amended)
NHRA	National Heritage Resources Act No 25 of 1999
PPP	Public participation process
RAM	Rhino Andalusite Mine
SAHRA	South African Heritage Resources Agency
SDF	Standard design flood
TIOM	Thabazimbi Iron Ore Mine
TLM	Thabazimbi Local Municipality
TSP	Total Suspended Particulates
WBPA	Waterberg/Bojanala Priority Area
WDM	Waterberg District Municipality

Executive summary

Applicant

BECS Environmental has been appointed by Imerys Refractory Minerals South Africa (Pty) Ltd: Rhino Andalusite Mine (RAM) to apply for a waste license to backfill and extent Quarry 9 into a tailings facility, on the mine. The backfilling of old mined-out quarries has been ongoing as part of rehabilitation for several years. From 24 July 2015, an applicant must obtain a waste licence for such backfill.

RAM was originally the Timeball Andalusite Mine. The mine has been in operation for more than 25 years and has sufficient ore reserves to continue operating for at least until 2030 including the new proposed Tygerkloof mining area.

The mine is located on the Farm Grootfontein 353 KQ and Buffelsfontein 353 KQ, and the Quarry 9 is located on the farm Buffelsfontein 353 KQ, Thabazimbi Local Municipality, Limpopo Province.

Refer to Table 1 below for a description of the applicant, and Figure 1 for an organogram of the applicant. The applicant is also the landowner of the mining site and therefore the property for which the application applies.

Table 1: Description of the applicant

Project applicant	Imerys Refractory Minerals South Africa (Pty) Ltd
Trading name	Rhino Andalusite Mine
Contact person	Alfred Marapyana
Designation	Mine Manager - Rhino Andalusite Mine
Telephone number	+27 14 784 0669
E-mail address	Alfred.Marapyana@imerys.com

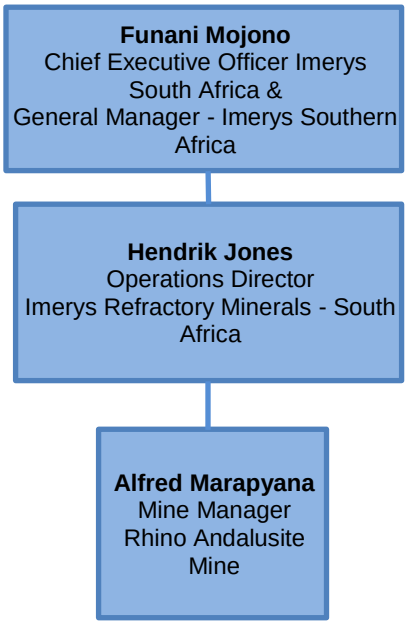

Figure 1: Rhino Andalusite Mine organogram

Project description

The preferred alternative to the waste license is to backfill and extent Quarry 9 with tailings from the mining and processing activities, into a new tailings facility. This is done as part of rehabilitation of the mine.

The second alternative is to construct a new tailings facility between Quarry 9 and Motswere Quarry; therefore, this will not be done as part of rehabilitation.

Legal requirements

According to Category B(11) of the National Environmental Management Waste Act, 2008 (Act No 59 of 2008) (NEMWA), GNR 633 of 24 July 2015 in terms of NEMWA, an applicant must obtain a waste licence for:

'*The establishment or reclamation of a residue stockpile or residue deposit resulting from activities which require a mining right, exploration right or production right in terms of the MPRDA.'*

Furthermore, a person who wishes to commence, undertake or conduct a waste management activity listed under this Category, must conduct a scoping and environmental impact reporting process set out in the EIA Regulations made under section 24(5) of the NEMA as part of a waste management licence application contemplated in section 45 read with section 20(b) of NEMWA.

Therefore, the applicant is applying for a waste license and undertaking an EIA process.

Summary of impacts

Both alternatives will have the following impact on groundwater:

The tailings material is mostly inert; therefore, the backfilled quarry or tailings facility is not expected to generate poor quality seepage. Some degree of groundwater mounding may occur as a result of artificial aquifer recharge; however, this recharge is expected to be very low due to the nature of the tailings material and low hydraulic properties of the underlying aquifer host rock. No significant impacts are therefore envisaged, both in terms of groundwater levels and quality.

The low hydraulic properties of the underlying fractured rock aquifer combined with relatively low groundwater gradients result in low seepage velocities, which further decrease the potential impacts on groundwater quality.

According to the waste assessment report (Aquatico, 2017): Both waste streams (Tailings and Waste Rock) are low risk waste and impact resulting from disposing this waste into a quarry should be negligible based on these testing standards.

The second alternative will further have significant impacts on vegetation, animal habitats, soil, stormwater, land use and land capability, and will be close to the prehistoric mine which is a heritage site. This alternative will also not aid in rehabilitation of the mine.

PART A

SCOPE OF ASSESSMENT AND ENVIRONMENTAL IMPACT ASSESSMENT REPORT

a) Details of the Environmental Assessment Practitioner

This section includes the following:

i. Details of the Environmental Assessment Practitioner (EAP);
ii. Expertise of the EAP, which includes the qualifications of the EAP (with evidence) and a summary of the EAP's past experience - in carrying out the EIA Procedure; and
iii. A declaration that the EAP is independent in a form as may be specified by the competent authority

BECS Environmental was appointed as an independent consultant (EAP) to meet the requirements as set out in regulation 13 of the EIA Regulations. Refer below to a description of the EAP, and refer to Addendum 2 for a detailed CV of the EAP, which includes the expertise including qualifications and past experience.

Table 2: 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)

I, Salome Beeslaar (8310190032081), hereby declare that I have no conflict of interest related to the work of this report. Specially, I declare that I have no business, personal, or financial interests in the property and/or mining right being assessed in this report, and that I have no personal or financial connections to the relevant property owners, or mine. I declare that the opinions expressed in this report are my own and a true reflection of my professional expertise and that there are no circumstances that may compromise my objectivity in performing such work.

_____

Salome Beeslaar
MSc – Geography
SACNASP (400385/14)
9 October 2017

b) Description of the property

The following is extracted from the Rhino Andalusite Mine (Pty) Ltd Quarry Backfill Project: Report on Geohydrological Investigation as Part of the Environmental Impact Assessment (EIA) and Environmental Management Program (EMP) (Groundwater Complete, 2016).

The mine is located within the Thabazimbi Local Municipality in the Limpopo Province, approximately 23km south-west of the town of Thabazimbi. A locality map of the project area is provided below in Figure 2.

Table 3: Farm names, 21-Digit Surveyor General codes, and coordinates

Farm Name	The farm Buffelsfontein 353 KQ
Application area (Ha)	3,007.4ha
Magisterial district	Thabazimbi Local Municipality, Limpopo Province
Distance and direction from nearest town	23km south-west of the town of Thabazimbi
21-digit Surveyor General Code for each farm portion	T00KQ00000000035300000
Coordinates	24.69125° S, 27.22595° E 24.66738° S, 27.26989° E 24.69647° S, 27.28963° E 24.74002° S, 27.27817° E 24.73811° S, 27.25084° E

The mine is located in the Limpopo catchment, Bierspruit Sub-catchment a part of the Crocodile Catchment, in the quaternary catchment area A2. The mine is further located in the Crocodile (West) and Marico Water Management Area.

c) Locality map

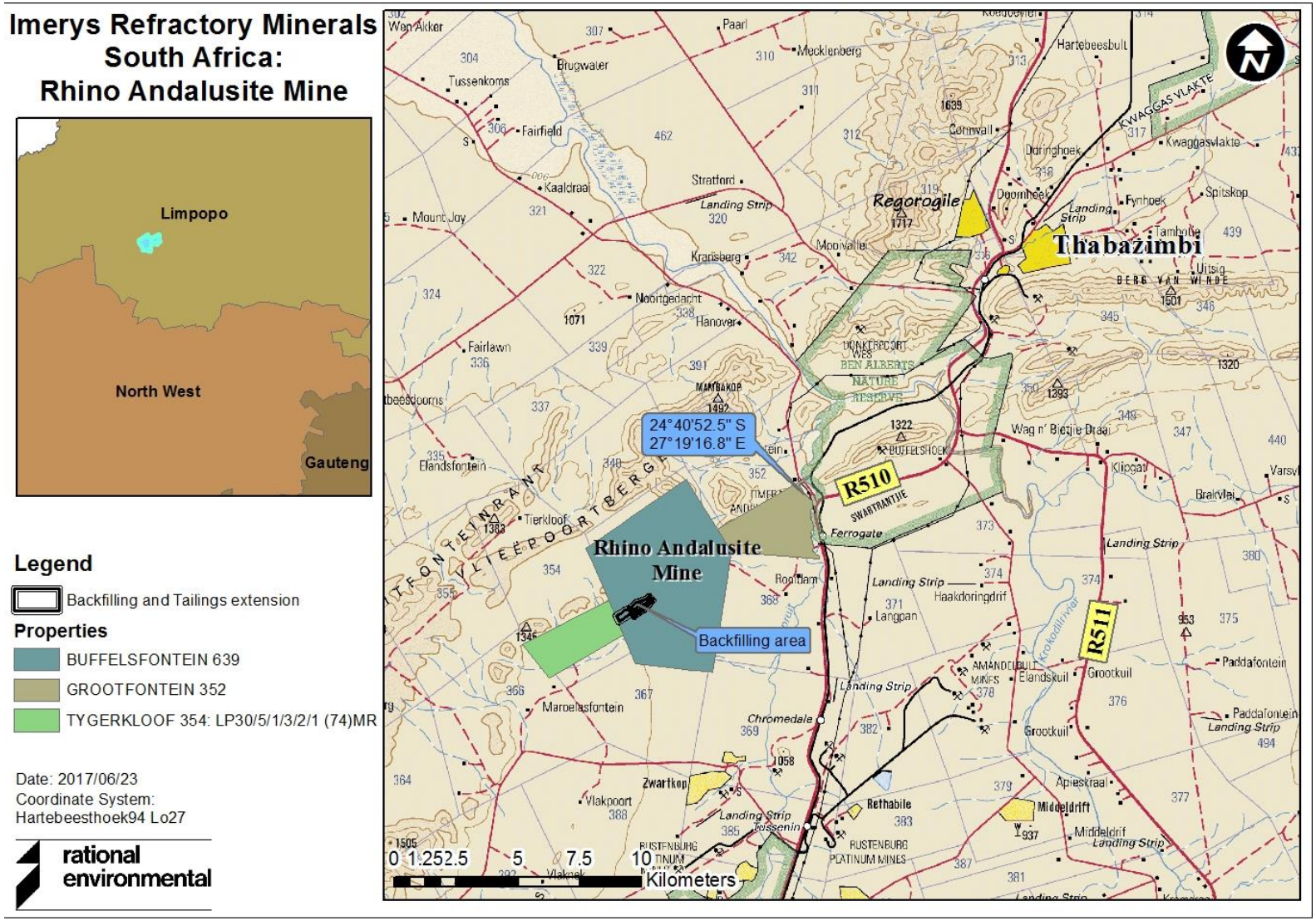

Figure 2: Locality map of Rhino Andalusite Mine Operation

d) Description of the scope of the proposed overall activity

Refer below to the surface layout plan for the preferred alternative, indicating the quarry to be backfilled. The quarry is located on the south-eastern slope of the foothills of the Witfonteinrand Mountain range and covers an area of approximately 30ha.

This layout plan includes having taken into consideration environmental features and current land uses, the issues raised by interested and affected parties (I&APs), and the consideration of alternatives to the initially proposed site layout thus. This layout plan includes both the preferred alternative as well as the second alternative.

(i) Listed and specified activities

The mine applied for an Integrated Water Use License (IWUL) with the Department of Water and Sanitation (DWS). This Integrated Water Use License Application (IWULA) was submitted on 4 June 2015 and includes the backfilling of quarry 9; however, it does not include the construction of a new tailings facility. A WULA must therefore be submitted to include the extension of the quarry. This WULA will be submitted to DWS after public participation is finalised. Refer to Addendum 5B for proof of submission of the original IWULA, and proof of submission of the additional IWULA.

Name of proposed activity	Aerial extent of the activity	Applicable GN and activity	Comment
Backfilling and extension of Quarry 9	67ha	GN 633 of 2015 Category B(11)	Category B waste license therefore a scoping and EIA process to be followed

(ii) Description of the activities to be undertaken

The preferred alternative to the waste license is to backfill and extent Quarry 9 with tailings from the mining and processing activities, to create a new tailings facility. This is done as part of rehabilitation of the mine. Quarry 9 will be expanded to have a maximum capacity of 16,000,000m³.

The second alternative is to construct a new tailings facility, and therefore this will not be done as part of rehabilitation.

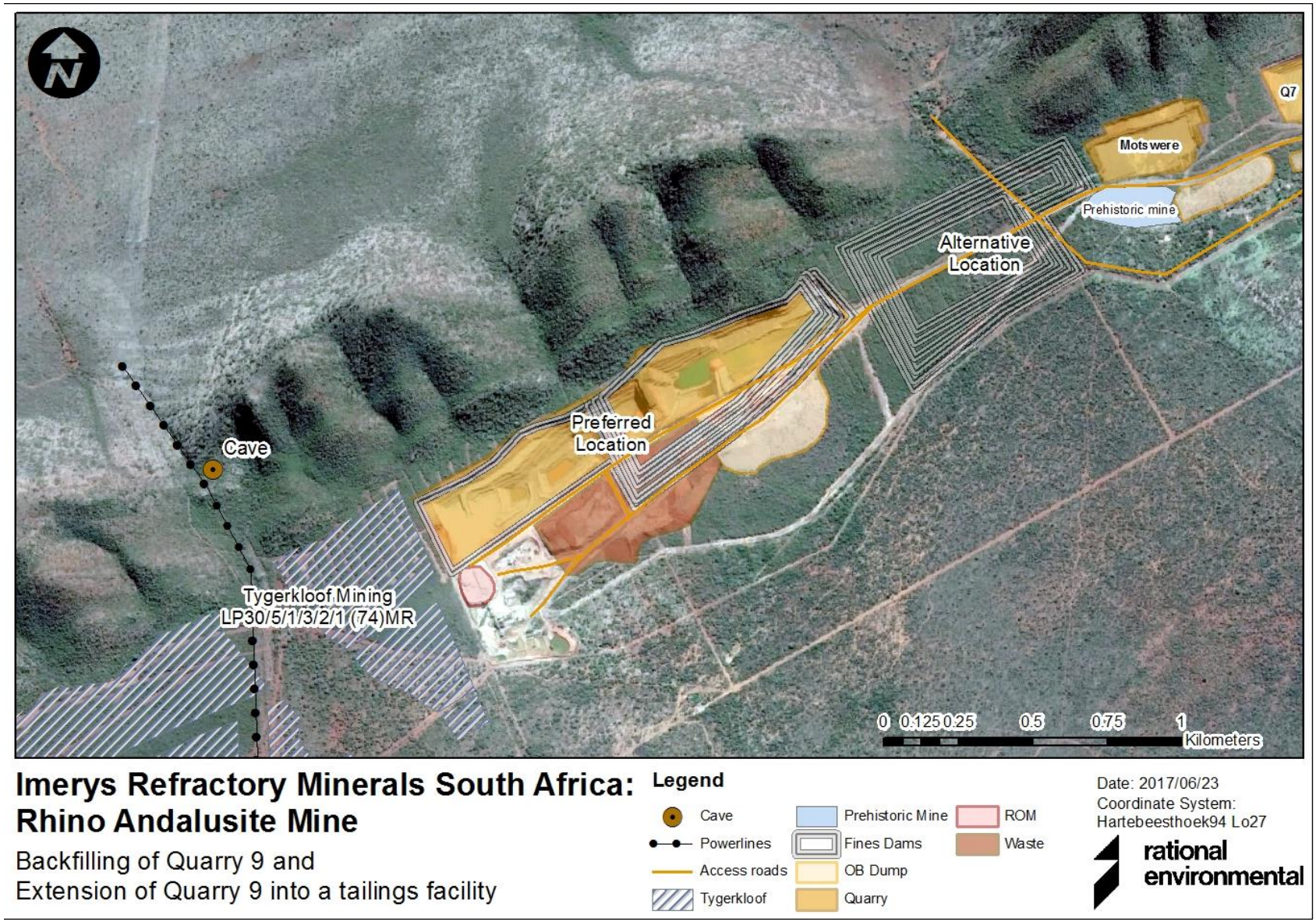

Figure 3: Surface layout plan and sensitivity map

e) Policy and legislative context

Applicable legislation and guidelines used to compile the report	Description of legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
Authorisation applications			
NEMWA	The list of activities which need a waste license in terms of NEMWA was updated on 24 July 2015. From this date, the establishment or reclamation of mine residue which result from a mining activity in terms of the MPRDA is included under the Category B waste license activities.	Part B, section 1(h)(i)(5.3)	This report is part of the waste licencing process to backfill Quarry 9.

f) Need and desirability of the proposed activities

The mine generates tailings as part of its processing activities. This is an inevitable part of its mining. Backfilling of mined-out quarries has been an ongoing process on the mine, thereby reducing the footprint of a complete additional tailing facility as well as rehabilitation of mined-out quarries.

g) Motivation for the preferred development footprint within the approved site including a full description of the process followed to reach the proposed development footprint within the approved site

i) Details of the development footprint alternatives considered

The following definition of "alternatives" is given in the EIA Regulations: *""alternatives", in relation to a proposed activity, means different means of meeting the general purpose and requirements of the activity, which may include alternatives to the -*

(a) property on which or location where the activity is proposed to be undertaken;

(b) type of activity to be undertaken;

(c) design or layout of the activity;

(d) technology to be used in the activity; or

(e) operational aspects of the activity;

and includes the option of not implementing the activity;

(a) The property on which or location where it is proposed to undertake the activity

Both the preferred alternative and the second alternative is located on the farm Buffelsfontein 353 KQ. The preferred alternative's location is Quarry 9 and adjacent to Quarry 9, whereby the second alternative's

location is between Quarry 9 and Motswere Quarry. Refer to Figure 3 indicating the preferred alternative as well as the second alternative's location.

(b) The type of activity to be undertaken

The preferred alternative will be the backfilling and extension of Quarry 9 whereby the second alternative will be the construction of a new tailings facility.

(c) The design or layout of the activity

Refer to Figure 4 for designs. Designs will only be drawn for the second alternative if this alternative is approved.

(d) The technology to be used in the activity

Quarry 9 will be expanded to have a maximum capacity of 16,000,000m³. The alternative must also be able to have a maximum capacity of 16,000,000m³ and will therefore require a larger footprint.

(e) The operational aspects of the activity

There will be no alternative to the operation.

(f) The option of not implementing the activity

This option cannot be included. The mine is currently generating tailings which must be discarded.

ii) Details of the Public Participation Process Followed

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):
"Interested and affected' parties 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."

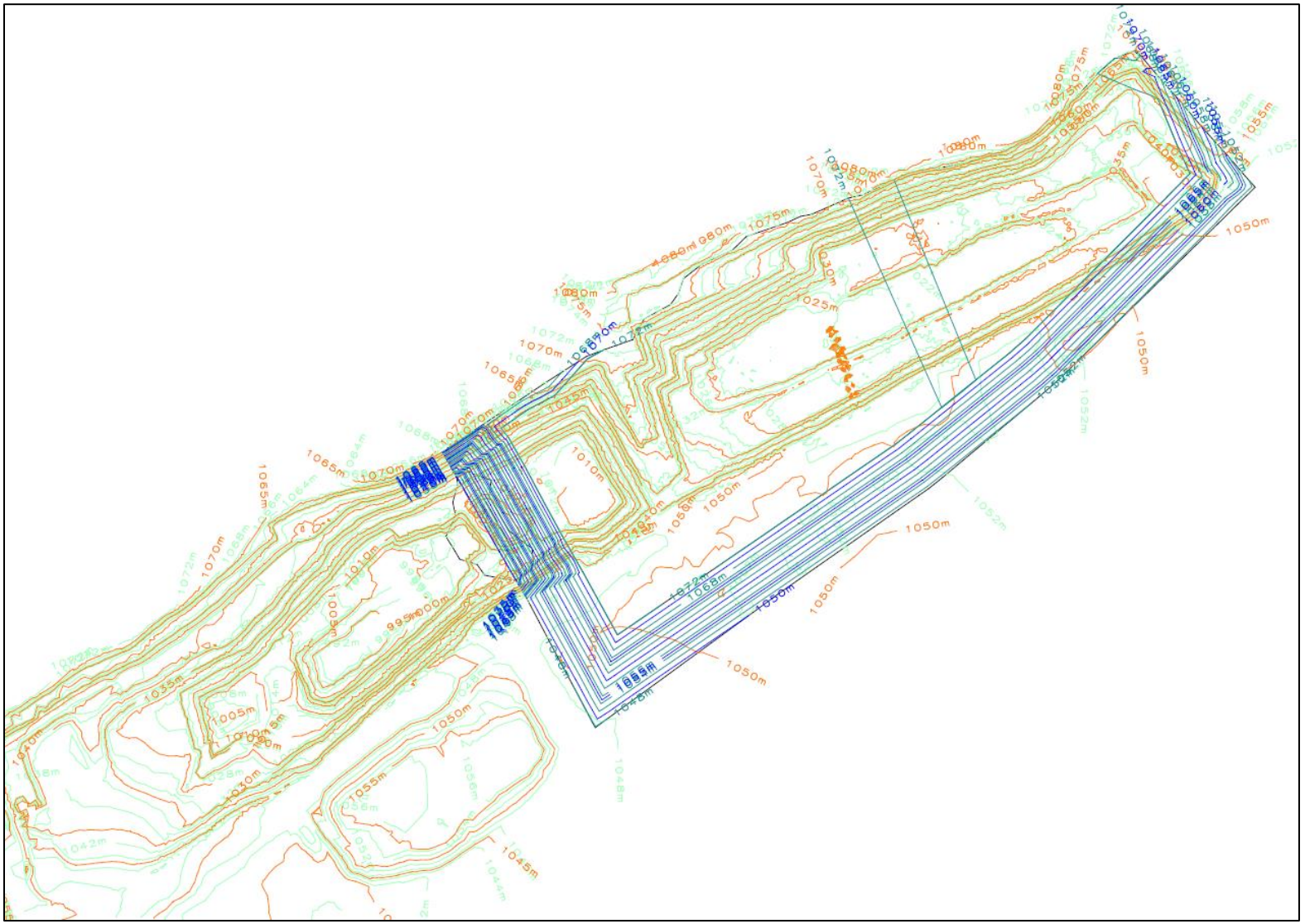

Figure 4: Design layout of the Quarry 9 extension, please note, this does not show the backfill into the complete quarry, only the extension of the quarry

iii) Summary of issues raised by interested and affected parties

1 Identification of interested and affected parties

See below a table of all interested and affected parties.

Table 4: Interested and affected parties identified

I&APs	Date comments received	Issues raised	EAPs response to issues as mandated by the applicant	Section reference in this EIA/EMP where issues and or response were incorporated
Affected parties				
Landowner/s				
RAM is the lawful landowner		Not applicable		Not applicable
Lawful occupier/s of the land				
RAM is the lawful land occupier		Not applicable		Not applicable
Landowners or lawful occupiers on adjacent properties				
Wild Spring Farm - Ferdie Botha: Tygerkloof 1 & Hartbeeskopje 2	X	Not applicable, no comments received, not registered.		Not applicable
DRDLR - Tinyiko Gift Makamu: Tygerkloof 4 (old 1, 2, 3)	X	16 March 2017	Registered as an I&AP, also requested an invitation to the public meeting.	Confirmed this, will send all information.	No issues raised
Prof Willie Erasmus: Hartbeeskopje 1	X	Not applicable, no comments received, not registered.		Not applicable
Scott Denton: Hartbeeskopje 3 & 4	X	Not applicable, no comments received, not registered.		Not applicable
Leadwood (Baruakhomo) – Josia & Victor Selvadi: Maroeloesfontein 1, 2, 22, 355 Buffelsfontein R & 1	X	Not applicable, no comments received, not registered.		Not applicable
Frans Halloway: Maroeloesfontein	X	Not applicable, no comments received, not registered.		Not applicable
Stephan Schoeman: Maroeloesfontein 6 & 7	X	Not applicable, no comments received, not registered.		Not applicable
Thabang Children's Project - Glory Vilakazi: Zwartkop 4	X	Not applicable, no comments received, not registered.		Not applicable
Kobus & Wanda Robertse: De Blauwe Banken	X	Not applicable, no comments received, not registered.		Not applicable

I&APs		Date comments received	Issues raised	EAPs response to issues as mandated by the applicant	Section reference in this EIA/EMP where issues and or response were incorporated
Landsberg: Roodedam 2, 13 & 15	X	Not applicable, no comments received, not registered.			Not applicable
Johan Venter: Roodedam 4	X	Not applicable, no comments received, not registered.			Not applicable
PJ Strydom: Roodedam 9	X	Not applicable, no comments received, not registered.			Not applicable
Kobus Muller: Roodedam 12 & 14	X	Not applicable, no comments received, not registered.			Not applicable
Hennie Naude: Roodedam 5	X	Not applicable, no comments received, not registered.			Not applicable
Maartin Venter: Roodedam 16	X	Not applicable, no comments received, not registered.			Not applicable
CJ Labuschagne: Roodedam 10 & 11	X	Not applicable, no comments received, not registered.			Not applicable
Cobus Van der Merwe: Roodedam 17	X	29 September 2016	Registered as an I&AP	Confirmed this, will send all information.	No issues raised
Bokkie Bronkhorst	X	Not applicable, no comments received, not registered.			Not applicable
Johan Rheeder & Peet Rheeder: Grootfontein 4	X	Not applicable, no comments received, not registered.			Not applicable
KUMBA - Heilet Hatting	X	Not applicable, no comments received, not registered.			Not applicable
Andalusite Resources - Tienie De Jager	X	26 September 2016, 7 March 2017, 3 April 2017	Registered as an I&AP, confirmed that he will attend the public meeting. No issues raised at public meeting.	Confirmed this, will send all information.	No issues raised
Jeremy Rieger: Unknown - 198081	X	Not applicable, no comments received, not registered.			Not applicable
Ward councillor – ward 3					
Daniel Mampeule	X	After several attempts to reach him on his cell phone number, he has not yet returned calls or SMSs. Refer to Addendum 4E for proof of SMSs send.			Not applicable
Waterberg District Municipality (WDM) - Environmental department					
Nozi Molteno	X	Not applicable, no comments received.			Not applicable
Thabazimbi Local Municipality (TLM) - Technical manager					
CG Booysen	X	Not applicable, no comments received.			Not applicable
Organs of state					

I&APs		Date comments received	Issues raised	EAPs response to issues as mandated by the applicant	Section reference in this EIA/EMP where issues and or response were incorporated
South African Heritage Resources Agency (SAHRA)	X	Not applicable, no comments received.			Not applicable
DWS: Nametso Kgabileng & Esmy Madumo	X	An IWULA was submitted to DWS for the backfilling of the quarry and extension of tailings dam. DWS required additional information for the original IWULA but not for this backfilling and extension.			Not applicable
Department of Agriculture Forestry and Fisheries (DAFF): MM Makwaana	X	Not applicable, no comments received.			Not applicable
Department of Mineral Resources (DMR): Mashudu Mudau	X	Not applicable, no comments received.			Not applicable
Communities					
No communities were identified by the DRDLA.	X	Not applicable			Not applicable
DRDLA					
Ms Lorraine Mosebedi	X	Not applicable, no comments received.			Not applicable
Traditional Leaders					
No traditional leaders were identified by the DRDLA.	X	Not applicable			Not applicable
Limpopo Department of Economic Development Environmental and Tourism (LEDET)					
Masungi Tshuketana	X	LEDET sent a letter, signed on 28 April 2017, but only faxed on 23 May 2017. LEDET requested in this letter that the following tools must be considered as part of the assessment: • The Limpopo Conservation Plan, 2013; • The Environmental Management Framework for the Waterberg District; • The Mining and Biodiversity Guidelines; • The Thabazimbi Spatial Development Framework; and • The Waterberg Spatial Development Framework.			Part A(g)(v)(1)(1.2-1.5) Part A(g)(v)(2)(1.2-1.5) Part B(1)(d)
Other Competent Authorities affected					
DMR is the competent authority for the waste license application as well as the mining right. DWS is	X	See above regarding DWS			See above regarding DWS

I&APs		Date comments received	Issues raised	EAPs response to issues as mandated by the applicant	Section reference in this EIA/EMP where issues and or response were incorporated
the competent authority for the WUL.					
Other affected parties					
Historical disadvantaged communities					
No historical disadvantaged communities were identified by the DRDLA.		Not applicable			Not applicable
Land claimants					
No land claimants were identified by the DRDLA.		Not applicable			Not applicable
Interested parties					
These are all the adjacent landowners.	X	Refer above			Refer above

X marks where those who must be consulted were in fact consulted.

2 The details of the engagement process

A pre-Public Participation Process (PPP) letter was sent to all registered I&APs and stakeholders on 26 September 2016, with some additionally send up until 14 October 2016, indicating that RAM is in the process of applying for a waste licence. Refer to Addendum 4A for a copy and proof of these letters.

An advertisement was published in the local newspaper “Platinum Bushvelder” on 10 March 2017. Refer to Addendum 4B for a copy and proof of this advertisement. Three site notices were placed at and around the site on 10 March 2017. One site notice was placed at the security gate of the mine, one site notice at the plant of the mine, and one site notice was placed at the Roodedam Farms, adjacent to the site. Refer to Addendum 4C for a copy and proof of the site notices placed. Refer to Addendum 4C for a map indicating the location of these site notices.

A public and stakeholders meeting was held on 6 April 2017, 10h00, at the Leadwood Lodge, adjacent to the existing mine. Refer to Addendum 4D for the meeting presentation, the attendance register and the minutes of the meeting. Only Mr. De Jager from Andalusite Resources attended the meeting. No specific issues were raised during the meeting.

Electronic copies of the environmental scoping report were sent to all registered I&APs and stakeholders 24 April 2017. Refer to Addendum 4F for proof of this. Hard copies were hand delivered to DAFF and LEDET on 29 March 2017 and to DWS on 30 March 2016. Refer to Addendum 4F for proof of these submissions.

3 Summary of the issues raised by interested and affected parties, and an indication of the manner in which the issues were incorporated, or the reasons for not including them

LEDET sent a letter, signed on 28 April 2017, but only faxed on 23 May 2017. LEDET requested in this letter that the following tools must be considered as part of the assessment:

- The Limpopo Conservation Plan, 2013;
- The Environmental Management Framework for the Waterberg District;
- The Mining and Biodiversity Guidelines;
- The Thabazimbi Spatial Development Framework; and
- The Waterberg Spatial Development Framework.

This has been included into the risk assessment of this report.

iv) The Environmental attributes associated with the development footprint alternatives

The environmental attributes described below include socioeconomic, social, heritage, cultural, geographical, physical and biological aspects. Refer below for the following:

a. Type of environment affected by the proposed activity - its current geographical, physical, biological, socio- economic, and cultural character;
b. Description of the current land uses;
c. Description of specific environmental features and infrastructure on the site; and
d. Environmental and current land use map - which shows all environmental, and current land use features.

Please note, that the proposed project is part of an already existing mine. The location is within an already existing quarry as well as adjacent to this quarry in an already disturbed area.

1 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.

2 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).

2.1 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 5). 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.

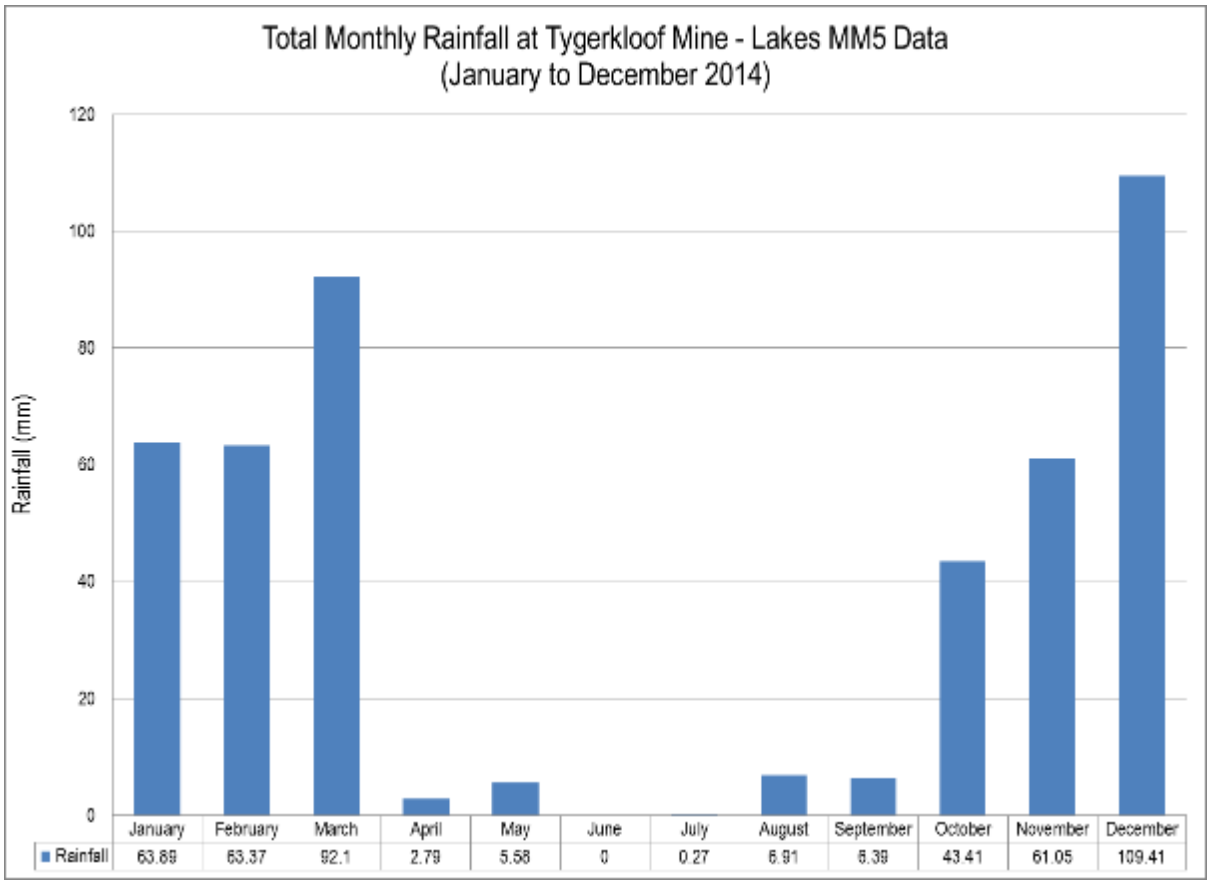

Figure 5: Monthly rainfall and relative humidity (MM5 data, 2014)

2.2 Temperatures

Diurnal and average monthly temperature trends are presented in Figure 6. Monthly mean, maximum and minimum temperatures are given in Table 7. 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 5: 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

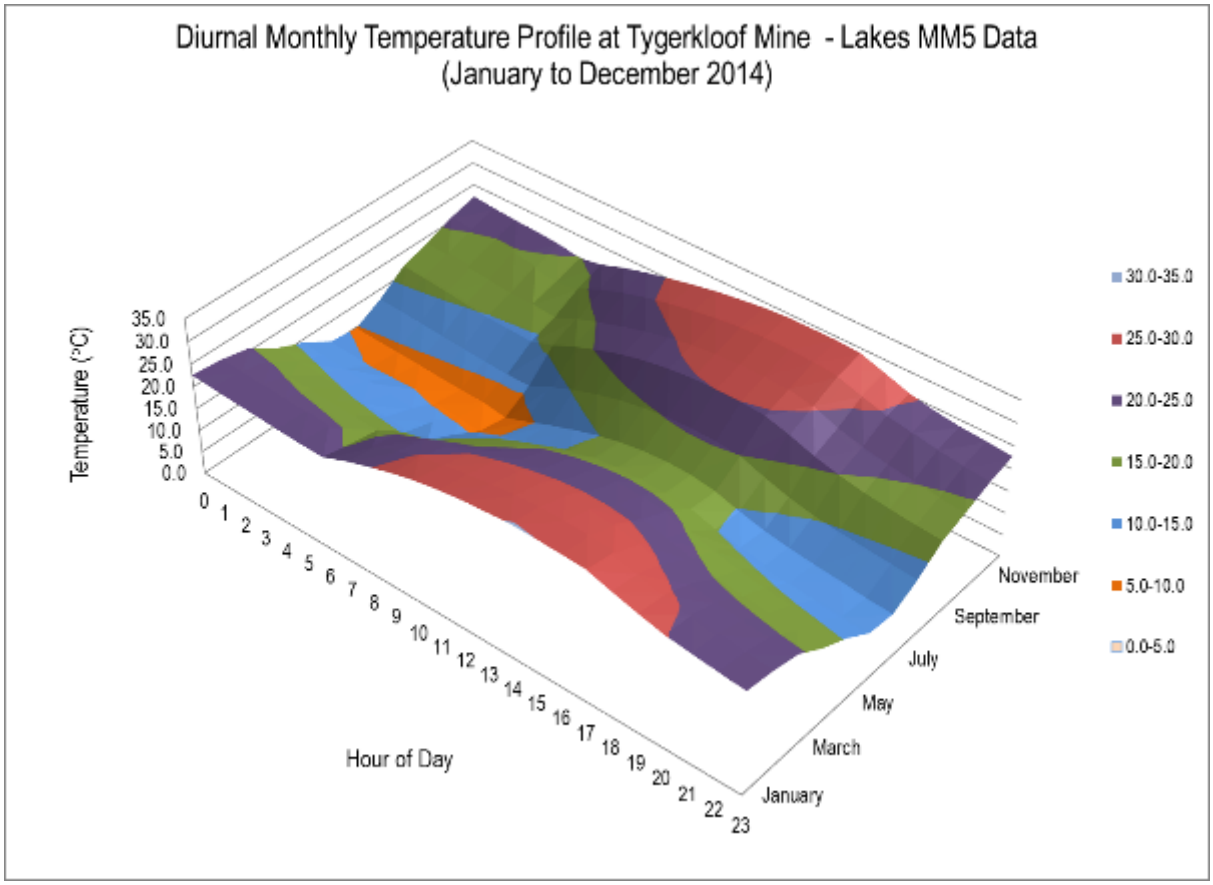

Figure 6: Diurnal temperature profile (MM5 Data, 2014)

2.3 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 7 while the seasonal variations are shown in Figure 8. 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.

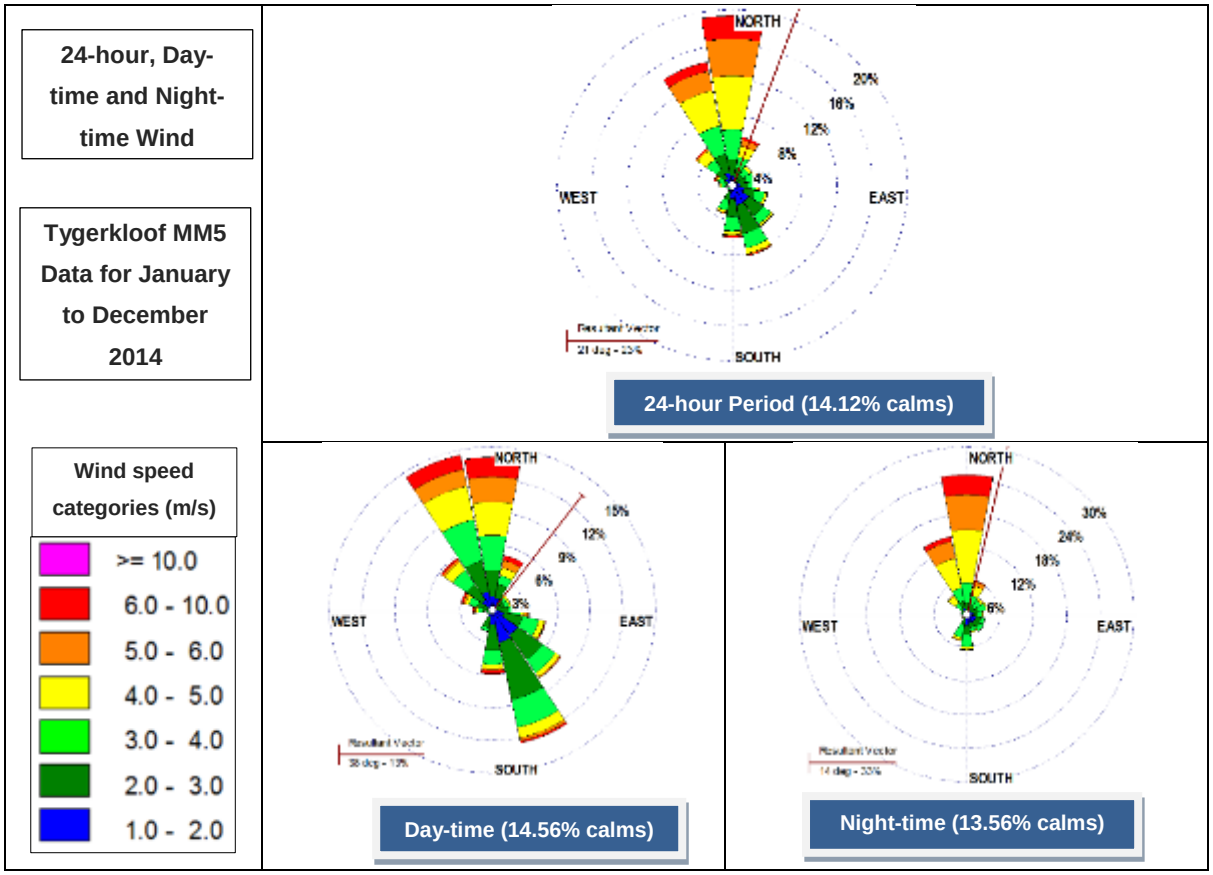

Figure 7: Period, day- and night-time wind roses (MM5 Data, January to December 2014)

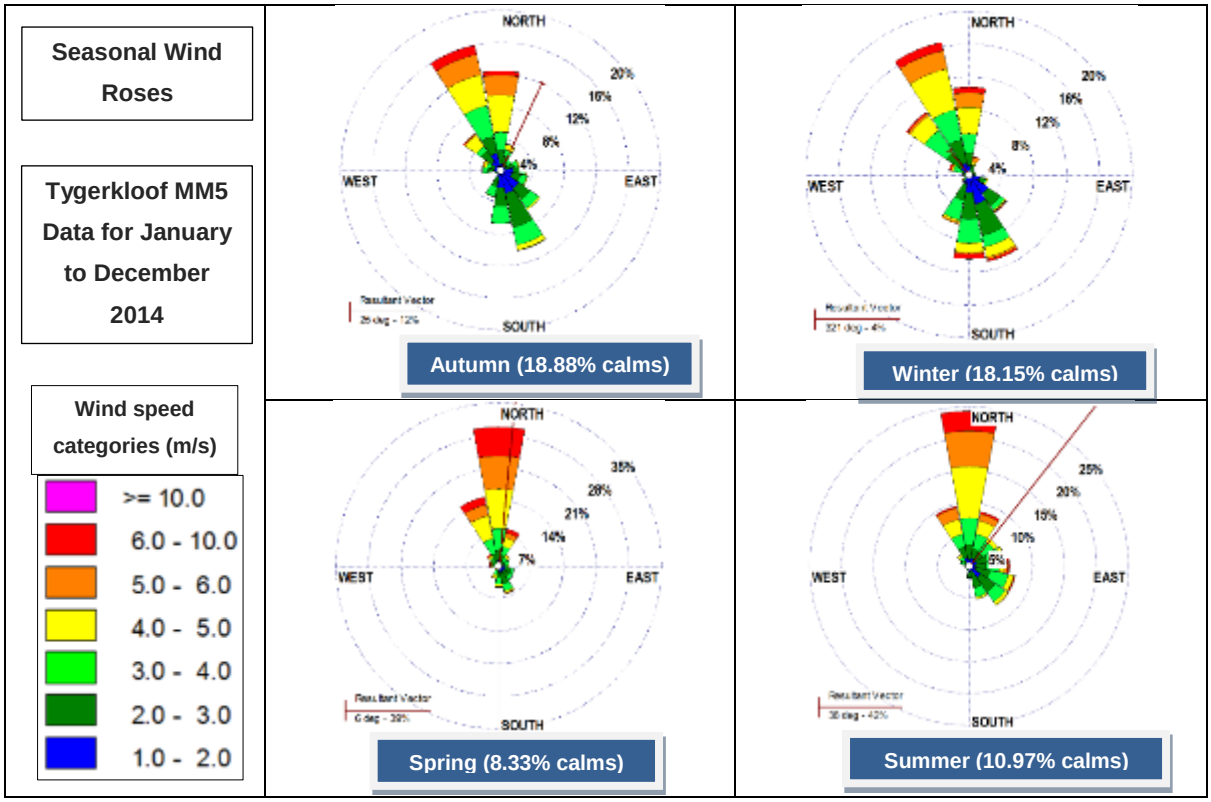

Figure 8: Seasonal wind roses (MM5 Data, January to December 2014)

2.4 Evaporation

The monthly evaporation for Thabazimbi is not available. The monthly evaporation for Swartklip Rustenburg Platinum Mine, about 80km from Thabazimbi, is given in Table 8 below.

Table 6: 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

2.5 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.

3 Topography

Information for this section was obtained from the Rhino Andalusite Mine (Pty) Ltd Quarry Backfill Project: Report on Geohydrological Investigation as Part of the Environmental Impact Assessment (EIA) and Environmental Management Program (EMP) (Groundwater Complete, 2016).

The project area is located on the south-eastern slope of foothills that run parallel to the Witfonteinrand Mountain range in a north-east/south-west direction. Surface elevations in the mine lease area vary from approximately 920m to 1,440m above mean sea level (mamsl). Two prominent water courses occur within the immediate vicinity of the project area, namely the Bierspruit (±7.2km east) and Crocodile River (17.8km east). The two water courses flow in a northerly direction and converge at a location approximately 3.3km north-east of the RAM lease area from where it continues to flow in a north-westerly direction. The Crocodile River is perennial, whereas the Bierspruit is known to run dry during times of low rainfall.

The project area is located within the A24F quaternary catchment, which covers an area of approximately 590km^2. Surface elevations for the project area are indicated in Figure 9.

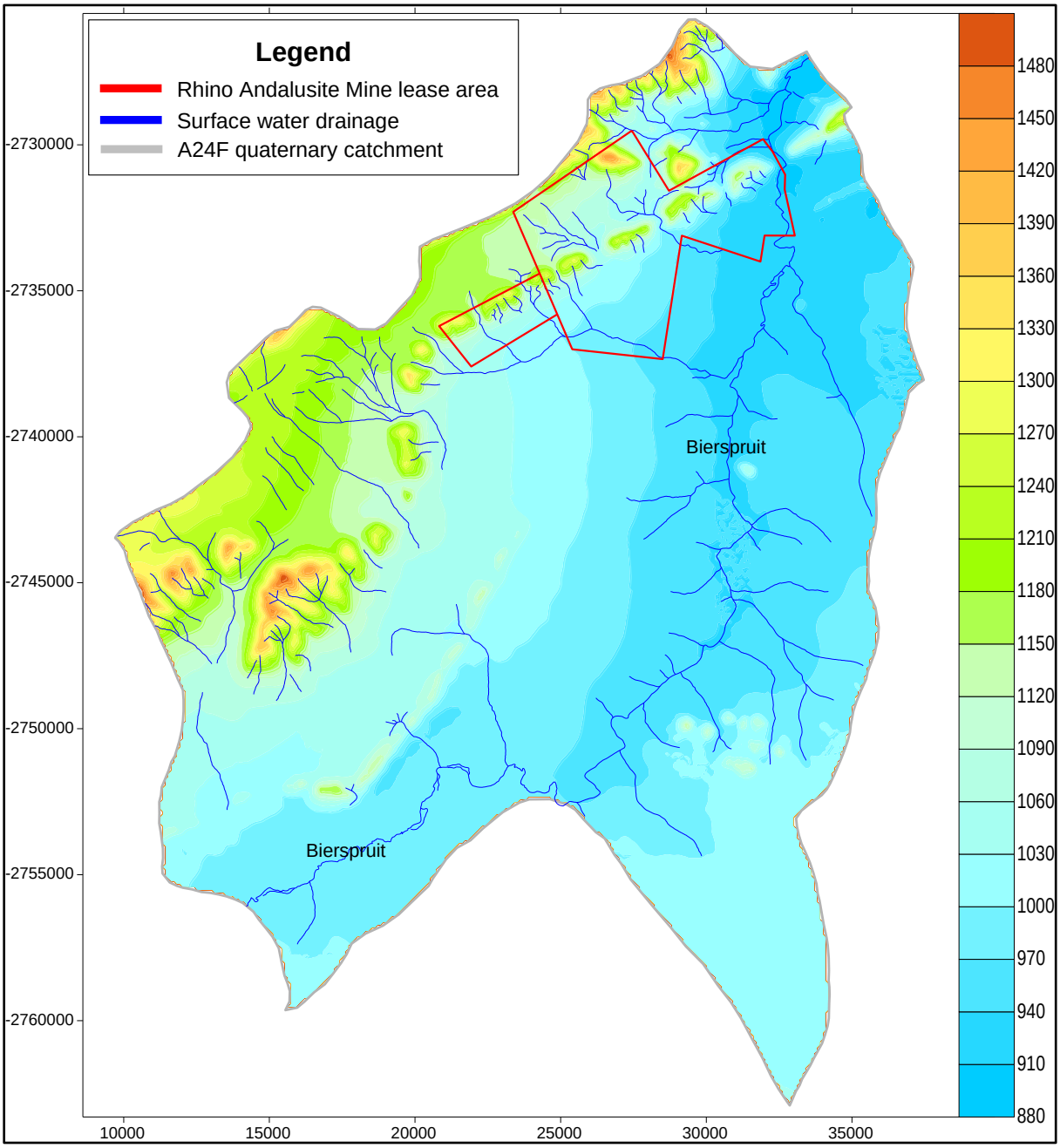

Figure 9: Surface elevation contours for the project area (mamsl)

4 Soil

Information for this section was obtained from 'Rhino Minerals: Buffelsfontein - EMPR Addendum' (Shangoni Management Services, 2010).

The RAM property covers 3 main soil types. The northern parts of the property are classified as soils with minimal development – usually shallow on hard or weathered rock- with or without intermittent diverse soils. On the eastern-most section of the property there is a thin band of soils classified as: black and red-strongly structured clayey soils with high base status. The remainder of the site consists of soils classified as red- massive or weak structured soils with high vase status.

The soils are, for the most part, shallow and stony red soils. Some black clay occurs in the low-lying Bierspruit valley and, bordering on these, the red soils tend towards having melanic A-horizons and Pedocutanic B-horizons. There is thus a gradient from the Hutton form to the Bonheim / Valsrivier spectrum to the Arcadia form going down slope. On the dolomites the red soils are lighter textured than on the shales and breccias. The Buffelsfontein section of the Mine had its development along the same topographic position and the soils are similar but seemingly deeper and sandier.

In terms of nutrients, as is the case with most soils under dry climatic conditions, the soils are fertile. In the undisturbed state the soils are not inherently erodible. There are no signs of erosion except in disturbed sites (along the roadways, etc.) in the area. Although topsoil is present it is not in such thick layers to promote topsoil recovery on most parts of the site.

5 Pre-mining land capability, land use and existing infrastructure

Information for this section was obtained from 'Rhino Minerals: Buffelsfontein - EMPR Addendum' (Shangoni Management Services, 2010).

Due to climatological conditions in this area and limiting crop production, no soils on the property are classified as arable. Soils that would physically be arable are classified as grazing land in this instance while most of the land that has been mined is occupied by more than 50% rock by volume, and 50% by wilderness land. Considering these findings and the size of the Mine property, it is not considered necessary to draw up a land capability map in this instance. The entire mining area roughly comprises:

Wilderness land:	49%
Arable Land:	0%
Grazing Land:	49%
Wetland:	2%

No natural wetlands were identified on the site, but due to the mining activities and perennial supply of water from the operation, some areas with wetland characteristics have developed. These are considered artificial. Land use is limited largely both by the dry climate and the limited arable soils. The areas where mining occurs are considered to be non-arable. Although occupied by a fairly steep colluvium, the topsoil that is being stripped for use in rehabilitation is very stony. Grazing of wild animals occurs on the site but no commercial land use other than mining occurs.

Game and cattle farming occurred on site prior to the mining activities. There is evidence of overgrazing and poor veldt management, especially where sickle bush is abundant in noticeable bush encroachment structures.

6 Vegetation

Information for this section was obtained from 'Rhino Minerals: Buffelsfontein - EMPR Addendum' (Shangoni Management Services, 2010).

The Mine falls within three different vegetation units. These vegetation units are described below. (Mucina & Rutherford, 2006).

SVcb 1 - Dwaalboom Thornveld:

The vegetation and landscape features can be described as: 'Plains with a layer of scattered, low, to medium high, deciduous microphyllous trees and shrubs with a few broad-leaved tree species, and an almost continuous herbaceous layer dominated by grass species.'

Acacia tortilis and *A. nilotica* dominate on the medium clays (at least 21% clay in the upper soil horizon but high in the lower horizons. On particularly heavy clays (>55% clay in all horizons) most other woody plants are excluded and the diminutive *A. tenuispina* dominates at a height of less than 1m above ground on the sandy clay loam soils (with not more than 35% in the upper horizon but high in the lower horizons). *A. erubescens* is the most prominent tree. The alteration of these substrates types creates a mosaic of patches typically 1–5km across, the unit west of Thabazimbi.

SVcb 17 - Waterberg Mountain Bushveld:

Vegetation and Landscape features include rugged mountains with vegetation grading from *Faurea saligna-Protea caffra* bushveld on higher slopes (in turn grading into the Gm 29 Waterberg-Magaliesburg Summit Sourveld) through broad-leaved deciduous bushveld (dominated by *Diplorhynchus cana-Terminalia sericea* savanna in the lower-lying valleys as well as on deeper sands on the plateaus. The grass layer is moderately developed or well developed.

Table 7: Protected trees found in the area

Scientific name	Common name
Acacia erioloba	Camel thorn
Sclerocarya birrea subspp *caffra*	Marula
Combretum imberbe	Leadwood
Securidaca longepunculata	Violet tree
Elaeodendron transvaalensis	Bushveld Saffron

Table 8: Specially protected trees found in the area

Scientific name	Common name
Erythrophysa transvaalensis	Transvaal red balloon

Table 9: Vulnerable trees found in the area

Scientific name	Common name
Spirostachys Africana	Tamboti

The following table lists all the plant species found during the survey done in Thabazimbi, 2005, which was updated for specific sections in April 2010.

Table 10: List of plant species found during the survey

Common name	Scientific name	Status
Trees		
Black monkey thorn / Swartapiesdoring	*Acacia burkei*	
Common Hook-thorn / Gewone haakdoring	*Acacia caffra*	
Sweet thorn / Soetdoring	*Acacia karroo*	Known endemic invader if not managed e.g. with overgrazing etc.
Knob Thorn / Knoppiesdoring	*Acacia nigrescens*	
Scented thorn / Lekkerruikpeul	*Acacia nilotica* subsp. *kraussiana*	
Ankle thorn / Enkeldoring	*Acacia robusta* subspecies *robusta*	
Umbrella thorn / Haak-en-steek	*Acacia tortilis*	
Worm-bark, False-thorn / Wurmbasvalsdoring	*Albizia anthelmintica*	
Red Ivory / Rooi-ivoor	*Berchemia zeyheri*	
Shepherd's tree / Witgat	*Boscia albitrunca*	
Lowveld Silver Oak / Laeveldvaalbos	*Brachylaena huillensis*	
Wild Seringa / Wildesering	*Burkea africana*	
White stinkwood / Witstinkhout	*Celtis africana*	
Leadwood / Hardekool	*Combretum imberbe*	
Velvet bushwillow / Fluweelboswilg	*Combretum molle*	
Large-fruited bushwillow / Raasblaar	*Combretum zeyheri*	*Deudorix dinochares* feeds on the tree.
Tall Common Corkwood / Groot Gewone Kanniedood	*Commiphora glandulosa*	
Common Corkwood / Gewone kanniedood	*Commiphora pyracanthoides*	
Highveld cabbage tree / Hoëveldse kiepersol	*Cussonia paniculata*	
Sickle bush / Sekelbos	*Dichrostachys cinerea*	In areas, the bush encroachment of this species was clearly visible

Common name	Scientific name	Status
Horn-pod tree / Horingpeultjieboom	*Diplorhynchus condylocarpon*	
Common wild pear / Gewone drolpeer	*Dombeya rotundifolia*	
Puzzle bush / Deurmekaarbos	*Ehretia rigida*	
Sumach bean / Basboontjie	*Elephantorrhiza burkei*	
Transvaal Milk plum / Stamvrug	*Englerophytum magalismontanum*	
Transvaal Red Balloon / Transvaalse Rooiklapperbos	*Erythrophysa transvaalensis*	Not only endemic to South Africa exclusively but on Red data list. Species is not threatened.
Red River Gum / Rooibloekom	*Eucalyptus camaldulensis*	Invader (Category 2)
Blue guarri / Bloughwarrie	*Euclea crispa*	
Transvaal Beech / Transvaalboekenhout	*Faurea saligna*	
Red-leaved Fig / Rooiblaarvy	*Ficus ingens*	
Common Wild Fig / Gewone Wildevy	*Ficus thonningii*	
Common spike-thorn / Gewone pendoring	*Gymnosporia buxifolia*	
Lavender Tree / Laventelboom	*Heteropyxis natalensis*	
Jacaranda / Jakaranda	*Jacaranda mimosifolia*	Invader (Category 3)
Koko Tree / Kokoboom	*Maytenus undata*	
Seringa / Sering	*Melia azedarach*	Invader (Category 3)
Cork Bush / Kurkbos	*Mundulea sericea*	
Lance-leaved Waxberry / Smalblaarwasbessie	*Myrica serrata*	
Peeling Plane / Lekkerbreek	*Ochna pulchra*	
Jacket-plum / Doppruim	*Pappea capensis*	
Weeping Wattle / Huilboom	*Peltophorum africanum*	
Kudu-berry / Koedoebessie	*Pseudolachnostylis maprouneifolia*	
Castor-oil Plant / Kasterolieboom	*Ricinus communis*	Invader (Category 2)
Common Karee / Gewone Karee	*Rhus lancea*	
Mountain Karree / Bergkaree	*Rhus leptodictya*	
Common Wild Currant / Gewone taaibos	*Rhus pyroides*	
Marula / Maroela	*Sclerocarya birrea* subsp. *Caffra*	
Violet Tree / Krinkhout	*Securidaca longipedumculata*	

Common name	Scientific name	Status
Tamboti / Tambotie	*Spirostachys Africana*	
Spine-leaved monkey orange / Stekelblaarklappper	*Strychnos pungens*	
Blue bitterberry / Bloubitterbessie	*Strychnos usambarensis*	
Blue sourplum / Blousuurpruim	*Ximenia americana*	
Sourplum / Suurpruim	*Ximenia caffra*	
Knobwood / Perdepram	*Zanthoxylum davyi*	
Buffalo-thorn / Blinkblaarwag-'n-bietjie	*Ziziphus mucronata*	
Shrubs and herbs		
	Abutilon angulatum var. *angulatum*	
Wild Apricot / Wilde-appelkoos	*Ancylobotrys capensis*	Northern side
Mexican poppy / Bloudissel	*Argemone ochroleuca*	Declared Weed (Category 1)
Milkbush / Melkbos	*Asclepias fruticosa*	
Blackjack / Knapsekêrels	*Bidens formosa*	
Velvet sweetberry / Fluweelsoetbessie	*Bridelia mollis*	
Mauritius Thorn / Kraaldoring	*Caesalpinia decapetala*	Declared weed. (Category 1)
Fish-bone Cassia / Boesmanstee	*Chamaecrista mimosoides*	Weed – eradication is needed
Flax-leaf fleabane / Kleinskraalhans	*Conyza bonariensis*	Weed in disturbed places
Large thorn apple / Groot stinkblaar	*Datura ferox*	Declared Weed (Category 1)
Smelter's bush / Smelterbossie	*Flaveria bidentis*	
Velvet raisin / Fluweelrosyntjie	*Grewia flava*	
Sandpaper raisin / Skruwe rosyntjie	*Grewia flavescens*	
Cross-berry / Kruisbessie	*Grewia occidentalis*	
Bladderweed / Terblansbossie	*Hibiscus trionum*	
Morning Glories / Purperwinde	*Ipomoea indica*	Declared Weed (Category 1)
Lantana	*Lantana camara*	Declared Weed (Category 1)
Wild Dagga / Wilde Dagga	*Leonotis ocymifolia* var. *schinzii*	
Soap-nettle / Seepnetel	*Pouzolzia mixta*	
Wild Asparagus / Katbos	*Protasparagus laricinus*	
Asparagus fern	*Protasparagus setaceus*	
	Siphonoglossa linifolia	
Khaki weed / Kakiebos	*Tagetes minuta*	
Monkey's tail / Bobbejaanstert	*Xerophyta retinervis*	
Blue sourplum / Blousuurpruim	*Ximenia americana*	
Sourplum / Suurpruim	*Ximenia caffra*	

Common name	Scientific name	Status
Redstar Zinnia / Wilde Jakobregop	*Zinnia peruviana*	Is an exotic plant and a weed but not invasive at all.
Grass		
Rolling Grass / Groot tolgras	*Aristida bipartita*	
Tassel Three-awn / Katstertsteekgras	*Aristida congesta* subsp. *congesta*	
Iron Grass / Ystergras	*Aristida diffusa*	
Spanish Reed / Spaanse riet	*Arundo donax*	Declared weed (Category 1)
False Love Grass / Vals-eragrostis	*Bewsia biflora*	
Pinhole Grass / Stippelgras	*Bothriochloa insculpta*	
Foxtail Buffalo Grass / Bloubuffelgras	*Cenchrus cilliaris*	
Narrow-leaved Turpentine Grass / Smalbaarterpentyngras	*Cymbopogon plurinodis*	
Couch Grass / Kweekgras	*Cynodon dactylon*	
Common Finger Grass / Gewone-vingergras	*Digitaria eriantha*	
Goose Grass / Afrikaanse osgras	*Eleusine coracana*	
Nine-awned Grass / Negenaaldgras	*Enneapogon cenchroides*	
Bottlebrush grass / Kalkgras	*Enneapogon scoparius*	
Weeping Love Grass / Oulandsgras	*Eragrostis curvula*	
Gum Grass / Gomgras	*Eragrostis gummiflua*	
Lehmann's love grass / Knietjiesgras	*Eragrostis lehmaniana*	
(Broad) Curly Leaf / (Breë-) Kruilblaar	*Eragrostis rigidior*	
Hairy Love Grass / Harige-pluimgras	*Eragrostis trichophora*	
Brown Rhodes Grass / Bruinhoenerspoor	*Eustachys paspaloides*	
Spear Grass / Assegaaigras	*Heteropogon contortus*	
Natal Red Top / Natal-rooipluim	*Melinis repens*	
Small Buffalo Grass / Kleinbuffelsgras	*Panicum coloratum*	
Gunea grass / Buffelgras	*Panicum maximum*	
Fountain grass / Pronkgras	*Pennisetum setaceum*	Declared Weed (Category 1)
Herringbone Grass / Sekelgras	*Pogonarthria squarrosa*	
Red Autumn Grass / Rooiherfsgras	*Schizachyrium sanguineum*	
Sand Quick / Sandkweek	*Schmidtia pappophoroides*	

Common name	Scientific name	Status
Mountain Bristle Grass / Berg-setaria	*Setaria lindenbergiana*	
Golden Bristle Grass / Goue-mannagras	*Setaria sphacelata* var. *Sericea*	
Bur Bristle Grass / Klitsgras	*Setaria verticillata*	
Johnson grass	*Sorghum halepense*	Invader (Category 2)
Ratstail Dropseed / Taaipol	*Sporobolus africanus*	
Dropseed Grass / Fynsaadgras	*Sporobolus fimbriatus*	
Red grass / Rooigras	*Themeda triandra*	
Giant Spear Grass / Bokbaardgras	*Trachypogon spicatus*	
Blue-seed Grass / Blousaadgras	*Tricholaena monachne*	
Quinine Grass / Varkstertgras	*Urelytrum agropyroides*	
Other		
Hard fern	*Pellaea calomelanos*	
Giant carrion flower / Reuse-aasblom	*Stapelia gigantea*	
Mistletoe / Voëlent	*Viscum rotundifollum*	

7 Animal life

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

7.1 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 17 & 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 11: 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.
Pronolagus randensis	Jameson's Red Rock Rabbit	Droppings	Mountain bushveld and savannoid grassland.

Scientific Name	Vernacular Name	Observation Indicators	Observed Habitat
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).

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.

7.2 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 12: 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

Species	Kalahari-Highveld	Zambezian
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 13: 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 18 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 14: 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	Regarded as a highly irregular foraging visitor on the study site.

Species	Global Conservation Status*	National Conservation Status**	Recorded during SABAP1	Recorded during SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
					farming areas and reserves.	
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 breeding colony at Kransberg. The study site does not provide breeding habitat.

Species	Global Conservation Status*	National Conservation Status**	Recorded during SABAP1	Recorded during SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
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

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*).

7.3 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 is 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 19) 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 15: 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.

7.4 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 16: 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 17: 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*	Wichgraf's Hillside Brown	Mountain bushveld
Nymphalidae	*Charaxes 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*	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*	Zebra White	Widespread & common
Pieridae	*Mylothris agathina*	Common Dotted Border	Localised to well-wooded ravines and mountain bushveld
Papilionidae	*Papilio 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 18: 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 is 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 19: 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

8 Surface water

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).

8.1 General description

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.

8.2 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 20: 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 21: 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 22: 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
1:50	0.45	71.18	100.00	159.07	0.95	43.8	3.677

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

8.3 Normal flow during dry weather

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

8.4 Surface water quality

Various surface water quality results for two points – RA2 & RA3 - are given in Figure 10 to 17 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.

8.4.1 Chemical analysis

<u>pH:</u>

According to Figure 10 below, all water qualities are within the pH limits for both the TWQG as well as the SANS 241-2011.

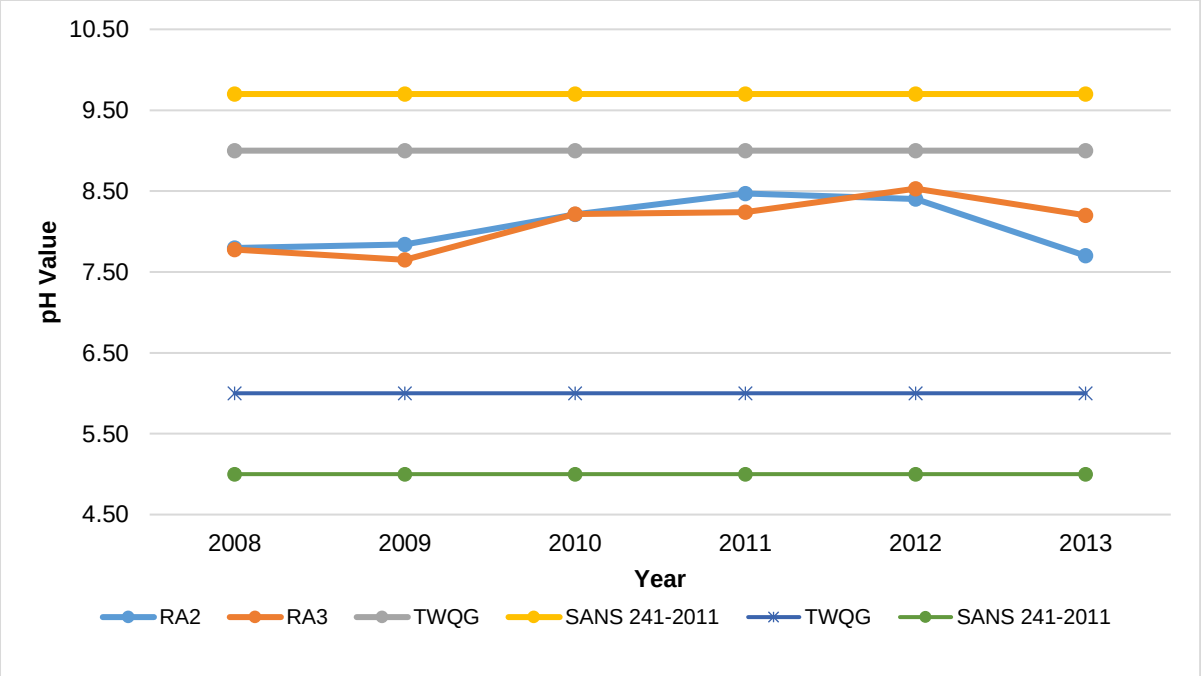

Figure 10: pH results of surface water for the years 2008 to 2013

Chloride:

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 11 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.

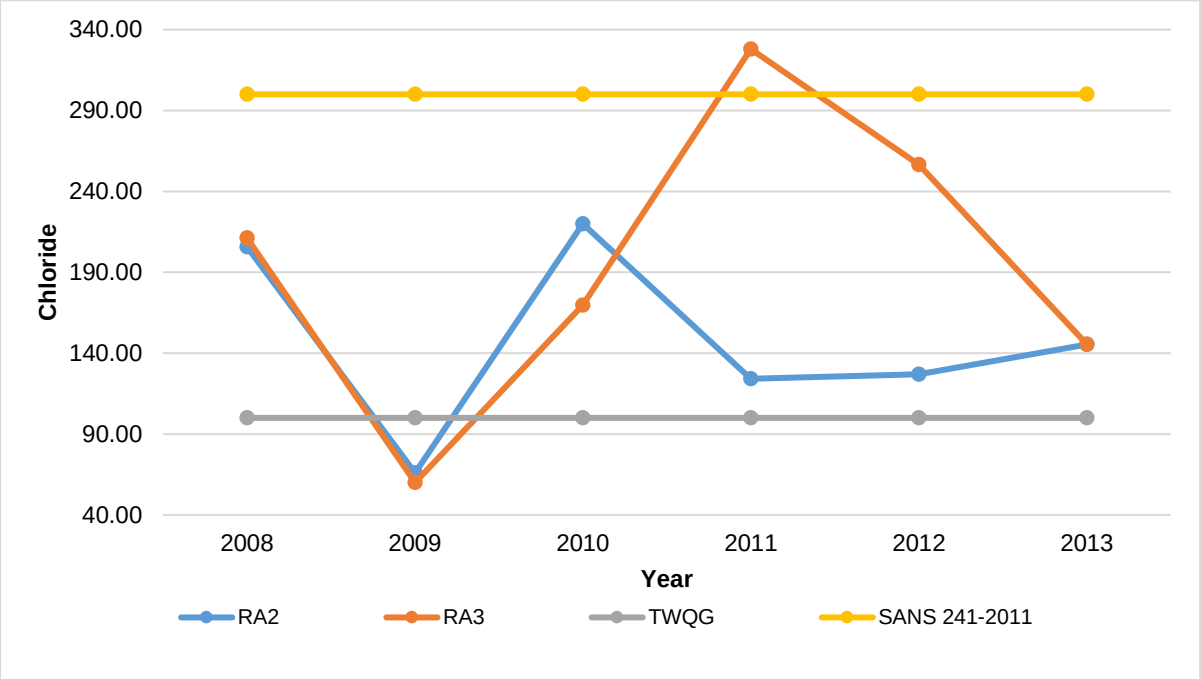

Figure 11: Chloride results of surface water for the years 2008 to 2013

Sulphate:

According to Figure 12 below, all water qualities are below the SO_4 limits for both the TWQG as well as the SANS 241-2011.

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 13 below the downstream water in 2010 is above the SANS 241-2011 limits, and the upstream water in 2011 is above these limits.

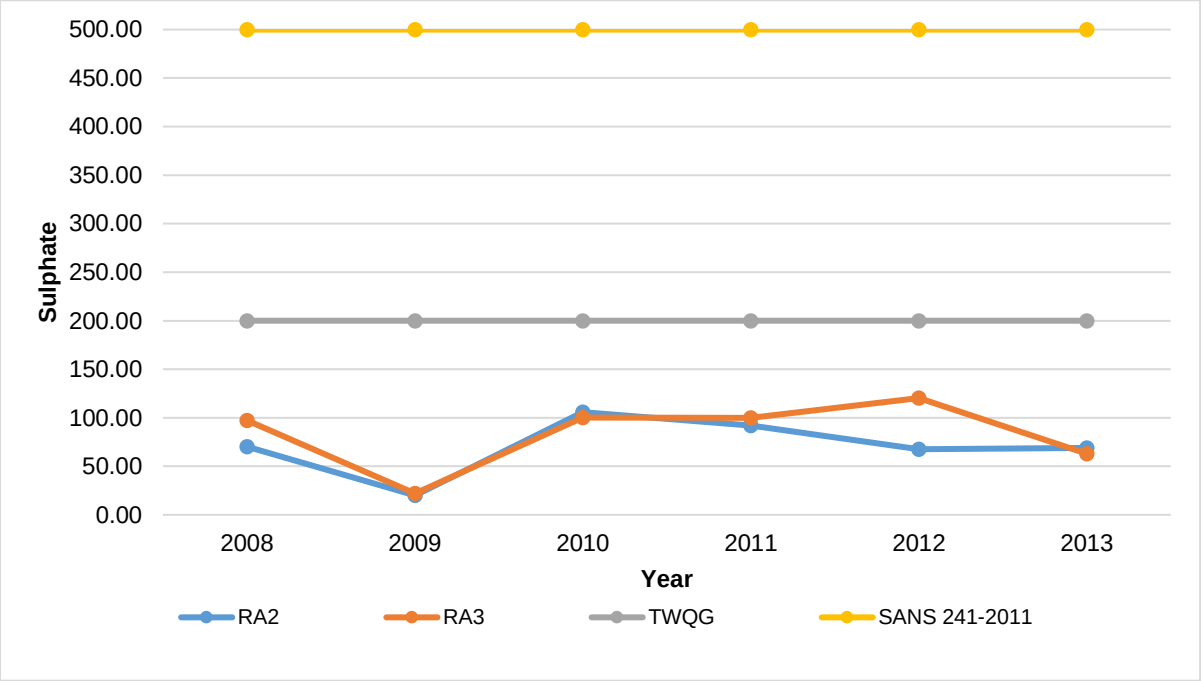

Figure 12: Sulphate results of surface water for the years 2008 to 2013

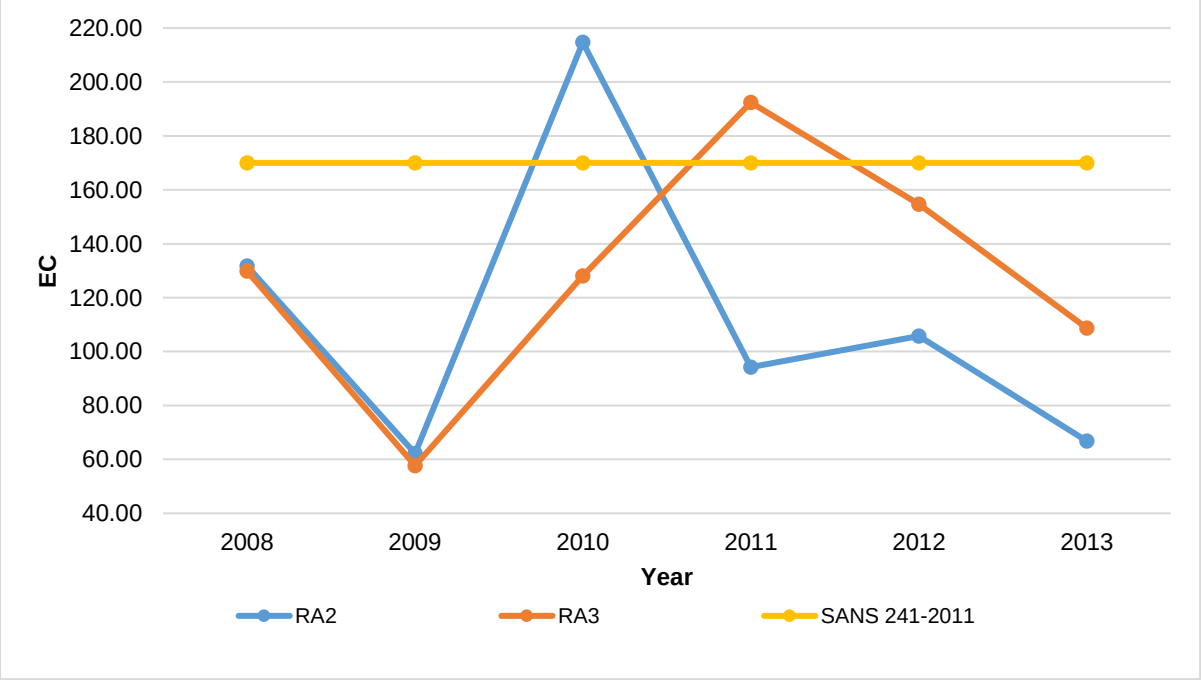

Figure 13: EC results of surface water for the years 2008 to 2013

Nitrates:

According to Figure 14 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.'

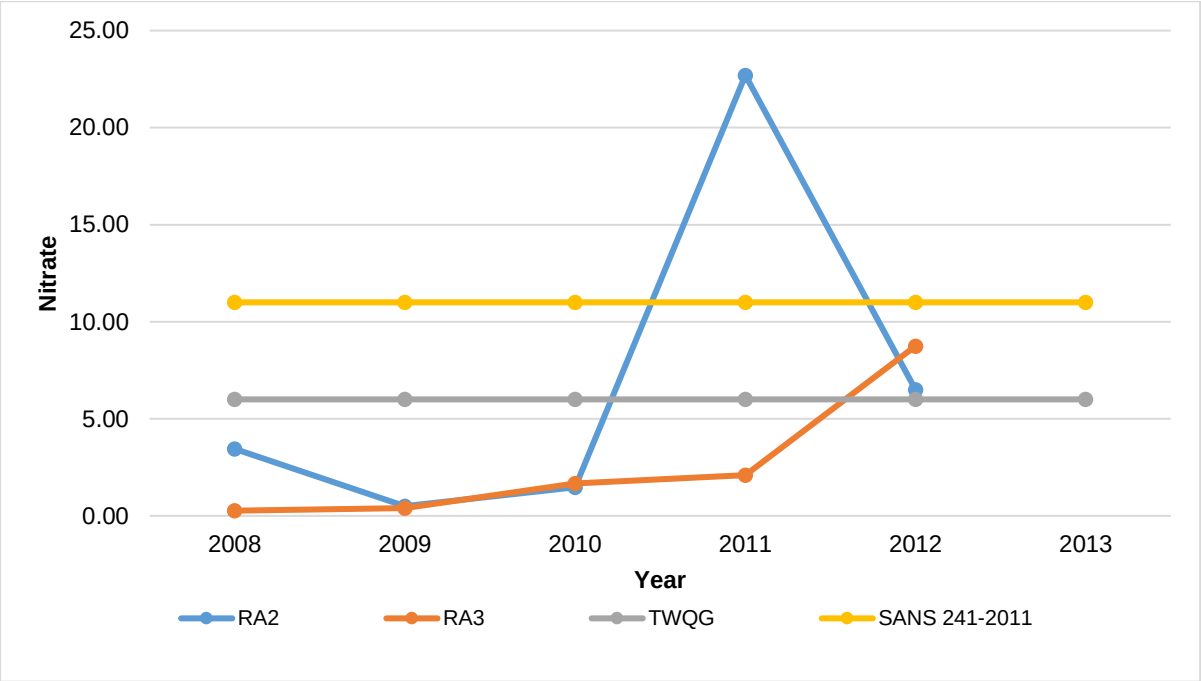

Figure 14: Nitrate results of surface water for the years 2008 to 2013

8.4.2 Bacteriological analysis

E. coli:

According to Figure 15 below, *E. coli* levels downstream of RAM were very high. Also refer to Figure 16 which indicates only downstream levels. These levels also exceeded the limits throughout the sampling period.

Total coliform bacteria:

According to Figure 17 below, Total coliform levels downstream and upstream of RAM were very high.

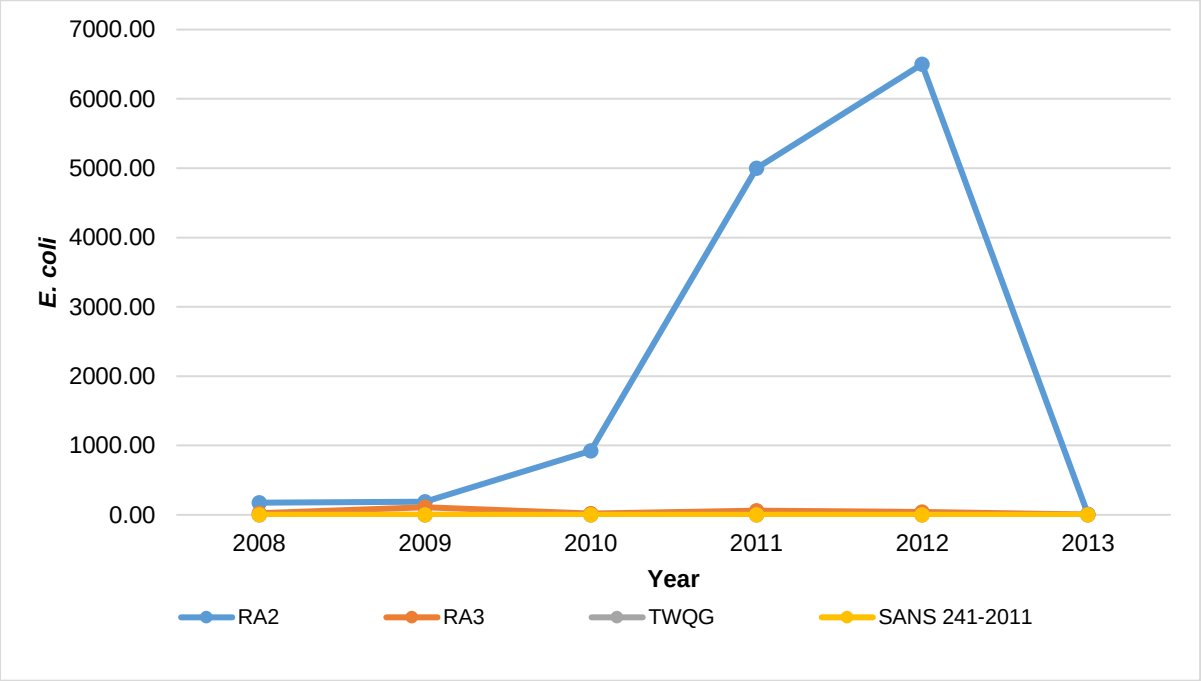

Figure 15: *E. coli* results of surface water for the years 2008 to 2013

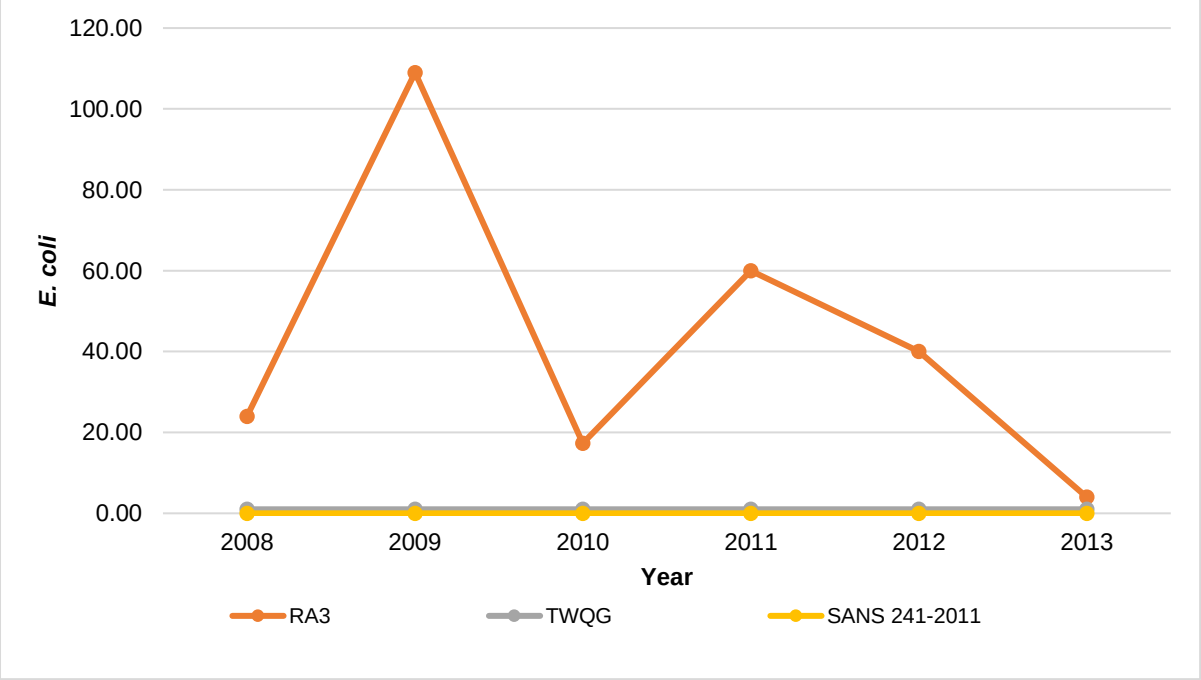

Figure 16: *E. coli* results of upstream surface water for the years 2008 to 2013

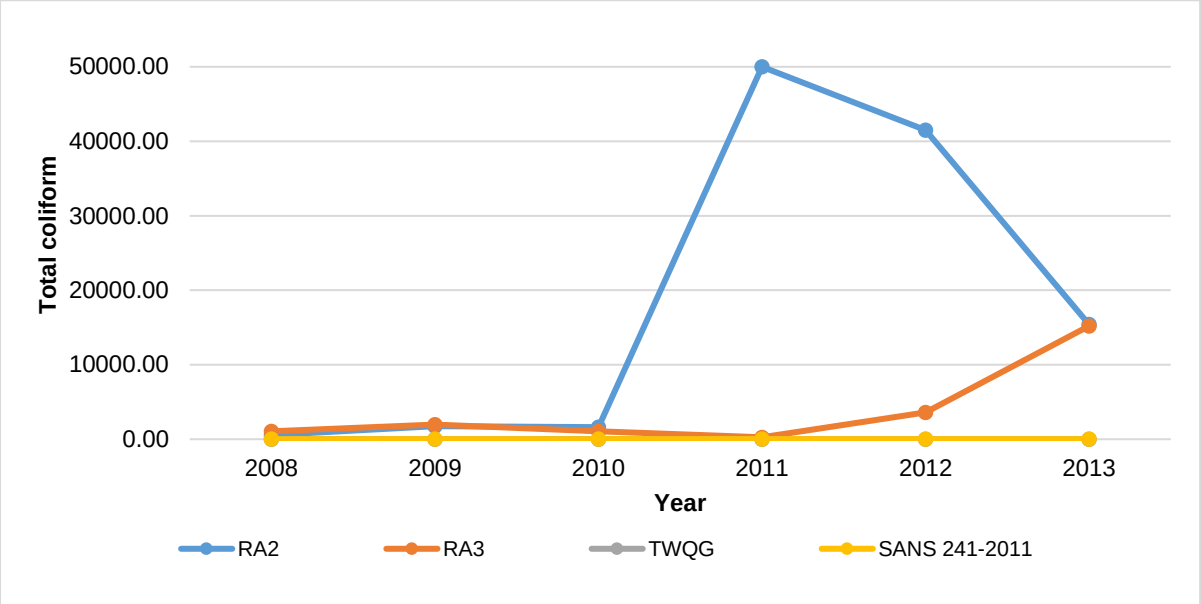

Figure 17: Total coliform results of surface water for the years 2008 to 2013

8.5 Water authority

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

8.6 Wetlands

No study was done; however, the proposed site is an already disturbed area.

8.7 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.

9 Groundwater

Information for this section was obtained from the Rhino Andalusite Mine (Pty) Ltd Quarry Backfill Project: Report on Geohydrological Investigation as Part of the Environmental Impact Assessment (EIA) and Environmental Management Program (EMP) (Groundwater Complete, 2016).

Conceptual model of geohydrology:

A conceptual model is in reality our holistic understanding of the workings and nature of the aquifer regime underlying the project area. A good understanding of the geohydrological environment is key to the accurate assessment of potential groundwater impacts associated with the proposed activities.

9.1 Results of hydrocensus/user survey

Numerous user surveys were performed during previous groundwater related studies and their findings are discussed in detail in the following two reports:

- Geo Pollution Technologies, 2010: Geohydrological Study for Rhino Minerals (PTY) LTD – Rhino Andalusite Mine.
- Groundwater Complete, 2015: Proposed Tygerkloof Quarry – Report on Geohydrological Investigation as Part of the EIA, EMP and IWULA.

The positions of all boreholes located during the various independent user surveys are indicated in Figure 18, while their findings are summarised in Tables 25 and 26. Widespread pollution or depletion of the groundwater resource will impact negatively on:

- The groundwater resource itself and interrelations with other natural resources (e.g. rivers and streams), and
- The users that depend on groundwater as sole source of domestic water as well as for livestock and gardening.

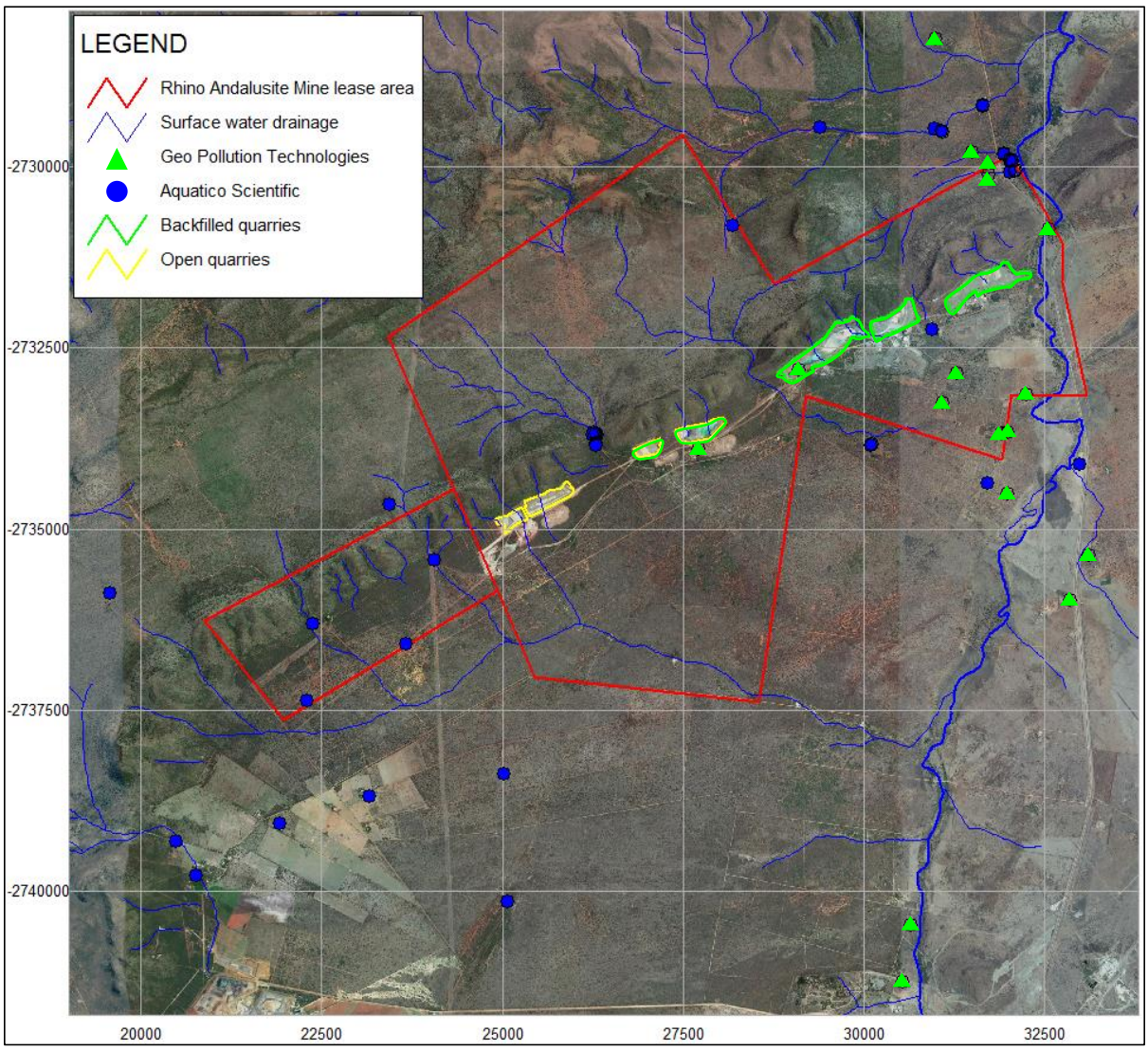

Figure 18: Positions of boreholes located during hydrocensus and user surveys

Table 23: Results of hydrocensus/user survey *(Geo Pollution Technologies, 2010)*

Locality	Coordinates		Static water level (m)	Abstraction (l/h)	In use	Use	Farmer/Owner
	South	East					
RGV2	-24.66992	27.30720	39.35	-	No	None	Jan Rheeder
RGV3	-24.66657	27.31268	14.18	-	Yes	Domestic	Jan Rheeder
RGV4	-24.65829	27.30611	13.01	-	Yes	Domestic	Jan du Plessis
BH7	-24.67334	27.31639	7.45	27000	Yes	Washing process	Rhino Minerals
BH8	-24.67336	27.31668	6.39	27000	Yes	Washing process	Rhino Minerals
BH9	-24.67249	27.31553	7.42	-	Yes	Washing process	Rhino Minerals
BH5	-24.67436	27.31354	17.31	54000	Yes	Washing process	Rhino Minerals
BH4	-24.67512	27.31348	12.74	-	Yes	Washing process	Rhino Minerals
BH1	-24.67468	27.31710	6.18	-	Yes	Washing process	Rhino Minerals
BH2	-24.67457	27.31720	6.53	-	Yes	Washing process	Rhino Minerals
BH3	-24.67462	27.31724	6.40	-	Yes	Washing process	Rhino Minerals
MAT2	-24.70753	27.25981	20.15	18000	Yes	Washing process	Rhino Minerals
MAT3	-24.70770	27.25934	20.15	5000	Yes	Washing process	Rhino Minerals
PIT1	-24.69954	27.28757	N/A	N/A	No	Recycling for washing	Rhino Minerals
BIER	-24.68201	27.32175	N/A	N/A	Yes	None	N/A
PIT2	-24.70950	27.27384	N/A	N/A	Yes	Recycling for washing	Rhino Minerals
MAT1	-24.70746	27.25948	16.70	8000	Yes	Washing process	Rhino Minerals
RD1	-24.70874	27.29761	41.80	-	Yes	Domestic	Frans Langsberg
RD2	-24.69999	27.30914	12.38	-	No	None	Rhino Minerals
RD3	-24.70263	27.31868	17.20	13600	Yes	Domestic, livestock watering	Piet Strydom
RD4	-24.71498	27.31621	N/A	-	Yes	Domestic, livestock watering	Jacobus Muller
RD5	-24.70726	27.31614	42.55	-	Yes	Domestic, livestock watering	Mr Venter
RD6	-24.70742	27.31534	55.16	12000	Yes	Domestic, livestock watering	H. Naude
RD7	-24.70359	27.30723	N/A	1500	Yes	Domestic, livestock watering	H. Naude

Locality	Coordinates		Static water level (m)	Abstraction (l/h)	In use	Use	Farmer/Owner
	South	East					
RD8	-24.72822	27.32471	16.98	14000	Yes	Domestic, livestock watering	B.J. Pistorius
ZRT1	-24.77585	27.30191	6.60	-	Yes	Domestic	Ray Makenzie
ZRT2	-24.76877	27.30309	N/A	-	No	None	Ray Makenzie
RD9	-24.72255	27.32738	N/A	-	Yes	Domestic	Hannes Nortje
RGV1	-24.67242	27.31122	17.05	-	No	None	Jan Rheeder

Note: *Coordinates – WGS84.*

Table 24: Results of hydrocensus/user survey (*Groundwater Complete, 2015)*

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

Locality	Farmer/Owner	Farm	Coordinates		Static water level (m)	Depth (m)	Sampled	Use
			South	East				
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
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.*

9.2 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 (topographic high or low areas/lines) or impermeable geological structures 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 and lows were used to roughly delineate the aquifer system underlying the project area (Figure 19). The aquifer was estimated to cover an area of approximately 420km^2. Please note that geological structures such as dykes are known to occur within the wider project area and have the ability to act as aquifer boundaries, thus subdividing the regional aquifer into various 'sub-aquifers' or compartments. No such structural geological information was available to aid in the detailed delineation of the aquifer/s, therefore aquifer boundaries as indicated in Figure 19 are considered to be conceptual and based on topographic controls only.

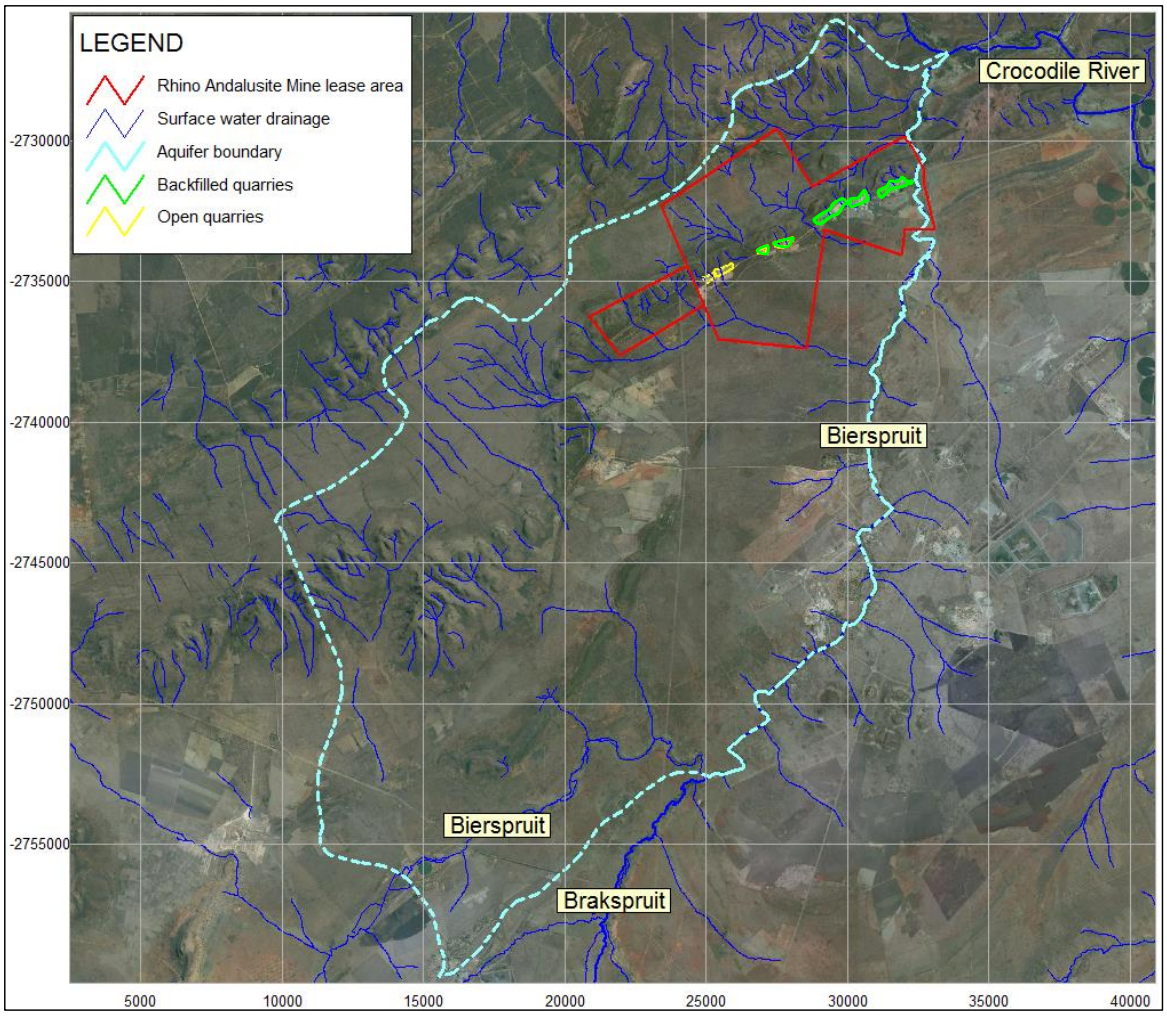

Figure 19: Aquifer delineation for project area

9.3 Groundwater level depth

Groundwater levels in the project area are available from boreholes that were located during a hydrocensus and user survey conducted for the Tygerkloof Project in 2015 *(Groundwater Complete, 2015)*. These boreholes include those of surrounding farmers as well as purpose drilled mine monitoring boreholes. Please refer to Table 25 for more information regarding these boreholes. A thematic groundwater level map of the entire project area is provided in Figure 22. 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 23).

Regional static groundwater levels around the mining area generally vary between ±9 and 70m below surface (Figure 22). Some of the deeper groundwater levels measured during the hydrocensus survey are the result of groundwater abstraction. Due to the generally low aquifer transmissivity the pumping causes deep drawdown of the groundwater level/piezometric head and a depression cone forms that is deep, but very limited in lateral extent.

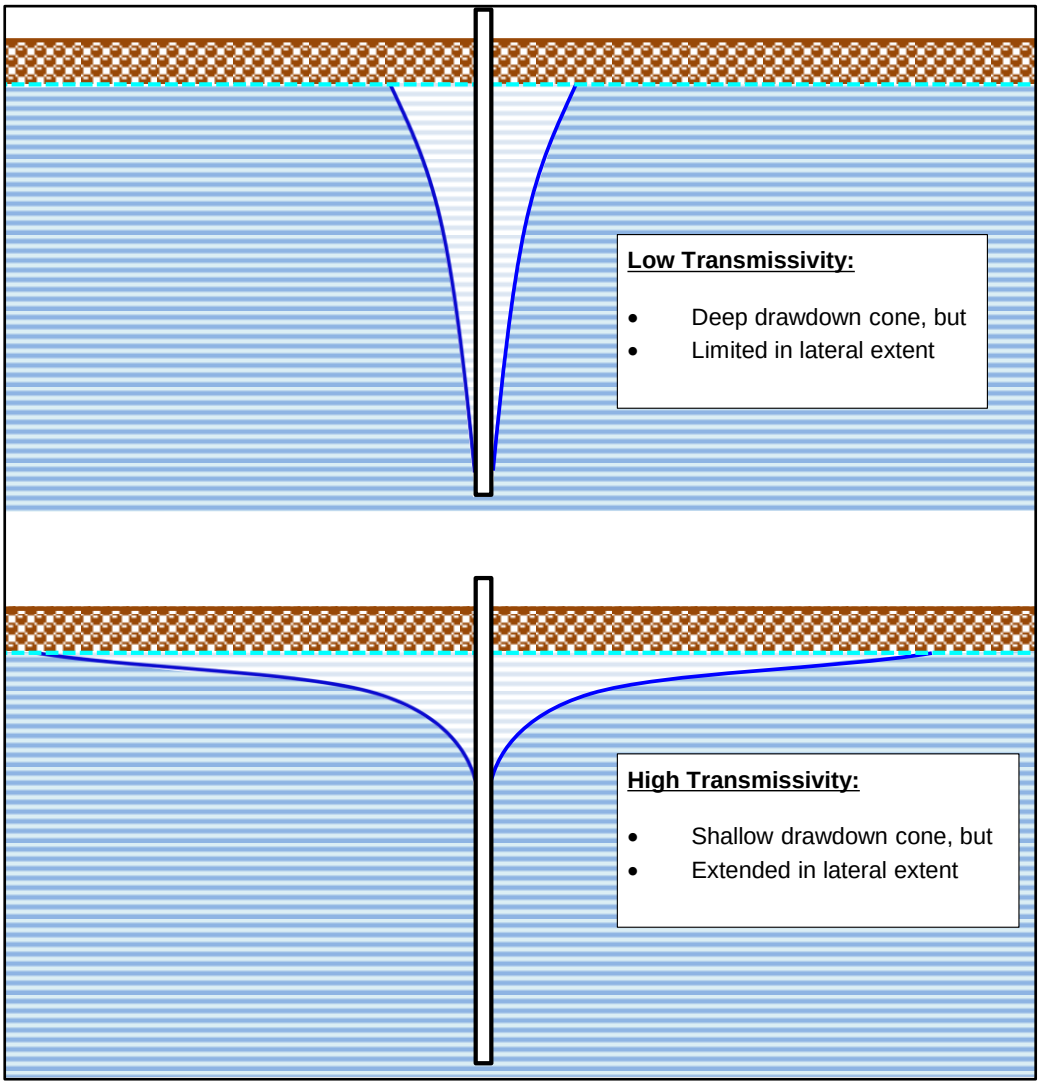

Figure 20: Effect of aquifer transmissivity on depression cone

The static groundwater elevation contour map provided in Figure 23 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, irrigation and mining 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 23 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 21 where the linear correlation of nearly 99% can be seen. It should be noted that groundwater levels from some boreholes were discarded because impacts from groundwater abstraction affect the natural groundwater level/topography relationship.

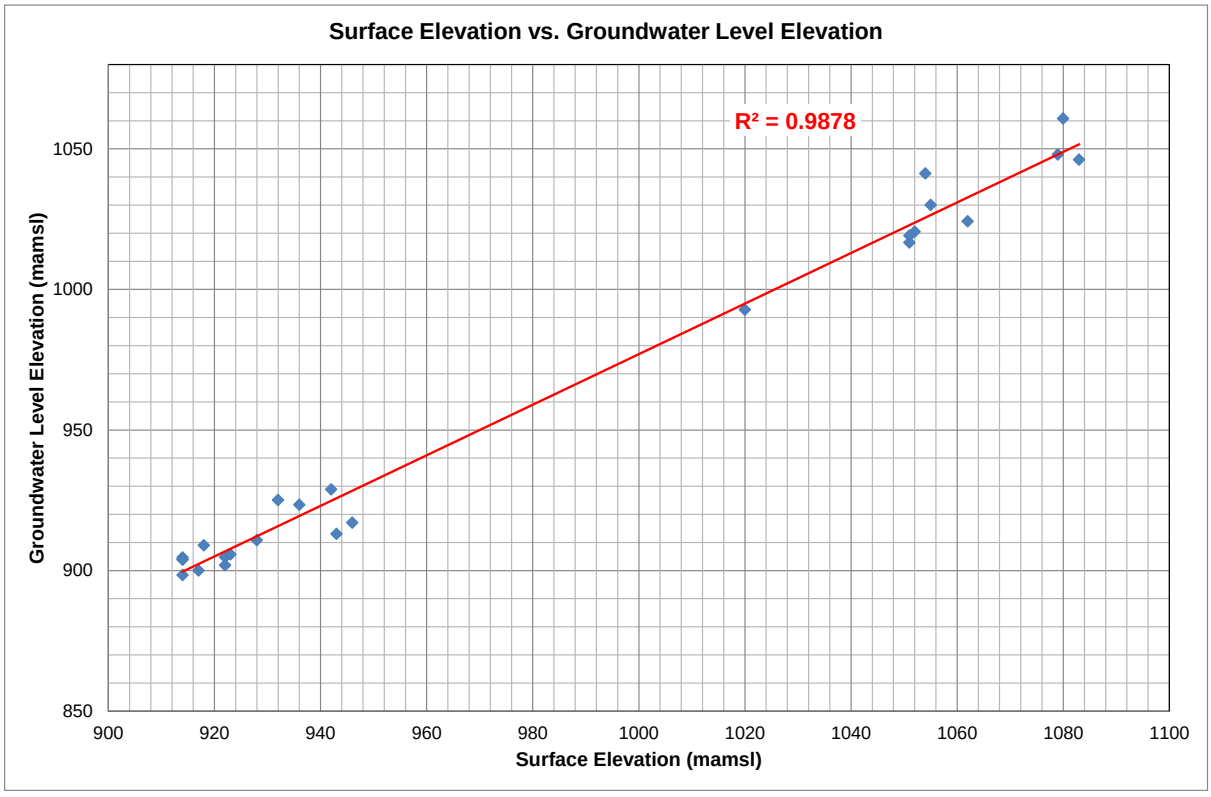

Figure 21: Relationship between surface- and groundwater elevations

The highest static water level elevation within the immediate vicinity of the mining area is approximately 1 360 mamsl and occurs in the topographic 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 23 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 are 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.**

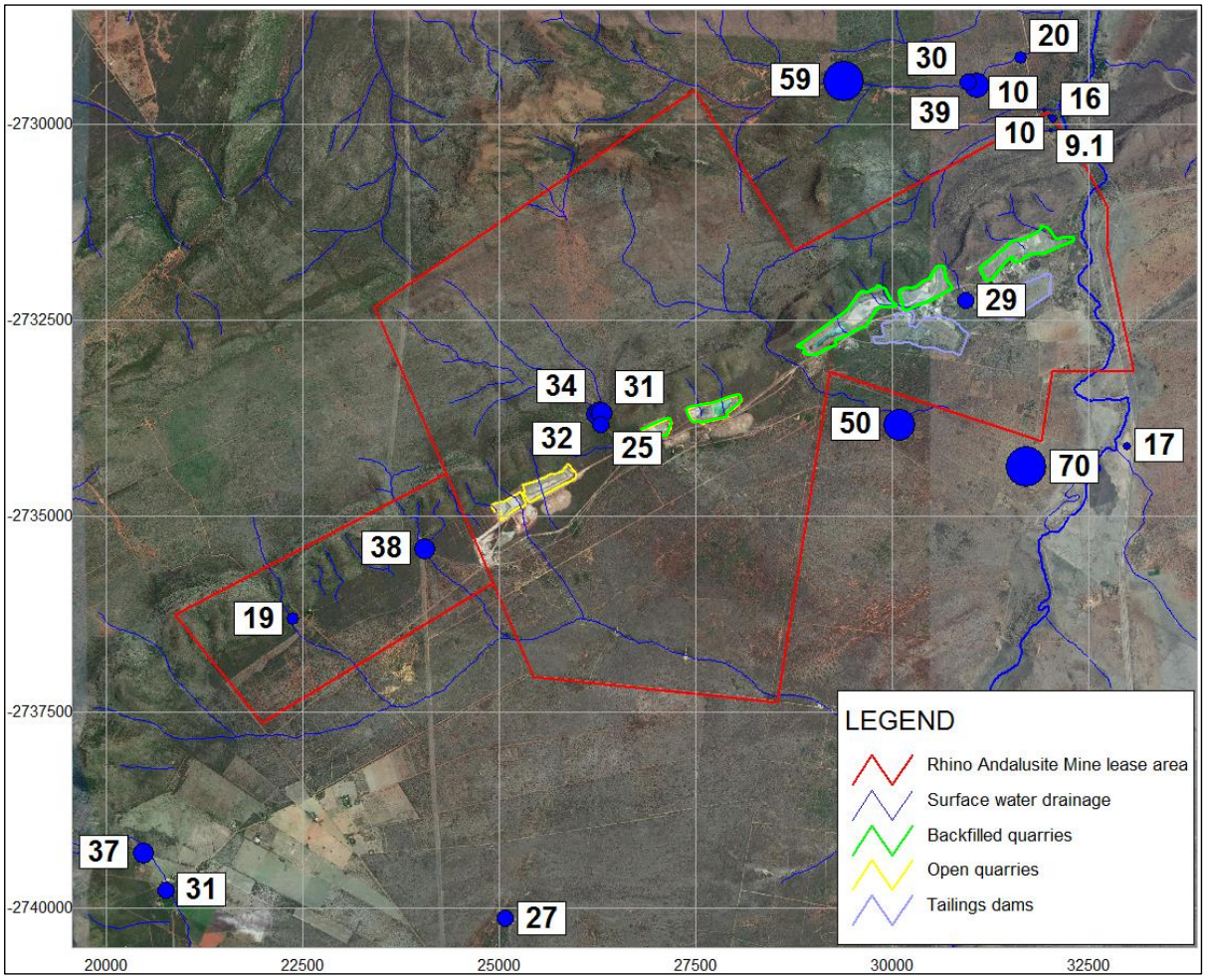

Figure 22: Thematic map of measured groundwater level depths (mbs)

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.

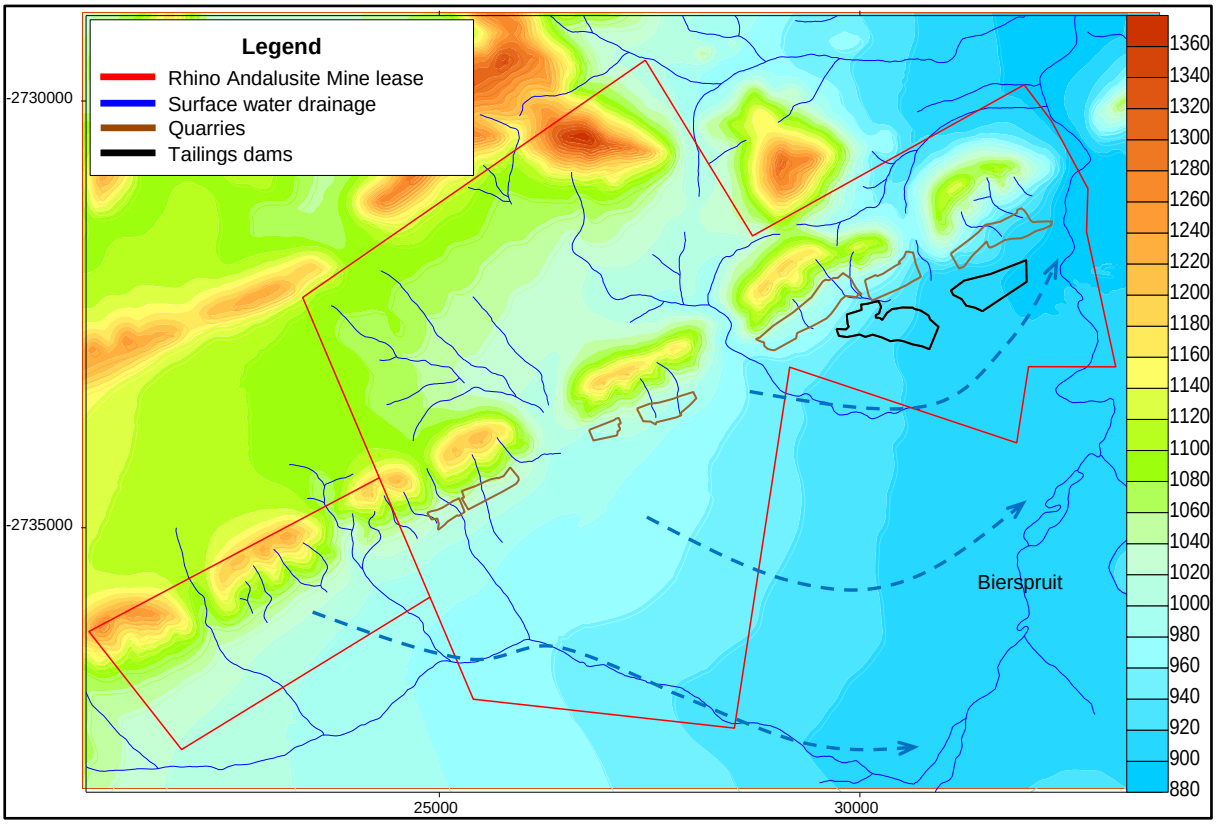

Figure 23: Bayesian interpolated groundwater elevation contour map of the project area (mamsl)

9.4 Groundwater flow directions, gradients and velocities

Contours of the static water levels or piezometric heads in and around the mining area are indicated in Figure 23. 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 gradients are thus steeper.

Groundwater gradients were calculated with the above formula from the water level elevation data (Figure 23). By substituting the hydraulic head difference over lateral distance an average hydraulic gradient of approximately 2% east/south-eastwards was calculated for the mining area.

The hydraulic conductivity and average porosity were chosen so as to provide a liberal estimation of seepage velocity. The actual seepage through the aquifer matrix should be lower than the products calculated, but highly transmissive fracture zones or areas of steeper gradient might cause higher transport rates.

The hydraulic conductivity and the average hydraulic gradient are known parameters. By making use of these values, the average steady state flow velocity (Darcy flux) in the mining area was calculated to be in the order of 2m/y (Table 27).

These estimates do however not take into account all known or suspected zones in the aquifer like preferential flow paths formed by igneous contact zones like intrusive dykes that have higher than average hydraulic properties. In secondary fractured aquifer media, the transport velocity is usually significantly higher than the average velocities calculated with this formula and may increase several meters or even tens of meters per year under steady state conditions.

Under stressed conditions such as at groundwater abstraction areas the seepage velocities could increase another order of magnitude.

Table 25: 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	2%	0.005	1.8

Notes: Flow velocity (Darcy flux) calculations were done by assuming an average aquifer porosity of 8% and hydraulic conductivity of 0.02 m/d.

9.5 Aquifer types

Information from geological maps and previously conducted geohydrological studies shows two possible types of aquifers to be present in the project area. 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 28.

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 areas where the groundwater level is deeper than the contact between the weathered zone and fresh bedrock.

The second 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 during drilling in the secondary fractured rock aquifer.

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, previously conducted groundwater studies found no signs of significant karst development within the immediate vicinity of the project area – the dolomite is estimated to underlie the mining area at a depth of approximately 4,500m below surface.

In spite of relatively low blow-out yields, pump tests were performed on two boreholes during the geohydrological investigation conducted for the Tygerkloof Project in 2015. The tests were performed using a low yield (± 0.3l/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 test results are provided in Table 29.

Table 26: Parsons Aquifer Classification *(Parsons, 1995)*

Sole Aquifer System	An aquifer that is used to supply 50% or more of domestic water for a given area, and for which there is no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields and natural water quality are immaterial.
Major Aquifer System	Highly permeable formation, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (less than 150 mS/m).
Minor Aquifer System	These can be fractured or potentially fractured rocks that do not have a primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large volumes of water, they are important both for local suppliers and in supplying base flow for rivers.
Non-Aquifer System	These are formations with negligible permeability that are generally regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer

	unusable. However, groundwater flow through such rocks, although impermeable, does take place, and needs to be considered when assessing the risk associated with persistent pollutants.
Special Aquifer System	An aquifer designated as such by the Minister of Water Affairs, after due process.

9.6 Aquifer transmissivity and storativity

Constant rate pump tests were performed on two boreholes during the geohydrological investigation conducted for the Tygerkloof Project *(Groundwater Complete, 2015)* and their positions are indicated in Figure 24. A summary of the pump test results is provided in Table 29.

Data collected from the pump tests was 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

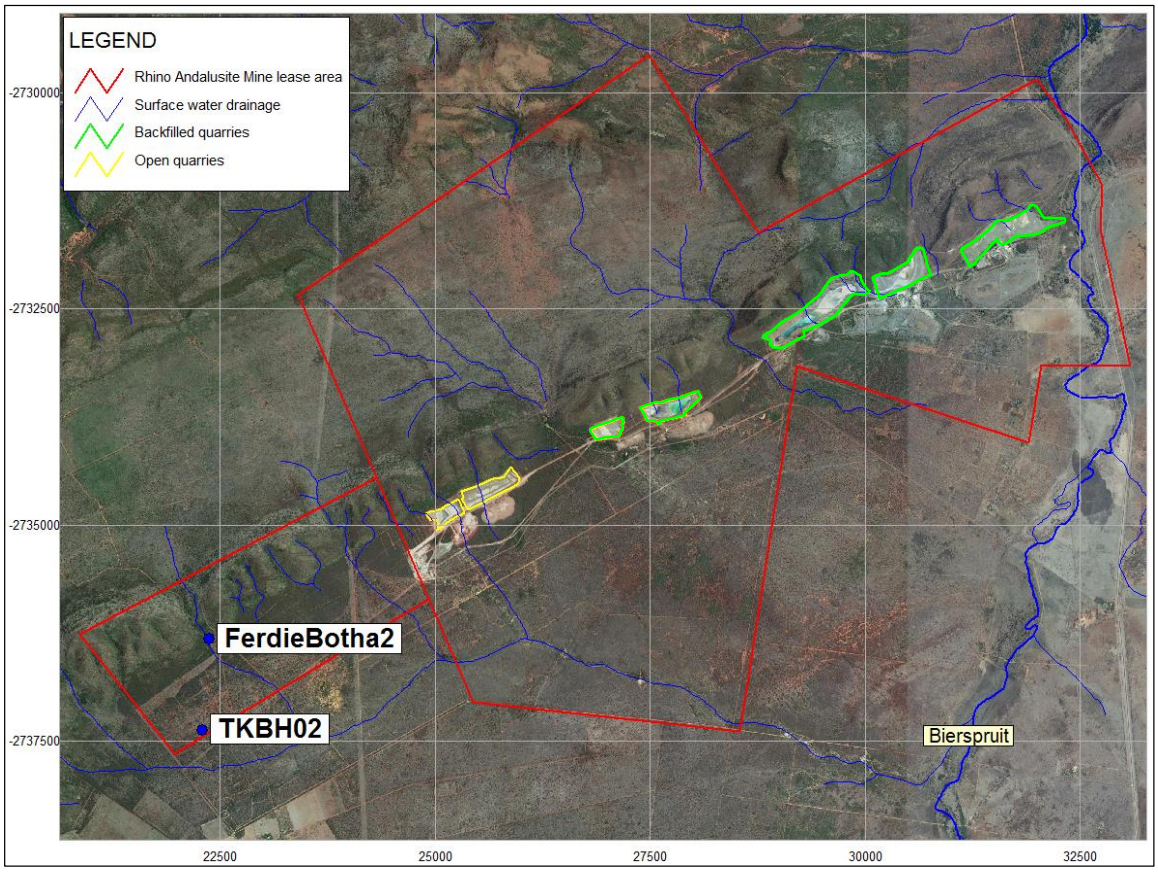

Figure 24: Positions of pump test boreholes

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 25 and 26, 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 test 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 to 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 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 were calculated and are provided in Table 30.

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**. Although we only have pump test data from two boreholes the hydraulic parameter values obtained are consistent with literature values and our experience in the same geological environment.

The heterogeneous nature of the fractured rock aquifer 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 entire mining area is far from ideal and aquifer parameters provided in Table 30 below cannot be considered representative of the wider project area. The values obtained, however, are precisely in line with literature values and with 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).

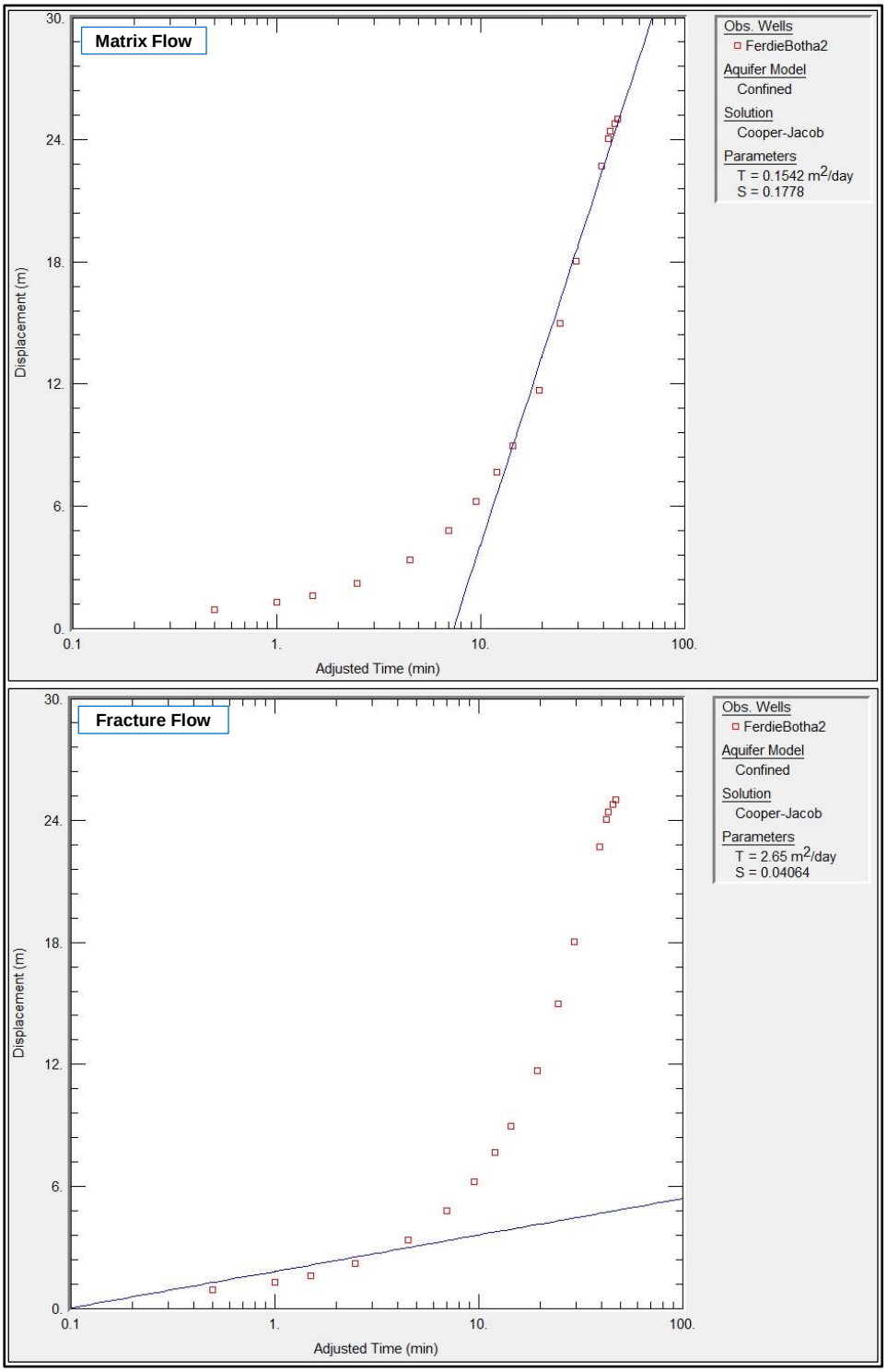

Figure 25: Analysis of pump test for borehole FerdieBotha2

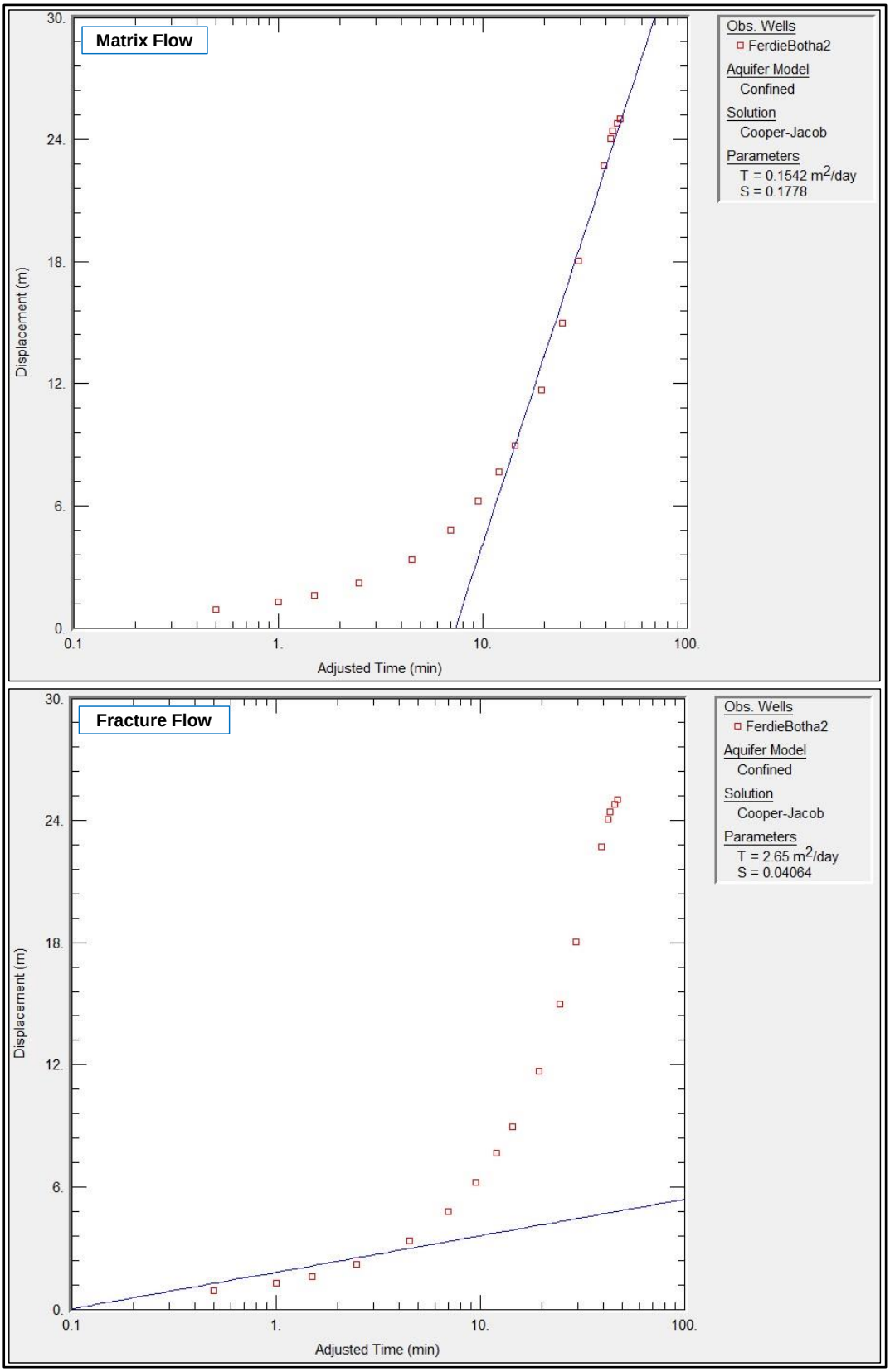

Figure 26: Analysis of pump test for borehole TKBH02

9.7 Aquifer recharge and discharge rates

According to Figure 27 the mean annual recharge to the aquifer underlying the project area varies between approximately 8 and 20mm, which based on an average rainfall of approximately 650mm/a 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 deposits, the effective recharge will be lower or even zero. Based on this estimate, the mean annual recharge to the aquifer regime should vary between ±3.3 and 8.3Mm^3.

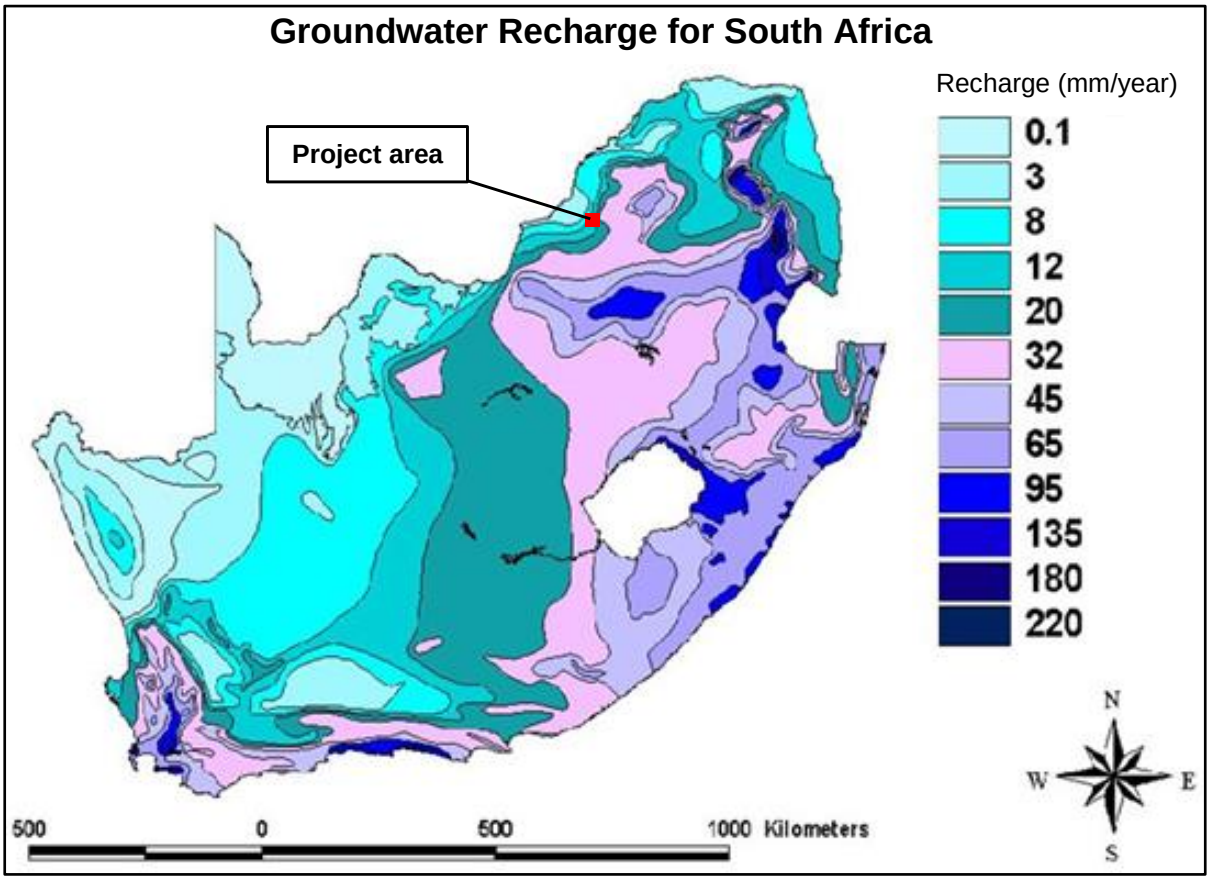

Figure 27: Mean annual aquifer recharge for South Africa *(Vegter, 1995)*

9.8 Groundwater quality characteristics

Groundwater quality data is available for two groups of boreholes, namely **user boreholes** and purposed drilled **monitoring boreholes**. Boreholes from both groups were located and sampled during the hydrocensus and user survey conducted for the Tygerkloof Project in 2015 *(Groundwater Complete, 2015)* and are discussed separately in the following sub sections.

Water collecting in Quarry 4/5 and the Motswere Quarry was sampled and analysed in June 2016 and the results of the chemical analyses are also discussed in a separate subsection.

Groundwater quality data were evaluated with the aid of diagnostic chemical diagrams and by comparing the inorganic concentrations to the South African National Standards for drinking water (Table 31). Because only once-off analyses data exists for both the hydrocensus boreholes and monitoring boreholes, time-series data, statistical analyses and trend analyses are not possible.

The four main factors usually influencing groundwater quality are:

- **Annual recharge** to the groundwater system,
- **Type of bedrock** where ion exchange may impact on the hydrogeochemistry,
- **Flow dynamics** within the aquifer(s), determining the water age and
- **Source(s) of pollution** with their associated leachates or contaminant streams.

Where no specific source of groundwater pollution is present upstream of the borehole, only the other three factors play a role.

One of the most appropriate ways to interpret the type of water at a sampling point is to assess the plot position of the water quality on different analytical diagrams like a Piper, Expanded Durov and Stiff diagrams. Of these three types, the Expanded Durov diagram probably gives the most holistic water quality signature. The layout of the fields of the Expanded Durov diagram (EDD) is shown in Figure 28.

Although never clear-cut like a fail-safe recipe, the general characteristics of the different fields of the diagram could be summarized as follows:

Field 1:

Fresh, very clean recently recharged groundwater with HCO_3 and CO_3 dominated ions.

Field 2:

Field 2 represents fresh, clean, relatively young groundwater that has started to undergo mineralization with especially Mg ion exchange.

Field 3:

This field indicates fresh, clean, relatively young groundwater that has undergone Na ion exchange (sometimes in Na - enriched granites or felsic rocks) or because of contamination effects from a source rich in Na.

Field 4:

Fresh, recently recharged groundwater with HCO_3 and CO_3 dominated ions that has been in contact with a source of SO_4 contamination or that has moved through SO_4 enriched bedrock.

Field 5:

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.

Field 6:

Groundwater from field 5 that has been in contact with a source rich in Na or old stagnant NaCl dominated water that resides in Na rich host rock/material.

Field 7:

Water rarely plots in this field that indicates NO_3 or Cl enrichment or dissolution.

Field 8:

Groundwater that is usually a mix of different types – either clean water from fields 1 and 2 that has undergone SO_4, but especially Cl mixing/contamination or old stagnant NaCl dominated water that has mixed with water richer in Mg.

Field 9:

Old or stagnant water that has reached the end of the geohydrological cycle (deserts, salty pans etc.) or water that has moved a long time and / or distance through the aquifer or on surface and has undergone significant ion exchange because of the long distance or residence time in the aquifer.

Another way of presenting the signature or water type distribution in an area is by means of Stiff diagrams. These diagrams plot the equivalent concentrations of the major cations and anions on a horizontal scale on opposite sides of a vertical axis. The plot point on each parameter is linked to the adjacent one resulting in a polygon around the cation and anion axes. The result is a small figure/diagram of which the geometry typifies the groundwater composition at the point. Groundwater with similar major ion ratios will show the same geometry. Ambient groundwater qualities in the same aquifer type and water polluted by the same source will for example display similar geometries.

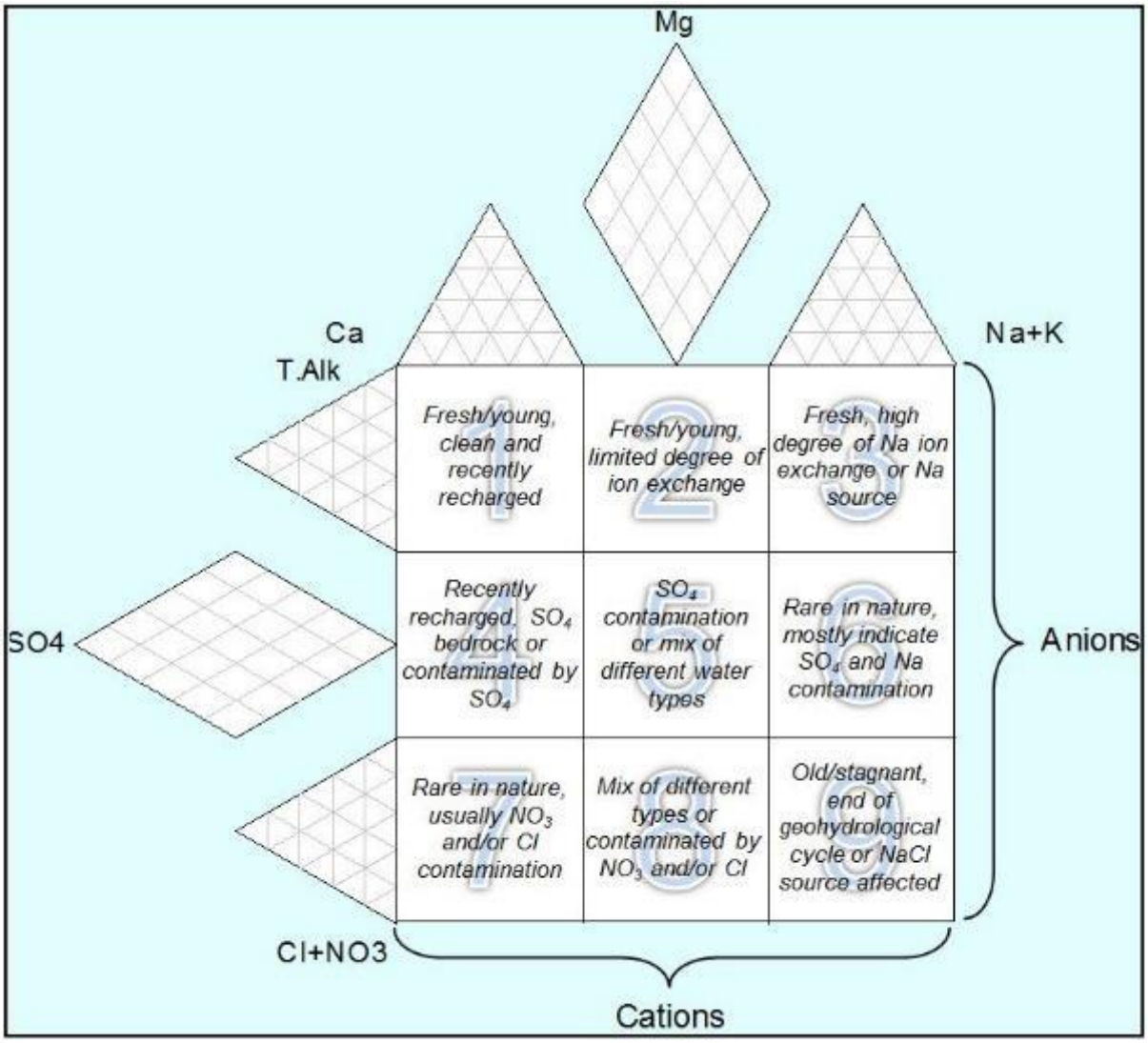

Figure 28: Layout of fields of the Expanded Durov diagram

Table 29: South African National Standards for drinking water *(SANS 241:2015)*

Determinant	Risk	Unit	Standard limits
Physical and aesthetic determinants			
Free chlorine	Chronic health	mg/l	≤ 5
Monochloramine	Chronic health	mg/l	≤ 3
Conductivity at 25 °C	Aesthetic	mS/m	≤ 170
Total dissolved solids	Aesthetic	mg/l	≤ 1 200
Turbidity	Operational	NTU	≤ 1
	Aesthetic	NTU	≤ 5
pH at 25 °C	Operational	pH units	≥ 5 to ≤ 9.7
Chemical determinants - macro-determinants			
Nitrate as N	Acute health – 1	mg/l	≤ 11
Nitrite as N	Acute health – 1	mg/l	≤ 0.9
Sulphate as SO_4^{2-}	Acute health – 1	mg/l	≤ 500
	Aesthetic	mg/l	≤ 250

Determinant	Risk	Unit	Standard limits
Fluoride as F^-	Chronic health	mg/l	≤ 1.5
Ammonia as N	Aesthetic	mg/l	≤ 1.5
Chloride as Cl^-	Aesthetic	mg/l	≤ 300
Sodium as Na	Aesthetic	mg/l	≤ 200
Zinc as Zn	Aesthetic	mg/l	≤ 5
Chemical determinants - micro-determinants			
Aluminium as Al	Operational	µg/l	≤ 300
Antimony as Sb	Chronic health	µg/l	≤ 20
Arsenic as	Chronic health	µg/l	≤ 10
Barium Ba	Chronic health	µg/l	≤ 700
Boron B	Chronic health	µg/l	≤ 2 400
Cadmium as Cd	Chronic health	µg/l	≤ 3
Total chromium as Cr	Chronic health	µg/l	≤ 50
Cobalt as Co	Chronic health	µg/l	≤ 500
Copper as Cu	Chronic health	µg/l	≤ 2 000
Cyanide (recoverable) as CN^-	Acute health – 1	µg/l	≤ 70
Iron as Fe	Chronic health	µg/l	≤ 2 000
	Aesthetic	µg/l	≤ 300
Lead as Pb	Chronic health	µg/l	≤ 10
Manganese as Mn	Chronic health	µg/l	≤ 400
	Aesthetic	µg/l	≤ 100
Mercury as Hg	Chronic health	µg/l	≤ 6
Nickel as Ni	Chronic health	µg/l	≤ 70
Selenium as Se	Chronic health	µg/l	≤ 40
Uranium as U	Chronic health	µg/l	≤ 15
Vanadium as V	Chronic health	µg/l	≤ 200
Organic determinants			
Total organic carbon	Acute health – 1	mg/l	≤ 10

9.8.1 Groundwater quality evaluation for user boreholes around the mine

Water quality information is available for a total of 17 user boreholes and their positions are indicated below in Figure 29. The results of the chemical analyses are provided in Table 32.

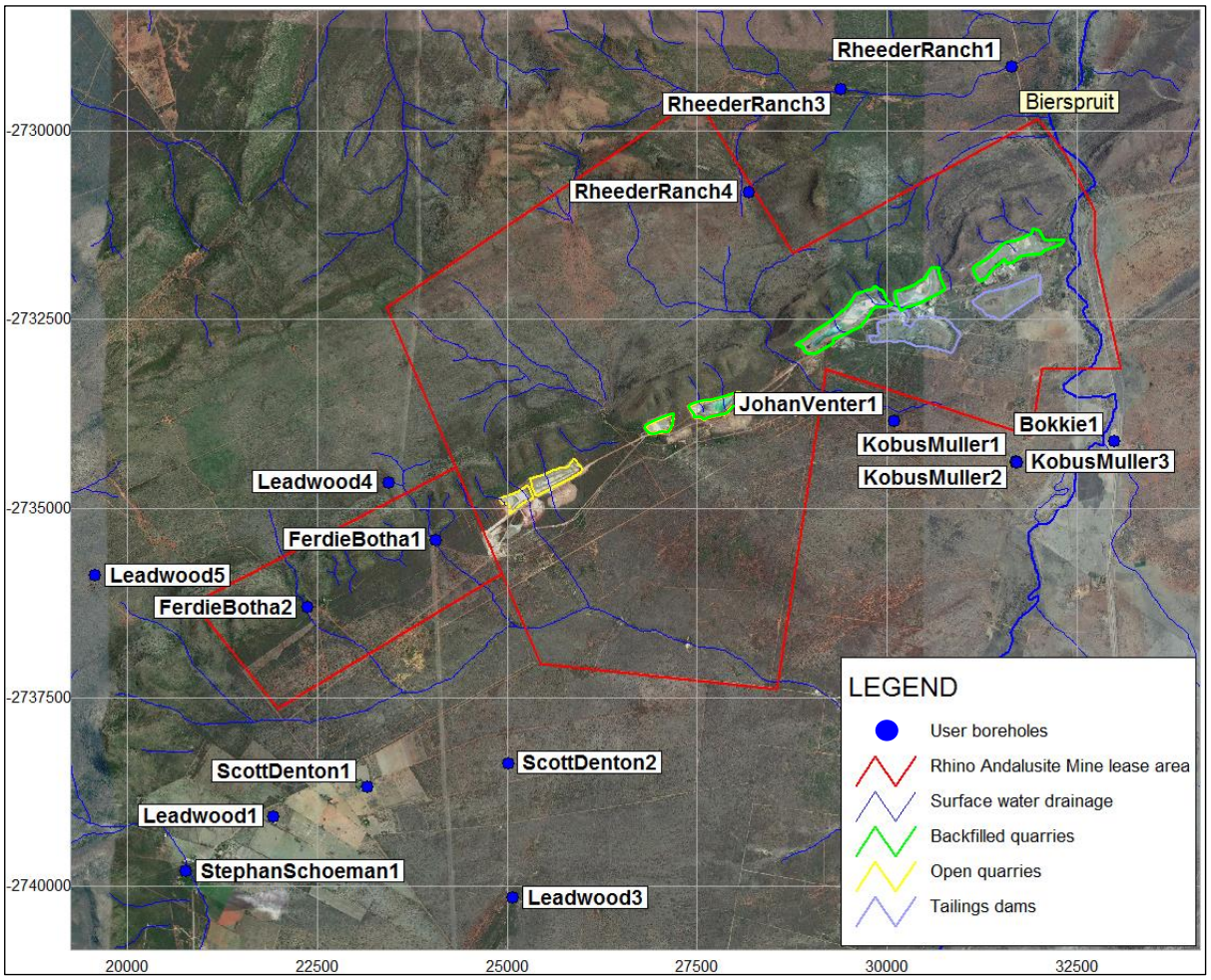

Figure 29: Positions of user boreholes used in groundwater quality assessment

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

The **total dissolved solids (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 varied between ±80mg/l and 850mg/l, which are well below the maximum permissible SANS value of 1,200mg/l (Table 31). 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.

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 **sulphate** content of groundwater measured within the user boreholes varied from below the detection limit of 0.04mg/l to approximately 50mg/l, which are well below the maximum permissible SANS value of 500mg/l and representative of ambient conditions. Sulphate contamination is more often than not associated with the oxidation of sulphide bearing minerals (in particular pyrite), which is illustrated by means of the below reaction:

$$2FeS_2 + 7O_2 + 2H_2O \longrightarrow 2Fe^{2+} + 4SO_4^{2-} + 4H^+$$

The reaction requires both oxygen and water to take place, which is readily available in opencast mining environments and is commonly referred to as Acid Mine Drainage (AMD). The production of hydrogen ions will consequently lead to a decrease in the groundwater pH conditions. No Acid Base Accounting (ABA) tests were conducted for the purpose of this study. However, ABA test results from previously conducted studies revealed that rock material from the mining area contains very low concentrations of sulphur and is also non-acid forming**.**

Groundwater **pH** conditions varied between 7.1 and 8.5, which are well within permissible SANS ranges for drinking water purposes. The relatively neutral pH conditions restrict the mobilisation of metals, which are also sensitive to groundwater redox conditions.

Nitrate contamination is generally associated with the usage of nitrate based explosives and leachate from sewage works. Health effects associated with high nitrate concentrations include impaired concentration, lack of energy and the formation of methahemoglobin in blood cells. Feedlots may also be significant sources of nitrate contamination. Groundwater nitrate concentrations measured in most boreholes are below the permissible SANS value of 11mg/l (Table 32). Exceptions did however occur and a concentration of 16mg/l was measured in user borehole ScottDenton1, which exceeds the maximum nitrate content allowed in drinking water (Table 32). 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 nitrate contamination affecting the abovementioned two boreholes is likely to originate from pit latrines and/or feedlots.

User boreholes displayed groundwater **chloride** concentrations of between ±5mg/l and 230mg/l, which are below the permissible SANS value of 300mg/l. Similar to groundwater salinity, overall higher chloride concentrations were measured in user boreholes Bokkie1, KobusMuller1 and KobusMuller2. These higher concentrations are also believed to be the result of natural occurring ion exchange reactions as the groundwater moves through the aquifer host rock (Table 32).

According to the Expanded Durov diagram (Figure 30) the user boreholes are dominated by fresh, clean, relatively young groundwater that has started to undergo mineralization with especially

magnesium ion exchange. The groundwater is therefore dominated by **magnesium** cations, while **bicarbonate alkalinity** dominates the anion content.

Summary:

- Groundwater from most user boreholes is considered to be of good quality and is suitable for human consumption.
- Exceptions do however occur as the groundwater nitrate content measured in user borehole ScottDenton1 exceeded the maximum permissible SANS value for drinking water purposes. The nitrate contamination is likely to originate from pit latrines and/or feedlots.
- The groundwater is dominated by magnesium cations and bicarbonate alkalinity, which is typical of natural, unaffected groundwater quality conditions.
- Overall higher TDS and chloride concentrations were measured in user boreholes Bokkie1, KobusMuller1 and KobusMuller2. These higher concentrations are believed to be the result of natural occurring ion exchange reactions as the groundwater moves through the aquifer host rock

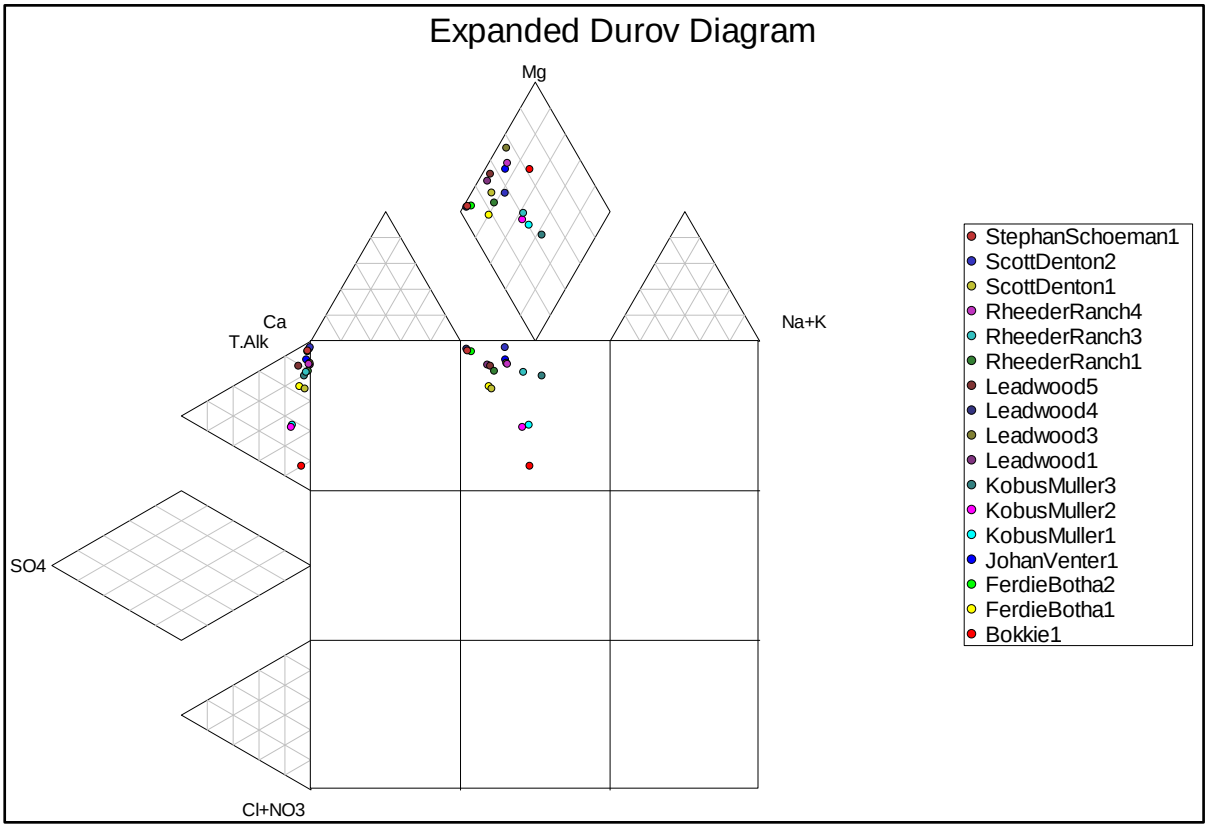

Figure 30: Expanded Durov diagram of groundwater chemistries for the user boreholes

Table 30: Concentrations of 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	0.3	91.6	84.3	75.5	3.4	<0.003	<0.003	<0.001	576.0

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
Muller2									
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: Red – Value exceeds the permissible SANS concentration for drinking water purposes **(Table 7)**.

9.8.2 Groundwater Quality Evaluation for Mine Monitoring Boreholes

Groundwater quality information is available for a total of 14 mine monitoring boreholes and their positions are indicated in Figure 31.

Groundwater **TDS** concentrations measured in mine monitoring boreholes varied between approximately 400mg/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 **sulphate** concentrations of less than 10 mg/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 value of 500mg/l; however, they do exceed the ambient concentration of approximately 6mg/l.

The groundwater **pH** conditions were more or less neutral and boreholes displayed values of between 7.3 and 8.2, which are well within recommended SANS ranges for drinking water purposes.

The mine monitoring boreholes displayed groundwater **nitrate** concentrations of between <0.392mg/l and approximately 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.

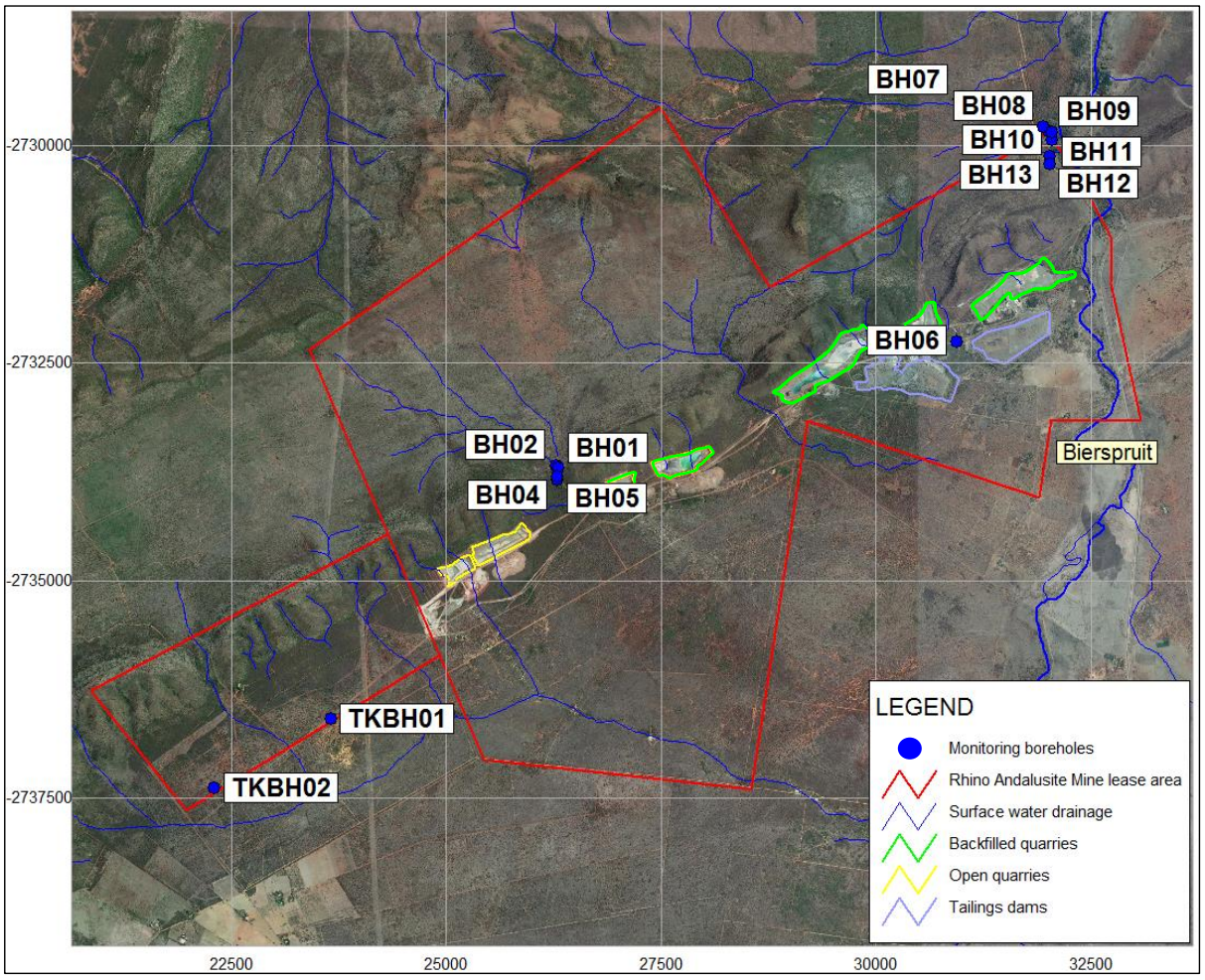

Figure 31: Positions of mine monitoring boreholes used in groundwater quality assessment

Groundwater **chloride** concentrations measured in most monitoring boreholes varied from less than 10 mg/l to approximately 140mg/l, which are below the permissible SANS value of 300mg/l. However, boreholes BH06 and BH07 displayed concentrations of ±330mg/l and 360mg/l respectively, therefore exceeding the permissible SANS value for drinking water purposes. The once-off sampling data is insufficient and does not provide any reasonable explanation for these anomalies.

According to the Expanded Durov diagram the mine monitoring boreholes are dominated by two main types of groundwater:

- Fresh, clean, relatively young groundwater that has started to undergo mineralization with especially magnesium ion exchange. The groundwater is therefore dominated by **magnesium** cations, while **bicarbonate 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 sulphate and sodium chloride mixing/contamination or old stagnant sodium chloride dominated water that has mixed with clean water. The groundwater is consequently dominated by **magnesium** cations and **sulphate** 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 sulphate contamination. Both boreholes also displayed elevated salinities in comparison to the other boreholes, which also suggest localised impacts on groundwater quality.

Summary:

- Groundwater from mine monitoring boreholes is generally of good quality and is suitable for human consumption according to the South African National Standards.
- Exceptions did however occur as boreholes BH06 and BH07 displayed elevated concentrations of especially TDS, sulphate and chloride.
- The once-off sampling data is insufficient and does not provide any reasonable explanation for these two anomalies.

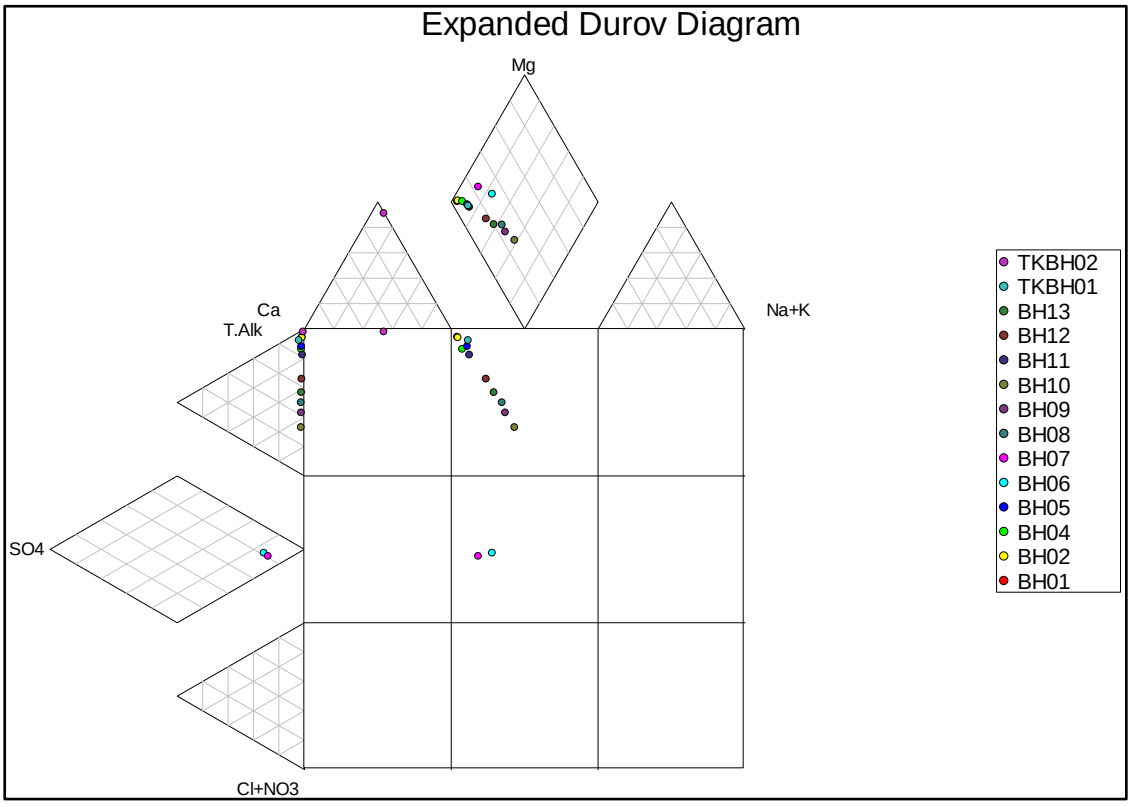

Figure 32: Expanded Durov diagram of groundwater chemistries for the mine monitoring boreholes

Table 31: Concentrations of 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	0.03	0.04
BH02	7.6	79.8	439.0	443.0	7.2	2.8	0.8	0.03	0.04
BH04	7.5	84.3	452.0	424.0	16.3	4.1	2.1	0.03	0.04
BH05	8.2	77.9	427.0	410.0	15.9	3.7	0.7	0.03	0.04
BH06	7.6	197.0	1116.0	439.0	333.0	162.0	0.6	0.03	0.04
BH07	7.5	199.0	1126.0	449.0	357.0	149.0	0.7	0.02	0.04
BH08	7.5	121.0	642.0	472.0	110.0	6.3	0.6	0.02	0.04
BH09	7.5	120.0	621.0	426.0	119.0	5.5	0.6	0.02	0.04
BH10	7.5	125.0	638.0	398.0	141.0	6.0	0.6	0.02	0.04
BH11	7.5	94.0	505.0	467.0	30.4	2.6	0.6	0.07	0.04
BH12	7.5	104.0	569.0	473.0	67.4	4.3	0.5	0.02	0.04
BH13	7.6	109.0	578.0	449.0	86.3	5.0	0.5	0.13	0.04
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: Red – Value exceeds the permissible SANS concentration for drinking water purposes (Table 7).

9.8.3 Quality evaluation of water collecting in the quarries

Water collecting in Quarry 4/5 and the Motswere Quarry was sampled in June 2016 and analysed for a range of chemical and physical parameters. The results of the analyses are also compared to the South African National Standards for drinking water *(SANS 241:2015)* and discussed in the following paragraphs.

The quarries present the correct environments for AMD reactions to occur, as oxygen and water are present in abundance. Furthermore, should the andalusite host rock contain reactive minerals, poor quality seepage is expected to be generated and the quality of water collecting in the quarries would deteriorate over time. This quarry water should therefore provide an indication of the mine's long term impact (if any) on the surrounding groundwater quality conditions. The results of the water analyses are provided below in Table 34.

Table 32: Results of analyses conducted on quarry water in June 2016

Parameter	Unit	Motswere Quarry	Quarry 4/5
pH	pH units	7.05	8.37
EC	mS/m	81	92.2
Temperature	^{o}C	21	21
Turbidity	NTU	<0 0 580	32.9
Colour	mg/l Pt-Co	0	12
E. coli	count/100ml	0	4
Total coliform	count/100ml	0	1300
Ammonium	mg/l	<0.01	<0.01
Orthophosphate	mg/l	<0.20	<0.20
Iron	µg/l	111	250
Manganese	µg/l	<10	11
Chromium	µg/l	<10	<10
Cobalt	µg/l	<10	<10
Copper	µg/l	<10	<10
Lead	µg/l	<10	<10
Nickel	µg/l	10	<10
Zinc	mg/l	0.04	<0.01
Aluminium	µg/l	<10	166
Cadmium	µg/l	<3.0	<3.0
Calcium	mg/l	89	49
Total hardness	mg/l	617	470
Magnesium	mg/l	95	84
Sodium	mg/l	<2	<2
Chloride	mg/l	<25	98
Nitrite	mg/l	<0.063	<0.063
Sulphate	mg/l	<20	70

Apart from the bacteria that were found present in Quarry 4/5, the two water samples are considered to be of good quality and **show no signs of impacts related to AMD or the generation of poor quality leachate**. However, dedicated monitoring and longer data records are required to identify trends and to confirm the above statement.

As mentioned in the preceding sections, sulphate is an important chemical indicator parameter of impacts related to the oxidation of iron sulphides (AMD). The sulphate content of water collecting in the Motswere Quarry is less than 20mg/l, while the Quarry 4/5 water displayed a concentration of 70mg/l. These concentrations are well below the maximum permissible SANS value of 500mg/l and are more or less representative of the ambient groundwater sulphate content.

Water samples from both quarries are neutral to slightly alkaline, which is yet another indication of the absence of AMD.

Summary:

- Water collecting in the Motswere Quarry and Quarry 4/5 seems to show no signs of impacts related to AMD or the generation of poor quality leachate.
- Dedicated monitoring and longer data records are however required to identify trends and to confirm the above statement.

10 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).

10.1 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.

10.1.1 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.).

10.1.2 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.

10.1.3 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.

10.1.4 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.

10.1.5 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.

10.1.6 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.

10.2 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 33.

10.2.1 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 34. 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 35. 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.

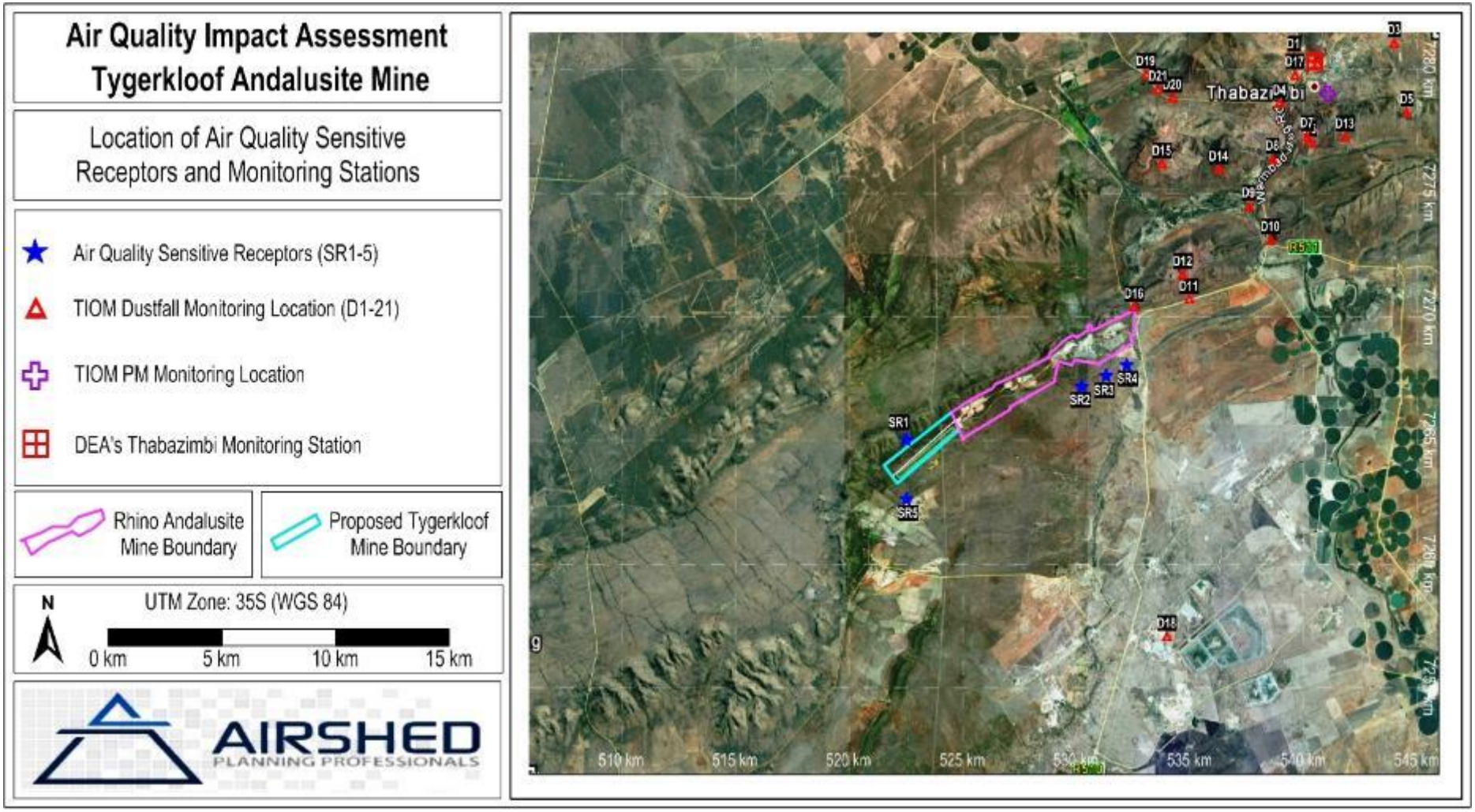

Figure 33: Location of air quality sensitive receptors and ambient monitoring stations in the vicinity of the project

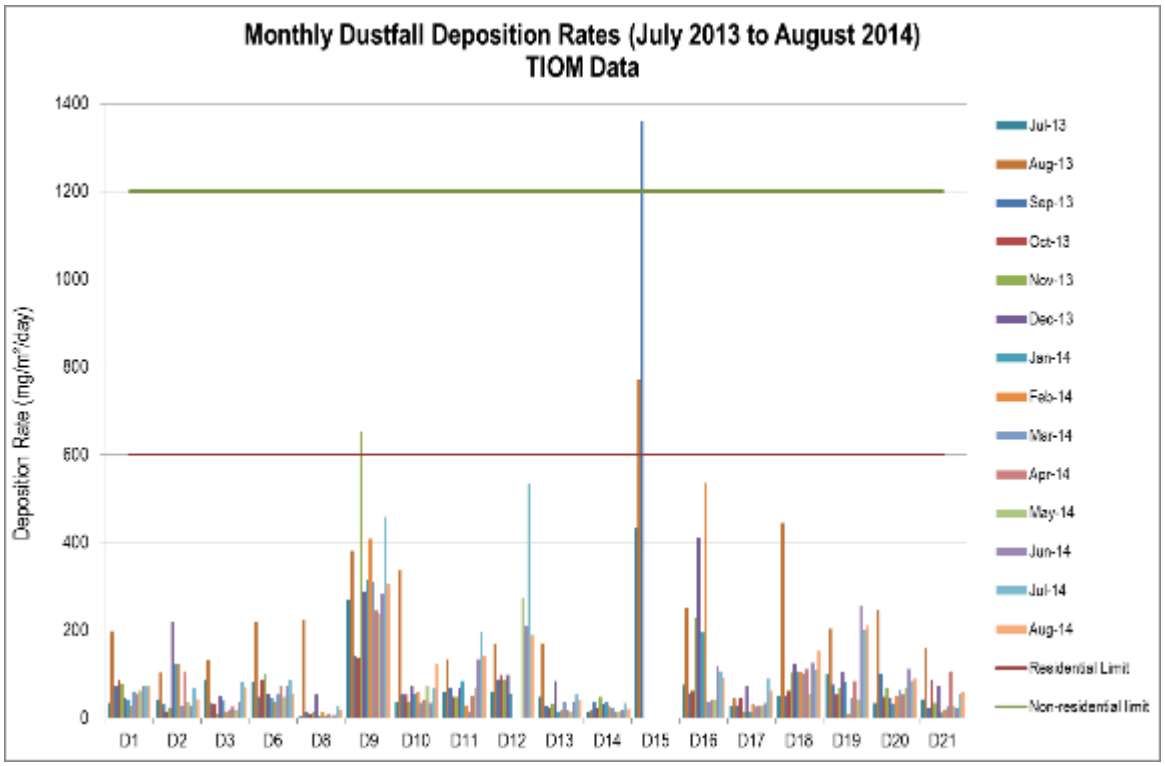

Figure 34: Monthly dustfall deposition rates (July 2013 to August 2014) TIOM monitoring station

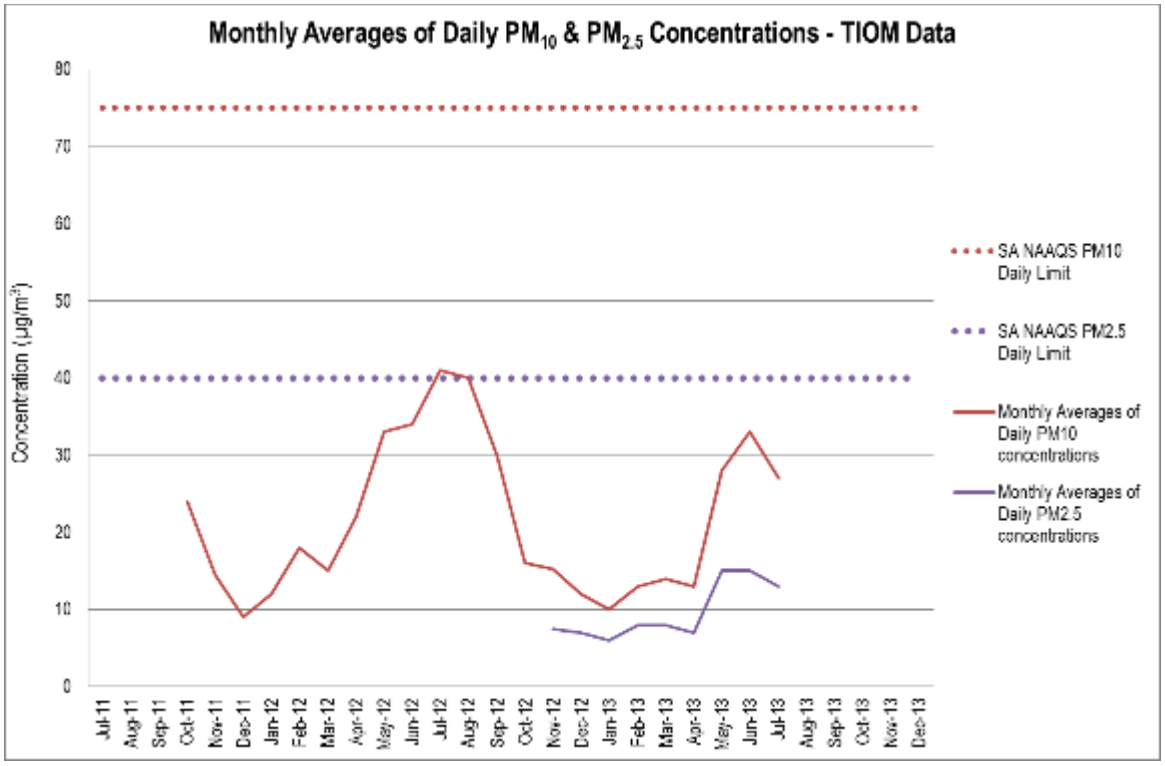

Figure 35: Monthly averages of daily PM_{10} & $PM_{2.5}$ concentrations - TIOM monitoring station

10.2.2 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.

10.3 Air quality sensitive receptors

Sensitive receptors around the project site are shown in Figure 33. 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.

11 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 35 below for the typical rating levels for ambient noise in districts.

Table 33: 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

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
(d) Urban districts with some workshops, business premises and with main roads.	60	60	50	50	50	40
(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 36 below for the environmental conditions present during the survey periods.

Table 34: 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 37 below for the results from the survey.

Table 35: 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	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.

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)	
new mining area. Close to the farmer's residence.								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 northern side towards the existing quarry area.	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. 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	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.

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)	
the proposed new area.								
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, adjacent of Plant 5 of the existing quarry.	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 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.

12 Visual aspects

The mine 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.

13 Cultural and heritage resources

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

13.1 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).

<u>Heritage resources</u>

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 was 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). Madematle/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).

13.2 Description of the 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.

Just west of the northern section of the Tygerkloof 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).

14 Sensitive landscapes

Refer to Figure 3 which also includes the sensitive landscape 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.

Please keep in mind that the project is the filling of already existing quarry and will not influence any sensitive feature. Alternative 2 might influence sensitive features.

15 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)

15.1 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 38 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 36: 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 39 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 37: 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 40 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 38: 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 41 below for the distribution of the population aged between 5 and 24 years by school attendance, and sex for 1996, 2001 and 2011

Table 39: Distribution of the population aged between 5 and 24 years by school attendance, and sex for 1996, 2001 and 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 42 below for the household demographics.

Table 40: 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

15.2 Basic services

Refer to Table 43 below for distribution of households using electricity for lighting, heating, cooking, Table 40 for distribution of households by access to piped water, Table 43 for distribution of households by type of refuse removal, and Table 44 for distribution of households by type of toilet facility

Table 41: 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 42: 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 43: 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 44: 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

15.3 Employment and income

Refer to Table 47 for the labour market demographics, Table 48 for the distribution of the population aged between 15 and 64 years by employment status for 1996, 2001 and 2011, and Table 48 for households by monthly income category. Majority of household earn between R3,201 – R6,400.

Table 45: 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 46: 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 47: 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

15.4 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 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.

15.5 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.

According to the EMF of the Waterberg DM, one of the key sectors in the district is mining which currently accounts for more than 50% of the income of the district.

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.

v) Impacts and risks identified including the nature, significance, consequence, extent, duration and probability of the impacts, including the degree to which these impacts

This section includes the nature, significance, consequence, extent, duration and probability of the impacts, including the degree to which these impacts can be reversed; may cause irreplaceable loss of resources; and can be avoided, an assessment of each identified potentially significant impact and risk, including cumulative impacts, as well as how these impacts can be managed or mitigated and level of residual risk.

Please note, significance rating should be done by the various specialists as part of the specialist studies. The geohydrologist conducted significance rating. Significance rating for all other environmental aspects are based on assumptions made by the EAP.

Information from the following tools have been incorporated into the impact assessment:

- The Limpopo Conservation Plan of 2013;
- The EMF of the Waterberg DM;
- The mining and biodiversity guidelines;
- The Thabazimbi SDF; and
- The Waterberg SDF.

Refer to Figure 36 indicating that the area falls within the Limpopo Critical Biodiversity Areas (SANBIGIS). Critical Biodiversity Areas are areas required to meet biodiversity targets for ecosystems, species and ecological processes, as identified in a systematic biodiversity plan. Ecological Support Areas are not essential for meeting biodiversity targets but play an important role in supporting the ecological functioning of Critical Biodiversity Areas and/or in delivering ecosystem services. Critical Biodiversity Areas and Ecological Support Areas may be terrestrial or aquatic (http://biodiversityadvisor.sanbi.org/industry-and-conservation/biodiversity-in-the-urban-economy/understand/definitions-related-to-urban-land-use-planning/critical-biodiversity-areas-and-ecological-support-areas/).

The following was extracted from the Waterberg District Environmental Management Framework Report. According to the EMF of the Waterberg DM, there are many definitions of sustainable development which may apply to a greater or lesser extent to the district. What is however important in this particular instance is that it should be focussed on all of the following, failing which the concept itself will in all likelihood not be sustainable in the district:

- It must ensure the adequate and appropriate protection of **biodiversity** in the district.

- It must ensure that the **surface water resource** in the area is managed in a manner that will ensure that it continues to provide in the needs of the area and that the water that is returned to the system is of an acceptable quality.
- It must ensure that the quantity and quality of the **groundwater** in the area is protected and kept at a level and quality where it can continue to sustain the activities that depend on it, especially rural communities
- It must ensure a continued and even increased **income** for the district and especially its poor communities.
- It must provide for increased levels of **employment** and better types of employment.
- It must provide incentives for the establishment of a more balanced **population structure** especially in respect to the age, health and general prosperity of the population.

The key issues of the district which could be linked to the activity applied for in this EIA are:

- water availability and utilisation;
- water quality and pollution; and
- air quality.

This EMF further states that mining is the cornerstone of the economy of the district and currently accounts for more than 50% of the GDP of the area. It is highly unlikely that this contribution will decrease over the next 60 to 100 years. The mining industry is therefore important for the development of the district over the medium to long term. The mining and industry sectors desire to see skills development and training programmes implemented.

The mine falls within two zones, zone 4 which is a mining focus area, and zone 11 which is Major infrastructure corridors. The activity falls within Zone 4. This zone represents areas where significant mineral resources of strategic national importance occur within largely natural environments. Larger scale water utilisation will be necessary to support mining and industrial activities in this zone. Activities should not be allowed to proceed unless the necessary water allocations and permits are in place. Water quality in this zone should not be allowed to deteriorate. Legislation to protect water quality and prevent pollution should be strictly enforced. Heavy penalties should be imposed on pollution caused by mining and industry. Conservation of natural habitat should be the primary focus of required buffer areas around mining and industrial sites. Preference should be given to catering for threatened species that may occur in this zone. Game and cattle farming should be the default activity in parts of the zone that is not used for mining or industrial purposes. Preferred activities include mining of minerals. Undesirable activities include any activity that sterilises the potential to explore a mineral resource in the area, for example constructing buildings on top of the mineral resource. The area does not fall within the Waterberg Biosphere Reserve.

According to the Mining and Biodiversity Guidelines map (SANBIGIS), the area falls within Highest biodiversity importance - highest risk for mining. This is because the area falls within the Limpopo Critical Biodiversity Area.

According to the Thabazimbi SDF, the area of the activity is marked as mines and quarries. This will also be similar in the Waterberg SDF.

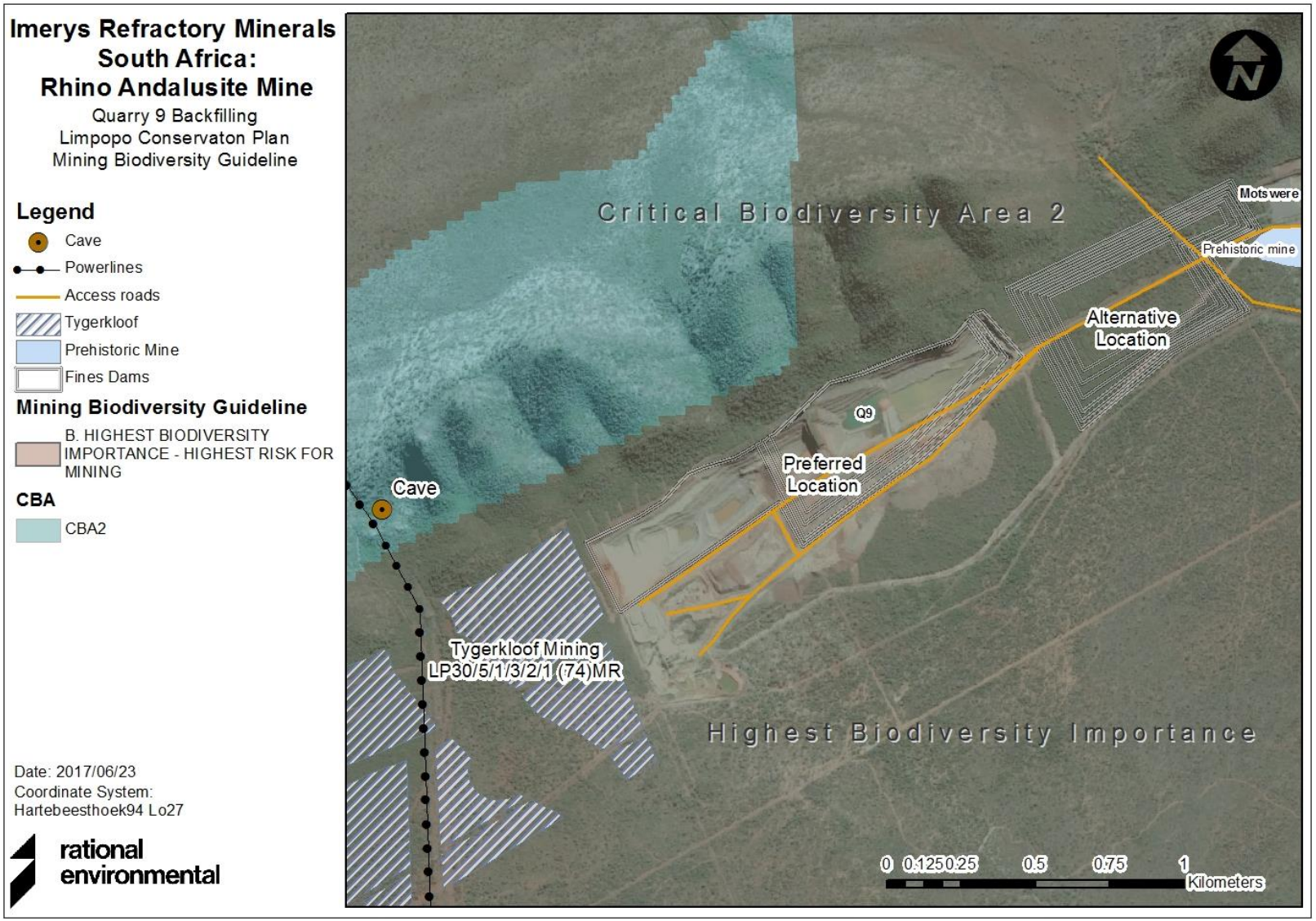

Figure 36: Rhino Andalusite Mine layout indicating the environmental tools and sensitivity of the area

1 Preferred option

1.1 Geology

There is no impact on the geology.

1.2 Soil, pre-mining land capability and land use

There is no impact on the soil, pre-mining land capability and land use. The area to be extended is already a disturbed area.

Management:

Rehabilitation for the entire mining site must also include replacement of vegetation in such a way that the requirements set out in the Limpopo Conservation Plan of 2013, the EMF of the Waterberg DM and the mining and biodiversity guidelines are met.

1.3 Vegetation and animal life

There is no impact on the vegetation and animal life. The area to be extended is already a disturbed area.

Management objective:

According to the Waterberg EMF: It must ensure the adequate and appropriate protection of biodiversity in the district.

Management:

Rehabilitation for the entire mining site must also include replacement of vegetation in such a way that the requirements set out in the Limpopo Conservation Plan of 2013, the EMF of the Waterberg DM and the mining and biodiversity guidelines are met.

1.4 Surface water

1.4.1 Mix of clean and dirty water, siltation of surface water resources

Information is based on the IWWMP (Shangoni Management Services, 2012).

Activity: Backfilling and extension of quarry 9.

Nature and consequence: Mixing of clean and dirty water and siltation of surface water resources.

Description		**Rating before management**	**Rating with management**
Quantity or size of disturbance			
Medium	The areas where spillages could occur include the quarry area	2	2
Severity or destruction effect			
Medium	It is expected that the impact of the mine on water quality will be low and may be attributed to the fact that the ore and overburden is relatively inert.	2	2
Extent			

Description		Rating before management	Rating with management
Area adjacent to the site	Siltation may extent in surface water and groundwater sources.	2	2
Duration (impact phase and estimated timeframes)			
Until final rehabilitation.	Until the area has been rehabilitated.	2	2
Probability			
Probable	Mixing of clean and dirty water as well as siltation is probable.	2	1
Reversibility			
Reversible	Siltation and mixing of water will be reversible with rainy season.	1	1
Irreplaceability of resources			
Receptor is somewhat sensitive.	The surface water is deemed somewhat sensitive.	2	2
Degree to which can be avoided, managed or mitigated			
Avoidable with management	The impact can be avoided with proper management.	1	1
Significance			
Medium-low	Medium significance prior to and after management.	15	14

Environmental objective:

- To keep clean and dirty water separate.
- To prevent siltation of water resources.
- Waterberg EMF: It must ensure that the surface water resource in the area is managed in a manner that will ensure that it continues to provide in the needs of the area and that the water that is returned to the system is of an acceptable quality.

Monitoring requirements:

- Surface water and groundwater monitoring.
- Regular inspections

Management or mitigation:

- Clean surface runoff upstream of the mine should be diverted around the quarry to separate clean and affected catchments as well as to limit runoff on site.
- The tailings facility must be developed and managed according to the CoP in accordance with the DMR guidelines Such CoPs will stipulate routine inspections, monitoring of performance criteria and regular management review meetings.
- Maintenance of water canals and structures to ensure affective separation and prevent overflow of clean/dirty water and that such canals are in compliance with the 1 50-year flood requirement.

Roles and responsibility:

- Mine manager

Management timeframe:

- Throughout LoM until rehabilitation is finished.

Environmental budget:

- RAM does not have a dedicated budget for Water Management. Replacing of pipes and moving them will be under the consumable maintenance or external services. RAM also has some CAPEX and investment for improvement - but it changes year after year

Description	Rating before management	Rating with management
Residual risk: • No residual risks.		

1.5 Groundwater

1.5.1 Groundwater quality

Information for this section was obtained from the Rhino Andalusite Mine (Pty) Ltd Quarry Backfill Project: Report on Geohydrological Investigation as Part of the Environmental Impact Assessment (EIA) and Environmental Management Program (EMP) (Groundwater Complete, 2016), and the Waste Assessment Report (Aquatico, 2017).

Activity: The disposal of tailings material in Quarry 9 and extension of Quarry 9.

Nature and consequence: The tailings material is mostly inert; therefore, the backfilled quarry is not expected to generate poor quality seepage. Some degree of groundwater mounding may occur as a result of artificial aquifer recharge; however this recharge is expected to be very low due to the nature of the tailings material and low hydraulic properties of the underlying aquifer host rock. No significant impacts are therefore envisaged, both in terms of groundwater levels and quality. Both waste streams (Q7 Tailings and Plant 5 Premier Waste) are low risk waste and impact resulting from disposing this waste into a quarry should be negligible based on these testing standards.

Additional comments: The low hydraulic properties of the underlying fractured rock aquifer combined with relatively low groundwater gradients result in low seepage velocities, which further decrease the potential impacts on groundwater quality.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Very small to small	Areas are not pristine and have already been disturbed by mining activities.	1	1
Severity or destruction effect			
Very low to low	No impacts are envisaged, both in terms of groundwater levels and quality.	1	1
Extent			
Site specific	No adverse impact envisaged.	1	1
Duration (impact phase and estimated timeframes)			
Throughout life of activity	No adverse impact envisaged.	2	2
Probability			
Not probable	No adverse impact envisaged.	1	1
Reversibility			
Reversible	No adverse impact envisaged.	1	1
Irreplaceability of resources			

Description		Rating before management	Rating with management
Resource somewhat replaceable, receptor moderately sensitive	Resource will recover (if impacts do occur), while users are located in the down gradient direction.	2	2
Degree to which can be avoided, managed or mitigated			
Avoidable with management measures	No adverse impact envisaged.	1	1
Significance			
Low	No adverse impact envisaged.	10	10
Environmental objectives: • To minimize the extent of disturbance of the aquifer, • To limit the degeneration of groundwater quality. • Waterberg EMF: It must ensure that the quantity and quality of the groundwater in the area is protected and kept at a level and quality where it can continue to sustain the activities that depend on it, especially rural communities			
Monitoring requirements: • Quarterly monitoring of purpose drilled groundwater monitoring boreholes are recommended, followed by annual reporting of monitoring results.			
Management or mitigation: • Clean surface water should not come into contact with dirty water, • Recycle and reuse of contaminated water as far as possible, • Continuous monitoring of groundwater levels and quality conditions are recommended.			
Roles and responsibility: • Mine manager in consultation with qualified geohydrologist.			
Management timeframe: • Throughout the life of mine and until final mine closure has been achieved.			
Environmental budget: • There is no dedicated budget. Replacing of pipes and moving them will be under the consumable maintenance or external services.			
Residual risk: • No significant impacts are envisaged during the life of mine; therefore, no residual risks are expected.			

1.6 Air quality

Information is based on the AEL for Annesley Mine (Shangoni Management Services, 2016) and from 'Air Quality Specialist Report for the Proposed Tygerkloof Mine, Thabazimbi, Limpopo Province' (Airshed Planning Professionals, 2015).

Activity: Dried out quarry and tailings facility.

Nature and consequence: Wind erosion from exposed surfaces filled with tailings.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	Air emission are divided into point sources and non-point sources. Non-point sources include the quarry.	2	2
Severity or destruction effect			
Moderate	The AEL does not indicate severity or destruction effects of the emissions. The severity is based on assumptions made. There have not yet been any complaints from the local community on air emissions.	2	1
Extent			
Area adjacent to site	Dust can be carried to areas adjacent to the site.	2	2
Duration (impact phase and estimated timeframes)			
Throughout the life of activity	Dust will cease once rehabilitation is completed.	2	2
Probability			
Probable		2	2
Reversibility			
Reversible		2	2
Irreplaceability of resources			
The resource is replaceable.		1	1
Degree to which can be avoided, managed or mitigated			
Avoidable with management measures		1	1
Significance			
Medium	Medium significance prior to and low significance after management.	14	13
Environmental objective: • To implement the required measures to effectively control air pollution sources.			
Monitoring requirements: • Fall-out dust and PM10 monitoring, and reporting.			
Management or mitigation: • 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. • 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.			
Roles and responsibility:			
Management timeframe:			

Description	Rating before management	Rating with management
• Throughout LoM until rehabilitation is finished.		
Environmental budget: • RAM does not have a dedicated budget.		
Residual risk: • There will be no residual risks if rehabilitation is adequate.		

1.7 Environmental noise

There is no impact on the environmental noise.

1.8 Visual aspects

Activity: The disposal of tailings material in Quarry 9 and extension of Quarry 9.

Nature and consequence: Change in topography leading to visible intrusions in the rural area.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	The change in topography is large, however, not the entire mining area is visible from outside areas.	2	2
Severity or destruction effect			
Low	The sense of place is disturbed, however, the visual intrusion is mostly only visible from the road.	1	1
Extent			
Area adjacent to site	Intrusion is on area adjacent to mining site	2	2
Duration (impact phase and estimated timeframes)			
Permanent	Depending on rehabilitation, this could be permanent.	3	2
Probability			
Definite	This is an ongoing activity.	3	3
Reversibility			
Only reversible with management	The change in topography is irreversible but with adequate rehabilitation, the visual impact can be reversed.	3	2
Irreplaceability of resources			
Resource replaceable	The resource is not sensitive.	1	1
Degree to which can be avoided, managed or mitigated			
Somewhat avoidable.	The visual impact can be somewhat avoided with adequate rehabilitation practices.	3	3
Significance			
Medium	Medium significance prior to and after management.	18	16

Description	Rating before management	Rating with management
Environmental objective: • To minimise the visual impact of the new tailings facility.		
Monitoring requirements: • Monitoring as per the rehabilitation plan.		
Management or mitigation: • Monitoring as per the rehabilitation plan.		
Roles and responsibility: • Mine manager		
Management timeframe: • As part of rehabilitation.		
Environmental budget: • No environmental budget will be allocated for the rehabilitation of the topography. This will be covered in the mine's financial provision.		
Residual risk: • Change in topography will be ongoing.		

1.9 Cultural and heritage resources

There is no impact on the cultural and heritage resources.

1.10 Regional socio-economic aspects

Activity: New tailings facility

Nature and consequence: Safety of tailings disposal facility

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	The facility is large, but forms part of the larger mine area.	2	2
Severity or destruction effect			
High	The safety risk is high	3	3
Extent			
Area adjacent to site	Risk is on area adjacent to mining site	2	2
Duration (impact phase and estimated timeframes)			
Permanent	Depending on rehabilitation, this could be permanent.	3	2
Probability			
Probable		2	2
Reversibility			
Only reversible with management	In the case of an event occurring, this will be irreversible.	3	3
Irreplaceability of resources			
Resource irreplaceable		3	3

Description		Rating before management	Rating with management
Degree to which can be avoided, managed or mitigated			
Somewhat avoidable.	The impact can be somewhat avoided with adequate rehabilitation practices.	3	3
Significance			
High	High significance prior to and after management.	21	20
Environmental objective: • To minimise the risk of the new tailings facility.			
Monitoring requirements: • Monitoring as per the CoP			
Management or mitigation: • Management as per the CoP.			
Roles and responsibility: • Mine manager			
Management timeframe: • Ongoing.			
Environmental budget: • None			
Residual risk: • Ongoing			

2 Alternative options

1.1 Geology

There is no impact on the geology.

1.2 Soil, pre-mining land capability and land use

1.2.1 Loss of topsoil, land capability and land use

Activity: The construction of a new tailings facility.

Nature and consequence: Stripping and stockpiling of topsoil will cause the natural soil horizon sequence to be disturbed. Stripping of lower quality subsoil and overburden 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. The tailings facility will cause all productive soil functions, and all land capability and land uses in terms of arable land or grazing, to cease completely. The impact on the soil will affect the land capability as well as land use.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The area of disturbance will be the entire area between quarry 9 and Motswere Quarry.	3	3
Severity or destruction effect			
Large	The incorrect removal of topsoil as well as the placement of mine residue on topsoil will have large destructive impacts on the soil, and therefore the land capability and land use wil also be affected.	3	2
Extent			
Site specific	Only soil at site to be disturbed.	1	1
Duration (impact phase and estimated timeframes)			
Permanent	Removal of soil and placement of tailings facility will stop once mining ceases, however, the impact on the soil wil be permanent.	3	3
Probability			
Definite	If this alternative is chosen it will be a definite impact.	3	3
Reversibility			
Irreversible	Once soil is destroyed, this cannot be replaced. The land capability and land use will then also be impacted.	3	3
Irreplaceability of resources			
Receptor is somewhat sensitive		2	2
Degree to which can be avoided, managed or mitigated			
Somewhat avoidable with management measures	This impact can be avoided with proper management measures going forward.	1	1
Significance			
Medium	Medium significance prior to and after management.	19	18
Environmental objective: • To implement all soil management measures in order to conserve soil. • To maximise land capability of disturbed / effected areas through effective rehabilitation and remediation practices and promote sustainable land use subsequent to rehabilitation			
Monitoring requirements: • There is no formal monitoring. • Inspections must be done to ensure topsoil is removed as per management measures.			
Management or mitigation: • Topsoil will be removed and stored separately from other material. • Rehabilitation for the entire mining site must also include replacement of vegetation in such a way that the requirements set out in the Limpopo Conservation Plan of 2013, the EMF of the Waterberg DM and the mining and biodiversity guidelines are met.			

Description	Rating before management	Rating with management
Roles and responsibility: • Mine manager		
Management timeframe: • Throughout mining operations.		
Environmental budget: • Budget only to be allocated if this alternative is chosen.		
Residual risk: • All soil not removed and stored for rehabilitation will be lost for any further use in the future.		

1.3 Vegetation and animal life

1.3.1 Vegetation and habitat destruction

Activity: The construction of a new tailings facility.

Nature and consequence: Destruction of indigenous vegetation and animal habitats.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The area of disturbance will be the entire area between quarry 9 and Motswere Quarry.	3	3
Severity or destruction effect			
Large	Complete removal of vegetation and habitat.	3	3
Extent			
Site specific	Only influence site	1	1
Duration (impact phase and estimated timeframes)			
Throughout the activity	Until after rehabilitation is finished.	3	2
Probability			
Definite	If this alternative is chosen it will be a definite impact.	3	3
Reversibility			
Only reversible with management	Natural regrowth will take place, however, the area is prone to regrowth of alien vegetation.	2	2
Irreplaceability of resources			
Recourse is replaceable	Vegetation and therefore habitat can be replaced.	1	1
Degree to which can be avoided, managed or mitigated			
Somewhat avoidable with management	Removal is unavoidable, but the extent of removal can be limited though proper management. Rehabilitation wil also lead to replacement of natural vegetation.	2	2
Significance			
Medium	Medium significance prior to and after management.	18	17

Description	Rating before management	Rating with management
Environmental objective: • To reduce disturbance to the environment through correct measures to be implemented. • To promote the establishment of self-sustaining plant communities. • According to the Waterberg EMF: It must ensure the adequate and appropriate protection of biodiversity in the district.		
Monitoring requirements: • Monitoring as per the rehabilitation plan.		
Management or mitigation: • Limit area of disturbance as per the construction site. • Ensure rehabilitation. • Rehabilitation for the entire mining site must also include replacement of vegetation in such a way that the requirements set out in the Limpopo Conservation Plan of 2013, the EMF of the Waterberg DM and the mining and biodiversity guidelines are met.		
Roles and responsibility: • Mine manager		
Management timeframe: • Throughout LoM and until rehabilitation is finished.		
Environmental budget: • No environmental budget will be allocated for the replacement of vegetation. This will be covered in the mine's financial provision.		
Residual risk: • No residual risks.		

1.3.2 Alien vegetation

Information is based on the IWWMP (Shangoni Management Services, 2012).

Activity: The construction of a new tailings facility.

Nature and consequence: Invasive species establishment.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The area of disturbance will be the entire area between quarry 9 and Motswere Quarry.	3	3
Severity or destruction effect			
Moderate	Moderate severity on indigenous vegetation.	2	2
Extent			
Site specific	Only influence site	1	1
Duration (impact phase and estimated timeframes)			
Throughout the activity	Until after rehabilitation is finished.	3	2
Probability			
Highly probable	If this alternative is chosen it will be a highly probable impact.	2	2
Reversibility			

Description		Rating before management	Rating with management
Only reversible with management	Natural regrowth will take place, however, the area is prone to regrowth of alien vegetation.	2	2
Irreplaceability of resources			
Recourse is replaceable	Vegetation can be replaced.	1	1
Degree to which can be avoided, managed or mitigated			
Somewhat avoidable with management	Removal of alien vegetation wil lead to avoidance of impact.	2	2
Significance			
Medium	Medium significance prior to and after management.	16	15
Environmental objective: • To control alien invasive species.			
Monitoring requirements: • Monitoring as per the rehabilitation plan.			
Management or mitigation: • Ensure rehabilitation.			
Roles and responsibility: • Mine manager			
Management timeframe: • Throughout LoM and until rehabilitation is finished.			
Environmental budget: • No environmental budget will be allocated for the replacement of vegetation. This will be covered in the mine's financial provision.			
Residual risk: • No residual risks.			

1.4 Surface water

1.4.1 The construction of a new tailings facility.

Information is based on the IWWMP (Shangoni Management Services, 2012).

Activity: Backfilling of quarry 9.

Nature and consequence: Mixing of clean and dirty water and siltation of surface water resources.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Large	The area of disturbance will be the entire area between quarry 9 and Motswere Quarry.	3	3
Severity or destruction effect			
Medium	It is expected that the impact of the mine on water quality will be low and may be attributed to the fact that the ore and overburden is relatively inert.	2	2

Description		Rating before management	Rating with management
Extent			
Area adjacent to the site	Siltation may extent in surface water and groundwater sources.	2	2
Duration (impact phase and estimated timeframes)			
Until final rehabilitation.	Until the area has been rehabilitated.	2	2
Probability			
Probable	Mixing of clean and dirty water as well as siltation is probable.	2	1
Reversibility			
Reversible	Siltation and mixing of water will be reversible with rainy season.	1	1
Irreplaceability of resources			
Receptor is somewhat sensitive.	The surface water is deemed somewhat sensitive.	2	2
Degree to which can be avoided, managed or mitigated			
Avoidable with management	The impact can be avoided with proper management.	1	1
Significance			
Medium-low	Medium significance prior to and after management.	16	15

Environmental objective:

- To keep clean and dirty water separate.
- To prevent siltation of water resources.
- Waterberg EMF: It must ensure that the surface water resource in the area is managed in a manner that will ensure that it continues to provide in the needs of the area and that the water that is returned to the system is of an acceptable quality.

Monitoring requirements:

- Surface water and groundwater monitoring.
- Regular inspections

Management or mitigation:

- Clean surface runoff upstream of the mine should be diverted around the quarry to separate clean and affected catchments as well as to limit runoff on site.
- The tailings facility must be developed and managed according to the CoP in accordance with the DMR guidelines Such CoPs will stipulate routine inspections, monitoring of performance criteria and regular management review meetings.
- Maintenance of water canals and structures to ensure affective separation and prevent overflow of clean/dirty water and that such canals are in compliance with the 1 50-year flood requirement.

Roles and responsibility:

- Mine manager

Management timeframe:

- Throughout LoM until rehabilitation is finished.

Environmental budget:

- Budget only to be allocated if this alternative is chosen.

Residual risk:

Description	Rating before management	Rating with management
• No residual risks.		

1.5 Groundwater

1.5.1 Groundwater quality

Information for this section was obtained from the Rhino Andalusite Mine (Pty) Ltd Quarry Backfill Project: Report on Geohydrological Investigation as Part of the Environmental Impact Assessment (EIA) and Environmental Management Program (EMP) (Groundwater Complete, 2016) and the Waste Assessment Report (Aquatico, 2017).

Activity: The disposal of tailings material at a new aboveground tailings storage facility.

Nature and consequence: The tailings material is mostly inert; therefore, the new tailings storage facility is not expected to generate poor quality seepage. Some degree of groundwater mounding may occur as a result of artificial aquifer recharge; however, this recharge is expected to be very low due to the nature of the tailings material and low hydraulic properties of the underlying aquifer host rock. This artificial recharge may however lead to the formation of a shallow perched aquifer in the presence of a confining/semi-confining layer, which is not regarded as a negative impact. No adverse impacts are therefore envisaged, both in terms of groundwater levels and quality. Both waste streams (Q7 Tailings and Plant 5 Premier Waste) are low risk waste and impact resulting from disposing this waste into a quarry should be negligible based on these testing standards.

Additional comments: The low hydraulic properties of the underlying fractured rock aquifer combined with relatively low groundwater gradients result in low seepage velocities, which further decrease the potential impacts on groundwater quality.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Very small to small	Areas are not pristine and have already been disturbed by mining activities.	1	1
Severity or destruction effect			
Very low to low	No impacts are envisaged, both in terms of groundwater levels and quality.	1	1
Extent			
Site specific	No adverse impact envisaged.	1	1
Duration (impact phase and estimated timeframes)			
Throughout life of activity	No adverse impact envisaged.	2	2
Probability			
Not probable	No adverse impact envisaged.	1	1
Reversibility			
Reversible	No adverse impact envisaged.	1	1
Irreplaceability of resources			

Description		Rating before management	Rating with management
Resource somewhat replaceable, receptor moderately sensitive	Resource will recover (if impacts do occur), while users are located in the down gradient direction.	2	2
Degree to which can be avoided, managed or mitigated			
Avoidable with management measures	Lining of facility will decrease seepage to the aquifer even further.	2	1
Significance			
Low	No adverse impact envisaged.	10	10
Environmental objectives: • To minimize the extent of disturbance of the aquifer, • To limit the degeneration of groundwater quality. • Waterberg EMF: It must ensure that the quantity and quality of the groundwater in the area is protected and kept at a level and quality where it can continue to sustain the activities that depend on it, especially rural communities.			
Monitoring requirements: • Quarterly monitoring of purpose drilled groundwater monitoring boreholes are recommended, followed by annual reporting of monitoring results.			
Management or mitigation: • Clean surface water should not come into contact with dirty water, • Recycle and reuse of contaminated water as far as possible, • Continuous monitoring of groundwater levels and quality conditions are recommended.			
Roles and responsibility: • Mine manager in consultation with qualified geohydrologist.			
Management timeframe: • Throughout the life of mine and until final mine closure has been achieved.			
Environmental budget: • Budget only to be allocated if this alternative is chosen.			
Residual risk: • No significant impacts are envisaged during the life of mine; therefore, no residual risks are expected.			

1.6 Air quality

Information is based on the AEL for Annesley Mine (Shangoni Management Services, 2016), and from 'Air Quality Specialist Report for the Proposed Tygerkloof Mine, Thabazimbi, Limpopo Province' (Airshed Planning Professionals, 2015).

Activity: Dried tailings facility

Nature and consequence: Wind erosion from exposed surfaces filled with tailings.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	Air emission are divided into point sources and non-point sources. Non-point sources include the quarry.	2	2
Severity or destruction effect			
Moderate	The AEL does not indicate severity or destruction effects of the emissions. The severity is based on assumptions made. There have not yet been any complaints from the local community on air emissions.	2	1
Extent			
Area adjacent to site	Dust can be carried to areas adjacent to the site.	2	2
Duration (impact phase and estimated timeframes)			
Throughout the life of activity	Dust will cease once rehabilitation is completed.	2	2
Probability			
Probable		2	2
Reversibility			
Reversible		2	2
Irreplaceability of resources			
The resource is replaceable.		1	1
Degree to which can be avoided, managed or mitigated			
Avoidable with management measures		1	1
Significance			
Medium	Medium significance prior to and low significance after management.	14	13
Environmental objective: • To implement the required measures to effectively control air pollution sources.			
Monitoring requirements: • Fall-out dust and PM10 monitoring, and reporting.			
Management or mitigation: • 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. • 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.			
Roles and responsibility: • Mine manager			

Description	Rating before management	Rating with management
Management timeframe: • Throughout LoM until rehabilitation is finished.		
Environmental budget: • Budget only to be allocated if this alternative is chosen.		
Residual risk: • There will be no residual risks if rehabilitation is adequate.		

1.7 Environmental noise

There is no impact on the environmental noise.

1.8 Visual aspects

Activity: New tailings facility

Nature and consequence: Change in topography leading to visible intrusions in the rural area.

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	The change in topography is large, however, not the entire mining area is visible from outside areas.	2	2
Severity or destruction effect			
Low	The sense of place is disturbed, however, the visual intrusion is mostly only visible from the road.	1	1
Extent			
Area adjacent to site	Intrusion is on area adjacent to mining site	2	2
Duration (impact phase and estimated timeframes)			
Permanent	Depending on rehabilitation, this could be permanent.	3	2
Probability			
Definite	This is an ongoing activity.	3	3
Reversibility			
Only reversible with management	The change in topography is irreversible but with adequate rehabilitation, the visual impact can be reversed.	3	2
Irreplaceability of resources			
Resource replaceable	The resource is not sensitive.	1	1
Degree to which can be avoided, managed or mitigated			
Somewhat avoidable.	The visual impact can be somewhat avoided with adequate rehabilitation practices.	3	3
Significance			

Description		Rating before management	Rating with management
Medium	Medium significance prior to and after management.	18	16
Environmental objective: • To minimise the visual impact of the new tailings facility.			
Monitoring requirements: • Monitoring as per the rehabilitation plan.			
Management or mitigation: • Monitoring as per the rehabilitation plan.			
Roles and responsibility: • Mine manager			
Management timeframe: • As part of rehabilitation.			
Environmental budget: • No environmental budget will be allocated for the rehabilitation of the topography. This will be covered in the mine's financial provision.			
Residual risk: • Change in topography will be ongoing.			

1.9 Cultural and heritage resources

Activity: New tailings facility

Nature and consequence: Potential damage to Prehistoric Mine site

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	The impact will be on the site itself	2	2
Severity or destruction effect			
High	Damage to this site will be severe.	3	2
Extent			
Area adjacent to site	Intrusion is on area adjacent to mining site	2	2
Duration (impact phase and estimated timeframes)			
Permanent	This will be permanent.	3	3
Probability			
Probably	This may take place.	2	1
Reversibility			
Not reversible.	Not reversible.	3	3
Irreplaceability of resources			
Resource irreplaceable	The resource is sensitive.	3	3
Degree to which can be avoided, managed or mitigated			
Somewhat avoidable.	The impact can be somewhat avoided with adequate avoidance practices.	2	2
Significance			

Description		Rating before management	Rating with management
High to medium	High significance prior to and medium after management.	20	18
Environmental objective: • To avoid the impact on the Prehistoric Mine			
Monitoring requirements: • Monitoring during construction			
Management or mitigation: • Ensure avoidance of site.			
Roles and responsibility: • Mine manager			
Management timeframe: • During construction and operation.			
Environmental budget: • No environmental budget will be allocated.			
Residual risk: • Permanent damage to the Prehistoric Mine.			

1.10 Regional socio-economic aspects

Activity: New tailings facility

Nature and consequence: Safety of tailings disposal facility

Description		Rating before management	Rating with management
Quantity or size of disturbance			
Moderate	The facility is large, but forms part of the larger mine area.	2	2
Severity or destruction effect			
High	The safety risk is high	3	3
Extent			
Area adjacent to site	Risk is on area adjacent to mining site	2	2
Duration (impact phase and estimated timeframes)			
Permanent	Depending on rehabilitation, this could be permanent.	3	2
Probability			
Probable		2	2
Reversibility			
Only reversible with management	In the case of an event occurring, this will be irreversible.	3	3
Irreplaceability of resources			
Resource irreplaceable		3	3
Degree to which can be avoided, managed or mitigated			

Description		Rating before management	Rating with management
Somewhat avoidable.	The impact can be somewhat avoided with adequate rehabilitation practices.	3	3
Significance			
High	High significance prior to and after management.	21	20
Environmental objective: • To minimise the risk of the new tailings facility.			
Monitoring requirements: • Monitoring as per the CoP			
Management or mitigation: • Management as per the CoP.			
Roles and responsibility: • Mine manager			
Management timeframe: • Ongoing.			
Environmental budget: • None			
Residual risk: • Ongoing			

3 Cumulative impacts

The quarry is surrounded by the rest of the mine and its mining activities.

3.1 Geology

None

3.2 Soil, pre-mining land capability and land use

None

3.3 Vegetation and animal life

None

3.4 Surface water

Mixing of clean and dirty water and siltation of surface water resources.

3.5 Groundwater

No significant impacts are envisaged, both in terms of groundwater levels and quality.

3.6 Air quality

Wind erosion from exposed surfaces filled with tailings and process waste and dust generation form the existing mine.

3.7 Environmental noise

None

3.8 Visual aspects

None

3.9 Cultural and heritage resources

None

3.10 Regional socio-economic aspects

None

vi) Methodology used in determining and ranking the nature, significance, consequences, extent, duration and probability of potential environmental impacts and risks

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 NEMA, the MPRDA, and the NWA.

Impacts on each **environmental component**, as well as an **indication of the phases** (construction, operational, decommissioning) and **estimated timeframes** in relation to the potential impacts rated, are assessed in section (h)(v)(1) above in the form of a table. The **management measures and mitigation** is also included in the tabel in section (h)(v)(1) 2, and 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. The **roles and responsibilities** for the

execution of the monitoring and management programmes are also included in this table. All impacts identified as part of this process are rated using the criteria as set out below.

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 managed or mitigated: 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	
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

Description	Rating
Only reversible with management	2
Irreversible	3
Irreplaceability of resources	
Resource replaceable, receptor not sensitive	1
Resource somewhat replaceable, receptor moderately sensitive	2
Resource irreplaceable, receptor highly sensitive	3
Degree to which can be avoided, managed or mitigated	
Avoidable with management measures or mitigation	1
Somewhat avoidable with management measures or mitigation	2
Not avoidable with management measures or mitigation	3
Significance	
Low	8-13
Medium	14-19
High	20-24

vii) The positive and negative impacts that the proposed activity (in terms of the initial site layout) and alternatives will have on the environment and the community that may be affected

The preferred activity is the backfilling of the quarry and the second alternative is the construction of a new tailings facility between Quarry 9 and Motswere Quarry. Refer to Table 50 below for the advantages and disadvantages of the proposed versus the alternative activity.

Table 48: Advantages and disadvantages of the proposed location versus the alternative location of overburden

Preferred	Alternative
Advantage or disadvantage	**Advantage or disadvantage**
No impact on soil, land use or land capability.	Loss of soil, land use and land capability.
Probably impact on clean water run-off. Impact smaller than with second alternative.	Probably impact on clean water run-off. Impact larger than with preferred alternative.
Probably impact on groundwater quality. Impact smaller than with second alternative.	Probably impact on groundwater quality. Impact larger than with preferred alternative.
Probable impact on air quality.	Probable impact on air quality.
Impact on visual aspects.	Impact on visual aspects.
Safety risk.	Safety risk.
No impact on heritage sites.	Possible impact on the Prehistoric Mine

viii) The possible mitigation measures that could be applied and the level of risk

Refer to Part A(g)(v) above for possible mitigation measures that could be applied and the level of risk.

ix) Motivation where no alternative sites were considered

Not applicable, a second alternative has been considered.

x) Statement motivating the alternative development location within the overall site

Based on the outcome of the EIA and significant ratings, the preferred site has a smaller impact than the second alternative. The second alternative also has an impact on more environmental components.

h) Full description of the process undertaken to identify, assess and rank the impacts and risks the activity will impose on the preferred site (In respect of the final site layout plan) through the life of the activity

Refer to Part A(g)(v) above for a full description of the process undertaken to identify, assess and rank the impacts and risks the activity will impose on the preferred site (In respect of the final site layout plan) through the life of the activity.

i) Assessment of each identified potentially significant impact and risk

This section includes all the known typical impacts of each of the activities (including those that could or should have been identified by knowledgeable persons) and not only those that were raised by registered I&APs). Refer to Part A, section (g) (v) for a complete impact assessment.

Table 49: Assessment of each identified potentially significant impact and risk

Activity	Potential impact	Aspects affected (environmental components)	Phase	Significance if not mitigated	Mitigation type - Refer to Part A, section (g) (v) above for mitigation	Significance if mitigated
Backfilling of quarry and extension of quarry	Mixing of clean and dirty water and siltation of surface water resources.	Surface water	Throughout life of the project and until closure of mine	Medium	Control measures and monitoring	Medium
	The tailings material is mostly inert; therefore, the backfilled quarry is not expected to generate poor quality seepage. Some degree of groundwater mounding may occur as a result of artificial aquifer recharge; however this recharge is expected to be very low due to the nature of the tailings material and low hydraulic properties of the underlying aquifer host rock. No significant impacts are therefore envisaged, both in terms of groundwater levels and quality. Both waste streams (Q7 Tailings and Plant 5 Premier Waste) are low risk waste and impact resulting from disposing this waste into a quarry should be negligible based on these testing standards.	Groundwater		Low	Control measures and monitoring	Low
	Wind erosion from exposed surfaces filled with tailings.	Air quality		Medium	Control measures and monitoring	Low

Activity	Potential impact	Aspects affected (environmental components)	Phase	Significance if not mitigated	Mitigation type - Refer to Part A, section (g) (v) above for mitigation	Significance if mitigated
	Change in topography leading to visible intrusions in the rural area.	Visual aspect		Medium	Monitoring through rehabilitation	Medium
	Safety of tailings disposal facility	Regional socio-economic aspects		High	Control measures and monitoring	Medium

Refer to Part A(g)(v) for a complete impact assessment.

j) Summary of specialist reports

Table 50: Summary of specialist reports

List of studies undertaken	Recommendations of specialist reports	Specialist recommendations that have been included in the EIA report	Reference to applicable section of report where specialist recommendations have been included.
Geohydrological Investigation	• Clean surface water should not come into contact with dirty water, • Recycle and reuse of contaminated water as far as possible, • Continuous monitoring of groundwater levels and quality conditions are recommended.	All recommendations form report	Part A(g)(v)
Waste Assessment Report	• Both waste streams (Q7 Tailings and Plant 5 Premier Waste) are low risk waste and impact resulting from disposing this waste into a quarry should be negligible based on these testing standards.	Not applicable.	Part A(g)(v)

Refer to Addendum 3 attached for of the specialist reports.

k) Environmental impact statement

(i) Summary of the key findings of the environmental impact assessment

Surface water

The mixing of clean and dirty water and siltation of surface water resources is a probability.

Groundwater

The tailings material is mostly inert; therefore, the backfilled quarry is not expected to generate poor quality seepage. Some degree of groundwater mounding may occur as a result of artificial aquifer recharge; however this recharge is expected to be very low due to the nature of the tailings material and low hydraulic properties of the underlying aquifer host rock. No significant impacts are therefore envisaged, both in terms of groundwater levels and quality. Both waste streams (Q7 Tailings and Plant 5 Premier Waste) are low risk waste and impact resulting from disposing this waste into a quarry should be negligible based on these testing standards.

Air quality

Wind erosion is probable from exposed surfaces filled with tailings.

Visual aspects

Change in topography is a definite impact leading to visible intrusions in the rural area; however, not the entire mining area is visible from outside areas.

Regional socio-economic aspects

There is a safety risk is on area adjacent to mining site

(ii) Final Site Map

Refer to Addendum 1C for a site sensitivity map.

(iii) Summary of the positive and negative implications and risks of the proposed activity and identified alternatives

1 **Negative implications**

Negative implications are as follow:

- Probable mixing of clean and dirty water and siltation of surface water resources if not mitigated.
- The tailings material is mostly inert; therefore, the backfilled quarry is not expected to generate poor quality seepage. Some degree of groundwater mounding may occur as a result of artificial aquifer recharge; however, this recharge is expected to be very low due to the nature of the tailings material

and low hydraulic properties of the underlying aquifer host rock. No significant impacts are therefore envisaged, both in terms of groundwater levels and quality.

- Wind erosion from exposed surfaces filled with tailings.
- Change in topography leading to visible intrusions in the rural area.
- Safety of tailings disposal facility

2 Positive implications

Positive implications are as follow:

- Rehabilitation of quarries.

l) Proposed impact management objectives and the impact management outcomes for inclusion in the environmental management programme

Refer to Part A(g)(v) for all Proposed impact management objectives and the impact management outcomes for inclusion in the EIA/EMP Part B.

m) Final proposed alternatives

The preferred alternative is a better method of mine residue disposal than the second alternative.

n) Aspects for inclusion as conditions of Authorisation

The mine already has a mining right, this EIA/EMP only includes the waste licence.

o) Description of any assumptions, uncertainties and gaps in knowledge

- Groundwater levels in the project area are available from boreholes that were located during a hydrocensus and user survey conducted for the Tygerkloof Project in 2015 (Groundwater Complete, 2015). These boreholes include those of surrounding farmers as well as purpose drilled mine monitoring boreholes.
- No ABA tests were conducted during the course of this study. However, ABA test results from a previously conducted geohydrological study (Geo Pollution Technologies, 2010) revealed that rock material at the Rhino Andalusite Mine contains very low concentrations of sulphur and is non-acid forming. The waste material (e.g. overburden, discard/waste rock, tailings material, etc.) generated by the mining activities is therefore not expected to generate poor quality seepage.
- No significant interaction is expected to occur between the backfilled quarry and groundwater, since all quarries are located largely above the local static groundwater level. This statement is also supported by the findings of the groundwater study conducted by Geo Pollution Technologies in 2010. Discussions with the mine personnel (Mr. Hendrik Jones) in February 2015 for the purpose

of the Tygerkloof Project confirmed that no groundwater seepage occurs at any of the existing quarries. The quarries remain dry and the only water in them comes from process water storage when process water is pumped to the quarry voids for settling, storage and reuse.

- Environmental descriptions were taken from previous EMPs.
- Impact assessment on surface water was taken from the IWWMP.
- Impact assessment on air was taken from the AEL for Annesley Mine (Shangoni Management Services, 2016) and from 'Air Quality Specialist Report for the Proposed Tygerkloof Mine, Thabazimbi, Limpopo Province' (Airshed Planning Professionals, 2015).

p) Reasoned opinion as to whether the proposed activity should or should not be authorised

i) Reasons why the activity should be authorised or not

It is of the opinion that the backfilling of the quarries is necessary and forms part of rehabilitation on the mine. The extension of quarry 9 into a tailings dam will also not have significant impacts on the environment if it is correctly managed.

ii) Conditions that must be included in the authorisation

1. Backfill the quarries as part of rehabilitation.
2. Compile a rehabilitation plan for the entire mining area which include all conditions from the Limpopo Conservation Plan of 2013, the EMF of the Waterberg DM, and the mining and biodiversity guidelines.
3. Adhere to the management measures as per this EIA/EMP.
4. Adhere to any additional conditions that DWS might give in the water use licence.

q) Period for which the Environmental Authorisation is required

Backfilling and tailings extension will be permanent.

r) Undertaking

The undertaking required to meet the requirements of this section is provided at the end of the EMPr and is applicable to both the EIA report and the Environmental Management Programme report.

s) Financial Provision

The financial provisioning must include:

1. Annual forecasted financial provision calculation;
2. Confirmation of the amount that will be provided should the right be granted (in this case, the mine already has a right, therefore the amount updated annually);

3. Method of providing financial provision contemplated in Regulation 53; and
4. Capacity to manage and rehabilitate the environment.

1 Annual forecasted financial provision calculation

The backfilling of the quarries will not increase the financial provision, because it forms part of rehabilitation. The financial provision for the mine is updated on an annual basis. The update will include any changes due to this project.

2 Confirmation of the amount that will be provided should the right be granted

Not applicable. This is not an application for a new mining right.

3 Method of providing financial provision contemplated in regulation 53

This amount will be provided using a bank guarantee.

4 Capacity to manage and rehabilitate the environment

Refer to the tables in Part A(g)(v) for a description of the environmental budget. None of the management measures for this licence has a dedicated budget.

t) Deviations from the approved scoping report and plan of study

There is no deviation from the scoping report. The comments as per LEDET has been included in this EIAR/EMP.

u) Other Information required by the competent Authority

i) Compliance with the provisions of sections 24(4)(a) and (b) read with section 24 (3) (a) and (7) of the National Environmental Management Act (Act 107 of 1998)

(1) Impact on the socio-economic conditions of any directly affected person

Refer to Part A(g)(v) above.

(2) Impact on any national estate referred to in section 3(2) of the National Heritage Resources Act

Refer to Part A(g)(v) above.

v) Other matters required in terms of sections 24(4)(a) and (b) of the Act

None.

PART B

ENVIRONMENTAL MANAGEMENT PROGRAMME REPORT

1) Draft environmental management programme.

a) Details of the Environmental Assessment Practitioner

Refer to Part A(a) for the requirement for the provision of the details and expertise of the EAP.

b) Description of the Aspects of the activity

The requirement to describe the aspects of the activity that are covered by the draft environmental management programme is already included in Part A(1)(h), and (g)(v) herein as required.

c) Composite map

Refer to Figure 3 for a sensitivity map.

d) Description of impact management objectives including management statements

i) Determination of closure objectives

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. This is also in line with the Waterberg EMF.

2 Residual impacts

Change in topography and safety to workers will be ongoing.

3 Closure objectives

Rehabilitation will aim to:

- Restore normal infiltration rates to areas where recharge was 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.

4 Rehabilitation process

The backfilling of the mine forms part of rehabilitation. Rehabilitation will entail the establishment of stormwater diversion berms around the quarry periphery. The safety berms can also be used effectively to divert stormwater around the quarry and the safety berms will be installed around the quarry perimeter. The northern high-wall has an established berm. This berm should be extended to the eastern and western high-wall to more effectively divert stormwater away from the quarry. As per the above this safety berm will consist of a barrier/berm and an excavated trench approximately 1m deep and 1m wide. The crest of the barrier will have to be vegetated. Once waste backfill commences one can adopt the closure quantum to make allowance for surface vegetation.

A sustainable grass cover must establish over the tailings dam extension. It is advised that a complete rehabilitation plan is compiled for the entire mining site in the future.

ii) The process for managing any environmental damage, pollution, pumping and treatment of extraneous water or ecological degradation as a result of undertaking a listed activity

Refer to Part A(d)(i).

iii) Potential risk of acid mine drainage

According to the Geohydrological Investigations (Groundwater Complete, 2016):

Acid Base Accounting (ABA) is done to determine the net acid generating and neutralising potentials of material. The main principles of acid-base accounting are:

- *Samples are exposed to complete oxidation of all sulphide-bearing minerals.*
- *This generates acid, which is counteracted by the natural base potential of the material.*
- *The initial pH before oxidation and the oxidised pH are recorded for each sample.*

Little or no drop in pH occurs whenever the base potential exceeds the acid potential. The opposite holds true when the acid potential exceeds the base potential – such a sample is therefore expected to generate acidic conditions when exposed to oxygen and water.

Acid base accounting conducted during previous groundwater related studies (Geo Pollution Technologies, 2010) revealed that both the rock and tailings material contain very low concentrations of sulphur and is non-acid forming. Furthermore, samples were also submitted to acid rain leach tests, which involves the percolation of an acid through a finely crushed sample of the material. The leachate (extract) is then retrieved and analysed for a wide range of chemical parameters. The results showed that both the rock and tailings material, even under acidic conditions, do not have the potential to generate poor quality leachate.

It can therefore be assumed that the risk of AMD or potential groundwater contamination associated with the mineral to be mined is therefore minimal to zero.

iv) Steps taken to investigate, assess, and evaluate the impact of acid mine drainage

Refer above, not necessary.

v) Engineering or mine design solutions to be implemented to avoid or remedy acid mine drainage

Refer above, not necessary.

vi) Measures that will be put in place to remedy any residual or cumulative impact that may result from acid mine drainage

Refer above, not necessary.

vii) Volumes and rate of water use required for the mining, trenching or bulk sampling operation

This EIA/EMP is not for a mining right. Refer below for the entire mines water balance indicating water ruse.

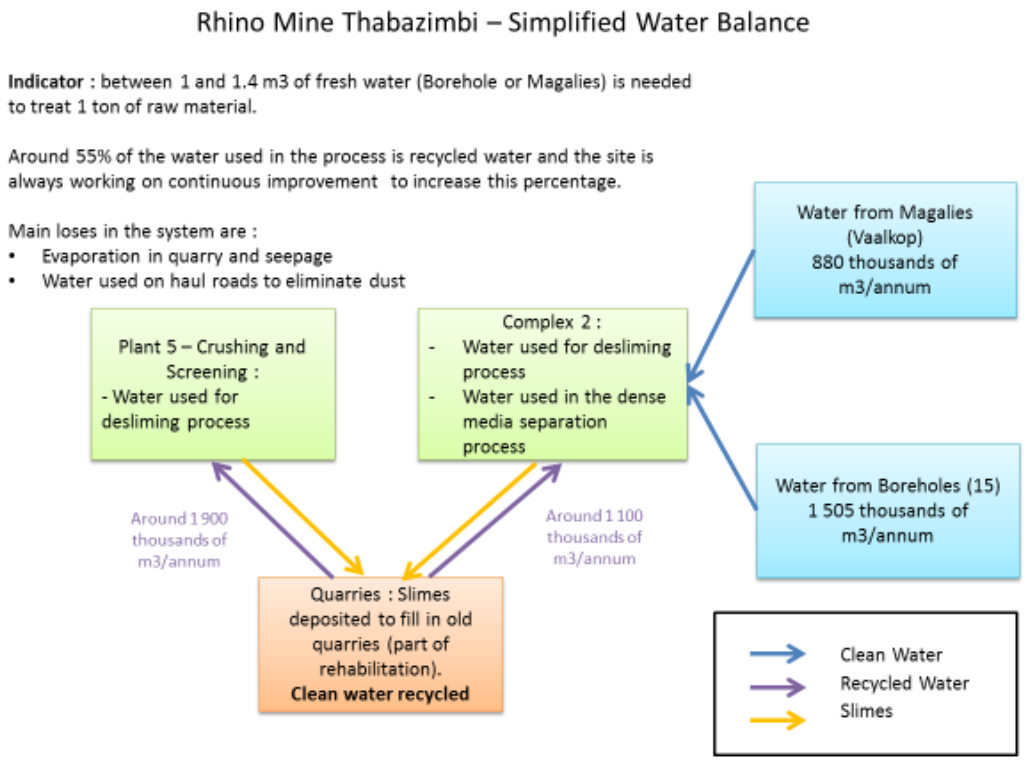

Figure 37: Simplified water balance diagram for the mine

viii) Has a water use licence has been applied for?

The mine has applied for a WUL. This WULA was submitted 25 August 2015. Refer to Addendum 5B for proof of this submission.

ix) Impacts to be mitigated in their respective phases

Refer to Part A(g)(v) as well as Part A(i) of this report.

e) Impact management outcomes

Refer to Part A(g)(v) as well as Part A(i) of this report.

f) Impact management actions

Refer to Part A(g)(v) as well as Part A(i) of this report.

g) Financial provision

(a) Describe the closure objectives and the extent to which they have been aligned to the baseline environment described under Regulation 22 (2) (d) as described in 2.4 herein

Refer to Part B(1)(d) for closure objectives.

(b) Confirm specifically that the environmental objectives in relation to closure have been consulted with landowner and interested and affected parties

This is the draft EIAR/EMP. Any comments from registered I&APs and stakeholders will be included in the final EIA/EMP.

(c) Provide a rehabilitation plan that describes and shows the scale and aerial extent of the main mining activities, including the anticipated mining area at the time of closure

Refer to site layout plan indicating backfilling which is also rehabilitation.

(d) Explain why it can be confirmed that the rehabilitation plan is compatible with the closure objectives

The closure objectives in this EMP were taken from the previous EMPs and closure plans.

(e) Calculate and state the quantum of the financial provision required to manage and rehabilitate the environment in accordance with the applicable guideline

Refer to Part A(s) for a complete description of the financial provision.

(f) Confirm that the financial provision will be provided as determined

Refer to Part A(s) for a complete description of the financial provision.

h) Mechanisms for monitoring compliance with and performance assessment against the environmental management programme and reporting thereon

Compliance monitoring should be carried out during the operation to ensure that the specified target limits are being met.

The following environmental monitoring is associated with the waste licence.

i) Monitoring of impact management actions

Source activity	Impacts requiring monitoring programmes	Functional requirements for monitoring*	Roles and responsibilities	Monitoring and reporting frequency and time periods for implementing impact management actions	Reference in EIA/EMP
Backfilling and extension of quarry 9.	Mixing of clean and dirty water and siltation of surface water resources.	Surface water quality monitoring.	Mine manager	As per the WUL once received	A(g)(v)(1.4)
		Groundwater quality monitoring.	Mine manager	Quarterly	A(g)(v)(1.4)
		Regular inspections of all water structures	Mine manager	Continuous monitoring	A(g)(v)(1.4)
	Groundwater levels and quality.	Groundwater levels monitoring.	Mine manager	Quarterly	A(g)(v)(1.5)
	Wind erosion from exposed surfaces filled with tailings.	Fall-out dust monitoring.	Mine manager	Monthly	A(g)(v)(1.6)
	Change in topography leading to visible intrusions in the rural area.	Rehabilitation monitoring	Mine manager	Monthly	A(g)(v)(1.8)
	Safety of tailings disposal facility	Monitoring as per the CoP	Production/mine manager	As per COP requirements	A(g)(v)(1.10)

*Refer below for a complete description

ii) Monitoring and reporting frequency

Refer to Part B, section (j) above.

iii) Responsible persons

Refer to Part B, section (j) above.

iv) Time period for implementing impact management actions

Refer to Part B, section (j) above.

v) Mechanism for monitoring compliance

Refer to Part B, section (j) above.

i) Indicate the frequency of the submission of the performance assessment report

The performance of the EIA/EMP will be assessed every two years. A financial provision will accompany the EIA/EMP which will be updated on an annual basis. This financial provision update will be accompanied by a report on rehabilitation that has taken place.

j) Environmental awareness plan

This section includes: Manner in which the applicant intends to inform his or her employees of any environmental risk which may result from their work; and Manner in which risks will be dealt with in order to avoid pollution or the degradation of the environment.

The following was extracted from the TYGERKLOOF MINING PTY LTD – TYGERKLOOF MINING, Final Environmental Management Programme (BECS Environmental, 2015).

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 consists 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.

k) Specific information required by the Competent Authority

1 Financial provision

The financial provision will be reviewed on an annual basis.

2 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.

2) Undertaking

The EAP herewith confirms

a) the correctness of the information provided in the reports

b) the inclusion of comments and inputs from stakeholders and I&APs ☒

c) the inclusion of inputs and recommendations from the specialist reports where relevant ☒

d) the acceptability of the project in relation to the finding of the assessment and level of mitigation proposed ☒

The EIA/EMP will, should it comply with the provisions of section 24N of NEMA as well as the applicable EIA Regulations i.t.o. NEMA, be approved, become an obligation in terms of the approved EIA/EMP and mining right issued.

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, and confirm that the above EIA & EMP compiled in accordance with Appendices 3 & 4 of the EIA Regulations.

Full Names and Surname	Salome Beeslaar
Identity Number	8310190032081
Designation	Environmental Assessment Practitioner
Signature	

-END-

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