dBAcoustics


| | | |
|---|---|---|
| **Tel.** | **+27 11 782 719** | **PO Box 1219** |
| **Fax** | **+27 11 782 719** | **Allensnek** |
| **Cell** | **+27 82 922 0298** | **1737** |
| **E-Mail** | **barendv@xsinet.co.za** | |


# Anglo American Platinum Der Brochen Project

## Environmental Noise and Vibration Impact Assessment

## Greater Tubatse Local Municipality

## Sekhukhune District Municipality

Project No : 173/2019
Compiled by : B v/d Merwe
Date : 12 August 2019

# DECLARATION OF INDEPENDENCE

I, **Barend J B van der Merwe,** as duly authorised representative of **dBAcoustics**, hereby confirm my independence and declare that I have no interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which **SRK Consulting (SA) (Pty) Ltd** was appointed as Environmental Assessment Practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act) for the compilation of an EIA and EMP for the establishment of the different mine expansion activities at the Der Brochen Mine. I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it. I have disclosed, to the environmental assessment practitioner, in writing, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act. I have further provided the environmental assessment practitioner with written access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not. I am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2014 and any other specific and relevant legislation (national and provincial), policies, guidelines and best practice.

| | | |
|---|---|---|
| Signature | : | |
| Full Name | : | Barend Jacobus Barnardt van der Merwe |
| Date | : | 12 August 2019 |
| Title / Position | : | Environmental noise specialist |
| Qualification(s) | : | MSc Environmental Management |
| Experience (years) | : | 16 years |
| Registration(s) | : | SAAI, NACA, IAIA and SAAG |

**Details of specialist and expertise**

I, Barend JB van der Merwe of 43 6th Street, Linden Johannesburg have been an environmental noise and ground vibration specialist for the last 15 years. I have been instrumental in the pre-feasibility studies of proposed projects which may have an impact on the environment and noise sensitive areas. I am also involved with the noise and ground vibration impact assessments and the environmental management plans compilation of large projects such as wind farms, mining, roads, trains (primarily the Gautrain) and various point noise sources. As a post-graduate student in Environmental Management at the University of Johannesburg, I obtained an MSc degree with the research project concentrating on the impact of noise and ground vibration on a village close to a new underground mine. I have played a major role in the identification, evaluation and control of physical factors such as noise and ground vibration in the following projects – wind farms, various platinum and coal mines and the quarterly noise evaluation of the Gautrain, the decommissioning of the N11 near Mokopane, construction of the P166 near Mbombela, design of the Musina by-pass, noise mitigatory measures at the N17 road near Trichardt, establishment of the weigh bridge along the N3 near Pietermaritzburg, George Western by-pass. The following large environmental companies are amongst my clients: Gibb, Royal Haskoning DHV, Coffey Environmental, Golder Associates Africa (Pty) Ltd, GCS Environmental (Pty) Ltd, Knight Piesold Environmental (Pty) Ltd and SRK Engineering (Pty) Ltd.

Qualifications

1. MSc – Environmental Management – University of Johannesburg;
2. BSc Honours in Geography and Environmental Management – University of Johannesburg;
3. National Higher Diploma in Environmental Health - Witwatersrand Technikon;
4. National Diploma in Public Health - Cape Town Technikon;
5. National Certificate in Noise Pollution - Technikon SA;
6. National Certificate in Air Pollution - Technikon SA;
7. National Certificate in Water Pollution - Technikon SA;
8. Management Development Diploma - Damelin Management School; and
9. Advanced Business Management Diploma - Rand Afrikaans University.

Membership

- South African Institute of Acoustics (SAAI);
- International Association of Impact Assessment (IAIA);
- National Association of Clean Air (NACA);
- South African Association of Geographers (SAAG).

Experience

- Noise impact assessment of different mine establishments;
- Noise Control Officer i.t.o. Noise Control Regulations;
- Compilation of noise management plans;
- Annual and quarterly baseline noise surveys;
- Moderator Wits Technikon – Environmental Pollution III.
- Various road projects for SANRAL.
- Compilation of the Integrated Pollution strategy for Ekurhuleni Town Council.
- Represent clients at Town Planning Tribunals.
- Represent clients at Housing Board tribunals.
- Determine residual noise levels in certain areas as required by clients.
- Noise attenuation at places of entertainment.
- Design and implementation of sound attenuators.
- Noise projections and contouring.
- Advisory capacity regarding noise related cases to local authorities: - Sandton, Roodepoort, Randburg, Krugersdorp, Alberton, Centurion, Vereeniging. Due to my previous experience in Local Government I provide a service to these Local government departments on the implementation of the Noise Control Regulations and SANS 10103 of 2008 – The measurement

and rating of environmental noise with respect to land use, health annoyance and to speech communication.

- Identification, Evaluation and Control of noise sources in industry.

I was involved in the following noise impact assessments during the Environmental Impact Assessment process (Noise and/or Vibration):

- Airlink BID for landing in Kruger National Park;
- Coal gasification plant in Theunissen;
- Langhoogte and Wolseley wind farms;
- Widening of N3 at Howick, KZN;
- Tulu Kapi Mine, Ethiopia;
- Boabab Iron Ore Mine, Mozambique;
- N11 Decommissioning Mokopane;
- Baseline noise survey for NuCoal Mines, Woestalleen, Vuna and Mooiplaats Collieries;
- Baseline noise monitoring Mooinooi mine;
- Leeuwpan coal mine;
- N17 Road at Trichardt for KV3 Engineers;
- N17 Road in Soweto;
- Proposed new by-pass road at Musina;
- George Western By-pass road between George Airport and Outeniqua Pass;
- Gautrain baseline monitoring;
- Upgrade of Delmas Road extensions in Moreletta Park, Pretoria;
- Proposed weigh bridge, N3, Pietermaritzburg:
- Tonkolili Manganese mine, Sierra Leone;
- Proposed wind turbines in the Western Cape – Caledon;
- Extension of works at the PPC factory in Piketberg;
- Exxaro Arnot Colliery – Mooifontein;
- Hydro power plant – 2 Sites in Durban;
- Coal export terminal in Beira, Mozambique;
- Site selection for new Power Station – Kangra Mine, Piet Retief;
- Gas exploration at Ellisras;
- Noise survey and assessment of future mine shafts at various mines;
- Mining exploration at Potgietersrus – Lonmin Akani;
- New coal mines in Witbank – Dorstfontein Expansion Project;
- New coal mines in Middelburg and Ermelo;
- New Vanadium Manganese mine in Potgietersrus;

- Xolobeni mining project in Transkei;
- Glynn mines in Sabie;
- Rezoning of properties for housing at Burgersfort, Shosanguve, Hammanskraal;
- Various noise impact assessment for clients in and around Centurion;
- Relocation of night races from Newmarket racecourse to Turfontein racecourse;
- Rezoning applications for private clients.

**Indemnity and Conditions Relating to this Report**

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information supplied by SRK Consulting. The accuracy of the results and conclusions are entirely reliant on the accuracy and completeness of the supplied data. dBAcoustics does not accept responsibility for any errors or omissions in the supplied data and information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions and the findings apply to the site conditions as they existed at the time of the field survey. These opinions do not necessarily apply to conditions that may arise after the date of the field survey and subsequent noise impact assessment report. The report is based on scientific and recommended survey and assessment techniques. This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

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Should the Client wish to utilise any part of, or the entire report, for a project other than the subject project, permission must be obtained from dBAcoustics CC. This will ensure validation of the suitability and relevance of this report on an alternative project.

# Executive summary

**Introduction**

dBAcoustics was appointed to determine the prevailing ambient noise and ground vibration levels in the vicinity of the proposed der Brochen expansion project and at the residential areas east, west and south of the study area.

The mine falls within the Greater Tubatse Local Municipality, under jurisdiction of the Greater Sekhukhune District Municipality. The Der Brochen Mine's mining right falls on the following farms:

Richmond 370 KT;

St George 2 JT;

Hermansdal 3 JT;

Hebron 5 JT;

Helena 6 JT; and

Der Brochen 7 JT.

In addition to the above-mentioned farms, RPM also holds the surface right to Portion 7 of the farm Mareesburg 8 JT on which the Mareesburg tailings storage facility (TSF), associated return water dams (RWDs) and tailings-return water pipeline are located, which forms part of the Der Brochen Mine operation. The north to south Steenkamp mountain range creates the Dwarsriver Valley with a mountain to the west and a plateau to the east with the relief measuring between 900m (plateau) to 2 000m (mountain) above sea-level. The location of the proposed mine expansions will take place in the Groot Dwarsrivier Valley and plateau to the east with noise receptors to the east, west and south of the valley.

The noise and vibration study was carried out on 30 and 31 January 2019 respectively.

The following mine establishment is proposed for the der Brochen expansion project:

- Decline shafts to access the proposed underground bord-and-pillar mining. The south decline shaft shall be located in the vicinity of the approved south open cast pit;
- Three up-cast ventilation shafts 1, 2 & 3) will be constructed in the vicinity the south decline shaft;

- A Dense Medium Seperation (DMS) plant, additional Chrome Plant and Crusher will be located on the eastern side of the within the footprint of the existing Mototolo Concentrator plant (MCP);
- A Run of Mine (RoM) stockpile and silos will be located in the vicinity of the MCP;
- A DMS stockpile, and associated pollution control dam (PCD) will be developed in the vicinity of the proposed DMS;
- The linear infra-structure will consist out of:
  A. Conveyor systems
     - DMS plant to DMS stockpile conveyor;
     - DMS feed conveyor
     - Southern decline shaft to Mototolo Concentrator plant;
     - ROM overflow stockpile conveyor;
     - Concentrator primary crusher feed conveyor.

  B. Access and haul roads
     - Ventilation access roads (3);
     - Der Brochen access road;
     - South complex access road;
     - North complex access road.

The following were noise sources in the vicinity of and the boundaries of the study area during the time of the noise survey:

- Traffic (motor-vehicles, hauling vehicles, delivery trucks and busses) to and from the Booysensdal mine complex;
- Distant mining activity noise;
- Distant traffic noise from the abutting feeder roads;
- Construction activities;
- Agricultural activities noise;
- Insects;
- Birds;
- Wind noise.

**Noise and Vibration Impact Assessment**

In terms of the Noise Regulations a noise disturbance is created when the prevailing ambient noise level is exceeded by 7.0dBA or more. Noise however becomes audible when the prevailing ambient noise level is exceeded by 5.0dBA. It will therefore be more environmentally sustainable for a new development that the latter benchmark be used as a completely mechanised development will be introduced into the study area. Noise, vibration or sound is part of our daily exposure to different sources which is part of daily living and some of these physical attributes which may at times be intrusive forms part of the ambient levels that people get used to without noticing the higher levels.

Two aspects are important when considering potential impacts of a project:

- The increase in the noise and vibration levels, and;
- The overall noise and vibration levels produced.

The proposed changes during the pre-construction, construction, operational, decommissioning and post closure phases will require approved management measures and ongoing environmental noise and ground vibration surveys to ensure compliance to the relevant environmental noise and ground vibration regulations and/or standards.

The ground vibration during underground blasting will be below 0.5mm/s at the abutting noise receptors except at the dam wall during a blast of 75.0kg per delay at UG 7 when the ground vibration level at the dam wall will be 4.85mm/s. The geology and the type of dam wall will have to be assessed to establish if the current dam wall can resist such levels of ground vibration.

**Conclusion and Recommendations**

The noise and vibration impact during the pre-construction, construction and decommissioning phases, of which most will be during daytime periods only, will be insignificant. There will be a slight noise increase during the operational phase of the project but not exceeding the 5.0dBA threshold value. Noise mitigatory measures must at all times be in place in order for the proposed mining activities to comply with the relevant noise and vibration standards.

The proposed der Brochen mine expansion will be in line with the noise and vibration standards and guidelines provided that the noise mitigatory measures are in place and that the Environmental management Plan (EMP) for the proposed mine establishment is adhered to and implemented at all times.

Barend van der Merwe – MSc UJ

Environmental noise and vibration specialist

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This report was prepared in terms of the Environmental Management Act, 1998 (Act No. 107 of 1998), the Environmental Impact Assessment Regulations, 2014 – Regulation 982 and the following aspects are dealt with in the report:

| No. | Requirement | Section in report |
|---|---|---|
| 1a) | Details of - | |
| (i) | The specialist who prepared the report | P 3 |
| (ii) | The expertise of that specialist to compile a specialist report including a curriculum vitae | P 3-4 |
| b) | A declaration that the specialist is independent | P 2 |
| c) | An indication of the scope of, and the purpose for which, the report was prepared | Section 1.3 |
| d) | The date and season of the site investigation and the relevance of the season to the outcome of the assessment | Section 1 |
| e) | A description of the methodology adopted in preparing the report or carrying out the specialised process | Section 3 |
| f) | The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure | Section 1.5 |
| g) | An identification of any areas to be avoided, including buffers | n/a |
| h) | A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers | Figures 1.2 & 1.3 |
| i) | A description of any assumption made and any uncertainties or gaps in knowledge | Section 1.4 |
| j) | A description the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment | Section 9.2 |
| k) | Any mitigation measures for inclusion in the EMPr | Section 10.2 |
| l) | Any conditions for inclusion in the environmental authorisation | Section 10.1 & 10.2 |
| m) | Any monitoring requirements for inclusion in the EMPr or environmental authorisation | Section 10.1 |
| n) | A reasoned opinion - | |
| (i) | As to whether the proposed activity or portions thereof should be authorised | Section 11 |
| (ii) | If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan | Section 11 |
| o) | A description of any consultation process that was undertaken during the course of preparing the specialist report | n/a |
| p) | A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and | n/a |
| q) | Any other information requested by the competent authority | n/a |

# 1. Introduction

The Der Brochen Mine is a Platinum Group Metals Project owned by Rustenburg Platinum Mines Limited (RPM), a wholly owned subsidiary of Anglo American Platinum (AAP), and is located approximately 25 km south-west of the town of Steelpoort, and 40 km west of Mashishing (Lydenburg), in the Limpopo Province. The mine falls within the Greater Tubatse Local Municipality, under jurisdiction of the Greater Sekhukhune District Municipality. The Der Brochen Mine's mining right falls on the following farms:

- Richmond 370 KT;
- St George 2 JT;
- Hermansdal 3 JT;
- Hebron 5 JT;
- Helena 6 JT; and
- Der Brochen 7 JT.

In addition to the above-mentioned farms, RPM also holds the surface right to Portion 7 of the farm Mareesburg 8 JT on which the Mareesburg tailings storage facility (TSF), associated return water dams (RWDs) and tailings-return water pipeline are located, which forms part of the Der Brochen Mine operation. The following activities and infrastructure are associated with the Der Brochen Mine, as authorised through the Der Brochen Mine's approved Environmental Management Programmes (EMPrs) and Water Use Licences (WULs).

Existing facilities and activities:

- Mototolo Concentrator;
- Helena TSF and two associated Return Water Dams (RWDs);
- Raising of the Helena Tailings Storage Facility (TSF);
- Mine offices (old farm house) and access roads;
- Prospecting activities comprising of site preparation, drilling of prospecting boreholes, site rehabilitation and monitoring;
- Abstraction of groundwater in support of mining from the Helena and Richmond licenced wellfields;
- Abstraction from Der Brochen Dam based on an existing lawful industrial allocation;
- Monitoring of surface and groundwater.

Activities previously authorised, which has not yet commenced:

- The Helena and Richmond wellfields (only two of the authorised boreholes per wellfield currently in use);

- Helena and Richmond shafts and associated waste rock dumps;
- Southern open pit and associated waste rock/overburden dumps and pollution control dam;
- Re-routing of a 132 kV powerline; and
- A Co-Disposal Facility (tailings disposal with a rock embankment in the north pit).

Authorised activities under construction:

- Mareesburg TSF and associated Return Water Dams (RWDs);and
- Mareesburg tailings-return water pipeline system to Mototolo Concentrator.

The location of the Der Brochen Mine and infra-structure is illustrated in Figure 1.1.

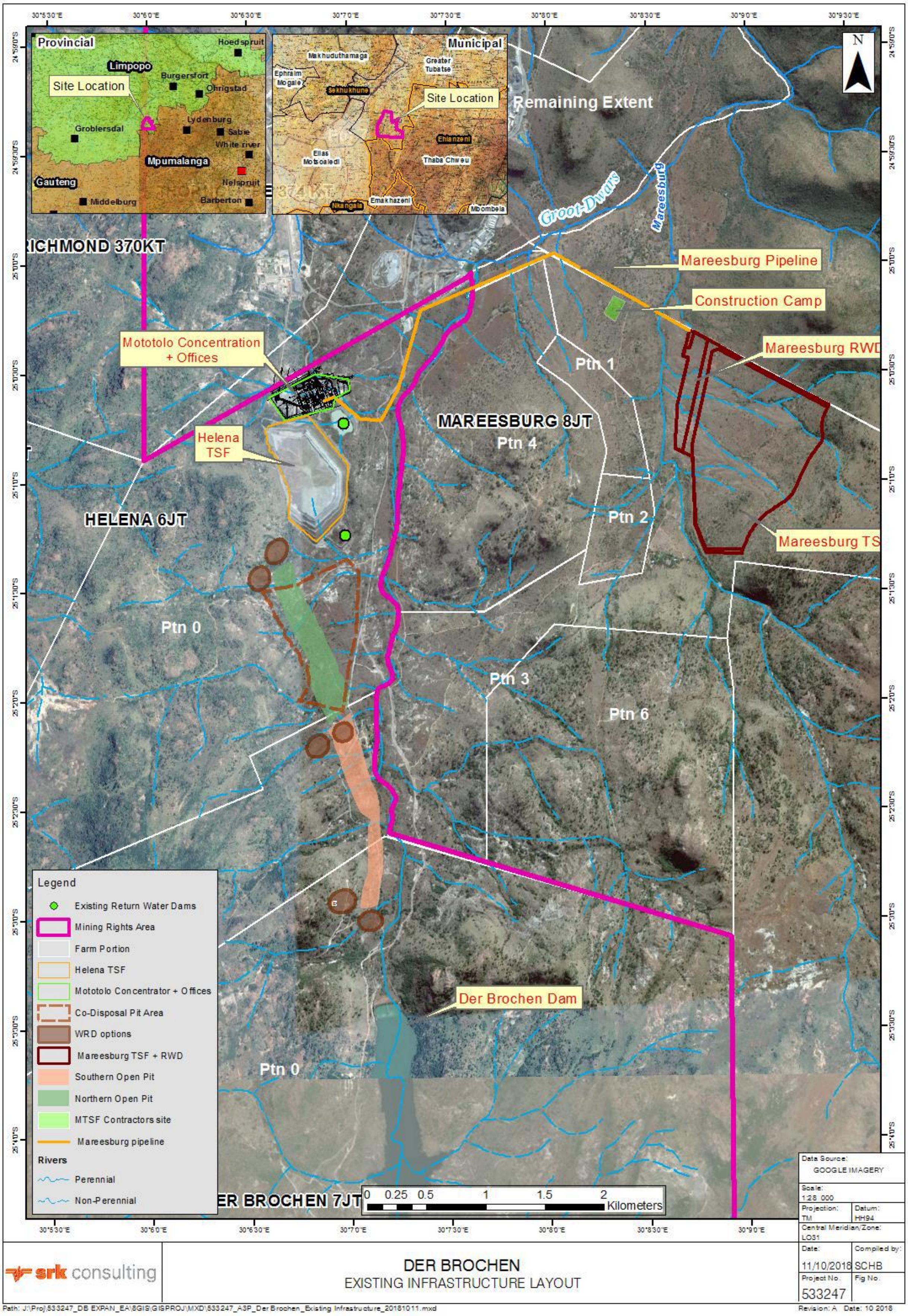



**Figure 1-1: Regional location and approved activities of the Der Brochen mine**

The following proposed activities will form part of the Der Brochen Mine's approved EMPr and associated Environmental Authorisation (EA):

- One decline shaft (South Shaft) to access the proposed underground bord-and-pillar mining;
- Three up-cast ventilation shafts for the South shaft will be constructed in the vicinity of the south decline shaft (3 upcast shafts);
- A Dense Medium Seperation (DMS) plant, additional Chrome Plant and Crusher will be located on the eastern side of the within the footprint of the existing Mototolo Concentrator plant (MCP);
- A Run of Mine (RoM) stockpile and silos will be located in the vicinity of the MCP;
- A DMS stockpile, and associated pollution control dam (PCD) will be developed in the vicinity of the proposed DMS;
- The linear infra-structure will consist out of:

C. Conveyor systems
  - DMS plant to DMS stockpile conveyor;
  - DMS feed conveyor;
  - Southern decline shaft to Mototolo Concentrator plant;
  - ROM overflow stockpile conveyor; and,
  - Concentrator primary crusher feed conveyor.

D. Access and haul roads
  - Ventilation (3) access roads;
  - Der Brochen access road; and,
  - South complex access road.

The proposed lay-out and infra-structure is illustrated in Figure 1. 2.

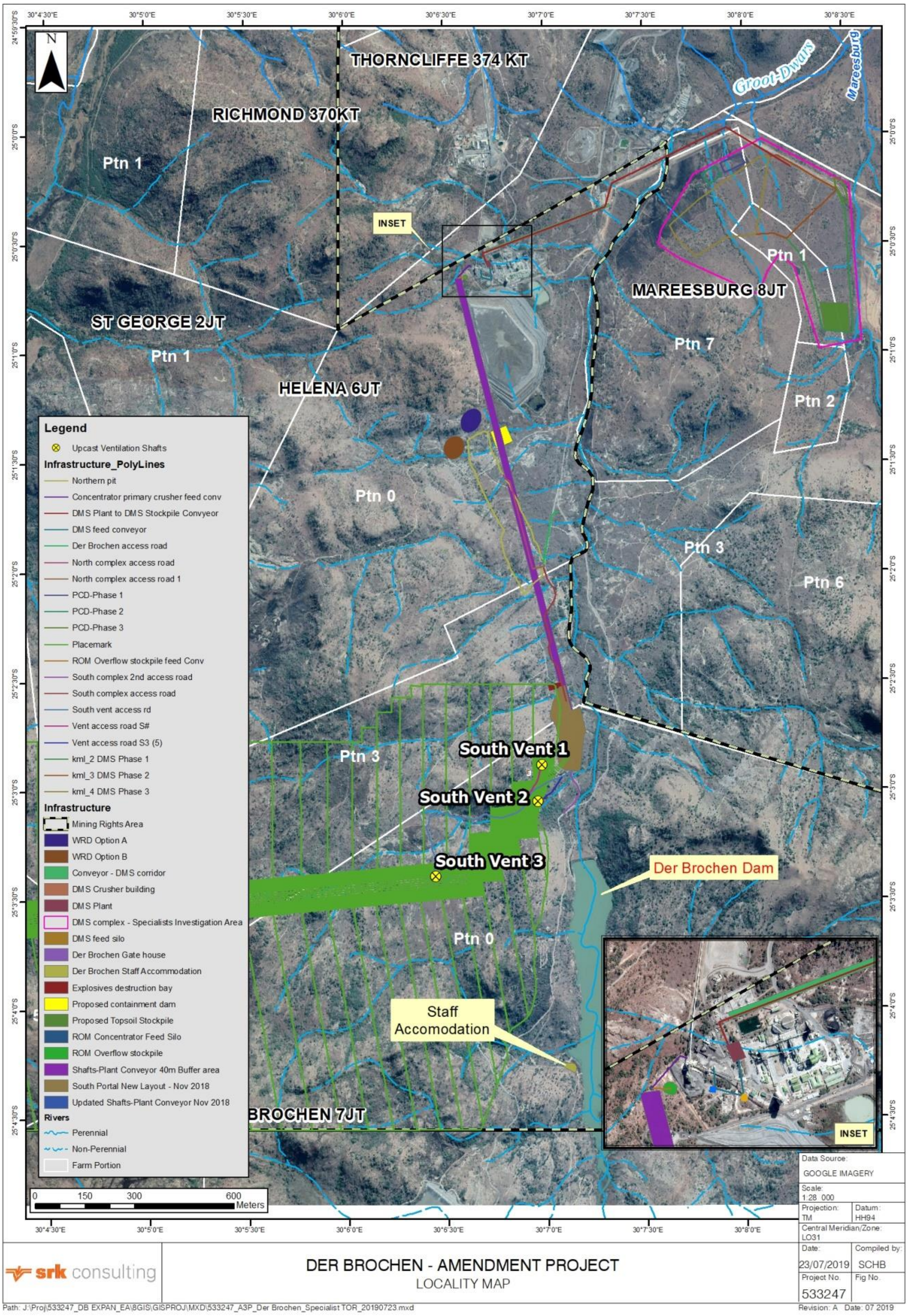



**Figure 1.2: Proposed lay-out and infra-structure**

The landscape of the region is mountainous traversed by deep river valleys in the vicinity of the decline shafts, Mototolo concentrator and the DMS waste rock. The Steenkampsberge lies to the east, south and west of the Der Brochen mine. The valley areas are approximately 1 052 metres above mean sea level (mamsl) and the Steenkampsberg 2 024 mamsl (BS4). The impacts anticipated from the proposed Der Brochen amendment project will be an increase in the prevailing ambient noise levels and ground vibration levels during the construction, operational and decommissioning phases of the project on a temporary and permanent basis.

The baseline noise and vibration survey was carried out during the summer time (30 January 2019 and 31 January 2019).

The purpose of the environmental noise and vibration study was to determine the environmental baseline noise levels and vibration levels at the proposed mine expansion study areas. The noise baseline information will be used to calculate the possible noise intrusion levels from the mine activities at the noise receptors to the east, west and south of the Groot Dwarsriver Valley.

The distances between the noise sources and the receptors, topography, vegetation, noise level at the noise source and the wind direction are all variables that may have an impact on how the sound will be propagated to and perceived by the noise receptor/s. The receptors are all situated on the plateau to the eastern and southern sides and behind mountains to the west and south of the proposed mining activities in the valley. The distances between the different linear and/or point sources and topography will be dealt with later on in the report.

The general objectives of the specialist study were to gain a detailed understanding of the baseline noise and vibration environment in the valley where the mine establishment will take place as well as at the abutting NSAs which are situated and along the plateau.

## 1.2 Project Description

Rustenburg Platinum identified an opportunity to expand its operations and increase production to meet the projected short to medium term platinum market demands. Having acquired the mining rights for the full extent of the project area earmarked for the expansion, mining expansion it was decided to change the mining method from open cast mining to underground mining with access to the underground mining through the southern decline shafts. Bord-and-pillar method will be used to remove the waste rock and ore from the underground mining areas. Such will be conveyed overland to the waste rock dumps and to the Mototolo concentrator plant respectively. This total expansion project is known as the Der Brochen Expansion project.

### 1.2.1 Der Brochen expansion areas

The Der Brochen expansion proposed development areas are given in Figure 1.3. This includes the upgrade of the Mototolo concentrator, overland conveyor system, existing TSF, access roads, Southern ventilation shaft footprint, vent shaft positions and the Der Brochen mining right boundary.

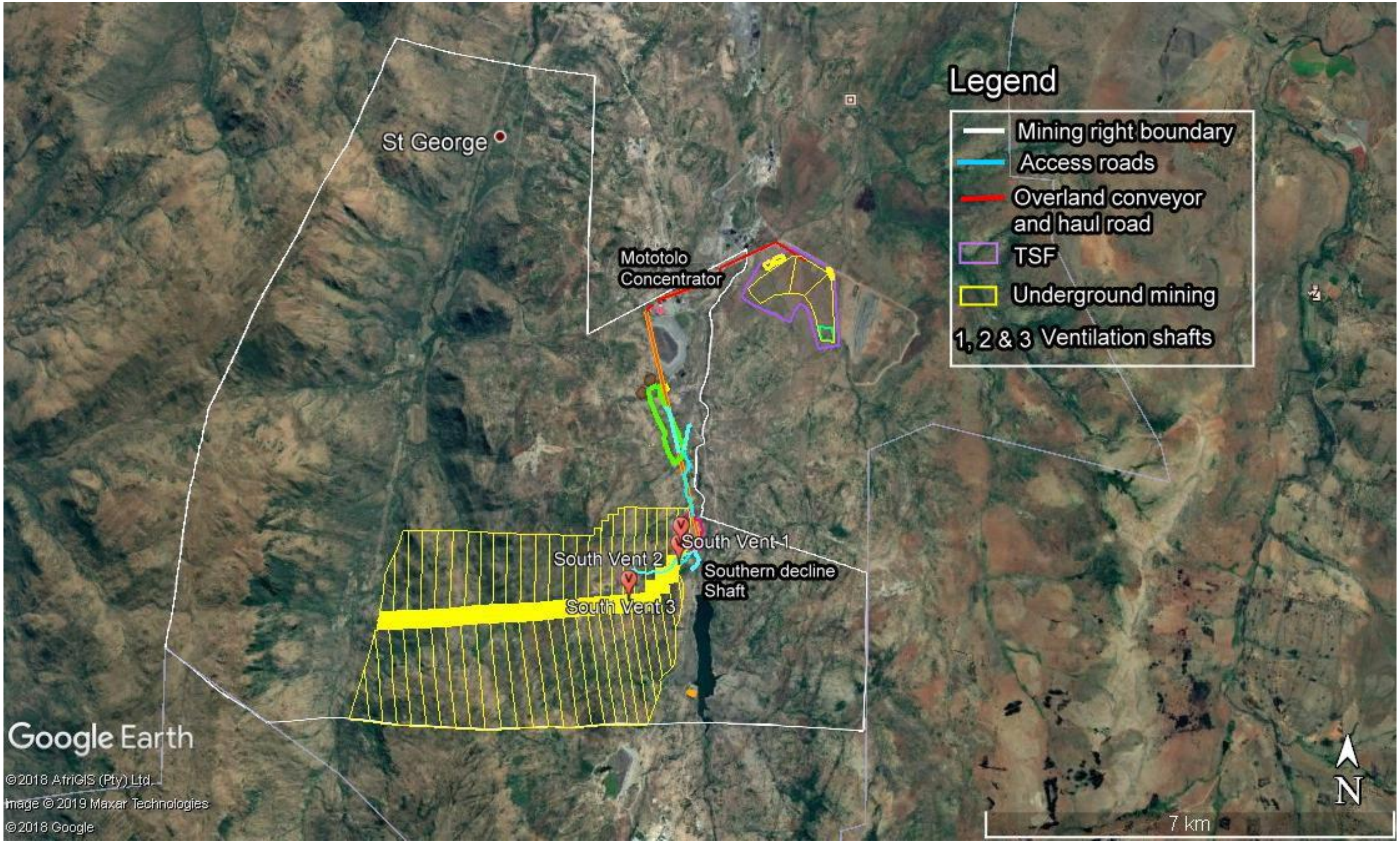



**Figure 1-3: Der Brochen expansion lay-out**

### 1.2.2 Mototolo concentrator plant upgrade

A new DMS, Conveyor system, crushers, silo and ROM pad will be provided within the footprint boundaries of the Mototolo concentrator plant. This is illustrated in Figure 1.4.

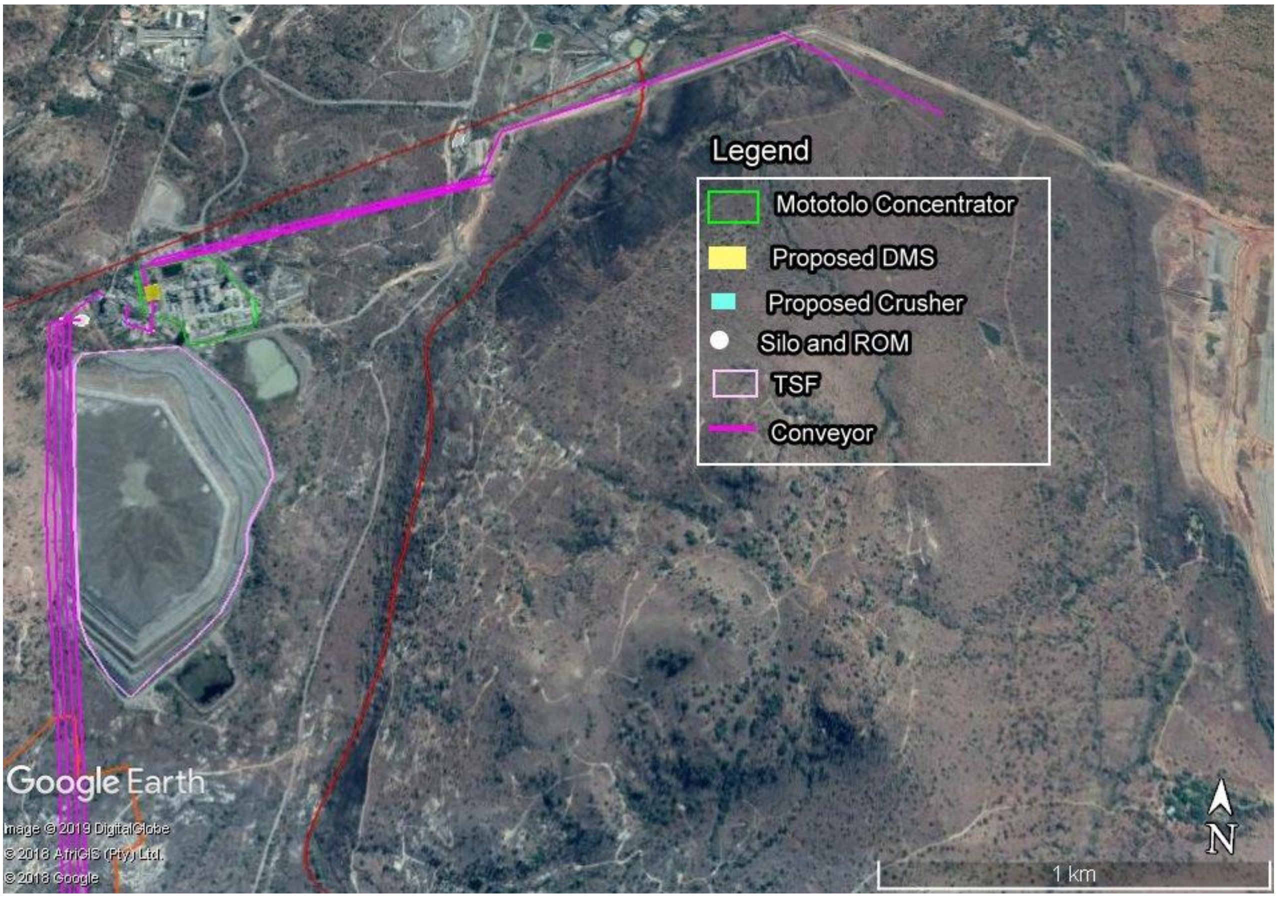



**Figure 1-4: Mototolo concentrator plant expansion**

### 1.2.3 Ventilation shafts and decline shafts

The southern decline shafts with upcast and down cast ventilation shafts and access roads are illustrated in Figure 1.5.

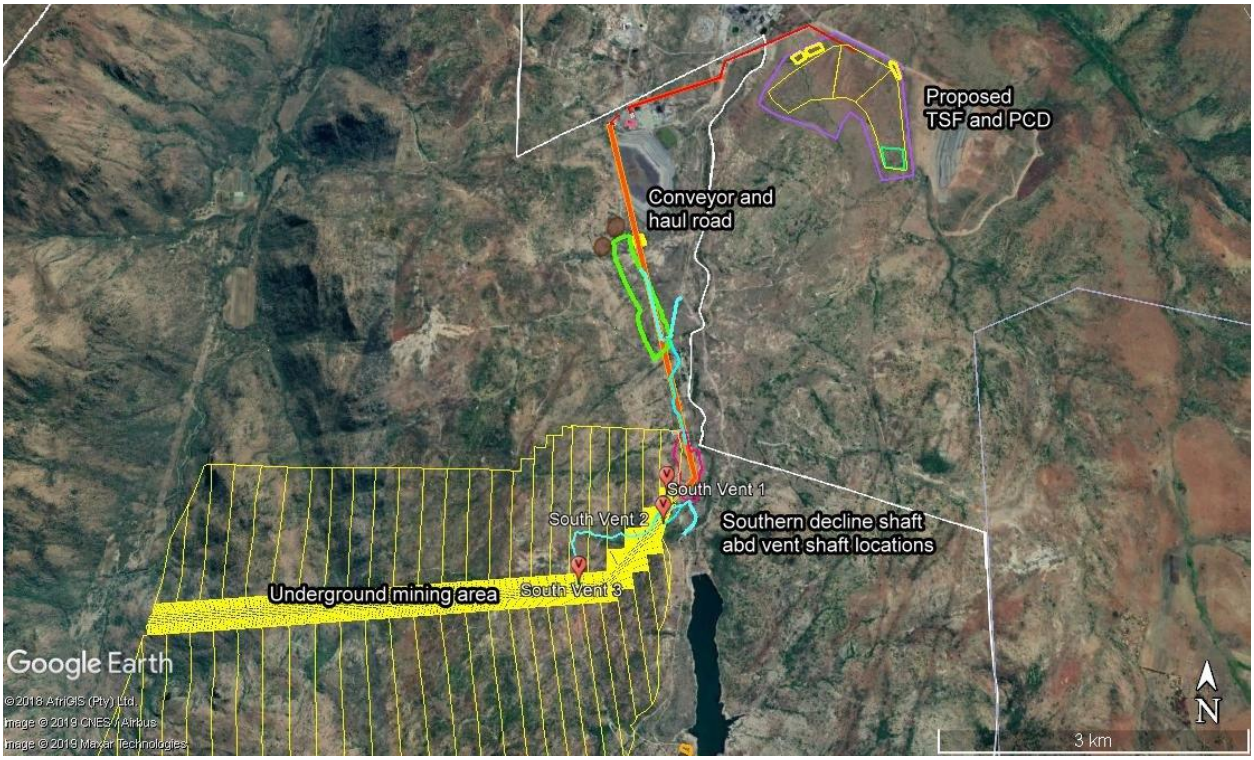



**Figure 1-5: Location of the decline shafts, ventilation shafts**

## 1.3 The purpose of the noise and vibration study

The field survey was done to determine the environmental baseline noise levels and vibration levels at the different expansion areas of the Der Brochen project.

The noise baseline information will be used to calculate the possible noise intrusion levels from the proposed mine activities and infra-structure at the noise receptors to the east, west and south of the Groot Dwarsriver Valley. The distances between the noise sources and the receptors, topography, vegetation, noise level at the noise source and the wind direction are all variables that may have an impact on how the sound will be propagated to the noise receptor/s. The receptors are all situated on the plateau whereas the activities will take place in the valley or the slope of the valley. The distances between the different linear and/or point sources will be given later on in the report. This will be direct line of site and the topography is of such that some of the activities will not be in sight from the residential areas.

## 1.4 Assumptions and Limitations

The following limitations forms part of the environmental noise measurements:

- The prevailing ambient noise levels for the study area was created by far and near noise sources associated with traffic, mining activities and seasonal agricultural activities with the result that the prevailing ambient noise level may change at times;
- The noise from the ventilation shafts were based on upcast ventilation shafts;
- The underground blasting calculations was based on 75kg explosives per delay;

- Noise measurements in the presence of winds in excess of 3.0m/s may impact the outcome of the environmental noise results;
- The identification of noise measuring points may create a problem in terms of the prevailing noise levels should it not be done with outmost care and in a scientific manner;
- The influx of traffic into an area will have an influence on the prevailing ambient noise levels and should be considered during the noise impact assessment process

There will be a difference in the prevailing ambient noise levels between the summer and winter periods as the insect activities such as crickets and cicadas raise the prevailing ambient noise levels during the summer period whereas the prevailing ambient noise levels will not be influenced by insects during the winter period. The distances and topography between the proposed mining establishment activities and the residential areas will play a role in the noise propagation and how the sound from the proposed mining establishment will be perceived.

## 1.5 Zone of influence

The possible noise and air vibration increase from the proposed mining activities will be determined at the abutting residential areas east and west of the project area as illustrated in Figure 5.1 (P39). This area will be the zone of influence (ZOI).

## 1.6 Mountains in the vicinity of the study area

The study area within the Groot Dwarsriver Valley is encompassed with mountains and a plateau which according to previous studies at mines in the valley will result in the noise from the Der Brochen mine carried along the valley (anabatic and katabatic airflow), but at the same time the hills will act as noise barriers that significantly attenuate the noise in certain directions from the source (JKA, 2010 & Acusolv, 2011). The mountains to the north, east, plateau and west are illustrated in Figure 1.6.

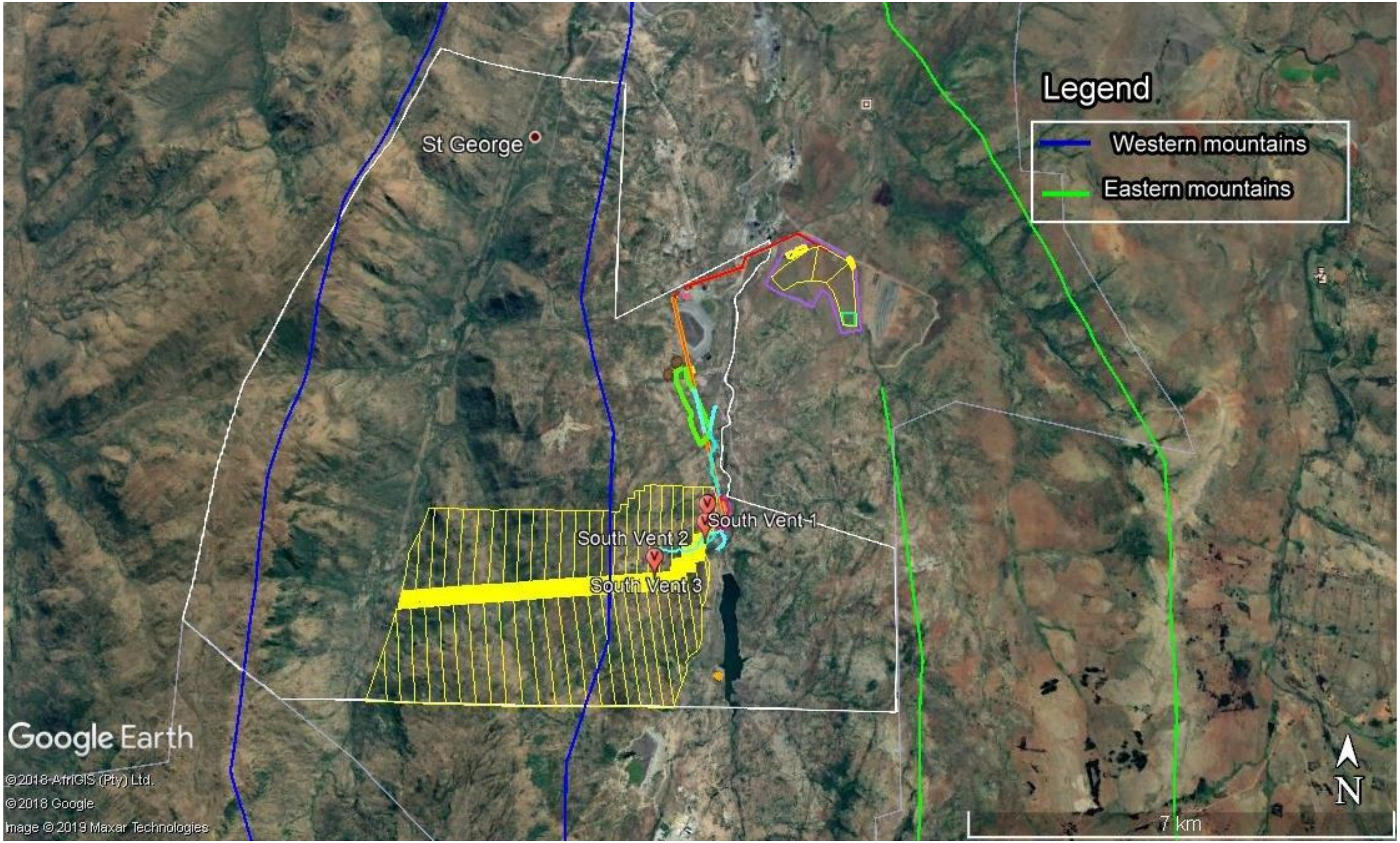



**Figure 1-6: Mountains in the vicinity of the min**

## 2. Background to environmental noise and vibration

### 2.1 Environmental noise

Sound is a wave motion, which occurs when a sound source sets the nearest particles of air in motion. The movement gradually spreads to air particles further away from the source. Sound propagates in air with a speed of approximately 340 m/s. The sound pressure level in free field conditions is inversely proportional to the square of the distance from the sound source – inverse square law. Expressed logarithmically as decibels, this means the sound level decreases 6.0dB with the doubling of distance. This applies to a point source only. If the sound is uniform and linear then the decrease is only 3.0dB per doubling of distance. The decibel scale is logarithmic, therefore decibel levels cannot be added in the normal arithmetic way, for example, two sound sources of 50.0dB each do not produce 100.0dB but 53.0dB, nor does 50.0dB and 30.0dB equal 80.0dB, but remains 50.0dB. Air absorption is important over large distances at high frequencies and it depends on the humidity but is typically about 40.0dB/km @ 4000 Hz. Traffic noise frequencies are mainly mid/low and will be unaffected below 200m.

When measuring the intensity of a sound, an instrument, which duplicates the ear variable sensitivity to sound of different frequency, is usually used. This is achieved by building a filter into the instrument with a similar frequency response to that of the ear. This is called an A-weighting filter because it conforms to the internationally standardized A-weighting curves. Measurements of sound level made with this filter are called A-weighted sound level measurements, and the unit is dB.

Sound propagation is affected by wind gradient rather than the wind itself. The profile of the ground causes such a gradient. The sound may be propagated during upwind conditions upwards to create a sound shadow. A downwind refracts the sound towards the ground producing a slight increase in sound level over calm isothermal conditions. The velocity of sound is inversely proportional to the temperature therefore a temperature gradient produces a velocity gradient and a refraction of the sound. Temperature decreases with height and the sound is refracted upwards.

For a source and receiver close to the ground quite large attenuation can be obtained at certain frequencies over absorbing surfaces, noticeably grassland. This attenuation is caused by a change in phase when the reflected wave strikes the absorbing ground and the destructive interference of that wave with the direct wave. The reduction in sound tends to be concentrated between 250 Hz and 600 Hz.

Noise screening can be effective when there is a barrier between the receiver and the source i.e. walls, earth mounds, cuttings and buildings. The performance of barriers is frequency dependent. To avoid sound transmission through a barrier the superficial mass should be greater than 10 $Kg/m^2$.

There is a complex relation between subjective loudness and the sound pressure level and again between annoyance due to noise and the sound pressure level. In general the ear is less sensitive at low frequencies and the ear will only detect a difference in the sound pressure level when the ambient noise level is exceeded by 3.0-5.0dBA.

There are certain effects produced by sound which, if it is not controlled by approved acoustic mitigatory measures, seem to be construed as undesirable by most people and they are:

- Long exposure to high levels of sound, which may damage the hearing or create a temporary threshold shift – in industry or at areas where music is played louder than 95.0dBA. This will seldom happen in far-field conditions;
- Interference with speech where important information by the receiver cannot be analysed due to loud noises;
- Excessive loudness; and
- Annoyance.

A number of factors, for example clarity of speech, age of listener and the presence of noise induced threshold displacement, will influence the comprehensibility of speech communication.

The effect of noise (with the exception of long duration, high level noise) on humans is limited to disturbance and/or annoyance and the accompanying emotional reaction. This reaction is very difficult to predict and is influenced by the emotional state of the complainant, his attitude towards the noise maker, the time of day or night and the day of the week.

Types of noise exposure:

- Continuous exposure to noise – The level is constant and does not vary with time e.g. traffic on freeway and an extractor fan;
- Intermittent exposure to noise – The noise level is not constant and occurs at times e.g. car alarms and sirens;
- Exposure to impact noise – A sharp burst of sound at intermittent intervals e.g. Explosions and low frequency sound.

Noise affects humans differently and the new noise which will be coming from the mine expansionist and the associated activities will depend upon the intensity of the sound, the length of time of exposure and how often over time the ear is exposed to it. Urban dwellers are besieged by noise, not only in the city streets but also in the busy workplaces and household noises.

The time-varying characteristics of environmental noise are described using statistical noise descriptors:

- Leq: The Leq is the constant sound level that would contain the same acoustic energy as the varying sound level, during the same period of time.
- $L_{Max}$: The instantaneous maximum noise level for a specified period of time.
- $L_{Min}$: The instantaneous minimum noise level for a specified period of time.

The following relationships occur for increases in A-weighted noise levels:

- The trained healthy human ear is able to discern changes in sound levels of 1.0dBA under controlled conditions in an acoustic laboratory;
- It is widely accepted that the average healthy ear can barely perceive noise level changes of 3.0dBA;
- A change in sound level of 5.0dBA is a readily perceptible increase in noise level; and
- A 10.0dBA change in the sound level is perceived as twice as loud as the original source.

The World Bank in the Environmental Health and Safety Guidelines has laid down the following noise level guidelines:

- Residential area – 55.0dBA for the daytime and 45.0dBA for the night-time period; and
- Industrial area – 70.0dBA for the day- and night-time periods.

The difference between the actual noise and the ambient noise level and the time of the day and the duration of the activity, will determine how people will respond to sound and what the noise impact will be. In order to evaluate such, there must be uniform guidelines to evaluate each scenario. SANS 10103 of 2008 has laid down sound pressure levels for specific districts and has provided the following continuous noise levels per district as given in Table 2.1.

**Table 2-1: Recommended noise levels for different districts**

| Type of district | Equivalent continuous rating level ($L_{Req.T}$) for ambient noise - dBA | | | | | |
|---|---|---|---|---|---|---|
| | Outdoors | | | Indoors, with open windows | | |
| | Day-night $L_{Rdn}$ | Daytime $L_{Reqd}$ | Night-time $L_{Reqn}$ | Day-night $L_{R.dn}$ | Daytime $L_{Req.d}$ | Night-time $L_{Req.n}$ |
| 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 |
| d) Urban districts with some workshops, with business premises and with main roads | 60 | 60 | 50 | 50 | 50 | 40 |
| e) Central business district | 65 | 65 | 55 | 55 | 55 | 45 |
| f) Industrial districts | 70 | 70 | 60 | 60 | 60 | 50 |

*For industrial districts, the $L_{R.dn}$ concept does not necessarily hold. For industries legitimately operating in an industrial district during the entire 24h day/night cycle, $L_{Req.d} = L_{Req.n}$ = 70dBA can be considered as typical and normal.*

The response to noise can be classified as follows:

- An increase of 1.0dBA to 3.0dBA above the ambient noise level will cause no response from the affected community. For a person with normal hearing an increase of 0.0dBA to 3.0dBA will not be noticeable.
- An increase between 1.0dBA to 10.0dBA will elicit little to sporadic response. When the difference is more than 5.0dBA above the ambient noise level a person with normal hearing will start to hear a difference.
- An increase between 5.0dBA to 15.0dBA will elicit medium response from the affected community.
- An increase between 10.0dBA to 20.0dBA will elicit strong community reaction.

Because there is no clear-cut transition from one community response to another as well as several variables, categories of responses can overlap. This should be taken into consideration during the evaluation of a potential noise problem. There is therefore a mixture of activities and higher noise levels as per the above recommended continuous rating levels within i.e. residential, industrial and feeder roads in close proximity of each other. The ambient noise level will therefore differ throughout the study area, depending on the region and the measuring position in relation to areas with existing mining activities. People exposed to an increase in the prevailing ambient noise level will react differently to the noise levels and the response is given in Table 2.2.

**Table 2-2: Estimated community/group response when the ambient noise level is exceeded**

| Excess | Estimated community/group response | |
|---|---|---|
| dB | Category | Description |
| 0 | None | No observed reaction |
| 0-10 | Little | Sporadic complaints |
| 5-15 | Medium | Widespread complaints |
| 10-20 | Strong | Threats of community/group action |
| >15 | Very strong | Vigorous community/group action |

### 2.2 Ground vibration

There was no ground vibration and/or over-air pressure levels measured as there was no blasting at the proposed sites during the time of the survey. Human reaction to vibration will be in response to the resulting effects of both ground and airborne vibration and in particular the combined effects of such vibration. The blasting process is the biggest contributor to vibration. Heavy-duty vehicles and/or machinery can furthermore create ground vibration depending on the distance and ground type between the activity and the receptor.

Wavelength differences associated with this frequency range mean that any effects of topography are likely to be pronounced for the audible component of air over pressure levels rather than the concussive component. A topographic barrier i.e. an earth berm or rock face will play an important role in reducing the audible effect (over-air pressure levels) rather than the concussive effect. The shock waves have a relatively high dominant frequency and the energy contained in the shock wave will reduce rapidly as the resultant energy will be subjected to geometric and natural attenuation.

#### 2.2.1 Drilling and Blasting

Upon firing an explosive charge in a blast hole, a compression wave travels through the rocks face. Rocks such as sandstone, shale, limestone, dolomite, and granite are generally strong in compression and little damage is inflicted by the compression wave. However, upon arrival at the free face, the compression wave is reflected back as a tensile wave. The tensile wave initiates cracks and fractures because most of the rocks are weak in tension. The gases from the detonation products enter into the tensile-fractured spaces and resume their expansion work causing propagation of cracks. Gas pressurization then causes the fragmented rock mass to burst out from the bench. If there is excessive local gas pressurization, fly rock could be generated.

The following factors also need to be considered when designing a blast:

- length of the charge - fly rock range is reduced for short charges only when the length of the charge is less than eight times the diameter of the hole
- if using bulk blasting explosives, risk increases when stemming lengths are less than 25 times the diameter of the blast hole

- Risk increases when drilling and blasting in broken or weakened rock, particularly if one blast is badly loaded. Shot firers should consult with the driller or examine drill logs before loading shots.

## Blast design

The blast design chart suggested in Rock Slope Engineering by Wyllie and Mah, 2004 will be used to quantify damage potential to residential properties. It is generally accepted that residential buildings of sound construction can safely withstand peak particle velocity (PPV) in m/s of 25mm/s. Poorly constructed buildings should however not be subjected to PPV's of more than 10mm/s.  Figure 2.1 illustrates the typical vibration control diagram where the charge per delay is combined with the distance from the blast to indicate the safe and damage zones and when damage to structures can be expected.

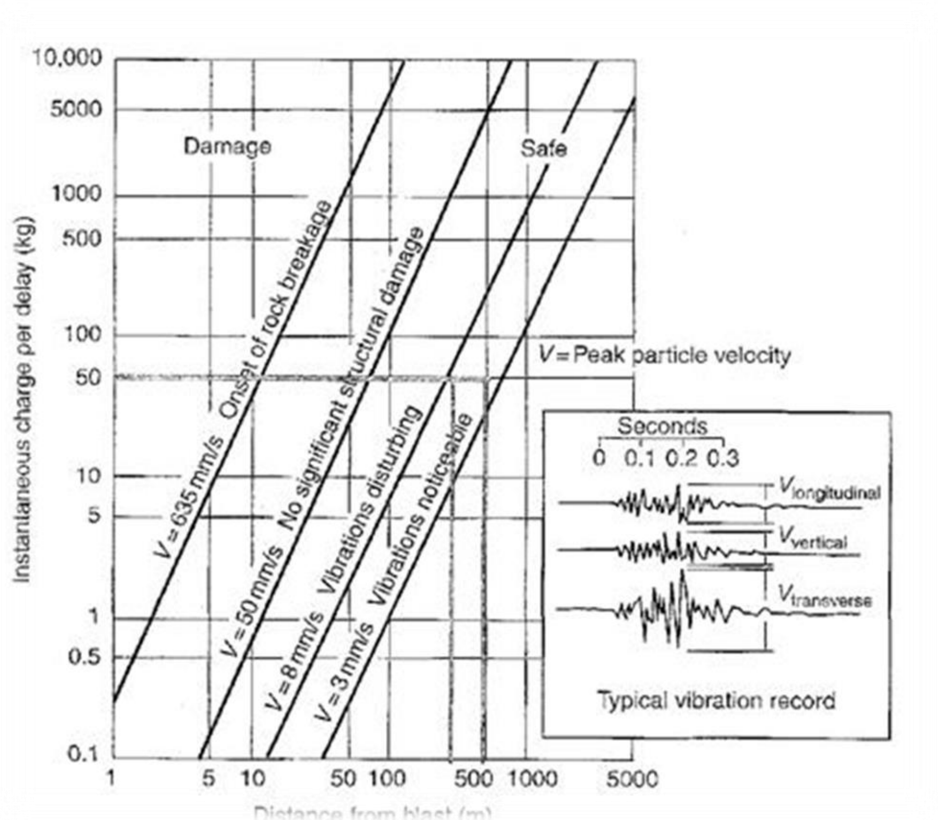



Figure 2-1: Blast design chart

In general, individual blasts should not exceed 25mm/s in the vicinity of properly constructed buildings and the average level should not exceed 10mm/s in the vicinity of poorly constructed buildings.

# 3. Study methodology

## 3.1 Instrumentation

The noise survey was conducted in terms of the provisions of the Noise Control Regulations, 1994 and the SANS 10103 of 2008 (The measurement and rating of environmental noise with respect to annoyance and to speech communication) using a digital Larson Davis 831 – Class 1 meter with Logging, Environmental 1/1, 1/3 Octave Band and percentiles Sound Level Meter (Class 1). On taking measurements the device-meter scale was set to the "A" weighed measurement scale which enables the device to respond in the same manner as the human ear. The device was held approximately 1.5 m above the surface and at least 3.0m away from hard reflecting surfaces. A suitable wind shield was used on the microphone for all measurements in order to minimise wind interference. The Instrument was checked and calibrated prior to use and maintained in accordance with equipment and coincided below 1.0dBA.The following instruments were used in the noise survey:

- Larsen Davis Integrated Sound Level meter Type 1 – Serial no. S/N 0001072;
- Larsen Davis Pre-amplifier – Serial no.PRM831 0206;
- Larsen Davis ½" free field microphone – Serial no. 377 B02 SN 102184;
- Larsen Davis Calibrator 200 – Serial no.9855;
- Certificate Number: 2018-AS-0912;
- Date of Calibration: 15 August 2018; and,
- Date of next calibration August 2019.

The instrument was calibrated before and after the measurements was done and coincided within 1.0dBA. Batteries were fully charged and the windshield was in place at all times.

The noise survey was carried out in terms of the Noise Control Regulations being:

"16 (1) Any person taking readings shall ensure that -

(a) sound measuring instruments comply with the requirements for type I instrument in accordance with SABS-IEC 60651, SABS-IEC 60804 and SABS-I EC 60942 as the case may be;

(b) the acoustic sensitivity of sound level meters is checked before and after every series of measurements by using a sound calibrator, and shall reject the results if the before and after calibration values differ by more than 1 dBA;

(c) the microphones of sound measuring instruments are at all times provided with a windshield;

(d) the sound measuring instruments are operated strictly in accordance with the manufacturer's instructions; and,

(e) sound measuring instruments are verified annually by a calibration laboratory for compliance with the specifications for accuracy of national codes of practice for acoustics, to comply with the Measuring Units and National Measuring Standards Act 1973 (Act No. 76 of 1973).

(2) The measuring of dBA values in respect of controlled areas, ambient sound levels or noise levels in terms of these regulations shall be done as follows:

(a) outdoor measurements on a piece of land: By placing the microphone of an integrating impulse sound level meter at least 1,2 metres, but not more than 1,4 metres, above the ground and at least 3,5 metres away from walls, buildings or other sound reflecting surfaces".

The calibration certificates are attached as Appendix A. The measured ambient noise level during the daytime and night time periods will be the baseline ambient noise criteria for the study area and will be evaluated in terms of SANS 10103 of 2008.

## 3.2 Measuring points

The measuring points for the study area were selected to be representative of the prevailing ambient noise levels for the study area and include all the noise sources such as distant traffic noise, agricultural activities but exclude traffic noise which was intermittent in the vicinity of the measuring points. The measuring points are illustrated in Figure 3.1.

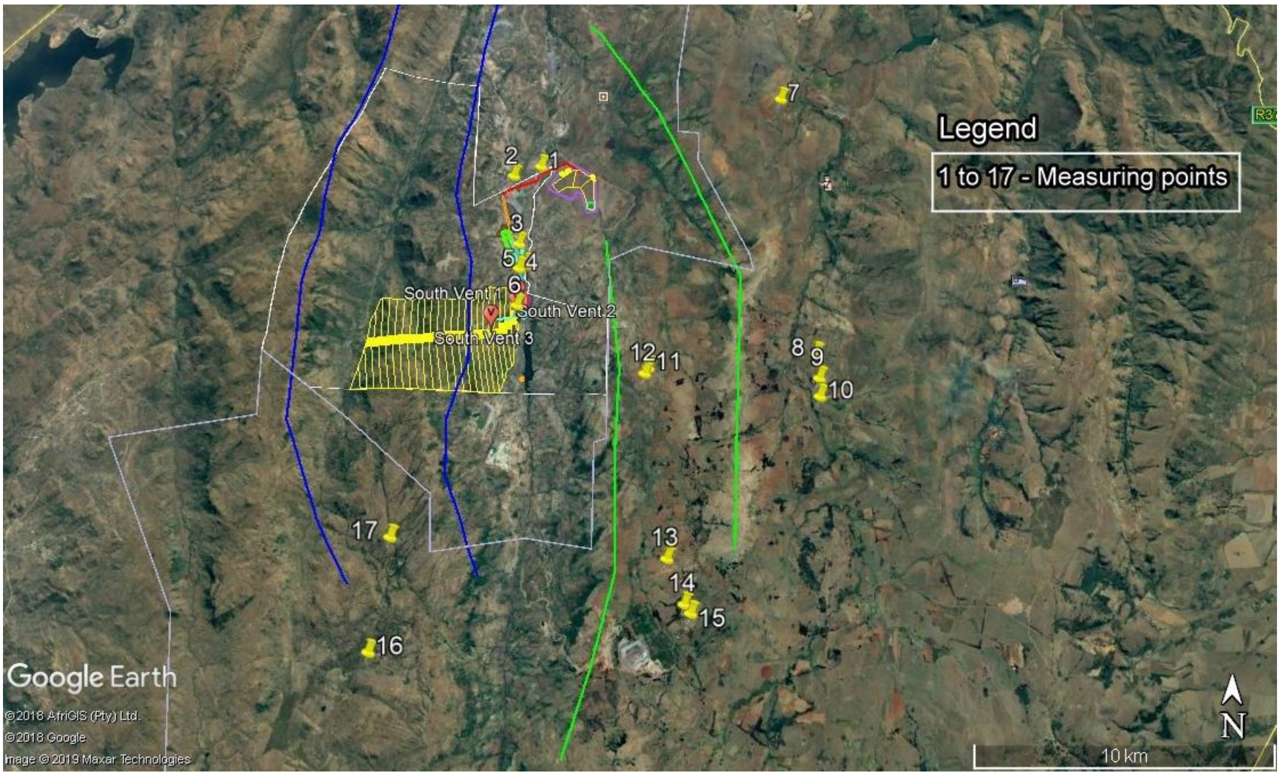



**Figure 3-1: Measuring points for the study area**

The measuring points along the boundaries of the study area and the physical attributes of each measuring point are illustrated in Table 3.1.

**Table 3-1: Measuring points and co-ordinates for the study area**

| Position | Latitude | Longitude | Remarks |
|---|---|---|---|
| **1** | $25^0$ 0.272' S | $030^0$ 07.319' E | At the combined mine entrance to Der Brochen and Booysensdal mines. |
| **2** | $25^0$ 5.708' S | $030^0$ 06.856' E | Boundary of the Mototolo concentrator plant. |
| **3** | $25^0$ 5.708' S | $030^0$ 06.856' E | Along the access road and proposed overland conveyor. |
| **4** | $25^0$ 5.708' S | $030^0$ 06.856' E | At the proposed mechanical ventilation central plant. |
| **5** | $25^0$ 5.708' S | $030^0$ 06.856' E | At the existing Der Brochen offices. |
| **6** | $25^0$ 5.708' S | $030^0$ 06.856' E | Access road to the south-west of the southern decline shaft. |
| **7** | $25^0$ 5.708' S | $030^0$ 06.856' E | Residential property east of the mining area. |
| **8** | $25^0$ 5.708' S | $030^0$ 06.856' E | Residential area east of the Lydenburg road and east of the mining area. |
| **9** | $25^0$ 5.708' S | $030^0$ 06.856' E | Residential area east of the Lydenburg road and east of the mining area. |
| **10** | $25^0$ 5.708' S | $030^0$ 06.856' E | Residential area east of the Lydenburg road and east of the mining area. |
| **11** | $25^0$ 5.708' S | $030^0$ 06.856' E | Residential properties east of the mining area. |

| | | | |
|---|---|---|---|
| **12** | $25^0$ 5.708' S | $030^0$ 06.856' E | Residential properties east of the mining area. |
| **13** | $25^0$ 5.708' S | $030^0$ 06.856' E | Residential properties south of the mining area and east of Booysensdal south mine. |
| **14** | $25^0$ 5.708' S | $030^0$ 06.856' E | Residential properties south of the mining area and east of Booysensdal south mine. |
| **15** | $25^0$ 5.708' S | $030^0$ 06.856' E | Residential properties south of the mining area and east of Booysensdal south mine. |
| **16** | $25^0$ 5.708' S | $030^0$ 06.856' E | Residential properties south-west of the mining area and west of Booysensdal south mine. |
| **17** | $25^0$ 5.708' S | $030^0$ 06.856' E | Residential properties south-west of the mining area and west of Booysensdal south mine. |

The following is of relevance to the ambient noise measurements:

- The $L_{Aeq}$ was measured over a representative sampling period exceeding 10 minutes at each measuring point; and
- The noise survey was carried out during the day and night-time period being 06h00 to 22h00 for the day time and 22h00 to 06h00 for the night time period

## 3.3 Site Characteristics

The following observations were made in and around the study area:

- The proposed Der Brochen mine expansion will take place in an area where there are other mining activities;
- There was a constant to intermittent flow of traffic along the tarred feeder road to the Booysensdal mine complex;
- There was an intermittent flow of traffic amongst the villages to the west of the mining area;
- Mining activity noise (Everest mine) was audible at MPs 13, 14 and 15;
- Traffic noise contributes to the higher prevailing ambient noise level at MPs 7, 8, 9 and 10;
- There was a continuous (daytime) to intermittent (night time) flow of traffic (motor-vehicles and hauling vehicles) along the Lydenburg road;
- The wind and weather conditions play an important role in noise propagation;
- Distant traffic noise contributes to a large portion of the prevailing ambient noise levels;
- The prevailing noise levels in and around the NSA M to P is typical of the noise levels expected within the vicinity of a road and farming activities; and
- There was no underground blasting during the time of the noise survey.

## 3.4 Current noise sources

The following are noise sources in the vicinity of and the boundaries of the study area:

- Booysensdal mining activities noise;
- Traffic noise along the feeder road to the Booysensdal mine complex;
- Distant traffic noise from the abutting feeder roads;
- Traffic noise from the Lydenburg road;
- Other mining activity noise in the valley;
- Farming activities noise;
- Insects;
- Birds; and
- Wind noise.

## 3.5 Atmospheric conditions during the noise survey

The noise readings were carried out at the different measuring points and the prevailing atmospheric conditions i.e. wind speed, wind direction and temperature were taken into consideration. The readings were done away from any large vertical structures, which may influence the outcome of the readings.
The following meteorological conditions were recorded:

30 January 2019
Daytime

- Wind speed – less than 2.6m/s;
- Temperature – 30.5$^{o}$C – No strong temperature gradient occurred near the ground;
- Cloud cover – High cloud cover;
- Wind direction – The wind was blowing from a north-westerly direction; and
- Humidity – 30 % humidity.

Night time

- Wind speed – less than 2.5m/s;
- Temperature – 19.5$^{o}$C ;
- Cloud cover – No cloud cover;
- Wind direction – The wind was blowing from a south-easterly direction; and

- Humidity – 30 % humidity.

31 January 2019

Daytime

- Wind speed – less than 1.0m/s;
- Temperature – 16.5ºC – No strong temperature gradient occurred near the ground;
- Cloud cover – High cloud cover;
- Wind direction – The wind was blowing from a south-westerly direction; and
- Humidity – No humidity recorded.

## 4. Regulatory and Legislative Requirements

There are specific regulatory and legislative requirements which regulate the proposed development in terms of environmental noise and vibration. The legislative documents are as follows:

### 4.1 Department of Environment Affairs: Noise Control Regulations promulgated under the Environment Conservation Act, (Act No. 73 of 1989), Government Gazette No. 15423, 14 January 1994.

These noise control regulations are applicable in the study area and the main aspect of these noise control regulations is that you may exceed the prevailing ambient noise levels by 7.0dBA before a noise disturbance is created.

### 4.2 South African National Standards – SANS 10103 of 2008

The South African National Standards provide the guidelines for the different recommended prevailing ambient noise levels and how to evaluate when a specific operation or activity is creating a noise disturbance and what reaction can be expected if a noise disturbance is created.

### 4.3 South African National Standards – SANS 10210 of 2004

This national standard is used when calculating or predicting increased road traffic noise during new developments.

### 4.4 General Environmental, Health and Safety Guidelines of the IFC of the World Bank

The recommended noise level for a noise sensitive area is 55.0dBA during the day and 45.0dBA during the night.

4.5 United States Bureau of Mines – USBM (1980). Structure response and damage produced by ground vibration from surface mine blasting.

The recommended ground vibration levels should not exceed 10,0m/s for clay huts and 25.0mm/s for properly constructed buildings.

4.6 United States Bureau of Mines – USBM (1980). Structure response and damage produced by air blast from surface mining.

The recommended air-over pressure levels should not exceed 120.0dBL and 140.0dBL at the blasting area.

The Constitution of the Republic of South Africa Act, (Act No 108 of 1996) makes provision for the health and well-being of the citizens and to prevent pollution and to promote conservation.

According to Article 24 of the Act, everyone has the right to:

*(a)* an environment that is not harmful to their health and well-being; and

(b) have the environment protected for the present and future generations through reasonable legislative and other measures:

- (i) prevent pollution and ecological degradation;
- (ii) promote conservation; and
- (iii) secure ecological sustainable development and use of natural resources, while promoting justifiable economic and social development.

It is widely recognized that many aspects of mining operations may lead to an increase in the environmental ambient noise levels. The impact of such an increase in the prevailing noise levels can be both physical and physiological. Many aspects of mining operations lead to an increase in noise levels and/or ground vibration levels over the prevailing ambient levels (Garvin *et al*., 2009).

## 5. Description of the receiving environment

Existing mining activities, traffic, seasonal agricultural activities, domestic activities contributes to the prevailing ambient noise level depending on the distance the residential area is to the proposed mining activities. The prevailing ambient noise levels were created by seasonal farming activity noise, intermittent traffic noise along the gravel roads, traffic noise along the R577 and feeder road to Booysensdal mine complex. The residential properties in the vicinity of the proposed mine project area and other mining activities are illustrated in Figure 5.1.

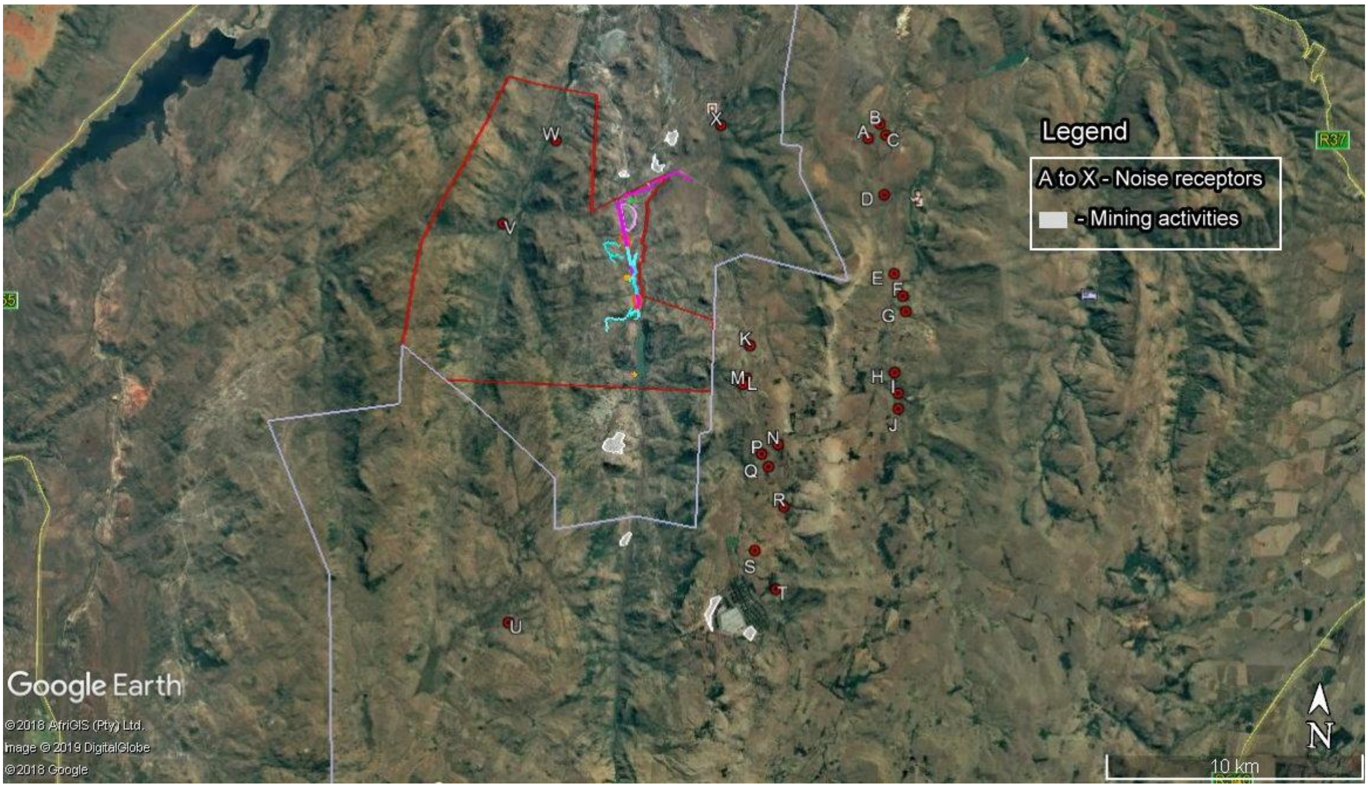



**Figure 5-1: Residential properties**

The distances between the different mine project areas and the residential properties are given in Table 5.1. This is for direct line of sight and vertical structures such as trees, topography between the source and receptors were not taken into consideration

**Table 5-1 Distances (in meter) between the different mining activities and the residential areas.**

| Position | DMS at Mototolo plant | TSF | Crusher at Mototolo plant | ROM at Mototolo plant | Conveyor | Southern decline | Southern Conveyor | Ventilation shaft V1 | Ventilation shaft V2 | Ventilation shaft V3 | Access road |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 9808 | 9921 | 9877 | 10145 | 10154 | 11108 | 11108 | 11325 | 11554 | 12610 | 10403 |
| B | 10365 | 10539 | 10468 | 10687 | 10663 | 11925 | 11761 | 12153 | 12367 | 13447 | 11183 |
| C | 10623 | 10689 | 10740 | 10862 | 10951 | 11840 | 11810 | 12121 | 12291 | 13379 | 11255 |
| D | 10142 | 10085 | 10222 | 10337 | 10271 | 10505 | 10411 | 10770 | 10949 | 12034 | 10169 |
| E | 10844 | 10623 | 10927 | 11039 | 10674 | 10104 | 10035 | 10454 | 10460 | 11454 | 10165 |
| F | 11425 | 11162 | 11461 | 11599 | 11204 | 10350 | 10374 | 10584 | 10646 | 11616 | 10547 |
| G | 11766 | 11499 | 11866 | 11420 | 11496 | 10546 | 10525 | 10767 | 10819 | 11767 | 10784 |
| H | 12412 | 12001 | 12407 | 12555 | 11920 | 10373 | 10325 | 10541 | 10520 | 11327 | 10935 |
| I | 13039 | 12505 | 12944 | 12995 | 12401 | 10735 | 10622 | 10914 | 10889 | 11581 | 11371 |
| J | 13324 | 12877 | 13319 | 13345 | 12745 | 10950 | 10875 | 11075 | 11020 | 11727 | 11669 |
| K | 7420 | 6891 | 7399 | 7479 | 6565 | 4771 | 4671 | 4882 | 4845 | 5659 | 5479 |
| L | 8377 | 7768 | 8358 | 8452 | 7415 | 5238 | 5087 | 5321 | 5214 | 5782 | 6162 |
| M | 8458 | 7884 | 8406 | 8484 | 7604 | 5225 | 5094 | 5274 | 5150 | 5678 | 6240 |
| N | 11101 | 10514 | 11042 | 11107 | 10194 | 7788 | 7572 | 7761 | 7565 | 7953 | 8806 |
| O | 11659 | 11004 | 11630 | 11680 | 10739 | 8232 | 7945 | 8097 | 7888 | 8149 | 9297 |
| P | 11031 | 10498 | 11029 | 11078 | 10029 | 7543 | 7332 | 7551 | 73336 | 7631 | 8711 |
| Q | 11624 | 11061 | 11578 | 11360 | 10703 | 8122 | 7921 | 8071 | 7871 | 8117 | 9250 |
| R | 13334 | 12674 | 13234 | 13402 | 12178 | 9762 | 9550 | 9812 | 9506 | 9661 | 10921 |
| S | 14344 | 13654 | 14284 | 14227 | 13253 | 10549 | 10305 | 10463 | 10177 | 10136 | 11840 |
| T | 15992 | 15369 | 15961 | 15966 | 14701 | 12245 | 11993 | 12114 | 11868 | 11798 | 13521 |
| U | 16737 | 16121 | 16629 | 16599 | 15578 | 13098 | 12941 | 12859 | 12156 | 11715 | 14373 |
| V | 4872 | 4862 | 4870 | 4861 | 4796 | 6148 | 6241 | 6061 | 6219 | 5928 | 5437 |
| W | 3546 | 4036 | 3558 | 3445 | 4273 | 6961 | 6326 | 6275 | 7326 | 7490 | 5760 |
| X | 4769 | 5117 | 4869 | 5403 | 5354 | 7634 | 7873 | 7897 | 8195 | 9143 | 6428 |

# 6. Results of the noise survey

## 6.1 Noise survey

In Table 6.1 are the different prevailing ambient noise levels for the specific areas, which include all the noise sources currently in the area such as domestic, traffic noise, distant mine noise and natural noise sources. Leq is the average noise level for the specific measuring point over a period of time, the Lmax is the maximum noise level and the Lmin is the minimum noise level registered during the noise survey for the specific area in dBA.

**Table 6-1: Noise levels for the day and night in the study area.**

| Position | Day time | | | | Night time | | | |
|---|---|---|---|---|---|---|---|---|
| | Leq - dBA | Lmax (Fast) - dBA | Lmin (Fast) - dBA | Remarks | Leq - dBA | Lmax (Fast) - dBA | Lmin (Fast) - dBA | Remarks |
| 1 | **48.7** | 62.7 | 37.9 | Distant plant, trucks at the communal entrance to Booysensdal and Der Brochen mines | **49.8** | 59.2 | 45.8 | Distant plant, trucks at the communal entrance to Booysensdal and Der Brochen mines |
| 2 | **63.1** | 78.1 | 59.7 | Boundary at the Mototolo Concentrator | **69.0** | 75.4 | 67.8 | Boundary at the Mototolo Concentrator |
| 3 | **33.1** | 49.1 | 28.1 | Distant traffic noise. | **48.5** | 64.4 | 36.9 | Distant traffic noise & insects. |
| 4 | **36.6** | 64.6 | 25.2 | Distant traffic noise. | **39.9** | 56.6 | 36.4 | Distant traffic noise & insects. |
| 5 | **34.7** | 67.1 | 23.7 | Distant mining activities – ventilation shaft noise. | **42.7** | 50.8 | 37.7 | Ventilation shaft noise & Insects. |
| 6 | **44.2** | 64.8 | 29.2 | Traffic noise. | **48.2** | 57.7 | 44.1 | Intermittent traffic & insect noise. |
| 7 | **35.0** | 63.8 | 22.0 | Distant traffic noise. | **33.0** | 55.0 | 24.3 | Distant intermittent & traffic noise. |
| 8 | **48.3** | 66.2 | 27.4 | Distant traffic noise. | **39.4** | 60.9 | 26.0 | Intermittent traffic & insect noise. |
| 9 | **41.6** | 58.1 | 27.5 | Traffic noise. | **39.4** | 60.9 | 26.0 | Intermittent traffic & insect noise. |
| 10 | **57.4** | 79.5 | 28.8 | Traffic noise. | **46.4** | 63.7 | 27.8 | Intermittent traffic & insect noise. |
| 11 | **37.3** | 55.4 | 24.5 | Distant domestic noise. | **35.1** | 64.2 | 24.1 | Domestic and insect noise. |
| 12 | **29.8** | 48.2 | 20.4 | Distant domestic noise. | **33.9** | 49.0 | 25.2 | Domestic and insect noise. |
| 13 | **31.8** | 55.8 | 22.0 | Domestic and distant mining activities noise. | **34.1** | 55.5 | 22.9 | Domestic, insects and distant mining activities noise. |
| 14 | **30.0** | 55.2 | 23.0 | Domestic and distant mining activities noise. | **35.8** | 47.0 | 30.3 | Domestic, insects and distant mining activities noise. |
| 15 | **34.7** | 56.1 | 26.6 | Domestic and distant mining activities noise. | **34.6** | 62.3 | 27.0 | Domestic, insects and distant mining activities noise. |
| 16 | **29.6** | 49.3 | 18.9 | Birds and slight wind noise. | **30.8** | 63.6 | 21.7 | Insect noises. |
| 17 | **28.0** | 49.6 | 18.8 | Birds and slight wind noise. | **29.2** | 62.0 | 21.3 | Insect noises. |

The following noise levels were recorded along the boundaries of the Concentrator plant:

- Flotation section – 60.4dBA;
- Spiral plant – 63.1dBA;
- Crushing noise – 74.2dBA.

The arithmetic averages throughout the study area are as follows:

- Plant area in the vicinity of roads – Daytime 46.5dBA and night time 49.0dBA;
- Distance from the feeder roads – Daytime 34.8dBA and night time 43.6dBA;
- Along the Lydenburg Road – Daytime 49.1dBA and night time 42.9dBA;
- Residential areas east and north of the project area - Daytime 32.2dBA and night time 34.8dBA;
- Residential areas west of the project area – 28.8dBA and night time 30.0dBA.

**Table 6-2: Sound pressure levels of construction machinery**

| Equipment | **Reduction in the noise level some distance from the source - dBA** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cumulative distance from source in meters | 2m from the machinery/ equipment | 15m | 30m | 60m | 120m | 240m | 480m | 960m | 1920m |
| Dump truck | 91.0 | 62.5 | 56.5 | 50.4 | 44.4 | 38.4 | 32.4 | 26.4 | 20.3 |
| Backhoe | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |
| Drilling Equipment | 100.0 | 71.5 | 65.5 | 59.4 | 53.4 | 47.4 | 41.4 | 35.4 | 29.3 |
| Flatbed truck | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |
| Pickup truck | 70.0 | 41.5 | 35.5 | 29.4 | 23.4 | 17.4 | 11.4 | 5.4 | -0.7 |
| Tractor trailer | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |
| Crane | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |
| Pumps | 70.0 | 41.5 | 35.5 | 29.4 | 23.4 | 17.4 | 11.4 | 5.4 | -0.7 |
| Welding Machine | 72.0 | 43.5 | 37.5 | 31.4 | 25.4 | 19.4 | 13.4 | 7.4 | 1.3 |
| Generator | 90.0 | 61.5 | 55.5 | 49.4 | 43.4 | 37.4 | 31.4 | 25.4 | 19.3 |
| Compressor | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |
| Pile driver | 100.0 | 71.5 | 65.5 | 59.4 | 53.4 | 47.4 | 41.4 | 35.4 | 29.3 |
| Jackhammer | 90.0 | 61.5 | 55.5 | 49.4 | 43.4 | 37.4 | 31.4 | 25.4 | 19.3 |
| Rock drills | 100.0 | 71.5 | 65.5 | 59.4 | 53.4 | 47.4 | 41.4 | 35.4 | 29.3 |
| Pneumatic tools | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |
| Cumulative noise levels from the construction activities when all of such work within a radius of 30m | 105.5 | 76.9 | 70.9 | 64.9 | 58.9 | 52.9 | 46.8 | 40.8 | 34.8 |

The noise reduction calculated in Table 5.2 is for direct line of sight and medium ground conditions. Engineering control measures and topography can have an influence on how the noise level is perceived by the occupants of nearby noise sensitive areas. The cumulative noise level of the machinery and equipment will be 64.9dBA at 60m and 40.8dBA at 960m from the construction area if all the machinery operates in a radius of 30m at one time. This will seldom happen and the cumulative noise level will therefore be lower.

## 6.2 Noise impact at the different noise receptors

The following equation was used to calculate the noise level at the noise sensitive areas during the construction phase:

$$Lp = Lw - 20\log R - 5dB$$

Where, Lp is the sound level at a distance from the source in dBA;
Lw is the sound level at the source in dBA; and
R is the distance from the source.

The following sound levels were used in determining the noise intrusion level during the construction phase during mining establishment:

- Clearing of decline shaft areas south – 85.0dBA;
- Construction activities at Mototolo concentrator – 90.0dBA;
- Construction of crushing plants at south decline plants – 85.0dBA;
- Construction of the infra-structure – 85.0dBA;
- Civil construction activities – 85.0dBA;
- Construction of the overland conveyor – 80.0dBA;
- Installation of mine machinery at south decline – 85.0dBA;
- Construction of ventilation shaft (south) – 90.0dBA.

The following sound levels were used in determining the noise intrusion level during the operational phase of the mining activities:

- DMS at Mototolo concentrator – 85.0dBA;
- Crusher activities at south decline – 95.0dBA;
- Ventilation shaft south – 100.0dBA;
- Traffic – 80.0dBA;
- Overland conveyor – 70.0dBA

- Extension of the TSF – 80.0dBA;
- Emergency generator – 85.0dBA; and
- Crusher at the Mototolo concentrator – 95.0dBA.

The following sound levels were used in determining the noise intrusion level during the Closure/rehabilitation phase of the mining activities:

- Removal of all Infra-structure – 80.0dBA; and
- Landfill and planting of grass – 80.0dBA.

This noise impact formula and the Interactive noise calculator (ISO 9613) will be used to determine the noise levels during the construction phase of the project. The noise levels at the noise sensitive areas will be added in a logarithmic manner to determine the overall sound exposure at the receptor. The categorization of the intrusion levels during the construction and operational phases will be as follows. The increase in the prevailing ambient noise level is calculated in the following manner:

$$\Delta L\text{Req,T} = L\text{Req,T (post)} - L\text{Req,T (pre)}$$

where,

$L$Req,T (post) – noise level after completion of the project – projected or calculated noise levels;

$L$Req,T (pre) – noise level before the proposed project – ambient noise level.

The criteria for assessing the magnitude of a noise impact are illustrated in Table 6.3.

**Table 6-3: Noise intrusion level criteria**

| **Increase** Δ-dBA | **Assessment of impact magnitude** | **Color code** |
|---|---|---|
| $0 < \Delta \leq 1$ | Not audible | |
| $1 < \Delta \leq 3$ | Very Low | |
| $3 < \Delta \leq 5$ | Low | |
| $5 < \Delta \leq 10$ | Medium | |
| $10 < \Delta \leq 15$ | High | |
| $15 < \Delta$ | Very High | |

The noise levels from the different mining activities will be added in a logarithmic manner as perceived at the noise sensitive areas. The noise intrusion level will be calculated by subtracting the prevailing ambient noise level from the cumulative noise level.

### 6.2.1 Construction phase

The noise intrusion levels during the construction phase at decline shafts, construction of overland conveyor and vent shafts are given in Table 6.4 (summer period) and Table 6.5 (winter period).

**Table 6-4: Noise intrusion levels (in dBA) during construction phase - summer**

| Position | Clearing of decline shaft area (South) | Construction activities at concentrator plant | Crushing | Construction of infra-structure | Civil Construction activities | Construction of overland conveyor | Installation of mine machinery (South) | Construction of Vent shaft South | Cumulative Levels | Cumulative noise level - Daytime | Cumulative noise level - Night time | Intrusion noise level - daytime | Intrusion noise level - night time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -0.4 | 0.7 | 1.6 | 1.6 | 2.2 | 1.9 | 1.7 | 1.8 | 11.4 | 33.6 | 34.5 | 0.1 | 0.1 |
| B | -1.0 | 0.2 | 1.0 | 1.0 | 1.8 | 1.4 | 1.2 | 1.2 | 10.8 | 33.6 | 34.5 | 0.0 | 0.0 |
| C | -1.0 | 0.0 | 1.0 | 1.0 | 1.5 | 1.2 | 1.1 | 1.1 | 10.8 | 33.6 | 34.5 | 0.0 | 0.0 |
| D | 0.1 | 0.4 | 2.1 | 2.1 | 2.2 | 1.9 | 1.8 | 2.0 | 11.6 | 33.6 | 34.5 | 0.0 | 0.0 |
| E | 0.4 | -0.2 | 2.4 | 2.4 | 2.0 | 1.8 | 1.8 | 2.2 | 11.7 | 33.6 | 34.5 | 0.0 | 0.0 |
| F | 0.2 | -0.7 | 2.2 | 2.2 | 1.6 | 1.5 | 1.5 | 1.9 | 11.4 | 32.2 | 34.8 | 0.1 | 0.0 |
| G | 0.0 | -0.9 | 2.0 | 2.0 | 1.4 | 1.3 | 1.3 | 1.7 | 11.2 | 49.1 | 42.9 | 0.0 | 0.0 |
| H | 0.2 | -1.4 | 2.2 | 2.2 | 1.2 | 1.2 | 1.2 | 1.7 | 11.2 | 49.1 | 42.9 | 0.0 | 0.0 |
| I | -0.1 | -1.8 | 1.9 | 1.9 | 0.8 | 0.7 | 0.7 | 1.4 | 10.8 | 49.1 | 42.9 | 0.0 | 0.0 |
| J | -0.3 | -2.0 | 1.7 | 1.7 | 0.6 | 0.6 | 0.7 | 1.2 | 10.7 | 49.1 | 42.9 | 0.0 | 0.0 |
| K | 6.9 | 3.1 | 8.9 | 8.9 | 6.5 | 6.6 | 6.7 | 7.8 | 17.3 | 33.7 | 34.6 | 0.2 | 0.1 |
| L | 6.1 | 2.0 | 8.1 | 8.1 | 5.5 | 5.5 | 5.8 | 6.9 | 16.4 | 33.7 | 34.6 | 0.1 | 0.1 |
| M | 6.1 | 2.0 | 8.1 | 8.1 | 5.4 | 5.6 | 5.8 | 6.9 | 16.4 | 33.7 | 34.6 | 0.1 | 0.1 |
| N | 2.7 | -0.4 | 4.7 | 4.7 | 2.7 | 2.9 | 3.0 | 3.9 | 13.3 | 32.3 | 34.8 | 0.1 | 0.1 |
| O | 2.2 | -0.8 | 4.2 | 4.2 | 2.2 | 2.4 | 2.6 | 3.4 | 12.8 | 32.2 | 34.8 | 0.1 | 0.0 |
| P | 2.9 | -0.4 | 4.9 | 4.9 | 2.7 | 3.0 | 3.2 | 4.0 | 13.4 | 32.3 | 34.8 | 0.1 | 0.1 |
| Q | 2.3 | -0.8 | 4.3 | 4.3 | 2.3 | 2.5 | 2.7 | 3.5 | 12.9 | 32.3 | 34.8 | 0.1 | 0.0 |
| R | 0.7 | -2.0 | 2.7 | 2.7 | 0.9 | 1.1 | 1.2 | 2.0 | 11.4 | 32.2 | 34.8 | 0.1 | 0.0 |
| S | 0.0 | -2.6 | 2.0 | 2.0 | 0.3 | 0.5 | 1.5 | 1.3 | 10.8 | 32.2 | 34.8 | 0.1 | 0.0 |
| T | -1.3 | -3.6 | 0.7 | 0.7 | -0.6 | -0.6 | -0.4 | 0.1 | 9.6 | 32.2 | 34.8 | 0.0 | 0.0 |
| U | -1.8 | -4.0 | 0.2 | 0.2 | -1.1 | -0.8 | -0.6 | -0.2 | 9.2 | 28.8 | 30.0 | 0.1 | 0.1 |
| V | 4.7 | 6.7 | 6.7 | 6.7 | 8.8 | 9.1 | 9.0 | 7.9 | 17.6 | 29.1 | 30.2 | 0.5 | 0.4 |
| W | 3.6 | 9.5 | 5.6 | 5.6 | 9.0 | 8.6 | 8.1 | 6.8 | 17.1 | 33.7 | 34.6 | 0.2 | 0.2 |
| X | 2.8 | 6.9 | 4.8 | 4.8 | 7.1 | 6.5 | 5.9 | 5.6 | 15.4 | 33.7 | 34.6 | 0.1 | 0.1 |

**Table 6-5: Noise intrusion levels (in dBA) during construction phase - winter**

| Position | Clearing of decline shaft area (South) | Construction activities at concentrator plant | Crushing | Construction of infra-structure | Civil Construction activities | Construction of overland conveyor | Installation of mine machinery (South) | Construction of Vent shaft South | Cumulative Levels | Cumulative noise level - Daytime | Cumulative noise level - Night time | Intrusion noise level - daytime | Intrusion noise level - night time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -0.4 | 0.7 | 1.6 | 1.6 | 2.2 | 1.9 | 1.7 | 1.8 | 11.4 | 30.7 | 31.0 | 0.3 | 0.2 |
| B | -1.0 | 0.2 | 1.0 | 1.0 | 1.8 | 1.4 | 1.2 | 1.2 | 10.8 | 30.6 | 31.0 | 0.1 | 0.1 |
| C | -1.0 | 0.0 | 1.0 | 1.0 | 1.5 | 1.2 | 1.1 | 1.1 | 10.8 | 30.6 | 31.0 | 0.1 | 0.1 |
| D | 0.1 | 0.4 | 2.1 | 2.1 | 2.2 | 1.9 | 1.8 | 2.0 | 11.6 | 30.7 | 31.0 | 0.1 | 0.1 |
| E | 0.4 | -0.2 | 2.4 | 2.4 | 2.0 | 1.8 | 1.8 | 2.2 | 11.7 | 30.7 | 31.1 | 0.1 | 0.1 |
| F | 0.2 | -0.7 | 2.2 | 2.2 | 1.6 | 1.5 | 1.5 | 1.9 | 11.4 | 30.7 | 31.0 | 0.1 | 0.1 |
| G | 0.0 | -0.9 | 2.0 | 2.0 | 1.4 | 1.3 | 1.3 | 1.7 | 11.2 | 49.1 | 42.9 | 0.0 | 0.0 |
| H | 0.2 | -1.4 | 2.2 | 2.2 | 1.2 | 1.2 | 1.2 | 1.7 | 11.2 | 49.1 | 42.9 | 0.0 | 0.0 |
| I | -0.1 | -1.8 | 1.9 | 1.9 | 0.8 | 0.7 | 0.7 | 1.4 | 10.8 | 49.1 | 42.9 | 0.0 | 0.0 |
| J | -0.3 | -2.0 | 1.7 | 1.7 | 0.6 | 0.6 | 0.7 | 1.2 | 10.7 | 49.1 | 42.9 | 0.0 | 0.0 |
| K | 6.9 | 3.1 | 8.9 | 8.9 | 6.5 | 6.6 | 6.7 | 7.8 | 17.3 | 30.8 | 31.2 | 0.3 | 0.3 |
| L | 6.1 | 2.0 | 8.1 | 8.1 | 5.5 | 5.5 | 5.8 | 6.9 | 16.4 | 30.8 | 31.1 | 0.3 | 0.3 |
| M | 6.1 | 2.0 | 8.1 | 8.1 | 5.4 | 5.6 | 5.8 | 6.9 | 16.4 | 30.8 | 31.1 | 0.3 | 0.3 |
| N | 2.7 | -0.4 | 4.7 | 4.7 | 2.7 | 2.9 | 3.0 | 3.9 | 13.3 | 30.7 | 31.1 | 0.1 | 0.1 |
| O | 2.2 | -0.8 | 4.2 | 4.2 | 2.2 | 2.4 | 2.6 | 3.4 | 12.8 | 30.7 | 31.1 | 0.1 | 0.1 |
| P | 2.9 | -0.4 | 4.9 | 4.9 | 2.7 | 3.0 | 3.2 | 4.0 | 13.4 | 30.7 | 31.1 | 0.1 | 0.1 |
| Q | 2.3 | -0.8 | 4.3 | 4.3 | 2.3 | 2.5 | 2.7 | 3.5 | 12.9 | 30.7 | 31.1 | 0.1 | 0.1 |
| R | 0.7 | -2.0 | 2.7 | 2.7 | 0.9 | 1.1 | 1.2 | 2.0 | 11.4 | 30.7 | 31.0 | 0.1 | 0.1 |
| S | 0.0 | -2.6 | 2.0 | 2.0 | 0.3 | 0.5 | 1.5 | 1.3 | 10.8 | 30.6 | 31.0 | 0.1 | 0.1 |
| T | -1.3 | -3.6 | 0.7 | 0.7 | -0.6 | -0.6 | -0.4 | 0.1 | 9.6 | 30.6 | 31.0 | 0.1 | 0.1 |
| U | -1.8 | -4.0 | 0.2 | 0.2 | -1.1 | -0.8 | -0.6 | -0.2 | 9.2 | 28.8 | 30.0 | 0.1 | 0.1 |
| V | 4.7 | 6.7 | 6.7 | 6.7 | 8.8 | 9.1 | 9.0 | 7.9 | 17.6 | 29.1 | 30.2 | 0.5 | 0.4 |
| W | 3.6 | 9.5 | 5.6 | 5.6 | 9.0 | 8.6 | 8.1 | 6.8 | 17.1 | 30.8 | 31.2 | 0.4 | 0.3 |
| X | 2.8 | 6.9 | 4.8 | 4.8 | 7.1 | 6.5 | 5.9 | 5.6 | 15.4 | 30.7 | 31.1 | 0.2 | 0.2 |

## 6.2.2 Ground-borne vibration

The blasting activities must be done in terms of the safe blasting procedures. This type of blasting will be localised blasting and the ground vibration threshold values of 12.5mm/s for poorly constructed houses and 25mm/s for modern type houses may not be exceeded. The following formulas were used to calculate the over-air pressure levels and ground vibration levels based on typical mass of charge per delay of 150kg site-mixed slurry explosives at the southern decline shaft. The ICI Handbook of Blasting Tables (ICI, 1971) provides the following formula for calculating ground-borne vibration:

$$V = k.\left(\frac{R}{\sqrt{W}}\right)^{b}$$

Where V is the peak particle velocity (mm/s)

*R* is the distance from the blast to the monitoring point (m)

*W* is the explosive charge weight per delay (kg)

The following constants will be used in the absence of site specific constants for *k* and *b* _*for the blasting at the decline shaft*_ in the above formula.

*k* 1140

*b* -1.6

The following constants will be used in the absence of site specific constants for *k* and *b* _*for the underground blasting*_ in the above formula.

*k* 1244

*b* -1.51

### 6.2.3 Air Overpressure Levels

The level of air overpressure during blasting at a distance from the blasting area may be calculated using the following equation from the ICI Blasting Handbook:

$$P[dBZ]5\% = 165.3 - 24\log 10\left(\frac{D}{\sqrt[3]{W}}\right)$$

Where *P* is the 95$^{th}$ percentile peak pressure (dBZ);

*D* is the distance from the blast (m); and

*W* is the charge per mass delay (kg).

The following criteria based on international standards in Table 6.6 are designed to ensure adequate protection of sensitive land uses whilst permitting the operations to be conducted in a practical manner. The criteria are presented as 95 percentile limits for human comfort in occupied buildings and avoiding risk of cosmetic and structural damage to buildings from long term effects of vibration. Lower limits are set for the night time period but no blasting will be done during night time. No distinction is made between minor and moderate significance because of the nature of impacts resulting from blasting and the response of receptors. Critical impacts from air blast are identified where air blast noise from blasting exceeds 140 dBL, generally accepted as the safe threshold for hearing.

**Table 6-6: Criteria for the evaluation of impacts from blasting**

| Period | Air blast dB(L) | | | | Vibration PPV mm/s | | | |
|---|---|---|---|---|---|---|---|---|
| | **Not significant** | **Minor/Moderate** | **Major** | **Critical** | **Not significant** | **Minor/Moderate** | **Major** | **Critical** |
| Daytime | <115 | >115-125 | >125-140 | >140 | <2 | >2-5 | >5-10 | >10 |
| Night time | <105 | >105-115 | >115-140 | >140 | <1 | >1-2 | >2-5 | >5 |

Air pressure and ground vibration levels at the noise receptors with set-back distances as per distance from the south decline shaft from the blast are given in Table 6.7. A dBL level of 140dB and lower is acceptable as this level is for a period of up to 4-seconds only.

**Table 6-7: Ground vibration levels and over pressure levels during blasting at the southern decline shaft**

| Noise receptor | Distance in meters - Southern decline shaft | Calculated vibration levels (mm/s) at the receptor with 150kg site mixed slurry explosives for Southern decline | Calculated air pressure levels (dBL value dB) at the receptor with 150kg site mixed slurry explosives for Southern decline |
|---|---|---|---|
| **A** | 11108 | 0.02 | 85.6 |
| **B** | 11925 | 0.02 | 84.9 |
| **C** | 11840 | 0.02 | 84.9 |
| **D** | 10505 | 0.02 | 86.2 |
| **E** | 10104 | 0.02 | 86.6 |
| **F** | 10350 | 0.02 | 86.4 |
| **G** | 10546 | 0.02 | 86.2 |
| **H** | 10373 | 0.02 | 86.3 |
| **I** | 10735 | 0.02 | 86.0 |
| **J** | 10950 | 0.02 | 85.8 |
| **K** | 4771 | 0.08 | 94.4 |
| **L** | 5238 | 0.07 | 93.4 |
| **M** | 5225 | 0.07 | 93.5 |
| **N** | 7788 | 0.04 | 89.3 |
| **O** | 8232 | 0.03 | 88.7 |
| **P** | 7543 | 0.04 | 89.6 |
| **Q** | 8122 | 0.03 | 88.9 |
| **R** | 9762 | 0.03 | 87.0 |
| **S** | 10549 | 0.02 | 86.2 |
| **T** | 12245 | 0.02 | 84.6 |
| **U** | 13098 | 0.02 | 83.9 |
| **V** | 6148 | 0.05 | 91.8 |
| **W** | 6961 | 0.04 | 90.5 |
| **X** | 7634 | 0.04 | 89.5 |

### 6.2.4 Operational phase

The calculated noise levels and subsequent noise intrusion levels at the abutting noise receptors during mining activities at south decline, ventilation shafts, access road, overland conveyor, crushing activities at the decline shaft and at the Mototolo concentrator and the DMS plant will be illustrated in Table 6.8

(summer time) and Table 6.9 (winter time) respectively. Noise modelling will be done later on in the report which is based on the ISO 9613 method (distance from the source, noise barriers, and ground effect and air absorption).

The mine activities will not be audible during the summer and/or winter period at the noise receptors during the day and during the night. The threshold value of 7.0dBA will not be exceeded at any of the noise receptors during the day and night.

**Table 6-8: Noise intrusion levels (dBA) at the residential areas during summer**

| Position | DMS at Mototolo Concentrator | Crusher activities South decline | Ventilation shaft South | Traffic | Overland conveyor | Overland conveyor south | Extension of TSF | Emergency generator | Crushing activities at Mototolo Plant | Cumulative Levels | Cumulative noise level - Daytime | Cumulative noise level - Night time | Intrusion noise level - daytime | Intrusion noise level - night time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 5.7 | 9.6 | 14.4 | -4.8 | -14.6 | -15.4 | 2.6 | 9.8 | 10.7 | 19.6 | 33.8 | 34.6 | 0.2 | 0.1 |
| B | 5.2 | 9.0 | 0.8 | 1.5 | 1.9 | 1.1 | 2.0 | 1.2 | 2.2 | 11.1 | 33.8 | 34.7 | 0.2 | 0.2 |
| C | 5.0 | 9.0 | 0.8 | 1.5 | 1.7 | 1.1 | 1.9 | 1.1 | 2.0 | 11.0 | 33.8 | 34.6 | 0.2 | 0.1 |
| D | 5.4 | 10.1 | 1.9 | 2.4 | 2.3 | 2.2 | 2.4 | 2.0 | 2.4 | 11.7 | 33.8 | 34.7 | 0.2 | 0.2 |
| E | 4.8 | 10.4 | 2.1 | 2.4 | 1.9 | 2.5 | 2.0 | 2.2 | 1.8 | 11.7 | 33.8 | 34.7 | 0.2 | 0.2 |
| F | 4.3 | 10.2 | 2.0 | 2.0 | 1.5 | 2.2 | 1.5 | 1.9 | 1.3 | 11.3 | 32.5 | 35.0 | 0.3 | 0.2 |
| G | 4.1 | 10.0 | 1.9 | 1.8 | 1.3 | 2.1 | 1.3 | 1.7 | 1.1 | 11.2 | 49.1 | 42.9 | 0.0 | 0.0 |
| H | 3.6 | 10.2 | 2.0 | 1.7 | 1.0 | 2.2 | 0.9 | 1.7 | 0.6 | 11.1 | 49.1 | 42.9 | 0.0 | 0.0 |
| I | 3.2 | 9.9 | 1.7 | 1.4 | 0.6 | 2.0 | 0.6 | 1.4 | 0.2 | 10.7 | 49.1 | 42.9 | 0.0 | 0.0 |
| J | 3.0 | 9.7 | 1.6 | 1.2 | 0.4 | 1.8 | 0.3 | 1.2 | 0.0 | 10.5 | 49.1 | 42.9 | 0.0 | 0.0 |
| K | 8.1 | 16.9 | 8.7 | 7.7 | 6.2 | 9.1 | 5.7 | 7.8 | 5.1 | 17.0 | 34.3 | 35.1 | 0.7 | 0.6 |
| L | 7.0 | 16.1 | 8.0 | 6.7 | 5.1 | 8.4 | 4.7 | 6.9 | 4.0 | 16.0 | 34.2 | 35.0 | 0.6 | 0.5 |
| M | 7.0 | 16.1 | 8.1 | 6.6 | 4.9 | 8.4 | 4.6 | 6.9 | 4.0 | 16.0 | 34.2 | 35.0 | 0.6 | 0.5 |
| N | 4.6 | 12.7 | 4.7 | 3.6 | 2.3 | 4.9 | 2.1 | 3.9 | 1.6 | 13.0 | 32.6 | 35.0 | 0.4 | 0.2 |
| O | 4.2 | 12.2 | 4.3 | 3.1 | 1.9 | 4.5 | 1.7 | 3.4 | 1.2 | 12.6 | 32.6 | 35.0 | 0.4 | 0.2 |
| P | 4.6 | 12.9 | 4.9 | 3.7 | 2.5 | 5.2 | 2.1 | 4.0 | 1.6 | 13.2 | 32.6 | 35.1 | 0.4 | 0.3 |
| Q | 4.2 | 12.3 | 4.4 | 3.2 | 1.9 | 4.5 | 1.6 | 3.5 | 1.2 | 12.6 | 32.6 | 35.0 | 0.4 | 0.2 |
| R | 3.0 | 10.7 | 2.7 | 1.7 | 0.8 | 2.9 | 0.4 | 2.0 | 0.0 | 11.2 | 32.5 | 35.0 | 0.3 | 0.2 |
| S | 2.4 | 10.0 | 2.1 | 1.0 | 0.1 | 2.2 | -0.2 | 1.3 | -0.6 | 10.5 | 32.4 | 34.9 | 0.2 | 0.1 |
| T | 1.4 | 8.7 | 0.8 | -0.1 | -0.8 | 0.9 | -1.2 | 0.1 | -1.6 | 9.4 | 32.4 | 34.9 | 0.2 | 0.1 |
| U | 1.0 | 8.2 | 0.3 | -0.7 | -1.4 | 0.3 | -1.6 | -0.2 | -2.0 | 8.9 | 29.2 | 30.3 | 0.4 | 0.3 |
| V | 11.7 | 14.7 | 6.8 | 7.8 | 8.9 | 6.6 | 8.8 | 7.9 | 8.7 | 17.6 | 30.8 | 31.6 | 2.0 | 1.6 |
| W | 14.5 | 13.6 | 6.5 | 7.3 | 9.9 | 6.5 | 10.4 | 6.8 | 11.5 | 18.1 | 34.4 | 35.1 | 0.8 | 0.6 |
| X | 11.9 | 12.8 | 4.6 | 6.3 | 7.9 | 4.6 | 8.3 | 5.6 | 8.9 | 16.3 | 34.1 | 34.9 | 0.5 | 0.4 |

**Table 6-9: Noise intrusion levels (dBA) at the different residential areas during winter**

| Position | DMS at Mototolo Concentrator | Crusher activities South decline | Ventilation shaft South | Traffic | Overland conveyor | Overland conveyor south | Extension of TSF | Emergency generator | Crushing activities at Mototolo Plant | Cumulative Levels | Cumulative noise level - Daytime | Cumulative noise level - Night time | Intrusion noise level - daytime | Intrusion noise level - night time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 5.7 | 9.6 | 14.4 | -4.8 | -14.6 | -15.4 | 2.6 | 9.8 | 10.7 | 19.6 | 30.9 | 31.3 | 0.3 | 0.1 |
| B | 5.2 | 9.0 | 0.8 | 1.5 | 1.9 | 1.1 | 2.0 | 1.2 | 2.2 | 11.1 | 30.6 | 31.0 | 0.0 | 0.2 |
| C | 5.0 | 9.0 | 0.8 | 1.5 | 1.7 | 1.1 | 1.9 | 1.1 | 2.0 | 11.0 | 30.6 | 31.0 | 0.0 | 0.1 |
| D | 5.4 | 10.1 | 1.9 | 2.4 | 2.3 | 2.2 | 2.4 | 2.0 | 2.4 | 11.7 | 30.7 | 31.1 | 0.1 | 0.2 |
| E | 4.8 | 10.4 | 2.1 | 2.4 | 1.9 | 2.5 | 2.0 | 2.2 | 1.8 | 11.7 | 30.7 | 31.1 | 0.1 | 0.2 |
| F | 4.3 | 10.2 | 2.0 | 2.0 | 1.5 | 2.2 | 1.5 | 1.9 | 1.3 | 11.3 | 30.7 | 31.0 | 0.1 | 0.2 |
| G | 4.1 | 10.0 | 1.9 | 1.8 | 1.3 | 2.1 | 1.3 | 1.7 | 1.1 | 11.2 | 49.1 | 42.9 | 0.0 | 0.0 |
| H | 3.6 | 10.2 | 2.0 | 1.7 | 1.0 | 2.2 | 0.9 | 1.7 | 0.6 | 11.1 | 49.1 | 42.9 | 0.0 | 0.0 |
| I | 3.2 | 9.9 | 1.7 | 1.4 | 0.6 | 2.0 | 0.6 | 1.4 | 0.2 | 10.7 | 49.1 | 42.9 | 0.0 | 0.0 |
| J | 3.0 | 9.7 | 1.6 | 1.2 | 0.4 | 1.8 | 0.3 | 1.2 | 0.0 | 10.5 | 49.1 | 42.9 | 0.0 | 0.0 |
| K | 8.1 | 16.9 | 8.7 | 7.7 | 6.2 | 9.1 | 5.7 | 7.8 | 5.1 | 17.0 | 30.8 | 31.2 | 0.2 | 0.6 |
| L | 7.0 | 16.1 | 8.0 | 6.7 | 5.1 | 8.4 | 4.7 | 6.9 | 4.0 | 16.0 | 30.7 | 31.1 | 0.1 | 0.5 |
| M | 7.0 | 16.1 | 8.1 | 6.6 | 4.9 | 8.4 | 4.6 | 6.9 | 4.0 | 16.0 | 30.7 | 31.1 | 0.1 | 0.5 |
| N | 4.6 | 12.7 | 4.7 | 3.6 | 2.3 | 4.9 | 2.1 | 3.9 | 1.6 | 13.0 | 30.7 | 31.1 | 0.1 | 0.2 |
| O | 4.2 | 12.2 | 4.3 | 3.1 | 1.9 | 4.5 | 1.7 | 3.4 | 1.2 | 12.6 | 30.7 | 31.1 | 0.1 | 0.2 |
| P | 4.6 | 12.9 | 4.9 | 3.7 | 2.5 | 5.2 | 2.1 | 4.0 | 1.6 | 13.2 | 30.7 | 31.1 | 0.1 | 0.3 |
| Q | 4.2 | 12.3 | 4.4 | 3.2 | 1.9 | 4.5 | 1.6 | 3.5 | 1.2 | 12.6 | 30.7 | 31.1 | 0.1 | 0.2 |
| R | 3.0 | 10.7 | 2.7 | 1.7 | 0.8 | 2.9 | 0.4 | 2.0 | 0.0 | 11.2 | 30.6 | 31.0 | 0.0 | 0.2 |
| S | 2.4 | 10.0 | 2.1 | 1.0 | 0.1 | 2.2 | -0.2 | 1.3 | -0.6 | 10.5 | 30.6 | 31.0 | 0.0 | 0.1 |
| T | 1.4 | 8.7 | 0.8 | -0.1 | -0.8 | 0.9 | -1.2 | 0.1 | -1.6 | 9.4 | 30.6 | 31.0 | 0.0 | 0.1 |
| U | 1.0 | 8.2 | 0.3 | -0.7 | -1.4 | 0.3 | -1.6 | -0.2 | -2.0 | 8.9 | 28.8 | 30.0 | 0.0 | 0.3 |
| V | 11.7 | 14.7 | 6.8 | 7.8 | 8.9 | 6.6 | 8.8 | 7.9 | 8.7 | 17.6 | 29.1 | 30.2 | 0.3 | 1.6 |
| W | 14.5 | 13.6 | 6.5 | 7.3 | 9.9 | 6.5 | 10.4 | 6.8 | 11.5 | 18.1 | 30.8 | 31.2 | 0.2 | 0.6 |
| X | 11.9 | 12.8 | 4.6 | 6.3 | 7.9 | 4.6 | 8.3 | 5.6 | 8.9 | 16.3 | 30.8 | 31.1 | 0.2 | 0.4 |

The projected noise levels and the frequencies (63Hz to 8kHz) at set-back distances of 500m, 1 000m and 1 960m during the operational phase of the ventilation shaft and crusher plant are given in the following Tables. This illustrates that the noise increase between 250Hz and 2kHz will be slightly higher than the prevailing ambient noise level frequencies which makes the sound to be audible at 500m for the ventilation shafts.

**Table 6-10: Noise levels from the ventilation fans at set-back distances**

| Distance - m | Calculated noise level - dBA | 63Hz | 125Hz | 250Hz | 500Hz | 1kHz | 2kHz | 4kHz | 8kHz |
|---|---|---|---|---|---|---|---|---|---|
| **500** | 39.9 | 0.3 | 15 | 35.1 | 35.4 | 34.3 | 25.1 | 6.8 | -39.5 |
| **1 000** | 32.7 | -5.5 | 7.1 | 25.8 | 28.2 | 26.1 | 14.8 | -10.5 | -84.1 |
| **1 960** | 24.7 | -11.3 | 3.1 | 22.0 | 19.8 | 15.6 | 0.4 | -38.3 | -164.3 |
| **Ambient noise level** | 33.1 | 41.6 | 36.8 | 29.7 | 26.2 | 22.7 | 21.2 | 26.2 | 24.1 |

The noise level from the crusher activities will be lower than the prevailing ambient noise levels at set back distances of 500m, 1 000m and 1 960m.

**Table 6-11: Noise levels from the crusher at set-back distances of 500m, 1 000m and 1 960m**

| Distance - m | Calculated noise level - dBA | 63Hz | 125Hz | 250Hz | 500Hz | 1kHz | 2kHz | 4kHz | 8kHz |
|---|---|---|---|---|---|---|---|---|---|
| **500** | 32.2 | -5.0 | 6.4 | 15.7 | 22.7 | 27.6 | 29.2 | 16.1 | -21.7 |
| **1 000** | 23.2 | -10.8 | 0.5 | 9.4 | 15.7 | 19.4 | 18.8 | -1.2 | -66.3 |
| **1 960** | 12.6 | -16.6 | -5.5 | 2.6 | 7.3 | 8.9 | 4.4 | -29.0 | -146.5 |
| **Ambient noise level** | 33.1 | 41.6 | 36.8 | 29.7 | 26.2 | 22.7 | 21.2 | 26.2 | 24.1 |

Underground blasting

Underground blasting will take place and the closest residential area will be NR V. The distances were calculated from the nearest point of the underground blasting areas and the identification of the underground blasting areas is illustrated in Figure 6-1.

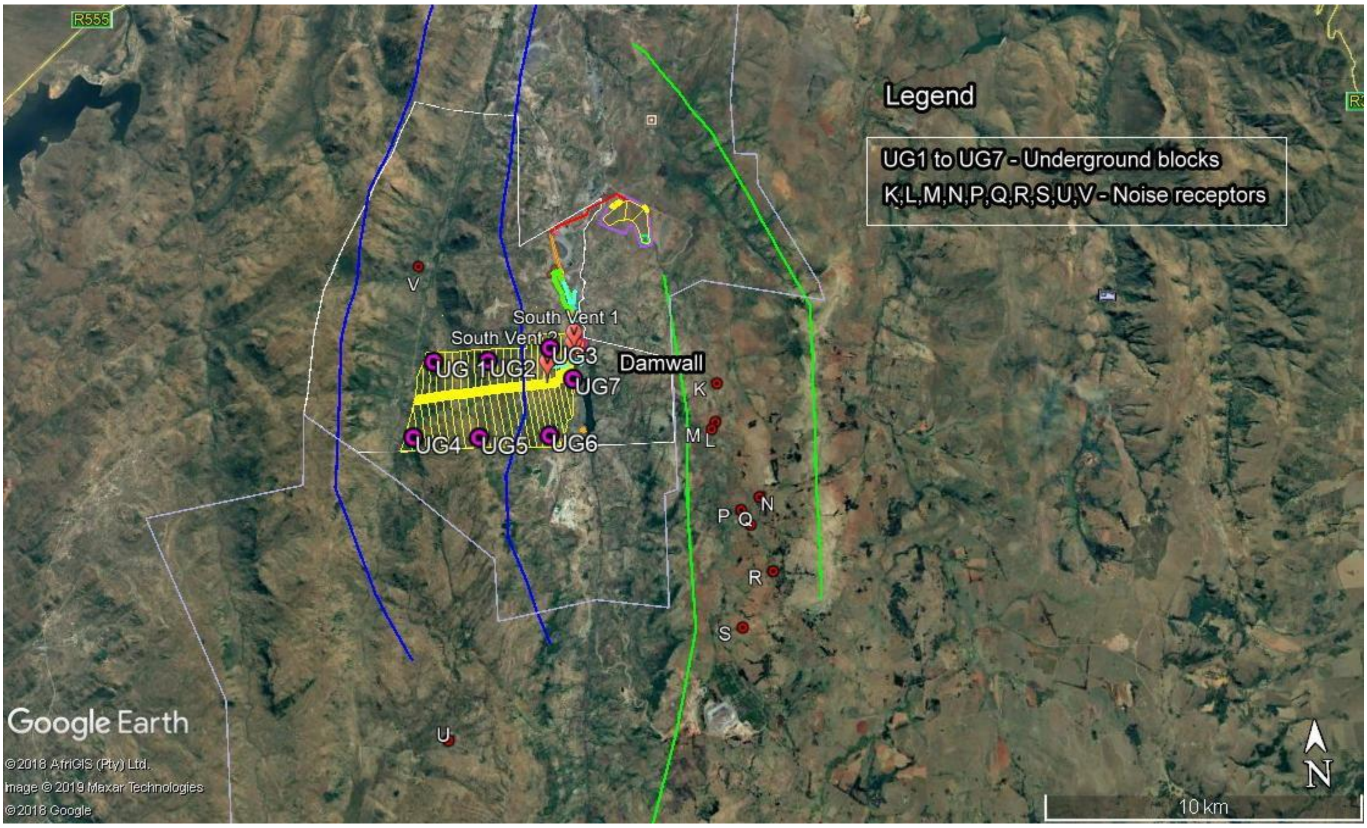



**Figure 6-1: Underground mining blocks**

The distances (direct line) between the different blocks and the abutting noise receptors and the der Brochen dam wall are illustrated in Table 6.12. This will be the shortest route between the noise receptor and the blasting area.

**Table 6-12: Distance between different blocks and the noise receptors**

| Noise receptor | UG1 | UG2 | UG3 | UG4 | UG5 | UG6 | UG7 |
|---|---|---|---|---|---|---|---|
| K | 9399 | 7451 | 5881 | 10271 | 7806 | 5511 | 4738 |
| L | 9519 | 7722 | 6429 | 10021 | 7660 | 5178 | 4924 |
| M | 9403 | 7701 | 6323 | 9878 | 7410 | 5125 | 4886 |
| N | 11614 | 9922 | 8830 | 11549 | 9027 | 6789 | 7406 |
| P | 11228 | 9693 | 8611 | 11082 | 8546 | 6437 | 7119 |
| Q | 11690 | 10165 | 9169 | 11441 | 9012 | 6807 | 7632 |
| R | 13030 | 11572 | 10692 | 12448 | 10315 | 8117 | 9076 |
| S | 13478 | 12148 | 11560 | 12242 | 10198 | 8347 | 9833 |
| U | 12443 | 12408 | 13195 | 9264 | 9280 | 9943 | 12147 |
| V | 2944 | 3880 | 4874 | 6030 | 6444 | 7546 | 6348 |
| DER Brochen dam wall | 5292 | 3325 | 1252 | 6077 | 4022 | 2005 | 341 |

The calculated ground vibration during blasting with 75kg and 100kg explosives per delay per blast is given in Table 6.13.

**Table 6-13: Calculated ground vibration levels (mm/s) at the different noise receptors during underground blasting (75kg/delay) at different blocks**

| Noise receptors | UG1 | UG2 | UG3 | UG4 | UG5 | UG6 | UG7 |
|---|---|---|---|---|---|---|---|
| K | 0.03 | 0.05 | 0.07 | 0.03 | 0.04 | 0.07 | 0.09 |
| L | 0.03 | 0.04 | 0.06 | 0.03 | 0.04 | 0.08 | 0.09 |
| M | 0.03 | 0.04 | 0.06 | 0.03 | 0.05 | 0.08 | 0.09 |
| N | 0.02 | 0.03 | 0.04 | 0.02 | 0.03 | 0.05 | 0.05 |
| P | 0.02 | 0.03 | 0.04 | 0.03 | 0.04 | 0.06 | 0.05 |
| Q | 0.02 | 0.03 | 0.03 | 0.02 | 0.03 | 0.05 | 0.04 |
| R | 0.02 | 0.02 | 0.03 | 0.02 | 0.03 | 0.04 | 0.03 |
| S | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.04 | 0.03 |
| U | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.02 |
| V | 0.19 | 0.12 | 0.09 | 0.06 | 0.06 | 0.05 | 0.06 |
| Dam wall | 0.08 | 0.16 | 0.68 | 0.06 | 0.12 | 0.33 | 4.85 |

Should the explosives during an underground blast be increased to 100kg per delay the vibration level at the dam wall during an underground blast at UG7 will be 6.03mm/s.

The noise contours when the haul road with the other mining activities and the overland conveyor , haul road and the other mining activities is illustrated in Annexure A and Annexure B respectively.

### 6.3.5 Calculation of road traffic noise

The main access road and other feeder roads in the vicinity of Der Brochen mine, R555, Lydenburg and Steelpoort are illustrated in Figure 6.1.

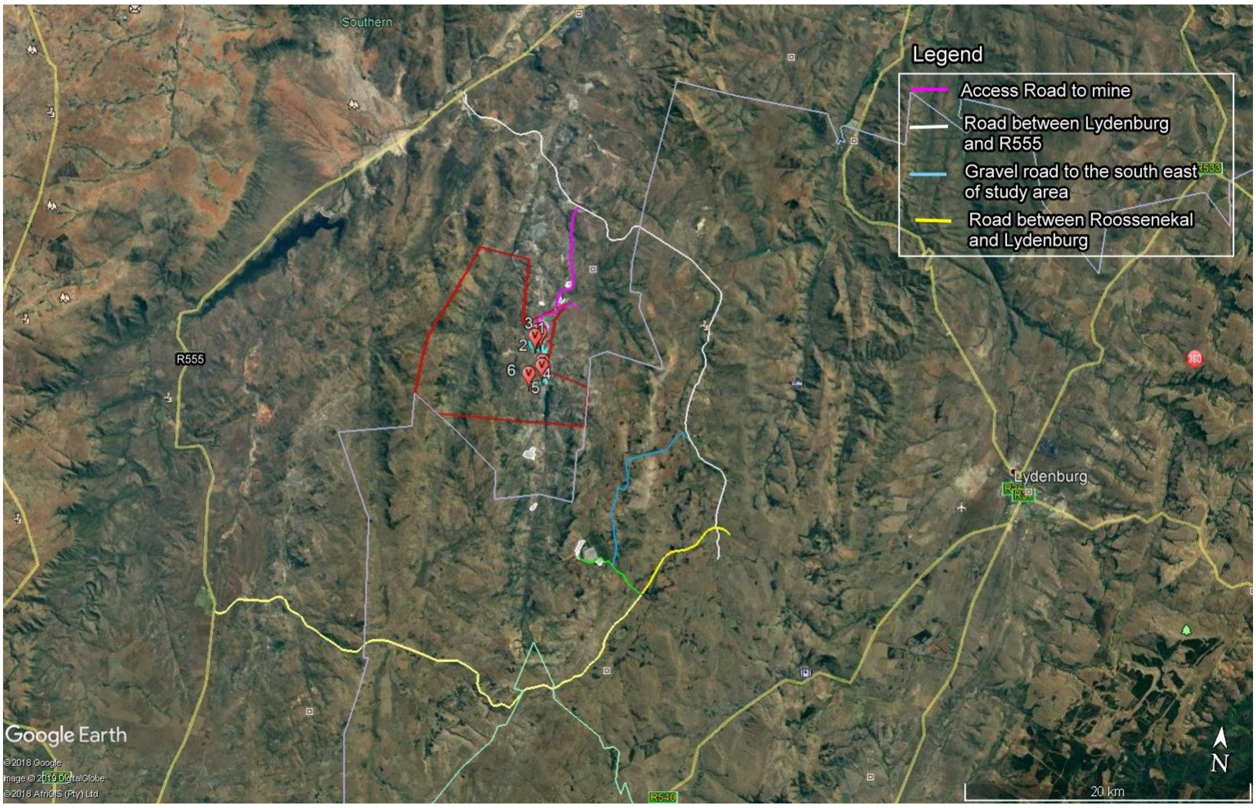



**Figure 6-1: Feeder roads in the vicinity of Der Brochen mine**

The calculations to determine the noise level from the additional traffic during peak times in the morning and the evening are based on the following equation:

SANS 10210 of 2004, the national standard for the calculating and predicting of road traffic noise was used to calculate the noise level to be generated by the traffic along the proposed road. The current status of traffic noise along the feeder road to the Booysensdal mine complex is illustrated in the following figure. This is a typical example of an intermittent type traffic flow with increased levels during peak periods. The measuring point was 20m from the edge of the road and the peak values were created by busses (7), taxis (6), and cars (5) over a period of 20-minutes.

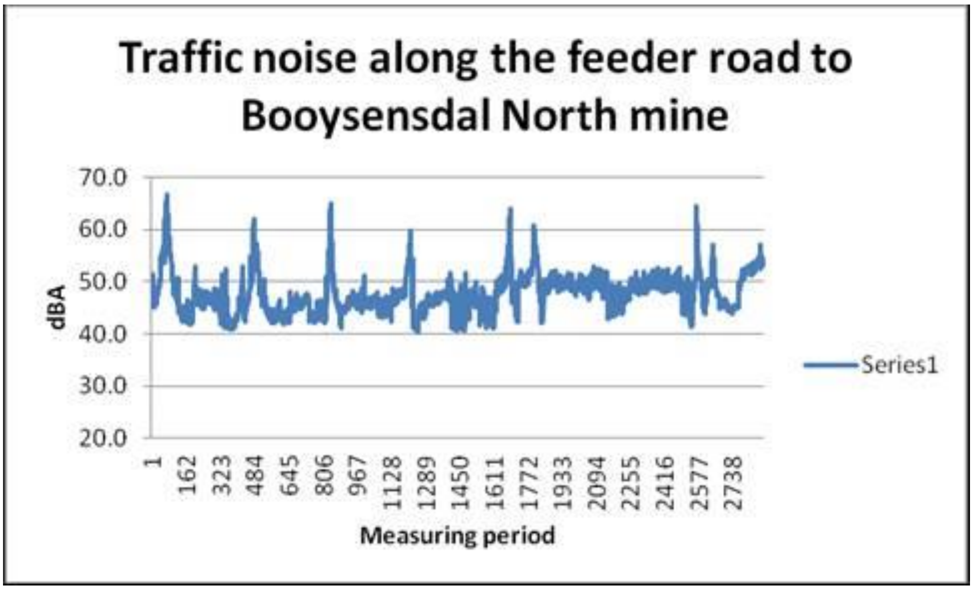



**Figure 6-2: Traffic noise levels along Booysensdal mine feeder road**

The calculation of the noise levels during the construction phase are based on a total of 52 vehicles per hour of which 45 will be heavy-duty vehicles and 7 will be motor-vehicles. The traffic volume per hour during the operational phase will be 95 vehicles of which 60 will be busses and 35 motor-vehicles per hour.

Basic Model

$L_{Basic} = 38.3 + 10 \text{ Log } (Q_r)$ dBA,

where; $L_{Basic}$ = basic noise level in dBA and $Q_r$ is the mean traffic flow per hour.

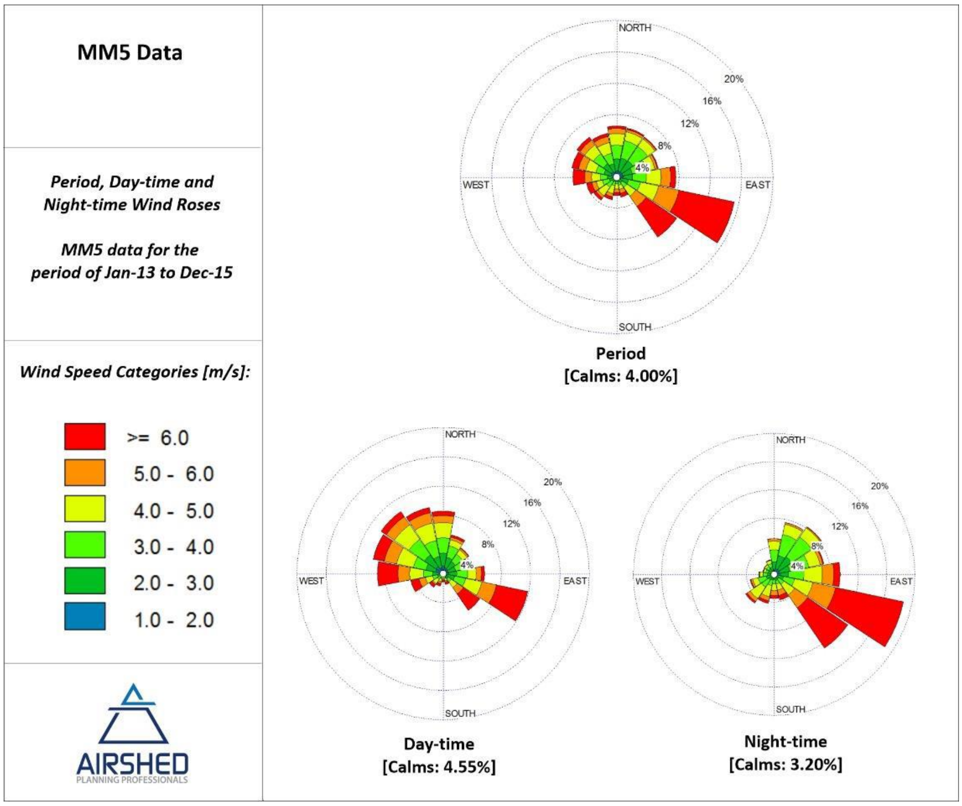
The calculated traffic noise level during the construction phase will be 57.5dBA at 25m from the road and 44.7dBA at 200m from the road. The traffic noise level during the operational phase will be 58.1dBA at 25m from the road and 45.6dBA at 200m from the road.

### 6.2.6 Wind direction

The wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind speeds; the yellow area, for example, representing winds in between 4m/s and 5m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated.

The flow field is dominated by south-easterly winds with a >14% frequency of occurrence. Thermo-topographical induced flow is anticipated to represent an important component in the airflow over the study area with significant differences evident between day-time and night-time wind field characteristics. The slope of the terrain accounts for the increased frequency of occurrence of northerly and north-westerly wind during the day-time and increased south easterly winds during the night-time. The differential heating and cooling of the air along a slope typically results in down-slope (katabatic) flow at night, with low-level up-slope (anabatic) airflow occurring during the day.

**Figure 6-3: Annual Average wind directions**




# 7. Noise impact assessment

In terms of the Noise Regulations a noise disturbance is created when the prevailing ambient noise level is exceeded by 7.0dBA or more. Noise however becomes audible when the prevailing ambient noise level is exceeded by 5.0dBA. It will therefore be more environmentally sustainable for a new development that the latter benchmark be used as a completely mechanised development will be introduced into an area where there is currently no noise except for natural type noises such as insect, bird or wind noise. The residents in the vicinity of the der Brochen mine were exposed to industrial type noise levels due to existing mining operations. The topography, wind direction, distances between the mine activities (point and/or linear noise sources) and the residential areas play an important role in how the sound will be propagated.

The slope of the terrain will account for the increased frequency of occurrence of south-easterly wind during the day-time and increased southerly to easterly winds during the night-time. Noise modelling was done for the operational phase during the day and night time periods for the summer and winter periods. These noise contours are attached as Appendix E. The noise projections were done with stable conditions with no winds. This illustrates that the sound will be confined to the valley with limited to no impact on the abutting noise receptors.

The topography between the proposed mine activities in the valley and some of the residential areas to the east and west are illustrated in the following figures and this will illustrate the natural barriers (high walls) which will create a natural noise barrier between the receptor/s and the proposed der Brochen mine.

The topography between north western and south eastern sides and the north eastern and the south western sides of the der Brochen mine are illustrated in Figure 7.1 and Figure 7.2 respectively.

**Figure 7-1: Topography between north eastern and south western sides**

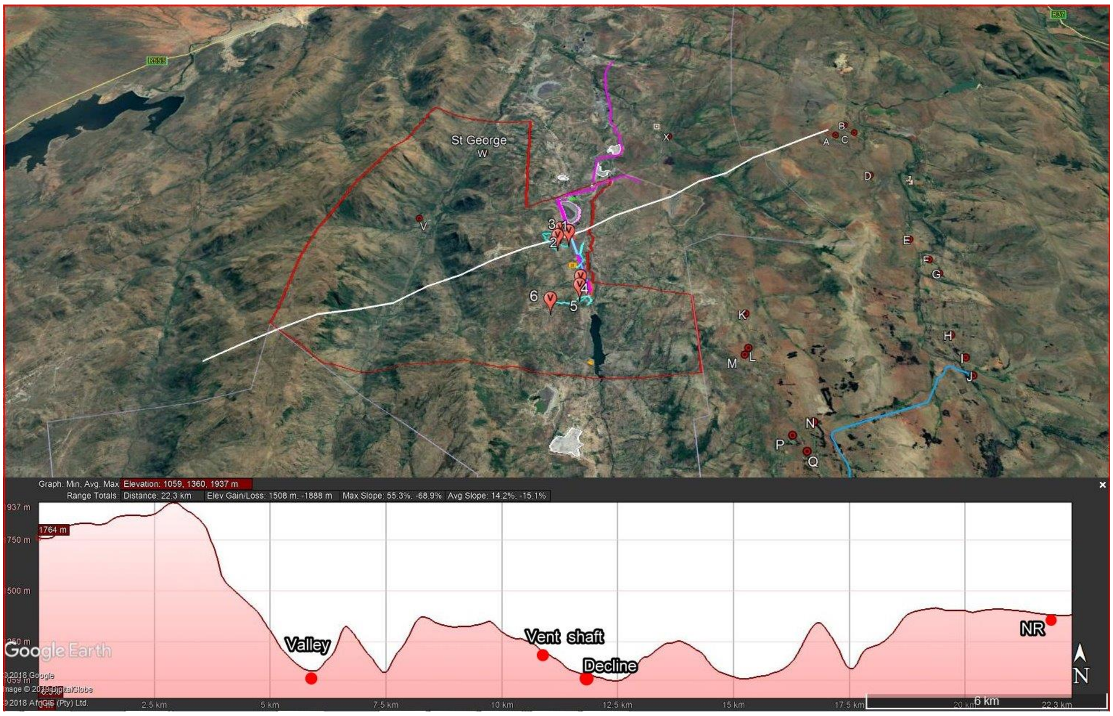
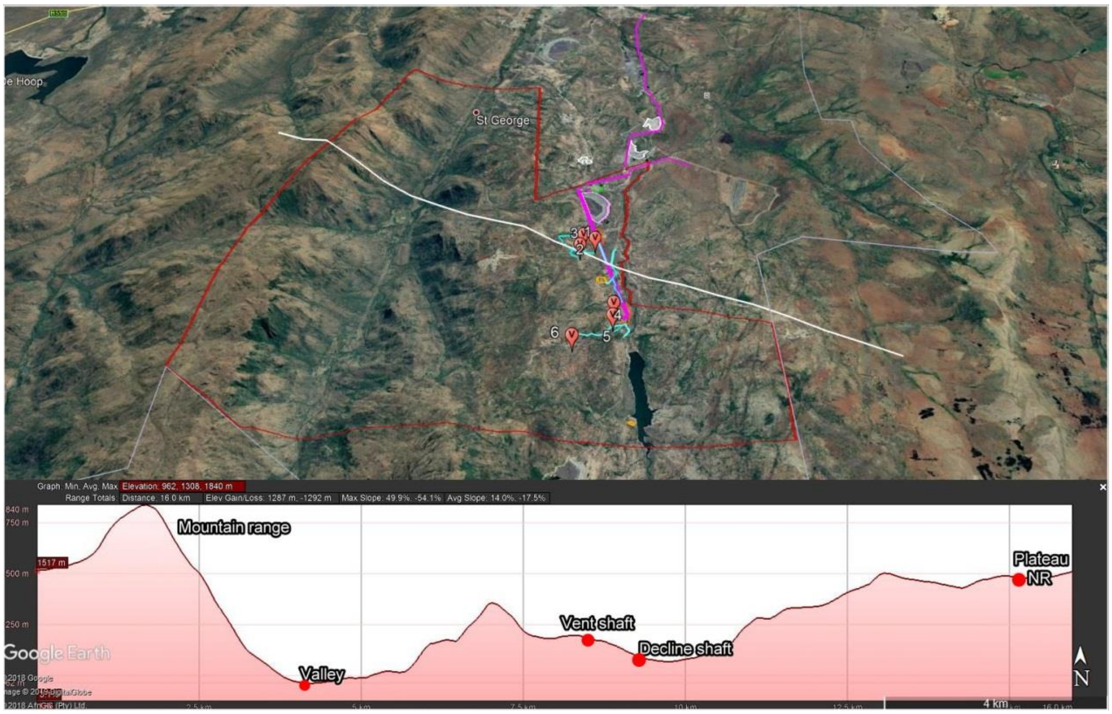



**Figure 7-2: Topography between the north western and south eastern**

**sides**




## 8. Vibration Impact Assessment

The vibration and over-air pressure levels which were evaluated for this project was based on blasting activities during the construction phase of the project. Blasting will be done at the decline shafts until it reaches the underground section of the der Brochen mine. The same physical attributes such as distance, topography and wind direction will play a role on how the receptors will perceive the over-air pressure and ground vibration levels which last for up to 3-seconds per blast.

## 9. Impact Identification and Assessment

Noise or sound is part of our daily exposure to different sources which is part of daily living and some of the sounds which are intrusive such as traffic noise forms part of the ambient noise that people get accustomed to without noticing the higher sound levels. Any person in the workplace and at home is exposed to the following noise levels as given in Table 9.1. These are the average noise levels in the workplace and at home that will mask noise from a source introduced into an area:

**Table 9-1: Different noise levels in and around the house and workplace**

| | **Activity** | **dBA** |
|---|---|---|
| Communication | Whisper | 30.0 |
| Communication | Normal Conversation | 55.0-65.0 |
| Communication | Shouted Conversation | 90.0 |
| Communication | Baby Crying | 80.0 |
| Communication | Computer | 37.0-45.0 |
| Home/Office | Refrigerator | 40.0-43.0 |
| Home/Office | Radio Playing in Background | 45.0-50.0 |
| Home/Office | Background Music | 50.0 |
| Home/Office | Washing Machine | 50.0-75.0 |
| Home/Office | Microwave | 55.0-59.0 |
| Home/Office | Clothes Dryer | 56.0-58.0 |
| Home/Office | Alarm Clock | 60.0-80.0 |
| Home/Office | Vacuum Cleaner | 70.0 |
| Home/Office | TV Audio | 70.0 |
| Home/Office | Flush Toilet | 75.0-85.0 |
| Industry | Industrial activities | 85.0-95.0 |
| Home/Office | Ringing Telephone | 80.0 |
| Home/Office | Hairdryer | 80.0-95.0 |
| Home/Office | Maximum Output of Stereo | 100.0-110.0 |

Two aspects are important when considering potential noise impacts of a project and it is:

- The increase in the noise level, and;
- The overall noise level produced.

## 9.1 Risk Assessment

A risk assessment methodology has been formalised to comply with Regulation 31(2)(l) of the National Environmental Management Act (Act 107 of 1998) as amended (NEMA). The identified noise sources for each stage of the proposed development will be assessed and mitigatory measures will be recommended to ensure compliance to the Noise Control Regulations and Blasting Standards.

The following activities may generate noise during the pre-construction phase of the project:

- Building of temporary roads;

The following activities may generate noise during the construction phase of the project:

- Clearing and stripping of topsoil and vegetation of south decline footprint;
- Construction activities at the Mototolo Concentrator plant;
- Construction activities of the crushers at the decline shaft;
- Construction of access road to South decline shaft; and
- Construction of access road to ventilation shafts 1, 2 and 3.
- Construction of the infra-structure at the different areas;
- Construction of the temporary haul road between south decline and the Mototolo plant;
- Construction of the overland conveyor from the south decline to the DMS;
- Installation of mining machinery and/or equipment at the decline shaft – south; and
- Construction of ventilation shaft south.

The noise sources within the project area that may create increased noise levels on a temporary and/or permanent basis during the <u>operational phase</u> of the project:

- DMS plant at the Mototolo concentrator plant;
- Crushing activities at the southern decline shaft;
- Southern upcast ventilation shaft;
- Additional traffic;
- Overland conveyor;
- TSF activities;
- Emergency generator; and,
- Crusher at Mototolo concentrator plant.

The following activities may generate noise during the <u>decommissioning phase</u> of the project:

- Backfill of mined areas;
- Planting of grass and vegetation at the rehabilitated area;
- Removal of infra-structure.

## 9.2 Environmental impact assessment

The impact assessment methodology has been formalised to comply with Regulation 31(2)(l) of the National Environmental Management Act (Act 107 of 1998) as amended (NEMA), which states the following:

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 …, and must include –

(l) 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**.

Based on the above, the EIA Methodology will require that each potential impact identified is clearly described (providing the nature of the impact) and be assessed in terms of the following factors:

- **extend** (spatial scale) - will the impact affect the national, regional or local environment, or only that of the site?
- **duration** (temporal scale) - how long will the impact last?;
- **magnitude** (severity) - will the impact be of high, moderate or low severity?; and
- **probability** (likelihood of occurring) - how likely is it that the impact may occur?.

To enable a scientific approach for the determination of the environmental significance (importance) of each identified potential impact, a numerical value has been linked to each factor.

The following ranking scales are applicable:

| | **Duration:** | **Probability:** |
|---|---|---|
| **Occurrence** | 5 – Permanent | 5 – Definite/don't know |
| | 4 - Long-term (ceases with the operational life) | 4 – Highly probable |
| | 3 - Medium-term (5-15 years) | 3 – Medium probability |
| | 2 - Short-term (0-5 years) | 2 – Low probability |
| | 1 – Immediate | 1 – Improbable |
| | | 0 – None |
| **Severity** | **Extent/scale:** | **Magnitude:** |
| | 5 – International | 10 - Very high/uncertain |
| | 4 – National | 8 – High |
| | 3 – Regional | 6 – Moderate |
| | 2 – Local | 4 – Low |
| | 1 – Site only | 2 – Minor |
| | 0 – None | |

Once the above factors had been ranked for each identified potential impact, the environmental significance of each impact can be calculated using the following formula:

*Significance = (duration + extend + magnitude) x probability*

The maximum value that can be calculated for the environmental significance of any impact is 100.

The environmental significance of any identified potential impact is then rated as either: high, moderate or low on the following basis:

- More than 60 significance value indicates a high (H) environmental significance impact;
- Between 30 and 60 significance value indicates a moderate (M) environmental significance impact; and
- Less than 30 significance value indicates a low (L) environmental significance impact.

In order to assess the ***degree to which the potential impact can be reversed and be mitigated***, each identified potential impact will need to be assessed twice.

- Firstly the potential impact will be assessed and rated prior to implementing any mitigation and management measures;  and
- Secondly, the potential impact will be assessed and rated after the proposed mitigation and management measures have been implemented.

The purpose of this dual rating of the impact before and after mitigation is to indicate that the significance rating of the initial impact is and should be higher in relation to the significance of the impact after mitigation measures have been implemented.

In order to assess the ***degree to which the potential impact can cause irreplaceable loss of resources***, the following classes (%) will be used and will need to select based on your informed decision and discression:

5) 100% - Permanent loss
4) 75% - 99% - significant loss
3) 50% - 74% - moderate loss
2) 25% - 49% - minor loss
1) 0% - 24% - limited loss

### 9.2.1 Impact assessment during the pre-construction phase

- Construction of temporary roads

**Table 9-2: Construction of temporary roads**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Construction of temporary roads** | | | | | |
| ***Project phase*** | *Pre-construction phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential properties* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 4 | 27 | Low |
| ***Mitigation measures*** | *Construction activities to be done during daytime working hours.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 3 | 2 | 4 | 18 | Low |

### 9.2.2 Impact assessment during the construction phase

The following mining establishment activities will be assessed:

- Clearing and stripping of topsoil and vegetation of south decline footprint;
- Construction activities at the Mototolo Concentrator plant;
- Construction activities of the crushers at the decline shaft;
- Construction of access road to south decline shaft;
- Construction of access road to ventilation shafts 1, 2 and 3;
- Construction of the infra-structure at the different areas;
- Construction of the temporary haul road between south decline and the Mototolo plant;
- Construction of the overland conveyor from the south decline to the DMS;
- Installation of mining machinery and/or equipment at the decline shaft – south; and
- Construction of ventilation shaft south.

**Table 9-3: Clearing and stripping of topsoil and vegetation at the south decline footprint**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Clearing and stripping of topsoil and vegetation of south decline footprint** | | | | | |
| ***Project phase*** | *Construction phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 6 | 33 | Moderate |
| ***Mitigation measures*** | *Earthwork activities to be done during daytime working hours unless there is no heavy duty machinery which may create a noise problem.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 3 | 2 | 4 | 27 | Low |

**Table 9-4: Construction activities at the Mototolo Concentrator plant**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Construction activities at the Mototolo Concentrator plant** | | | | | |
| ***Project phase*** | *Construction phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 6 | 33 | Moderate |
| ***Mitigation measures*** | • *Building activities to be done during daytime working hours only.*<br>• *All equipment which will be used will have to comply with the manufacturers specifications.*<br>• *Noise survey to be done to ensure that the 85.0dBA threshold value will not be exceeded.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 3 | 2 | 4 | 27 | Low |

**Table 9-5: Construction activities of the crushers at the decline shafts**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Construction activities of the crushers at the decline shafts** | | | | | |
| ***Project phase*** | *Construction phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 6 | 33 | Moderate |
| ***Mitigation measures*** | • *Building activities to be done during daytime working hours only.*<br>• *All equipment which will be used will have to comply with the manufacturers specifications.*<br>• *Noise survey to be done to ensure that the 85.0dBA threshold value will not be exceeded.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 3 | 2 | 4 | 27 | Low |

**Table 9-6: Construction of access road to south decline shaft**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Construction of access road to south decline shaft** | | | | | |
| ***Project phase*** | *Construction phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 6 | 33 | Moderate |
| ***Mitigation measures*** | • *Building activities to be done during daytime working hours only.*<br>• *All equipment which will be used will have to comply with the manufacturers specifications.*<br>• *Noise survey to be done to ensure that the 85.0dBA threshold value will not be exceeded.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 3 | 2 | 4 | 27 | Low |

**Table 9-7: Construction of access road to ventilation shafts 1, 2 and 3**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Construction of access road to ventilation shafts 1, 2 and 3** | | | | | |
| ***Project phase*** | *Construction phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 6 | 33 | Moderate |
| ***Mitigation measures*** | • *Building activities to be done during daytime working hours only.*<br>• *All equipment which will be used will have to comply with the manufacturers specifications.*<br>• *Noise survey to be done to ensure that the 85.0dBA threshold value will not be exceeded.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 3 | 2 | 4 | 27 | Low |

**Table 9-8: Construction of the infra-structure at the different areas**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Construction of the infra-structure at the different areas** | | | | | |
| ***Project phase*** | *Construction phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 6 | 33 | Moderate |
| ***Mitigation measures*** | • *Building activities to be done during daytime working hours only.*<br>• *All equipment which will be used will have to comply with the manufacturers specifications.*<br>• *Noise survey to be done to ensure that the 85.0dBA threshold value will not be exceeded.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 3 | 2 | 4 | 27 | Low |

**Table 9-9: Construction of the temporary haul road between south decline and the Mototolo plant**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Construction of the temporary haul road between south decline and the Mototolo plant** | | | | | |
| ***Project phase*** | *Construction phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 6 | 33 | Moderate |
| ***Mitigation measures*** | • *Building activities to be done during daytime working hours only.*<br>• *All equipment which will be used will have to comply with the manufacturers specifications.*<br>• *Noise survey to be done to ensure that the 85.0dBA threshold value will not be exceeded.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 3 | 2 | 4 | 27 | Low |

**Table 9-10: Construction of the overland conveyor from the south decline to the DMS**

| *Activity* | **Construction of the overland conveyor from the south decline to the DMS** | | | | | |
|---|---|---|---|---|---|---|
| *Project phase* | *Construction phase* | | | | | |
| *Impact Summary* | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| *Potential Impact Rating* | *Probability* | *Duration* | *Extent* | *Magnitude* | *Significance score* | *Significance* |
| | 3 | 3 | 2 | 6 | 33 | Moderate |
| *Mitigation measures* | • *Building activities to be done during daytime working hours only.*<br>• *All equipment which will be used will have to comply with the manufacturers specifications.*<br>• *Noise survey to be done to ensure that the 85.0dBA threshold value will not be exceeded.* | | | | | |
| *After Management Impact rating* | *Probability* | *Duration* | *Extent* | *Magnitude* | *Significance score* | *Significance* |
| | 2 | 3 | 2 | 4 | 27 | Low |

**Table 9-11: Installation of mining machinery and/or other equipment at the decline shaft**

| *Activity* | **Installation of mining machinery and/or equipment at the decline shaft** | | | | | |
|---|---|---|---|---|---|---|
| *Project phase* | *Construction phase* | | | | | |
| *Impact Summary* | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| *Potential Impact Rating* | *Probability* | *Duration* | *Extent* | *Magnitude* | *Significance score* | *Significance* |
| | 3 | 3 | 2 | 6 | 33 | Moderate |
| *Mitigation measures* | • *Building activities to be done during daytime working hours only.*<br>• *All equipment which will be used will have to comply with the manufacturers specifications.*<br>• *Noise survey to be done to ensure that the 85.0dBA threshold value will not be exceeded.* | | | | | |
| *After Management Impact rating* | *Probability* | *Duration* | *Extent* | *Magnitude* | *Significance score* | *Significance* |
| | 2 | 3 | 2 | 4 | 27 | Low |

**Table 9-12: Construction of ventilation shaft south**

| *Activity* | **Construction of ventilation shaft south** | | | | | |
|---|---|---|---|---|---|---|
| *Project phase* | *Construction phase* | | | | | |
| *Impact Summary* | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| *Potential Impact Rating* | *Probability* | *Duration* | *Extent* | *Magnitude* | *Significance score* | *Significance* |
| | 3 | 3 | 2 | 6 | 33 | Moderate |
| *Mitigation measures* | • *Building activities to be done during daytime working hours only.*<br>• *All equipment which will be used will have to comply with the manufacturers specifications.*<br>• *Noise survey to be done to ensure that the 85.0dBA threshold value will not be exceeded.* | | | | | |
| *After Management Impact rating* | *Probability* | *Duration* | *Extent* | *Magnitude* | *Significance score* | *Significance* |
| | 2 | 3 | 2 | 4 | 27 | Low |

### 9.2.3 Impact assessment during the operational phase

The following mining activities will be assessed:

- DMS plant at the Mototolo concentrator plant;
- Crushing activities at the southern decline shaft;
- Southern upcast ventilation shaft 1, 2 and 3;

- Additional traffic;
- Overland conveyor between the south decline and the concentrator;
- TSF activities;
- Emergency generator;
- Crusher at Mototolo concentrator plant;
- Stockpiling of ore at Mototolo Concentrator;
- Deposition of DMS material onto the DMS Stockpile area.
- Blasting impact during underground blasting (see Figure 6-1 in Noise Report 173/2019)

**Table 9-13: DMS plant at the Mototolo concentrator plant**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **DMS plant at the Mototolo concentrator plant** | | | | | |
| ***Project phase*** | *Operational phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 6 | 39 | Moderate |
| ***Mitigation measures*** | • *All noise sources exceeding 85.0dBA to be identified and if practical to be acoustically screened off.*<br>• *Noise survey to be done on a quarterly basis and after one year to change to an annual basis if the prevailing ambient noise levels at the boundaries of the Mototolo concentrator plant have not changed.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 4 | 33 | Moderate |

**Table 9-14: Crushing activities at the southern decline shaft**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Crushing activities at the southern decline shaft** | | | | | |
| ***Project phase*** | *Operational phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 6 | 39 | Moderate |
| ***Mitigation measures*** | • *All noise sources exceeding 85.0dBA to be identified and if practical to be acoustically screened off.*<br>• *Noise survey to be done on a quarterly basis and after one year to change to an annual basis if the prevailing ambient noise levels at the footprint boundaries are in line with the 70.0dBA threshold value.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 4 | 33 | Moderate |

**Table 9-15: Southern upcast ventilation shafts 1, 2 and 3.**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Southern upcast ventilation shafts 1, 2 and 3** | | | | | |
| ***Project phase*** | *Operational phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 6 | 39 | Moderate |
| ***Mitigation measures*** | • *All noise sources exceeding 85.0dBA to be identified and if practical to be acoustically screened off.*<br>• *Noise survey to be done on a quarterly basis and after one year to change to an annual basis if the prevailing ambient noise levels at the footprint boundaries are in line with the 70.0dBA threshold value.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 4 | 33 | Moderate |

**Table 9-16: Additional traffic**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Additional traffic** | | | | | |
| ***Project phase*** | *Operational phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 5 | 2 | 6 | 26 | Low |
| ***Mitigation measures*** | *Speed limit of mining areas to be adhered to at all times.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 5 | 2 | 4 | 22 | Low |

**Table 9-17: Overland conveyor between the south decline and the concentrator**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Overland conveyor between the south decline and the concentrator** | | | | | |
| ***Project phase*** | *Operational phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 5 | 2 | 6 | 26 | Low |
| ***Mitigation measures*** | • *Noise survey to be done on a quarterly basis and after one year to change to an annual basis if the prevailing ambient noise levels at the footprint boundaries are in line with the 70.0dBA threshold value.*<br>• *All screeching rollers to be replaced on a pro-active basis.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 5 | 2 | 4 | 22 | Low |

**Table 9-18: TSF activities**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **TSF activities** | | | | | |
| ***Project phase*** | *Operational phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 5 | 2 | 6 | 26 | Low |
| ***Mitigation measures*** | • *Noise survey to be done on a quarterly basis and after one year to change to an annual basis if the prevailing ambient noise levels at the footprint boundaries are in line with the 70.0dBA threshold value.*<br>• *All noise sources to be acoustically screened off.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 5 | 2 | 4 | 22 | Low |

**Table 9-19: Emergency generator**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Emergency generator** | | | | | |
| ***Project phase*** | *Operational phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 5 | 2 | 6 | 26 | Low |
| ***Mitigation measures*** | *Noise survey to be done at the footprint boundaries of the emergency generator and the threshold value of 70.0dBA may not be exceeded at any one time.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 5 | 2 | 4 | 22 | Low |

**Table 9-20: Crusher at Mototolo concentrator plant**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Crusher at Mototolo concentrator plant** | | | | | |
| ***Project phase*** | *Operational phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 6 | 39 | Moderate |
| ***Mitigation measures*** | • *All noise sources exceeding 85.0dBA to be identified and if practical to be acoustically screened off.*<br>• *Noise survey to be done on a quarterly basis and after one year to change to an annual basis if the prevailing ambient noise levels at the footprint boundaries are in line with the 70.0dBA threshold value.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 4 | 33 | Moderate |

**Table 9-21: Deposition of DMS material onto the DMS Stockpile area**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Deposition of DMS material onto the DMS Stockpile area** | | | | | |
| ***Project phase*** | *Operational phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 6 | 39 | Moderate |
| ***Mitigation measures*** | • *All noise sources exceeding 85.0dBA to be identified and if practical to be acoustically screened off.*<br>• *Noise survey to be done on a quarterly basis and after one year to change to an annual basis if the prevailing ambient noise levels at the boundaries of the Mototolo concentrator plant have not changed.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 4 | 33 | Moderate |

**Table 9-22: Blasting impact during underground blasting**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Blasting impact during underground blasting** | | | | | |
| ***Project phase*** | *Operational phase* | | | | | |
| ***Impact Summary*** | *Vibration increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 6 | 39 | Moderate |
| ***Mitigation measures*** | • *Blasting to be done in terms of the safe blast techniques.*<br>• *Ground vibration levels to be monitored at the noise receptors.*<br>• *Optimise blast design parameters and to control ground vibration at lowest possible levels.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 5 | 2 | 4 | 33 | Moderate |

### 9.2.4 Impact assessment during the decommissioning phase

**Table 9-23: Removal of infra-structure**

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Activity*** | **Removal of infra-structure** | | | | | |
| ***Project phase*** | *Decommissioning phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 4 | 27 | Low |
| ***Mitigation measures*** | *Demolition activities to be done during daytime working hours unless there is no heavy duty machinery which may create a noise problem.* | | | | | |
| | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***After Management Impact rating*** | 2 | 3 | 2 | 4 | 18 | Low |

**Table 9-24: Backfill of disturbed areas**

| ***Activity*** | **Backfill of disturbed areas** | | | | | |
|---|---|---|---|---|---|---|
| ***Project phase*** | *Decommissioning phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 4 | 27 | Low |
| ***Mitigation measures*** | *Earthworks activities to be done during daytime working hours unless there is no heavy duty machinery which may create a noise problem.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 3 | 2 | 4 | 18 | Low |

**Table 9-25: Planting of grass and vegetation at rehabilitated**

| ***Activity*** | **Planting of grass and vegetation at rehabilitated area** | | | | | |
|---|---|---|---|---|---|---|
| ***Project phase*** | *Decommissioning phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 4 | 27 | Low |
| ***Mitigation measures*** | *Planting of grass and vegetation to be done during daytime working.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 3 | 2 | 4 | 18 | Low |

### 9.2.5 Impact assessment during the post closure phase

**Table 9-26: Maintenance of disturbed areas**

| ***Activity*** | **Maintenance of disturbed areas** | | | | | |
|---|---|---|---|---|---|---|
| ***Project phase*** | *Post closure phase* | | | | | |
| ***Impact Summary*** | *Noise increase at the boundary of the mine footprint and at the abutting residential areas* | | | | | |
| ***Potential Impact Rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 3 | 3 | 2 | 4 | 27 | Low |
| ***Mitigation measures*** | *Maintenance activities to be done during daytime working hours.* | | | | | |
| ***After Management Impact rating*** | ***Probability*** | ***Duration*** | ***Extent*** | ***Magnitude*** | ***Significance score*** | ***Significance*** |
| | 2 | 3 | 2 | 4 | 18 | Low |

## 9.3 Summary of the potential impacts

The proposed der Brochen mine expansion project will take place in an area where there are other mining activities and feeder roads with a continuous flow of traffic during the day and intermittent traffic flow during the night. The prevailing ambient noise level in the vicinity was made up out of traffic noise and mining activity noises.

The potential noise and vibration impact will be low during the post construction, decommissioning and post closure phases. The implementation of noise mitigatory measures will ensure that the impact will change from moderate to low.

Blasting during the construction phase (opening of the decline shaft and the ventilation shafts 1, 2 &3 will be the biggest increase in the prevailing ambient noise level on an intermittent basis. The blasting activities during the construction phase must be done in conjunction with the safe blasting techniques and monitoring of each blast must take place. The use of mechanised machinery will create a noise increase in the immediate vicinity of the construction activity.

The ground vibration during underground blasting will be below 0.5mm/s at the abutting noise receptors except at the dam wall during a blast of 75.0kg per delay at UG 7 when the ground vibration level at the dam wall will be 4.85mm/s. The geology and the type of dam wall will have to be assessed to establish if the current dam wall can resist such levels of ground vibration.

The following mining related activities will create a noise increase in the immediate vicinity of the mining activities on a permanent basis:

- Mine ventilation shafts 1, 2 & 3;
- DMS plant activities;
- Crushing activities at the decline shafts and at the concentrator plant;
- Emergency generators;
- Traffic to the mining areas;
- Emergency sirens; and
- Reverse signals on mining vehicles.

Noise monitoring according to the noise monitoring management plan to be carried out to identify the noise sources on a pro-active manner.

# 10. Recommendations

The following three primary variables should be considered when designing acoustic screening measures for the control of sound and/or noise:

- The source – Reduction of noise at the source;
- The transmission path – Reduction of noise between the source and the receiver;
- The receiver – Reduction of the noise at the receiver.

The last option is not applicable and the noise levels at the noise source will be controlled on a pro-active manner when and if such increase the prevailing noise levels.

## 10.1 Acoustic screening recommendations

The acoustic screening measures for the project are given in Table 10.1. These are based on the best practicable methods, acoustic screening techniques and the IFC's Health and Safety Guidelines.

**Table 10-1: Recommended acoustic screening measures**

| Activity | Recommendations |
|---|---|
| Construction phase | • Equipment and/or machinery which will be used must comply with the manufacturer's specifications on acceptable noise levels and any noise sources above 85.0dBA to be acoustically screened off.<br>• Construction activities to take place during daytime period only.<br>• Blasting to be done during daytime and to use the safe blasting techniques.<br>• Ground vibration monitoring must be done at the nearest residential areas during each blast.<br>• Environmental noise monitoring on a quarterly basis. |
| Operational phase | • Equipment and/or machinery which radiate noise levels between 85.0dBA and 90.0dBA to be acoustically screened off.<br>• The ventilation shaft outlet to face away from any residential area.<br>• Emergency generators to be placed in such a manner that it is away from any residential area.<br>• Noise monitoring to be carried out along the footprint boundaries at the Mototolo concentrator plant, decline shaft (south), ventilation shafts, ventilation plant, overland conveyor;<br>• Noise monitoring at the residential areas and the mine boundaries to be done on a quarterly basis for a year after which the frequency can change to an annual basis;<br>• Actively manage the process and the noise management plan must be used to ensure compliance to the noise regulations and/or standards. The levels to be evaluated in terms of the baseline noise levels.<br>• Blasting to be done in terms of the safe blast techniques.<br>• Ground vibration levels to be monitored at the noise receptor V.<br>• Optimise blast design parameters and to control ground vibration at lowest possible levels. |
| Decommissioning phase | • Machinery with low noise levels which complies with the manufacturer's specifications to be used; and<br>• Activities to take place during daytime period only. |

The following are the Environmental, Health and Safety Guidelines of the IFC of the World Bank, which should be taken into consideration during the construction, operational and decommissioning phases of the project:

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;

- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment causing radiating noise;
- Installing vibration isolation for mechanical equipment;
- Re-locate noise sources to areas which are less noise sensitive, to take advantage of distance and natural shielding;
- Taking advantage during the design stage of natural topography as a noise buffer;
- Develop a mechanism to record and respond to complaints.

The following noise impact management plan Table 10.2 will be applicable during the pre-construction, construction, operational, decommissioning and post closure phases:

The Noise Impact Management Plan (NIMP) for the proposed mine establishment will consist of the following as illustrated in Table 10-2. Regular environmental monitoring (ground vibration and airborne noise propagation) will provide the data for reviewing, checking and revising the NIMP.

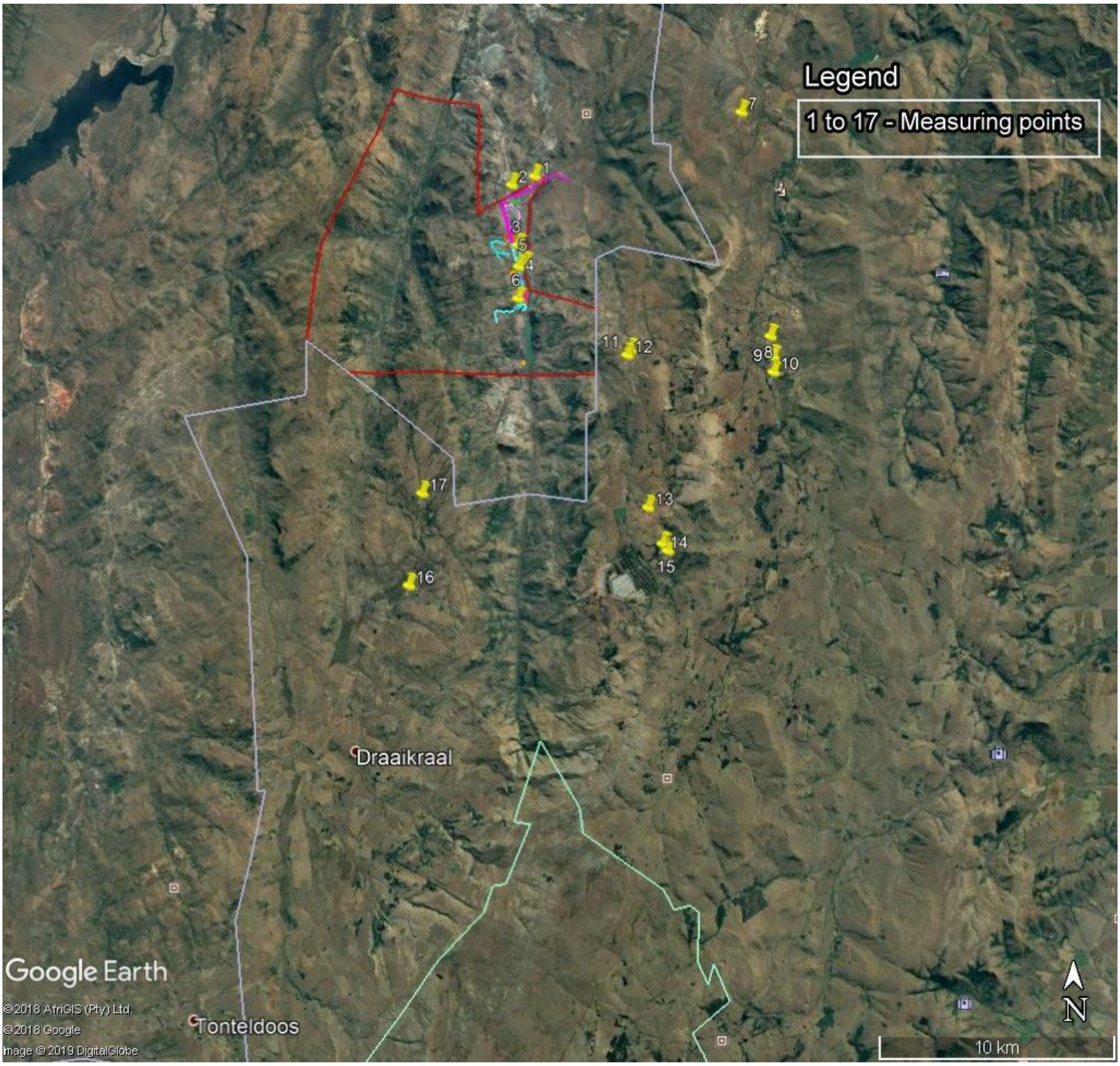
**Table 10-2: Noise and vibration environmental management plan**

| Action | Description | Frequency | Responsible person |
|---|---|---|---|
| Management objective | To ensure that the legislated noise and ground vibration levels will be adhered to at all times. | Quarterly for a period of a year after which the frequency can change to an annual basis. | The engineer during the construction phase and the responsible person (der Brochen Environmental Department) during the operational phase of the project |
| Monitoring objective – Construction phase | Measure the environmental noise levels and ground vibration levels during the construction phase of the project to ensure compliance to the recommended noise and vibration levels. | Quarterly for a period of a year after which the frequency can change to an annual basis. | Der Brochen environmental department |
| Monitoring objective – Operational phase | Measure the environmental noise levels and ground vibration levels during the operational phase of the project to ensure compliance to the recommended noise and vibration levels. | Quarterly for a period of a year after which the frequency can change to an annual basis. | Der Brochen environmental department |
| Monitoring technology | The environmental noise monitoring must take place with a calibrated Class 1 noise monitoring equipment.<br><br>Ground vibration and over-air pressure noise levels must be | Quarterly for a period of a year after which the frequency can change to an annual basis. | Der Brochen environmental department |

| | | | |
|---|---|---|---|
| | monitored with calibrated ground vibration and air-over pressure equipment. | | |
| Specify how the collected information will be used | The data must be collated and discussed on a monthly basis during the construction phase and on a quarterly basis during the operational phase for the first two years thereafter on an annual basis with the Booysendal Mine Environmental Department | Quarterly for a period of a year after which the frequency can change to an annual basis. | Der Brochen environmental department |
| Spatial boundaries | At the boundaries of the identified residential areas A to W as well as at the boundaries of the different mining areas. | Quarterly for a period of a year after which the frequency can change to an annual basis. | Der Brochen environmental department |
| Define how the data will be analysed and interpreted and how it should be presented in monitoring reports | Reports must be compiled for each monitoring cycle and the results must be compared to the previous set of results to determine if there was a shift in the prevailing ambient noise and vibration levels. | Quarterly for a period of a year after which the frequency can change to an annual basis. | Der Brochen environmental department |
| Accuracy and precision of the data | The noise and vibration surveys will have to be conducted in terms of the recommendations of SANS 10103 of 2008 and vibration standards. | Calibrated equipment must be used at all times and at the measuring points given in Figure 10.1. | Environmental noise and vibration specialist |

The proposed noise monitoring points for the study area is illustrated in Figure 10.1.

**Figure 10-1: Proposed measuring points for the der Brochen mine expansion project**




## 10.2 Recommended conditions for authorisation

The following conditions will be applicable from an environmental noise and vibration point of view:

- Baseline environmental noise and vibration levels to be measured and recorded;
- All acoustic screening measures must be in place before commissioning the mining activities;
- Environmental noise and vibration monitoring to be carried out during the different phases of the project;
- All noise sources at the different mining areas to be identified and registered;

- The noise (Noise Control Regulations, 1994) and vibration (BMRI 8507) control legislation and/or guidelines to be adhered to at all times.

## 11. Conclusion

The noise and vibration impact during the pre-construction, construction and post-closure phases will be insignificant during summer and winter periods. The noise impact will change during the operational phase where the noise intrusion will be moderate to low. This is based on a noise intrusion level of 5.0dBA and not the benchmark noise intrusion of 7.0dBA before a noise disturbance is created. The ground vibration levels at the abutting noise receptors K,L,M,N,P,Q,V,U will be below 0.5mm/s which is insignificant and at the dam wall during an underground blast at UG7 of 4.85mm/s

The potential noise intrusion from the blasting and mine activities can however be controlled by means of approved acoustic screening measures, state of the art equipment, proper noise management principles and compliance to the Noise Regulations, 1994 and the International Finance Corporation's Environmental Health and Safety Guidelines. The proposed noise and vibration management plan must be in place during the construction and operational phases so as to identify any noise increase on a pro-active basis and to address the problem accordingly.

The proposed der Brochen mine establishment will be in line with the noise and vibration standards and guidelines provided that all the noise mitigatory measures are in place and that the Noise Impact Management Plan (NIMP) and Noise Monitoring Plan (NMP) for der Brochen mine is adhered to.

Barend van der Merwe – MSc UJ

Environmental noise and vibration specialist

12. List of Definitions and Abbreviations

## 12.1 Definitions

**Ambient noise**

The totally encompassing sound in a given situation at a given time and usually composed of sound from many sources, both near and far

A-weighted sound pressure level (sound level) ($L_{pA}$), in decibels

The A-weighted sound pressure level is given by the equation:

$L_{pA} = 10 \log (p_A/p_o)^2$

Where

$p_A$ is the root-mean-square sound pressure, using the frequency weighting network A in pascals; and

$p_o$ is the reference sound pressure ($p_o$ = 20 μPa).

NOTE The internationally accepted symbol for sound level is dBA.

**Distant source**

A sound source that is situated more than 500 m from the point of observation

Equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$), in decibels

The value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval $T$, has the same mean-square sound pressure as a sound under consideration whose level varies with time. It is given by the equation

$$L_{Aeq,T} = 10 \log \left[ \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} \frac{p_A^2(t)}{p_o^2} \, dt \right]$$

Where

$L_{Aeq,T}$ is the equivalent continuous A-weighted sound pressure level, in decibels, determined over a time interval $T$ that starts at $t_1$ and ends at $t_2$;

$p_o$ is the reference sound pressure ($p_o$ = 20 μPa); and

$p_A(t)$ is the instantaneous A-weighted sound pressure of the sound signal, in pascals.

**Impulsive sound**

Sound characterised by brief excursions of sound pressure (acoustic impulses) that significantly exceed the residual noise

**Initial noise**

The component of the ambient noise present in an initial situation before any change to the existing situation occurs

**Intelligible speech**
Speech that can be understood without undue effort

**Low frequency noise**
Sound, which predominantly contains frequencies below 100 Hz

**Nearby source**
A sound source that is situated at a distance of 500 m or less from the point of observation

**Residual noise**
The ambient noise that remains at a given position in a given situation when one or more specific noises are suppressed

**Specific noise**
A component of the ambient noise which can be specifically identified by acoustical means and which may be associated with a specific source
NOTE Complaints about noise usually arise as a result of one or more specific noises.

**Ambient sound level**
Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such meter was put into operation.

**Disturbing noise**
Means a noise that causes the ambient noise level to rise above the designated zone level by 7.0dBA or if no zone level has been designated, the typical rating levels for ambient noise in districts, indicated in table 2 of SANS 10103.

**Noise nuisance**
Means any sound which disturbs or impairs the convenience or peace of any person

## 12.2 Abbreviations

dBA – A-weighted sound pressure level;

IBR – Angular trapezoidal fluted profile sheet;

IFC – International Finance Corporation;

Km/h - Kilometres per hour;

Kg/m$^3$ – Kilogram per cubic meter;

m/s – meters per second;

NIMP – Noise impact management plan;

NMP – Noise monitoring plan;

NSA – Noise sensitive areas;

$L_{Basic}$ – Basic noise level in dBA;

SANS – South African National Standards;

TLB – Tractor-loader-backhoe

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Appendix A

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**M AND N ACOUSTIC SERVICES** (Pty) Ltd
Co. Reg. No: 2012/123238/07 VAT NO: 4300255876 BEE Status: Level 4
P.O. Box 61713, Pierre van Ryneveld, 0045
No. 15, Mustang Avenue
Pierre van Ryneveld, 0045
Tel: 012 689 2007/8 • Fax: 086 211 4690
E-mail: calservice@mweb.co.za

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| ORGANISATION | dB ACOUSTICS |
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| CALIBRATION OF | INTEGRATING SOUND LEVEL METER complete with built-in ⅓ OCTAVE/OCTAVE FILTER and ½" MICROPHONE |
| MANUFACTURERS | LARSON DAVIS and PCB |
| MODEL NUMBERS | 831, PRM 831 and 377B02 |
| SERIAL NUMBERS | 0001072, 0206 and 102184 |
| DATE OF CALIBRATION | 15 AUGUST 2018 |
| RECOMMENDED DUE DATE | AUGUST 2019 |
| PAGE NUMBER | PAGE 1 OF 6 |

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## Annexure B - Haul road

## Annexure C – Conveyor route