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ENVIRONMENTAL IMPACT ASSESSMENT REPORT

PROPOSED PERING MINING PROJECT

DEDECT REF: NWP/EIA/50/2010

DRAFT, OCTOBER 2012

Pering Mine

MARSH & McLENNAN COMPANIES

Executive Summary

Pering Mine (Pty) Ltd proposes to re-open a existing closed opencast zinc and lead mine located on the farm Pering Mine 1023 HN in the magisterial district of Vryburg in the North West Province. The proposed project will result in approximately 250 job opportunities whereby the applicant will focus on the Local Economic Development of Reivilo / Boipelo in the Greater Taung Municipality in fulfilment of the commitments made in the Social and Labour Plan (SLP).

The desirability of the project is supported by the following:

- The mineral resources can be economically extracted from the existing open-cast pit and existing rock waste dumps.
- Some infrastructure such as roads and electricity infrastructure already exists. This will result in lower start-up costs.
- The mine has historically provided employment to the receiving community (Reivilo) who are generally in favour of the proposed continuation of the mining operation.

Residual environmental impacts from historic activities

The key remaining residual features/impacts at Pering Mine which resulted from historic mining activity include the following:

- Tailings dam which has been lined with a cladding of waste rock to limit water seepage into the tails dam and minimize wind and water erosion and dust fallout.
- A sulphurous groundwater contamination plume from the tailings dam which has migrated beyond the mine boundary, in an easterly direction.
- Main Pit and Pit 24 – These pits have been infiltrated with groundwater and rainwater since closure and currently there is approximately 8 million m^3 of water in the Main Pit.

Stakeholder consultation

In general the project is supported by the residents of Reivilo based on the potential for improved economic development opportunities. The DWA is an important stakeholder engaged to administer the water use license and provide guidance in terms of the pit dewatering alternatives. The GPEPG with adjacent farmer representation has submitted its objection to the MPRDA mining license application. The basis for the objection is rooted in a concern around the cumulative impact of new mining activities considering the impacts which resulted from past mining practices.

Pit dewatering

Alternative options of discharging into the environment and provision of drinking water to the community were investigated. Discharge of pit water into the environment (Droe Harts River) is limited due to the high cost of treating the pit water to the standard suitable for mitigating the off-site environmental impacts which have been identified. Similarly, the cost of provision of potable water to Reivilo seemingly outweighs the benefit and sustainability thereof due to high treatment and water storage costs. A combination of on-site evaporation alternatives is thus preferred based on the findings of this EIAR. Should the enhanced evaporation option be instituted, the manufacturer of the water canons should be contacted with regard to the potential for evaporation of the solids and dispersion into the environment. It is recommended that the Water Use License proceed on this basis.

It is therefore recommended that the pit water disposal occur on site as far as possible through natural and enhanced evaporation to mitigate off-site residual environmental impacts. Water shall be of a quality suitable for the method of dewatering to eliminate off-site impacts and further groundwater contamination. However a combination of on-site disposal coupled with off-site disposal into the Droe Harts River may be considered (with the intention to recharge the aquifer and feed water back into the reserve) provided that:

- Landowner consent is obtained from the landowner(s) to discharge the water.
- Pit water is treated to irrigation standards (as per the specialist recommendation made by GCS) with specific attention given to PH, sulphate levels and metals.
- Chemical modelling of the downstream water quality and study to confirm the affect on soils, flora and fauna (after water treatment)
- As many boreholes as possible in the vicinity of the discharge point and surrounding pan-like areas as well as south east of the discharge point must be made.
- Any infrastructure associated with the discharge pipeline should be designed by a professional engineer, who would need to consider foundation conditions in selecting a discharge site.
- Continuous groundwater monitoring is recommended for the duration of the discharge and one year after discharge has ceased, should it happen.

Groundwater contamination plume

Previous mining impacts are responsible for the formation of the sulphurous groundwater contamination plume migrating to the east. The proposed mining project will not have a significant cumulative impact on the sulphate pollution plume due to lining of the SSF and TSF. The existing sulphate plume is not expected to impact on the adjacent landowner until after mine closure. Monitoring of the pollution plume is recommended (extension of network onto adjacent properties extension of network onto adjacent properties with landowner consent) in order to quantify future liabilities and recommend measures for mitigating the progression thereof, to be funded by the mines rehabilitation fund.

Predicted air quality impacts

From an air quality perspective, the proposed mining project is not anticipated to impact on the sensitive receptors identified however exceedences in ground level concentrations of PM_{10} and NO_2 are anticipated and dust management and vehicle maintenance is recommended to mitigate these impacts. It is recommended that the existing dust monitoring network be extended to include PM_{10} and NO_2 monitoring.

Predicted ecological impact

From a biodiversity perspective the project is supported as no areas of particular ecological significance were identified and no restrictions in terms of placement of infrastructure are relevant. The implementation of generic mitigation measures are likely to result in amelioration of expected impacts to a low significance.

Other predicted impacts

All other environmental impacts identified in this EIAR can be mitigated to acceptable standards provided that the recommendations and mitigation measures contained in this report as well as the draft EMP are adhered to.

Conditions of authorisation

In addition to the abovementioned, the following conditions of authorisation are recommended:

- Monitoring of the groundwater pollution plume is required (including an extension of the monitoring network onto adjacent properties) in order to quantify future liabilities and recommend measures for mitigating the progression thereof.
- Should the enhanced evaporation dewatering alternative be instituted (recommended alternative), the manufacturer of the water canons should be contacted with regard to the potential for evaporation of the solids and dispersion into the environment.
- A site-wide surface water and stormwater management plan must be prepared with the objective of achieving compliance with Regulation 704 under the National Water Act which regulates mining related impacts on water resources. This plan should demonstrate the separation of clean and dirty water systems on the site.
- Should a portion of the pit water need to be discharged into any natural surface water feature off-site for any reason, that the volume of discharge be specified and that the necessary mitigation measures as proposed by the specialist study undertaken by GCS (Ref: 12-030) be implemented. Landowner consent and water use authorization will be required by DWA before further consideration to this option is given.
- An emergency response plan to include procedures for environmental related emergencies must be developed. This should include responses in the event that the monitoring data suggests that migration of the sulphate plume will impact on other water users.
- It is recommended that the existing dust monitoring network be extended to include PM_{10} and NO_2 monitoring.
- It is recommended that noise monitoring be started prior to starting operations in order to establish a baseline against which future monitoring results may be compared to.
- No sites of heritage significance were identified however a palaeontological desktop study and (if required) a palaeontological impact assessment will have to be undertaken in terms of the project and its associated activities and the finding presented to SAHRA.
- A waste management plan must be prepared for the mine.
- The draft EMP prepared as part of this EIA process must be implemented and updated accordingly.

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List of Acronyms and Abbreviations

Acronym	Description
AGIS	Agricultural Geo-Referenced Information System
BID	Background Information Document
ºC	Degrees Celsius
Ca	Calcium
CaCO3	Calcium carbonate
Cl	Chloride
CO_3	Carbonate
COD	Chemical Oxygen Demand
dBA	Decibels
DEAT	Department of Environmental Affairs and Tourism
DM	District Municipality
DME	Department of Minerals and Energy
DMS	Degrees, minutes and seconds
DWAF	Department of Water Affairs and Forestry
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
F	Fluoride
GDP	Gross Domestic Profit
GTLM	Greater Taung Local Municipality
Ha	Hectares
Ha / AU	Hectare per animal unit
HCO_3	Bicarbonate
HIV / AIDS	Human Immunodeficiency Virus / Acquired Immune Deficiency Syndrome
I&AP	Interested and Affected Parties
IRR	Issues Response Register
K	Potassium
mamsl	Metres above mean sea level
mbgl	Metres below ground level
m/s	metre per second
m^3/day	Cubic metres per day
mamsl	meters above mean sea level
mbgl	meters below ground level
Mg	Magnesium
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
mS/m	Milli Siemens per metre
Na	Sodium
NH_4	Ammonia
NO_3	Nitrate

NT	Near Threatened
Pb	Lead
PbS	Galena
SANS	South African National Standard
SARDB	South African Red Data Book
SAWQG	South African Water Quality Guideline
SAWS	South African Weather Services
SO_4	Sulphate
SSF	Slimes Tailings Dam
TDS	Total Dissolved Solids
TSF	Dry tailings dam
ZN	Zinc
Zn-Pb	Zinc – Lead
ZnS	Sphaelerite

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1

Introduction

Marsh Environmental Services (MES) has been appointed as an independent Environmental Assessment Practitioner (EAP) by Pering Mine (Pty) Ltd (to be referred to as the Applicant) to undertake an Environmental Impact Assessment (EIA) process in application for the re-commencement of mining activities at Pering Mine.

In line with the minimum requirements of the EIA Regulations 2006 (refer to Section 1.3), the information contained in this Environmental Impact Assessment Report (EIAR) is divided into the following sections:

- Section 1: Introduction to the project including a needs and desirability statement.
- Section 2: Legislative framework and legislative requirements specific to the proposed mining operation.
- Section 3: Provides a description of the new proposed mining operation as well as a description of historic closure activities undertaken informing the current status.
- Section 4: Provides a description of the receiving environment presenting baseline information used to determine the overall environmental risks of the proposed project and to assess the potential environmental impacts.
- Section 5: Provides a description of the alternatives considered.
- Section 6: A description of the public participation process followed and comments received is provided.
- Section 7: Provides a description of the expected environmental impacts and issues that will result from the proposed mine and an evaluation of these impacts in terms of their significance.
- Section 8: Mitigation measures - Based on the results of the impact assessment, recommendations are made on the management strategy that should be implemented for the construction, operation and closure phases of the proposed mining operation.
- Section 9: Assumptions and gaps in knowledge are discussed.
- Section 10: Environmental Impact Statement
- Section 11: Conclusion

1.1 Background

The Applicant proposes to reopen an opencast zinc and lead mining operation at Pering Mine located on the farm Pering Mine 1023 HN in the magisterial district of Vryburg in the North West Province. The Pering Mine was historically mined by Shell and subsequently by BHP Billiton until 2002. BHP Billiton instituted closure and decommissioning activities in 2003 as ore grades were not considered to be economically viable. Pering Mine intends to re-open the mine by processing the existing waste rock dumps and extending the mine pit using Dense Media Separation (DMS) mining techniques.

Large areas of the proposed mining project may be considered “brown-fields” given the impact of historic open-cast mining activities and associated mining footprints. Despite the sites brown-fields status, this Environmental Impact Assessment Report (EIAR), prepared for the second phase of the EIA process (Scoping Phase completed) is a requirement for the continuation of mining of the zinc and lead deposits at Pering Mine and includes an assessment of the potential environmental impacts and alternatives identified during the EIA process.

1.2 Need and desirability statement

1.2.1 Strategic view

The applicant has a strategic mission to become a significant zinc metal producer through the integration of mining, processing and marketing activities in South Africa. As the first step in the realisation of this initiative, the company secured an option to acquire Pering Mine (Pty) Ltd (Pering Mine), holder of the rights to the Pering lead and zinc mine, from BHP Billiton. The name change to PBM resulted from a decision to broaden its strategic mission to include base metals beyond lead and zinc.

PBM conducted a feasibility study and a due diligence study on the Pering Mine during 2008, following which PBM exercised its option to acquire Pering Mine from BHP Billiton. The transfer of ownership was completed on 1 July 2009. The global financial crisis of 2008 had a major impact on all resource markets and although prices did recover during the second half of 2009, equity and debt providers were still hesitant to enter the market. PBM used the lull in investment markets as an opportunity to embark on a risk review and optimization study to ensure that the planned development of the Pering Mine would remain robust in the challenging environment post the financial crisis. The study introduced a number of improvements over the feasibility study published in 2009 supplemented by favorable metallurgical test work and the application of new processing technologies, which allows for the mining of low grade resources, previously considered uneconomic.

The company's professional team has a track record in change management and the ability to focus on the lower grade Zn-Pb sulphide orebodies, for optimal extraction using grade control and innovative processing techniques, as such DMS is a core strategy of the company. Given the limited number of high grade deposits this is an important strategic objective in South Africa.

1.2.2 Historic mining and mine feasibility

The desirability of the project is further supported by the following:

- The mineral resources can be economically extracted from the existing open-cast pit and existing rock waste dumps. This will result in lower start-up costs;
- Some infrastructure such as roads and electricity infrastructure already exists. This will result in lower start-up costs,
- The mine has historically provided employment to the receiving community who are generally in favour of the proposed continuation of the mining operation.

1.2.3 Economic development

The proposed project will result in approximately 250 job opportunities and the Applicant will focus on the Local Economic Development of Reivilo / Boipelo in the Greater Taung Municipality in fulfilment of the commitments made in the Social and Labour Plan (SLP) required in terms of the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA). Through the SLP, the Applicant is committed to develop their workforce through various training interventions in line with the operational requirements of the mine, provide mentoring, coaching and upskilling of its employees and implement infrastructure and poverty eradication projects.

1.3 Applicant Details

Name of Applicant:	Pering Mine (Pty) Ltd
Registration No. of Applicant:	05/13451/07
Name of Mine:	Pering Mine
Contact Person:	Martin Swanepoel
Physical Address:	3rd Floor, Block D, Old Trafford Building Cnr Carse O'Gowrie Road & Boundary Roads Houghton, 2041
Postal Address:	Postnet Suite 201 Private Bag X 30500 Houghton, 2041
Telephone Number:	+27 11 484 2240
Fax Number:	+27 11 484 2262
Email:	MSwanepoel@pering.co.za
Commodity:	• Lead (Pb) • Zinc (Zn)

1.4 Details of the Environmental Assessment Practitioner

The details of the Environmental Assessment Practitioner (EAP) are included below.

Marsh Environmental Services
A division of Marsh (Pty) Ltd

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Marsh Environmental Services, a division of Marsh (Pty) Ltd, an environmental, health and safety service provider to South African government, business and industry. We utilise a network of specialist services allowing us to offer a comprehensive environmental solutions. MES has extensive experience in the mining industry. A list of key mining projects undertaken by MES is appended as Appendix 1.

2

EIA Process & legislative framework

2.1 Background

According to Section 24 of NEMA, an activity which may have a substantial detrimental impact on the environment requires environmental authorisation from the relevant competent authority prior to the commencement of such activities proposed by the applicant. The purpose of the EIA Process is to identify the potential environmental impacts associated with the proposed activity and further assess the extent and significance thereof. In terms of the EIA Regulations any activity listed in GN. R387 is subject to the Scoping / Environmental Impact Assessment Process.

In a meeting on 27 January 2011 between the DACERD, the applicant and the EAP, it was agreed that this application for environmental authorisation would be undertaken in terms of the 2006 EIA Regulations, given that the Application Form was submitted prior to 2 August 2010.

2.2 Scoping & Environmental Impact Assessment Process

2.2.1 Plan of Study for EIA contained in the Scoping Report

Section 2.2.1 provides a summary of commitments made in the Plan of Study (POS) for EIA contained in the Final Scoping Report dated October 2011 detailing actions to be undertaken, information to be included and issues to be considered in this EIAR .

2.2.1.1 Specialist studies identified

The following specialist studies were identified in the POS for inclusion in the EIAR:

- Hydrocensus
- Hydrogeological investigation
- Traffic impact assessment
- Heritage and paleontological impact assessment
- Flora & fauna assessment
- Air quality impact assessment

2.2.1.2 Public participation

A Public Participation Process (PPP) will be conducted at which time the findings of the in-depth investigations will be presented to the Interested and Affected Parties (I&APs) to obtain comments and issues raised. Agreement will be reached with I&APs that the EIA addresses all issues and concerns. The following steps are envisaged:

- Notification of all I&APs registered to date that the EIA process is commencing;
- Notification of all I&APs informing them of the release of the draft EIR;
- Advertisements as to the availability of the draft EIR for public review;
- Release of the draft EIR for public review;
- Public Meeting;

- Notification of I&APs of the Record of Decision and Appeals procedure and period, and
- Notification of I&APs of the outcome of the Appeals period.

2.2.1.3 Alternatives

Alternatives identified during the Scoping Phase will be further investigated during the EIA Phase. Alternatives that will be further investigated are not limited to but will include:

- Layout alternatives;
- Land use alternatives;
- Dewatering alternatives;
- Design alternatives, and
- No-go alternative.

2.2.1.4 Environmental Impact Statement

The following will be provided in the EIAR:

- A summary of the key findings of the environmental impact assessment, and
- A comparative assessment of the positive and negative implications of the proposed activity and identified alternatives.

2.2.2 Scoping Report approval

On 25 November 2011, the DEDECT issued its approval of the Scoping Report (refer to Appendix 2) thereby allowing the continuation of the EIA process. The following information is included in this EIAR as requested by DEDECT in their correspondence:

- The impact on water resources are to be investigated in terms of quality and pollution (sulphate plume)
- Water release point must be identified and investigated
- All concerns and comments must be addressed
- Air quality dust fallout monitoring carried out in February and September is not sufficient, due to high wind speed experienced between August and December. We therefore expect dust fallout monitoring to be conducted during that period.
- All concerns raised by Ghaapse Plateau Environmental Protection Group

2.2.3 Listed activities requiring environmental authorisation

In a meeting on 27 January 2011 between the DACERD, the applicant and the EAP, it was agreed that this application for environmental authorisation would be undertaken in terms of the 2006 EIA Regulations an not the 2010 EIA Regulations, given that the Application Form was submitted prior to 2 August 2010.

Activities considered as having a substantial detrimental impact on the environment are listed in the 2006 EIA Regulations, in particular GN R 386 and GN R 387 promulgated in terms of the NEMA. The proposed mining operation and activities associated thereto are considered listed activities requiring environmental authorisation from the DEDECT.

(Table 1and Table 2) below provides the applicable listed activities and a summarised description of the application at Pering Mine.

Table 1: Listed activities as per the GN. R386 (April 2006)

#	Describe each listed activity:	Application at Pering Mine
386 (1)(b)	The construction of facilities or infrastructure, including associated structures or infrastructure, for the above ground storage of 1 000 tons or more but less than 100 000 tons of ore;	Approximately 70.6 megatonnes of tons of ore will be mined and stored aboveground.
386 (1)(k)(i)	The construction of facilities or infrastructure, including associated structures or infrastructure, for the bulk transportation of sewage and water, including storm water, in pipelines with an internal diameter of 0,36 metres or more	Reticulation infrastructure for the conveyance of process, wastewater, sewage and stormwater over the site. This includes any pipelines which may extend off site over and above the 0,36 m diameter.
386 (1)(k)(ii)	The construction of facilities or infrastructure, including associated structures or infrastructure, for the bulk transportation of sewage and water, including storm water, in pipelines with a peak throughput of 120 litres per second or more	As above
386 (1)(l)	The construction of facilities or infrastructure, including associated structures or infrastructure, for the transmission and distribution of electricity above ground with a capacity of more than 33 kilovolts and less than 120 kilovolts	Upgrade and maintenance of the existing Eskom substation.
386 (7)	The above ground storage of a dangerous good, including petrol, diesel, liquid petroleum gas or paraffin, in containers with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres at any one location or site	Approximately XXX of diesel and other dangerous goods will be stored above ground.
386 (13)	The abstraction of groundwater at a volume where any general authorization issued in terms of the National Water Act, 1998 (Act No. 36 of 1998) will be exceeded	Groundwater abstraction will occur at a volume of XXXm^3 per day during the construction phase. This constitutes a Section 21 activity in terms of the National Water Act 36 of 1998 and an application to the Department of Water Affairs is in process.
386 (15)	The construction of a road that is wider than 4 metres or that has a reserve wider than 6 metres, excluding roads that fall within the ambit of another listed activity or which are access roads of less than 30 metres long	Many of the existing internal roads will be upgraded and paved to approximately XXXm in width.

Table 2: Listed activities as per the GN. R387 (April 2006)

	Describe each listed activity:	
387 (1)(c)	The construction of facilities or infrastructure, including associated structures or infrastructure, for the above ground storage of a dangerous good, including petrol, diesel, liquid petroleum gas or paraffin, in containers with a combined capacity of 1 000 cubic metres or more at any one location or site including the storage of one or more dangerous goods, in a tank farm	Approximately XXX of diesel and other dangerous goods will be stored above ground.
387 (1)(e)	The construction of facilities or infrastructure, including associated structures or infrastructure, for any process or activity which requires a permit or	The release of the following emissions or effluent into the environment is applicable: Effluent treatment plant

	license in terms of legislation governing the generation or release of emissions, pollution, effluent or waste and which is not identified in Government Notice No. R. 386 of 2006	
387 (1)(h)	The construction of facilities or infrastructure, including associated structures or infrastructure, for the manufacturing, storage or testing of explosives, including ammunition, but excluding licensed retail outlets and the legal end use of such explosives	Explosives will be stored in an explosives magazine located at the mine.
387 (2)	Any development activity, including associated structures and infrastructure, where the total area of the developed area is, or is intended to be, 20 hectares or more	The total footprint of the proposed mining operations is 883.1 ha in extent. Expansion of the existing mine footprint is anticipated to expand by XXX %.

2.2.4 New EIA Regulations, 2010

The new EIA Regulations (GN.R. 543) and listing notice 1, 2 and 3 (GN.R. 544, 545 and 546) promulgated under NEMA repealed the 2006 EIA Regulations on 2 August 2010. As stated above, in a meeting on 27 January 2011 between the DACERD, the applicant and the EAP, it was agreed that this application for environmental authorisation would be undertaken in terms of the 2006 EIA Regulations and not the 2010 EIA Regulations, given that the Application Form was submitted prior to 2 August 2010.

2.2.5 Environmental Impact Assessment Process

The proposed continuation of mining activities requires that environmental authorisation is obtained before commencement, in accordance with Government Notice R 385, R 386 and R 387 (April 2006), promulgated in terms of Sections 24 and 24D of the National Environmental Management Act 107 of 1998 (NEMA). Environmental Authorisation is to be considered by the approving authority, namely the North West Department of Economic Development, Environment, Conservation and Tourism (DEDECT).

This Environmental Impact Report (EIR) is compiled in accordance with the provisions of the Environmental Impact Assessment Regulations (April 2006) promulgated in terms of Chapter 5 of the NEMA. The EIR content is dictated by Regulation 32(2) of G.N. R 385 (2006) and must include the following, as a minimum requirement:

(2) An environmental impact assessment report must contain all information that is necessary for the competent authority to consider the application and to reach a decision contemplated in regulation 36, and must include –

a) details of –
  i. the EAP who compiled the report; and
  ii. the expertise of the EAP to carry out an environmental impact assessment;

b) a detailed description of the proposed activity;

c) a description of the property on which the activity is to be undertaken and the location of the activity on the property, or if it is –
  i. a linear activity, a description of the route of the activity; or
  ii. an ocean-based activity, the coordinates where the activity is to be undertaken;

d) a description of the environment that may be affected by the activity and the manner in which the physical, biological, social, economic and cultural aspects of the environment may be affected by *the proposed activity ;details of the public participation process conducted in terms of sub-regulation (1), including –*

- *i. steps undertaken in accordance with the plan of study;*
- *ii. a list of persons, organisations and organs of state that were registered as interested and affected parties;*
- *iii. a summary of comments received from, and a summary of issues raised by registered interested and affected parties, the date of receipt of these comments and the response of the EAP to those comments; and*

- *e) copies of any representations, objections and comments received from registered interested and affected parties; a description of the need and desirability of the proposed activity and identified potential alternatives to the proposed activity, including advantages and disadvantages that the proposed activity or alternatives may have on the environment and the community that may be affected by the activity;*
- f) *an indication of the methodology used in determining the significance of potential environmental impacts;*
- *g) a description and comparative assessment of all alternatives identified during the environmental impact assessment process;*
- *h) a summary of the findings and recommendations of any specialist report or report on a specialised process;*
- *i) a description of all environmental issues that were identified during the environmental impact assessment process, an assessment of the significance of each issue and an indication of the extent to which the issue could be addressed by the adoption of mitigation measures;*
- *j) an assessment of each identified potentially significant impact, including –*
  - *i. cumulative impacts;*
  - *ii. the nature of the impact;*
  - *iii. the extent and duration of the impact;*
  - *iv. the probability of the impact occurring;*
  - *v. the degree to which the impact can be reversed;*
  - *vi. the degree to which the impact may cause irreplaceable loss of resources; and*
  - *vii. the degree to which the impact can be mitigated;*
- *k) a description of any assumptions, uncertainties and gaps in knowledge;*
- *l) an opinion as to whether the activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation;*
- *m) an environmental impact statement which contains –*
- *n) a summary of the key findings of the environmental impact assessment; and*
- *o) a comparative assessment of the positive and negative implications of the proposed activity and identified alternatives;*
- *p) a draft environmental management plan that complies with regulation 34;*
- *q) copies of any specialist reports and reports on specialised processes complying with regulation 33; and*
- r) *any specific information that may be required by the competent authority.*

2.2.6 Additional Applications

In addition to obtaining environmental authorisation in terms of NEMA from DEDECT for the listed activities required in order to commence with the proposed mining project, the following legislation and requirements in terms thereof must be observed and the relevant authorisations or approvals obtained:

Mineral and Petroleum Resource Development Act, Act 28 of 2002

Pering Mine must be in possession of an approved Mining Right for the mining of zinc and lead within the study area before mining operations may commence. Pering submitted a mining right application to the DME, North West Province which was submitted on 05 December 2008 [NW/30/5/1/2/2/417/MR]. A Scoping Report, as per Regulation 49(1) of the Mineral and Petroleum Resources Development Act [MPRDA] (Act No. 28 of 2002), was submitted to the DMR on 15 June 2009. An Environmental Impact Assessment (EIA) and Environmental Management Programme (EMP) Report in terms of Regulations 50 and 51 were submitted on 11 June 2010 to the DMR for approval. The DMR subsequently requested additional information and in March 2012, the revised EMPR was submitted to the DMR for review.

National Water Act, Act 36 of 1998

In accordance with Section 21 and 40 of the National Water Act 36 of 1998, a draft Integrated Water Use Licence Application was submitted to the DWA on 21 January 2010 [16/27/C33B/A]. The following activities were applied for:

- 21(a): Taking of water from a water resource.
- 21(f): Discharging water into a water resource through a pipe.
- 21(g): Disposing of waste in a manner which may detrimentally impact on a water resource.
- 21(i): Altering the bed, banks, course or characteristics of a watercourse. Altering watercourses will be identified in specialist studies and a water use in that regard identified if required.
- 21(j): Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

A summary of correspondence with the DWA concerning the Water Use License and dewatering alternatives is provided in Section 6.

2.3 Legislation and Policy Documents considered during the Environmental Assessment

This section details the various legislations that will be considered in the Scoping Report and EIA Report.

2.3.1 General

Environmental Rights
The Constitution of the Republic of South Africa Act, No. 108 of 1996
Section 24 states that: – Everyone has the right to an environment that is not harmful to their health or well-being – Everyone has the right to have the environment protected for the benefit of present and future generations

Environmental Management Guiding Principles
National Environmental Management Act, No. 107 of 1998
Comments or findings pertaining to the principles are not included specifically though all sections in this report but have been applied with these principles in mind. The National Environmental Management principles, listed at Section 2 of the National Environmental Management Act 107 of 1998 (NEMA), which provide for the social, environmental and economic sustainability of activities, apply "to the actions of all organs of state that may significantly affect the environment". – Environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental and cultural and social interests equitably (Section 2(2))

- Pollution and degradation of the environment must be avoided, or, where they cannot be altogether avoided, are minimised and remedied (Section 2(4)(ii)
- The use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource (Section 2(4)(v)
- A risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions (Section 2(4)(vii)
- The participation of all interested and affected parties in environmental governance must be promoted, and all people must have the opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation, and participation by vulnerable and disadvantaged persons must be ensured (Section 2(4)(f))
- Decisions must take into account the interests, needs and values of all interested and affected parties, and this includes recognising all forms of knowledge, including traditional and ordinary knowledge (Section 2(4)(g))
- The social, economic and environmental impacts of activities, including disadvantages and benefits, must be considered, assessed and evaluated, and decisions must be appropriate in the light of such consideration and assessment (Section 2(4)(i))

Duty of Care and Remediation of Environmental Damage

The duty of care principle is overtly regulated in sections 28 (1) and (3) of the National Environmental Management Act of 1998, and the National Water Act, Section 1:

(1) Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment

(3) The measures required in terms of subsection (1) may include measures to-

- Investigate, assess and evaluate the impact on the environment
- Inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment
- Cease, modify or control any act, activity or process causing the pollution or degradation
- Contain or prevent the movement of pollutants or the cause of degradation
- Eliminate any source of the pollution or degradation
- Remedy the effects of the pollution or degradation
- Remedy the effects of any disturbance to the bed and banks of a watercourse

Although Section 28 is applicable to all areas of pollution and environmental impact, only those items which have not specifically been addressed in subsequent sections and items of particular importance to Section 28 are included here. However, this section must be borne in mind when assessing any environmental impact described in subsequent sections.

Access to Environmental Information

Promotion of Access to Information Act of 2000 Section 70 and NEMA Section 31

Anyone has the right to request information of an environmental nature from the Client and cannot be refused on grounds that are not compliant with the legal requirements.

2.3.2 National Environmental Air Quality Act, No. 39 of 2004

The object of this Act is-

(a) to protect the environment by providing reasonable measures for-

(i) the protection and enhancement of the quality of air in the Republic;

(ii) the prevention of air pollution and ecological degradation; and

(iii) securing ecologically sustainable development while promoting justifiable economic and social development; and

(b) generally to give effect to section 24(b) of the Constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people.

The act aims to minimise pollution through vigorous control, cleaner technologies and cleaner production practices, thereby ensuring that air quality is improved.

Comments or findings pertaining to these principles are not included specifically though all sections in this report but have been applied with these principles in mind.

Air Quality Standards

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality guideline values indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. The South African Air Quality Standards are provided in Table 3.

Table 3: South African Air Quality Standards

Status	Averaging period						
	Instantaneous peak	1 hour	8 hours	24 hours		Annual	
Standards (µg/m³)	Current [(a)]	Proposed [(b)]		Current [(a)]	Proposed [(b)]	Current [(a)]	Proposed [(b)]
PM10				180	75	60	40
SO_2	500	350		125		50	
NO_2	940	376		188	200	94	40
CO_2		30,000	10,000				

[(a)] As per Schedule 2 of the NEM Air Quality Act (Act No. 39) of 2004

[(b)] as per Government Notice 263 in Government Gazette 31987 published 13 March 2009 for public comment)

Updated ambient air quality standards for South Africa were published (Gazette No.: 32816, 24 December 2009). The updated PM10 standards issued nationally are documented in Table 4.

Table 4: National Air Quality Standard for Inhalable Particulates less than 10 µm in Diameter (PM10)

Authority	Maximum 24-Hour Concentration (µm/m³)	Annual Average Concentration (µm/m³)
SA Standards (Government Gazette No.: 32816)	120[(a)]	60
SA Standards (Government Gazette No.: 32816)	75[(b)]	40

[(a)] Not to be exceeded more than 4 times per year. Applicable immediately to 31 December 2014.

(b) Not to be exceeded more than 4 times per year. Applicable from 1 January 2015.

Nuisance impacts due to dust are associated with dustfall and soiling impacts and with reductions in visibility. Atmospheric particulates change the spectral transmission, thus diminishing visibility by scattering light. The scattering efficiency of such particulates is dependent upon the mass concentration and size distribution of the particulates. Various costs are associated with the loss of visibility, including: the need for artificial illumination and heating; delays, disruption and accidents involving traffic; vegetation growth reduction associated with reduced photosynthesis; and commercial losses associated with aesthetics.

The soiling of building and materials due to dust frequently gives rise to damages and costs related to the increased need for washing, cleaning and repainting. Dustfall may also impact negatively on sensitive industries, e.g. bakeries, textile industries or paint manufacture.

Locally dust deposition is evaluated according to the criteria published by the South African Department of Environmental Affairs and Tourism (DEAT). In terms of these criteria dust deposition is classified as follows:

- SLIGHT - less than 250 mg/m^2/day
- MODERATE - 250 to 500 mg/m^2/day
- HEAVY - 500 to 1200 mg/m^2/day
- VERY HEAVY - more than 1200 mg/m^2/day

The Department of Minerals and Energy (DME) uses the uses the 1 200 mg/m2/day threshold level as an action level. In the event that on-site dustfall exceeds this threshold, the specific causes of high dustfall should be investigated and remedial steps taken.

It has recently been proposed (as part of the SANS air quality standard setting processes) that dustfall rates be evaluated against a four-band scale, as presented in Table 5. Proposed target, action and alert thresholds for ambient dust deposition are given in Table 6.

According to the proposed dustfall limits an enterprise may submit a request to the authorities to operate within the Band 3 ACTION band for a limited period, providing that this is essential in terms of the practical operation of the enterprise (for example the final removal of a tailings deposit) and provided that the best available control technology is applied for the duration. No margin of tolerance will be granted for operations that result in dustfall rates in the Band 4 ALERT.

Table 5: Bands of dustfall rates proposed for adoption

Band Number	Band Description Label	Dustfall Rate (D) (mg/m^2/day), 30-Day Average	Comment
1	Residential	D < 600	Permissible for residential and light commercial
2	Industrial	600 < D < 1,200	Permissible for heavy commercial and industrial
3	Action	1,200 < D < 2,400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	2,400 < D	Immediate action and remediation required following the first incidence of dustfall rate being exceeded. Incident report to be submitted to relevant authority.

Table 6: Target, action and alert thresholds for ambient dustfall

Level	Dustfall rate (D) (mg/m^2/day, 30 day average)	Averaging Period	Permitted Frequency of Exceedances
Target	300	Annual	
Action Residential	600	30 days	Three within any year, no two sequential months.
Action Industrial	1200	30 days	Three within any year, not sequential months
Alert Threshold	2400	30 days	None. First exceedance requires remediation and compulsory report to authorities.

2.3.4 Water Management

Pollution of Water Resources

National Water Act, No. 36 of 1998: Section 19

Measures must be undertaken by the Developer/Proponent to:

- Cease, modify or control any act or process causing pollution
- To contain or prevent the movement of pollutants
- To remedy the effects of pollution

Water Use

National Water Act, No. 36 of 1998, Section 21

Water use must be licensed with the regional Department of Water Affairs (DWA), in this case the Northern Cape office in Kimberley.

A water use application will be made, in application for the following activities, where applicable (based on the results of specialist investigations):

- 21(a): Taking of water from a water resource.
- 21(b): Storing of water.
- 21(g): Disposing of waste in a manner which may detrimentally impact on a water resource
- 21(j): Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

Water Wastage

National Water Act, No. 36 of 1998, Section 22(2)(d)

Water wastage is prohibited under this section. The developer/proponent must therefore be able take account for all the water received and be able to demonstrate the optimal use of water.

2.3.5 Waste Management

Waste Management

National Environmental Management Waste Act, No.59 of 2008

The objects of this Act are—

(a) to protect health, well-being and the environment by providing reasonable 15 measures for—

(i) minimising the consumption of natural resources;
(ii) avoiding and minimising the generation of waste;
(iii) reducing, re-using, recycling and recovering waste;
(iv) treating and safely disposing of waste as a last resort;
(v) preventing pollution and ecological degradation;
(vi) securing ecologically sustainable development while promoting justifiable economic and social development;
(vii) promoting and ensuring the effective delivery of waste services;
(viii) remediating land where contamination presents, or may present, a significant risk of harm to health or the environment: and
(ix) achieving integrated waste management reporting and planning;
(b) to ensure that people are aware of the impact of waste on their health, well-being and the environment;
(c) to provide for compliance with the measures set out in paragraph (a)\ and
(d) generally, to give effect to section 24 of the Constitution in order to secure an environment that is not harmful to health and well-being.

No person may commence, undertake or conduct a waste management activity listed in the General Notice 718 unless a licence is issued in respect of that activity.

Governing Principles for Waste Management

Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste, 2nd Edition (DWAF, 1998)

The following principles, many of which are considered internationally as being essential for the management of Hazardous Waste, are acknowledged in the Minimum Requirements and will also be acknowledged in future regulations.

'Duty of Care Principle' – whereby the generator of the waste is ultimately responsible for ensuring that the waste is handled, stored, transported and disposed of according to the legislation and in an environmentally sound and responsible manner.

'Polluter Pays Principle' – the person or organisation causing pollution is liable for any costs involved in remediation or rehabilitating its effects. The generator of the waste is thus liable unless able to prove that the transferral of management of the waste was a responsible action.

'Precautionary Principle' – All waste is assumed to be both highly hazardous and toxic until proven otherwise.

2.3.6 Biodiversity

National Biodiversity

National Environmental Management: Biodiversity Act, 2004

The purpose of the Act is to
"provide for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act1, 998; the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources and the establishment and functions of a South African National Biodiversity Institute."

Weeds and Invader Plants

National Environmental Management: Biodiversity Act, 2004 Draft Alien And Invasive Species Regulations, 2009
The purpose of these regulations is to *(a) prevent the unauthorized introduction and spread of alien species to ecosystem and habitats where they do not naturally occur;* *(b) manage and control invasive species to prevent or minimize harm to the environment and to biological diversity in particular; and* *(c) where possible and appropriate, eradicate invasive species that may cause such harm.*

International Law
Convention on Biological Diversity (CBD), June 1993, Ratified 2 November 1995
The aim of the CBD is to effect international co-operation in the conservation of biological diversity and to promote sustainable use of the living natural resources worldwide. It also aims to bring about the sharing of the benefits arising from the utilisation of natural resources.

Threatened or Protected Species
National Environmental Management: Biodiversity Act 10 of 2004 section 57
A person may not carry out a restricted activity involving a specimen of a listed threatened or protected species without a permit.

2.3.7 Environmental Authorisation under NEMA

Environmental Impact Assessments
An environmental assessment for this development is required in terms of Sections 24 and 24D of the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998), in terms of which GN R 385, 386 and 387of 2006 was promulgated, which lists the activities that require such an assessment. The applicable activities are listed in Section 2.2.3. The new EIA Regulations (GN.R. 543) and listing notice 1, 2 and 3 (GN.R. 544, 545 and 546) promulgated under NEMA repealed the 2006 EIA Regulations on 2 August 2010.

2.3.8 Contractors and Tenants

The Law of Contract
As a general rule, the Developer/Proponent cannot escape liability to third parties in terms of an agreement between themselves and a contractor. Such an agreement is not binding on third parties. A third party will still be able to hold Developer/Proponent liable. It is possible for Developer/Proponent to join the contractor as a defendant in legal proceedings, alternatively, recover the damages (or part thereof) paid to the third party from the contractor on a contractual basis. The agreement between Developer/Proponent and the contractor must at least state that the contractor is aware of all the applicable environmental legislation pertaining to his tasks and that the contractor will strictly adhere to this legislation.

Contractors / Tenants on Site
This section applies to any contractor working on site or tenant on the property controlled by the Proponent. This section is included as additional information in ensuring compliance (with regards to all section above) of Client is maintained - compliance remarks is thus not included in this section.

As mentioned in section 3 in this Register, NEMA section 28(1) states that reasonable measures must be taken to prevent pollution or degradation of the environment. Section 28(2) states that the persons on whom subsection (1) imposes an obligation to take reasonable measures include an owner of land or premises, a person in control of land or premises or a person who has a right to use the land or premises.

Section 154(a) of the National Water Act states the following:

154. Offences in relation to employer and employee relationships:
Whenever an act or omission by an employee or agent constitutes an offence in terms of this Act, and takes place with the express or implied permission of the employer or principal, as the case may be, the employer or principal, as the case may be, is, in addition to the employee or agent, liable to conviction for that offence.

The Proponent would be considered as the Employer or Principal, the employee or agent being the tenant or contractor. Developer/Proponent is therefore responsible for ensuring that contractors and tenants are compliant with the legislation where it affects the site. Thus Proponent may be liable for any illegal discharges, spills or accidents caused by these contractors or tenants (in addition to these contractors or tenants being liable).

2.3.9 Heritage

South African Heritage Resources
National Heritage Resources Act, Act 125 of 1999
The SA Heritage Resources Agency (SAHRA) must be notified during the early stages certain planned activities (barriers, bridges, change of site character). Certain permit and reporting requirements apply for heritage sites, structures older than 60 years, archaeological, palaeontological and meteorite findings, burial grounds and graves and public monuments and memorials.

2.3.10 Common Law

Common law principles form the basis of current neighbour law and the law of nuisance. It protects an individuals use and enjoyment of property, but limits the use of property so such use does not interfere with the rights of other people (i.e. Neighbours).

Applicant has not taken reasonable measures to ensure that contractors/stakeholders on site are aware of their responsibility on site and the environmental legal requirements (indicated by the incidents and potential incidents that may have caused environmental degradation associated with the contractors/stakeholders activities.

Delict, Nuisance & Neighbour Law
Nuisance and neighbour law are both fall under the law of delict. Nuisance law means to cause a disturbance to another person. This means that the requirements for a successful delict as outlined below apply to neighbour law and the law of nuisance. The common law rules of delict, nuisance and neighbours can be used to protect your client's environmental rights relating to: – Noise Pollution – Air Pollution – Water Pollution

The Law of Delict – Actions of other People that Cause Harm to Your Clients

The common law of delict allows an individual to claim compensation from someone who does something that causes harm.

Requirements for a successful delictual claim

For such a claim to succeed the person making the claim (the claimant) must prove:

- That the action of the other person was wrong
- That the person doing the action was negligent, i.e. that the other person was at fault
- That the claimant suffered a loss which can be given a monetary value
- That the action of the negligent person caused the monetary loss
- The requirements of wrongfulness and negligence are very important here

Was the Action Wrong?

In deciding whether an action was wrong the law tries to determine which actions are seen as wrong by the community as a whole. The action must be wrong because it violates a legal duty to take care (e.g. NEMA, Section 28: 'Duty of Care') or because it results in an unjustified infringement of the legally protected rights of another person. Generally speaking it is wrong to cause harm to another person or their property through negligent conduct.

Was the Action Negligent?

A person's liability to pay a claim (their guilt) usually depends on whether or not the court finds that they were at fault - i.e. Whether they acted negligently or not. In order to test whether the person doing the action was negligent, the courts apply the test of the "reasonable man". In applying this test the court asks:

- Would the reasonable man, in the position of the person doing the action, have foreseen that the action would cause harm?
- Would the reasonable man have taken steps to avoid the harm?
- The court may find the action of a person caused the damage to the claimant and he or she will have to pay the claimant a sum of money equal to the amount of damage that the claimant suffered to compensate the claimant for his loss, if the court finds:
  - That the reasonable person would have foreseen that the action would cause harm
  - That the reasonable person would then have taken steps to avoid the harm
  - That the person who actually did the action did not take steps to avoid the harm

The Law of Nuisance

The Law of Nuisance is divided into three categories:

- Public nuisance - where someone's action causes an inconvenience to the general public
- Private nuisance - where an action by one person interferes with another person in the ordinary use of his or her property
- Statutory nuisance - where a legislative authority declares an action or process to be a nuisance

The Law of Private Nuisance

The law of Private Nuisance recognises the right of an owner of land to enjoy their land in physical comfort, convenience and well-being without unreasonable interference from others. Due to the fact that we have to make some allowances for the actions of the people with whom we share our society, each landowner must be prepared to put up with some interference with their right to enjoy their land. It is therefore possible for this right to enjoy land to be interfered with by smoke, gas, fumes or noise generated by another person, as long as it is not unreasonably interfered with. If the interference is unreasonable then the landowner can take legal action to protect his right to enjoy his land under the law of private nuisance.

In the case of private nuisance the person who is usually liable is the person who owns the land from which the nuisance originates. The following people may be liable:

- The owner or occupier of the land who actually causes the nuisance
- The person who did not cause the nuisance in the first place, but who has control of the land or has taken over control of the land

The person who has taken over the land is only liable if that the nuisance is on-going, he or she became aware of the nuisance, and failed to take reasonable steps to stop or limit the nuisance.

The Law of Neighbours

It is a general rule of our law that a landowner may not use his or her property in a way that causes harm to another person. This means that a landowner's right to use the property is limited and that there is an obligation on him or her not to act in a way that will infringe the rights of a neighbour.

The test of whether the landowner's use of his property fails to comply with this obligation is one of reasonableness and fairness. This principle of reasonableness is relevant to all forms of polluting activities.

3

Project description

Pering Mine (Pty) Ltd proposes to re-open an opencast zinc and lead mining operation at Pering Mine located on the farm Pering Mine 1023 HN in the magisterial district of Vryburg in the North West Province, where mining activities ceased in 2003. The extent of the mining area is 883.1 ha.

This section of the EIAR provides a description of the following:

- Activities which occurred at the closure and decommissioning stage in 2003/2004,
- A description of the current situation at the mine (the receiving environment is addressed in Section 4), and
- A description of the future proposed mining activities.

3.1 Project Location

Pering Mine is situated on the farm Pering Mine 1023 HN in the magisterial district of Vryburg in the North West Province (Table 7). The mine covers an area of approximately 883.1236 hectares (ha), and is the result of the consolidation of the farms described in Table 7. The closest towns to Pering Mine are as follows:

- Reivilo – approximately 18 km to the south-west.
- Taung – approximately 50 km to the south-east.
- Vryburg – approximately 70 km to the north-east.
- Kuruman – approximately 80 km to the north-west.

Table 7: Description of the mining area

Farm name		Portion	Deed number	Owner
Pering Mine 1023 HN	Scheurfontein 785 HN	Portion 8	T 1409 / 1995	Pering Mine (Pty) Ltd
	Pering 787HN	Portion 2	T 1409 / 1995	Pering Mine (Pty) Ltd
	Pering Mine 1022 HN	-	T 1409 / 1995	Pering Mine (Pty) Ltd

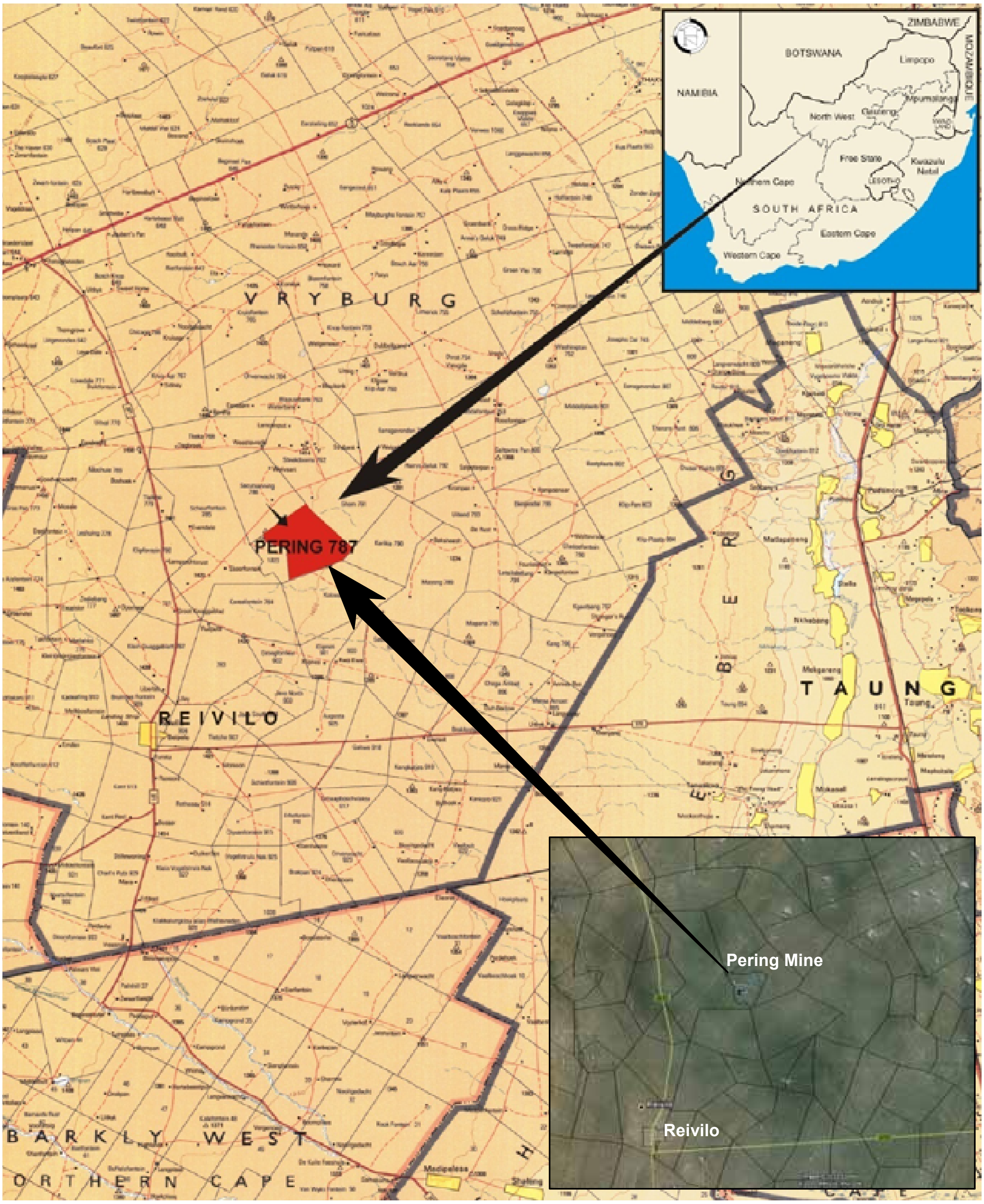


Figure 1: Pering Mine Locality plan

The co-ordinates of the mining area are listed in **Table 8** while the mine boundary and surfacefeatues are indicated in **Figure 1**. The co-ordinates are provided in datum WGS84 and co-ordinate system DMS (Degrees, Minutes and Seconds).

Table 8: Geographic co-ordinates of the registered mining area.

Reference	Y Co-ordinate (East)	X Co-ordinate (South)
	Datum: WGS84 Co-ordinate System (DMS)	
A	24°15'20.370"E	27°24'57.280"S
B	24°15'23.469"E	27°24'53.528"S
C	24°15'25.644"E	27°24'59.319"S
D	24°15'21.702"E	27°25'03.805"S
E	24°15'28.988"E	27°25'22.555"S
F	24°15'46.280"E	27°25'10.225"S
G	24°15'51.690"E	27°25'17.607"S
H	24°16'45.563"E	27°25'18.355"S
J	24°17'19.776"E	27°25'09.099"S
K	24°17'56.883"E	27°25'18.613"S
L	24°17'05.731"E	27°27'03.728"S
M	24°16'53.510"E	27°27'08.345"S
N	24°16'34.559"E	27°26'45.032"S
P	24°16'16.847"E	27°26'52.322"S
Q	24°16'01.096"E	27°26'45.261"S
R	24°15'51.944"E	27°26'08.623"S
S	24°15'56.928"E	27°25'58.483"S
T	24°15'28.445"E	27°25'23.153"S
V	24°16'39.098"E	27°25'47.202"S

Figure 2: Aerial image (Google Earth) including existing surface features relative to the boundary of the Pering Mining Area

3.2 Historic closure and decommissioning activities

Pering Mine was an operational mine between 1986 and 2003. After 2003 Pering Mine instituted rehabilitation procedures whereby all mine related infrastructure was removed and disturbed areas rehabilitated in accordance with a BHP Billiton Closure Plan. The following decommissioning and closure activities were undertaken at Pering Mine (Source: Metago Closure Plan):

3.2.1 Tailings Dam

- Slope modification and rock cladding of the tailings dam for erosion protection.
- Sealing of the penstock outfall pipe and inner delivery lines.
- Burial and / or salvage of drums and pipe sections that are scattered over the surface of the tailings dam.
- Refurbishment, rock cladding and construction of soakaways to the tailings dam catchment paddocks and seepage collection trench.
- The blue gum trees along the seepage collection trench was felled.
- Shaping of the top of the dam to form adequate freeboard for closure and long term erosion resistance.
- Final removal of the access ramp to the top of the tailings dam.

3.2.2 Return Water Dam

- Rock cladding of the basin of the return water dam to cover the deposited tailings.
- The construction of a coarse rock soak away in the lower portion of the return water dam.
- Clean up of spillage or re-vegetation of the impacted area in the vicinity and downstream of the spillway.
- Demolition and safe disposal of the intake structure.
- Demolition of the pumphouse. Salvage of the pumps, motors, switchgear and other salvageable equipment will not form part of this contract.
- Sealing of the intake pipeline where it passes through the earth embankment.
- Backfilling of the penstock outfall trench with selected waste rock.
- Backfilling of the clean water diversions to the north and south of the return water dam with the original excavated material.

3.2.3 Waste Rock Dumps

- Smoothing of the top surface of the waste rock dumps, using a dozer.
- Flattening of the side slopes where the side slopes exceed the angle of repose, as a result of excavation of material from the side slopes.

3.2.4 Open Pits

- Construction of bund walls, to prevent inadvertent access to the pit lakes.
- Removal and rehabilitation of haul roads.
- Provision of signage.
- Fencing around the pit lakes to control access to the lakes.

3.2.5 Buildings

- Demolition of concrete structures and specific buildings after completion of the plant removal:
  - Fine Ore Bin.
  - Concrete towers beneath the ROM stockpile.
  - Crusher retaining wall and concrete structure.
  - Magazines.
  - Demolition of brick and other buildings.
  - Disposal of any remaining building rubble in the borrow pit.
  - Burial of building rubble at designated sites, approved by the Engineer.
  - Burial of foundations and rehabilitation of the building footprints.

3.2.6 Roads

- Removal of designated roads and rehabilitation of road footprints (excluding the planting of vegetation).

3.2.7 Borrow Pits

- Backfilling of the borrow pit to the south of the tailings dam to form a dome shaped covered and vegetated area.
- Pushing down the sides of the borrow pit adjacent to the crusher ramp (Louis Lake).

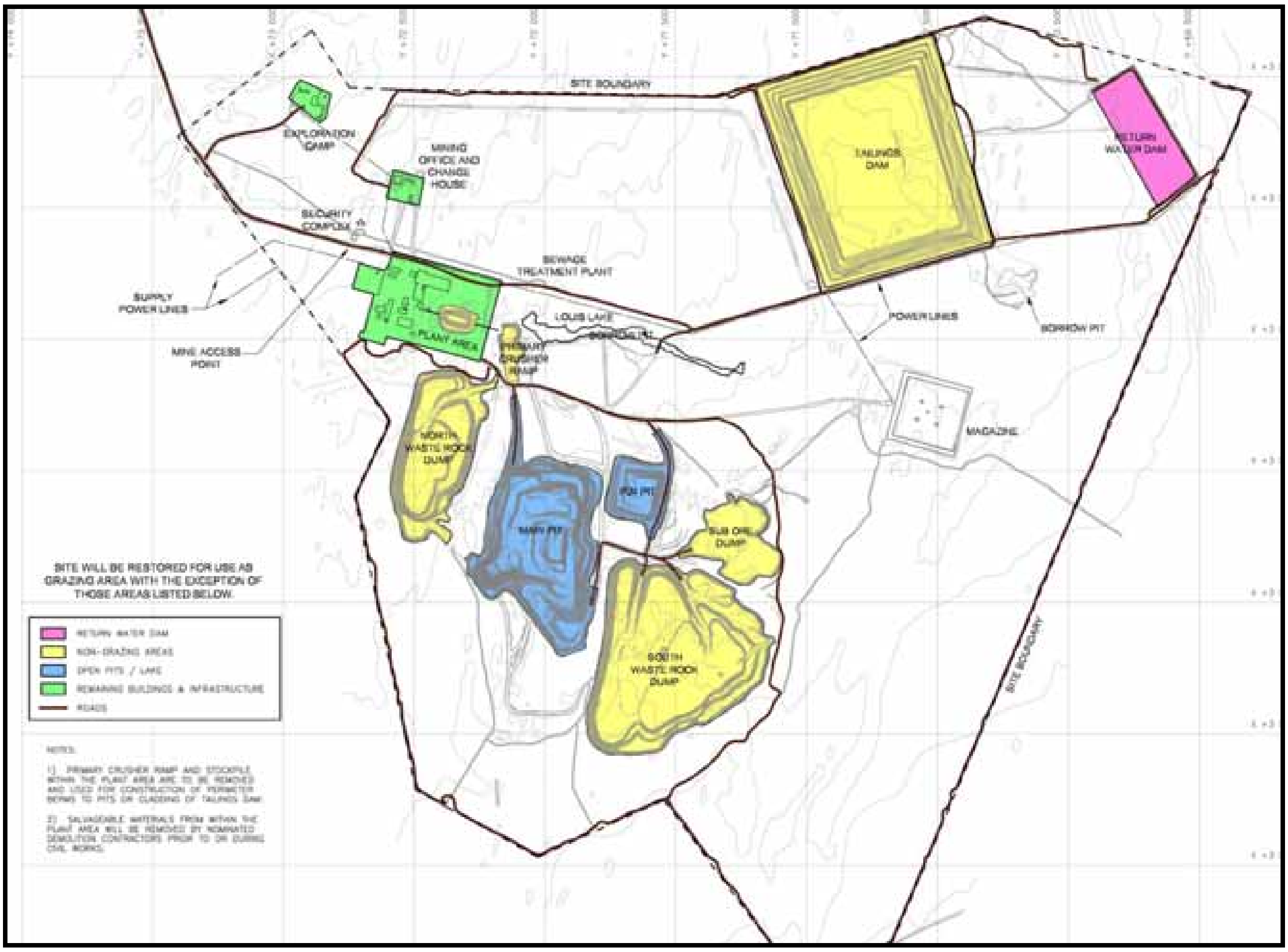


Figure 3: Mining footprint at closure indicating non-restored grazing areas

Figure 4: Activities undertaken at closure (rock cladding of tailings dam and plant demolition)

3.3 Current situation at Pering Mine

3.3.1 Key residual features

According to Metago's Closure Plan, certain areas were contaminated with dust blown tailings, burst tailings pipes, evaporates, concentrate spillages and oil and grease spillages. These areas were remediated. The key remaining residual features at Pering Mine currently include the following:

- Tailings dam – The top and side slopes of the entire tails dam surface was lined with a cladding of waste rock to limit water seepage into the tails dam and minimize wind and water erosion and dust fallout.
- Main Pit and Pit 24 – These pits have been infiltrated with groundwater and rainwater since closure and currently there is approximately 8 million m^3 of water in the Main Pit.
- A groundwater sulphur plume from the tailings site which has migrated in an easterly direction.

3.3.2 Remaining infrastructure & activities

Pering Mine consists of the following broad habitats:

- Transformed habitat (remaining infrastructure, roads, etc.) (235.8ha, 26.7%);
- Degraded habitat (79.7ha, 9.0%); and
- Natural woodland variations (568.1ha, 64.3%).

Currently, the following infrastructure / mining associated footprints are located on site:

- A security hut;
- Access roads;
- Eskom power lines and substation;
- A tailings dam;
- Two rock dumps;
- Two mined-out pits (Main Pit and Pit 24), and
- A return water dam.

3.3.3 Current monitoring network

Post operational phase monitoring at Pering Mine included the following:

- Water quality monitoring, including the following key aspects:

    - Groundwater monitoring to confirm that water levels, contaminant concentrations and the extent of the cone of depression are in line with predictions.
    - Pit lake water quality monitoring, to confirm that the pit water does not pose an acute toxicity threat to livestock and humans.
    - Return water dam inspections, to confirm that the soak-away pollution control facilities are functioning properly.
- Dust monitoring campaigns around the tailings dam, to demonstrate, on completion of the closure construction, that the dust loads reduce to background levels.
- Inspections and removal of alien invasive species on the Pering mine site.
- Physical inspections to demonstrate the satisfactory performance of the closure designs in terms of erosion, access control, and physical hazards.

3.4 Proposed new mining activities

3.4.1 Introduction

The Applicant has determined that the mine will yield approximately 0.8Mt of Lead and Zinc over the life of the mine. The operational Life of Mine (LOM) is estimated to be in the region of 13 years. The proposed mining activities will include mining of 70.6Mt of material from the existing open-cast pits and the existing stockpile facilities / tailings situated on the site. The proposed mining activity will take place in three phases, namely:

Phases		Duration
Construction Phase	Infrastructure development	3 years
	Mine development	
	Pit dewatering	
	Implementation Phase	
Operational Phase	Mining of rock dumps and reprocessing of slimes dam	13 years
	Opencast mining	
	Ongoing tailings dam construction	
	Ongoing pit dewatering	
	Processing	
Closure and Decommissioning Phase	Decommissioning	1 year
	Closure and Rehabilitation	2 years
	Maintenance and monitoring	3 years

3.4.2 Construction phase

3.4.2.1 Infrastructure Development

The construction phase will include, but may not be limited to the following activities:

- Construction of:
    - Workshops, administration buildings, power and water infrastructure;
    - Zinc and lead recovery plant:
        - Crushing plant;
        - Dense Medium Separation (DMS) plant;
        - Milling plant; and
        - Flotation plant.
    - Haul roads;

   - Sewage and grey water handling facility;
   - Slimes return water facility; and
   - Tailings facility.
- Dewatering of the pits;
- Identification and hiring of staff;
- Identification and appointment of suitable contractors; and
- Identification and appointment of suitable suppliers.

Figure 5 shows the proposed locations of the mining related infrastructure.

3.4.2.2 Mine Development

The proposed new dry Tailings Storage Facility (TSF) area is to be located immediately west of the existing tailings dam adjacent to the northern boundary of the mine and will have an extent of approximately 600m x 900m. The coarse component waste will be disposed of here and it will not be lined. Under drainage and a solution trench will be provided around the perimeter of the TSF.

The proposed lined Slimes Storage Facility (SSF) and Return Water Sump will be located adjacent to the eastern mine boundary, approximately 700m south of the tailings dam. The slimes impoundment walls will be constructed with waste rock from the open cast operations using the “dumping in layers method” and trench drains will be provided along the centre of the waste rock wall.

Tailings will be deposited onto the new SSF by means of the conventional spigot method of deposition via spigot openings located at 50m centres along the top perimeter of the dam. Each basin within the SSF will be lined with a 2mm thick HDPE primary liner, underlain by a geofabric bedding layer to reduce seepage. The impoundment will therefore be a full contained facility.

The new plant will be located to the west of the DMS tailings, not within the old plant footprint. The new mine pit will encompass both the Main Pit and Pit 24 in much larger layout which will require removal of some of the old waste rock dumps and re-processing of the sub-ore dump.

Pering Mine will require 5 MVA construction power and 10 MVA for use by the plant during operation.

Figure 5 shows the proposed locations of the abovementioned infrastructure. Also refer to the mine layout plan attached in Appendix 3.

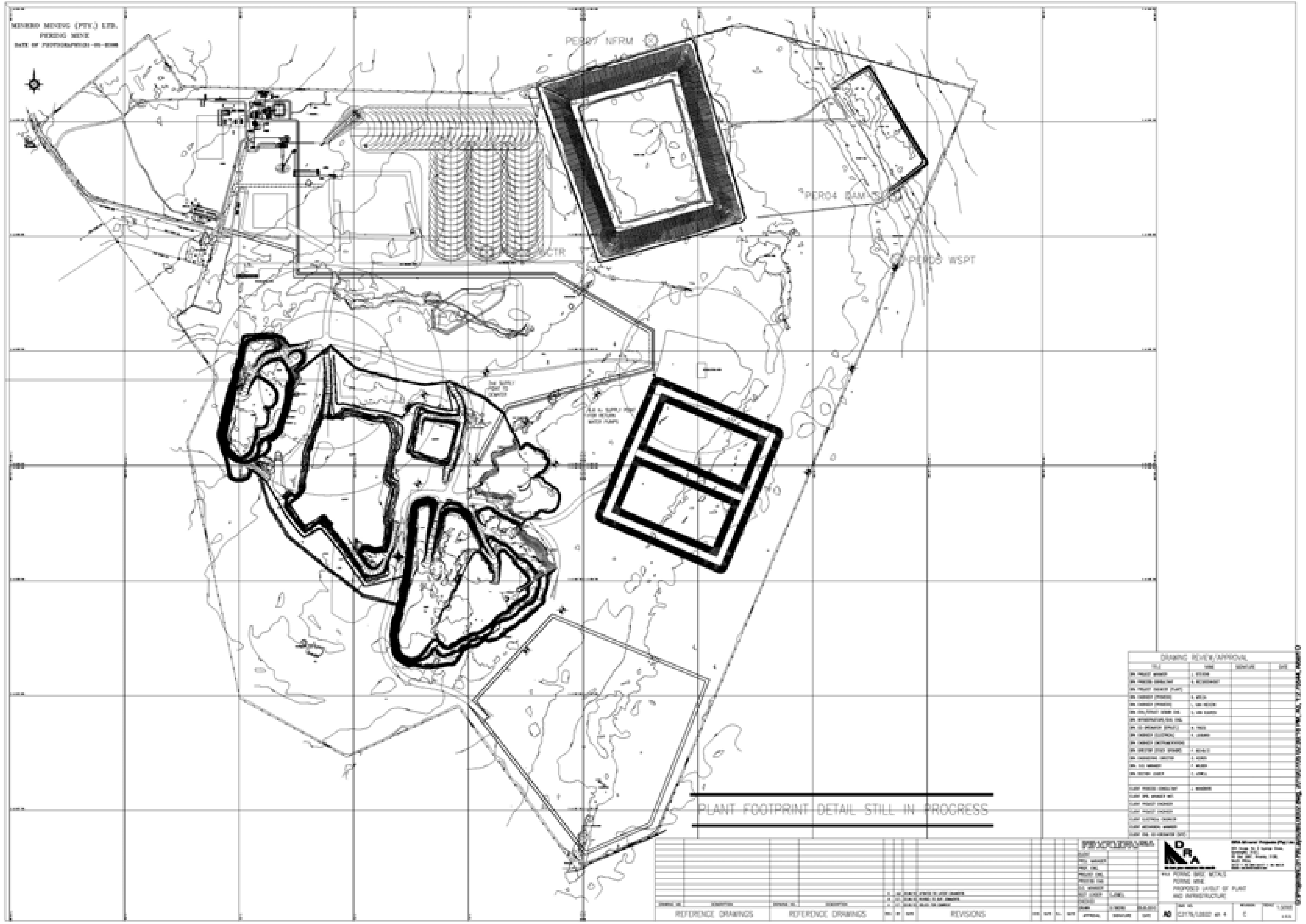


Figure 5: Proposed Pering Mine Layout

The construction phase will be followed by the commencement of pre-stripping / overburden stripping operations. The stripped overburden will be stockpiled or utilised in the tailings dam construction Alternatively the overburden will be stockpiled until rehabilitation operations commence at the end of the Life of Mine.

3.4.2.3 Pit Dewatering

The quantity of water presently accumulated in the Main Pit and Pit 24 pits at Pering Mine is estimated at approximately 8 million m^3.

The inflow to the pits is variable and is dependent on the rainfall. Post mine closure, the pits filled at an average rate of 1,666 m^3 per day (or 70 m^3 per hour). In order to resume mining operations, it is necessary to remove the volume of water contained in the pits. During de-watering pumping operations, the inflow hydraulic gradient will be steeper. The expected inflow has been calculated to be between 5,500 m^3 and 8,600 m^3 per day (220 m^3 and 350 m^3 per hour). Additionally, a number of boreholes will be re-established around the mine pits for the purposes of:

- Providing makeup water for the plant;
- Drawing down the water table around the pits to reduce water ingress into the pits.

Before mining of the pits can commence, the dewatering of the pits needs to be undertaken so that access to the ore body is facilitated. Various alternatives for the dewatering of the pits have been investigated by Pering Mine with the assistance of AGES and CHEMC Environmental. The options have been communicated to the stakeholders including the DWA and surrounding landowners. The sulphurous pit water is not suitable for unmitigated release into the environment. The pit water will therefore be treated at the mines water treatment plant to a standard ultimately depending on which of the dewatering alternative or combination of alternatives is deemed to be desirable (as will be motivated in this EIA report). The following pit dewatering alternatives have been considered, the feasibility of each alternative further discussed in Section 5 (Alternatives).

1. Enhanced evaporation - spraying water through water canons over the pits to speed up evaporation over a period of approximately 18 months.
2. Pumping water through a ±17 km pipeline into a defined non-perennial watercourse (Droe-Harts) located on neighbouring farms.
3. Pumping water through a ±7 km pipeline into a poorly defined floodplain.
4. Treatment to potable standards, conveyance and storage of water at Reivilo for human consumption.
5. Supply of water to the regional water board (Sedibeng Water).
6. Discharge onto other areas of the mining site – construction of evaporation dams sealed with bentonite making use of plants to increase evaporation through evapo-transpiration of the plants.
7. A combination of the above alternatives.

The pit de-watering installation will be comprised of a pontoon that is equipped with two single stage “150 PF PCH Warman” pump sets each delivering water to surface for storage in tanks before disposal (based on the selected dewatering alternatives discussed above). Once the pits have been emptied, ongoing pumping will be required to maintain the de-watered condition. The pumping installation pump drives will be re-designed to suit the variable volume arising. After re-commissioning of the mine, make up water will be required on an ongoing basis for the process plant.

It is noted that if Pering Mine was still operational, the pit water would have been “lost” to the reserve due to recycling by the mine. Currently the water is unavailable to the reserve as it is merely evaporating from the pits.

3.4.2.4 Implementation Phase

The implementation phase will run concurrently with the construction phase and will include, but may not be limited to the following activities:

- Identification and hiring of essential upper and middle management employees;
- Identification and hiring of essential working class employees;
- Identification and appointment of suitable contractors; and
- Identification and appointment of suitable suppliers.

3.4.3 Operational Phase

The operational phase will take place over a period of approximately thirteen (13) years and will include:

- Ongoing tailings dam construction;
- Ongoing pit dewatering;
- Mining of rock dumps and reprocessing of slimes dam;
- Opencast mining;
- Processing; and
- Environmental monitoring:
  - Surface water;
  - Groundwater;
  - Air quality; and
  - Noise levels.

3.4.3.1 Mining

There will be two phases to the mining operation. While the pits are being dewatered, the existing waste rock dumps will be mined and processed. Once the pits are dewatered, opencast mining will take place in the pits (year three). In total, 4Mt will be mined from the pit annually, of which 1.8Mt will be waste and 2.2Mt ore. This translates to on average 330Kt mined each month. Conventional drill, blast, load and haul, open pit mining operations is envisaged for the future mining of the ore deposit. Mining will consist of drilling and blasting, where the rock will be broken down to less than 400 mm. . It is envisaged that standard face shovels and tipper truck configurations will be employed to mine the pit. Face shovels will load blasted material to off-highway dump trucks for hauling to the crushing plant (where it will be reduced to less than 18mm), stockpiles or waste dumps. In summary, future proposed mining will involve:

- Mining of the existing stockpiles;
- Dewatering of two existing open pits to permit their re-mining (construction phase);
- Deepening and expansion of the open pits through a series of cut backs;
- Ore and waste will be drilled and blasted in mining blocks on 10m bench heights;
- Blasted ore will be loaded by an excavator and hauled with dump trucks. Material will either be tipped directly into the crusher or stockpiled for later use;
- Waste will be loaded by an excavator and hauled.

The simplified flow-sheet in **Figure 6** illustrates the proposed mining and mineral processing approach to be implemented at Pering Mine.

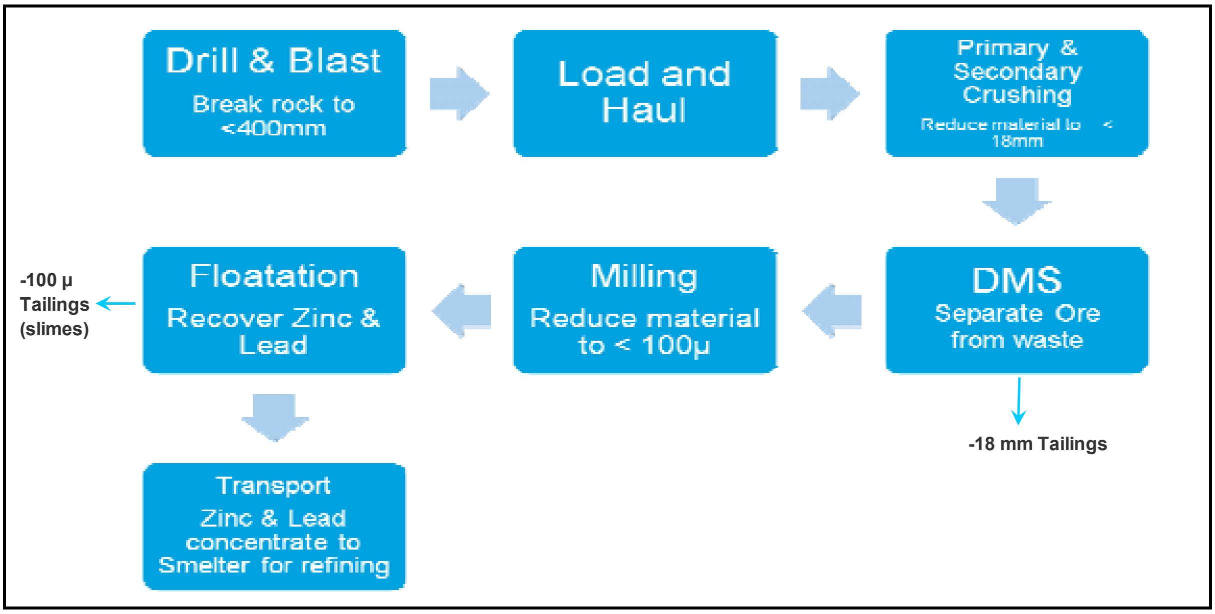


Figure 6: Flow sheet detailing the proposed mineral processing approach at Pering Mine

Mined material

In total 70.6Mt of material will be moved from the open pit and existing surface stockpiles. Of this, 19.2Mt is waste that will be hauled to designated waste dumps. The remaining 51.4Mt hauled to the plant for processing consists of 25Mt ore from the pit operations and 26.4Mt ore from the stockpile reclamation. Of the 51.4Mt processed, 38.5Mt (or 74.9%) will end up on the DMS tails dam as waste, 12.1Mt (or 23.6%) on the plant tails dam and the remaining 0.8Mt (or 1.5%) will be moved from the mine in the form of Lead and Zinc concentrate.

In total, 4Mt will be mined from the pit annually, of which 1.8Mt will be waste and 2.2Mt ore. This translates to on average 330Kt mined each month. (Bulk density = 1.6t per m/3; Moisture content = 10%)

Materials handling, crushing, screening and milling

Ore from pits and stockpile dumps loaded onto 30 ton haul tipper trucks for transport via haul roads to the tip located at the plant. The tip will feed directly into the primary crusher (ore throughput will be 330Ktpm) from where is will move to the secondary and tertiary crushers, spirals, DMS and mill via conveyor belts. The rejects from the spiral and DMS plants will also be transported to the DMS tails dump at a rate of 348Ktpm via conveyor belts and spread using a bull dozer. The tails from the floatation plant will transported to the slimes dam via a pipeline at a rate of 98Ktpm.

Waste materials stockpiling

The Slimes Storage Facility (SSF) will cover an area of 75 ha (900m by 800m) at an overall height of 34 meters and at the end of mine life, will store 9 million m^3 of slimes or 12.1Mt. The dry tailings dam (DMS) will cover an area of 54 ha (900m by 600m) at an overall height of 44 meters and at the end of mine life, will store 24 million m^3 of slimes or 38.4Mt.

Dust suppressants

Dust suppressants will be applied to all mine access and haul roads. The existing tails dam has already been capped with waste rock while the new tails dam will contain a return water dam on top of the tails dam.

Figure 7: 3D model - Mining progression at Pering Mine

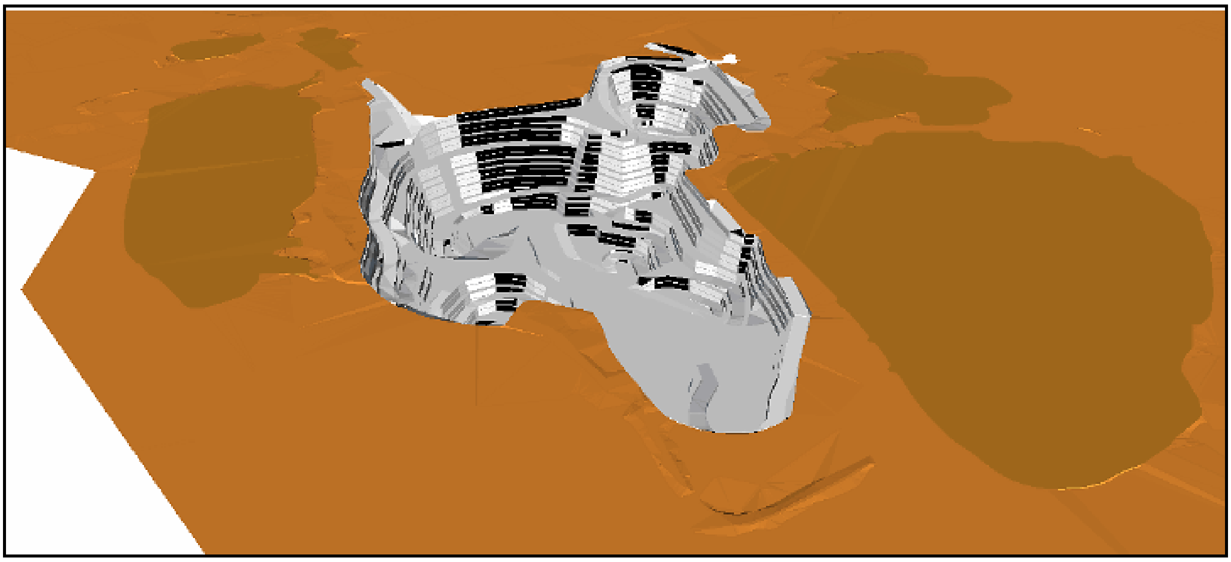


Figure 8: 3D model - Final void at the end of life of mine indicating removal of waste rock dumps

3.4.3.2 Processing

Once the ore has been crushed to a suitable size, it will be fed into a DMS system from which the Zinc and Lead mixture will be fed into a differential floatation plant resulting in the final separation of the Zinc from the Lead to generate Zinc and Lead concentrate. -18mm DMS tailings will be generated from the DMS process and -100µ tailings (slimes) will be generated from the flotation process.

The plant has been designed to treat a nominal 3.5 mpta of ROM ore and to produce a dual stream of DMS material to the quaternary crushing and milling circuit. The DMS plant will ultimately include a feed preparation section comprised of a wet double deck screen with which to feed the coarse DMS (+10 -25 mm) and the fines DMS (+1 -10 mm).

The objective of this circuit is to stabilise the feed grade to the milling and flotation circuit ensuring optimum recovery of zinc and other by-products.

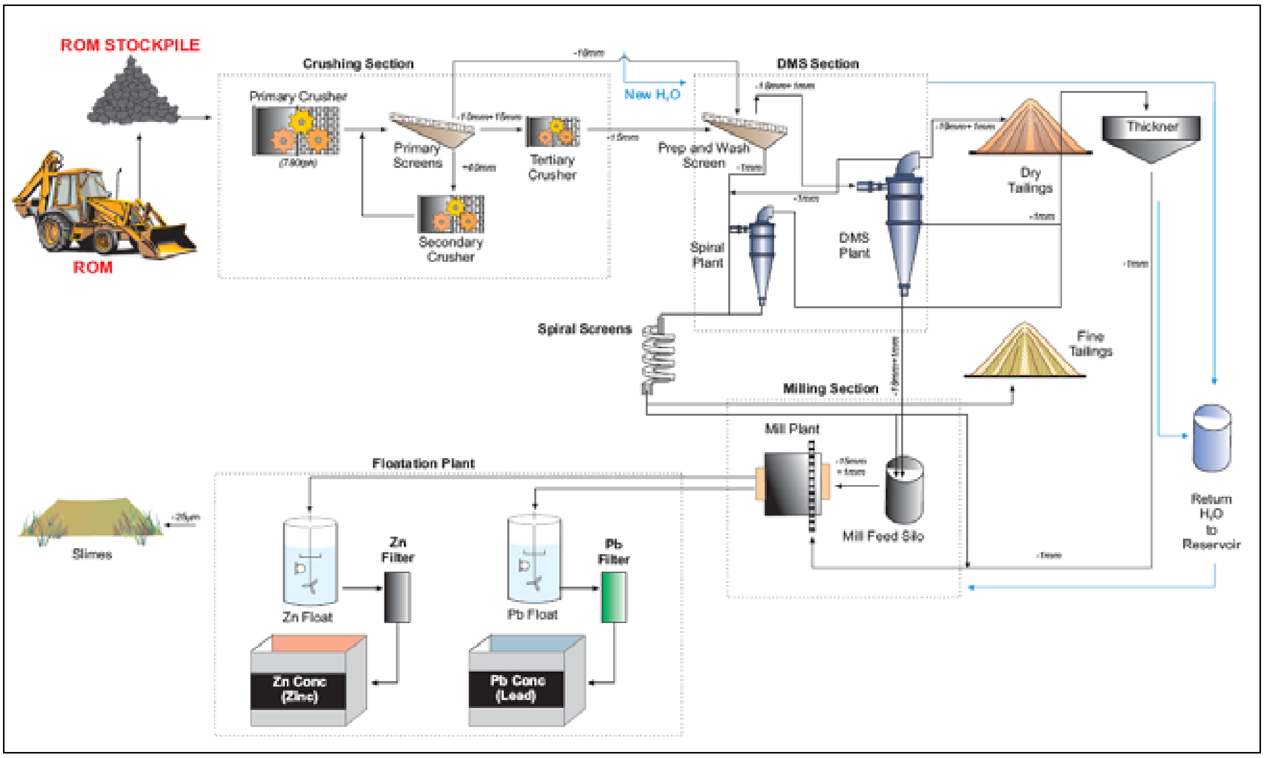


Figure 9: Mass balance diagram for processing plant in full production

3.4.3.3 *Mineral outputs*

The Applicant has determined that the mine will yield approximately 0.8Mt of Lead and Zinc over the life of the mine. The zinc concentrate will be transported via a closed truck to the rail siding in Taung from where it will be loaded onto rail coaches and transported to wherever the smelter is located. Zinc is expected to be destined for export to China. The lead concentrate will be transported to the Taung rail siding in sealed bags via truck and then transported to a smelter in Namibia.

3.4.3.4 *Waste Management*

Pering Mine will appoint a contractor to manage and control all waste generated at the Mine. The contractor will keep a detailed register for all waste that enters and leaves the salvage yard. A print out of the register will be supplied to the environmental office after reconciliation with the salvage yard supervisor at the end of each month.

Hazardous waste will be kept separate from general waste as small quantities can lead to contamination of the entire waste stream system. All hazardous waste will be disposed of in accordance with the current environmental legislation and regulations and disposal certificates supplied to the environmental officer.

Domestic Waste

All domestic / general waste will be disposed of at its point of generation into green colour coded drums. The contractor will collect the waste on a weekly basis. The waste will be disposed of at a licensed / registered municipal dumpsite.

Industrial Waste

The following industrial waste will be managed as follows:

- Empty printer cartridges:
  - Empty printer cartridges must accompany the Stores Requisition for new cartridges to the stores. The empty cartridges will be kept by the stores and sold from time to time. Until they are sold, the cartridges will be kept in a dry area in order to avoid leaks or contamination from occurring.
- Scrap metal, rubber, conveyor belts, etc.:
  - The contractor will place skips (where necessary) at the sites that generate the above mentioned scrap and waste. The bins will be emptied out on a regular basis and scrap is transported to the salvage yard, where it will be sorted and processed.
  - Any reusable material / items will be sorted in the reusable area. All ferrous and non-ferrous scrap is to be removed from the salvage yard on a bi-weekly basis. Each waste type will be weighed separately.
- Building rubble:
  - For any contractor performing construction at Pering Mine, it shall be part of the contractor's contract that building rubble be removed by his / her company. It is the responsibility of the Head of Department (HOD) who require the work, to ensure that building rubble is removed.
- Re-usable material and items:
  - Any reusable material and items entering the salvage yard will be sorted, graded and stored in a separate area. A detailed inventory is to be kept of all reusable materials. Reusable material and items not used will from time to time be disposed of in the appropriate manner.

Hazardous Waste

- Oily rags, oil filters, hydraulic oil hoses, hydrocarbon contaminated soil, etc:
  - All oil filters will be drained of their excess oils on an oil filter drainer and is then disposed of into the hazardous waste drum.
  - All hydrocarbon (oil, diesel, grease, etc.) contaminated cloths will be disposed of into the hazardous waste drum.
  - Once the drum is full, the contractor will empty the drums into the Hazardous Waste Skip. Once this skip is full, it is disposed off according to the relevant legislation by the sub-contractor. A replacement drum is to be made available immediately.
- Batteries:
  - All old batteries will be sent to the salvage yard.
- Oil:
  - All used oil drained from the various sumps, will be sold to an external contractor for recycling purposes.
- Medical waste:
  - All medical waste like blood stained dressings, expired medicine, etc. generated from treatment of employees at the on-site clinic will be disposed of into a purpose specific bin provided by the contractor. Once the bin is filled, the occupational nurse seals the container and notifies the salvage yard contractor to remove it. A replacement drum is made available immediately. The contractor then disposes the waste in accordance to relevant legislation and regulations. The contractor provides the environmental officer with the necessary documentation.
  - Needles and syringes are disposed of in a Sharps Container. Once it is filled, it is sealed and transported to a Du Buisson and Partner's laboratory for incineration. A replacement container is provided immediately.
  - All body fluids (urine, etc.) are flushed down the sluice.
- Fluorescent tubes:

- It is the responsibility of the relevant engineers to ensure that the workshops and designated areas are equipped with this disposal drum (yellow colour coded drum).
- All fluorescent tubes are to be disposed into this drum. Once the drum is full, it will be sealed and given to the salvage yard to dispose of as a hazardous substance. A replacement drum is to be made available immediately.

Other Wastes

There is no other waste at the mine that needs to be disposed of.

Waste Minimisation and Recycling

Pering will implement a recycling programme where the following will be recycled:

- Paper and cardboard;
- Plastic;
- Tins;
- Glass; and
- Printer cartridges.

3.4.3.5 Policies and procedures to be implemented during operation

Operational hours

The plant will run 24 hours per day for 26 days a month, while the mining operation will work 2 shifts of each 8 hours each per day (16 hours) for 26 days a month. On average 300 working days per annum (26 days per month less public holidays) will be required for mine operation. Working hours will be two shifts of 8 hours each on weekdays (06:00 – 14:00 and 14:00 – 22:00) and a day shift on Saturdays.

Environmental awareness programme

Pering Mine is required to develop an environmental awareness and induction programme, taking into account site conditions and impacts, while addressing, amongst others, the following:

- What is the environment?
- Why must we look after the environment?
- How do we look after the environment?
- The importance of working areas and no-go areas
- Surface water aspects
- Plants and animals
- The hazards associated with smoking and fire
- The use of petrol, oil and diesel
- The importance of dust control and dust management
- Noise
- Use of toilets
- Rubbish
- Trucks and driving
- Emergency procedures
- Fines and penalties

Procedures for environmental related emergencies

Pering Mine is required to develop an emergency plan and procedure to include procedures for environmental related emergencies.

3.4.4 Decommissioning and Closure Phase

The closure and decommissioning phase will take place over approximately six (6) years and will be undertaken in three phases (decommissioning, closure and rehabilitation, maintenance and monitoring).

3.4.4.1 Decommissioning phase

The decommissioning phase will take place over a period of one (1) year and will include, but may not be limited to the following activities:

- Notifying the DME of the intention to close the operation;
- Scaling down of the operation;
- Implementing the Social and Labour Plan retrenchment plan; and
- Retrenching the non-essential workforce.

3.4.4.2 Closure and rehabilitation phase

The closure and rehabilitation phase will take place over a period of two (2) years and will include, but may not be limited to the following activities:

- Dismantling of processing plant and related structures;
- Demolition of steel buildings and structures;
- Demolition of reinforced concrete buildings and structures;
- Demolition of housing and administration facilities;
- Rehabilitation of access roads;
- Opencast rehabilitation;
- Fencing off pit areas;
- Rehabilitation of overburden, spoil and process plant waste;
- General surface rehabilitation;
- Waste removal; and
- Water management.

3.4.4.3 Maintenance and monitoring

The maintenance and monitoring phase will take place over a period of three (3) years and will include, but may not be limited to the following activities:

- Fertilisation of rehabilitated areas;
- Surface water quality monitoring;
- Groundwater quality monitoring;
- Dust fallout air quality monitoring;
- Fauna and flora monitoring;
- Alien and invasive plant species monitoring and control;
- General maintenance, including rehabilitation of cracks and subsidence;
- Annual environmental performance assessment report development;
- Environmental closure report development;
- Annual environmental aspect reporting; and
- Final closure application development and motivation.

3.4.4.4 Fundamental closure objectives

- The main closure objective at Pering Mine will be to rehabilitate the mining site, so as not to pose a safety hazard for humans and animals, at the same time allowing for an alternative land use as far as possible.
- The objective is also to establish a self-sustainable and stable vegetation cover in order to mitigate the visual impact of the TSF and SSF facilities, to control erosion and to create grazing land for animals.
- The rehabilitated environment also needs to be aesthetically acceptable according to the principle of BATNEEC (Best (proven) Available Technology Not Entailing Excessive Cost).
- Rehabilitation will be done to ensure water resources will be to acceptable water standards when a closure certificate is issued for the new proposed mining activities.

Pering Mine commits to the following principles at mine closure and will ensure that the mine is:

- Neither a danger to public health and safety nor to animal health and safety.
- Not a source of pollution.
- Ecologically and geophysically stable.
- Rehabilitated to a predetermined and agreed land use.
- Compatible with the surrounding biophysical environment.
- Aesthetically acceptable.
- Not an economic an economic, social or environmental liability to the local community or the state now or in the future.
- That the physical and chemical stability of the rehabilitated mining site is such that the risk to the environment is not increased by naturally occurring forces.
- Ensure that the operation is not abandoned but closed efficiently, cost effectively and in accordance with the relevant legal requirements and legislation regarding mine closure.
- Ensure that interested and affected parties will be considered.

3.4.4.5 Social and Labour Plan

As per the SLP, the mining operation will implement local economic development programmes. These programmes would be implemented so as to ensure that once the mine closes, there would be viable self-sustaining businesses which would be able to offer employment to mine workers and community members.

3.4.4.6 Financial provision for closure

Section 41of the MPRDA and regulations 53 and 54 promulgated in terms of the MPRDA deals with financial provision for mine rehabilitation and closure. PBM currently has R13,1 million available for rehabilitation. As per the Quantum of closure-related financial provision in the EMPR, provision for an additional R89.3 million is to be made.

3.4.4.7 Mine Closure Plan

Metago Environmental Engineers was commissioned by BHP Billiton to provide a Closure Plan for Pering Mine. The objectives of this closure plan have been largely fulfilled. Future closure objectives will need to be defined in an updated closure plan to be initiated by PBM to include a post closure monitoring plan.

3.4.4.8 Waste management programme

A waste management programme for the mine closure phase will be developed as part of the mine closure plan.

4

Environmental baseline

This section of the report primarily provides information sourced from specialist studies conducted to provide a baseline from which the overall environmental risks associated with the proposed project can be determined. Baseline information on the following aspects is provided:

- Physical environment.
- Biophysical environment.
- Cultural / Heritage environment.
- Socio-economic environment.

4.1 Climatology

The regional climatology is included in the description of the receiving environment to provide the reader with an understanding of the climatic conditions anticipated for the mining area. This information will then be used in the assessment of impacts that are influenced by seasonal factors, such as dust fallout, and storm water run-off, etc. The hydrological cycle in South Africa runs from October to September, therefore, all climatic information illustrated in the tables and graphs presented in this section of the report are presented from October to September.

The nearest South African Weather Services (SAWS) monitoring stations with complete and detailed information to the proposed mining operation are located at Taung and Vryburg, approximately 50 km east and 70 km north-east of the mine respectively. The Taung weather station has 11 years of recorded data and the Vryburg weather station has 29 years of recorded data. Data recorded at these stations was used to get an approximation of what the climatic conditions experienced within the mining area may be like.

The SAWS recommends using a minimum of a 30 year period to generate what is known as the "*normal*" climatic conditions. This is to allow for the fluctuation in climatic conditions, particularly when considering rainfall. For the purposes of this report, the long-term average data obtained from the SAWS generally includes a 30 year period. However, the averaging period for rainfall may not be the same as the averaging period for wind field data.

4.1.1 Mean Monthly Annual Rainfall

Based on the long-term average rainfall data, the region is characterised by summer rainfall, with 74% of the annual rainfall occurring between November and March (Table 9). Taung is drier than Vryburg, receiving 21.04 mm less rain annually than Vryburg. The average annual rainfall for Taung and Vryburg is 459.30 mm and 480.34 mm respectively.

Table 9: Average monthly rainfall recorded at the Taung and Vryburg SAWS stations

Month	Taung (mm)	Vryburg (mm)
October	29.02	40.07
November	55.73	53.26
December	73.23	58.30
January	92.58	88.50
February	52.60	90.28

March	60.75	66.39
April	33.37	36.10
May	35.73	17.84
June	4.13	5.06
July	2.80	1.46
August	6.38	6.36
September	12.97	16.72
TOTAL	**459.30**	**480.34**

During the drier months, it is anticipated that the amount of dust that will be generated at the Pering Mine operation will increase. The average monthly rainfall will help anticipate during which months more water will be required for dust mitigation measures. Furthermore, the monthly rainfall gives an indication of when Pering Mine must maintain its stormwater systems to prevent flooding, and how much the stormwater systems must be able to handle.

4.1.2 Maximum Rainfall Intensities per Month

The long-term 24-hour maximum rainfalls recorded for the SAWS station at Taung and Vryburg are given in Table 10. The highest 24 hour maximum rainfall at both Taung and Vryburg, have occurred in February.

Table 10: Long-term 24-hour maximum rainfalls recorded for the SAWS stations at Vryburg and Taung

Month	24 Hour Maximum – Taung		24 Hour Maximum – Vryburg	
	Rainfall (mm)	Year of Occurrence	Rainfall (mm)	Year of Occurrence
October	25.0	1999	60.0	2002
November	62.0	2003	90.	1986
December	74.2	2000	56.0	1983
January	50.8	2008	83.0	2000
February	80.6	2006	125.0	1988
March	54.6	2003	74.0	1988
April	36.0	2005	47.5	1982 / 1988
May	50.2	2003	44.0	2001
June	13.0	2007	26.5	1991
July	7.0	1997	10.0	1983
August	36.2	2002	31.5	1979
September	71.6	2007	57.0	2007

Rainfall intensities indicate when it is most likely that flash flooding could occur on site, as well as what capacities the storm water systems must be able to handle.

4.1.3 Mean Monthly Evaporation

According to Midgley *et.al.* (1994(b)), Pering Mine lies in a zone with an average annual evaporation of between 2,000 – 2,200 mm. The closest evaporation stations to Pering Mine are located at Armoedsvlakte (C3E002) and Vaalharts (C3E006).

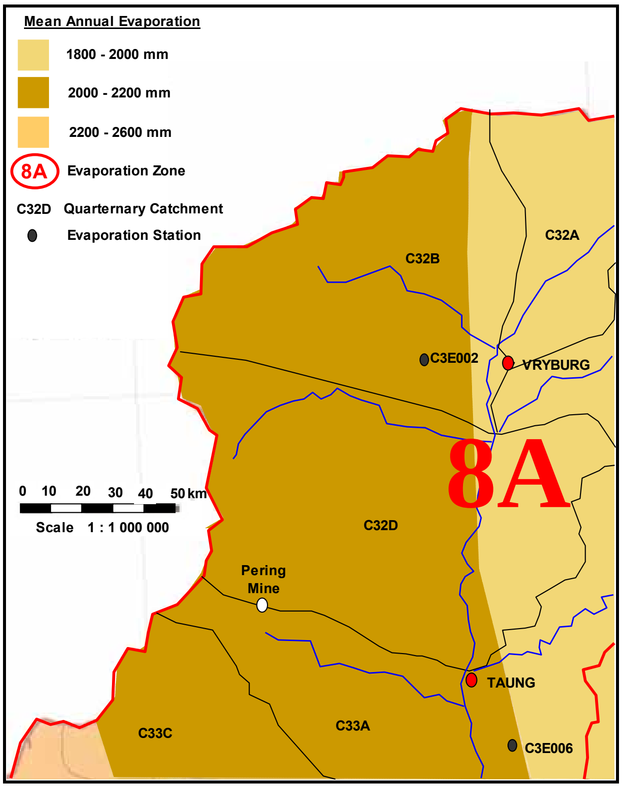


Figure 10: Evaporation stations closest to Pering Mine (adapted from Midgley *et.al.*, 1994(b))

The highest evaporation occurs during the summer months (November to March) (Table 11). Evaporation will influence the amount of water that will be lost from open water systems at Pering Mine. As with rainfall, evaporation influences how much water will be required to reduce the amount of dust generated on site.

The monthly evaporation rate exceeds the monthly rainfall rate throughout the year Table 11. Due to the high evaporation deficit, the option of dewatering the pits prior to mining would possibly be feasible.

Table 11: Evaporation measured at C3E002 and C3E006 (Midgley *et.al.*, 1994(a))

Month	Evaporation (mm)	
	Evaporation Station C3e002 Armoedsvlakte	Evaporation station C3e006 Vaalharts
October	296.50	253.487
November	312.27	266.968
December	323.90	276.913
January	304.51	260.338
February	230.84	197.353
March	212.49	181.662
April	158.46	135.473
May	126.15	107.848
June	100.04	85.527
July	116.58	99.671
August	169.06	144.534
September	234.20	200.226
TOTAL	**2,585**	**2,210**

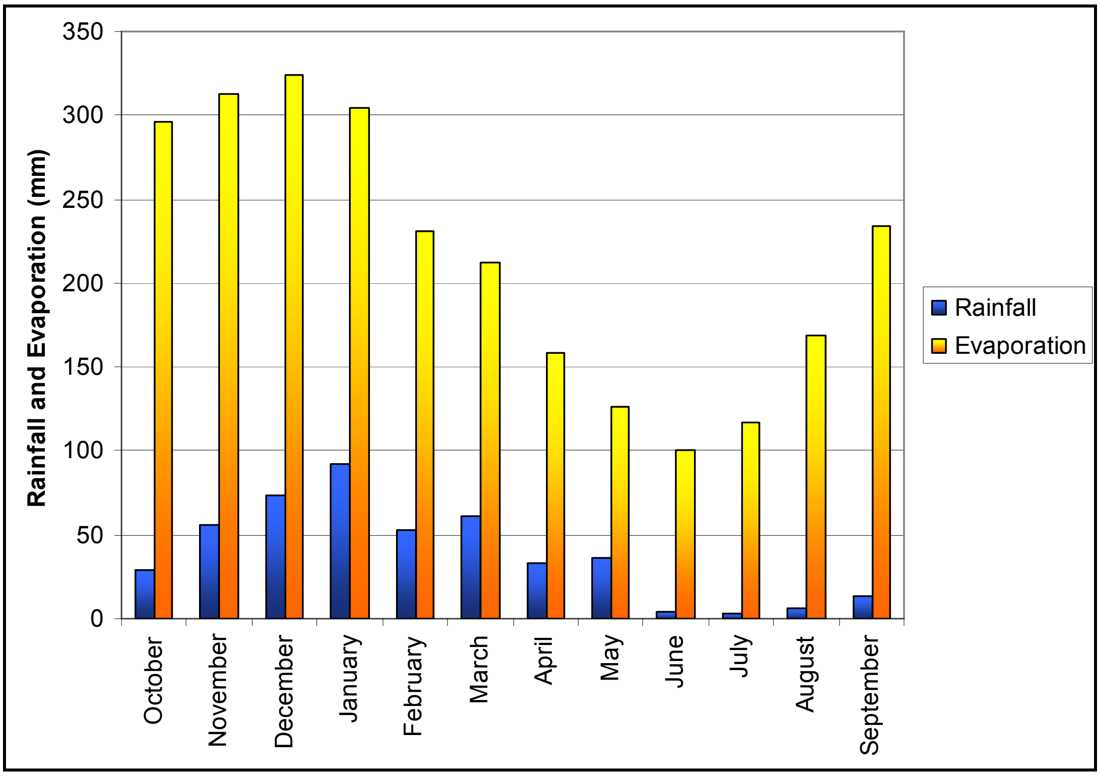


Figure 11: Rainfall and evaporation rate comparisons

4.1.4 Mean Monthly, Maximum and Minimum Temperatures

The monthly average of daily temperatures, illustrating the long-term monthly mean, minimum and maximum temperatures are presented in Table 12. As is typical throughout South Africa, there is a distinct seasonal variation in temperature. The mean monthly temperatures are highest between November and February which are typically summer months. Temperatures gradually drop with the lowest temperatures being recorded during June and July, which are typically winter months in South Africa.

Table 12: Long-term monthly maximum, minimum and mean temperatures recorded at the SAWS at Taung and Vryburg

Month	Minimum Temperature (°C)			Maximum Temperature (°C)		
	Taung	Vryburg	Average	Taung	Vryburg	Average
October	13.12	11.79	12.46	30.44	29.26	29.85
November	15.11	13.94	14.53	31.91	30.76	31.34
December	17.31	15.83	16.57	32.90	31.90	32.40
January	17.78	16.92	17.35	32.12	32.02	32.07
February	17.82	16.47	17.15	32.42	31.01	31.71
March	15.75	14.16	14.96	30.26	29.33	29.80
April	11.10	9.75	10.43	26.95	26.69	26.82
May	5.94	4.52	5.23	23.37	23.29	23.33
June	2.38	0.55	1.46	21.16	20.10	20.63
July	1.73	-0.05	0.84	21.02	20.26	20.64
August	4.28	2.81	3.54	23.88	23.18	23.53
September	8.17	7.39	7.78	27.39	27.11	27.25

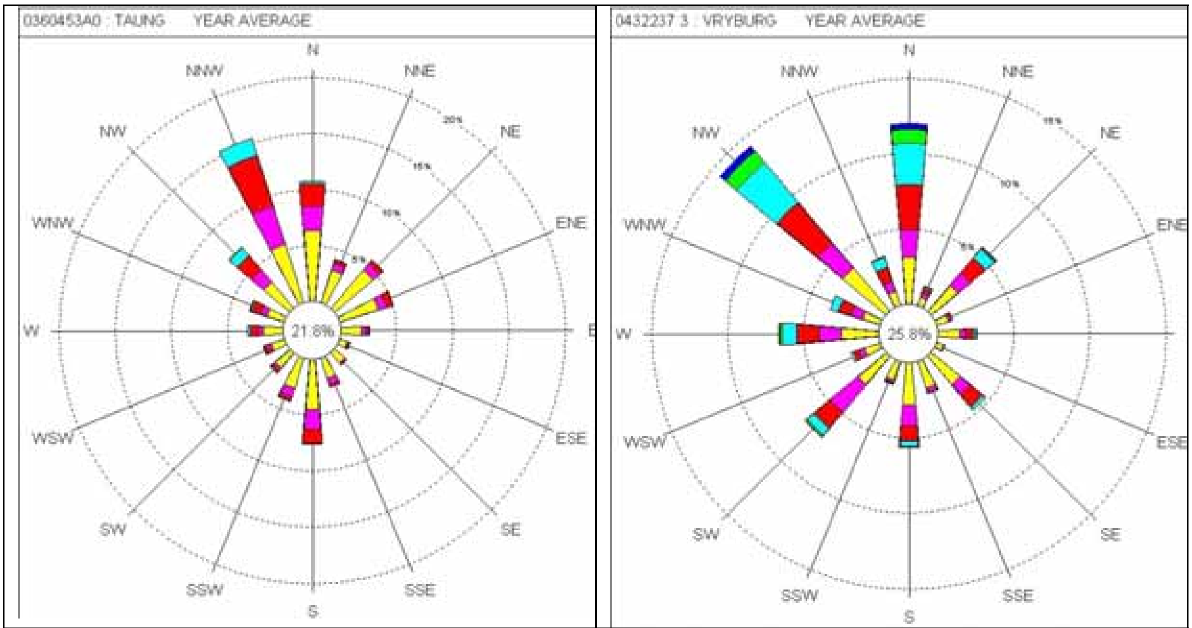
Temperatures and evaporation are linked. The higher the temperature, the more likely it is for the evaporation rates to be high.

4.1.5 Monthly Wind Direction and Speed

Annual average and monthly average wind roses have been generated using hourly wind speeds recorded at the SAWS stations at Taung and Vryburg (Figure 12). The wind roses indicate the wind frequencies for the 16 cardinal wind directions. The frequency of occurrence of winds in each direction is indicated by the length of the shaft compared with the dotted circles, representing a 5% frequency of occurrence. At the bottom of each wind rose are wind speed classes. These illustrate the frequencies of occurrence of winds in each category, for each wind direction. The frequencies of calm periods, wind speeds are below 1 metre per second (m/s), are indicated as a percentage value in the centre of each wind rose.

The predominant wind direction for this region arises from the north-western quadrant. On average, calm periods are recorded as occurring 21.8 – 25.8% of the year.

During a year, the frequency of north-westerly winds remains prominent, with an increase in south-westerly winds during the winter months. It is during these periods that any dust generated from the mining operation would have the greatest impact. However, with the start of the summer rains in November, the generation and transportation of dust between November and December will be reduced.



	0.5 – 2.5 m/s		2.5 – 3.5 m/s		3.5 – 5.6 m/s		5.6 – 8.7 m/s		8.7 – 10.7 m/s		>10.7 m/s

Figure 12: Annual average wind direction and speed for Taung and Vryburg

Wind direction determines which areas and communities will be affected by the fugitive dust generated by the mining activities. From the Taung and Vryburg data it is anticipated that the area to the south-east of the site is the most likely to be affected.

4.2 Topography and residual features

4.2.1 *Topography*

Pering Mine is situated at 1,420 meters above mean sea level (mamsl). The general area is flat with a shallow topographic gradient of 1 in 323 dipping to the east, but in vicinity of the mine the gradient steepens slightly to 1 in 286. The only breaks in the flat topography are calcrete ridges formed over faults and shale bands. These can vary in height from less than a metre to several metres, depending on the width of the feature and the extent of the dolerite intrusion (EMP, 1997). The topography of the mining area is further broken by the tailings dam, the two rock dumps, the return water dam, the dried out Louis Lake area and the two pits.

4.2.2 *Key residual features from historic mining practices*

Pering Mine was an operational mine between 1986 and 2003. After 2003 rehabilitation procedures were instituted, whereby all mine related infrastructure was removed and disturbed areas were rehabilitated. Certain areas were contaminated with dust blown tailings, burst tailings pipes, evaporates, concentrate spillages and oil and grease spillages. These areas were remediated. The key remaining residual features at Pering Mine include the following:

- Tailings dam – The top and side slopes of the entire tails dam surface was lined with a cladding of waste rock to limit water seepage into the tails dam and minimize wind and water erosion and dust fallout.
- Main Pit and Pit 24 – These pits have been infiltrated with groundwater and rainwater since closure and currently there is approximately 8Mm^3 in the Main Pit.
- A groundwater sulphur plume from the tailings dam which has migrated in a north easterly direction.

Currently, the following infrastructure / mining associated footprints are located on site:

- A security hut;
- Access roads;
- Eskom power lines and substation;
- A tailings dam;
- Two rock dumps;
- Two mined-out pits, and
- A return water dam.

The location of the various structures is shown in Figure 17.

Figure 13: Tailings dam at Pering Mine

Figure 14: Main Pit at Pering Mine

Figure 15: Pit 24 at Pering Mine

Figure 16: Dried-out return water dam at Pering Mine

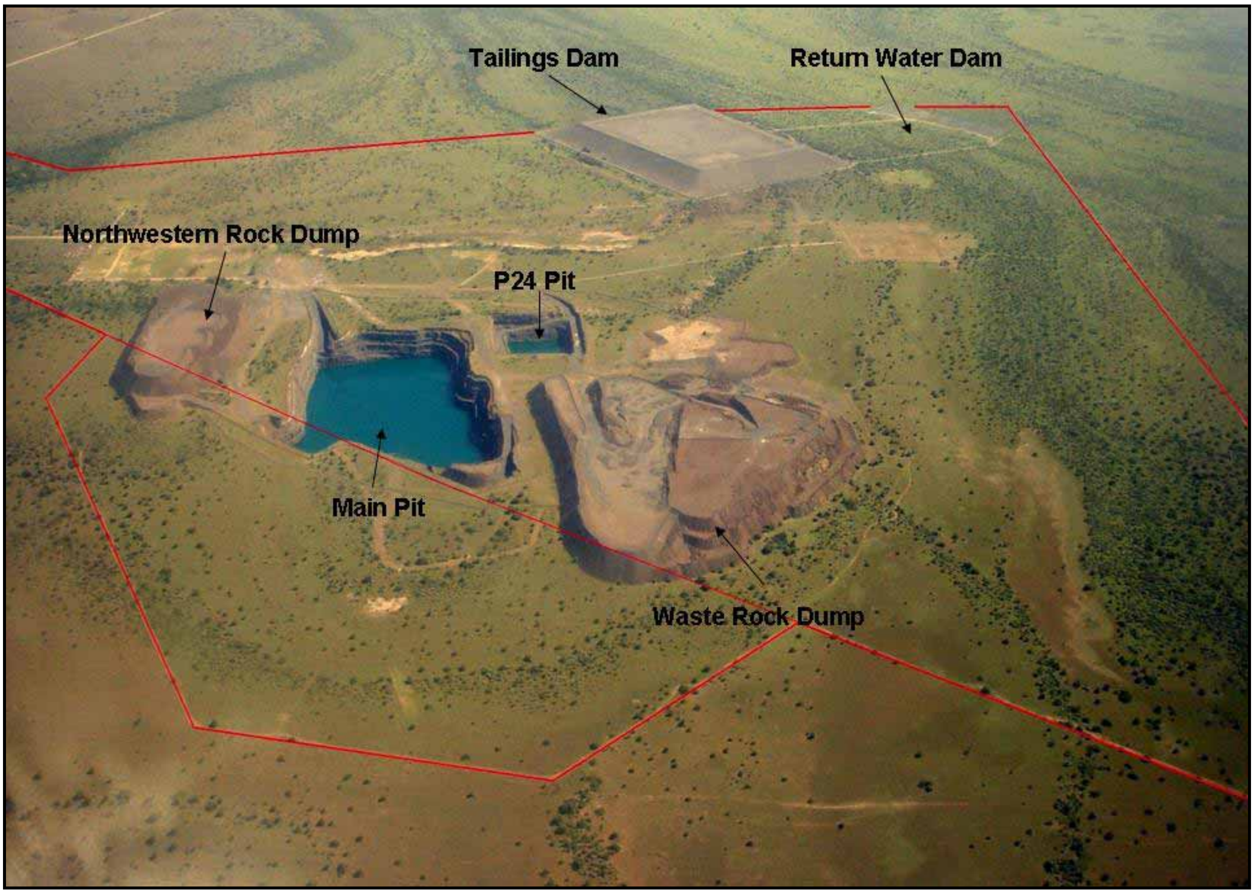


Figure 17: Oblique aerial photograph of Pering Mine and existing surface residues

4.3 Geology

4.3.1 Regional Geology

The epigenetic zinc-lead (Zn-Pb) mineralisation at Pering Mine is hosted by the Steekdorings Member (platform carbonate sediments) of the Reivilo Formation (dolomitic) of the Campbell Rand Subgroup of the Transvaal Supergroup of rocks. The dolomitic host rocks consist of near-horizontal beds of columnar stromatolites and massive dolomite, with thin carbonaceous shale interbeds. The carbonates are part of an extensive Lower Proterozoic volcano-sedimentary sequence filling a depressed regional structure known as the Vryburg Trough. The mineralised setting of the Pering Mine deposit strongly resembles that of the Mississippi Valley-type Zn-Pb deposits.

A regional geological map of the region is provided in Figure 18, whilst Figure 19 illustrates the surface geology of the local area. The Ghaap Plateau is defined by the large outcrop region of the Ghaap Group in the Griqualand West basin.

4.3.2 Local and Economic Geology

The Pering Mine Zn-Pb mineralisation is associated with two oval breccia[1] bodies which cut across the stratigraphy and which occur in the core of a small basin-like downwarp, approximately 2 km in diameter.

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[1] A breccia is a clastic sedimentary rock composed of angular clasts in a consolidated matrix. Breccias can be produced in several geologic processes: tectonic breccia, volcanic breccia (eruption breccia, vent breccia), sedimentary breccia (e.g., rock fall breccia),

The dip of the host sediments is from the edge towards the centre of the downwarp, ranging from 2 degrees at the edge to 15 degrees at the centre.

The mineralisation occurs either as broadly horizontal stratabound layers, preferentially exploiting the stromatolitic horizons in close proximity to the breccia bodies, or as subvertical breccia zones, on the margins of the core breccia.

Sphalerite (ZnS) and Galena (PbS) are the main ore minerals, with minor amounts of pyrite, marcasite and trace amounts of chalcopyrite being observed. Sphalerite and galena are either very fine-grained in the stratabound ore, or occur as crustiform and colloform masses in the breccia, often filling vugs[2], with associated calcite and lesser quartz veining. Galena crystallisation marginally post-dates the sphalerite. The Zn:Pb ratio varies within the deposit but averages approximately 5:1. The sphalerite contains very little iron (± 0.5%) and thus produces a very clean, acceptable zinc concentrate.

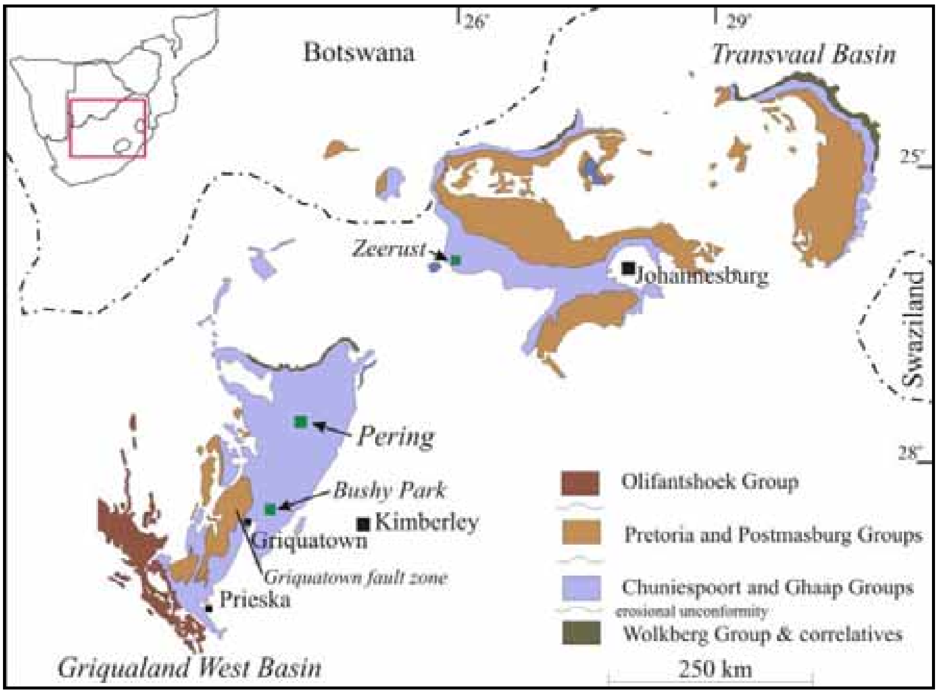

Figure 18: Regional geological map

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collapse breccia (e.g., in karst areas). Depending on the origin of the clasts, monomictic (monogenetic, monolithologic) and polymictic (polygenetic, polylithologic) breccias may be distinguished [http://www.impact-structures.com/breccia/breccia.htm].

[2] Small to medium sized cavities inside rock that may be formed through a variety of processes.

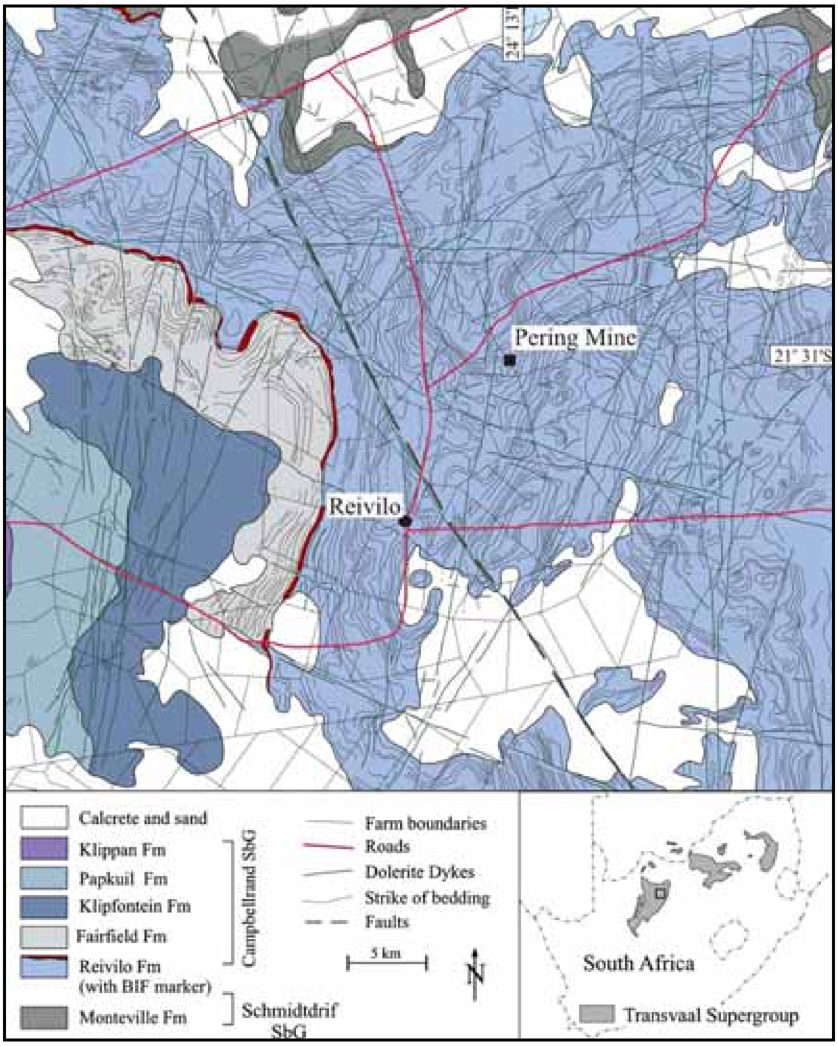


Figure 19: Geology of the area around Reivilo and the location of Pering Mine (modified after Beukes 1978)

There is no silver associated with the base metal sulphides. The metal-bearing brines from which the Pering Mine mineralisation formed are thought to have been derived from solution dewatering of the underlying basement, with a strong structural control focussing their migration and emplacement. Favourable carbon-rich stromatolitic horizons, coupled with host rock dissolution and brecciation resulted in precipitation of the base metal sulphides.

The nature of the mineralisation tends towards a relatively erratic and laterally restricted distribution of patchy higher-grade base metal sulphides in an environment of more laterally extensive lower grade. Meteoric oxidation of the sulphides is prevalent to between 5 and 10 meters from surface.

Figure 20 illustrates the surface geological map of the Pering Mine deposit and surrounding areas. The subvertical breccia bodies that host the bulk of the mineralization are marked on the figure whilst **Figure 21** indicates the topographical digital terrain model with an outline of the current waste rock dump location.

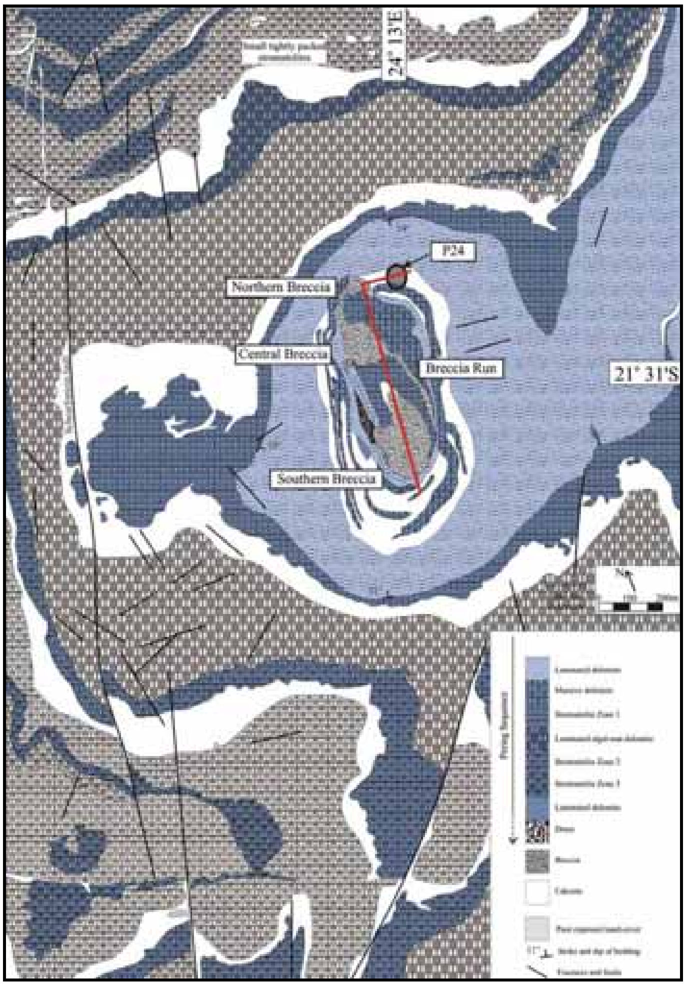


Figure 20: Surface geological map of the Pering deposit and surrounding area (modified after Wheatley *et al.* 1986

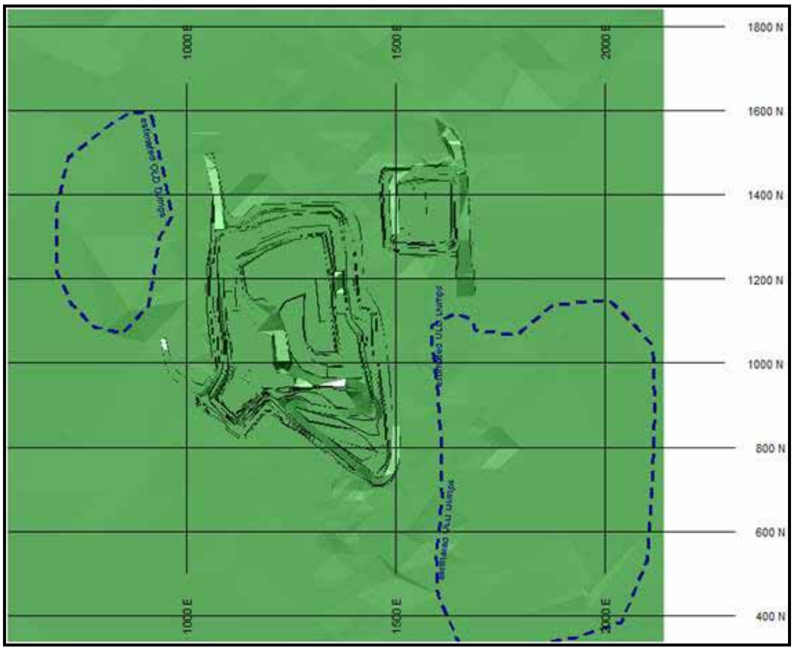


Figure 21: Topographical digital terrain model indicating the location of the waste rock dumps

4.4 Soil and Agricultural Potential

4.4.1 Soil

According to the Department of Environmental Affairs and Tourism (DEAT) Environmental Potential Atlas for the North West Province (Figure 22), the soils found in and around Pering Mine are described as being soils with minimal pedological development, being usually shallow on hard or weathering rock, with or without intermittent diverse soil. Lime is generally present in part or most of the landscape. (DEAT *et.al,* 2000). These soils are less than 450 mm deep (AGIS, 2009).

A soil survey was undertaken for the 1997 EMP (Table 13). The soils of the Mispah form cover 90% of the site. This soil type is divided into 2 families, namely:

- Myhill: The orthic A horizon[3] consists of a brown, single grain, fine to loamy sand topsoil (8 – 12% clay) of an aeolian origin. The depth of the topsoil varies between 10 and 30 cm. This soil family is dominant of the area.
- Gulu: This soil family consists of a greyish-brown to grey, single grain, fine loamy sand topsoil of aeolian origin. The depth of these soils varies between 10 and 40 cm. This family is predominantly present in the southern and south-eastern parts of the area.

Soils of the Coega form consist of an orthic A horizon on a hardpan carbonate horizon[4]. The A horizon consists of a greyish-brown to grey, single grain, fine loamy sand topsoil of aeolian origin. The topsoil depth varies between 10 and 20 cm. The soils of the Mispah and Coega forms have a very low clay percentage (8 – 15%). This results in soils with a very low water holding capacity.

Table 13: Soil forms and their families encountered at Pering Mine (EMP, 1997)

Soil Form	Area Covered at Pering Mine	Soil Family	Diagnostic Properties	Diagnostic Horizon
Mispah	90%	Myhill	A horizon not bleached	Ortic A
		Gulu	A horizon bleached	Hard rock
Coega	10%	Nabies	A horizon not calcareous	Orthic A Hardpan carbonate horizon

[3] A surface horizon that does not qualify as organic, humic, vertic or melanic topsoil horizon.
[4] A horizon consisting of a continuous, very hard, massive layer cemented by carbonates.

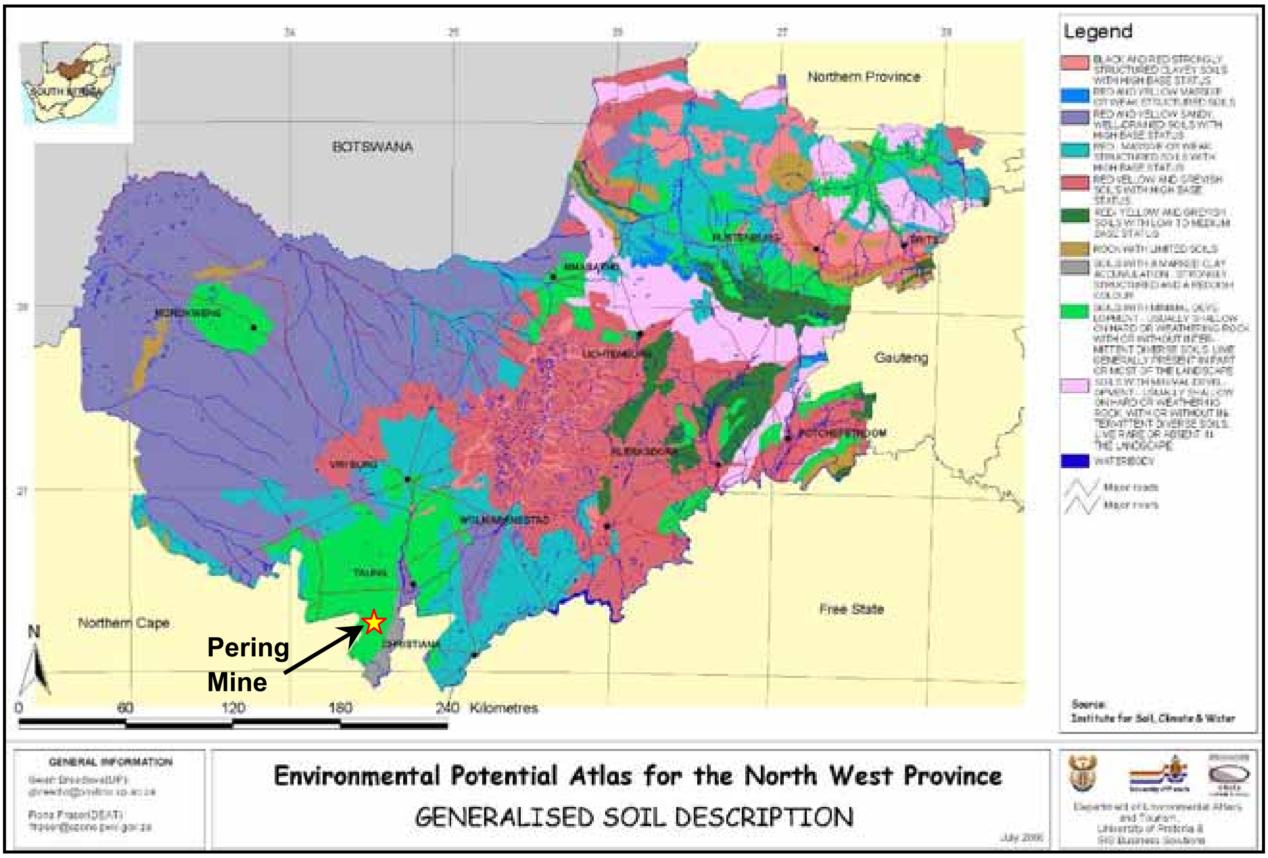


Figure 22: General soil type found on site (DEAT *et.al.*, 2000)

4.4.2 Agricultural Potential

Pering Mine can be viewed as a combination of Class III (grazing land) and Class IV (wilderness land), being the latter being the dominant class. According to Agricultural Geo-Referenced Information System (AGIS, 2009), the land capability for Pering Mine is non-arable, with a low to moderate potential, grazing land. The grazing capacity is between 10 and 12 ha / LSU (Livestock Units). According to the local farmers, the Pering property was stocked at 6.5 ha/LSU.

4.5 Surface Water

Pering Mine is situated within the Vaal River drainage region (Midgley *et.al,* 1994(b)). The movement of water on site is south east towards the Harts River, which eventually flows into the Vaal River (EMP, 1997).

There is no clearly defined stream system in the immediate area, indicating that water movement in the area would largely be a result of sheet flow (EMP, 1997). There is a defined dry drainage channel to the south east of the site (Figure 23: Dry channel in the south-east of the site

and overland flow from the site would likely reach this channel. The lowest area of the mining property lies in the eastern part of the site, which means that much of the mine area would be affected by sheet flow caused by the east-south-east slope of the terrain.

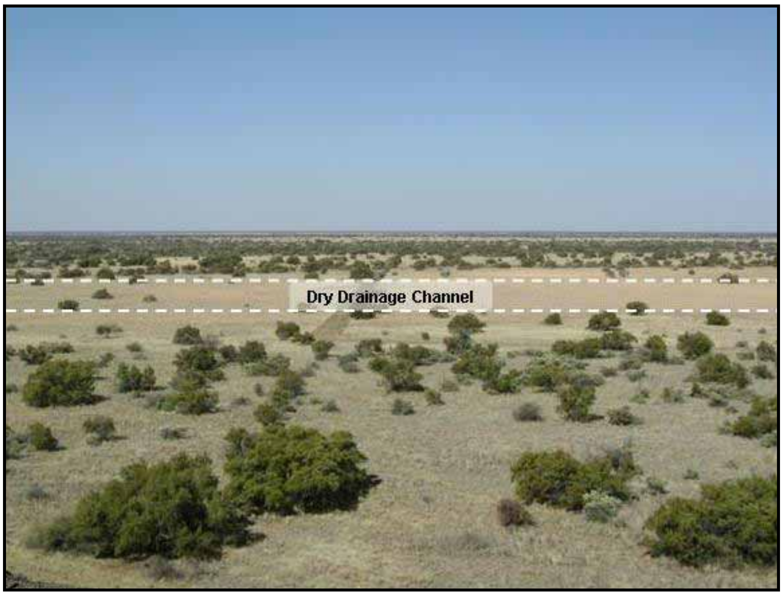


Figure 23: Dry channel in the south-east of the site

Locally the site is drained by south-eastward flowing non-perennial drainage courses that are active during and after rain events. The more resistant stromatolitic features which define the east-south-east slope of the terrain also control drainage. There is little stream development in the area and runoff generally collects in pans, which can persist for several weeks until the water has either evaporated or infiltrated into the ground. (SRK, 2009)

4.5.1 Surface Water Quality

Surface water monitoring is conducted at the Main Pit and Pit 24 on a bi-annual basis. Results from water monitoring from the Main Pit and P24 for September 2010 are provided below (refer to the full specialist report in Appendix 4).

The results are as follows:

- Exceeding elements in the Main Pit:
  - Domestic use: Total Dissolved Solids (TDS), Sulphates (SO_4), Electrical Conductivity (EC), Calcium (Ca), Magnesium (Mg) and Lead (Pb).
  - Livestock watering: TDS and SO_4.
  - Aquatic ecosystem: Pb and Zinc (Zn) above the Acute Effect Value, Selenium (Se) above the Chronic Effect Value and Cadmium (Cd) exceeded the Target Water Quality Guidelines (TWQG).
- The predicted increase in salinity and Pb levels in the pit lakes over time cannot be confirmed. Water quality remained fairly stable.
- No active intervention in the control of the pit lake water quality is required as the concentrations were within the upper bound limits.
- Exceeding (above TWQR) parameters at several groundwater sites;
  - Domestic use: mainly TDS, Mg, SO4, EC, Ca, Na, NO3-N, Cl, Hg, Pb and Mn as well as F, Zn, Se and Al at selected sites
  - Livestock watering: mainly TDS, Mg, SO4 and Cu as well as Al at one site.
- Of special concern were the following sites: WW16 (east of return water dam), FD1 (between pit and south waste dam), FD3 (west of waste rock dump), GW2B-1D (north of pits, close to Pit 24), GW2B-2 (east of northern waste rock dump) and GW2B-4 (east of retail dam).

- The following parameters proved to be evident in groundwater in concentrations, exceeding the expected upper level at closure (Metago, 2006): SO4, Mg, Hg, Pb and Al.
- The water level dropped in most boreholes in 2007 but increased again in the following years with exception of borehole PNN17. Due to the nature of the geology in the area (i.e. with reference to the localised fracturing), it is difficult to accurately explain the variances in water levels without updating the entire groundwater model. This information should be incorporated into the groundwater model when updated in order to make sensible conclusions from these variances.

Pit lake results

The chemical makeup of both pits is similar based on the physico-chemical results of the monitoring programme (Refer to **Table 14** as well as CHEMC report in **Appendix 4**). The main anion proved to be SO4 whereas the main cation was Mg. Electrical Conductivity levels proved to be higher in the Main Pit than in Pit 24 which is mainly attributed to higher SO4 concentrations in the Main Pit. However, when compared to the previous results SO4 levels in Pit 24 increased. Nonetheless, since monitoring started salinity levels in both pits remained fairly static. According to the applied drinking water standard, TDS, EC and SO4 levels were high and above the standard limit. While SO4 concentration in the Main Pit proved to be slightly above the livestock guideline, SO4 levels in Pit 24 complied with the livestock guideline. Total dissolved solid levels on the other hand exceeded the livestock guideline in both pits.

Table 14: Physico Chemical results for surface and groundwater (CHEMC)

Site Name	pH	TDS mg/l	EC mS/m	Tot Alk CaCO3	Tot Hardness CaCO3	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	NO3-N mg/l	NH4 mg/l	Carbonate	Cl mg/l	SO4 mg/l	Phosphate mg/l	Bicarbonate	F mg/l	SAR meq/l
SURFACE WATER																		
Main Pit A	8.37	[illegible]	211.00	208.00	1193.71	166.40	235.89	34.49	2.09	2.09	0.05	4.80	80.90	[illegible]	0.00	244.00	0.56	0.40
Main Pit B	8.36	[illegible]	210.00	207.00	1148.20	159.01	229.28	32.36	1.98	1.63	0.02	4.20	72.92	[illegible]	0.00	244.00	0.43	0.38
Main Pit C	8.36	[illegible]	210.00	206.00	1158.38	161.30	230.12	33.10	1.96	1.93	0.02	4.20	76.93	[illegible]	0.00	242.78	0.43	0.39
Main Pit D	8.38	[illegible]	214.00	214.00	1164.71	159.90	234.18	34.91	2.21	1.85	0.05	4.80	78.90	[illegible]	0.00	251.32	0.37	0.41
P 24	8.54	[illegible]	179.00	264.00	809.17	115.06	186.36	32.34	1.89	0.76	0.02	6.30	66.77	768.10	0.00	309.27	0.43	0.43
GROUNDWATER																		
B10	8.16	443.31	78.00	329.00	117.75	95.23	50.04	12.60	0.08	0.75	0.02	0.00	18.58	62.90	0.00	401.38	0.34	0.26
B11	8.08	434.85	77.00	315.00	108.02	77.13	55.41	10.68	0.24	1.69	0.02	0.00	27.87	63.96	0.00	384.30	0.38	0.23
B12C	8.19	513.70	89.00	400.50	155.52	108.82	68.32	14.25	5.03	0.54	0.49	0.00	21.27	49.31	0.00	488.61	0.36	0.26
PNN 3	8.00	[illegible]	296.00	512.00	1534.34	259.39	335.81	68.29	1.39	1.41	0.02	0.00	131.59	[illegible]	0.00	624.64	0.00	0.66
PNN 4	7.69	[illegible]	394.00	340.50	2557.42	327.25	502.33	105.21	0.81	2.19	0.02	0.00	151.93	[illegible]	0.00	415.41	0.97	0.85
PNN 5	8.03	[illegible]	652.00	463.00	3531.96	408.91	712.16	160.89	2.19	3.54	0.02	0.00	228.26	[illegible]	0.00	564.88	1.30	1.11
PNN 6	7.93	4180.47	454.00	243.50	2814.47	294.23	556.64	100.89	9.99	0.00	0.08	0.00	148.34	[illegible]	0.00	297.07	1.14	0.80
PNN 8	8.31	734.69	103.00	174.00	423.28	62.48	103.64	31.73	1.93	0.00	0.02	1.80	33.04	391.61	0.00	208.62	0.42	0.57
PNN 9	8.11	[illegible]	469.00	269.00	2732.48	310.47	531.51	95.47	10.21	0.00	0.01	0.00	135.74	[illegible]	0.00	328.18	1.25	0.76
PNN 10	8.24	561.08	89.00	372.00	201.62	113.18	69.78	13.63	0.88	3.07	0.03	0.00	30.25	92.73	0.00	453.84	0.34	0.25
PNN 11	8.17	1094.36	133.00	394.50	509.90	143.14	127.59	25.20	5.78	1.23	0.06	0.00	25.05	520.22	0.00	481.29	0.62	0.37
PNN 12	8.32	[illegible]	271.00	287.50	1379.20	223.63	266.37	54.77	0.79	4.04	0.03	3.00	113.39	[illegible]	0.00	344.65	0.82	0.59
PNN 13	8.26	[illegible]	277.00	276.00	1365.43	222.88	261.83	61.39	0.47	3.68	0.01	0.00	92.31	[illegible]	0.00	336.72	0.00	0.66
PNN 14	8.39	649.23	95.00	365.00	227.43	110.86	73.82	15.97	0.20	1.36	0.02	4.80	15.87	203.40	0.00	435.54	0.55	0.29
PNN 15	8.20	697.61	105.00	399.00	242.58	123.63	79.82	19.78	0.46	2.08	0.06	0.00	64.47	156.77	0.00	486.78	0.60	0.34
PNN 16	7.52	[illegible]	297.00	463.50	1586.07	312.18	307.30	78.95	0.44	0.00	0.05	0.00	410.92	[illegible]	0.00	565.47	0.00	0.76
PNN 17	8.14	[illegible]	155.00	178.00	1060.07	219.23	167.20	12.19	0.41	7.89	0.02	0.00	13.84	947.50	0.00	217.16	0.47	0.15
PNN 18	8.02	749.27	119.00	393.00	352.48	133.97	98.26	27.29	0.66	2.78	0.04	0.00	37.43	198.88	0.00	479.46	0.57	0.44
PNN 19	8.28	614.63	103.00	417.00	231.59	123.55	81.64	15.39	0.50	2.05	0.05	0.00	34.17	95.56	0.00	508.74	0.43	0.26
BHP2	7.68	924.66	121.00	394.00	375.32	101.11	123.33	37.01	0.15	0.28	0.03	0.00	44.25	376.62	0.00	480.68	0.83	0.58
PNN 20	8.32	624.70	101.00	332.00	247.20	78.45	90.99	25.15	0.87	0.24	0.03	1.20	34.61	190.02	0.00	402.60	0.67	0.46
FD	8.25	900.65	121.00	435.00	376.87	142.08	109.88	16.80	1.14	0.41	0.03	0.00	33.35	329.29	0.00	530.70	0.71	0.26
FD 2	7.93	991.05	128.00	465.50	389.85	144.64	118.46	24.09	1.38	0.24	0.03	0.00	47.43	369.05	0.00	567.91	0.56	0.36
FD 3	8.14	962.47	128.00	443.50	383.74	142.35	113.05	23.78	1.43	0.30	0.03	0.00	47.61	361.29	0.00	541.07	0.76	0.36
GW-2B 1D	8.41	580.03	84.00	182.00	303.66	60.52	79.46	22.34	0.32	2.19	0.03	3.00	10.51	286.14	0.00	215.94	0.27	0.44
GW-2B 1S	8.34	423.75	64.00	198.50	135.37	59.23	43.78	18.63	0.11	0.00	0.04	1.80	5.49	174.87	0.00	238.51	0.38	0.45
GW-2B 2	8.17	[illegible]	363.00	126.50	3491.77	329.29	679.08	13.37	0.76	0.55	0.04	0.00	10.05	[illegible]	0.00	154.33	0.00	0.10
GW-2B 3	8.26	813.16	117.00	244.00	454.81	116.98	98.22	10.29	0.26	5.13	0.02	0.00	8.95	406.28	0.00	297.68	0.64	0.17
GW-2B 4	7.96	[illegible]	364.00	313.00	1919.42	211.00	406.84	48.09	17.53	0.00	0.03	0.00	34.42	[illegible]	0.00	381.86	0.00	0.45
GW-2B 5	7.98	[illegible]	395.00	376.00	1998.48	209.40	441.89	54.17	18.07	0.00	0.03	0.00	32.37	[illegible]	0.00	458.72	0.00	0.49
GW-2B 6	7.92	[illegible]	578.00	179.50	2981.39	232.05	619.51	119.37	7.82	0.00	0.77	0.00	210.36	[illegible]	0.00	218.99	0.00	0.93
TR 1	8.01	490.44	84.00	396.00	116.49	101.52	61.90	12.21	0.40	2.12	0.05	0.00	14.43	48.55	0.00	483.12	0.45	0.24
TR 2	7.85	683.56	102.00	404.00	342.82	123.00	105.76	13.57	0.27	1.90	0.04	0.00	19.67	165.81	0.00	492.88	0.51	0.22
TR 3	7.90	583.22	104.00	396.00	191.86	105.50	77.96	14.45	0.47	3.08	0.15	0.00	11.07	116.74	0.00	485.56	0.56	0.26
TR 4	7.89	1061.73	182.00	407.00	411.41	138.95	112.70	30.34	1.29	0.83	0.02	0.00	65.30	460.17	0.00	496.54	0.61	0.46
TR 10	8.09	[illegible]	217.00	417.50	858.87	175.86	200.25	56.95	0.66	0.48	0.07	0.00	65.89	940.84	0.00	509.35	0.42	0.70
BHP 1	8.17	694.94	98.00	346.00	252.89	94.43	86.38	20.07	0.83	0.97	0.09	0.00	115.74	161.60	0.00	422.12	0.53	0.36
BHP 3	8.00	888.51	155.00	509.00	390.22	156.90	122.08	20.54	0.59	0.86	0.04	0.00	53.88	220.10	0.00	620.98	0.49	0.30
BHP 4	8.13	537.07	95.00	413.00	182.91	107.94	78.69	10.56	0.34	0.36	0.03	0.00	20.99	65.30	0.00	503.86	0.45	0.19
PGBH 2	8.25	[illegible]	404.00	212.50	1989.09	195.71	408.10	129.65	11.90	1.63	0.02	0.00	313.52	[illegible]	0.00	259.25	1.53	1.21
o/B hole	8.19	555.87	85.00	333.00	265.13	108.36	78.84	10.41	0.18	1.23	0.01	0.00	20.42	128.50	0.00	406.26	0.45	0.19
N North	8.07	801.41	96.00	319.00	202.45	100.48	65.05	11.07	0.24	2.22	0.02	0.00	19.62	400.11	0.00	389.18	0.41	0.21
N South	7.39	[illegible]	430.00	346.50	2294.95	341.67	431.46	93.03	0.72	6.77	0.13	0.00	167.12	[illegible]	0.00	422.73	0.00	0.79
W 253	8.31	[illegible]	190.00	312.00	925.78	178.14	190.35	38.39	1.49	0.38	0.06	0.60	83.43	[illegible]	0.00	379.42	0.75	0.48
W 453	7.95	[illegible]	315.00	162.50	1678.72	302.69	283.21	12.22	0.92	9.90	0.02	0.00	11.07	[illegible]	0.00	198.25	0.00	0.12
WP 1	8.08	607.88	99.00	392.00	235.75	115.07	82.10	13.93	0.00	0.37	0.02	0.00	24.12	132.03	0.00	478.24	0.31	0.24
WW 16	7.94	[illegible]	436.00	425.00	2445.67	298.62	508.25	91.36	6.70	1.06	0.06	0.00	93.57	[illegible]	0.00	518.50	0.00	0.75

Exceedance of Drinking Water Standard highlighted in yellow, livestock in orange and if both were exceeded results were highlighted in red.

Heavy metals

Metal concentrations in the pits complied with the applied drinking water standard with the exception of Pb levels. The metal analyses revealed that Pb concentrations exceeded the drinking water standard in both pits which was also commonly observed in the past. Historic data however, do not show a clear trend in terms of metal contamination.

Lead is defined by the USEPA as potentially hazardous to most forms of life, and is considered toxic and relatively accessible to aquatic organisms. The Domestic Use Guidelines (DWAF 1996a) for Pb concentrations of 10-50 µg/l state the following; "No danger of any adverse health effects except for a slight risk of behavioural changes and possibility of neurological impairment, where the exposure to lead from other sources, such as food, is not minimised". Lead concentrations during this sampling cycle remained below 50 µg/l.

4.6 Groundwater

The following section is a summary of findings from specialist studies and monitoring results. This section examines the quantity and quality of groundwater and compares the changes over time. Full specialist reports can be found in Appendix 5.

Information for this section was extrapolated from bi-annual monitoring results, a Hydrocensus of the farm Pering 1023HN undertaken by Rison Groundwater Consulting cc (Appendix 5) in December 2009, as well as a hydrogeological investigation for the extension to the Pering Mine tailings facility (August 2009, Appendix 6) undertaken by SRK Consulting. The aim of the groundwater investigations was to determine the likely impacts the proposed SSF (slimes tailings dam) and TSF (dry tailings dam) would have on the groundwater so that mitigation measures can be put in place during the design phase.

Desktop investigations of the off-site groundwater baseline were also undertaken to determine the potential impact of dewatering the pits into watercourses located on other farms (Refer to Section 4.6.8 and **Appendix 7**).

4.6.1 Hydrogeology

Both lithology and structural features control the groundwater flow within the sub-surface. The sub-horizontal weathered and fractured dolomite to a depth of 60-80m forms the main regional aquifer. The bedding planes form fractures resulting in a much higher hydraulic conductivity in the horizontal direction compared with the vertical direction. The stromatolitic zones are jointed both vertically and horizontally resulting in very blocky jointing which allows both the horizontal and vertical migration of groundwater flow as shown in Figure 24.

Figure 24: Stromatolites intercepted in pit high walls showing blocky jointing

Several dykes cross cut the mine area and are associated with higher flows along the contacts and appear to compartmentalise the aquifers. Aquifer transmissivities range from 1 to 160 m^3/day.

The pre-mining water table was on average around 4 – 5 meters below ground level (mbgl) at an elevation of 1410 mamsl. Groundwater flow is from west to east, towards the Harts catchment. The aquifer was confined but since mining, has been depressurised due to the dewatering of the aquifer. The old mine pits (Main Pit and Pit 24) are currently still flooding as the groundwater rebounds to its natural piezometric surface (Figure 25 and Figure 26).

Figure 25: Main Pit

Figure 26: Pit 24

Water levels in the Main Pit are being monitored on a daily basis. Rainfall is also monitored on a daily basis. The monitoring results show the progressive increase in the water table at a rate of approximately 1 m / month. At the time of a follow-up site visit by SRK on the 30th June 2009, the water table in the main pit had risen by 72m. The water temperature fluctuates from around 13 ºC in winter to 24 ºC in summer.

4.6.2 Aquifer Description

The aquifer system inferred from previous studies and the current investigation consists of a confined to semi-confined weathered and fractured aquifer system. The relatively shallower water level depths compared to the water strike depths in the boreholes are indicative of the semi-confined nature of the aquifer system. To date there is no indication of the formation of karsts or cavities within the dolomitic strata.

The aquifers in the vicinity of the proposed slimes tailings dam (SSF) and the dry tailings dam (TSF) are overlain by calcrete and a thin unconsolidated gravely sands up to 0.3m thick. Although the dolomite is slightly weathered to fresh below this, there are bands of soft rock carbonaceous shale horizons within it which are more permeable to seepage from the tailings and slimes impoundment facilities.

There are fault zones that underlie the slimes impoundment as shown by the geophysical survey and drilling and testing of boreholes P2 and P4, which provide a more permeable flow path to the groundwater system.

The aquifer system at Pering Mine can be classified as a Sole Source Aquifer, i.e. an aquifer which is used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon or depleted. The aquifer is overlain by a thin to non-existent layer of weathered top soil so the underlying aquifer is ranked as having medium vulnerability to contamination

The underlying hydrogeology of the SSF facility comprises a dual permeability system, where the carbonaceous shales and fault zones have a higher permeability than the dolomite matrix which is relatively impermeable. Seepage from the tailings facility will report to the more permeable fault zones and contamination can be transported off-site via these structures (SRK, 2009).

4.6.3 Hydrocensus

The purpose of the hydrocensus undertaken by Rison Groundwater Services (refer to **Appendix 5**), was to assess the level of groundwater usage in the area and evaluate the importance of the aquifer/s as a future source of water supply. Forty eight boreholes were identified and three were sampled Figure 27 and Table 15.

Groundwater is used as the potable water supply in the surrounding communities. Surface water sources are non-perennial. Groundwater can therefore be considered as a sole source of potable water for the community.

The specialist recommends that a more regional hydrocensus be undertaken to include private properties. Without such information, it will be impossible assess future mining impacts on the surrounding environment. It is further recommend that a numerical flow model be used as a predictive tool to determine flow volumes into the pit during dewatering as well as to evaluate the impact that such an exercise would have on the regional water table.

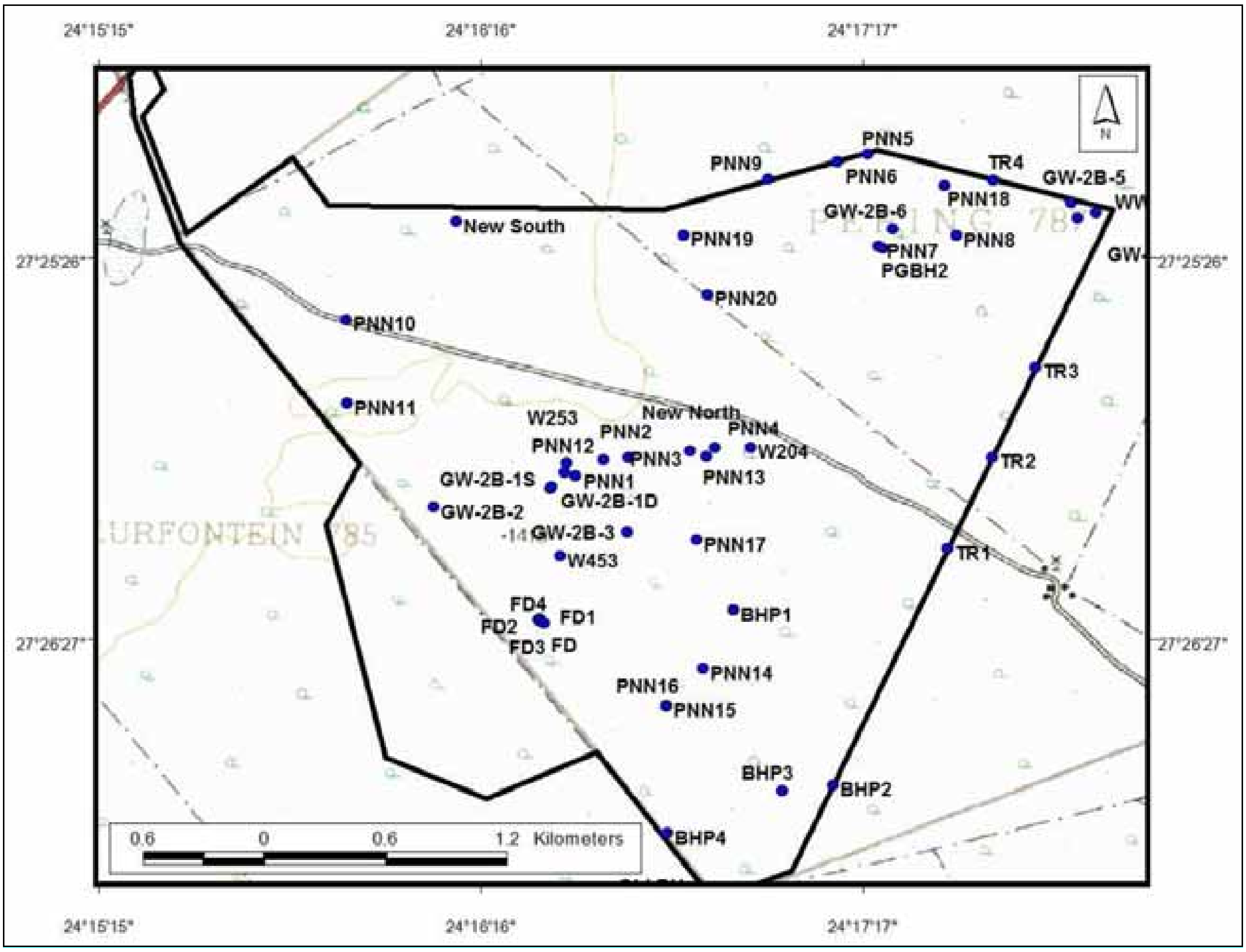


Figure 27: Boreholes located during the hydrocensus

Table 15: Hydrocensus Data Collected in October 2009 (Decimal Degrees, WGS84).

BH ID	Co-ordinates		Altitude (m)	SWL (mbc)	BH Depth (mbc)	Collar (meters)	Cas Dia (meters)	Comments
	East	South						
PNN1	24.27479	-27.4344	1419	Dry	20	0	0.17	Monitoring BH, no

								cap, BH dry
PNN2	24.27652	-27.43287	1421	-	Unknown	-	-	Completely destroyed
PNN3	24.27763	-27.43279	1418	23.14	40	0.38	0.17	Monitoring BH with cap
PNN4	24.28146	-27.43233	1418	4.52	20	0.17	0.17	Monitoring BH with cap
PNN5	24.28826	-27.41934	1419	17.67	25	0.19	0.17	Monitoring BH with cap
PNN6	24.28693	-27.41968	1418	9.73	100+	0.34	0.17	Monitoring BH with cap
PNN7	24.28875	-27.42343	1416	No reading	Unknown	0.43	0.17	Monitoring BH with cap
PNN8	24.29220	-27.42294	1420	18.6	100+	.021	0.17	Monitoring BH with cap
PNN9	24.28384	-27.42042	1423	10.01	100+	0.05	0.17	Open BH, old mono pump, no cap
PNN10	24.26509	-27.42665	1429	24.25	100+	0.52	0.17	Open BH, old mono pump, no cap
PNN11	24.26514	-27.43036	1427	8.84	35	0.45	0.17	Monitoring BH with cap
PNN12	24.27490	-27.43302	1425	20.25	40	0.25	0.17	Monitoring BH with cap
PNN13	24.28108	-27.43274	1418	No reading	Unknown	0.29	0.17	Monitoring BH with cap, casing is at an angle
PNN14	24.28093	-27.44214	1413	19.38	80	0.41	0.17	Monitoring BH with cap
PNN15	24.27931	-27.44377	1417	19.23	30	0.31	0.17	Monitoring BH with cap
PNN16	24.27933	-27.44383	1416	19.33	70	0.38	0.17	Monitoring BH with cap
PNN17	24.28065	-27.43642	1417	6.13	50	0.27	0.17	Monitoring BH with cap
PNN18	24.29164	-27.42071	1424	18.71	100+	0.34	0.17	Monitoring BH with cap
PNN19	24.28007	-27.42291	1419	17.51	100+	0.41	0.17	Open BH, old mono pump, no cap
PNN20	24.28114	-27.42555	1420	19.68	100+	0.55	0.17	Open BH, old mono pump, no cap
TR1	24.29180	-27.43682	1414	15.88	45	0.36	0.17	Monitoring BH with cap
TR2	24.29378	-27.43275	1416	17.38	50	0.46	0.17	Monitoring BH with cap
TR3	24.29567	-27.42877	1416	18.29	50	0.44	0.17	Monitoring BH with

								cap
TR4	24.29382	-27.42046	1414	6.68	50	0.23	0.17	Monitoring BH with cap
FD	24.27369	-27.43994	1419	27.13	45	0.19	0.17	Monitoring BH with cap
FD1	24.27368	-27.43997	1419	Bees	Unknown	-	-	Monitoring BH with cap, bees
FD2	24.27372	-27.44000	1421	27.09	60	0.09	0.17	Monitoring BH with cap
FD3	24.27377	-27.44002	1417	27.25	70	0.43	0.17	Monitoring BH with cap
FD4	24.27389	-27.44010	1414	27.18	100+	0.45	0.17	Monitoring BH with cap
GW-2B-1D	24.27417	-27.43418	1420	14.9	70	0.56	0.17	Monitoring BH with cap
GW-2B-1S	24.27421	-27.43406	1421	7.75	18	0.48	0.17	Monitoring BH with cap
GW-2B-2	24.26899	-27.43500	1418	24.9	50	0.41	0.17	Monitoring BH with cap
GW-2B-3	24.27759	-27.43610	1420	24.36	50	0.48	0.17	Monitoring BH with cap
GW-2B-4	24.29758	-27.42217	1403	5.14	50	0.46	0.17	Monitoring BH with cap
GW-2B-5	24.29729	-27.42150	1414	5.05	50	0.5	0.17	Monitoring BH with cap
GW-2B-6	24.28935	-27.42262	1417	15.88	50	0.43	0.17	Monitoring BH with cap
WW16	24.29840	-27.42192	1405	7.5	100+	0.23	0.17	Monitoring BH with cap
W253	24.27527	-27.43358	1418	24.8	100+	0.21	0.17	Monitoring BH with cap
W453	24.27462	-27.43715	1426	24.12	100+	0	0.17	Monitoring BH with cap
W204	24.28306	-27.43232	1419	Bees	Unknown	-	-	Monitoring BH with cap, bees
PGBH2	24.28894	-27.42350	1419	7.67	40	0.8	0.125	Monitoring BH with cap
BHP1	24.28230	-27.43954	1412	15.96	100+	0.66	0.135	Monitoring BH with cap, recently drilled
BHP2	24.28671	-27.44730	1411	11.46	100+	0.46	0.135	Monitoring BH with cap, recently drilled
BHP3	24.28445	-27.44755	1415	11.57	100+	0.49	0.135	Monitoring BH with cap, recently drilled
BHP4	24.27938	-27.44943	1418	12.26	100+	0.6	0.135	Monitoring BH with cap, recently drilled

New North	24.28037	-27.43247	1419	No access	Unknown	0.32	No access	Windmill that used to feed wild game, broken
New South	24.26999	-27.42230	1419	No access	Unknown	0.2	No access	Windmill that used to feed wild game
Old BH	24.28108	-27.45186	1418	No access	Unknown	0.54	No access	Windmill that used to feed wild game

4.6.4 Depth of Groundwater / Aquifer

Static water levels obtained from the new boreholes as well as existing boreholes in the vicinity of the mine were used to infer groundwater flow directions of the area. Pre-mining conditions indicated that groundwater flow at the site followed the gently sloping topography from west to east towards the Harts River with the water table at 1,410 mamsl in the vicinity of the pits and the average depth to the water level was 4.4 mbgl (SRK 1981). Following the commissioning of the mine in 1987, the Main Pit was mined to a final depth of 100 mbgl, and Pit 24 was mined to a depth of 45mbgl. A cone of drawdown developed around the pits and induced changes in the groundwater flow direction towards them. As the mine pits are still re-watering following cessation of mining activities in 2002, there is still a localised component of groundwater flow towards them.

Monitoring of the boreholes on site is undertaken on a bi-annual basis. Groundwater sampling was last undertaken in September 2011 by CHEMC Environmental (see detailed report in **Appendix 4**). The results concluded that the water level dropped in most boreholes in 2007, but increased again in the following years with the exception of borehole PNN17 where the water level is currently decreasing, as can be seen in the Figure 28 which presents the water level elevation of boreholes included in the monitoring programme.

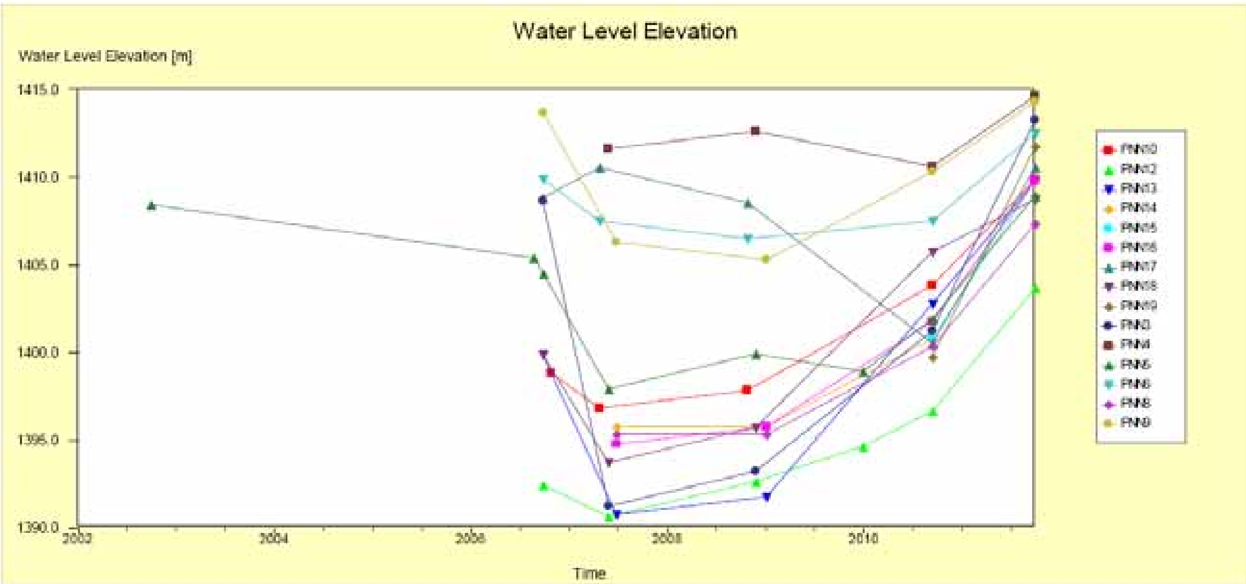


Figure 28: Time graph presenting the water level elevation of 15 boreholes that are situated at Pering Mine (CHEMC Environmental)

4.6.5 Groundwater Flow

The groundwater levels within the boreholes were measured as a first step to determine the groundwater flow directions. It is known that in similar geological terrains a relationship exists between the groundwater table and the topography. This relationship is known as the Bayesian relationship and was tested by plotting the borehole collar elevation against the measured groundwater elevation. If a linear correlation exists it can be assumed that the groundwater table would mimic the topography. The result of this assessment showed that a poor correlation of 13 % exists between the topography and the groundwater elevation. This is typical of carbonate aquifers as they commonly possess extensive secondary porosity due to dissolution.

Because of the poor correlation, groundwater levels were contoured to determine a local groundwater table (Figure 29). An important aspect of any groundwater study is to evaluate the groundwater flow directions. An understanding of the flow patterns will assist with the evaluation of the mines potential impact on the aquifer and other groundwater dependants.

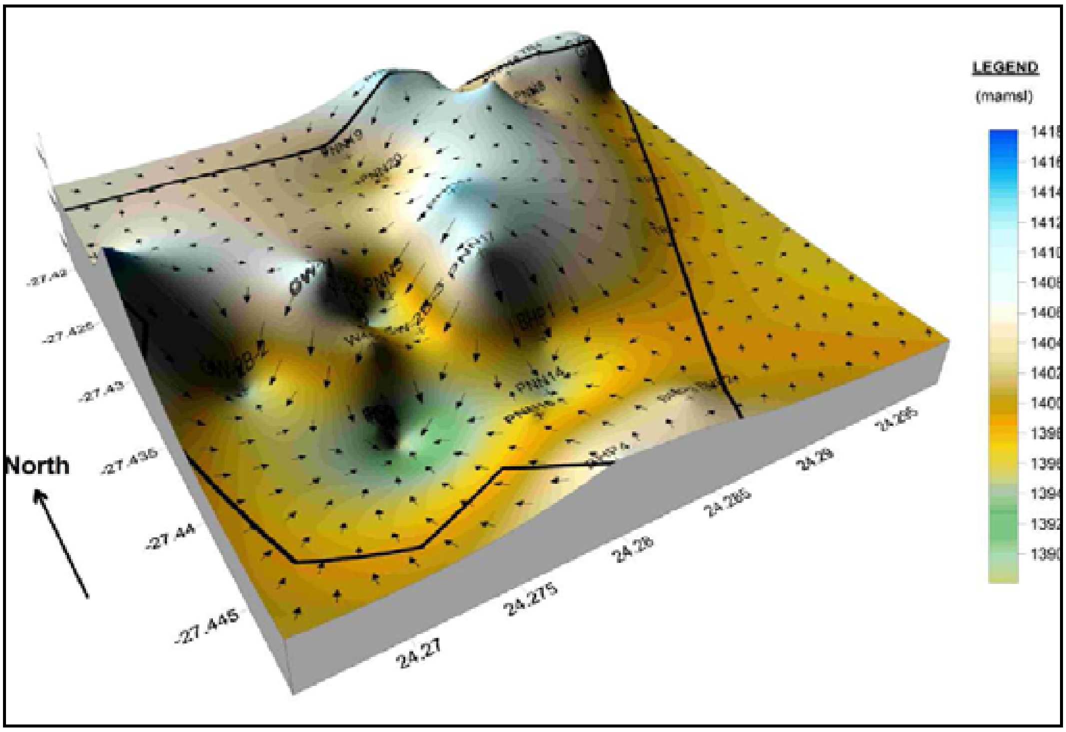


Figure 29: Contoured 3-D piezometric surface

4.6.6 Groundwater Quality

Groundwater and surface water qualities were compared to the latest (2011) South African National Standard for Drinking Water (SANS 241). These revised standards were aligned to recognized world standards such as from the World Health Organization.

Table 16: South African National Standard for Drinking Water (SANS 241:2011)

Determinant	Risk	Unit	Standard limits[a]
Physical and aesthetic determinant			
pH – Value at 25°C	Operational	pH units	≥5.0 to ≤ 9.7
Conductivity at 25°C	Aesthetic	mS/m	≤170
Total Dissolved Solids	Aesthetic	mg/L	≤1 200
Chemical determinants – macro determinants			
Chloride as Cl-	Aesthetic	mg/L	≤300

Sulphate as SO_4^{2-}	Acute health - 1 Aesthetic	mg/L mg/L	≤500 ≤250
Sodium as Na	Aesthetic	mg/L	≤200
Fluoride as F-	Chronic health	mg/L	≤1.5
Nitrate as N	Acute health - 1	mg/L	≤11
Zinc as Zn	Aesthetic	mg/L	≤5
Chemical determinants – micro determinants			
Antimony as Sb	Chronic health	µg/L	≤20
Arsenic as As	Chronic health	µg/L	≤10
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
Iron as Fe	Chronic health Aesthetic	µg/L µg/L	≤2 000 ≤300
Lead as Pb	Chronic health	µg/L	≤10
Manganese as Mn	Chronic health Aesthetic	µg/L µg/L	≤500 ≤100
Mercury as Hg	Chronic health	µg/L	≤6
Nickel as Ni	Chronic health	µg/L	≤70
Selenium as Se	Chronic health	µg/L	≤10
Uranium as U	Chronic health	µg/L	≤15
Vanadium as V	Chronic health	µg/L	≤200
Aluminium as Al	Operational	µg/L	≤300

Figure 30 below presents only those sites where TDS concentrations above the drinking water standard or livestock guideline were encountered. A total of 40% exceeded the applied drinking water standard for TDS and 45% exceeded the livestock guideline with special mention to sites PNN5, GW2-B2 and GW2-B6 (Figure 30).

36% of the groundwater sites exceeded the applied livestock guideline whereas 43% of the sites exceeded the drinking water standard limit for SO4, being highest at the same three sites as mentioned above (PNN5, GW2-B2 and GW2-B6) (Figure 31). Great fluctuation in SO4, levels can be observed in boreholes GW2-B2 (between Main Pit and South Waste Rock Dump) and WW16 (north east of return water dam) (Figure 31). While the latter site shows a decreasing trend in SO4 concentration the former site shows a slightly increasing trend. However, the greatest increase in SO4 levels were observed at sites PNN16 and Main Pit New South Windmill (Figure 31).

Besides elevated Cl levels that exceeded the standard limit at sites PNN16 and PG-BH2 as well as marginal exceedance of F concentration at the latter site, the measured physico-chemical parameters complied with the drinking water standard. As depicted in Figure 32 below Mg levels proved to exceed the applied guideline for livestock at five groundwater sites (11% exceedance). During this sampling cycle the highest Mg levels were evident at site GW2-B2 (Figure 32).

The reason why boreholes at the waste rock dumps proved to be more impaired than the water in the pits, is that those borehole sites represent the immediate groundwater plume surrounding these dumps. The volumes of the natural groundwater inflows into the pits is so significant that it dilutes the plumes from these dumps significantly, hence the better (although still not acceptable) water qualities in the pits.

Water quality at many sites is not fit for human or animal consumption and should therefore not be used for domestic or livestock purposes. Though high salinity is not toxic per say, sulphate especially in connection with Mg, will induce diarrhoea. Of more concern are the toxic effects of certain metals if consumed, with special mention to Hg and Pb.

It is recommended to continue with the current sampling program. Furthermore, it is recommended to do regular (every 5 years) Hydrocensus and sampling of selected neighbouring farms to ensure that groundwater qualities are acceptable for domestic use and/or livestock watering.

The metal analysis show that the most prevalent metals detected in concentrations above the applicable standards proved to be Copper (Cu) (30 sites), Mn (21 sites), Mercury (Hg) (20 sites) and Pb (6 sites). At some sites Al (4 sites), Se (3 sites) and Zn (1 site) were also measured in concentrations above the applied standard. The highest Pb (46.62 µg/l) and Al (8 µg/l) concentrations above the TWQG (DWAF, 2006) for domestic use were measured in borehole GW2B 1D (north of pits, close to Pit 24). Such high Al levels were not measured in the past and the historic data show that Al concentrations were within the TWQG (DWAF, 2006) for domestic use for most of the time. Similarly high Pb levels were evident at FD1 where 44.73 µg/l Pb were measured.

The highest Hg (6.16 µg/l) and Mn (901.1 µg/l) levels were evident in borehole GW2B4. Both parameters as well as Al level exceeded the TWQG for domestic use. While Hg concentrations proved to exceed the TWQG (DWAF, 2006) at times, Mn levels were above the TWQR since monitoring has started.

Se levels proved to be evident in borehole GW2B2. Although a decreasing trend can be observed, the current Se levels (39.99 µg/l) exceeded the TWQG for TWQG (DWAF, 2006) domestic use. Mercury and Cu levels too proved to be elevated and above the TWQR (DWAF, 2006) for domestic use and livestock respectively. Similarly high Se levels as observed for GW2B2 was evident in borehole FD3 where 33.54 µg/l Se were measured. Site FD3 also proved to have the highest Zn concentration (3336 µg/l) which exceeded the TWQG for domestic use. Copper levels too proved to be in concentrations exceeding the suggested guideline for livestock.

Mercury serves no known beneficial physiological function in humans, and is a chronic neurotoxin (DWAF 1996a). Poisoning takes the form of neurological (organic mercury) and renal (inorganic mercury) disturbances. Both organic and inorganic forms are toxic although organic mercury is about one order of magnitude more toxic because it is able to cross biological membranes more readily. Depending on the dosage, effects associated with the ingestion of mercury are either chronic or acute. There is a risk of chronic toxicity with exposure to concentrations greater than 20 µg/l, particularly if the mercury is organically complex. Such high levels however, were not reported during this sampling session (DWAF 1996a).

Mercury and mercury-organic complexes are also of concern in the natural aquatic environment because of their extreme toxicity to aquatic organisms and the potential to bio-accumulate in the food chain. Intake of mercury can occur via air, food and water. Because of its neuro- and renal toxicity, mercury is severely poisonous to mammals. Bio-accumulated mercury increases the risk of mercury toxicity to aquatic and terrestrial organisms in the food chain. The toxic effects of mercury on aquatic organisms cannot be reversed (DWAF 1996c).

Selenium in excess, is toxic and clinical symptoms can be observed. It is recommended that the concentration of selenium in potable water never exceed 50 µg/l, due to the risk of liver damage, particularly in children (DWAF 1996a). Measurements however, proved to be below 50 µg/.

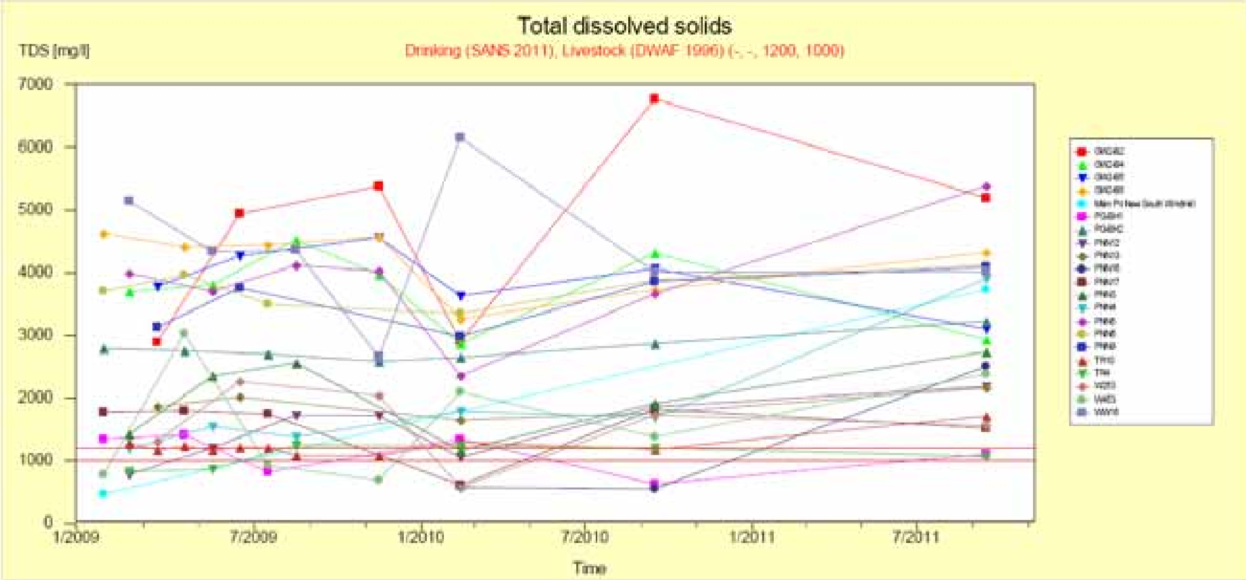


Figure 30: Time graph presenting TDS levels of selected groundwater sites (CHEMC Environmental)

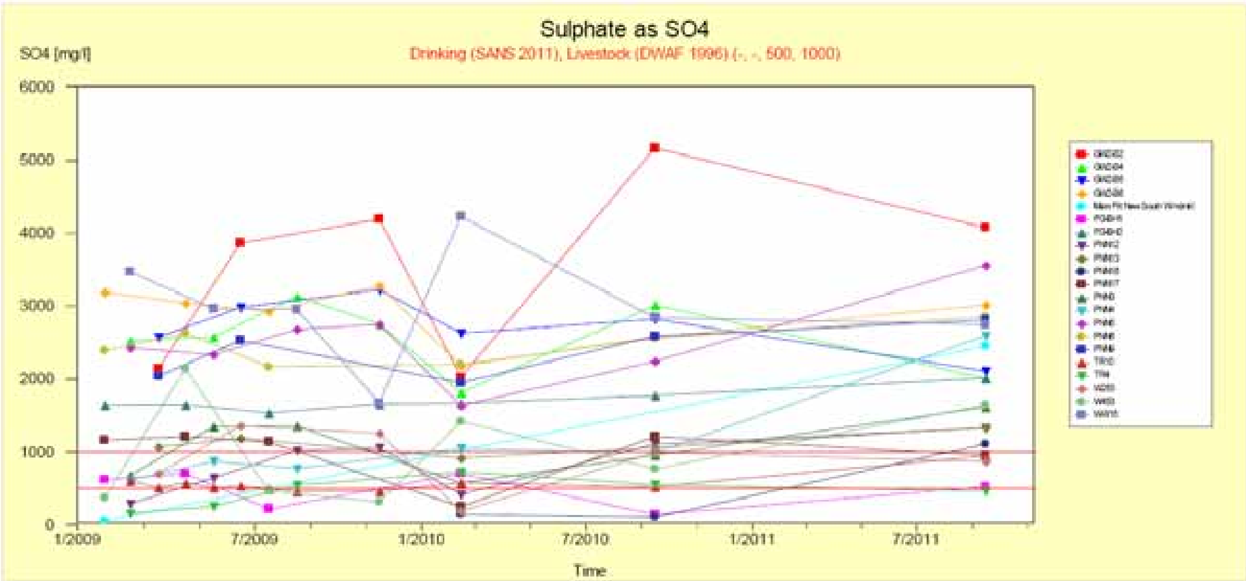


Figure 31: Time graph presenting SO_4 levels of selected groundwater sites (CHEMC Environmental)

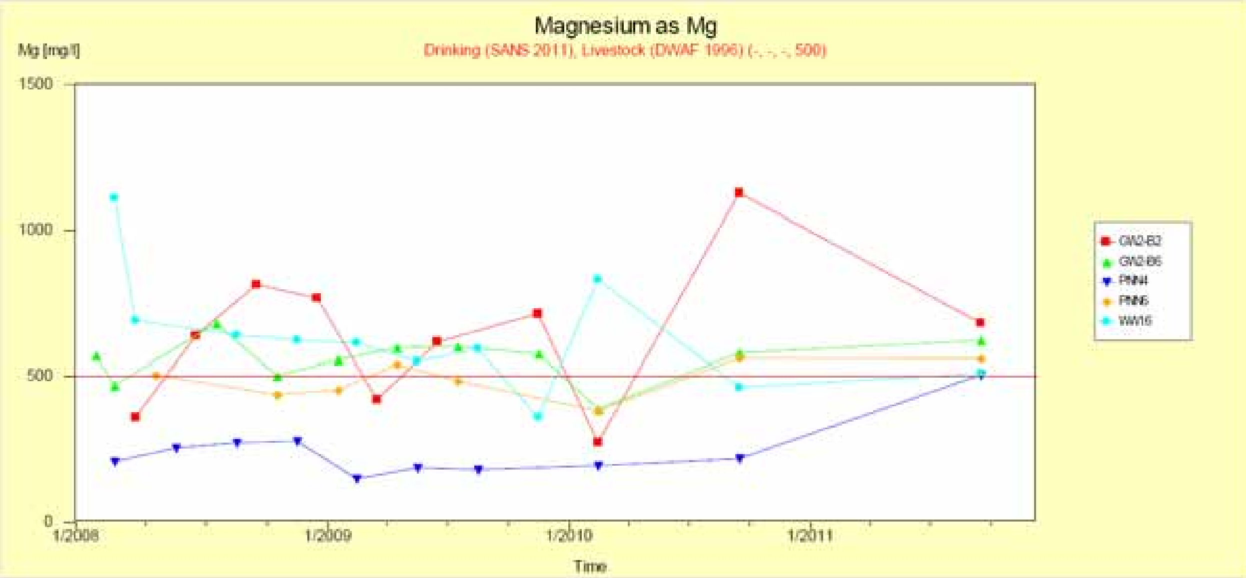


Figure 32: Time graph (January 2008 onwards) representing Mg levels of five groundwater sites where the livestock guideline was exceeded (CHEMC Environmental)

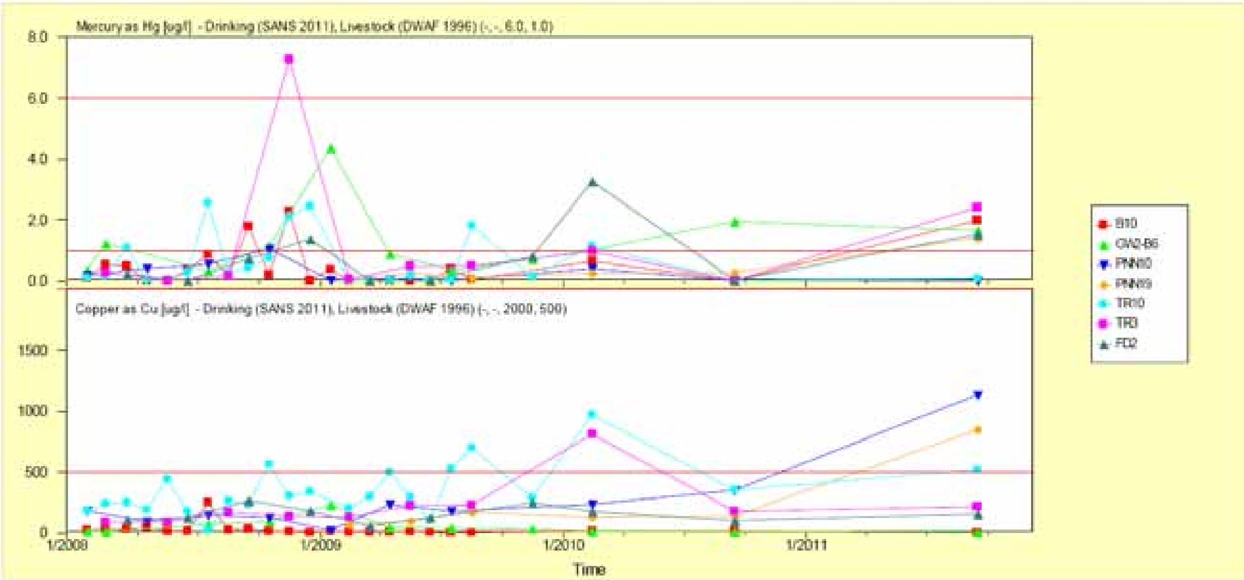


Figure 33: Time graph representing Cu and Hg levels of selected groundwater sites (CHEMC Environmental)

4.6.7 Groundwater modelling

The impacts on the groundwater quality at potential receptors downgradient of the proposed SSF and TSF for proposed new mining operations were determined during the hydrological investigation undertaken by SRK (refer to **Appendix 6**). This report also took into consideration the existence of a contamination plume due to seepage from the existing tailings dam documented by Metago Environmental Engineers in their Closure Plan as well as AGES, ChemC in their numerical groundwater models. The tailings dam has since been capped as part of the initial mining closure and rehabilitation activities to mitigate the seepage of rainwater into the tailings thereby leading to potential cumulative future impacts.

The reason why boreholes at the waste rock dumps is more impaired than the water in the pits, is that those borehole sites represent the immediate groundwater plume surrounding the dumps. The volumes of the natural groundwater inflows into the pits is so significant that it dilutes the plumes from these dumps significantly, hence the better (although still not acceptable) water qualities in the pits.

As discussed previously, water quality at many sites is not fit for human or animal consumption and should therefore not be used for domestic or livestock purposes. Though high salinity is not toxic per say, sulphate especially in connection with Mg, will induce diarrhoea. Of more concern are the toxic effects of certain metals if consumed, with special mention to Hg and Pb.

Although all of the salts are expected to increase in time due to re-circulation and concentration, only sulphate has been modelled as indicators of the contaminant plume. The geochemical test work has indicated that metals are unlikely to be mobilised as the system is well buffered. Therefore it is unlikely that heavy metals would leach to the groundwater.

The following two scenarios were modelled:

1. Leachate concentrations of 4,000 mg/l SO_4 for the SSF, TSF and existing tailings facility was used, simulating a worst case. A SO_4 concentration of up 4,000mg/l was measured in monitoring boreholes. The existing plume from the decommissioned slimes dam was also included. This scenario after a 20 year period is shown in **Figure 34** below.

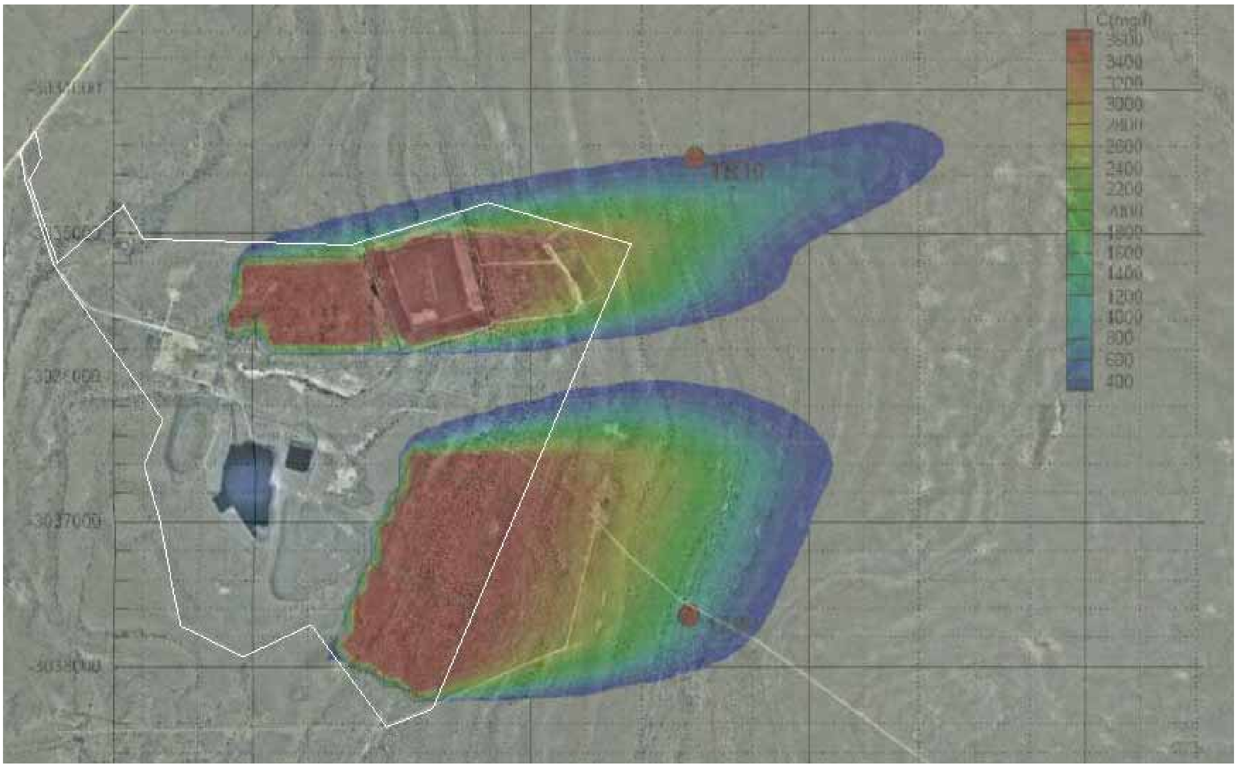


Figure 34: SO4 plume after 20 years without liner (adapted from SRK)

2. Leachate concentrations of 10 mg/l (SO_4) assuming the SSF is lined and only a limited amount of leachate enters the groundwater. The leachate concentration is derived by applying a 400 fold dilution factor that is based on a typical linear leakage of 0.015 l/m^2/day (Aquatan, 2001). The leachate concentration for the TSF and existing tailings remained unchanged at 4 000 mg/l. This scenario after a 20 year period is shown in **Figure 35** below.

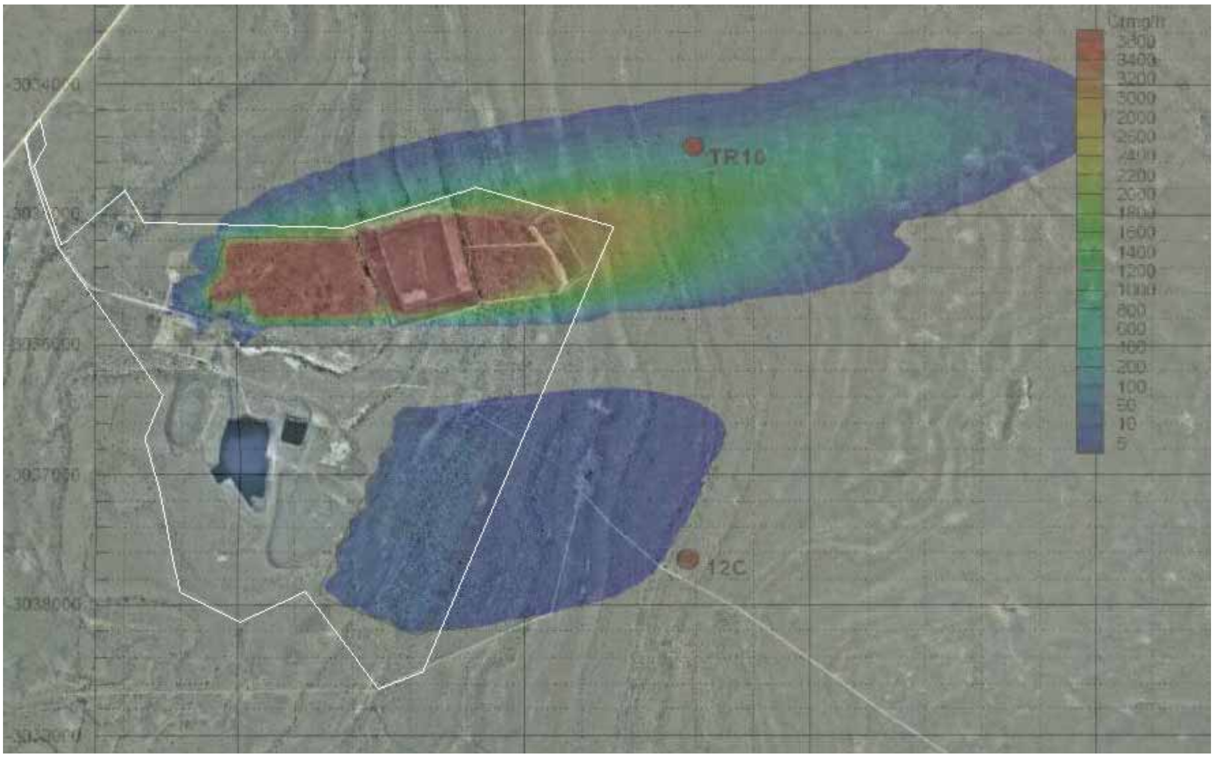


Figure 35: SO4 Plume after 20 years with liner (adapted from SRK)

Numerical modelling has indicated that potential contaminated seepage could impact on water supply boreholes. Mitigation measures are aimed at reducing the seepage from the SSF. The scenario with a liner in place results in a relatively minor increase in cumulative SO_4 concentrations however minor tears and holes always occur in the liner and leakage will still occur due to the higher head on the liner system. Lining of the tailings dam has been included in the design of the tailings dam. In addition a drainage system to collect any seepage from the SSF will be incorporated into the design.

By the end of Life of Mine (26 years), the plume extent is not expected to reach the farm water supply borehole, 12C. However post closure of the mine the plume will continue to migrate and by year 20 after commissioning of the SSF, a significant deterioration in the water quality will occur rendering the groundwater unacceptable as a domestic water supply.

SRK identified the following potential impacts for future mining operations:

Issue 1: Emptying of pit lakes

The pit lakes will first have to be dewatered prior to mining. Disposal of this volume of water is problematic as the water quality is marginal (due to the elevated sulphate concentrations). There are no surface water drainage features that can accommodate the volume of water that will be required to be disposed of. Ponding of this water will seep to the groundwater and could impact on the quality of the underlying groundwater, although dilution from the aquifer will render the impact negligible (depending on where it is disposed of).

Issue 2: Dewatering of aquifer

Once the pits have been dewatered, the much larger pit that will be developed will induce a larger cone of drawdown which could impact on the surrounding farmers boreholes, resulting in a reduction in yields.

Issue 3: Deterioration of groundwater quality

The quality of groundwater based on samples collected to date, indicate that the tailings dams, and waste rock dumps have resulted in a deterioration of the groundwater quality due to increased sulphate and magnesium concentrations. The DMS dump and slimes impoundment is also expected to have a similar impact on the groundwater quality resulting in a further deterioration in the groundwater migrating off site to the east.

The impact on groundwater due to contamination is expected to be HIGH due to increasing concentrations of sulphate, nitrate and magnesium. Due to the high pH and buffering capacity of the host rock, leaching of metals is not anticipated.

4.6.8 Hydrological baseline off-site

The Main Pit and Pit 24 at Pering Mine will need to be dewatered during the mine construction phase in order to continue mining of the pits. The various alternatives for dewatering of the pits were listed in Section 3 and are further assessed in Section 7.

One of the alternatives investigated is the treatment, conveyance via a 17km pipeline and discharge of the water into the Droe Harts River in the vicinity of the farms Kgore 898 HN (belonging to Mr David Nel) and Sebetse Tsapitse 899 HN (belonging to Mr Isaac Jocum). The option of discharging into the Droe Harts River was investigated as the watercourse provides the nearest opportunity for discharge of the mine water into a natural drainage line. Pering Mine wishes to treat the sulphurous pit water to the desired land use standard (being cattle watering standard of 1000 mg/l for sulphur). For this reason the hydrological and environmental baseline of the general discharge area needed to be determined to establish the feasibility of such a proposal.

This section of the report considers the findings of undertaking the 17km pipeline treatment, conveyance and discharge option based on the surface water investigation undertaken by GCS (refer to report attached in **Appendix 7**). GCS was appointed to:

- Conduct a base-line survey of surface water quality in the vicinity of the proposed discharge point. Assess the impact of the planned discharge on local river systems in terms of flow volumes, flow depths and impacts on flood-lines etc.
- Assess options for design of a discharge point in terms of hydrological and engineering concerns.

Figure 36: Approximate area of discharge point for 17km pipeline alternative relative to Pering Mine

4.6.8.1 Local hydrology

In their study, GCS considered the local hydrological conditions including soils, rainfall, variable infiltration rates. Much of the area surrounding the proposed discharge point is endoreic. The vast majority of rain falling on soil surfaces will not run off, but will percolate into the soils. Soils are typical Kalahari soils and comprise mainly fine sands in deep sand beds. Groundwater levels seem to vary from 4 to 8 meters below the surface. Underlying rock formations are mainly heavily fractured dolomitic rock and various reports on local geology suggest very high lateral movement of water through this layer. It is expected that local runoff will only occur as a direct result of extreme flood-producing rainfall events. This was confirmed during discussions with a local Farmer during a visit to the site. Water falling on the soil surfaces is likely to seep into underlying aquifers at a rate of between 86 and 173 mm per day. The river bed comprises flat, poorly defined watercourses that link a series of pan-like depressions. Intermittent layers of calcrete in the soil may limit flow rates through the soil. A relatively high percentage of fines in local soils seem to suggest that with intense rain storms and high rainfall intensities, bare soils could form a surface crust that causes a change in infiltration properties.

Based on the hydrological conditions, flows downstream of the discharge point were simulated assuming:
1. A stream-bed of 20 m wide
2. Lateral seepage into a wetted area of 80 m wide
3. Flood irrigation of natural vegetation over 80 m width
4. Seepage into deep aquifers over 40 m width at 60 mm per month

Based on the calculations, **the vast majority of water released from the mine will seep into the river bed within the first 4 km downstream of the discharge point**. In dry years flow will not reach a point 7 km downstream of the release point. Wetter conditions near the stream (caused by the planned releases) are likely to facilitate flows that extend some distance downstream of the discharge point in wetter periods. In these wet periods, water from the mine is likely to be diluted and will not have the same impact in terms of pollution load on water that is available to distant water users.

4.6.8.2 Stream conditions

GCS conducted a site visit on 3 May 2012 to assess local conditions first hand and to collect surface water samples if possible. It was confirmed by Mr Isaac Jocum that the watercourse tends to only flow after extreme rainfall events, possibly only once, on average, in 9 to 11 years. The watercourse follows a defined path interspersed with pan-like areas where water could potentially spread out over much wider areas.

Figure 37: Rocky outcrop near suggested discharge point and good veld conditions nearby

4.6.8.3 Water sampling

As there was no natural surface water in the watercourse for a considerable distance downstream of the proposed discharge point, it was not possible to obtain a surface water sample for analysis. Potential surface water sampling sites were identified at considerable distances downstream, but water from these points was considered to not be representative of local stream conditions. Instead of surface water samples, two groundwater samples were taken, at the request of the farmers, from wind-pumps in the vicinity of the proposed discharge point, one from the farm of Mr Jocum and one from the farm of Mr D Nel. Two pit samples were provided by the Mine, one for pit 24 and one for the Main pit. All samples were then analysed. Water quality monitoring reports were taken into consideration. The results of the groundwater samples are not necessarily indicative of surface water conditions, should the watercourse flow after rainfall events, but the results could be used as an indication of the groundwater condition, however, groundwater fell outside the scope of the study.

4.6.8.4 Water quality

Sulphur levels in the pits at Pering Mine typically exceed concentrations of 1000 mg/l according to the monitoring reports. TDS and electro-conductivity levels are high while lead and magnesium levels are elevated, but fall within allowable limits for stock-watering. Water from the mine has elevated, but not toxic, levels of many metals. Pit water seems to have, on average, in the order of 1000 mg/l sulphates. It is likely that some sulphates will combine with metallic ions forming natural flocculants and facilitate sedimentation of a range of impurities in the water. Aluminium and Magnesium sulphates play a role in flocculating and sedimentation of a number of impurities present in water. Metals and sulphates will, however, tend to be retained in the upper layers of soils over the 4 km stretch below the discharge point.

4.6.8.5 Hydrogeology and groundwater quality

Under natural conditions the groundwater flow direction will be in a south-east direction from the mine towards the Dry Hartz river. Human activities, eg. mining and dewatering at Pering, abstraction, causes this flow direction to change on a local scale. The compartmentalization of the dolomites further influences the regional flow direction.

The aquifer at Pering mine was classified as a sole source aquifer with little topsoil cover, awarding it a GQM index of 12 (Parsons 1995) which indicates that the groundwater must be afforded a strictly non-degradation level of protection. The extent of this dolomitic aquifer also applies to the area of the expected discharge point. The highly fractured, permeable rock will transport any contaminants fast and could affect large volumes of water.

4.6.8.6 Potential impacts

Very high sulphate levels could act as biocides and tend to kill off many of the naturally occurring microbes within the soil in this 4km stretch if sulphate levels become too high. Under anaerobic conditions, a range of bacteria will tend to digest sulphates, releasing hydrogen sulphate gas (which has an unpleasant smell). It is not clear how much natural sulphate digestion is likely to occur in the soils below the stream bed, but sulphate digestion is likely to be low unless high levels of other bacteria-supporting nutrients are available. It is considered likely that sulphates will accumulate to toxic or near-toxic levels. High sulphate levels could disturb the natural distribution of plant species in the river system, which would then also impact on natural fauna, but this should be confirmed by relevant specialists. The main risk related to groundwater emanating from the proposed discharge of mine water into a natural stream is the deterioration of groundwater quality. A sulphate dispersion plume through the soils could also lead to increased sulphates in nearby ground-water resources. The quantification of this anticipated impact is only possible through continuous monitoring and the subsequent evaluation of the data

While the suggestion has been made that discharge water should be treated to an acceptable standard for stock-watering, it is not clear what the impact of accumulated sulphates in the 4 km stretch downstream of the discharge point will be. The South African standard for sulphates in drinking water for livestock is 500 mg/l (for large stock, while higher concentrations are accepted for sheep and goats). At that level, some sulphate accumulation in the river, release of salts to downstream water users and increased sulphate levels in local water tables is likely. While sulphates effect the taste of drinking water at levels above 500 mg/litre at this concentration they do not pose any significant health risk. The major concern revolves around the mobility of sulphates and their tendency to concentrate under certain conditions. Most developed countries in the world recommend that sulphate levels in drinking water are maintained at below 250 mg/l.

Based on the impact of sulphates on groundwater quality and within the watercourse it is therefore recommended that the discharge water be treated so as not to exceed 300mg/l.

This significance of the potential impacts are discussed in Section 9 and 10.

4.7 Terrestrial Biodiversity

4.7.1 Vegetation

A terrestrial biodiversity impact assessment of floral and faunal attributes of the study area was undertaken by Bathusi Consulting, with field survey conducted on 12 October 2011 and again between 23-25 January 2012. The study took into account the biophysical attributes of the study area, taking into account the floral and faunal composition. The study is attached as **Appendix 8**, with a summary of the findings provided below.

4.7.1.1 Regional vegetation

The regional vegetation is described as Ghaap Plateau Vaalbosveld (Mucina & Rutherford, 2006), but does show some affinity with the nearby Kuruman Vaalbosveld. The conservation status of this vegetation type is regarded Least Threatened, although none is conserved in statutory conservation areas; only about 1% is transformed.

The SANBI database indicates the known presence of only 16 plant species within this particular ¼-degree grid (2724AD), reflecting a poor floristic knowledge of the region. No Red Data flora species are known to occur in the region. Several individuals (<10) of Olea europaea subsp. africana (Protected tree, National Forest Act) were however observed within the study area, while the presence of Acacia erioloba (Protected tree, National Forest Act) was indicated in earlier reports and was confirmed by visual observations in surrounding areas.

4.7.1.2 Observed botanical diversity & species of conservation importance

A total of 101 plant species were identified during the field investigations. This diversity is regarded representative of the regional vegetation. The presence of various weeds and invasive species indicates the presence of degraded and transformed habitat within the study area. The floristic diversity is dominated by forbs (46), grasses (19) and shrubs (15). The physiognomy is however dominated by the woody component, comprising shrubs and trees (8). The floristic diversity comprises 41 plant families, dominated by Poaceae (19) and Asteraceae (18).

No plant species of conservation importance was observed during the survey period.

Table 17: Plant species recorded during the survey

Species Name	Growth Form	Family	Status/ Uses
Acacia karroo	Tree	*Fabaceae*	Edible parts, dyes and tans, medicinal uses,
Acacia mellifera	Shrub	*Fabaceae*	Declared indicator of encroachment, medicinal
Acacia tortilis	Tree	*Fabaceae*	None
Aerva leucura	Forb	*Amaranthaceae*	None
Aloe grandidentata	Succulent	*Liliaceae*	None
Alternanthera pungens	Forb	*Amaranthaceae*	Weed, pioneer species
Anthericum species	Succulent	*Liliaceae*	None
Argemone ochroleuca	Forb	*Papaveraceae*	Declared Invader -Category 1
Aristida barbicollis	Grass	*Poaceae*	None
Aristida diffusa	Grass	*Poaceae*	None
Aristida meridionalis	Grass	*Poaceae*	None
Aristida species	Grass	*Poaceae*	None
Arundo donax	Grass	*Poaceae*	Declared weed -Category 1
Asparagus species	Shrub	*Liliaceae*	None
Berkheya species	Forb	*Asteraceae*	Weed
Bidens pilosa	Forb	*Asteraceae*	Weed, edible parts
Bulbine abyssinica	Succulent	*Liliaceae*	None
Bulbine narcissifolia	Succulent	*Liliaceae*	Medicinal uses
Calobota cuspidosa	Shrub	*Fabaceae*	None
Casuarina species	Tree	*Casuarinaceae*	None
Ceratotheca triloba	Forb	*Pedaliaceae*	Medicinal properties
Chascanum species	Forb	*Verbenaceae*	None
Chrysopogon serrulatus	Grass	*Poaceae*	Increaser, palatable grazing grass
Cissus species	Climber	*Vitaceae*	None
Cleome species	Forb	*Capparaceae*	None
Commelina africana	Forb	*Commelinaceae*	Medicinal properties
Commelina erecta	Forb	*Commelinaceae*	None
Conyza podocephala	Forb	*Asteraceae*	Weed, indicator of disturbed areas
Cucumis zeyheri	Forb	*Cucurbitaceae*	Edible parts
Cymbopogon plurinodis	Grass	*Poaceae*	Unpalatable grazing
Cynodon dactylon	Grass	*Poaceae*	Indicator of disturbed areas, grazing potential
Cyperus fastigiatus	Sedge	*Cyperaceae*	None
Delosperma species	Succulent	*Mesembryanthemaceae*	None
Digitaria eriantha	Grass	*Poaceae*	Weaving, palatable
Diospyros lycioides	Shrub	*Ebenaceae*	Medicinal uses, edible parts, dyes
Ehretia rigida	Shrub	*Ehretiaceae*	None
Elionurus muticus	Grass	*Poaceae*	None, unpalatable
Enneapogon scoparius	Grass	*Poaceae*	None
Eragrostis echinochloidea	Grass	*Poaceae*	None
Eragrostis lehmanniana	Grass	*Poaceae*	Weaving
Eragrostis rigidior	Grass	*Poaceae*	None

Eucalyptus species	Tree	*Myrsinaceae*	Declared Invader -Category 2, essential oils
Euclea undulata	Shrub	*Ebenaceae*	Firewood
Felicia muricata	Forb	*Asteraceae*	None
Felicia species	Forb	*Asteraceae*	None
Fimbristylis complanata	Sedge	*Cyperaceae*	None
Fingerhuthia africana	Grass	*Poaceae*	Moderate grazing potential
Gazania krebsiana	Forb	*Asteraceae*	None
Geigeria ornativa	Forb	*Asteraceae*	Potentially poisonous, indicator of poor habitat
Gomphocarpus fruticosus	Shrub	*Asclepiadaceae*	Medicinal uses
Grewia flava	Shrub	*Tiliacea*	Edible parts, weaving
Gymnosporia buxifolia	Tree	*Celastraceae*	None
Helichrysum argyrosphaerum	Forb	*Asteraceae*	None
Helichrysum species	Forb	*Asteraceae*	None
Hermannia coccocarpa	Forb	*Sterculiaceae*	None
Hermannia species	Forb	*Sterculiaceae*	None
Hermbstaedtia odorata	Forb	*Amaranthaceae*	None
Heteropogon contortus	Grass	*Poaceae*	Moderate grazing potential, irritant
Hibiscus species	Forb	*Malvaceae*	None
Homeria pallida	Geophyte	*Iridaceae*	Potentially poisonous to livestock
Indigofera species	Forb	*Fabaceae*	None
Ipomoea simplex	Forb	*Convolvulaceae*	None
Jamesbrittanea aurantiaca	Forb	*Scrophulariaceae*	None
Jamesbrittanea burkeana	Shrub	*Scrophulariaceae*	None
Kleinia longiflora	Succulent	*Asteraceae*	Traditional uses
Leucas capensis	Forb	*Lamiaceae*	None
Leucas glabrata	Forb	*Lamiaceae*	None
Lobelia angolensis	Forb	*Lobeliaceae*	None
Lobelia erinus	Forb	*Lobeliaceae*	None
Malva species	Forb	*Malvaceae*	None
Melolobium candidans	Shrub	*Fabaceae*	None
Merremia tridentata	Climber	*Convolvulaceae*	None
Momordica balsamina	Climber	*Cucurbitaceae*	Edible parts, medicinal uses
Nidorella anomala	Forb	*Asteraceae*	None
Nidorella hottentotica	Forb	*Asteraceae*	None
Oldenlandia herbacea	Forb	*Rubiaceae*	None
Olea europaea subsp. africana	Tree	*Oleaceae*	Protected Tree (National Forest Act, 1998)
Paspalum dilatatum	Grass	*Poaceae*	Moist places, palatable
Pentarrhinum insipidum	Climber	*Asclepiadaceae*	Edible parts
Pentzia calcarea	Shrub	*Asteraceae*	None
Pollichia campestris	Shrub	*Illebracaceae*	Edible parts
Pseudognaphalium luteo-album	Forb	*Asteraceae*	Weed (Europe)
Raphionacme species	Forb	*Peripoplacaceae*	None
Salsola species	Shrub	*Chenopodiaceae*	None
Salvia disermas	Forb	*Lamiaceae*	None
Searsia lancea	Tree	*Anacardiaceae*	Edible parts, tanning
Searsia pyroides	Shrub	*Anacardiaceae*	None
Sebaea leiostyla	Forb	*Sentianaceae*	None

Senecio achilleifolius	Forb	*Asteraceae*	Indicator of moist conditions
Sericorema remotiflora	Forb	*Amaranthaceae*	None
Stachys species	Forb	*Lamiaceae*	
Stipagrostis ciliata	Grass	*Poaceae*	None
Tagetes minuta	Forb	*Asteraceae*	Essential oils, colours & dyes
Tarchonanthus camphoratus	Shrub	*Asteraceae*	Medicinal uses
Themeda triandra	Grass	*Poaceae*	Palatable grazing
Tribulus terrestris	Forb	*Zygophyllaceae*	None
Vahlia capensis	Forb	*Vahliaceae*	None
Wahlenbergia undulata	Forb	*Campanulaceae*	None
Walafrida densiflora	Forb	*Selaginaceae*	None
Xanthium strumarium	Forb	*Asteraceae*	Category 1, weed (S. America)
Ziziphus mucronata	Tree	*Rhamnaceae*	Edible parts, medicinal uses

4.7.1.3 Habitat characteristics

Results of the photo analysis and site investigations revealed the presence of the following habitat types:

- Transformed habitat (remaining infrastructure, roads, etc.) (235.8ha, 26.7%);
- Degraded habitat (79.7ha, 9.0%); and
- Natural woodland variations (568.1ha, 64.3%).

The vegetation of the study area is distinctly divided into natural vegetation and areas where previous mining operations resulted in decimation of the natural vegetation. These transformed and degraded areas exhibit typically low floristic importance or sensitivity; this is also reflected by a poor floristic composition, containing mostly weedy, invasive and opportunistic species.

Remaining natural vegetation is representative of the regional vegetation. While mosaical variations are present within the woodland community, the mapping and delineation thereof is not possible, or necessary for this particular assessment, and similar sensitivity and importance values are ascribed. These variations reflect localized substrate variations of soil depth and surface rock. Moderate grazing pressure has resulted in low degradation levels and the species composition of this community is typical of the woodland of the region. Visual observations from surrounding areas furthermore revealed that there is extremely low variability; natural habitat types identified in the study area are therefore likely to be continued in adjacent areas. A medium floristic sensitivity is therefore ascribed to this woodland community and implied variations.

4.7.1.4 Vegetative status

Because of existing degradation and transformation on the property and the medium status ascribed to natural woodland variations of the property as well as the likely absence of flora species of conservation importance, the loss of this portion of woodland is not expected to result in significant floristic impacts on a regional scale. However, the implementation of generic mitigation measures that will prevent the spread of impacts to surrounding areas are regarded important. Rehabilitation of post-operational areas should be done by means of re-establishing plant species that occur naturally in the region, with particular reference to the woody layer.

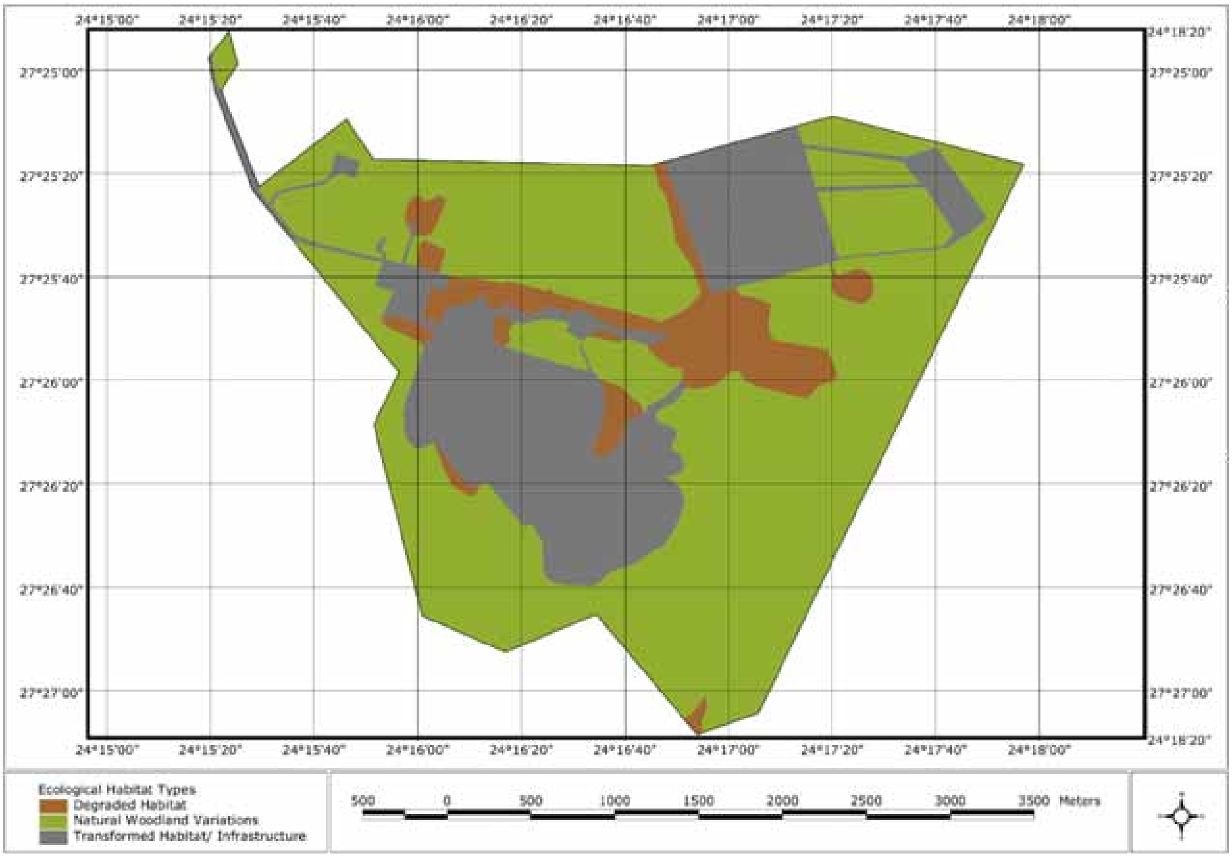


Figure 38: Floristic habitat types of the study area

4.7.2 Fauna

A terrestrial biodiversity impact assessment of floral and faunal attributes of the study area was undertaken by Bathusi Consulting, with field survey conducted on 12 October 2011 and again between 23-25 January 2012. The study took into account the biophysical attributes of the study area, taking into account the floral and faunal composition. The study is attached as **Appendix 8**, with a summary of the findings provided below.

The presence of 80 animal species was confirmed during the site investigation, by means of visual sightings, tracks, scats, burrows and species-specific calls, including:

- 1 centipede;
- 1 scorpion;
- 18 insects;
- 5 reptiles;
- 43 birds; and
- 12 mammals.

Additionally, invertebrates of 36 families were also observed during the survey period. Animals (species and families) observed in the study area are, for most part, typical arid savanna species and representative of savanna animal communities that are widespread in the regional areas of the Ghaap Plateau Vaalbosveld and in the larger extent of the Eastern Kalahari Bushveld Bioregion.

Sixty-two Red Data animals are known to occur in the North West Province (butterflies, frogs, reptiles and mammals) and in the Q-grid 2724AD (birds). It is estimated that 39 of the 62 animals listed have a low probability of occurring in the study area, 6 have a moderate-low probability, 10 a moderate probability, 3 a moderate-high and 2 species a high probability of occurring in the study area. Two species were confirmed to be present in the study area, namely **Kori Bustard** and **Tawny Eagle**.

During the field investigation, 80% of the species observed (59 species) were identified during the first 38% of the time spent (313 minutes). Within the first half of the survey time (410 minutes), 92% of the total number of species (68 species) has been identified. Considering the plateau reached in the species accumulation, it would appear as if most of the species present within the survey area were noted. Only with considerable effort could the species diversity be improved. For the purpose of this investigation, the species
diversity observed during the survey period is therefore considered satisfactory. Based on results of the site investigations and Red Data assessments the following faunal sensitivities area ascribed to the habitat types:

- Transformed habitat (low faunal sensitivity);
- Degraded habitat (medium-low faunal sensitivity); and
- Natural woodland variations (medium faunal sensitivity).

Most of the original ecological characteristics and ecosystem processes of the Ghaap Plateau Vaalbosveld are reflected in the study area. Natural woodland of the study area is also well connected to other untransformed woodland areas and most animals would be able to migrate freely within the region, with the exception of animal groups unable to cross the fences surrounding the study area. Most of the animals observed in the study area are found in most parts of South Africa; others are limited to the arid regions of the country. Except for the livestock present in the study area, no introduced or alien animal species were observed during the field investigation.

Considering the regionally untransformed status of available faunal habitat, the loss of the property for the purpose of the proposed mining development is not expected to result in significant impacts on the faunal attributes of the study area. While localised impact will inevitably occur, most animal species are able to evacuate an area that becomes unfavourable. Red Data animals present in the region are unlikely to be affected beyond a local scale; suitable habitat is present in the surrounding areas. The implementation of generic mitigation measures are expected to ameliorate impacts to an acceptable significance level.

Table 18: Animal species observed in the study area

Class	Order	Family	Biological Name	English Name
Chilopoda	*Scolopendromorpha*		*Scolopendra sp*	Red-footed Centipede
Arachnida	*Scorpiones*	*Scorpionidae*	*Opistophthalmus carinatus*	Kalahari Burrowing Scorpion
Insecta	*Odonata*	*Coenagrionidae*	*Ischnura senegalensis*	Marsh Bluetail
		Aeshnidae	*Anax emperator*	Blue Emperor
		Libellulidae	*Trithemis arteriosa*	Red-veined Dropwing
	Isoptera	*Termitidae*	*Trinervitermes sp*	Snouted Harvester Termite
	Neuroptera	*Myrmeleontidae*	*Myrmeleon sp*	Pit-building Antlion
	Coleoptera	*Scarabaeidae*	*Pachnoda sinuata*	Garden Fruit Chafer
		Coccinellidae	*Cheilomenes lunata*	Lunate Ladybird
		Meloidae	*Mylabris oculata*	CMR Beetle
	Lepidoptera	*Nymphalidae*	*Danaus chryssipus*	African Monarch
			Junonia hierta	Yellow Pansy
			Ypthima asterope	African Ringlet
		Lycaenidae	*Tarucus sybaris*	Dotted Blue

			Zintha hintza	Hintza Blue
		Pieridae	*Belenois aurota*	Brown-veined White
			Catopsilla florella	African Migrant
		Papilionidae	*Papilio demodocus*	Citrus Swallowtail
	Diptera	*Tabanidae*	*Haematopota species*	Cleg
	Hymenoptera	*Apidae*	*Apis meliffera*	Honey Bee
Reptilia	*Testudines*	*Testudinidae*	*Stigmochelys pardalis*	Leopard Tortoise
	Squamata	*Viperidae*	*Bitis arietans*	Puff Adder
		Agamidae	*Agama aculeata*	Ground Agama
		Lacertidae	*Pedioplanis lineoocellata*	Spotted Sand Lizard
			Nucras intertexta	Spotted Sandveld Lizard
Aves	*Galliformes*	*Numididae*	*Numida meleagris*	Helmeted Guineafowl
		Phasianidae	*Scleroptila levaillantoides*	Orange River Francolin
	Ciconiiformes	*Threskiornithidae*	*Bostrychia hagedash*	Hadeda Ibis
	Falconiformes	*Accipitridae*	*Circaetus pectoralis*	Black-chested Snake-Eagle
			Aquila rapax	Tawny Eagle
			Falco rupicoloides	Greater Kestrel
	Gruiformes	*Otididae*	*Ardeotis kori*	Kori Bustard
	Charadriiformes	*Burhinidae*	*Burhinus capensis*	Spotted Thick-knee
	Columbiformes	*Columbidae*	*Columba guinea*	Speckled Pigeon
			Streptopelia capicola	Ring-necked Dove
			Spilopelia senegalensis	Laughing Dove
			Oena capensis	Namaqua Dove
	Apodiformes	*Apodidae*	*Apus affinis*	Little Swift
	Coliiformes	*Coliidae*	*Colius colius*	White-backed Mousebird
			Urocolius indicus	Red-faced Mousebird
	Coraciiformes	*Meropidae*	*Merops apiaster*	European Bee-eater
	Upupiformes	*Upupidae*	*Upupa africana*	African Hoopoe
	Piciformes	*Lybiidae*	*Tricholaema leucomelas*	Acacia Pied Barbet
	Passeriformes	*Laniidae*	*Laniarius atrococcineus*	Crimson-breasted Shrike
			Lanius collurio	Red-backed Shrike
		Corvidae	*Corvus capensis*	Cape Crow
			Corvus albus	Pied Crow
		Alaudidae	*Mirafra fasciolata*	Eastern Clapper Lark
			Calendulauda africanoides	Fawn-coloured Lark
		Pycnonotidae	*Pycnonotus nigricans*	African Red-eyed Bulbul
		Hirundinidae	*Cecropis semirufa*	Red-breasted Swallow
		Cisticolidae	*Cisticola chiniana*	Rattling Cisticola
			Cisticola rufilatus	Tinkling Cisticola
			Cisticola juncidis	Zitting Cisticola

			Prinia flavicans	Black-chested Prinia
		Sylviidae	*Sylvia subcaerulea*	Chestnut-vented Tit-Babbler
		Sturnidae	*Lamprotornis nitens*	Cape Starling
		Muscicapidae	*Erythropygia paena*	Kalahari Scrub Robin
			Cercomela familiaris	Familiar Chat
		Passeridae	*Passer motitensis*	Great Sparrow
		Ploceidae	*Plocepasser mahali*	White-browed Sparrow-Weaver
			Sporopipes squamifrons	Scaly-feathered Weaver
			Ploceus velatus	Southern Masked Weaver
		Estrildidae	*Uraginthus granatinus*	Violet-eared Waxbill
		Motacillidae	*Anthus cinnamomeus*	African Pipit
		Fringillidae	*Crithagra atrogularis*	Black-throated Canary
			Crithagra flaviventris	Yellow Canary
			Emberiza flaviventris	Golden-breasted Bunting
Mammalia	*Lagomorpha*	*Leporidae*	*Lepus capensis*	Cape Hare
	Rodentia	*Bathyergidae*	*Cryptomys hottentotus*	Common Mole-rat
		Hystricidae	*Hystrix africaeaustralis*	Porcupine
		Muridae	*Aethomys namaquensis*	Namaqua Rock Mouse
			Rhabdomys pumilio	Striped Mouse
	Carnivora	*Viverridae*	*Genetta felina*	Feline Genet
		Canidae	*Canis mesomelas*	Black-backed Jackal
	Tubulidentata	*Orycteropodidae*	*Orycteropus afer*	Aardvark
	Artiodactyla	*Suidae*	*Phacochoerus africanus*	Common Warthog
		Bovidae	*Raphicerus campestris*	Steenbok
			Antidorcas marsupialis	Cape Springbok
			Sylvicapra grimmia	Bush Duiker

4.7.3 Discussion of findings of the Biodiversity Assessment

It could reasonably be expected, that surface impacts on the natural environment constitute the most significant impact on biodiversity attributes of the study area, albeit estimated to be of medium significance. Decimation of remaining areas of natural habitat during the construction phase will not only destroy the existing natural habitat, but will also severely limit the potential of other area to be inhabited by a relative diverse and natural composition of plants and animals. The loss of biodiversity attributes in the study area is unlikely to affect the local or regional biodiversity attributes to a significant level or the conservation status of animals that are likely to inhabit these parts.

The implementation of generic mitigation measures are likely to result in amelioration of expected impacts to a low significance. No area was observed that are regarded to be of particular ecological significance and no restrictions in terms of placement of development facilities and infrastructure are placed on the area. The loss of the remainder of the property because of the proposed development is unlikely to have a significance bearing on the biological environment beyond a relative short distance from the activity. The most important recommendation in this regard is to prevent the contamination, degradation and pollution of surrounding areas by means of the implementation of adequate preventative barriers and the containment of effluent from the plant and water treatment facilities.

While little impact on the vegetation is expected beyond the boundaries of the site, effects on animals are expected to continue for prolonged periods as well as further than the site boundaries, mainly because of animal movement into the activity area. While this impact cannot be controlled, every effort should be made to prevent accidental, or fatal, contact with animals.

4.8 Air Quality

4.8.1 Historical information

Historic information as it relates to the dust generating potential of the mine includes the following (not appended hereto as the information relates to the previous mining and closure activities):

- Pollution potential of tailings dust fallout – Walmsley Environmental Consultants (March 2000) – Residues from the flotation process were deposited in the tailings dam and tailings dust was mobilised and dispersed downwind of the tailings dam. The study was undertaken due to concern about the pollution potential from the tailings dam which are dispersed downwind of the tailings dam.
- Air dispersion modelling for the Tailings Dam at Pering Mine – Airshed Planning Professionals – Impact assessment and predictions of resultant ambient respirable particulate concentrations and dust fallout of the tailings dams with and without cladding (for closure).

4.8.2 Dustfall standards

Dust fallout monitoring at Pering Mine began in 2003 and are assessed according to the standards published by the South African Bureau of Standards (SANS 1929:2005) (Table 19). Dust fallout rates within the residential and industrial threshold are generally tolerated, while action and alert threshold dust fallout, generally result in public complaints, and are therefore considered to be action levels, at which sources of excessive dust must be investigated (if not known) and suitable mitigation measures instituted.

Table 19: Four-band scale evaluation criteria for dust deposition (SANS 1929:2005)

Band Number	band Description Label	Dustfall Rate (D) (mg/m^2/day), 30-Day Average	Comment
1	Residential	D < 600	Permissible for residential and light commercial
2	Industrial	600 < D < 1,200	Permissible for heavy commercial and industrial
3	Action	1,200 < D < 2,400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	2,400 < D	Immediate action and remediation required following the first incidence of dustfall rate being exceeded. Incident report to be submitted to relevant authority.

4.8.3 Current Monitoring Network

Dust fallout monitoring at Pering Mine began in 2003 where windblown dust is monitored based on the American Society of Testing and Materials standard method for collection and analysis of dustfall (ASTDM D1739) with certain modifications. Bi-annual dust monitoring is undertaken at Pering Mine (February 2010 and September 2010). There are four dust buckets at three locations (12 buckets in total) located at "West tailings", "Green Gate" and "Firebreak " sites.

In their latest Dust Deposition Monitoring Report dated 26 October 2010 (**Appendix 9**), SGS Environmental concluded that the following is relevant at Pering Mine based on their survey for the period of 15 August 2010 to 15 September 2010:

- Single Buckets (Table 20**):**All monitoring sites recorded fall within the residential dust fall-out rates. The results are regarded as satisfactory as they will not result in community complaints and nuisance.
- Dust Watch Buckets (Table 21): All sectors of the Dust Watch's recorded fall within the residential dust fall-out rates. The results are regarded as satisfactory.
- All sites complied with the SANS target.

Table 20: Single bucket monitoring results

Site Description	Site No.	Site Classification	Dust Fallout – February 2010	Dust Fallout – September 2010
			Mg/m2/day	Mg/m2/day
Firebreak	PER 01	Industrial	57	143
Greengate	PER 02	Industrial	89	52
West Tailings	PER 03	Industrial	122	55

Table 21: Dust watch monitoring results

Site Description	Site No.	Site Classification	Dust Fallout – February 2010	Dust Fallout – September 2010
			Mg/m2/day	Mg/m2/day
Firebreak	Fire2 North	Industrial	25	156
	Fire2 East		25	122
	Fire2 South		30	27
	Fire2 West		5	70
Greengate	Green3 North	Industrial	6	147
	Green3 East		3	151
	Green3 South		8	123
	Green3 West		17	107
West Tailings	West1 North	Industrial	ND	109
	West1 East		ND	71
	West1 South		ND	74
	West1 West		ND	48

The dustfall monitoring data at Pering Mine indicates that all results are satisfactory and within SANS targets (for residential rates). The Department of Economic Development, Environment, Conservation and Tourism (DEDECT) has requested that an updated air quality study be undertaken with the aim of assessing the air quality impacts of the future mining scenario to be considered as part of the Application in terms of NEMA.

4.8.4 Air quality impact assessment for proposed new mining activities

Airshed Planning Professionals (Pty) Ltd were appointed to undertake an air quality impact assessment to determine the potential air quality impacts associated with the proposed new mining activities associated with the Pering Mine project (refer to specialist report attached as **Appendix 10**). This included a baseline characterisation using meteorological data, analysis of ambient monitoring data and an impact assessment of pollutants of concern for the construction and operational phases of the project. Dispersion modelling was used (using the AERMOD model) to simulate the potential for impacts on the surrounding environment and human health.

The air quality standards presented below are applicable to all areas where the general public has access to, as well as all off-site areas including all areas outside the property boundary. These standards are not applicable on site. On site concentrations to which workers are an occupational health and safety concern are not regulated by the National Environmental Management Air Quality Act. Evaluation of on-site air pollutant concentrations did not form part of the scope of the air quality impact assessment.

Criteria pollutants are considered those pollutants most commonly found in the atmosphere, that have proven detrimental health effects when inhaled and are regulated by ambient air quality criteria. These generally include CO, NO2, PM10, ground level ozone (O3) and SO2.The South African Bureau of Standards (SABS) was engaged to assist DEA in the facilitation of the development of ambient air quality standards. This included the establishment of a technical committee to oversee the development of standards. Standards were determined based on international best practice for PM10, dust fall, SO2, NO2, O3, CO, lead (Pb) and benzene (C6H6). These standards were published for comment in the Government Gazette on 9 June 2007. The proposed revised national ambient standards were published for comment in the Government Gazette on the 13th of March 2009. The final national ambient standards, were published in the Government Gazette on the 24th of December 2009

In assessing atmospheric impacts from the afore-mentioned activities, an emissions inventory was compiled for the proposed mining operations and extensions at Pering. The pollutants of concern that will be generated as a result of the operations include PM10, fugitive dust, CO, SO2 and NOx.

The main findings of the baseline characterisation are as follows:

- The mine boundary was identified as a receptor, as NAAQ standards must be met outside of the mine boundary.
- The local wind field is dominated by winds from the north-north-west and north.
- The area is characterised by low wind speeds and calm conditions (18.28 %) with winds in the order of 0.5 to 5.7 m/s occurring commonly.
- Summers and winters are relatively warm with maximum temperatures reaching 30 º C during the summer and minimum winter temperatures reaching lows of around 6 º C.
- Pering is located in a semi- arid rainfall area and receives relatively low precipitation.

4.8.4.1 Emissions inventory

The release of emissions represents the environmental impact of concern during the proposed mining operations. In the development of an emissions inventory the first approach is to establish a comprehensive list of all sources that would generate the pollutants of concern. Such sources were identified by firstly utilising the inputs and outputs to the operational processes and secondly considering the disturbance to the environment. **Table 22** indicates the total ore production, waste generation, explosive consumption tonnages and fuel consumption (litres) at Pering mine per year. These values were used to estimate emission rates in the emission inventory

Table 22: Total ore production, waste generation, explosive consumption tonnages and fuel consumption (litres) per year.

Ore from pits (tpa)	Reclaimed material from stockpiles (tpa)	Waste from pits (Overburden) (tpa)	Waste from processing plant (tpa)	Total Explosives (tpa)	Total fuel Consumption (l/a)
2 200 000	2 030 769	1 800 000	3 850 000	214.29	5 221 728

In assessing atmospheric impacts from the afore-mentioned activities, an emissions inventory was compiled for the proposed mining operations and extensions at Pering. The pollutants of concern that will be generated as a result of the operations include PM_{10}, fugitive dust, CO, SO_2 and NOx.

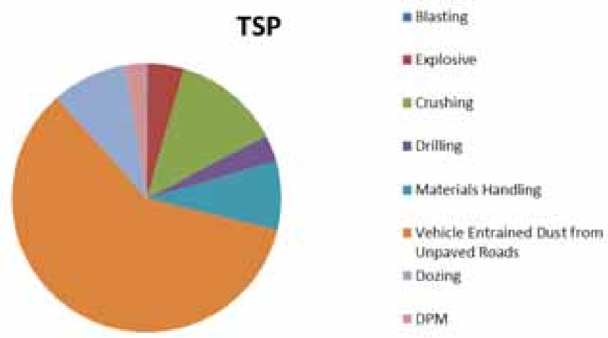
The following sources impacting on air quality were included in the emissions inventory:

- Materials Handling Operations
- Vehicle Entrained Dust from Unpaved Roads
- Drilling and blasting
- Dozing
- Crushing
- Vehicle tailpipe emissions

The total emissions for each pollutant caused by the different sources at the Pering mine for both the unmitigated (left hand column) and mitigated scenarios (right hand column) are summarised below.

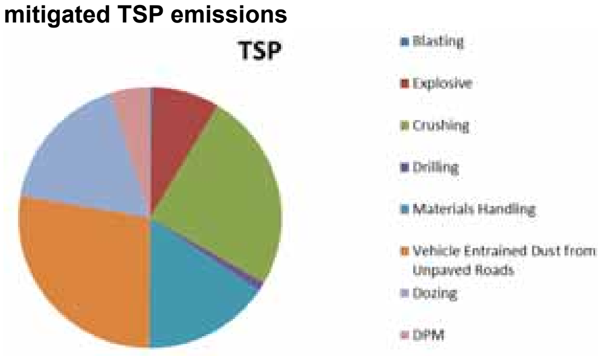
Dust fallout (TSP)

Each source's contribution to total unmitigated TSP emissions



Source	TSP (tpa)	TSP (%)
Blasting	4.3	0%
Explosive	98.9(a)	4%
Crushing	296.2	13%
Drilling	74.3	3%
Materials Handling	187.6	8%
Vehicle Entrained Dust from Unpaved Roads	**1 365.0**	**61%**
Dozing	208.7	9%

Each source's contribution to total mitigated TSP emissions

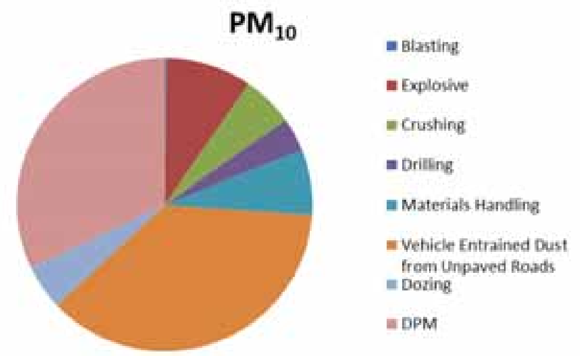


Source	TSP	TSP
Blasting	4.3	0%
Explosive	98.9	9%
Crushing	296.2	26%
Drilling	13.4	1%
Materials Handling	187.6	16%
Vehicle Entrained Dust from Unpaved Roads	**330.6**	**29%**
Dozing	208.7	18%

Total	2 235.0	100%	Total	1139.7	100%

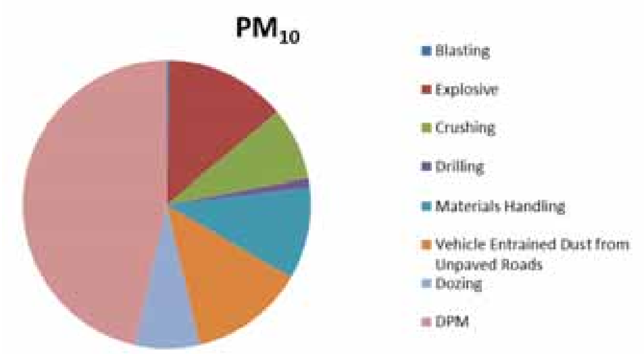
PM10

Each source's contribution to total unmitigated PM_{10} emissions



Source	PM10 (tpa)	PM10 (%)
Blasting	2.25	0.3%
Explosive	98.90	13.8%
Crushing	59.23	8.3%
Drilling	39.06	5.5%
Materials Handling	75.03	10.5%
Vehicle Entrained Dust from Unpaved Roads	388.15	54.3%
Dozing	52.33	7.3%
Diesel particulate matter	337.23	47.2%
Total	**714.95**	**100.0%**

Each source's contribution to total mitigated PM10 emissions



Source	PM10 (tpa)	PM10 (%)
Blasting	2.25	0.6%
Explosive	98.90	25.4%
Crushing	59.23	15.2%
Drilling	7.03	1.8%
Materials Handling	75.03	19.3%
Vehicle Entrained Dust from Unpaved Roads	94.01	24.2%
Dozing	52.33	13.5%
Diesel particulate matter	337.23	86.7%
Total	388.78	100.0%

Gasses

Source	CO		NOx		SO^2	
	tpa	%	tpa	%	tpa	%
Vehicle tailpipe emissions	337.2	82	801.6	98	10.3	83
Detonation of Explosives	73.1	18	17.2	2	2.2	17
Total	**410.3**	**100**	**818.8**	**100**	**12.4**	**100**

4.8.4.2 Construction phase - enhanced evaporation as a pit dewatering alternative

The Main Pit and Pit 24 will need to be dewatered during the construction phase before mining can commence. As part of the Air quality Impact Assessment, the alternative dewatering method of enhanced evaporation making use of water canons/sprinklers over the Main Pit was modelled.

Pering Mine requested AGES to investigate a number of options for dewatering including the pumping of the Main Pit and discharging into P24 pit for settling; treating the water through a temporary installation;

waste water treatment and enhanced evaporation through the application of sprinklers. The latter option would result in the higher rate of evaporation, dewatering the pit in a period of 18 months (AGES, 2008).

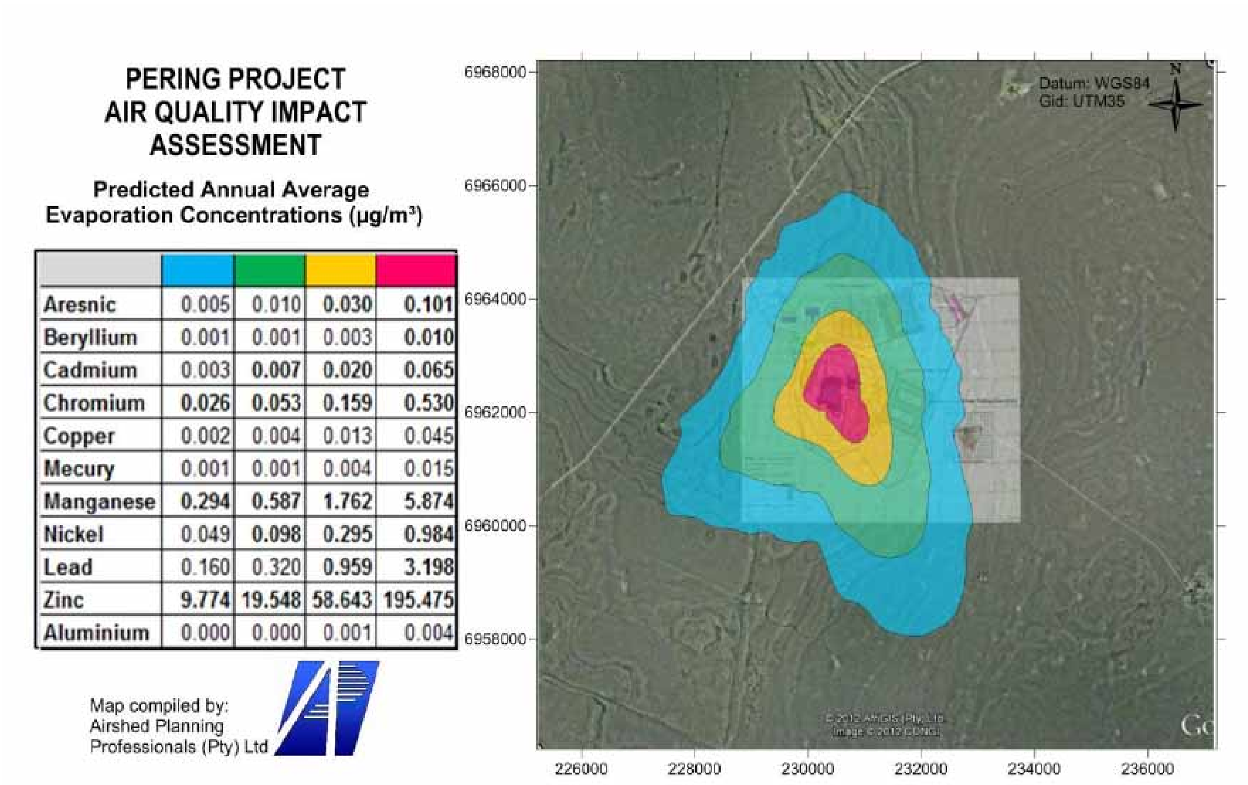
The enhanced evaporation process will entail 47 water canons placed 25 m apart on the north-eastern perimeter of the Main Pit. Each canon will release 40.7 m³ of water per hour at 7 bar for a period of 8 hours per day (AGES, 2008). The emission rate for each canon was based on the amount of water released.

Heavy metals reported on as part of the annual surface and ground water monitoring were used to determine the amount of metals that may be released during evaporation. Only heavy metals with associated health thresholds were included in the assessment. The emission rate for each water canon was calculated at 11 305.5 g/s. According to literature on waste water evaporators in Australia, these water cannons should achieve evaporation losses of between 40% and 90% (http://www.wetearth.com.au/Waste-Water -Evaporation). For the purpose of the air quality impact assessment modeling it was assumed that the canons would achieve 90% control efficiency.

Figure 39: Waste water evaporators (http://www.wetearth.com.au/Waste-Water-Evaporation)

In the case of enhanced evaporation, predicted ground level concentrations of manganese and zinc were predicted to exceed the selected thresholds off-site (refer to impact assessment in Section 7). These predictions were based on a conservative approach of assuming that all the metals in the water would evaporate.

Heavy metals reported on as part of the annual surface and ground water monitoring were used to determine the amount of metals that may be released during evaporation. In the case of enhanced evaporation, predicted ground level concentrations of manganese and zinc were predicted to exceed the selected thresholds off-site (**Figure 40** below). These predictions were based on a conservative approach of assuming that all the metals in the water would evaporate.



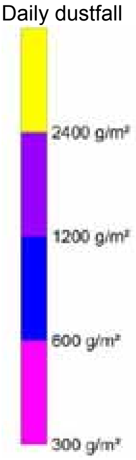
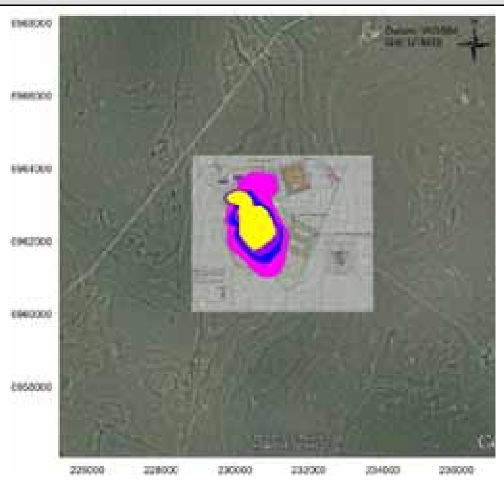
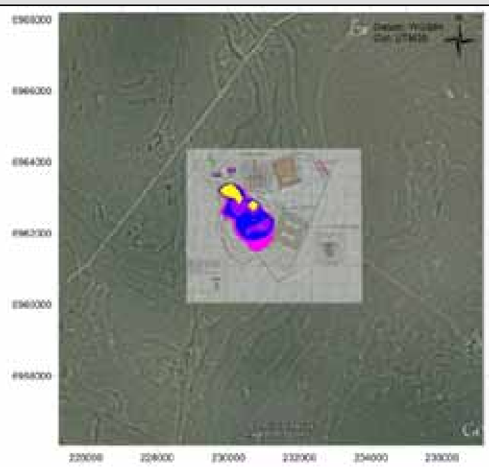
	(blue)	(green)	(yellow)	(red)
Aresnic	0.005	0.010	0.030	0.101
Beryllium	0.001	0.001	0.003	0.010
Cadmium	0.003	0.007	0.020	0.065
Chromium	0.026	0.053	0.159	0.530
Copper	0.002	0.004	0.013	0.045
Mecury	0.001	0.001	0.004	0.015
Manganese	0.294	0.587	1.762	5.874
Nickel	0.049	0.098	0.295	0.984
Lead	0.160	0.320	0.959	3.198
Zinc	9.774	19.548	58.643	195.475
Aluminium	0.000	0.000	0.001	0.004

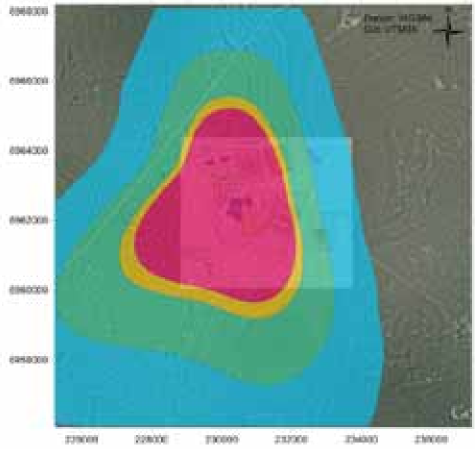
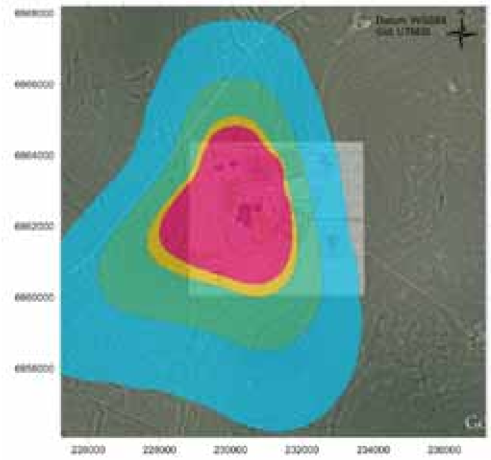
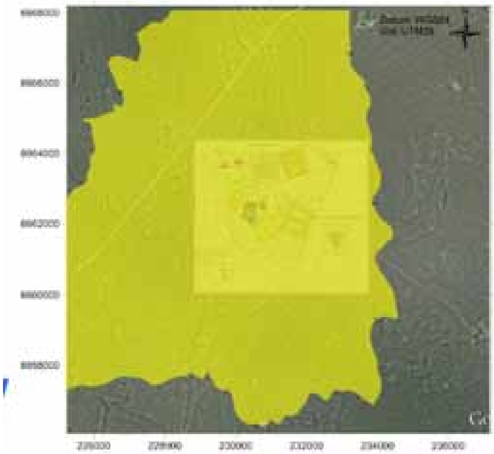
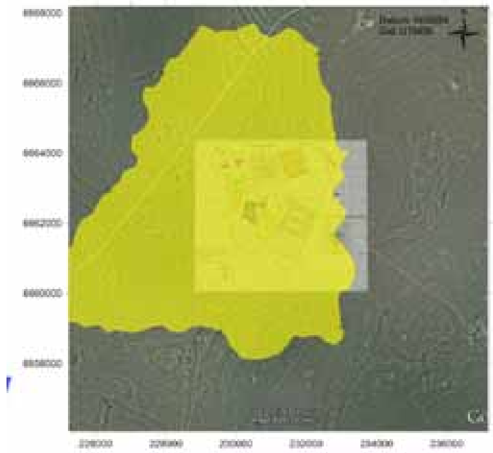
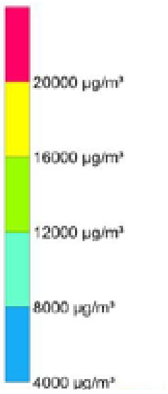
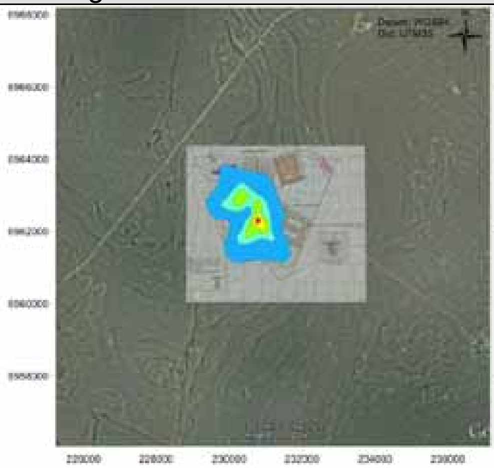
Figure 40: Enhanced evaporation predicted concentrations

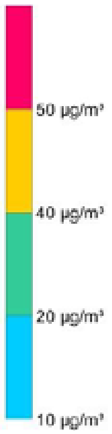
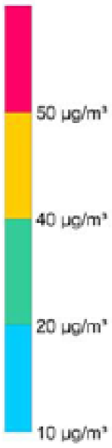
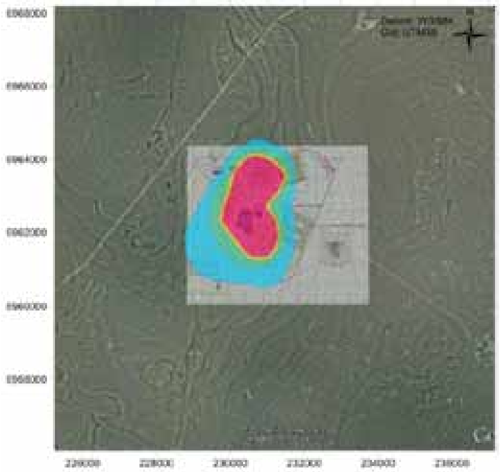
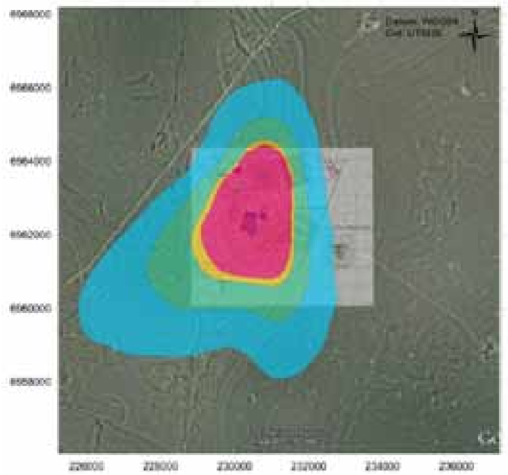
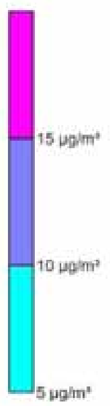
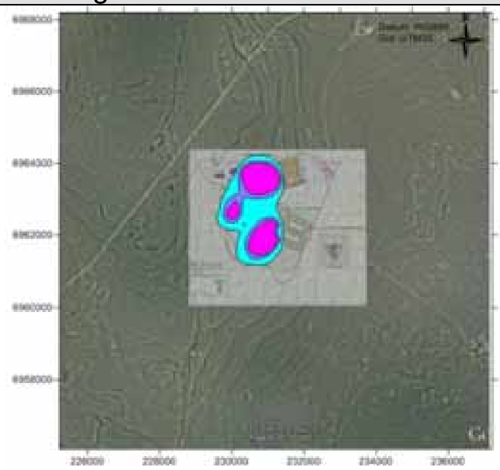
4.8.4.3 Operational phase impacts

Based on the air quality modeling results, it can be concluded that PM10 and NO2 impacts are most significant as exceedences are shown to extend beyond the mine boundary. It is important that feasible air quality management measures for PM10 and NO2 emissions be implemented to ensure the lowest possible impacts on the sensitive receptors within and outside the boundaries of the Pering mine. Crushing, materials handling and unpaved roads (in that order) are the prime contributors to PM10 concentrations at the mine boundary. Mitigation and management efforts should thus be primarily focussed on these sources. **Table 23** provides a summary of the unmitigated and mitigated scenarios.

Table 23: Mitigated and unmitigated scenarios for identified criteria pollutants

Dust fallout (TSP) impacts	Unmitigated	Mitigated
Daily dustfall 		

PM_{10} impacts	Unmitigated	Mitigated
NAAQS – 40 µg/m^3 		
PM_{10} – daily exceedences	Unmitigated	Mitigated
		
CO impacts	Unmitigated	Mitigated
NAAQ limit – 30 000 µg/m^3 		It is clear from the adjacent figure that the CO concentrations are generally quite low and do not exceed the NAAQ standards. No mitigation is therefore proposed.

SO_2 impacts	Unmitigated	Mitigated
NAAQS – 50 µg/m^3 		It is clear from the adjacent figure that the SO_2 concentrations do not exceed the NAAQ standards (annual as well as daily and hourly concentrations). No mitigation is therefore proposed.
NO_2 impacts	Assuming NO_2 equal to 20% NO_X	Assuming NO_2 is to 75% NO_X
NAAQS – 40 µg/m^3 		
VOC impacts	Unmitigated	Mitigated
NAAQS limit value – 10 µg/m^3 		It is clear from the adjacent figure that the VOC concentrations do not exceed the NAAQ standards (annual as well as daily and hourly concentrations). No mitigation is therefore proposed.

Based on the figures in **Table 23**, the following is relevant:

- TSP/Dust fall out rates (unmitigated and mitigated) did not exceed the Draft NAAQ limit values.

- Mitigated and unmitigated PM_{10} concentrations exceeded the 2015 NAAQ PM_{10} annual standard (40 µg/m³) and the daily standard (75 µg/m³ not to be exceeded more than 4 days per year) outside of the northern and western mine boundary. Exceedance takes place at a maximum distance of approximately 2 km from the boundary.
- SO_2 concentrations are relatively low and NAAQ limits for SO_2 were not exceeded.
- CO NAAQ standards were not exceeded.
- An upper (75%)–and lower (20%) conversion rate for NO_2 were modelled. From this it was evident that the upper boundary NO_2 predictions exceeded the NAAQ annual standard and hourly limit more than the allowed frequency of exceedance.
- The NAAQ limit for Benzene was not exceeded when compared to the VOC concentrations.
- In the case of enhanced evaporation, predicted ground level concentrations of manganese and zinc were predicted to exceed the selected thresholds off-site. These predictions were based on a conservative approach of assuming that all the metals in the water would evaporate. Natural evaporation from the Main Pit and P24 would not result in metals released into the ambient air but rather the accumulation of the metals in the remaining water.

4.9 Noise

According to the SANS 0103: 2004 (The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication, and the surrounding land uses), Pering Mine is considered to be within a rural district (Table 24).

Table 24: Acceptable rating levels for noise in districts (SANS 10103:2004)

Type of District	Equivalent Continuous Rating Level ($L_{req,t}$) for Noise Dba					
	Outdoors			Indoors, with open windows		
	Day-night	Day-time	Night-time	Day-night	Day-time	Night-time
	$L_{R,dn}$ [a]	$L_{Req,d}$ [b]	$L_{Req,d}$ [b]	$L_{R,dn}$ [a]	$L_{Req,d}$ [b]	$L_{Req,d}$ [b]
RESIDENTIAL DISTRICTS						
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
NON RESIDENTIAL DISTRICTS						
d) Urban districts with some workshops, with business premises, and with main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
e) Industrial districts	70	70	60	60	60	50

[a] The values given in column 2 and 5 are equivalent continuous rating levels and include corrections for tonal character, impulsiveness of the noise and time of day.

[b] The value given in columns 3, 4, 6 and 7 are equivalent continuous rating levels and include corrections for tonal character and impulsiveness of the noise.

As no operations have taken place since 2003, no noise monitoring is currently being undertaken. Should noise monitoring be re-initiated, then the ratings in the above table will be regarded as the applicable standard.

4.10 Traffic Impact Assessment

A Traffic Impact Assessment was undertaken by FoT Consulting (refer to **Appendix 11**) to determine the potential impact of the proposed mine project on road infrastructure and user safety.

The following transport-related issues and / or queries were identified and recorded during the Public Participation sessions:

- Increasing road traffic along R371 (Reivilo / Boipelo) road;
- Building a road to circumnavigate Reivilo for the transportation of the processed ore;
- Concern about dust, noise, road degrading and road safety generated by mine traffic;
- Trucks using the Boipelo location as short-cut to Taung (Voortrekker / Boipelo entrance); and
- The size of trucks and fleet.

The logistical feasibility investigations as presented in the logistics study report focused on the projected supply chain process of the reinstated Pering Mine as part of which process the transport solutions and transport facilities form critical elements. The following potential issues and challenges have been identified:

- The concern of housing shortage in Reivilo to accommodate projected demand as a result of creating new job opportunities which relate to the employees' transport requirements;
- Generally narrow and not fully tarred roads. The study also recorded concerns about road holes which could develop into potholes and gravel road section from the Pering Mine that could get flooded and extensively damaged in a rainy season;
- The proposed rail siding is situated within the Taung major economic node and therefore not easily accessible;
- The physical access to the siding is off the main road traversing through the Taung CBD; and
- The wild animals / livestock presence on all the roads within the study area increase the traffic safety risk.

The traffic counts were conducted on a weekday i.e. 11th December 2009 for the 12-hours period (06h00-18h00) at the following intersections, the results of which are presented in Table 25.

- Intersection of the 'main' road traversing through Reivilo (R371) and the Pering Mine access road.
- T-junction of the main road traversing through Reivilo (R371) and the Taung Road (R372).
- Intersection of the Taung-Reivilo Road (R372) and Vryburg-Taung Road (N18).

Table 25: Summary of traffic observations

Intersection	Weekday AM Peak Hour				Weekday PM Peak Hour			
	Period	HV%	PHF	Volume	Period	HV%	PHF	Volume
Voortrekker (R371) / Hugenote Street	7:15 – 8:15	4.5	0.69	44	15:30 – 16:30	1.5	0.93	67
Voortrekker (R371) / Greeff Street	7:00 – 8:00	0.0	0.85	115	15:00 – 16:00	3.1	0.89	161
Voortrekker (R371) / Taung Road	7:15 – 8:15	7.7	0.81	39	16:00 – 17:00	6.8	0.85	44
R372 / N18	7:45 – 8:45	6.0	0.92	746	14:00 – 15:00			411

The road network serving the private and commercial transport needs in the study area is shown in Figure 41. It basically includes two main road sections (identified as R372 and R371) linking small towns and township in the study area with the national road network via N18 and Taung CBD as the main commercial centre in this region. Pering Mine is located off a gravel road (not numbered) linking the R371 to the west and the N18 to the east of the mine.

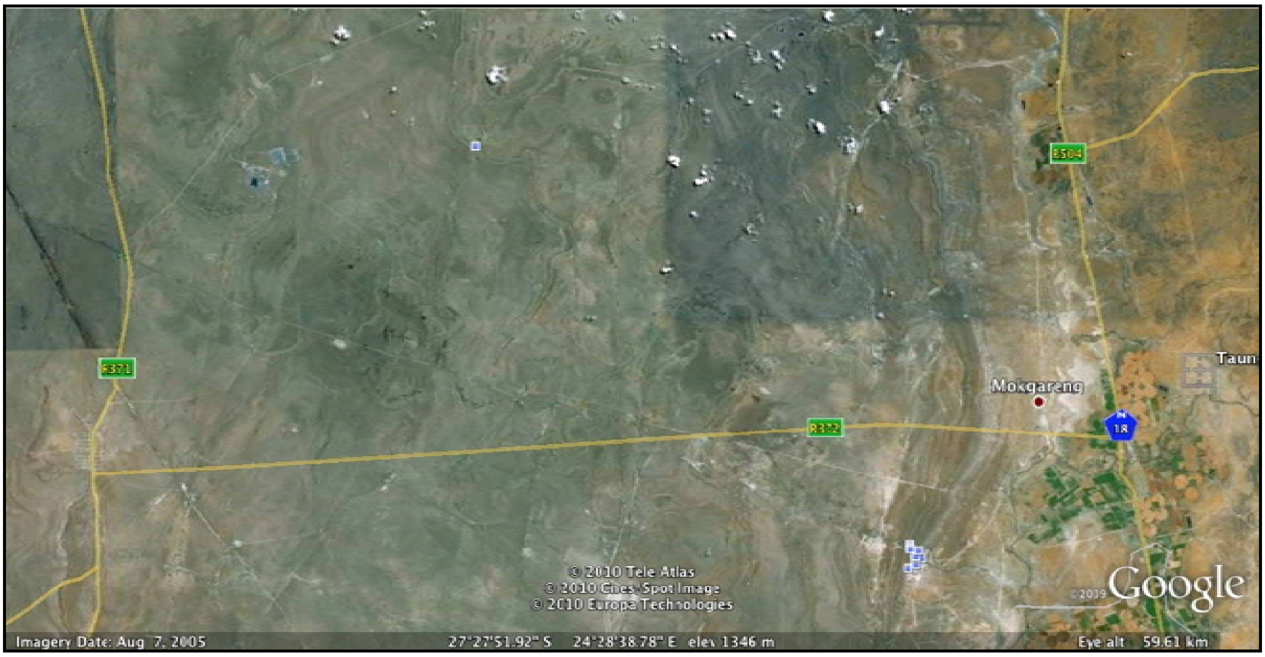


Figure 41: Road Network in the Study Area

The R371 and R372 are tarred road sections and in reasonable condition though not protected from the farm areas along the road. Some of the critical distances between the origin and destination points relevant to the mine development are presented in Table 26.

Table 26: Critical distances in the study area

From	To	Distance (km)	Tar (km)	Gravel (km)	Rail (km)
Pering Mine	Taung Siding	77.4	70.05	6.9	0
Pering Mine	Reivilo	20	13.1	6.09	0
Entrance Reivilo	Exit Reivilo	2	2	0	0
Mine Road	N/A	9.4	2.5	6.9	0
Pering Mine	Springs (Over Wolfeal / Krugersdorp)	569	538.5	30.5	0
Pering Mine	Springs (Amalia / N12)	500	453	47	0
Pering Mine	Springs (Lykso / Vryburg)	709	674.10	34.9	0
Pering Mine	Springs (Taung)	576.4	569.5 (Road very narrow)	6.9	0
Pering Mine	Vryburg (shortest route)	91	13.1	779	0
Taung Siding	Springs	480	0	0	480

The vehicle demand and traffic utilisation levels of the road network are very low and typical for many rural areas in the Country. Internal vehicle and pedestrian movements within towns and townships are more intensive though still at insignificant levels.

As an illustration of the above perception the traffic counts revealed the daily vehicle demand of below 1000 vehicles along R371 and below 2000 vehicles along R372. The vehicle demand is not expected to grow significantly in the future regardless of a few development initiatives within the study area.

With regard to the traffic demand projections related to the mine operations, two types of trips are expected to be generated by the Pering Mine. These include the truck trips from the mine to the rail siding in Taung, and also the employment related trips to and from the mine. The employees transport will entail the private vehicle trips and public transport vehicle trips.

There are several aspects of the transport system identified as possible challenges in the near future and especially as the result of the reinstatement of the mine operations. These include the following:

- Traffic and safety conditions at the major intersection of R372 and N18 roads
- Position of and vehicle manoeuvring limitations at the rail siding access point.
- Traffic safety conditions along the main roads.
- A gravel road section providing direct access to the mine development.

The main intersection of R372 and N18 is the priority STOP controlled junction at the minor legs i.e. eastern and western legs along R372. The movement across the N18 could sometimes cause a challenge especially to large trucks with slow acceleration times. A slow clearance of the intersection could cause safety risk to the road users along the N18. The installation of the traffic signals might not be justified at this stage though it may be identified as a viable solution in the near future.

The access to the rail siding, situated off the main road section traversing through the Taung CBD, is provided in a close proximity to the main intersection on the one side and the rail crossing on the other side of the access point (approximately 200m to the east of the main intersection). The main road does not provide auxiliary traffic lanes or road space to facilitate easier manoeuvring of the heavy vehicles at the point of access to the rail siding. The turning movements of the large trucks into and out of the rail siding will most likely cause some delay to the vehicle movements downstream and upstream of the access point in both directions. The proposed expansion of the access gate to accommodate simultaneous movement of a large truck and conventional vehicle in and out of the siding premises is supported as it would alleviate possible vehicle delays. The situation would have to be monitored after the inception of the mine operations and further analysed if necessary to identify adequate improvement measures.

4.11 Sites of Archaeological and Cultural Importance

A Heritage Impact Assessment was undertaken by Professional Grave Solutions (PGS) in November 2011 in fulfilment of the provisions of the National Heritage Resources Act 25 of 1999 (refer to **Appendix 12**).

The following type of archaeological sites may be located within the surrounding landscape:

- Stone Age sites
- Rock art, and specifically rock engravings
- Late Iron Age stonewalled sites
- Historic settlements
- Graves and burial grounds

The Heritage Impact Assessment included a desktop study and field survey. Based on the desktop study undertaken, no heritage sites occur on the farm Pering Mine. The field survey identified one heritage site in the project area:

Site Type: Later Stone Age surface scatter
GPS Coordinates: S27° 26’ 41.2” E24° 16’ 59.1” (WGS84)
Site Description: The site comprises a low density surface scatter of Later Stone Age lithics in proximity to a dry water pan. A total of six lithics were observed over an area roughly 400m² in extent.
Approximate Age: Unknown at present
Potential Impact: High potential impact during any development of the study area.
Proposed Mitigation: Although the site appears to be in primary context, it is of such low density that it is of Low Significance. As a result no further mitigation work would be required.

Figure 42: General view of the site and two of the lithics observed

4.12 Regional Socio-Economic Structures

The following information has been sourced from the Social and Labour Plan generated for the Pering Mine Mining Right Conversion Application (December 2008).

4.12.1 Social Economic Profile of the Greater Taung Local Municipality within the North-West Province

Pering Mine is situated within the Greater Taung Local Municipality (GTLM). The GTLM is located within the western part of the North-West Province in the Bophirima District Municipality (DM). The GTLM is approximately 5,649 km^2 in extent, which represents approximately 11.8% of the area covered by the Bophirima District Municipality. The GTLM, which is comprised of numerous villages and towns is one of six (6) municipalities in the Bophirima DM.

The poverty rate, combined with the low household income and number of unemployed people, highlights the need for additional employment opportunities. The towns and villages provide a service to the surrounding rural communities and offer a range of commercial facilities, light industrial area for small industries, social services (hospital, clinics and churches), primary and secondary schools, as well administrative functions, including local government offices, police services and post offices. This indicates the importance of these two sectors in stimulating local economic growth.

Cattle and mixed livestock farming are of the most prominent economic activities within these areas, while intensive irrigation cropping is an additional activity within Taung. Other activities include mining and recreational / tourist facilities, such as the Taung Sun Hotel and Taung Dam.

According to the GTLM, the Census 2001 data is not an accurate reflection of the current situation in the GTLM as the data is outdated. However, there are very few other reliable data sources available. For this reason, this background information utilises both Census 2001 and some other data sources.

According to Census 2001 (STATSSA), the Bophirima DM population was 439,674, and the GTLM population was 182,164 at the time. In 2004, the total population of GTLM estimated at approximately 4.9% (187,000) of the North-West Province population, growing at an average rate of 0.1% / annum[5].

Of this population, 25.3% of those of working age are female. This is common where working age men have left the area in search of employment. A number of the small villages and towns in the GTLM area are far from employment hubs and this also adds additional pressure on men to move from their homes in search of employment. Despite the migratory labour of the GTLM Human Immunodeficiency Virus / Acquired Immune Deficiency Syndrome (HIV / AIDS) prevalence rates, which increased by 15.4% in GTLM from 2000 - 2004, are still in line with the national average of 15.3%.

According to Census 2001 data with regards to the level of education in the GTLM, 31.9% of the population did not have any formal education, and just fewer than 10% had completed Grade 12. 68% of the adult population in GTLM had, however, some form of primary education and could be regarded as literate.

According to Census 2001 data, the majority of households in GTLM have no income, followed by 26.3% of households which earn between R4,801 - R 9,600 per month. According to Census 2001 data, the majority of employed people (i.e. 25% of those employed) earned between R1 - R400 per month. This indicates quite an impoverished community, in need of economic growth and development, in order to improve the wellbeing of this community.

4.12.2 Social and Economic Profile of Reivilo / Boipelo

When Pering Mine was decommissioned in 2003, the majority of the Pering workforce resided in Reivilo / Boipelo. The employment statistics in June 2002 indicated that Pering Mine employed 192 permanent employees and 12 contractors. Reivilo / Boipelo is a small town in Ward 1 of the GTLM. As per the October 2006 Ward Plan from the GTLM, the total population of Reivilo / Boipelo was 3,125 people.

Table 27: Household services available to residents of Reivilo / Boipelo

Household Services	Reivilo Houses	Boipelo Houses
Have Water in House and / on Site	1,008	510
Flush Toilet	930	510
No Toilet	25	0
Electricity	980	361
Paraffin / Other	36	149
Informal House	36	36
Shelter Project	0	24
Telephone in House	228	Unknown

5 Greater Taung LED Strategy, June 2006.

In terms of housing and household services in 2006, the residents of Reivilo / Boipelo live on 601 stands, of which 520 are formal and semi-formal dwellings. The town itself has one hospital, one community hall, a post office, a clinic, four (4) formal sports facilities, three (3) primary schools and two (2) secondary schools.

4.12.2.1 Sanitation

The sanitation situation in Reivilo / Boipelo is shocking with only a few of the population having access to either a tank or chemical flush toilet. Based on observations within Reivilo / Boipelo it is noticeable that a staggering amount of the population has only pit latrines as a form of sanitation and some have no access whatsoever, this is due to the amount of informal dwellings that are currently in place in the area. The information provided by the GTLM indicates a completely different situation, however, than that observed (Table 27:).

4.12.2.2 Energy

The two main sources of energy in Reivilo / Boipelo are wood and paraffin. Only a small portion of the population use electricity. Most of the households resort to candles for lighting. The remaining households in the municipality use either gas, paraffin, or other sources of power. Most of the electricity infrastructure is in place but due to limited household income, other sources are utilised as they are more cost efficient.

4.12.2.3 Water

In terms of access to water, only a small number of households in the municipality have access to piped water in the dwelling, while others receive their water through a regional scheme. Some households do have access to community taps (less than 200 m from their dwellings), while others walk over 200 m to reach a community tap. The remainder of the dwellings in the municipality access to water via boreholes.

4.12.2.4 Refuse Removal

A small number of the households in Reivilo receive a weekly refuse removal service by their respective local municipalities and some of the households claim to have their own dump. A small percentage of households in Reivilo / Boipelo claim to make use of communal dumps and other municipal services, while a few households have no disposal facilities at all.

4.12.2.5 Social Services

In terms of the social services available to the community of Reivilo / Boipelo, there is currently a clinic nurse that comes through to Reivilo five (5) days a week. The nurse is required to distribute Tuberculosis (TB) medication, as well as offer counselling to the community as and when required. The nurse screens all patients who wish to see the doctor and treats minor illnesses herself, such as high blood pressure, influenza, skin rashes, wounds, slight degrees of infection (e.g. tonsils), coughing, diarrhoea, etc. She also performs immunisations of babies and pre-natal care.

The existing hospital is set to become a Health Centre providing the same level of services as they currently render and, potentially, even more services in the future. The Health Centre will fall under District Health Service instead of Taung Hospital. Reivilo Hospital was managed / administered as part of the District Health Service five years ago but were then moved to Taung Hospital, under which the hospital is currently managed / administered. The move back to the District Health Service has been welcomed by the community and is seen in a preferred light by the community.

There are currently two doctors who administer care at the Reivilo Hospital. One doctor, who works for the government, visits Reivilo Hospital from the Taung Hospital once a week. This service provision is, however, very unreliable. Occasionally other health professionals, such as physiotherapists, radiologists, and occupational therapists, accompany the doctor on his visits to Reivilo Hospital. The second doctor who provides services to Reivilo Hospital is a private doctor.

4.12.2.6 Social Economic Conclusions for the Area in which the Mine Operates

The social economic profile of the Reivilo / Boipelo area is a concern, due to the lack of employment, sanitation and infrastructure and the high instances of poverty. The area surrounding the Pering Mine is in need of additional assistance in order to create sustainable initiatives which will uplift and develop the local municipality and population therein.

4.12.3 The Key Economic Activities of the Area in which the Mine Operates

Key economic activities in the GTLM based on the percentage Gross Domestic Profit (GDP) contribution[6], are generated from the following sectors:

- Agriculture (4.1%); Mining (11.4%); Manufacturing (3.4%); Utilities (1.8%); Construction (3.4%); Trade (11.2%); Transport (12.3%); Finance (11.6%); and Services (42.4%).

Of the businesses operating in the GTLM, 53.1% of the formal businesses are classified as being in the retail sector, followed by personal services (7.14%), restaurants (7.14%), transport (1.02%) and accommodation (1.02%). Within Reivilo / Boipelo there are approximately 20 formal businesses These include, but are not limited to, various general dealers, a butchery, a bottle store and a restaurant.

Of the total number of employment opportunities within the GTLM, 81.3% are classified as permanent and 18.7% are part-time. In the informal sector, 57.1% of traders indicated that they had assistants helping them; 56.3% of the time the assistant was a family member and 62.5% of the assistants are paid.

The average annual economic growth rate in the GTLM from 1998 – 2004 is 0.7%. This growth rate is not linked to the North-West Province (growth rate of 3.2% from 2000 – 2004) or the country as a whole (growth rate of 3.3% from 2000 – 2004) and therefore there is a need to improve and strengthen the business opportunities in this municipality. The sectors which showed the majority of growth during 2000 – 2004 were mining (6%) and transport (7.7%). The mining sector in the GTLM, however; accounted for only 500 jobs in 2004. The agriculture (-2.5%) and the manufacturing sector (-1.2%) declined, which indicates a cause for concern as these are high employment sectors within the GTLM. This said, these two sectors accounted for 10.3% and 14.9% of formal employment opportunities within the GTLM in 2004. This indicates the importance of these two sectors in stimulating local economic growth.

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[6] Quantec Research, 2006 & Urban-Econ calculations, 2006.

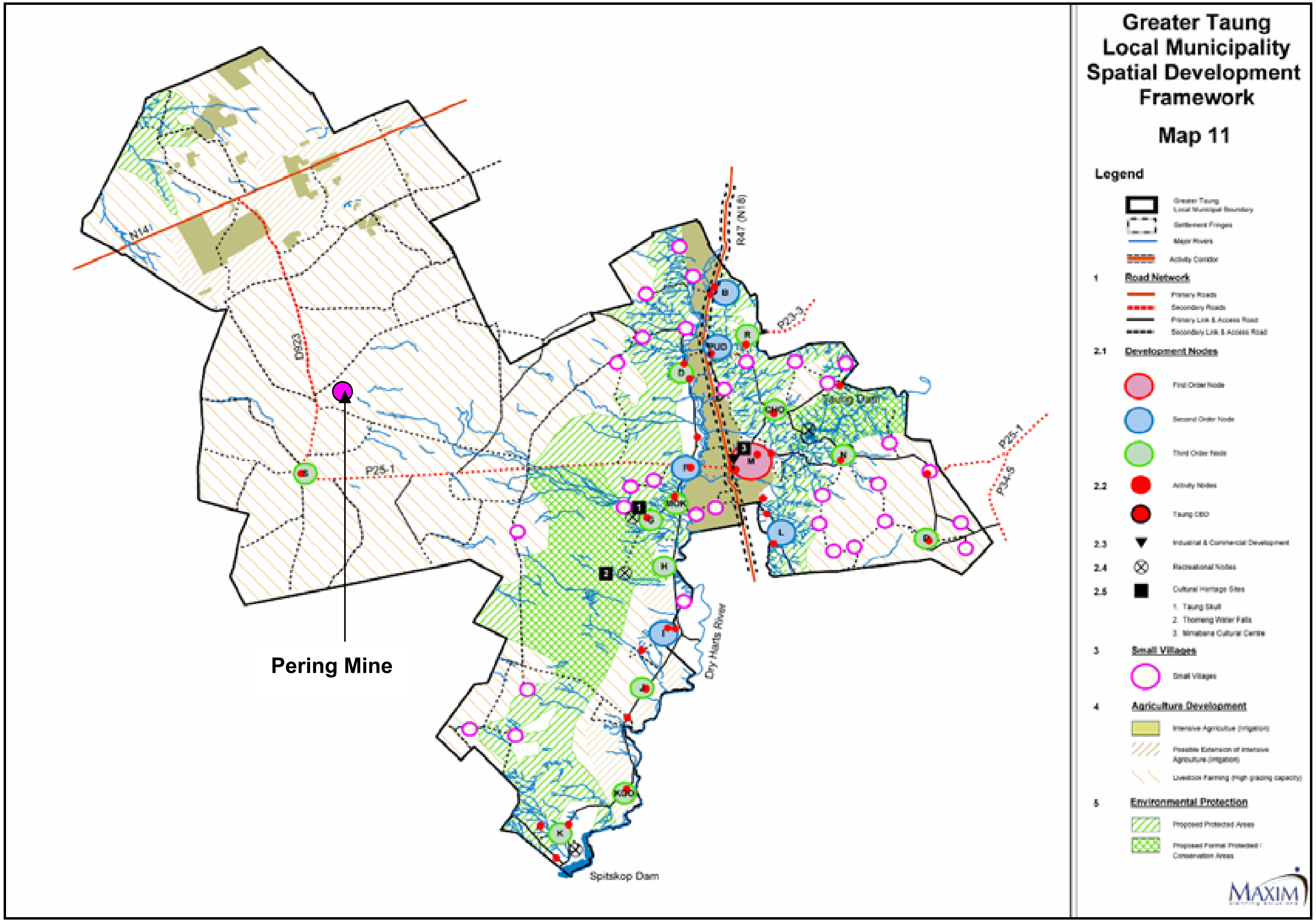

Figure 43: The spatial perspective of activity nodes for nodal development within the GTLM in the North-West Province (Maps provided by the GTLM Integrated Development Plan [IDP] Reviewed 2008/09 May 2008

5

Alternatives

Guideline 5 in support of the EIA Regulations defines alternatives as different means of meeting the general purpose and requirements of the activity, which may include alternatives to:

- The property on which or location where the activity will occur;
- The type of activity to be undertaken.
- The design or layout of the activity.
- The technology to be used in the activity.
- The operational aspects of the activity.

The alternatives which have been further investigated and considered for the proposed Pering Mine project are indicated below. Eleven alternatives (A0-A11) are discussed below using the no-project option as a baseline.

5.1 No Project Option (A0)

This alternative is mandatory in terms of the EIA Regulations and establishes a baseline against which the environmental impacts of the alternatives are rated against.

The following factors were considered during the assessment of each of the alternatives:

- Direct environmental impacts.
- Latent environmental impacts extending off-site.
- Socio-economic impacts.
- Financial feasibility.
- Considerations for construction, operational and closure phases.

The no project option would be instituted if the proposed mining operation is refused by the DEDECT or by the DMR. Following a no project decision, the mining area would achieve full closure in terms of the current Closure Plan.

The proposed mining operation intends to create in the region of 250 jobs for people in the vicinity of the mine. As Reivilo / Boipelo suffers from unemployment, the re-opening of the mine would bring much needed employment. The Pering Mine operation would also implement local economic development programmes as per the SLP. These programmes would be implemented so as to ensure that once Pering Mine closes, there would be viable self-sustaining businesses which would be able to offer employment to mine workers and community members.

5.2 Site / location Alternatives (A1)

The project requires the continuation of mining activities within an existing mining footprint. No site alternatives have been considered as the benefits derived from the operation extend from the Pering Mine site, where mineral reserves have been determined.

The site is 883ha in extent with 235ha (or 26.7%) previously impacted and transformed. Optimal placement of future proposed infrastructure (DMS and SSF) on the site has been considered by the

Applicants engineers and communicated in the mine layout plan with minor refinements occurring during the planning phase. Placement of infrastructure is regarded to have been undertaken as optimally and sustainably as possible considering current and future mining footprints and operational requirements.

5.3 Land Use Alternatives

5.3.1 Crop farming (A2)

The soils at Pering Mine are described as being shallow (less than 450 mm deep). AGIS (2009) describes the land capability as being non-arable. As a result of a low land capability and shallow soils, using the land for agricultural purposes is not viable. Due to this restriction this alternative has proven to be impractical.

5.3.2 Grazing (A3)

Prior to the start of mining operations, the land was used for livestock grazing. A grazing capacity of 12 ha / AU at Pering Mine was applicable however many of the grasses occurring have established due to their soil stabilization and rehabilitation properties. Of the 19 grass species identified in the Biodiversity Assessment at Pering Mine, only four species (*Chrysopogon serrulatus, Digitaria eriantha, Paspalum dilatatum, Themeda triandra*) are palatable grazing species. The site is not widely regarded as suitable grazing land given its current mine post-closure status however there is limited grazing currently occurring on the site.

5.4 Alternative mining & processing methods

5.4.1 Pit dewatering during the construction phase

The quantity of water presently accumulated in the Main and P24 pits at the Pering Mine is estimated at ~8 million m^3. Before mining of the pits can commence the pits need to be dewatered.

Various dewatering options have been considered in communication with the DWA, surrounding landowners and other stakeholders in order to reach a decision as to which option would be the most preferable and feasible one, each of which is discussed in detail below. Detailed water sampling programs continue to be conducted at Pering Mine to establish the pit water quality as benchmarked against the DWA requirements for disposal of water onto neighbouring properties or into water courses.

5.4.1.1 Enhanced evaporation / evapo-transpiration (A4)

This option involves spraying water over the pit (inwards from the perimeter) and over the waste rock dumps to speed up evaporation (refer to **Figure 44**). Water will be pumped at a rate of 180l/s from the pit water surface to the outside of the pit. A small booster pump station will pressurize the water into a manifold from where water will be discharged through sprinklers in a fine mist. The mist will enhance evaporation as such that the minimum infrastructure will be required. The evaporation rate achieved will be the highest by utilizing forced evaporation. High pressure sprinklers will be installed and operated during peak heat load periods to maximize energy consumed. The dewatering can be achieved in 18 months. The estimated cost of implementing this option is R18 million which is the most financially feasible of the dewatering options investigated.

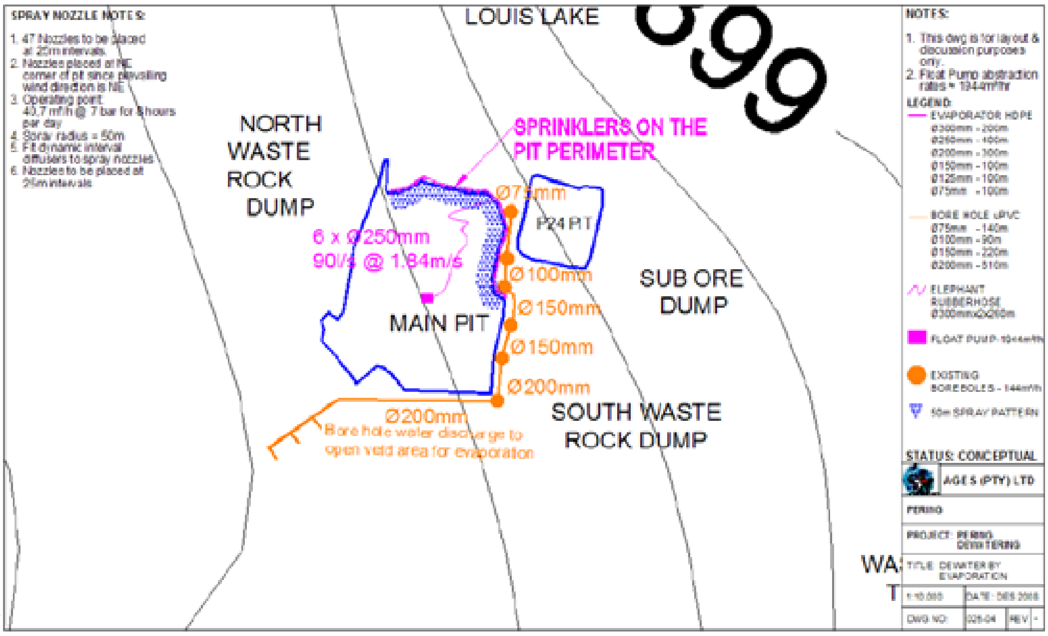

Figure 44: Conceptual diagram indicating sprinklers on pit perimeter

5.4.1.2 Discharge onto other areas of the mining site

Expansion of Louis Lake occurring at Pering Mine (A5)

Water will be pumped at a rate of 180l/s into Pit 24 pit for settling purposes. From Pit 24 the water will be transferred to an enlarged Louis Lake (**Figure 45**) occurring to the north east of the pits. Louis Lake will be enlarged to 165ha surface area with a volume of less than 8 million m^3. The surface area is required to achieve the evaporation rate. The estimated cost of implementing this option is R235 million which is prohibitively expensive due to high earthwork costs. The water will be recycled as process water. The treated water will need to comply with DWAF general water treatment standards.

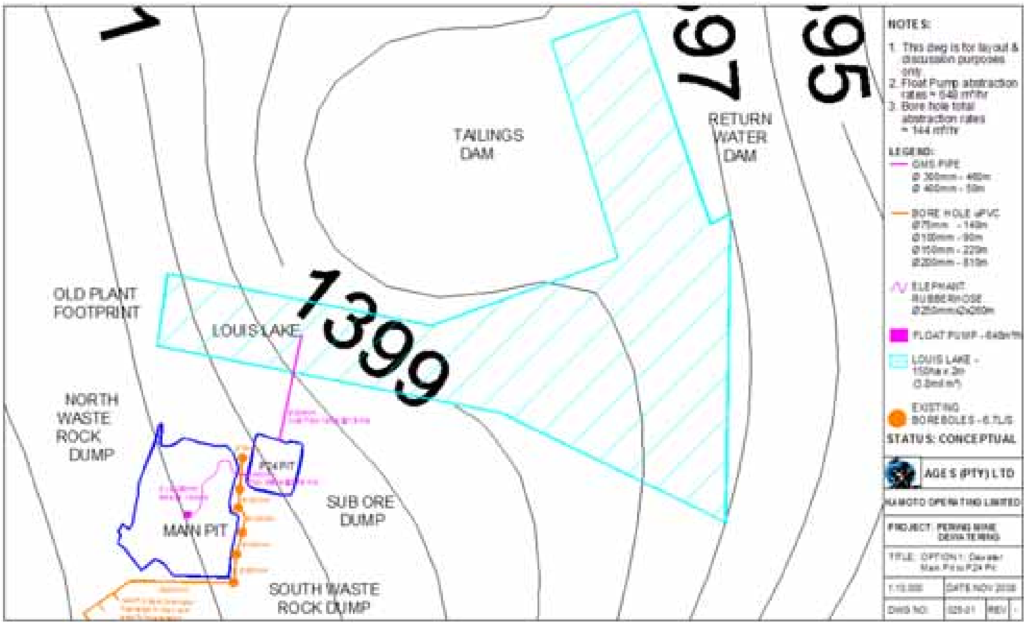

Figure 45: Conceptual diagram for Louis Lake construction option

Combination option (A6)

In its proposed water management strategy for Pering Mine dated April 2010, CHEMC proposed the "combination concept" stating that it was the best solution to stakeholder issues, while remaining cost effective. The combination concept involves:

The construction of 9 equally sized evaporation dams over a 99ha area to be sealed with bentonite (to line the dams) in which water from the pits will be discharged via bentonite mixing facilities. The introduction of plants into some of the dams is proposed to improve evaporation through evapo-transpiration. This process will also serve to partially treat the water through phytoremediation though absorption of contaminants. Additionally high pressure spraying atomizers could be employed to enhance evaporation from the dams.

Originally this proposal was extended to include an off-site natural pan (also sealed with bentonite) thereby providing an additional area to evaporate the pit water. This option would have provided employment through aquaculture opportunities while harvesting of the plants (responsible for phytoremediation) to provide compost was also considered. No further consideration to this aspect of the combination alternative has been given.

5.4.1.3 Treatment, conveyance and discharge of pit water into the environment

Treatment and conveyance of water through a ±17 km pipeline into a non-perennial tributary of the Harts River (A7)

This option involves treating the pit water and conveying it through a 17-18 km long 300mm Nominal Bore (NB) pipeline that discharges into a well defined non-perennial tributary of the Harts River located to the south east of Pering Mine on Kgore 898 HN (belonging to Mr David Nel) and Sebetse Tsapitse 899 HN (belonging to Mr Isaac Jocum). A capital cost at R28 million with a connected power load of 1,320 kVA is anticipated. The estimated discharge point and the affected farms relative to the position of the mine is indicated in **Figure 46**.

The servitude of the pipeline will be located along farm boundaries and existing roads in order to minimise land transformation and sterilisation. Based on the site visit conducted by GCS, a rocky formation in the vicinity of the proposed discharge point would provide a more stable foundation, where the outlet of the discharge pipeline could be firmly anchored in a concrete block that is unlikely to be threatened by any future floods. It is suggested that some attention be paid to site selection and protection of the pipeline against potential flood damage. Any infrastructure associated with the discharge pipeline should be designed by a professional Engineer.

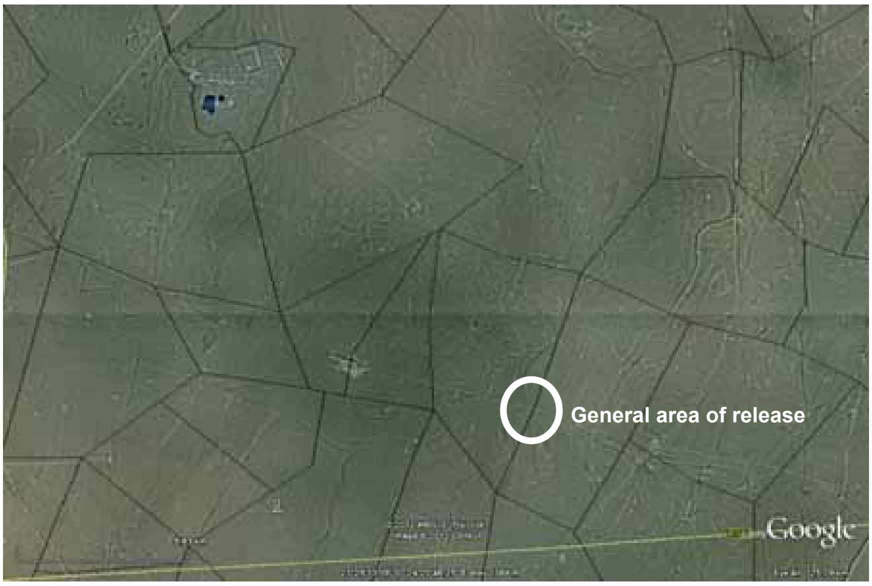

Figure 46: 17km discharge option into the Droe Harts River in relation to Pering Mine

Treatment and conveyance of water through a ±7 km pipeline into a poorly defined floodplain (A8)

This option involves constructing a 7.2km pipeline (**Figure 47**) along a farm boundary and discharging the water into a poorly defined floodplain. The financial costs at R10,6 million is more than one third of the cost of the 17 km pipeline. The connected power for the shorter pipeline is 730 kW.

As the flow of water will not be directed into a channel, but into the floodplain, water infiltration into the aquifer is anticipated as a result of water standing/ponding for prolonged periods. This option will likely result in the sterilisation of land currently used for grazing due to prolonged flooding.

The servitude of the pipeline will be located along farm boundaries and existing roads in order to minimise land transformation and sterilisation.

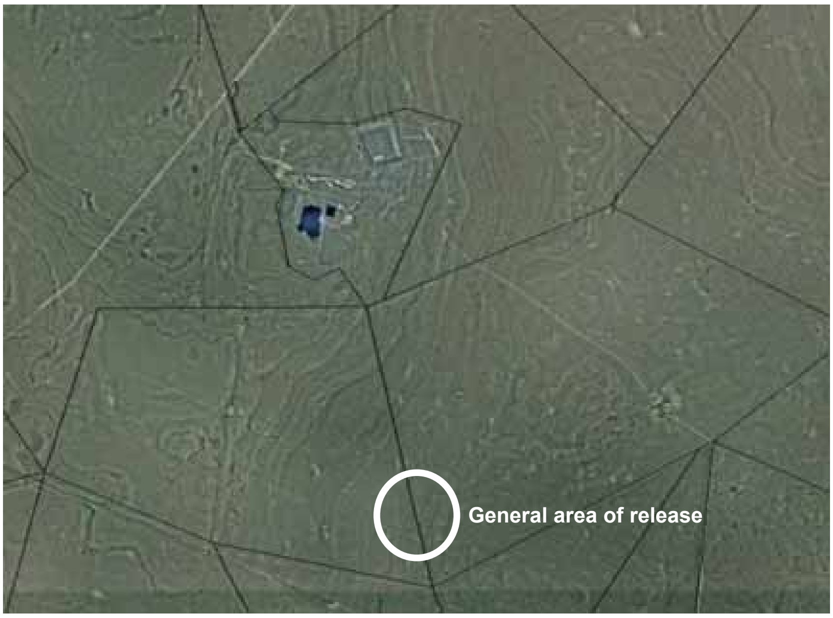

Figure 47: 7km discharge option into undefined floodplain

5.4.1.4 Treatment, conveyance and storage of pit water for human consumption

Reivilo reservoir (A9)

This option speaks to the National Water Act, 1998 in terms of beneficial use of waste water. The pit water could be treated and piped for human and animal consumption. The water will have to be stored in a storage reservoir near to Reivilo and accommodate a flow of approximately 180m^3/hour. This option would thus require treatment of water to potable standards at the mine, conveyance of water via a pipeline and discharge of treated water into a constructed 3 million m^3 storage reservoir.

Infrastructure commitments for implementing this option are estimated to be in the region of R100 million for the water treatment plant. Apart from the prohibitive cost of implementing this option, land would need to be identified to accommodate the storage dam and it is unlikely that the residents of Reivilo would be able to consume half of the water discharged every day, resulting in large evaporation losses. Furthermore, the sustainability of the reservoir is questionable, as once the mine commences operation after the pits are dewatered (dewatering period expected to be 30 months), much less water will be discharged and the constructed reservoir will quickly become redundant. This option is rendered unsustainable as the dam will result in landuse changes near Reivilo, the earthwork costs will be prohibitive and the amount of time that water will be available for human consumption will be very limited.

The feasibility of supplying Reivilo with potable water is slightly improved if combined with the enhanced evaporation option discussed above. This will result in the construction of a smaller 80m^3-160m^3 reservoir requiring less land within Reivilo. This option would still however require treatment of water to potable standards at the mine, conveyance of water via a pipeline and discharge of treated water into a constructed storage reservoir, at a capital cost of approximately R100 million for the water treatment plant alone.

Supply to Sedibeng Water (A10)

Sedibeng Water is responsible for the supply and provision of water and sanitation services in the Free State, North West and Northern Cape provinces and also maintains and operates boreholes in the North West Province supplying water to poor rural communities. The Applicant has indicated that queries submitted by the Applicant to Sedibeng Water concerning the possible treatment and conveyance of the mine water to Sedibeng Water, have not been answered.

5.4.2 Pit water treatment during the construction phase (A11)

The dewatering options which will require the installation of a water treatment plant at the mine include those options where supply of water for human/animal consumption and discharge into the environment off site is contemplated.

Water treatment will make provision for the demineralization of the water using reverse osmosis (RO) membranes. A calcium carbonate crystallization process is proposed as a first step for the pre-treatment of the water due to scale forming properties.

The water is moderately hard and the high calcium and sulphate concentrations contribute to the permanent hardness, requiring the use of sodium carbonate for softening. Concentrations of zinc and lead are high. Sulphate should be reduced, depending on the standard but other major parameters that contribute to conductivity are calcium, magnesium and carbonate species. Chemical precipitation of calcium carbonate where the pH will be sufficiently high to precipitate these metals is required. Any remaining dissolved metals will be removed in the reverse osmosis system. The average concentrations of all the other metals are not of concern. The brine produced as waste from the RO process will contain high concentrations of sodium or magnesium sulphate. Quick lime will be added to the brine where it will be allowed to react and mature in stirred tanks. Magnesium hydroxide and gypsum (calcium sulphate dehydrate) will precipitate. The suspended material will be allowed to settle in a settling tank and then be dewatered in a filterpress. The cake will be collected in 1-ton bulk bags. The filter cake, containing magnesium hydroxide and gypsum, can be processed to recover gypsum and a concentrated solution of magnesium sulphate.

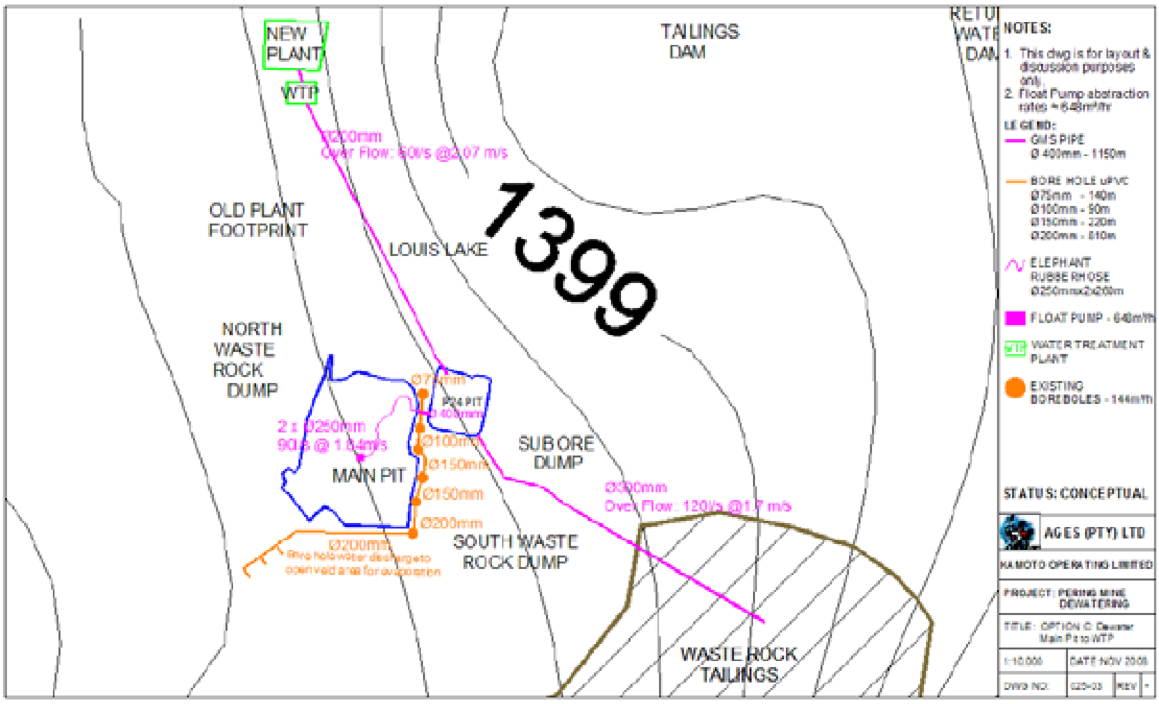

Figure 48: Conceptual infrastructure layout - water treatment plant

Water treatment will take place to the standard necessary with which to operate, or to mitigate the predicted environmental impact in the event of disposal:

- Mine use -
- Enhanced evaporation option – to be determined based on correspondence with manufacturer
- Discharge into natural water resource – less than 300mg/l specified sulphates

5.4.3 Operational phase

5.4.3.1 Alternative mining processes

Historically, the Zn-Pb ore was mined by opencast methods. Pering Mine intends to re-open the mine by processing / optimising the existing waste rock dumps and extending the mine pit using Dense Media Separation (DMS) mining techniques. DMS is commonly used as a method of selectively separating "heavy" particles from the host rock. A good example of this is the separation of diamonds from kimberlite. In this example, the diamond, having a density of 3.52 g/cm³ is significantly heavier than the host kimberlite with a density of 2.70 g/cm³.

In nickel sulphide mining, the target minerals have a density differential in excess of the differential between diamonds and kimberlite. This differential is used to selectively concentrate the sulphide minerals in a DMS plant. The separation of the high-density (concentrate) material from the tailings occurs in the dense medium cyclone where centrifugal forces assist the particles to float or sink in the medium, depending on their density. The higher density particles move outwards and down the wall of the cyclone and are discharged through the spigot. The less dense gravel particles move towards the central axis of the cyclone and are caught in the vortex, and discharged into the overflow chamber.

The separation density (d50) is generally 0.3 to 0.5 density units lower than the medium density at the spigot. The differential depends on the cyclone geometry and the pressure to the Dense Medium cyclones and the grade of Ferro-Silicon being used. By combining both of these technologies, the Applicant will be able to upgrade the Run of Mine ores on a metal basis.

The DMS plant will ultimately include a feed preparation section comprised of a wet double deck screen with which to feed the coarse DMS (+10 -25 mm) and the fines DMS (+1 – 10mm). The objective of this circuit is to stabilise the feed grade to the milling and flotation circuit ensuring optimum recovery of zinc and other by-products.

6

Public participation & stakeholder consultation

6.1 PPP under MPRDA and NEMA Scoping Phase

The final Scoping Report dated October 2011 submitted to DEDECT provided information concerning the public participation process undertaken for the proposed Pering Mine project for the MPRDA mining license, the IWULA application as well as the NEMA application.

Public Participation Process as part of the EIA process commenced on 9 February 2011 to 10 March 2011. Advertisements were placed in local and regional newspapers in February 2011 calling for IAP registration and comments/concerns. Existing registered I&APs as well as previously not identified I&APs were notified of commencement with the Scoping/EIA Process.

No new persons requested to be registered as I&APs during the Scoping Phase, however several telephone calls were received in terms of potential employment. The draft Scoping Report was posted at the local municipal office for comment and distributed to all registered I&APs upon request. One request to review the draft Scoping Report was received from a neighbouring landowner/NGO, Isaac Jocum, representing the Gaapse Plateau Environmental Protection Group. No new comments were received from existing I&APs who had registered/commented. This is believed to be a result of I&APs already having been afforded the opportunity to comment during the public participation process as part of the Mining License application.

All correspondence with regards to the above can be sourced in the Final Scoping Report for the Proposed Pering Mining Project (Revision 1).

6.2 Stakeholders

Various parties were requested to register as I&APs and stakeholders including National, Provincial and Local authorities, research groups, NGO's, conservation groups and farmers. Consultation with stakeholders is further elaborated below:

6.2.1 Reivilo community

The Reivilo community is a stakeholder as a significant portion of the human resources will be sourced from here. The concerns raised at the public meetings held during PPP included:

- Water pollution and cumulative effects
- Quality of the pit water
- End use of water pumped from pits;
- Groundwater depletion;
- Biological baseline;
- Dust and air quality impacts;
- Effects of blasting and vibration;
- Impacts of traffic on road and Reivilo / Boipelo;
- Noise impacts;
- Zinc and lead impacts on health;

- Traffic impacts including road degradation and road safety due to ore transportation
- Minéro's social responsibility towards Reivilo /Boipelo;
- Job creation;
- Employment equity; and
- Health and safety of employees.

The draft Scoping Report was posted at the Reivilo Municipal Office and made available to I&APs on request. No comments on the draft Scoping Report were received by Marsh. This is believed to be a result of I&APs already having been afforded the opportunity to comment during the public participation process as part of the Mining License application.

6.2.2 Department of Water Affairs

6.2.2.1 Previous consultation with DWA

Table 28 below provides a summary of the correspondence between the DWA, Marsh and the Applicant.

Table 28: Summary of correspondence between DWA, Marsh and the Applicant

Date	Description
15 April 2009	▪ The objective of the site visit was to provide the DWAF representatives with an overview of the Pering Mine site as well as the receiving environment into which water from the pits was likely to be pumped (for dewatering purposes ▪ Licenses required were identified ▪ Applicable standards for assessing water quality were discussed ▪ WULA would be prioritised at a regional level (Northern Cape)).
11 August 2009	Meeting to discuss the advantages and disadvantages of the pit dewatering alternatives. Specialist studies to be initiated
21 January 2010	Draft WULA submitted to DWA
15 July 2010	Meeting held with DWA to discuss outstanding information and dewatering alternatives.
6 August 2010	Comments from DWA on draft WULA submitted. Additional information is requested before application can be processed further.
8 September 2010	Response from Marsh concerning letter of 6 August 2010 from DWA.

Much of the correspondence with DWA involved discussions regarding the dewatering of the mine pits. The DWA wishes that beneficial use of waste water be undertaken in line with the National Water Act, thereby supplying water to the recipient community (as potable water to Reivilo), to farmers in the area (for cattle watering), or as a minimum, that groundwater/aquifer recharge occurs.

6.2.2.2 Future consultation with DWA

The pit dewatering alternatives were discussed in Section 5 of this EIAR and a comparative assessment of the alternatives is provided in Section 8. This information serves to suggest that on-site solutions to pit dewatering are favoured as off-site solutions will be less sustainable as a result of prohibitive costs and predicted off-site pollution. A final WULA Report will be submitted to DWA Northern Cape Regional Office for approval of the mine water uses and consideration of the dewatering alternatives.

6.2.3 Gaapse Plateau Environmental Protection Group (GPEPG)

6.2.3.1 Objections

The GPEPG is an NGO represented mostly by local farmers within the region. The GPEPG submitted their objection to the Pering Mine project in their response to the EMPR Mining Rights application. The basis for the objection is rooted in a concern around the cumulative impact of new mining activities considering the impacts which resulted from past mining practices.

A consolidated comments and responses report for correspondence between the GPEPG and Marsh is attached hereto in **Appendix 13**.

6.2.3.2 Mining right and DMR RMDEC

A meeting between the DMR Regional Mining and Development Environmental Committee (RMDEC), Pering Mine as applicant and GPEPG (as complainant) was scheduled to be held on 16 August 2012. The applicant and complainant were in attendance however RMDEC did not achieve full representation. The meeting was rescheduled to October 2012 and then to November 2012.

6.2.3.3 Hydrology study

On 28 March 2012, the GPEPG granted permission to Pering Mine to access farms in order to allow specialists to conduct a site investigation to obtain information to supplement the surface water study as it relates to the 17km pipeline pit dewatering alternative (into the Droe Harts River). Refer to GCS Report attached as **Appendix 7**. The farms to which access was provided include Kgore 898 HN (belonging to Mr David Nel) and Sebetse Tsapitse 899 HN (belonging to Mr Isaac Jocum).

The draft hydrology report was subsequently provided to GPEPG and provisional comments were submitted by GPEPG to Marsh on 14 August 2012.

6.2.3.4 Comments on the draft Environmental Impact Assessment Report

Refer to Section 6.4 below.

6.2.3.5 Future consultation with farmers and GPEPG

No agreements are currently in place between Pering Mine and the GPEPG concerning the discharge of treated mine water into the Droe Harts River over the farms Kgore 898 HN and Sebetse Tsapitse 899 HN. As per the findings of this EIAR (refer to Sections to follow), treatment and disposal within the mine boundary is recommended. However a combination of on site treatment and off-site disposal may be considered subject to certain conditions which includes obtaining landowner consent for discharge of the water (refer to Section 3) as part of the Water Use License Application.

Furthermore an extension of the groundwater monitoring network onto neighbouring farms is recommended in order to monitor the progression of the pollution plume. Permission from the farmers and GPEPG is required before this is undertaken.

6.3 PPP under the NEMA EIA Phase

6.3.1 Public participation during the EIA phase

Public participation as part of the EIA phase commenced on 15 October 2012. I&APs were notified by way of sms, fax and email of the availability of the draft EIAR. A 30-day comment period was provided.

The following comments (Table 29) were received from I&APs and stakeholders who had been provided with an opportunity to review and comment on the draft EIAR report:

Table 29: Comments and responses for EIAR review period

I&AP / Stakeholder	Aspect	Comment	EAP Response
DMR			
Greater Taung Local Municipality			
DWA			
GPEPG			

Proof of the comments received by I&APs and stakeholders with regard to the draft EIAR is appended as Appendix 13.

7

Identification and assessment of issues and impacts

7.1 Methodology for impact assessment

This section of the report includes a description of the expected environmental impacts that may result from the proposed Pering Mine project as informed by:

- Professional judgment and specialist assessment.
- Public participation.
- Simulations and mapping.
- Past experience.

The expected environmental impacts were then rated in terms of its potential status, extent, duration probability and significance. The purpose of this assessment is to determine the significance of impact associated with the proposed development and to determine whether adverse impacts could be mitigated to acceptable standards.

Table 30: Status of Impact

Rating	Description	Quantitative Rating
Positive	A benefit to the receiving environment.	+
Neutral	No cost or benefit to the receiving environment.	N
Negative	A cost to the receiving environment.	-

The extent of the impact refers to the spatial scale of the impact or benefit of the proposed project.

Table 31: Extent of Impact.

Rating	Description	Quantitative Rating
Low	Site Specific; Occurs within the site boundary.	1
Medium	Local; Extends beyond the site boundary; Affects the immediate surrounding environment (i.e. up to 5km from Project Site boundary).	2
High	Regional; Extends far beyond the site boundary; Widespread effect (i.e. 5km and more from Project Site boundary).	3
Very High	National and/or international; Extends far beyond the site boundary; Widespread effect.	4

The duration of the impact refers to the time scale of the impact or benefit.

Table 32: Duration of Impact.

Rating	Description	Quantitative Rating

Low	Short term; Quickly reversible; Less than the project lifespan; 0 – 5 years.	1
Medium	Medium term; Reversible over time; Approximate lifespan of the project; 5 – 17 years.	2
High	Long term; Permanent; Extends beyond the decommissioning phase; >17 years.	3

The probability of the impact describes the likelihood of the impact actually occurring.

Table 33: Probability of Impact.

Rating	Description	Quantitative Rating
Improbable	Possibility of the impact materialising is negligible; Chance of occurrence <10%.	1
Probable	Possibility that the impact will materialise is likely; Chance of occurrence 10 – 49.9%.	2
Highly Probable	It is expected that the impact will occur; Chance of occurrence 50 – 90%.	3
Definite	Impact will occur regardless of any prevention measures; Chance of occurrence >90%.	4

The intensity of the impact is determined to quantify the magnitude of the impacts and benefits associated with the proposed project area.

Table 34: Intensity of Impact.

Rating	Description	Quantitative Rating
Negligible	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are not affected.	1
Minor	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are only marginally affected.	2
Average	Where the affected environment is altered but natural, cultural and / or social functions or processes continue, albeit in a modified way.	3
Severe	Where natural, cultural and / or social functions or processes are altered to the extent that it will temporarily cease.	4
Very Severe	Where natural, cultural and / or social functions or processes are altered to the extent that it will permanently cease.	5

The impact magnitude and significance rating is utilised to rate each identified impact in terms of its overall magnitude and significance.

Table 35: Impact Magnitude and Significance Rating.

Impact	Rating	Description	Quantitative Rating
Positive	High	Of the highest positive order possible within the bounds of impacts that could occur.	12 – 16

Impact	Rating	Description	Quantitative Rating
	Medium	Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. Other means of achieving this benefit are approximately equal in time, cost and effort.	6 – 11
	Low	Impacts is of a low order and therefore likely to have a limited effect. Alternative means of achieving this benefit are likely to be easier, cheaper, more effective and less time-consuming.	1 – 5
No Impact	No Impact	Zero impact.	0
Negative	Low	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts, mitigation is either easily achieved or little will be required, or both. Social, cultural, and economic activities of communities can continue unchanged.	1 – 5
	Medium	Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. In the case of adverse impacts, mitigation is both feasible and fairly possible. Social cultural and economic activities of communities are changed but can be continued (albeit in a different form). Modification of the project design or alternative action may be required.	6 – 11
	High	Of the highest order possible within the bounds of impacts that could occur. In the case of adverse impacts, there is no possible mitigation that could offset the impact, or mitigation is difficult, expensive, time-consuming or a combination of these. Social, cultural and economic activities of communities are disrupted to such an extent that these come to a halt.	12 - 16

7.2 Construction Phase

The construction phase at Pering Mine will progress over a period of approximately 3 years and will primarily include the construction of infrastructure and the dewatering of the pits. This section details the anticipated impacts that may result from the proposed activities to be undertaken during this phase of the project.

Table 36: Construction phase impact assessment

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
Climate	Contribution to climate change	Carbon and other greenhouse gasses into the atmosphere.	Construction activities.	(-)	-1	-1	-4	-1	-7	-6
			Land-based vehicle activity.	(-)	-2	-1	-4	-1	-8	-7
			Use of backup diesel generators during construction activities.	(-)	-1	-1	-2	-1	-5	-5
	Change in precipitation and humidity levels	Impact of enhanced evaporation alternative on precipitation and humidity levels	Pit dewatering involving enhanced evaporation of the pits	(-)	-2	-1	-1	-1	-5	-5
Geology	None	-	-	-	-	-	-	-	-	
Soils	Disturbance of topsoil.	Soil disturbance, loss of nutrients, loss of topsoil cover, loss of in situ structure and physical / chemical properties.	Clearing of vegetation for infrastructure development.	(-)	-1	-3	-4	-4	-12	-11
			Removal of topsoil for infrastructure development.	(-)	-1	-3	-4	-4	-12	-11
			Infrastructure construction footprint.	(-)	-1	-3	-4	-4	-12	-11
			Establishment of plant foundations.	(-)	-1	-3	-4	-4	-12	-11
			Construction of surface water management system.	(-)	-1	-3	-4	-4	-12	-11
			Rom stockpile pad construction.	(-)	-1	-3	-4	-4	-12	-11
			Stockpiling of soils.	(-)	-1	-3	-4	-3	-11	-10
			Spillages.	(-)	-1	-1	-4	-4	-10	-9

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
Land capability and land use	Change of land capability. And land use.	Land capability will be reduced to "mining land" status.	Disruption of ecosystem due to mining related activities and infrastructure.	(-)	-1	-3	-3	-5	-12	-10
		Loss of natural habitat (i.e. A change of land use from wilderness to mining).	Mining infrastructure and preparation.	(-)	-1	-3	-3	-5	-12	-11
Flora and fauna	Destruction of local ecological integrity, decimation of vegetation on site, peripheral impacts relating to human presence and mining related activities.	Direct impacts on flora species of conservation importance	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-5
		Direct impacts on fauna species of conservation importance	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-5
		Loss or disruption of migration routes on a local scale	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-5
		Direct impacts on sensitive/ pristine habitat types of the study area	Mining infrastructure and preparation.	(-)	-1	-1	-1	-1	-4	-4
		Direct impacts on common fauna species occurring on the study area	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-5
		Faunal interactions with structures, servitudes and personnel	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-5
		Impacts on surrounding habitat/ species, including ecosystem functioning	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-5

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
		Impacts on south africa's conservation obligations & targets (vegmap vegetation types)	Mining infrastructure and preparation.	(-)	-1	-1	-1	-1	-4	-4
		Increase in local and regional fragmentation/ isolation of habitat	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-5
		Increase in environmental degradation, pollution (air, soils, surface water)	Mining infrastructure and preparation.	(-)	-1	-2	-3	-3	-9	-7
		Laying of pipeline for dewatering into Droe Harts river resulting in injury to animals. Disturbance of grazing land potentially affecting the grazing land value during construction.	Laying of pipeline for off-site pit dewatering alternatives	(-)	-2	-1	-1	-2	-6	-5
Surface water	Topsoil stripping on site	Erosion by both water and wind. This will result in increased suspended solids content of water draining off the site. However, because the area is endoreic and there are no dams or water courses that are directly affected, the impact will be confined to the localised area potentially affecting vegetation growth in areas where soil is deposited by water.	Topsoil and vegetation stripping will be undertaken to allow bulk earthworks to commence	(-)	-1	-2	-3	-3	-9	-8

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
	Pit dewatering into natural watercourse	Impact on surface water quality downstream considering that water will recharge/evaporate within 4km – 7km from discharge point	Discharge into natural watercourse	(-)	-3	-3	-3	-3	-12	-10
		Alteration of the floodline and soil erosion occurring at discharge point	High velocity flows at discharge point	(-)	-3	-1	-1	-1	-6	-6
		Accumulation of sulphates to near toxic levels in soils and vegetation of the Droe Harts river due to low dilution potential	Occurrence of sulphates in the water. Low dilution potential within the watercourse (dry watercourse)	(-)	-3	-3	-3	-3	-12	-12
		Negative impacts on naturally occurring microbes in the soils of the Droe Harts river affecting soil and vegetation	Occurrence of sulphates in the water	(-)	-3	-3	-3	-3	-12	-12
		Sulphate dispersion plume leading to increased sulphates in groundwater resources	Occurrence of sulphates in the water. Low dilution potential within the watercourse (dry watercourse)	(-)	-3	-3	-3	-3	-12	-12
		Recharge of the aquifer due to simulation of rainfall events	Fractures in the aquifer permitting recharge	(+)	+3	+3	+3	+3	+12	+12

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
	Pit dewatering into undefined floodplain	Sulphate dispersion plume leading to increased sulphates in groundwater resources	Occurrence of sulphates in the water and ponding over prolonged period. Accumulation of sulphates in the soils	(-)	-3	-3	-3	-3	-12	-12
		Sterilisation of farming land	Ponding of water due to lack of drainage	(-)	-3	-3	-3	-3	-12	-12
		Recharge of the aquifer	Ponding of water due to lack of drainage	(+)	+3	+3	+3	+3	+12	+12
	Pit dewatering onto site	Increase in surface water pollution on site	Transfer of polluted pit water onto other areas of the site	(-)	-1	-2	-2	-2	-7	-7
	Pit dewatering for human use	Impact on land use at Reivilo for construction of reservoir	Need to temporarily store treated water for human consumption	(-)	-3	-2	-2	-3	-10	-10
Groundwater	Depletion of aquifer	Lowering of groundwater level due to provision of make up water to the plant and dewatering of the pits	Dewatering of the pits to ensure dry mining conditions and pit slope stability.	(-)	-2	-3	-4	-3	-12	-11
			Groundwater abstraction for potable and process water demand.	(-)	-2	-2	-4	-3	-11	-10
	Pollution	Groundwater quality deterioration	Biological contamination of localised aquifer due to domestic and sewage effluent disposal and hydrocarbon contamination.	(-)	-2	-2	-2	-3	-9	-8

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
Air quality	Fugitive dust and particulate matter	Reduction in ambient air quality from fugitive dust emissions.	Stockpile reclamation activities at the existing tailings dams including hauling of waste to designated waste dumps leading to the liberation of dust.	(-)	-2	-1	-3	-3	-9	-7
		Dust emissions resulting in respiratory and cardiovascular ailments.	Undertaking activities in high dust areas.	(-)	-2	-2	-2	-3	-9	-6
		Reduced visibility, soiling of buildings, materials and environment.	Undertaking activities in high dust areas.	(-)	-2	-1	-2	-2	-7	-5
	Exceedences in NO_2 ground level concentration		Vehicle exhaust emissions	(-)	-2	-1	-1	-2	-6	-4
	Exceedences in ground level concentrations	Uptake of metals into the atmosphere causing off-site impacts	Enhanced evaporation of pit water over the pits	(-)	-2	-1	-1	-1	-5	-5
Noise and vibration	Noise pollution	Increased ambient noise levels.	Construction activities (mine and other infrastructure).	(-)	-2	-1	-3	-2	-8	-6
			Use of diesel generators.	(-)	-2	-1	-3	-2	-8	-6
			Increase traffic flow (on-site).	(-)	-1	-1	-3	-2	-7	-6
			Periodic blasting as part of topsoil and overburden stripping activities.	(-)	-2	-1	-3	-2	-8	-7
	Vibration	Nuisance disruption to sensitive fauna, employees and communities.	Blasting of waste material and ore.	(-)	-2	-1	-4	-2	-9	-6

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
		Impact on building foundation stability.	Blasting of waste material and ore.	(-)	-2	-1	-3	-3	-9	-7
Archaeology and heritage	Impact on heritage environment	Impact on identified heritage site (lithics)	Surface alterations	(-)	-1	-1	-1	-2	-5	-5
Waste	Contamination of soil, surface water and groundwater; health risks as a result of exposure to hazardous substances.	Contamination of surface water and groundwater.	Leaching of hazardous substances from construction equipment and storage areas	(-)	-3	-3	-4	-4	-14	-12
		Contamination of soil and groundwater	Generation and disposal of general waste to landfill.	(-)	-3	-3	-3	-4	-13	-5
		Contamination of soil.	Temporary storage of hazardous waste on unlined and / or unbunded areas,; hazardous waste spills.	(-)	-1	-2	-3	-3	-9	-4
	Contamination of soil, surface water and groundwater; health risks as a result of exposure to hazardous substances.	Contamination of groundwater.	Disposal of hazardous wastes on general landfills.	(-)	-2	-3	-3	-5	-13	-8
		Litter (aesthetic impacts, ingestion by animals).	Waste not placed in designated waste bins / containers.	(-)	-1	-1	-2	-2	-6	-4
		Odour (unpleasant odours and the proliferation of pests as a result of waste).	Waste not disposed of timeously or kept in closed containers.	(-)	-1	-2	-2	-2	-7	-5
		Infections from medical and other waste.	Unsuitable handling and disposal of medical waste (i.e. Sharps and bandages) and other wastes.	(-)	-2	-3	-3	-4	-12	-5

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
		Health risks of staff and public from exposure to hazardous wastes.	Handling of hazardous waste without suitable PPE by staff or public.	(-)	-2	-3	-3	-4	-12	-6
Visual	Visual impact	Change in land-use and current views.	Construction vehicle movement (sequential impact).	(-)	-2	-1	-3	-1	-7	-5
			Temporary structures (including temporary residential facilities and contractors camp).	(-)	-1	-1	-3	-1	-6	-4
			Entrances, signs and boundary treatment.	(-)	-2	-2	-4	-1	-9	-8
			Material storage (topsoil stockpiles and material stockpiles).	(-)	-2	-2	-4	-1	-9	-8
	Visual impact	Light pollution.	Lighting of construction operations during night time.	(-)	-2	-2	-4	-3	-14	-10
Social	Employment (mine specific).	Creation of mine specific employment opportunities.	Construction at the pering mine.	(+)	+3	+3	+4	+3	+13	+15
	Employment (directly affected area).	Creation of employment opportunities not directly related to the mine itself.	Construction at the pering mine.	(+)	+3	+1	+4	+3	+11	+13
	Hiv and aids (mine specific).	Increased infection rates.	Construction at the pering mine (permanent employees).	(-)	-1	-2	-4	-5	-12	-8
			Construction at the pering mine (contractor employees).	(-)	-3	-3	-4	-4	-14	-11
Economic	Levels of economic activity.	Increase in gross geographic product (ggp).	Increase in business activity / sales and demand for consumer services.	(+)	+4	+2	+4	+5	+15	+15

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
	Employment.	Employment opportunities.	Reduction in unemployment.	(+)	+3	+2	+4	+4	+13	+13
	Living conditions.	Poverty alleviation.	Increase in spending power.	(+)	+3	+2	+4	+4	+13	+14
	Skills.	Improvement of skill levels.	Provision of training programmes related to work.	(+)	+4	+3	+3	+2	+12	+13
	Health (regional).	Impact of HIV/AIDS on the health care system.	Transitory work force and sex trade.	(-)	-3	-2	-3	-3	-11	-7

7.3 Operational Phase

Table 37: Operational phase impact assessment

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
Climate	Contribution to climate change.	Carbon and other greenhouse gasses into the atmosphere.	Mining operation.	(-)	-1	-3	-3	-4	**-11**	**-8**
			Land-based vehicle activity.	(-)	-1	-3	-3	-4	**-11**	**-8**
Geology	Destruction of geology	Total removal of target ore.	Zinc and lead will be removed, processed and stockpiled.	(-)	-1	-4	-4	-5	**-14**	**-14**
Soils	Expansion of disturbed areas	Soil resource management (compaction, erosion, denutrification.)	Ore stockpiling	(-)	-1	-2	-4	-4	**-11**	**-9**
			Erosion by wind and water.	(-)	-1	-2	-4	-4	**-11**	**-9**
			Spillage from conveyors and / or roads.	(-)	-1	-3	-3	-4	**-10**	**-6**
	Disturbance of topsoil.	Soil disturbance, loss of nutrients, loss of topsoil cover, loss of in situ structure and physical / chemical properties.	Construction of surface water management system.	(-)	-1	-3	-4	-4	**-12**	**-11**
Land capability and land use	Change of land capability and land use.	Land capability will be reduced to “mining land” status.	Disruption of ecosystem due to mining related activities and infrastructure.	(-)	-1	-3	-3	-5	**-12**	**-9**
		Loss of natural habitat (i.e. A change of land use from wilderness to mining).	Mining infrastructure and actual mining operations.	(-)	-1	-3	-3	-5	**-12**	**-11**

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
Flora and fauna	Destruction of local ecological integrity, decimation of vegetation on site, peripheral impacts relating to human presence and mining related activities.	Direct impacts on flora species of conservation importance	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-5
		Direct impacts on fauna species of conservation importance	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-5
		Loss or disruption of migration routes on a local scale	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-5
		Direct impacts on sensitive/ pristine habitat types of the study area	Mining infrastructure and preparation.	(-)	-1	-1	-1	-1	-4	-4
		Direct impacts on common fauna species occurring on the study area	Mining infrastructure and preparation.	(-)	-1	-1	-1	-1	-4	-4
		Faunal interactions with structures, servitudes and personnel	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-6
		Impacts on surrounding habitat/ species, including ecosystem functioning	Mining infrastructure and preparation.	(-)	-1	-1	-1	-1	-4	-4
		Impacts on South Africa's conservation obligations & targets (Vegmap vegetation types)	Mining infrastructure and preparation.	(-)	-1	-1	-1	-1	-4	-4
		Increase in local and regional fragmentation/ isolation of habitat	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-6
		Increase in environmental degradation, pollution (air, soils, surface water)	Mining infrastructure and preparation.	(-)	-1	-2	-2	-2	-7	-6

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
Archaeology and heritage	Impact on paleontological resources	Impact on paleontological resources	Chance finds of a paleontological nature	(-)	-1	-1	-1	-1	**-4**	-4
		Impact on site of low significance identified as comprising a low density surface scatter of later stone age material	Mining infrastructure and preparation.	(-)	-1	-1	-2	-1	**-5**	-4
Groundwater	Depletion of aquifer	Lowering of groundwater level	Dewatering of the pit to ensure dry mining conditions and pit slope stability.	(-)	-3	-3	-4	-5	**-15**	**-13**
			Groundwater abstraction for potable and process water demand.	(-)	-3	-3	-4	-5	**-15**	**-13**
	Pollution	Groundwater quality deterioration	Biological contamination of localised aquifer due to domestic and sewage effluent disposal and hydrocarbon contamination.	(-)	-3	-3	-2	-5	**-13**	**-10**
		Sulphate plume	Cumulative groundwater impacts as a result of seepage through the tailings facilities into the groundwater.	(-)	-3	-3	-4	-4	**-14**	**-13**
Surface water	Impact on surface water quality.	Increased TDS, possible erosion (wind and water).	Stripping of vegetation as part of on-going pit establishment and instability of stockpiles.	(-)	-3	-2	-4	-4	**-13**	**-9**

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
		Spillage of water from the mine during extreme rainfall events.	Insufficient storage on site for the 1:50 year events.	(-)	-3	-1	-3	-3	**-10**	

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
		Surface water contamination.	– Sludge from washing plant. – Sludge and water effluent from sewage works. – Impact from workshop area, including areas of storage of diesel, fuel, lubricants and cleaning materials. – Surface water runoff from roads and mining areas affected by oil spills or other contaminated material. – Accidental fuel and other hazardous, toxic, chemical spills. – Ongoing chemical contamination (e.g. Fertiliser application during rehabilitation). – Leachate from mining infrastructure (i.e. Slimes dam, waste rock overburden dump and return water dams (rwds)). – Water pumped from open pit for dewatering purposes.	(-)	-3	-2	-3	-4	**-12**	-8

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
	Reduction of surface water yield.	Reduced catchment to ecological systems.	Development of mining infrastructure and opencast pit areas.	(-)	-3	-2	-3	-3	**-11**	-9
Air quality	Fugitive dust and particulate matter	Reduction in ambient air quality from fugitive dust emissions.	Crushing activities, materials handling and entrainment from unpaved roads	(-)	-2	-2	-4	-3	**-11**	**-10**
		Reduced visibility, soiling of buildings and materials.	Mining operation causing elevated dust levels.	(-)	-2	-2	-4	-3	**-11**	**-8**
		Dust emissions resulting in respiratory and cardiovascular ailments.		(-)	-2	-2	-2	-3	**-9**	**-7**
	Exceedences in ground level concentrations	Exceedences in NO_2 beyond the site boundary (upper limit)	Vehicle exhaust emissions	(-)	-2	-2	-2	-2	**-8**	-7
		Exceedences in PM_{10} beyond the site boundary	Crushing activities, materials handling and entrainment from unpaved roads	(-)	-2	-2	-3	-3	**-10**	-8
Noise and vibration	Noise pollution	Increased ambient noise levels.	Mining operation (earth moving, mineral processing plant, specifically crushing).	(-)	-1	-2	-4	-3	**-10**	**-8**
			Increase traffic flow (on-site).	(-)	-1	-2	-4	-3	**-10**	**-8**
		Nuisance disruption to sensitive fauna, employees and communities.	Periodic blasting as part of mining activities.	(-)	-1	-2	-4	-3	**-10**	**-8**

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
	Vibration	Nuisance disruption to sensitive fauna, employees and communities.	Blasting of waste material and ore.	(-)	-2	-2	-4	-3	**-11**	**-9**
		Impact on building foundation stability.	Blasting of waste material and ore.	(-)	-2	-2	-4	-3	**-11**	**-9**
Visual	Visual impact.	Change in land-use and available view.	Mining vehicle movement (sequential impact).	(-)	-2	-2	-4	-2	**-10**	**-9**
			Buildings and other structures (including residential structures, process plant and offices).	(-)	-2	-2	-4	-2	**-10**	**-9**
			Entrances, signs and boundary treatment.	(-)	-2	-2	-4	-2	**-10**	**-9**
			Material storage (topsoil stockpiles and material stockpiles).	(-)	-2	-2	-4	-2	**-10**	**-9**
		Light pollution.	Lighting of mining operations during night time.	(-)	-2	-2	-4	-2	**-10**	**-9**
Waste	Contamination of soil, surface water and groundwater; health risks as a result of exposure to	Contamination of surface water and groundwater.	Leaching of hazardous substances from construction equipment and storage areas	(-)	-3	-3	-4	-4	**-14**	**-12**
		Contamination of soil and groundwater	Generation and disposal of general waste to landfill.	(-)	-3	-3	-3	-4	**-13**	**-4**

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
	hazardous substances.	Contamination of soil.	Temporary storage of hazardous waste on unlined and / or unbunded areas, hazardous waste spills.	(-)	-1	-2	-3	-3	**-9**	**-4**
	Contamination of soil, surface water and groundwater; health risks as a result of exposure to hazardous substances.	Contamination of groundwater.	Disposal of hazardous wastes on general landfills.	(-)	-2	-3	-3	-5	**-13**	**-8**
		Litter (aesthetic impacts, ingestion by animals).	Waste not placed in designated waste bins / containers.	(-)	-1	-1	-2	-2	**-6**	**-4**
		Odour (unpleasant odours and the proliferation of pests as a result of waste).	Waste not disposed of timeously or kept in closed containers.	(-)	-1	-2	-2	-2	**-7**	**-5**
		Infections from medical and other waste.	Unsuitable handling and disposal of medical waste (i.e. Sharps and bandages) and other wastes.	(-)	-2	-3	-3	-4	**-12**	**-5**
		Health risks of staff and public from exposure to hazardous wastes.	Handling of hazardous waste without suitable ppe by staff or public.	(-)	-2	-3	-3	-4	**-12**	**-6**
Social	Employment (mine specific).	Creation of mine specific employment opportunities.	Construction at the pering mine.	(+)	+3	+3	+4	+2	**+12**	+15
	Employment (directly affected area).	Creation of employment opportunities not directly related to the mine itself.	Construction at the pering mine.	(+)	+3	+1	+2	+2	**+11**	+12
	Hiv and aids (mine specific).	Increased infection rates.	Construction at the pering mine (permanent employees).	(-)	-1	-2	-4	-5	**-12**	**-8**
			Construction at the pering mine (contractor employees).	(-)	-3	-3	-4	-4	**-14**	**-11**

Aspect	General impact	Specific impact	Cause	Status	Impact significance Prior to mitigation					Significance after mitigation
					E	D	P	I	S	
Economic	Levels of economic activity.	Increase in GDP	Increase in business activity / sales and demand for consumer services.	(+)	+4	+2	+4	+5	**+15**	**+16**
	Employment.	Employment opportunities (national).	Reduction in unemployment.	(+)	+3	+2	+4	+4	**+13**	+13
		Employment opportunities (local and regional).	Reduction in unemployment.	(+)	+3	+2	+4	+4	+13	+13
	Living conditions.	Poverty alleviation.	Increase in spending power.	(+)	+3	+2	+4	+4	**+13**	**+13**
	Enabling environment.	Infrastructure.	Development of roads, electricity, houses, social, health and educational facilities.	(+)	+3	+3	+2	+3	**+11**	**+12**
	Skills.	Improvement of skill levels.	Provision of training programmes related to work.	(+)	+4	+3	+3	+2	**+12**	**+13**
	Health (regional).	Impact of HIV/AIDS on the health care system.	Transitory work force and sex trade.	(-)	-3	-2	-2	-3	**-10**	**-9**
	Economic activity.	Entrepreneurship.	Growth of the informal sector.	(+)	+3	+2	+3	+3	**+11**	**+13**
	Governance.	Increase commitment for government in the area.	Government involves communities and drives / funds community projects as specified in the local economic development (led) plan.	(+)	+3	+2	+2	+3	**+10**	**+10**

7.4 Decommissioning and closure phase

Table 38: Decommissioning and closure phase impact assessment

Aspect	General Impact	Specific Impact	Cause	Status	Impact Significance Prior To Mitigation				
					E	D	P	I	S
Geology And Soils	Improvement In The Soil Status And Reclamation Of Soil Areas With No Effect On Geology	Rehabilitation, Soil Replacement And Re-Vegetations	Rehabilitation Including Soil Placement, Soil Fertilisation, Sloping / Contouring And Re-Vegetation.	(+)	+1	+3	+3	+2	**+9**
Land Capability And Land Use	Re-Vegetation Of Natural Areas (I.E. Roads) And The Vegetation And Topdressing Of Dumps And Rehabilitated Areas.	Re-Use Of Rehabilitated Areas For Natural Vegetative Growth And Farming Establishment.	Rehabilitation Including Soil Placement, Soil Fertilisation, Sloping / Contouring And Re-Vegetation.	(+)	+1	+3	+3	+4	**+11**
Natural Vegetation / Plant Life	Re-Vegetation Of Natural Areas (I.E. Roads) And The Vegetation And Topdressing Of Dumps And Rehabilitated Areas.	Re-Establishment Of Vegetative Habitats.	Rehabilitation Including Soil Placement, Soil Fertilisation, Sloping / Contouring And Re-Vegetation.	(+)	+1	+3	+3	+2	**+9**
		Alteration Of Natural Ecological Processes / Ecosystem Functioning.	Creation Of Atypical / Non-Natural Habitat, Presence Of Humans For Prolonged Periods.	(-)	-3	-3	-2	-3	**-11**
		Changes In Vegetation Dynamics.	Fires, Water, Alien Species Control, Vegetation Transformation.	(-)	-2	-2	-2	-3	**-9**

Aspect	General Impact	Specific Impact	Cause	Status	Impact Significance Prior To Mitigation				
					E	D	P	I	S
		Introduction Of Species Not Associated With The Region.	Aesthetic Developments (I.E. Mine Gardens) And Invasive Species.	(-)	-2	-3	-4	-3	**-12**
Animal Life	Effect Of Impacts Beyond The Project Boundary.	Potential Loss / Degradation Of Local Pristine Faunal Habitat And /Or Communities	Land Transformation Though Rehabilitation Activities.	(-)	-2	-3	-4	-5	**-14**
		Road Deaths Of Animals On Access Roads.	Reckless Driving And Night-Time Driving On Access Roads.	(-)	-1	-3	-4	-3	**-11**
Animal Life	Effect Of Impacts Beyond The Project Boundary.	Alteration Of Natural Ecosystem Functioning / Disruption Of Natural Migration Routes.	Land Transformation Though Mine Related And Associated Infrastructure Development.	(-)	-3	-3	-4	-2	**-12**
		Impact Of Chemical Compounds From Construction On Animals	Release Of Hazardous / Bio-Accumulating Chemicals Into The Environment.	(-)	-2	-3	-2	-2	**-9**
Surface Water	Erosion Of Slopes.	Unstable Land Form Resulting In Increased Erosion.	Establish Final Slopes As Per Post-Closure Profile.	(-)	-2	-2	-3	-4	**-11**
	Sustainability Of Sloped Areas.	Erosion Of Side Slopes Of Rehabilitated Areas.	Side Slopes Too Steep Resulting In Erosion And Potential Danger To Animals Attempting To Access Pit Area For Water Requirements.	(-)	-1	-3	-3	-3	**-10**

Aspect	General Impact	Specific Impact	Cause	Status	Impact Significance Prior To Mitigation				
					E	D	P	I	S
Groundwater	Recharge Of Aquifer.	Recovery Of Groundwater Level.	Rainfall Recharge.	(+)	+2	+3	+5	+5	**+15**
	Pollution.	Groundwater Quality Deterioration.	Pollution Of The Neighbouring Aquifers Form The Opencast Areas Post Closure (Pollution Plume Movement.	(-)	-2	-3	-3	-3	**-11**
Air Quality	Fugitive Dust And Particulate Matter	Reduction In Ambient Air Quality From Fugitive Dust Emissions.	Material Transfer Operations.	(-)	-2	-51	-3	-3	**-9**
			Wind Erosion From Exposed Areas Being Rehabilitated.	(-)	-2	-1	-2	-1	**-6**
			Vehicle Entrained Dust From Both Paved And Unpaved Road Surfaces.	(-)	-2	-1	-3	-3	**-9**
			Fugitive Emissions From Rehabilitation Activities.	(-)	-2	-1	-3	-3	**-9**
			Remediation And Rehabilitation Activities.	(+)	+1	+1	+3	+2	**+7**
Noise And Vibration	Noise Pollution	Increased Ambient Noise Levels.	Increase Traffic Flow Due To Rehabilitation Activities.	(-)	-1	-2	-4	-3	**-10**
			Dismantling And Decommissioning Activities.	(-)	-1	-1	-4	-3	**-9**

Aspect	General Impact	Specific Impact	Cause	Status	Impact Significance Prior To Mitigation				
					E	D	P	I	S
			Final Rehabilitation Activities.	(-)	-1	-1	-4	-3	**-9**
Archaeology And Heritage	None	-	-	-	-	-	-	-	-
Waste	Contamination Of Soil, Surface Water And Groundwater; Health Risks As A Result Of Exposure To Hazardous Substances.	Usage Of Landfill Areas.	Generation And Disposal Of General Waste (E.G. Rubble) To Landfill	(-)	-2	-3	-3	-2	**-10**
			Generation And Disposal Of Hazardous Waste To Landfill (E.G. Oil-Contaminated Rubble)	(-)	-2	-2	-2	-3	**-9**
			Burial Of Waste On Site.	(-)	-2	-3	-1	-2	**-8**
Visual	Visual Impact	Change In Land-Use And Current Views.	Mining Related Infrastructure And Buildings.	(-)	-2	-2	-4	-2	**-10**
			Material Storage (Topsoil Stockpiles And Material Stockpiles).	(-)	-2	-2	-4	-2	**-10**
Social	Employment (Mine Specific).	Creation Of Mine Specific Employment Opportunities.	Rehabilitation And Closure Activities At The Pering Mine.	(+)	+3	+3	+4	+2	**+12**

Aspect	General Impact	Specific Impact	Cause	Status	Impact Significance Prior To Mitigation				
					E	D	P	I	S
	Employment (Directly Affected Area).	Creation Of Employment Opportunities Not Directly Related To The Rehabilitation Activities.	Rehabilitation And Closure Activities At The Pering Mine.	(+)	+3	+1	+2	+2	**+8**
Economic	Employment.	Decline In Employment Opportunities.	Increase In Unemployment.	(-)	-3	-2	-4	-4	**-13**

8

Mitigation and management measures

Based on the results of the impact assessment (Section 7), recommendations have been made concerning the mitigation and management measures that should be implemented for the construction, operation and closure of the proposed mining operation. These are articulated through the draft Environmental Management Plan (EMP) attached as **Appendix 14**.

8.1 Organisational commitment and environmental policy

The Pering Mine environmental policy is attached in Appendix XXX.

8.2 Mine design, construction and operation

8.2.1 Climate

In order to minimise the release of greenhouse gasses and other contaminants to the atmosphere, maintenance of vehicles with specific focus on exhaust systems are required. Energy conservation programmes will be required to be put in place.

8.2.2 Geology

No mitigation for impact on geology is proposed. The impact upon the geology is to be limited to the pits. In total 70.6Mt of material will be moved from the open pit and existing surface stockpiles All waste material will be hauled to the designated waste dumps.

8.2.3 Soils

8.2.3.1 Construction phase

It is recommended that all usable soil be stripped and stockpiled in advance of activities that might contaminate the soil. The stripped soil should be stockpiled upslope of areas of disturbance or development to prevent contamination of stockpiled soils by dirty runoff or seepage. All stockpiles should also be protected by a bund wall to prevent erosion of stockpiled material and deflect surface water runoff.

8.2.3.2 Operational Phase

- Implement live placement of soil where possible
- Improve organic status of soils
- Maintain fertility levels
- Curb topsoil loss
- It is recommended that all usable soil be stripped and stockpiled in advance of activities that might contaminate the soil. The stripped soil should be stockpiled upslope of areas of disturbance or development to prevent contamination of stockpiled soils by dirty runoff or seepage. All

stockpiles should also be protected by a bund wall to prevent erosion of stockpiled material and deflect surface water runoff.

- Stockpiles can be used as a barrier to screen operational activities (to mitigate visual impacts). If stockpiles are used as screens, the same preventative measures described above should be implemented to prevent loss or contamination of soil. The stockpiles should not exceed a maximum height of 6 m and it is recommended that the side slopes and surface areas be vegetated in order to prevent water and wind erosion. If used to screen construction operations, the surface of the stockpile should not be used as a roadway as this will result in excessive soil compaction.

8.2.3.3 Decommissioning and Closure Phase

- When stockpiled soils have been replaced during rehabilitation, the soil fertility should be assessed to determine the level of fertilisation required to sustain normal plant growth. The fertility remediation requirements need to be verified at time of rehabilitation. The topsoil should be uniformly spread onto the rehabilitated areas and care should be taken to minimise compaction that would result in soil loss and poor root penetration.
- When returning the soil to the rehabilitation site care should be taken to place soil in a manner that will allow for levelling of soil to take place in a single pass. The soil profile should not be built up using a repeated tipping and levelling action to increase the soil depth. Proper water control measures should be implemented to ensure a free draining rehabilitated landscape.

8.2.3.4 Post-Closure Phase

- When stockpiled soils have been replaced during rehabilitation, the soil fertility should be assessed to determine the level of fertilisation required to sustain normal plant growth. The fertility remediation requirements need to be verified at time of rehabilitation. The topsoil should be uniformly spread onto the rehabilitated areas and care should be taken to minimise compaction that would result in soil loss and poor root penetration.
- When returning the soil to the rehabilitation site care should be taken to place soil in a manner that will allow for levelling of soil to take place in a single pass. The soil profile should not be built up using a repeated tipping and levelling action to increase the soil depth. Proper water control measures should be implemented to ensure a free draining rehabilitated landscape.

8.2.4 Surface water

8.2.4.1 Construction phase

- Stormwater structures will need to be installed to prevent clean water catchments from being contaminated and keep dirty water within the mine boundaries.
- Limit areas to be stripped for construction purposes.
- Minimise wind and water erosion.
- Implement slope stabilisation and surface water management structures.
- Construction of a water treatment plant with a capacity of XXX m^3/day will be required for dewatering of the pits.
- Water will be treated to the standards suitable for which the water will be used at the mine or discharged into the environment (if applicable):

Off-site discharge into the Droe Harts River

- Treatment of water to DWA standards but no more than 300mg/l for sulphates.
- Align pipeline with existing infrastructure including roads and farm fences.
- Construct subterranean pipeline by way of trench and backfill method.
- Implement erosion control measures at the discharge point.

8.2.4.2 Operational phase

Increased TDS, possible erosion (wind and water) and spillage of water from the mine during extreme rainfall events:

- Institute a surface water monitoring network at the mine within clean and dirty water catchments.
- Limit areas to be stripped for pit development purposes.
- Minimise wind and water erosion.
- Implement slope stabilisation.
- Implementation of surface water management structures.
- Develop a detailed DTM of the area.

Surface water contamination:

- Sludge will be managed in terms of legal requirements for its hazard classification.
- Sewage sludge will be classified and managed accordingly.
- Hydrocarbons will be contained within engineered areas at point sources and managed accordingly.
- Remediation kits to be made available on site for diesel and other hydrocarbon related spills.
- Slimes dam design has been undertaken to mitigate seepage impacts.
- Waste rock is predicted to be inert and therefore no further mitigation is proposed.
- Follow general principle to allow clean runoff to flow back to the environment.

8.2.4.3 Closure phase

Unstable land form resulting in increased erosion.

- Maintain a surface water monitoring network at the mine monitoring quality at high risk areas including the TSF and SSF.
- Develop and implement a rehabilitation plan.
- Follow the recommendations in the EMP and Rehabilitation Plan for final rehabilitation procedures.
- Ensure slopes are developed at angles7 that will achieve the recommended slope profile.
- Vegetate all contoured areas and slopes.
- Aftercare post rehabilitation to ensure free drainage.

8.2.5 Groundwater

- The Groundwater Monitoring Programme undertaken for Pering Mine by SRK should be implemented during all mining phases.
- It is recommended to do regular (every 5 years) Hydrocensus and sampling of selected neighbouring farms to ensure that groundwater qualities are acceptable for domestic use and/or livestock watering.

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[7] Angles are recommended to be 18° by the DME.

- The mine water balance should be accurately maintained, so that a reliable estimate of losses from the SSF can be made.
- The monitoring data, water balance information and other relevant data should be reviewed periodically so that any plume emanating from the TSF and SSF can be effectively managed and liabilities defined.
- Liner to be installed at the TSF and SSF.
- The post closure conditions of the mine includes a detailed monitoring network incorporating the farm boreholes downgradient and closest to the mine that could be impacted by the past mining activities.

8.2.6 Flora and fauna

8.2.6.1 General aspects

- Remove and relocate all protected tree species where necessary. Relevant permits should be acquired from DAFF and North-West Nature Conservation.
- Appoint an Environmental Control Officer (ECO) prior to commencement of construction. Responsibilities should include, but not necessarily be limited to, ensuring adherence to EMP guidelines, guidance of activities, planning, reporting;
- Compile and implement environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation. Biodiversity monitoring should be conducted at least twice per year (Summer, Winter) in order to assess the status of conservation areas;
- Allow for a suitable buffer in order to provide protection of surrounding areas against peripheral impacts. No effluent of any nature should be released into natural habitat;
- Ensure proper storage of hazardous materials during construction and operation, including chemicals, fuels, oils, etc. in order to prevent accidental spillage, contamination or pollution of sensitive areas;
- Develop emergency maintenance operational plan to deal with any event of contamination, pollution or spillages;

8.2.6.2 Fences and demarcation

- Demarcate construction/ development areas by semi-permanent means/ material, in order to control movement of personnel, vehicles, providing boundaries for construction sites in order to limit spread of impacts;
- No painting or marking of rocks or vegetation to identify locality or other information shall be allowed, as it will disfigure the natural setting. Marking shall be done by steel stakes with tags, if required;

8.2.6.3 Fires

- Prevent all open fires;
- The use of fire as a management tool should be guided and instructed by a qualified ecologist;
- Provide demarcated fire-safe zones, facilities and suitable fire control measures;
- Picking or removing of plants, trees (living or dead) for fire making purposes is strictly prohibited;

8.2.6.4 Roads and access

- Access is to be established by vehicles passing over the same track on natural ground. Multiple tracks are not permitted;
- A road management plan should be compiled prior to the commencement of construction activities;
- Dust control on all roads should be prioritised;
- No roads should be allowed within ecologically sensitive areas.
- The use of roads around ecologically sensitive areas for the purpose of buffers should be done with circumspect particularly in view of accidental killing of animals;

8.2.6.5 Workers and personnel

- Provide temporary on-site ablution, sanitation, litter and waste management and hazardous materials management facilities;
- Abluting anywhere other than in provided toilets shall not be permitted. Under no circumstances shall use of the veld be permitted;

8.2.6.6 Vegetation clearance and operations

- Removal of vegetation/ plants shall be avoided until such time as soil stripping is required and similarly exposed surfaces must be re-vegetated or stabilised as soon as is practically possible;
- Woody vegetation should be chipped and stored separately to use as rehabilitation material;
- Remove and store topsoil separately in areas where excavation/ degradation takes place. Topsoil should be used for rehabilitation purposes in order to facilitate regrowth of species that occur naturally in the area;
- Disturbance of vegetation must be limited to areas of construction;
- The removal or picking of any protected or unprotected plants shall not be permitted and no horticultural specimens (even within the demarcated working area) shall be removed, damaged or tampered with unless agreed to by the ECO;
- Cut vegetation (grass and shrubs) only if required within areas where surface disturbances are not planned. No clearing of vegetation or soil by grading machinery shall be undertaken;
- The establishment and regrowth of alien vegetation and weeds must be controlled after the removal of vegetation cover;
- All declared aliens must be managed in accordance with the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983);
- Ensure proper surface restoration and resloping in order to prevent erosion, taking cognisance of local contours and landscaping;
- The grass mix should consist of indigenous grasses adapted to the local environmental conditions
- The revegetated areas should be temporarily fenced to prevent damage by grazing animals;
- Revegetated areas showing inadequate surface coverage (less than 30% within eight months after re-vegetation) should be prepared and revegetated from scratch;
- Damage to re-vegetated areas should be repaired promptly;
- Exotic weeds and invaders that might establish on the revegetated areas should be controlled to allow the grasses to properly establish;
- Monitoring the potential spread of declared weeds and invasive alien vegetation to neighbouring land and protecting the agricultural resources and soil conservation works are regulated by the Conservation of Agricultural Resources Act, No. 43 of 1983 and should be addressed on a continuous basis;

8.2.6.7 Animals

- No animal may be hunted, trapped, snared or killed for any purpose whatsoever;

- Fences and boundaries should be patrolled weekly in order to ensure the removal of snares;
- Vehicular traffic should not be allowed after dark in order to limit accidental killing of nocturnal animals;
- Dangerous animals should be handled by a competent person;
- Compile a graphic list of potentially dangerous animals and present this to all workers as part of site induction;
- Fences should allow free movement of small/ medium size animals;
- Ensure that a snake handler and/ or anti venom serum is available at all times, together with a competent person to administer this serum.

8.2.7 Air quality

8.2.7.2 Construction phase

Recommendation for Enhanced Evaporation

No sensitive receptors were identified within the manganese and zinc impact area. Also, the duration for the enhanced evaporation is given as 18 months, thus the long-term impacts may be limited. It is however recommended that the enhanced evaporation option be investigated further to ensure minimal off-site impacts. The manufacturer of the water canons should be contacted in this regard and a statement provided based on scientific evidence concerning the potential for evaporation of the solids and dispersion into the environment.

8.2.7.2 Operational phase

Mitigation of crushing operations

Crushing operations can be mitigated in a number of ways; these include the continuous use of water sprays (50% control efficiency), hooding with cyclones (65 % control efficiency), hooding with scrubbers (75 % control efficiency), hooding with fabric filters (83 % control efficiency) and enclosing crushing operations (100 % control efficiency) (NPI, 2012).

Mitigation of Materials handling

Dust generation from materials handling will reduce by 62% by merely doubling the moisture content of the material handled. Control efficiencies from the application of liquid spray systems at conveyor transfer points have in practice been reported to be in the range of 42% to 75%. General engineering guidelines which have been shown to be effective in improving the control efficiency of liquid spray systems are as follows:

- Of the various nozzle types, the use of hollow cone nozzles tend to afford the greatest control for bulk materials handling applications whilst minimizing clogging;
- Optimal droplet size for surface impaction and fine particle agglomeration is about 500µm; finer droplets are affected by drift and surface tension and appear to be less effective; and,
- Application of water sprays to the underside of conveyor belts has been noted by various studies to improve the efficiency of water suppression systems and belt-to-belt transfer points.

Mitigation of Vehicle Entrained Dust on Unpaved Roads

The unpaved roads were modelled with a 75% efficient control efficiency during the mitigated TSP and PM10 model runs. However, exceedances of the NAAQ limit values still existed at the mine boundary and a control efficiency of 75% is thus not expected to be sufficient. Pering mine stated that watering and periodical chemical dust suppression will take place at the mine. As the level of watering and chemical dust suppression was unknown, the mitigation control measure was taken to be a conservative 75% (taking in account level 2 watering of unpaved haul roads only).

The amount of dust that will be emitted from an unpaved haul road is dependent on the following two factors (Australian Roads Research Board - ARRB., 1996), (Thompson & Visser, 2007):

1. The erodibility of the wearing course, and
2. The erosivity of the actions to which the wearing course is subjected.

How effective or not the controls applied to the road will be is dependent on changing one or both of these factors. Many approaches of dust suppression exists but it seems as if only regular watering, the application of chemical dust palliatives together with booming and the optimal selection of wearing course materials are the only viable ones that exist.

- Dust palliative classes include (Jones, 1996), (Australian Roads Research Board - ARRB., 1996), (Thompson & Visser, 2007):
- Water groundwater containing dissolved salts or watering agents.
- Hygroscopic salts
- Lignosulphonates
- Petrolium (or sulponated pertoleum) resins
- Polymer emulsions
- Tar – and butimen – emulsion products.

Of the above mentioned palliative classes each have climatic, wearing course and traffic limitations and therefore careful investigation should be done before deciding which class to use in a certain mining environment.

Depending of the amount of fines contained on the unpaved roads at Pering mine (on which information was unavailable for this study) the best choices of palliatives would be Lignosulphonates, Petrolium and tar-butimen based products and others.

It has been found that poor wearing course material cannot be improved to deliver and adequate performance only through the addition of a dust palliative. The inherent functional defeciencies of the material will outweigh any of the financial benefit gained from dust palliatives (Thompson & Visser, 2007). However, when a wearing course material is close to specification, the use of dust palliatives has the potential to deliver cost savings compared to water-based spraying (although not necessarily initially), but more certainly in the longer term. Due to the fact that the Pering mine is located in such a dry part of our country, the benefits of using dust palliatives may outweigh the costs associated with water (as significant amounts of water will have to be used to counteract evaporation). Some dust palliatives (**such as lignosulphonates**) have almost no negative environmental effects, and will therefore not harm the sensitive semi-arid environment in which the Pering mine is situated.

PM_{10} Monitoring

It is recommended that PM10 monitoring be conducted at the Pering mine, especially on the northern, western and southern boundaries where exceedances of the NAAQS were predicted by the dispersion model in this study. The best location for both of these monitors will be just outside the west mine boundary, as this is the boundary where predicted exceedances are the most common. A map indicating the recommended location for both a PM10 monitor and a passive sampler (for measuring NO2 levels) can be seen in **Figure 49**.

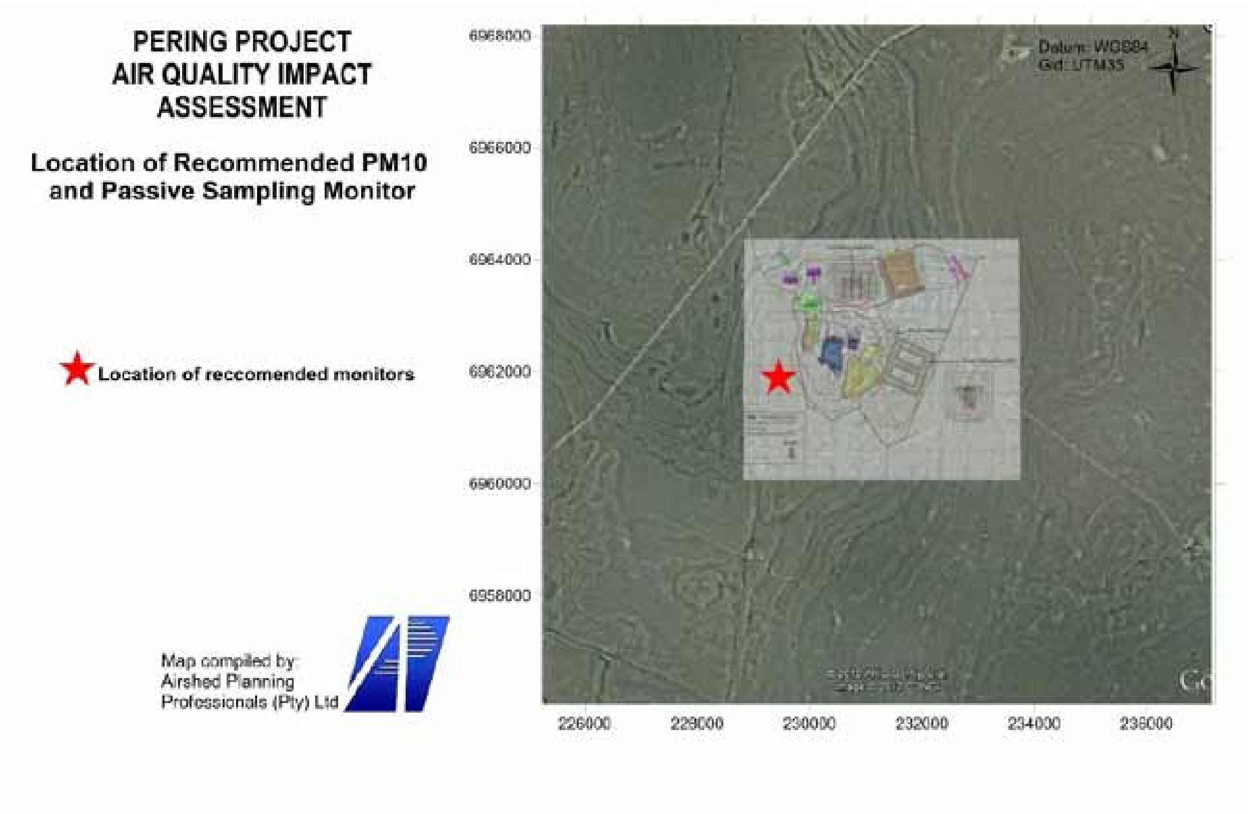

Figure 49: Map indicating a preferable site for the recommended PM10 and passive sampling monitoring station.

Mitigation of NO_2 emissions

It is recommended that two passive sampling campaigns are launched during the first operational year at Pering mine. The aim of the campaign is to establish whether measured data correlate with modelled results from this study, as only an upper and lower boundary could be predicted in this study. As predicted NO_2 emissions at the Pering mine are high, it is strongly advised that vehicles be properly maintained in order to keep emissions as low as possible.

8.2.8 Noise and vibration

8.2.8.1 Construction phase

Increased ambient noise levels.

- All machinery used during construction will be maintained in sound mechanical condition.
- PPE will be worn by all personnel operating in high noise areas (i.e. ear plugs).
- On-site generators should be clad in suitable material or housed in structures that would reduce their noise impacts.
- Generators will be fitted with appropriate silencers.
- All vehicles will be fitted with appropriate sound suppression devices or silencers.
- Keep within the applicable speed limits.

Nuisance disruption to sensitive fauna, employees and communities.

- Complaints by I&APs will be recorded in an Issues and Complaints Register and addressed throughout the duration of the existence of the operation.
- Blasting activities will be designed by a suitably qualified engineer.

Impact on building foundation stability.

- Foundations of buildings close to the open-pit area are to be able to withstand the effects of the ground vibrations.

8.2.8.2 Operational phase

- All machinery used during construction will be maintained in sound mechanical condition
- PPE will be worn in areas where noise levels are expected to be increased.
- All vehicles will be fitted with appropriate sound suppression devices or silencers.
- Vehicles will be regularly monitored and maintained.
- Keep within the applicable speed limits.
- Placement of waste structures (tailings dam) has been designed such as to create a noise barrier.
- PPE will be worn at all times during operational activities.
- Complaints by I&APs will be recorded in an Issues and Complaints Register and addressed throughout the duration of the existence of the Pering Mine.
- Blasts will be designed and executed by a suitably qualified engineer.
- Foundations of buildings closer to the open-pit area are to be able to withstand the effects of the ground vibrations.

8.2.8.3 Closure phase

- Follow the recommendations in the EMP and Rehabilitation Plan for final rehabilitation procedures.
- Reduction of vehicles during closure phase.
- All vehicles will be fitted with appropriate sound suppression devices or silencers.
- Vehicles will be inspected on a regular basis.
- All machinery utilised in the decommissioning phase will be in sound mechanical condition.

8.2.9 Sites of archaeological and cultural interest

- A palaeontological desktop study and (if required) a palaeontological impact assessment will have to be undertaken in terms of the project and its associated activities.
- While the study area was covered in detail during the physical survey, the subterranean nature of some heritage sites such as archaeological deposits, graves and burials means that one can never exclude the potential existence of any such resources within the study area.
- Should any heritage sites not included in this report be discovered during the construction phase of the project, construction should stop immediately in that area and a suitably qualified archaeologist or heritage practitioner called to site to investigate the finds and make recommendations on the way forward.

8.2.10 Visual

- All buildings and structures shall be finished in a colour (or a surface which weathers to a colour) in shades of green, brown or grey with a maximum reflectance value of 37% (excluding fittings).
- Limit signage (number and size).
- Restriction of the height of mineralogical waste structures.
- Ongoing rehabilitation and re-vegetation of mineralogical waste structures.
- Appropriate light fitting installation.
- Installation of shielding.
- Limit light intensity.

8.2.11 Waste management

8.2.11.1 Construction and operational phases

- Equipment must be regularly inspected for leaks.
- Storage areas must be lined and / or secured by an adequate bund wall.
- Re-use of waste, where possible.
- Recycling of waste material on and off site.
- Waste removal to licensed site.
- Storage of hazardous wastes in purpose built stores (impermeable floors, bunding etc.).
- Labelling of containers.
- Waste removal to a licensed waste site.
- Contactor control to ensure correct disposal procedures is followed.
- Traceability (documentation) and reconciliation of waste disposed.
- Provision of waste bins (colour coded for different waste types).
- Management and education of people.
- Frequent removal of waste bins.
- Operate according to the generated Waste Code of Practise (COP).
- Provision of suitable medical waste disposal / storage containers.
- Contractor control to ensure correct disposal procedures is followed.
- Disposal to authorised sites only.
- Provision of suitable waste containers and PPE for waste handling activities (medical and other).
- Contractor controls to ensure correct disposal procedures are followed.
- Disposal to authorised sites only.

8.2.11.2 Closure phase

- Follow the recommendations in the EMP and rehabilitation plan for final rehabilitation procedures.
- Recycling of waste off site.
- Use of rubble waste for backfilling purposes.
- Ensure rubble is not contaminated by hazardous materials.
- Off-site disposal of waste contaminated by hazardous material.

8.2.12 Social impacts

8.2.12.1 Construction and operational phase

- Site-specific construction employing unskilled, semi-skilled, skilled labour within the project area.
- Focus on short-term employment opportunities near communities, preceded by extensive community liaison to support employment across community members.
- Implement an HIV/AIDS plan of action.
- Implement condom programming, information and attitudinal change, gender relations and power over sexual decision-making, life skills education, testing, Anti-Retroviral (ARV) education, and recreational activities for on-site employees.
- Conduct education within the context of a broader wellness programme.
- Construction firms required to engage in enhanced HIV/AIDS response.
- Contracting local partner NGOs skilled in HIV/AIDS prevention and response.

8.2.12.3 Closure phase as per the Social and Labour Plan

The mine will put in place appropriate and practicable retrenchment and closure management programs for the life of the mine in addition to the Human Resources and Local Economic Development Programs.

The fundamental objectives of the plans for managing downscaling and retrenchment during the life of the mine, in line with the ethos of the Department of Labour's Social Plan are:

- To avoid or minimise job losses resulting from major restructuring or retrenchment exercises as far as possible;
- To mitigate negative social and economic impacts on local and regional economies and labour-sending areas should retrenchment or closure be required;
- To ensure the relevant processes for effective retrenchment and mine closure are in place during the life of the mine;
- To adequately communicate with employees in respect of training and re-skilling programs, applicable to mining and non-mining industries; and
- To ensure the workforce is informed as to the current and future business prospects (i.e. business plan) for the mine in order to equip them with sufficient information to make informed decisions in respect of careers and general livelihoods should retrenchment programs be required in the near future.

The mine undertakes to establish a Future Forum, in line with the requirements of the legislation, within eighteen (18) months after the granting of a new order mining right. The Future Forum will consist of representatives of mine management (mine and core contractors), employee representatives and trade unions (if in place at the time). The Future Forum will initially meet quarterly, however should a downscaling exercise be required, and prior to the planned mine closure, the Forum will sit more frequently, possible monthly.

8.2.13 Traffic

The traffic safety issues have been identified as the main challenges already present in the study area. The additional movement of heavy vehicles would certainly increase the traffic safety risk to vulnerable members of the local community and relevant mitigation and improvement measures would have to be considered and implemented gradually based on the regular monitoring of the traffic safety parameters and consultation with the members of the local community. The following are the specific recommendations in this regard:

- Continuous road safety awareness program should be prepared by the management of the Pering Mine in conjunction with the Local Municipality and other community representatives;
- Implementation of pedestrian sidewalks and/or road grading of shoulders should be further considered for sections downstream and upstream of the intersections of R372 road and access roads to Qhoo and Mogkareng villages. This measure would minimise the vehicle and pedestrian conflict situations in the vicinity to the residential places;
- Speed restriction measures and road lighting should further be considered along the same road sections as proposed in the previous recommendation as further measures based on the outcome of the traffic safety monitoring programmes and input provided by the local community;
- The road maintenance authorities should take into consideration additional EVUs and determine impact on the road maintenance requirements in the study area; and
- The traffic conditions at the R372 / N18 intersection and at the rail siding access point should be monitored on an annual basis to address potential impact of the traffic movements of large trucks on the traffic conditions.

- The proposed shortest route between the Pering Mine and the rail siding in Taung comprises a gravel road section of approximately nine kilometres between the access point to the mine premises and the junction of the mine access road and R371 road. This gravel road section has been identified as a project risk element as it gets flooded during rainy seasons and could get further damaged if used frequently by heavy vehicles. It is proposed to pave this road section to prevent frequent gravel road maintenance interventions and uncomfortable and unsafe situations to all road users in the area.

9

Assumptions & gaps in knowledge

9.1 Assumptions

The following assumptions are made before conclusions are reached and recommendations made in Sections 10 and 11:

9.1.1 Pit dewatering alternative – 17km pipeline discharging into watercourse

As no surface water quality baseline could be determined based on the outcome of the study undertaken by GCS owing to characteristically dry surface conditions, it has been assumed based on the groundwater sample collected in close proximity to the discharge area, that surface water will be of a high quality when the watercourse is in flow.

Due to very low dilution potential in the watercourse due to dry conditions and the predicted precipitation and accumulation of sulphates in the soils, it is assumed that the impact of discharging sulphurous water into the environment at this point will be significant.

9.1.2 Pit dewatering alternative – enhanced evaporation

While metals are not expected to evaporate as a result of forced evaporation, it has been assumed for conservative purposes that metals will evaporate thereby resulting in exceedences of manganese and zinc for a short distance beyond the site boundary. It has also been assumed that the water will be treated through the water treatment plant before being evaporated, thereby mitigating the potential off-site impact.

9.2 Gaps in knowledge

The following gaps in knowledge are relevant:

9.2.1 17km pipeline stream discharge dewatering alternative

The potential hydrological impacts as a result of discharging treated mine water through a 17km pipeline into the nearest watercourse were determined in the hydrological study undertaken by GCS. The study was limited to determining the potential hydrological impacts and additional studies to determine the impact on soils, flora and groundwater were recommended. Certain assumptions have been made (refer to 9.1.1) whereby further assessment will not serve to demonstrate the desirability of this dewatering alternative.

9.2.2 Enhanced evaporation dewatering alternative

The potential for metals to evaporate as a result of enhanced evaporation over the pits over an 18 month period has been modelled in the air quality impact study undertaken by Airshed. Airshed has stipulated that further investigation is required to ensure minimal off-site impacts. This represents a gap in knowledge to be queried with the manufacturer of the waste water evaporation system. Based on the assumption (refer to 9.1.2) that treatment of the pit water will occur prior to evaporation, this alternative is recommended.

9.2.3 Water treatment standard

The standard to which water will be treated at the mines water treatment plant and distributed for use or disposal is undetermined. It is however assumed that the pit water and all groundwater ingress into the pit will be treated to a standard appropriate to the dewatering alternative selected to eliminate off-site impacts.

9.2.4 Groundwater

Due to landowner access issues at the time of the hydrocensus survey, neighbouring farms were not included in the study undertaken by Rison Groundwater Services. A future hydrocensus of the mine must include neighbouring farms in the monitoring network to determine liability and potential actions to be taken by the mine. A response plan is required in the event that the monitoring data suggests that migration of the sulphate plume will impact on other water users.

9.2.5 Palaeontology

The physical survey of the proposed development area yielded one tangible heritage resource of low significance. Due to the discovery of early hominid fossils within the Taung district, the potential discovery of other fossils in the region cannot be discounted. A palaeontological desktop study and (if required) a palaeontological impact assessment will have to be undertaken in terms of the project and its associated activities and the finding presented to SAHRA.

9.2.6 Occupational exposure

The potential for occupational exposure falls outside of the scope of this study. Occupational monitoring will be undertaken by Pering Mine.

10

Environmental impact statement

10.1 Selection of the desired alternative

The alternatives were discussed in Section 5. The alternative pit dewatering options have been thoroughly investigated due to the significance of the potential environmental impacts and the associated social issues. **Table 39** below provides a comparative assessment of the advantages and disadvantages of each of the alternatives.

Table 39: Comparative assessment of the advantages and disadvantages of the alternatives investigated

#	Alternative	Advantages	Disadvantages
(A1)	Site / location Alternatives	N/A	N/A
(A2)	Crop farming	▪ Land not viable for crop farming	▪ Shallow, non arable soils ▪ Impractical alternative
(A3)	Grazing	▪ Moderate potential grazing land ▪ Currently limited grazing on site	▪ Mining land status ▪ Few palatable grass species identified on site
Pit dewatering alternatives			
#	**Alternative**	**Advantages**	**Disadvantages**
(A4)	Enhanced evaporation / evapo-transpiration	▪ Pits dewatered in 18 months ▪ Environmental impacts confined to mine property ▪ Off site environmental impacts of low significance ▪ Partial recycling as process water ▪ Financially feasible	▪ No aquifer recharge potential ▪ Recycling of water for beneficial use limited to mine area ▪ Concentrations of manganese and zinc were predicted to exceed the selected thresholds off-site (conservative modelling)
(A5)	Expansion of Louis Lake occurring at Pering Mine	▪ Pit dewatering time improved ▪ Impacts confined to mine property ▪ Water recycled as process water	▪ Large surface are required for evaporation (165 ha) ▪ Recycling of water for beneficial use limited to mine area (process water) ▪ Prohibitive expense due to high earthwork costs
(A6)	Combination option (on-site)	▪ Pit dewatering time improved ▪ Smaller evaporation area required than Louis Lake option (99ha). ▪ Evaporation enhanced though water canons/sprinklers ▪ Partial recycling as process water ▪ Groundwater contamination mitigated by bentonite lining ▪ Partial treatment through	▪ Recycling of water for beneficial use limited to mine area (process water) ▪ Aquifer recharge limited as dams will be lined with bentonite

		phytoremediation ▪ Financially feasible but high earthwork costs ▪ Potential social spin-offs	
(A7)	Treatment and conveyance of water through a ±17 km pipeline into a tributary of the Harts River	▪ Pits dewatered in 18 months ▪ Pipeline can be aligned with farm boundaries and roads ▪ Water evaporates or enters groundwater between 4-7km downstream ▪ Aquifer recharge potential ▪ Water treated to standard suitable for cattle watering or better ▪ Suitable anchoring material at Droe Harts River identified ▪ Financially feasible	▪ Surface water baseline could not be determined (assumed to be of a very high quality) thus water treatment to cattle watering standards deemed insufficient ▪ Dilution potential limited, leads to accumulation of sulphates in soils and vegetation ▪ Dilution potential limited, leads to cumulative negative impact on groundwater ▪ Landowner approval to discharge treated water not anticipated
(A8)	Treatment and conveyance of water through a ±7 km pipeline into a poorly defined floodplain	▪ Pits dewatered in 18 months ▪ Pipeline can be aligned with farm boundaries and roads ▪ Ponding for prolonged periods leads to aquifer recharge ▪ Financially feasible	▪ Ponding for prolonged periods sterilises large tracts of land minimising grazing potential ▪ Landowner approval to discharge treated water not anticipated
(A9)	Reivilo reservoir	▪ Water recycling for beneficial human use (drinking water provided to water scarce area)	▪ Land required to construct reservoir ▪ Prohibitive costs due to treatment of water to potable standards and high earthwork costs ▪ Short term redundancy of reservoir (not sustainable) ▪ High maintenance requirements
(A10)	Supply to Sedibeng Water Board	▪ Water recycling for beneficial human use (drinking water provided to water scarce area)	▪ No apparent interest in this proposal ▪ High water treatment costs
(A11)	Pit water treatment during the construction phase	▪ Standard of water treatment will depend on: o Quality of process water required o On site evaporation solution o Off site disposal solution o Drinking water solution	

Based on the comparative assessment in **Table 39** of the advantages and disadvantages of the pit dewatering alternatives, the following is evident:

- Provision of water for human consumption (supply to Reivilo) requires a significant financial investment for land purchase, earthworks and water treatment (to potable standards) and is not considered to be sustainable beyond the short term.
- Water treatment, conveyance and discharge into off-site water resources and watercourses is problematic due to the predicted off-site environmental impacts (if irrigation standard is not achieved) as well as landowner issues.
- On-site evaporation - water will be lost to the aquifer but off-site environmental impacts will be curtailed.

10.2 Summary of impacts and mitigation

10.2.1 Economic geology

Pering Mine (Pty) Ltd proposes to reopen an opencast zinc and lead mining operation at Pering Mine located on the farm Pering Mine 1023 HN in the magisterial district of Vryburg in the North West Province. Mining activities will include processing of the existing waste rock dumps and extending the mine pit using Dense Media Separation (DMS) mining techniques.

10.2.2 Agricultural potential

The potential impact of the proposed mine on agricultural potential is not considered significant. The main objective at Pering Mine as far as agricultural potential is concerned will be to rehabilitate the mining site at closure, so as not to pose a safety hazard for humans and animals, at the same time allowing for an alternative land use or the continuation of grazing as far as possible.

10.2.3 Geohydrology

The quality of groundwater based on samples collected to date, indicate that the tailings dams, and waste rock dumps have resulted in a deterioration of the groundwater quality due to increased sulphate and magnesium concentrations. The movement of the sulphate plume as a result of historic mining activities (unlined deposition of slimes at the TSF and SSF) off-site and in an easterly direction was modelled in the geohydrological study undertaken by SRK. The TSF and SSF have since been capped to minimize seepage as far as possible. No additional tailings will be deposited onto the old dam.

By the end of Life of Mine, the plume extent is not expected to reach the farm water supply borehole, 12C. However post closure of the mine the plume will continue to migrate and by year 20 after commissioning of the SSF, a significant deterioration in the water quality will occur rendering the groundwater unacceptable as a domestic water supply. Pering has made financial provision to acquire from impacted farmers the land sterilized by the tailings dam plume and/or to drill and equip replacement bore-holes for those contaminated by the tails plume. Monitoring of the progress of the sulphate plume will form part of the monitoring network.

Provided that the TSF and SSF are lined as planned, the proposed mining activities are not expected to present significant cumulative groundwater impacts.

10.2.4 Surface water hydrology

Pit water quality

Surface water monitoring is conducted at the Main Pit and Pit 24 on a bi-annual basis and the quality of the pit water is well understood. Exceeding elements in the Main Pit are as follows (based on the November 2010 monitoring report:

- Domestic use: Total Dissolved Solids (TDS), Sulphates (SO_4), Electrical Conductivity (EC), Calcium (Ca), Magnesium (Mg) and Lead (Pb).
- Livestock watering: TDS and SO_4.
- Aquatic ecosystem: Pb and Zinc (Zn) above the Acute Effect Value, Selenium (Se) above the Chronic Effect Value and Cadmium (Cd) exceeded the Target Water Quality Guidelines (TWQG).

Pit dewatering

In order to continue with mining of the pits, pit dewatering alternatives have been considered and include the following:

- Enhanced evaporation - spraying water through water canons over the Main Pit to speed up evaporation over a period of 18 months.
- Treating, conveying and discharging water through a ±17 km pipeline into a defined non-perennial watercourse (Droe-Harts) located on neighbouring farms.
- Treating, conveying and discharging water through a ±7 km pipeline into a poorly defined floodplain. This option could result in the sterilisation of farm land where flood plains are flooded for prolonged periods.
- Treatment to potable standards, conveyance and storage of water to Reivilo for human consumption.
- Supply of water to the regional water board (Sedibeng Water).
- A combination of alternatives.

Recycling of the pit water for beneficial human use has proven not to be feasible for the following reasons:

- The high cost of treating the pit water to potable standards for human consumption in Reivilo.
- The lack of interest from the Water Services board concerning treatment and supply.
- Discharge of water into the Droe Harts River following treatment thereof to cattle watering standards could result in potential cumulative impacts on vegetation and soils due to the very low in-stream dilution potential leading to precipitation and accumulation of sulphates within the soils at the discharge area.
- Discharge of water into the Droe Harts River following treatment thereof to irrigation standards is unlikely to comply with the environmental baseline for the area (although surface water quality could not be determined, it is assumed to be near pristine based on groundwater sampling nearby). Treatment of pit water to any non-representative standard is thus unlikely to be accepted by the farmers affected. Further investigation of this option should only continue pending landowner consent.
- Discharge of mining water into the Droe Harts River may be in conflict with Regulation 704 under the National Water Act which regulates mining related impacts on water resources.

The combination option for pit dewatering which involves primarily the evaporation of the pit water is desirable for the following reasons:

- Loss of water from the aquifer is not regarded to be of significance as the impact on adjacent water user will be low. The loss should also be offset against the predicted off-site environmental impacts and the economic issues.
- This alternative will not result in direct environmental impacts and all necessary infrastructure can be established on site.
- The potential exceedances in ground level concentrations for metals outside the site due to enhanced evaporation were modelled on a precautionary approach as metals are unlikely to evaporate. No sensitive receptors were identified within the manganese and zinc impact area. Also, the duration for the enhanced evaporation is given as 18 months, thus the long-term impacts may be limited.
- Potential off-site exceedences or residual impacts could likely be mitigated through treatment of the water at the treatment plant (standard must be specified by manufacturer).

The environmental impacts of undertaking the combination alternative will be less significant as off-site impacts can be mitigated.

10.2.5 Air quality

The Pering Mine boundary was identified as a receptor as NAAQ standards must be met outside of the mine boundary. Based on the modelling undertaken, exceedences of the limits for PM10 and NO2 during the operational phase of the mining project may become relevant, however due to the absence of sensitive receptors outside the mine boundary, the impact of such exceedences are considered to be of low significance. Pering Mine is required to implement air quality mitigation measures described in Section 7 of this report as well as the Environmental Management Plan attached as **Appendix 14**.

10.2.6 Terrestrial biodiversity and ecological significance

A total of 101 plant species and 80 animal species were identified during the field investigations undertaken as part of the biodiversity assessment. This diversity is regarded to be representative of the Ghaap Plateau Vaalbosveld. The presence of various weeds and invasive species indicates the presence of degraded and transformed habitat within the study area.

Based on the biodiversity impact assessment undertaken, no area of the mine site was observed that could be regarded to be of particular ecological significance and no restrictions in terms of placement of development facilities and infrastructure are placed on the area. The loss of the remainder of the property because of the proposed development is unlikely to have a significance bearing on the biological environment beyond a relative short distance from the activity. The most important recommendation in this regard is to prevent the contamination, degradation and pollution of surrounding areas by means of the implementation of adequate preventative barriers and the containment of effluent from the plant and water treatment facilities.

The implementation of generic mitigation measures are likely to result in amelioration of expected impacts to a low significance.

10.2.7 Heritage aspects

Both a desktop study and physical survey of the study area was undertaken. One site of low significance was identified comprising a Low Density Surface Scatter of Later Stone Age material. From a heritage point of view the development may be allowed to continue. Due to the discovery of early hominid fossils within the Taung district, the potential discovery of other fossils in the region cannot be discounted. A palaeontological desktop study and (if required) a palaeontological impact assessment will have to be undertaken in terms of the project and its associated activities and the finding presented to SAHRA. Furthermore, Pering Mine is required to observe heritage mitigation measures described in Section 7 of this report as well as the Environmental Management Plan attached as **Appendix 14**.

10.2.8 Noise

As indicated in Section 8, a noise impact study was not undertaken to determine the ambient noise levels for the operational phase as part of this EIA and represents a potential gap in knowledge. At the plant the main source of noise is the crushers while drilling and blasting will be confined to the pits. Noise levels at most working stations are anticipated to be above the statutory limits impacting on workers at these stations whereby PPE will be issued and occupational monitoring undertaken. Ambient noise monitoring will be undertaken by the mine during construction and operation to determine compliance in accordance with SANS 10103: 2004. It is recommended that noise monitoring be started prior to starting operations in order to establish a baseline against which future monitoring results may be compared to.

10.2.9 Visual

The cumulative visual impact of the mine will increase due to the extension of the mining footprint over the site. This impact is not considered significant due to the absence of sensitive receptors in the area. No mitigation is thus proposed.

10.2.10 Waste management

No significant waste management impacts are anticipated however the preparation of a waste management plan for the mine will ensure that waste management is prioritised.

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Conclusion

Pering Mine (Pty) Ltd proposes to re-open a existing closed opencast zinc and lead mine located on the farm Pering Mine 1023 HN in the magisterial district of Vryburg in the North West Province. The proposed project will result in approximately 250 job opportunities whereby the applicant will focus on the Local Economic Development of Reivilo / Boipelo in the Greater Taung Municipality in fulfilment of the commitments made in the Social and Labour Plan (SLP).

The desirability of the project is supported by the following:

- The mineral resources can be economically extracted from the existing open-cast pit and existing rock waste dumps.
- Some infrastructure such as roads and electricity infrastructure already exists. This will result in lower start-up costs.
- The mine has historically provided employment to the receiving community (Reivilo) who are generally in favour of the proposed continuation of the mining operation.

11.1 Residual environmental impacts from historic activities

The key remaining residual features/impacts at Pering Mine which resulted from historic mining activity include the following:

- Tailings dam which has been lined with a cladding of waste rock to limit water seepage into the tails dam and minimize wind and water erosion and dust fallout.
- A sulphurous groundwater contamination plume from the tailings dam which has migrated beyond the mine boundary, in an easterly direction.
- Main Pit and Pit 24 – These pits have been infiltrated with groundwater and rainwater since closure and currently there is approximately 8 million m^3 of water in the Main Pit.

11.2 Stakeholder consultation

In general the project is supported by the residents of Reivilo based on the potential for improved economic development opportunities. The DWA is an important stakeholder engaged to administer the water use license and provide guidance in terms of the pit dewatering alternatives. The GPEPG with adjacent farmer representation has submitted its objection to the MPRDA mining license application. The basis for the objection is rooted in a concern around the cumulative impact of new mining activities considering the impacts which resulted from past mining practices.

11.3 Pit dewatering

Alternative options of discharging into the environment and provision of drinking water to the community were investigated. Discharge of pit water into the environment (Droe Harts River) is limited due to the high cost of treating the pit water to the standard suitable for mitigating the off-site environmental impacts which have been identified. Similarly, the cost of provision of potable water to Reivilo seemingly outweighs the benefit and sustainability thereof due to high treatment and water storage costs. A combination of on-site evaporation alternatives is thus preferred based on the findings of this EIAR. Should the enhanced evaporation option be instituted, the manufacturer of the water canons should be contacted with regard to the potential for evaporation of the solids and dispersion into the environment. It is recommended that the Water Use License proceed on this basis.

It is therefore recommended that the pit water disposal occur on site as far as possible through natural and enhanced evaporation to mitigate off-site residual environmental impacts. Water shall be of a quality suitable for the method of dewatering to eliminate off-site impacts and further groundwater contamination. However a combination of on-site disposal coupled with off-site disposal into the Droe Harts River may be considered (with the intention to recharge the aquifer and feed water back into the reserve) provided that:

- Landowner consent is obtained from the landowner(s) to discharge the water.
- Pit water is treated to irrigation standards (as per the specialist recommendation made by GCS) with specific attention given to PH, sulphate levels and metals.
- Chemical modelling of the downstream water quality and study to confirm the affect on soils, flora and fauna (after water treatment)
- As many boreholes as possible in the vicinity of the discharge point and surrounding pan-like areas as well as south east of the discharge point must be made.
- Any infrastructure associated with the discharge pipeline should be designed by a professional engineer, who would need to consider foundation conditions in selecting a discharge site.
- Continuous groundwater monitoring is recommended for the duration of the discharge and one year after discharge has ceased, should it happen.

11.4 Groundwater contamination plume

Previous mining impacts are responsible for the formation of the sulphurous groundwater contamination plume migrating to the east. The proposed mining project will not have a significant cumulative impact on the sulphate pollution plume due to lining of the SSF and TSF. The existing sulphate plume is not expected to impact on the adjacent landowner until after mine closure. Monitoring of the pollution plume is recommended (extension of network onto adjacent properties with landowner consent) in order to quantify future liabilities and recommend measures for mitigating the progression thereof, to be funded by the mines rehabilitation fund.

11.5 Predicted air quality impacts

From an air quality perspective, the proposed mining project is not anticipated to impact on the sensitive receptors identified however exceedences in ground level concentrations of PM_{10} and NO_2 are anticipated and dust management and vehicle maintenance is recommended to mitigate these impacts. It is recommended that the existing dust monitoring network be extended to include PM_{10} and NO_2 monitoring.

11.6 Predicted ecological impact

From a biodiversity perspective the project is supported as no areas of particular ecological significance were identified and no restrictions in terms of placement of infrastructure are relevant. The implementation of generic mitigation measures are likely to result in amelioration of expected impacts to a low significance.

11.7 Other predicted impacts

All other environmental impacts identified in this EIAR can be mitigated to acceptable standards provided that the recommendations and mitigation measures contained in this report as well as the draft EMP are adhered to.

11.8 Conditions of authorisation

In addition to the abovementioned, the following conditions of authorisation are recommended:

- Monitoring of the pollution plume is required (including an extension of the monitoring network onto adjacent properties) in order to quantify future liabilities and recommend measures for mitigating the progression thereof.
- Should the enhanced evaporation dewatering alternative be instituted (recommended alternative), the manufacturer of the water canons should be contacted with regard to the potential for evaporation of the solids and dispersion into the environment.
- A site-wide surface water and stormwater management plan must be prepared with the objective of achieving compliance with Regulation 704 under the National Water Act which regulates mining related impacts on water resources. This plan should demonstrate the separation of clean and dirty water systems on the site.
- Should a portion of the pit water need be discharged into any natural surface water feature off-site, that the volume of discharge be specified and that the necessary mitigation measures as proposed by the specialist studies be implemented. Landowner consent and water use authorization will be required by DWA before further consideration to this option is given.
- An emergency response plan to include procedures for environmental related emergencies must be developed. This should include responses in the event that the monitoring data suggests that migration of the sulphate plume will impact on other water users.
- It is recommended that the existing dust monitoring network be extended to include PM_{10} and NO_2 monitoring.
- It is recommended that noise monitoring be started prior to starting operations in order to establish a baseline against which future monitoring results may be compared to.
- No sites of heritage significance were identified however a palaeontological desktop study and (if required) a palaeontological impact assessment will have to be undertaken in terms of the project and its associated activities and the finding presented to SAHRA.
- A waste management plan must be prepared for the mine.
- The draft EMP prepared as part of this EIA process must be implemented and updated accordingly.

12

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Social And Labour Plan For Pering Mine
Pering Mine

Pering Mine Feasibility Study

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