Blast Management & Consulting

Quality Service on Time

Report: Blast Impact Assessment Proposed Nhlabathi Minerals (Pty) Ltd Rietkol Mining Operation (Rietkol Project)	
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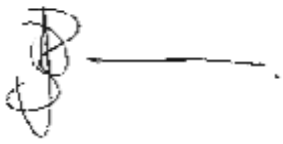
Signed:	
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ii. Independence Declaration

Blast Management & Consulting is an independent company. The work done for the report was performed in an objective manner and according to national and international standards, which means that the results and findings may not all be positive for the client. Blast Management & Consulting has the required expertise to conduct such an investigation and draft the specialist report relevant to the study. Blast Management & Consulting did not engage in any behaviour that could be result in a conflict of interest in undertaking this study.

iii. Legal Requirements

In terms of the NEMA 2014 EIA Regulations contained in GN R982 of 04 December 2014 all specialist studies must comply with Appendix 6 of the NEMA 2014 EIA Regulations (GN R982 of 04 December 2014). Table 1 show the requirements as indicated above.

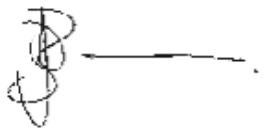
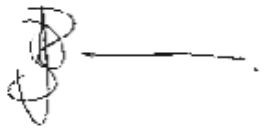
Table 1: Legal Requirements for All Specialist Studies Conducted

Legal Requirement		**Relevant Section in Specialist study**
(1)	A specialist report prepared in terms of these Regulations must contain-	
(a)	details of-	
	(i) the specialist who prepared the report; and	i
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae	Section ii and 23

Legal Requirement		**Relevant Section in Specialist study**
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Section iii
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 4
(d)	the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 8
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process	Section 6
(f)	the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	Section 11
(g)	an identification of any areas to be avoided, including buffers;	Section 11
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 11
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 9
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	Section 17
(k)	any mitigation measures for inclusion in the EMPr;	Section 17.14
(l)	any conditions/aspects for inclusion in the environmental authorisation;	Section 21
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 20
(n)	a reasoned opinion (Environmental Impact Statement)-	Section 23
	as to whether the proposed activity or portions thereof should be authorised; and	Section 23
	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 23
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 12
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Section 12

Legal Requirement		**Relevant Section in Specialist study**
(q)	any other information requested by the competent authority.	None

iv. Document Control:

Name & Company	Responsibility	Action	Date	Signature
C Zeeman Blast Management & Consulting	Document Preparation	Report Prepared	23/03/2018	
JD Zeeman Blast Management & Consulting	Consultant	Report Finalise	05/05/2018	
C Zeeman Blast Management & Consulting	Document Preparation	Report Amended with new Infrastructure Layout	06/05/2021	
JD Zeeman Blast Management & Consulting	Consultant	Report Finalised	06/05/2021	

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List of Acronyms used in this Report

a and b	Site Constant
ANFO	Ammonium nitrate fuel oil
APP	Air Pressure Pulse
B	Burden (m)
BH	Blast Hole
BM&C	Blast Management & Consulting
Bs	Scaled Burden ($m^{3/2}kg^{-1/2}$)
D	Distance (m)
D	Duration (s)
E	East
E	Explosive Mass (kg)
EIA	Environmental Impact Assessment
Freq.	Frequency
GRP	Gas Release Pulse
I&AP	Interested and Affected Parties
k	Factor value
L	Maximum Throw (m)
Lat/Lon	Latitude/Longitude
hddd°mm'ss.s"	Hours/degrees/minutes/seconds
M	Charge Height
m (SH)	Stemming height
M/S	Magnitude/Severity
Mc	Charge mass per metre column
N	North
NE	Northeast
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxide
NOx's	Noxious Fumes
NW	Northwest
P	Probability
POI	Points of Interest
PPD	Peak particle displacement
PPV	Peak Particle Velocity
PVS	Peak vector sum
RPP	Rock Pressure Pulse
S	Scale

S	South
SE	Southeast
SH	Stemming height (m)
SW	Southwest
T	Blasted Tonnage
TNT	Explosives (Trinitrotoluene)
USBM	United States Bureau of Mine
W	West
WGS 84	Coordinates (South African)
WM	With Mitigation Measures
WOM	Without Mitigation Measures

List of Units used in this Report

%	percentage
cm	centimetre
dB	decibel
dBL	linear decibel
g	acceleration
g/cm^3	gram per cubic centimetre
Hz	frequency
kg	kilogram
kg/m^3	kilogram per cubic metre
kg/t	kilogram per tonne
km	kilometre
kPa	kilopascal
m	metre
m^2	metre squared
MJ	Mega Joules
MJ/m^3	Mega Joules per cubic meter
MJ/t	Mega Joules per tonne
mm/s	millimetres per second
mm/s^2	millimetres per second square
ms	milliseconds
Pa	Pascal
ppm	parts per million
psi	pounds per square inch
θ	theta or angle

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1 Executive Summary

Blast Management & Consulting (BM&C) was contracted as part of Environmental Impact Assessment (EIA) to perform an initial review of possible impacts with regards to blasting operations at the proposed Rietkol Mining Operation (Rietkol Project). Ground vibration, air blast, fly rock and fumes are some of the aspects that result from blasting operations. The report concentrates on the ground vibration and air blast and intends to provide information, calculations, predictions, possible influences and mitigations of blasting operations for this project.

The evaluation of effects yielded by blasting operations was evaluated over an area as wide as 3500 m from the mining area considered. The effects of ground vibration, air blast and fly rock specifically were evaluated. There are various structures and installations observed surrounding the project area ranging from typical roads (tar and gravel), low cost houses, corrugated iron structures, brick and mortar houses, Agricultural buildings, Hot Houses/Flower Tunnels, boreholes and heritage sites.

This project is a greenfields project with no existing blasting operations.

The location of structures around the open pit areas is such that the charges evaluated showed possible influences due to ground vibration. The closest structures observed are the Heritage Site (Informal Graveyard - 20 graves), Heritage Site (Old Trigonometrical beacon), Heritage Site (Ruins of a house/outbuilding), Farm Buildings/Structures, Hot Houses/Nursery/Orchards, Informal Housing Settlement, Agricultural Buildings and Buildings (Business Commercial).

Initial evaluation of ground vibration indicates that mitigation will be required for surrounding structures and installations. Ground vibrations predicted for all pit areas ranged between low and very high. The minimum charge used indicated thirteen POI's of concern. Six of these POI's are located inside the pit area, seven are located inside the MRA with no POI's located outside the MRA. The maximum charge indicated sixteen POI's of concern. Six of these POI's are inside the pit area, eight are located inside the MRA and two are located outside the MRA and regarded as private. Ground vibration at structures and installations other than the identified problematic structures is well below any specific concern for inducing damage.
Proposed mitigation reduces the range of influence significantly. Ground vibration exceedance predicted is only observed for structures inside the MRA. Expected levels of ground vibration at structures outside the MRA is expected to be within acceptable limits.

Air blast predicted showed some concerns for opencast blasting. Maximum air blast levels predicted showed levels greater than the limit for structures. The current accepted limit on air blast is 134 dB for house structures. Damages are only expected to occur at levels greater than 134dB. Limits for hot houses and tunnels are lower at 120 dB due to the plastic covering used. High levels may

contribute to effects such as rattling of roofs or door or windows with limited points that are expected to be damaging and others could lead to complaints.
Initial charges considered indicates that air blast will be greater than 134 dB at a distance of 266 m and closer to pit boundaries. Maximum charge predictions indicate that forty-six POI's could experience air blast that could lead to complaints and seventeen POI's are identified where levels are greater than applied limit. Six POI's are located inside the MRA and eleven are located outside the MRA on private land which include six hothouses / tunnels with a lower limit than normal house structures. It is expected that structures within the mining right application (MRA) area may be relocated and thus not problematic. The Hot Houses/Nursery/Orchards (POI 4), Farm Buildings (POI 3), Informal Housing Settlement (POI 5 & 259), Agricultural Buildings/Flower Tunnels (POI 164), Agricultural Buildings (POI 165) and Buildings (Business Commercial) (POI 222) are a concern for the initial evaluation done. After mitigation possible influence is reduced to one structure (POI 4) outside the MRA. Based on levels greater than 120dB but less than the formal limit of 134 dB for possible structural damage, three POI's were identified where complaints may arise due to air blast.

Blast preparation and specific stemming controls will need to be exercised effectively. The pits are located such that "free blasting" – meaning no controls on blast preparation – will not be possible.

An exclusion zone for safe blasting was also calculated based on possible fly rock travel range. The exclusion zone was established to be at least 526 m. Generally, a minimum exclusion zone of 500 m for mining operations as a minimum but based on initial evaluation a minimum of at least 526 m should be used. This distance exclusion zone will include the Farm Buildings/Structures, Informal Housing Settlement, Hot Houses/Nursery/Orchards, Agricultural Buildings/Flower Tunnels, Hydrocensus Boreholes and Heritage Sites. Proposed mitigations reduces the exclusion zone to 105 m. This is due to the use of proper stemming lengths and stemming material. This reduction excludes all structures outside the MRA.

Eighty-Seven Hydrocensus boreholes were identified within the influence area at the Pit areas. There are boreholes that are in close proximity of the blasting areas but are found to be within acceptable limits. There is one borehole that falls within the North Block Pit area. This borehole will be destroyed. At all other identified boreholes, the expected levels of ground vibration were found to be within acceptable limits.

Recommendations were made and should be considered. Specific actions will be required for all pit areas such as Mine Health and Safety Act requirements when blasting is done within 500 m from private structures. Structure inspections to be considered at least up to 1200 m from the pit area. People is expected to experience ground vibrations as perceptible to this distance.

A specific blast design was proposed as mitigation measure to be considered. The application of the design reduces the area of influence. Ground vibration levels are reduced to no levels greater than applied limit for any structure outside the MRA. Air blast levels are reduced to one agricultural tunnel outside the MRA being just greater than the proposed limit and fly rock exclusion zone reduced to 105 m.

No roads are negatively impacted with regards to ground vibration. The farming community around the pit areas must be considered when temporary closures of roads are required during blasting operations.

The probable influence of blasting operations on animals causing fatalities is none. Different animals will react different to the noise effect and in many cases gets used to the noise. There is however concern with regards to horses and their reaction to sudden noises. The noise effect expected is rather a rumble effect and not loud instant bangs. An understanding will need to be arranged between horse owners and the mine when blasting is done that that no riding is done for that short period. The reaction of horses and chickens are to be monitored from the onset of blasting operations. A mitigation process can then be further detailed to the satisfactory of both parties.

The pit areas are located such that specific concerns were identified and addressed in the report. The author is of opinion that the project will be possible but only under circumstances that will be acceptable by the client and the neighbouring community. A changed consideration of blast designs and possible bench levels will be required.

This concludes this investigation for the proposed Rietkol Project.

2 Introduction

Consol Glass (Pty) Limited (Consol) has recently reorganised its mining interests in terms of the Mineral and Petroleum Resources Development Act (MPRDA), 2002 (Act 28 of 2002). The developer (applicant) for the Rietkol Mining Operation (Rietkol Project) is Nhlabathi Minerals (Pty) Ltd (Nhlabathi), a wholly owned subsidiary of Apex Silica Mining (Pty) Ltd. An application for a Mining Right to mine silica and associated minerals (clay, sand, etc.) was submitted to the Department of Mineral Resources (DMR) in terms of section 22 of the MPRDA.

The Rietkol Project is located in Wards 8 and 9 of the Victor Khanye Local Municipality within the Nkangala District Municipality of Mpumalanga Province at coordinates (Lat/Lon WGS84) 26° 7'41.22"S; 28°36'26.06"E. Delmas/Botleng is approximately 6 km east and Eloff 4 km south of the Mining Right Application (MRA) area. The Rietkol Project is located strategically close to major roads in the area, including the N12 (to the north-west), R50 (to the north-east) and R555 (to the south). The Springs/Durban Transnet Freight Rail (TFR) railway line is situated to the south, alongside the R555.

The Rietkol MRA covers an area of 221 ha consisting of:

- 16 Modder East Agricultural Holdings on the farm Olifantsfontein 196 IR, each approximately 4.1 ha in extent;
- Portion 71 of the farm Rietkol 237 IR; and
- A portion of Remaining Extent (RE) of portion 31 of the farm Rietkol 237 IR.

Silica is planned to be mined by means of conventional opencast methods to a depth of between 30 and 50 meters below surface (mbs). The estimated life of mine (LOM) for the proposed Rietkol Project is 20 years. Further exploration drilling will be conducted during the operational phase, which may increase the LOM and mining depth if the resource proofs viable. It is important to note that this EA application deals with the first 20 years of mining only.

The proposed project includes the following mining and related infrastructure:

- Opencast pits;
- Run of mine (RoM) stockpiles;
- Processing plant (crushing, screening, washing and drying operations);
- Product stockpiles;
- Administration office facilities (security building, administration and staff offices, reception area, ablution facilities);
- Production facilities (locker rooms, laboratory, workshops, stores, ablution facilities);

- Bagging facility and warehouse;
- Weigh bridge;
- Access roads; and
- Clean and dirty water management infrastructure.
-

Silica will be mined through an opencast bench mining method. The benches will be mined at a width of 30m and a height of 5m. Final mining depth will be between 30 and 50 mbs. Mining will commence in the northern portion of the MRA area and will progress in a south-easterly direction.

Drilling and blasting of the rock face will be conducted on a predetermined schedule in accordance with projected volumes of production and will be undertaken by blast professionals and with the required safety procedures applied.

The mining method will include:

- Vegetation and topsoil will be stripped ahead of mining. At least one cut (30m) should already be stripped and available for drilling between the active topsoil stripping operation and the open void;
- The topsoil will be loaded onto dump trucks by excavators and hauled to areas that require rehabilitation;
- Drilling operations will commence in the front of the advancing pit after the topsoil has been removed;
- The blasted Run of Mine (RoM) will be stockpiled with excavators; and
- Thereafter RoM will be transported to the crushing plant by means of haul trucks with a loading capacity of approximately 40 tons.

As part of Environmental Impact Assessment (EIA), Blast Management & Consulting (BM&C) was contracted to perform a review of possible impacts from blasting operations and specifically for the proposed Rietkol Project. Ground vibration, air blast and fly rock are some of the aspects that result from blasting operations and this study considers the possible influences that blasting may have on the surrounding area in this respect. The report concentrates on ground vibration and air blast and intends to provide information, calculations, predictions, possible influences and mitigating aspects of blasting operations for the project.

3 Objectives

The objectives of this document are: outlining the expected environmental effects that blasting operations could have on the surrounding environment; proposing the specific mitigation measures

that will be required. This study investigates the related influences of expected ground vibration, air blast and fly rock. These effects are investigated in relation to the blast site area and surrounds and the possible influence on nearby private installations, houses and the owners or occupants.

The objectives were dealt with whilst taking specific protocols into consideration. The protocols applied in this document are based on the author's experience, guidelines taken from literature research, client requirements and general indicators in the various appropriate pieces of South African legislation. There is no direct reference in the following acts to requirements and limits on the effect of ground vibration and air blast and some of the aspects addressed in this report:

- National Environmental Management Act No. 107 of 1998;
- Mine Health and Safety Act No. 29 of 1996;
- Mineral and Petroleum Resources Development Act No. 28 of 2002;
- Explosives Act No. 15 of 2003.

The guidelines and safe blasting criteria are based on internationally accepted standards and specifically criteria for safe blasting for ground vibration and recommendations on air blast published by the United States Bureau of Mines (USBM). There are no specific South African standards and the USBM is well accepted as standard for South Africa.

4 Scope of blast impact study

The scope of the study is determined by the terms of reference to achieve the objectives. The terms of reference can be summarised according to the following steps taken as part of the EIA study with regards to ground vibration, air blast and fly rock due to blasting operations.

- Background information of the proposed site;
- Blasting Operation Requirements;
- Site specific evaluation of blasting operations according to the following:
    - Evaluation of expected ground vibration levels from blasting operations at specific distances and on structures in surrounding areas;
    - Evaluation of expected ground vibration influence on neighbouring communities;
    - Evaluation of expected blasting influence on national and provincial roads surrounding the blasting operations if present;
    - Evaluation of expected ground vibration levels on water boreholes if present within 1500 m from blasting operations;
    - Evaluation of expected air blast levels at specific distances from the operations and possible influence on structures;
    - Evaluation of fly rock unsafe zone;
    - Discussion on the occurrence of noxious fumes and dangers of fumes;

- Evaluation the location of blasting operations in relation to surrounding areas according to the regulations from the applicable Acts.

- Impact Assessment;
- Mitigations;
- Recommendations;
- Conclusion.

5 Study area

The Rietkol Project is located in Wards 8 and 9 of the Victor Khanye Local Municipality within the Nkangala District Municipality of Mpumalanga Province at coordinates (Lat/Lon WGS84) 26° 7'41.22"S; 28°36'26.06"E. Delmas/Botleng is approximately 6 km east and Eloff 4 km south of the Mining Right Application (MRA) area. The Rietkol Project is located strategically close to major roads in the area, including the N12 (to the north-west), R50 (to the north-east) and R555 (to the south). The Springs/Durban Transnet Freight Rail (TFR) railway line is situated to the south, alongside the R555.

Figure 1 shows a Locality Map of the proposed Project area. Figure 2 shows view of the Project Layout and Figure 3 shows the Mine Schedule Map.

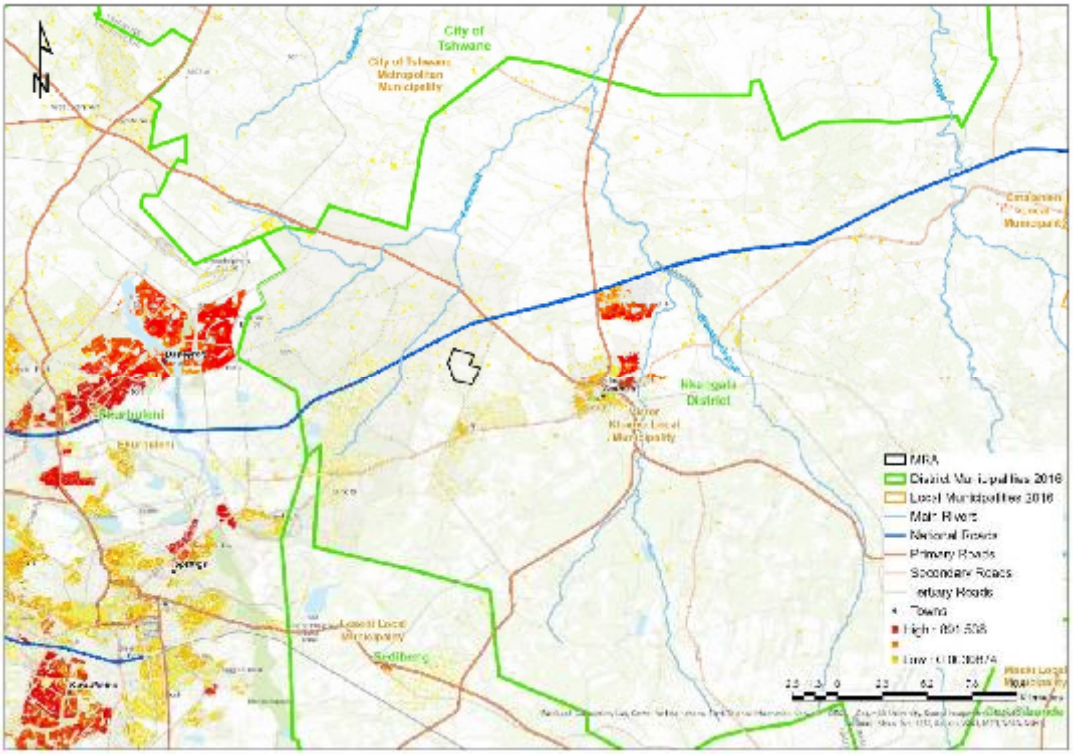

Figure 1: Locality Map of the proposed Project area

Figure 2: Rietkol Project Layout

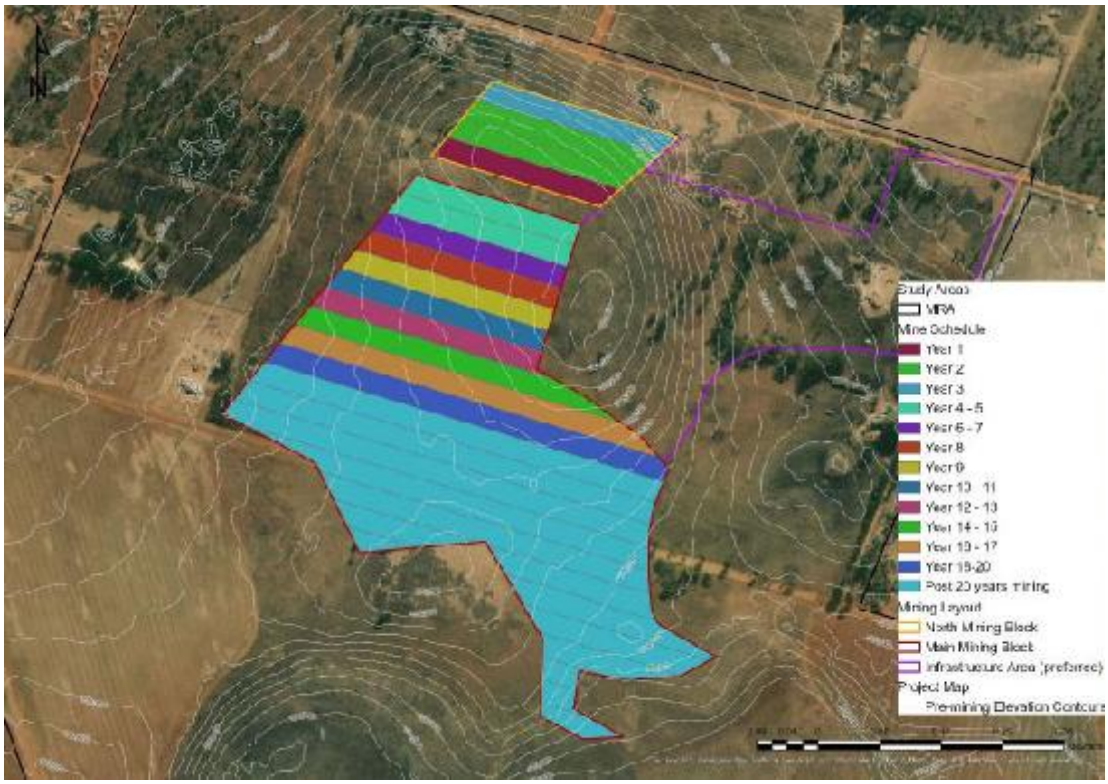

Figure 3: Mine schedule for first 20 years of mining

6 Methodology

The detailed plan of study consists of the following sections:

- Site visit: Intention to understand location of the site and its surroundings;
- Identifying surface structures / installations that are found within reason from project site. A list of Point of Interests (POI's) is created that will be used for evaluation;
- Base line influence or Blast Monitoring: The project evaluated is a new operation with no blasting activities currently being done. No monitoring is thus specifically required as baseline is considered zero with no influence;
- Site evaluation: This consists of evaluation of the mining operations and the possible influences from blasting operations. The methodology is modelling the expected impact based on the expected drilling and blasting information provided for the project. Various accepted mathematical equations are applied to determine the attenuation of ground vibration, air blast and fly rock. These values are then calculated over the distance investigated from site and shown as amplitude level contours. Overlaying these contours on the location of the various receptors then gives an indication of the possible impacts and the expected results of potential impacts. Evaluation of each receptor according to the predicted levels then gives an indication of the possible mitigation measures to be applied. The possible environmental or social impacts are then addressed in the detailed EIA phase investigation;
- Reporting: All data is prepared in a single report and provided for review.
- Due to the four pit areas located significantly apart the pit areas are reviewed separately in all analysis done in this report.

7 Site Investigation

The site was visited on 19 April 2017 and May 2018. This site visit was done to get understanding of the location and the structures and installations surrounding the proposed new pit areas.

8 Season applicable to the investigation

The drilling and blasting operations are not season dependable. The investigation into the possible effects from blasting operations is not season bounded.

9 Assumptions and Limitations

The following assumptions have been made:

- The project is a greenfields project with no drilling and blasting operations currently active.

- The anticipated levels of influence estimated in this report are calculated using standard accepted methodology according to international and local regulations.
- The assumption is made that the predictions are a good estimate with significant safety factors to ensure that expected levels are based on worst case scenarios. These will have to be confirmed with actual measurements once the operation is active.
- The limitation is that no data is available from this operation for a confirmation of the predicted values as it is a greenfields site with no current blasting activities.
- Blast Management & Consulting was not involved in the blast design. The information on blast design applied was provided by the client.
- The work done is based on the author's knowledge and information provided by the project applicant.

10 Legal Requirements

The protocols applied in this document are based on the author's experience, guidelines elicited by the literature research, client requirements and general indicators provided in the various applicable South African acts. There is no direct reference in the consulted acts specifically with regard to limiting levels for ground vibration and air blast. There is however specific requirements and regulations with regards to blasting operations and the effect of ground vibration and air blast and some of the aspects addressed in this report. The acts consulted are: National Environmental Management Act No. 107 of 1998; Mine Health and Safety Act No. 29 of 1996; Mineral and Petroleum Resources Development Act No. 28 of 2002; and the Explosives Act No. 15 of 2003.

The guidelines and safe blasting criteria applied in this study are as per internationally accepted standards, and specifically the United States Bureau of Mines (USBM) criteria for safe blasting for ground vibration and the recommendations on air blast. There are no specific South African standards and the USBM is well accepted as standard for South Africa. Additional criteria required by various institutions in South Africa was also taken into consideration, i.e. Eskom, Telkom, Transnet, Rand Water Board, etc.

In view of the acts consulted, the following guidelines and regulations are noted: (where possible detail was omitted and only some of the information indicated)

- **MINE HEALTH AND SAFETY ACT 29 OF 1996**

(Gazette No.17242, Notice No. 967 dated 14 June 1996. Commencement date: 15 January 1997 for all sections with the exception of sections 86(2) and (3), which came into operation on 15 January 1998, [Proc.No.4, Gazette No. 17725])

MINE HEALTH AND SAFETY REGULATIONS

Precautionary measures before initiating explosive charges

4.7 The employer must take reasonable measures to ensure that when blasting takes place, air and ground vibrations, shock waves and fly material are limited to such an extent and at such a distance from any building, public thoroughfare, railway, power line or any place where persons congregate to ensure that there is no significant risk to the health or safety of persons.

General precautions

4.16 The employer must take reasonable measures to ensure that:

4.16(1) in any mine other than a coal mine, no explosive charges are initiated during the shift unless –

(a) such explosive charges are necessary for the purpose of secondary blasting or reinitiating the misfired holes in development faces;

(b) written permission for such initiation has been granted by a person authorised to do so by the employer; and

(c) reasonable precautions have been taken to prevent, as far as possible, any person from being exposed to smoke or fumes from such initiation of explosive charges;

4.16(2) no blasting operations are carried out within a horizontal distance of 500 metres of any public building, public thoroughfare, railway line, power line, any place where people congregate or any other structure, which it may be necessary to protect in order to prevent any significant risk, unless:

(a) a risk assessment has identified a lesser safe distance and any restrictions and conditions to be complied with;

(b) a copy of the risk assessment, restrictions and conditions contemplated, in paragraph (a) have been provided for approval to the Principal Inspector of Mines;

(c) shot holes written permission has been granted by the Principal Inspector of Mines; and

(d) any restrictions and conditions determined by the Principal Inspector of Mines are complied with.

17(6) The employer must take reasonable measures to ensure that the competent person referred to in regulation 17(2)(a) in writing notifies the employer, which notification must be dated, of any workings being advanced to come within:

(a) a horizontal distance of 100 (one hundred) metres from reserve land, buildings, roads, railways, dams, waste dumps or any other structure whatsoever including structures beyond the mining boundaries, or from any surface, which it may be necessary to protect in order to prevent any significant risk.

(b) 50 (fifty) metres from any excavation, workings, restricted area or any other place where there is, or is likely to be a dangerous accumulation of fluid material, noxious or flammable gas. Such notification must include a sketch plan giving the distance to such place from the nearest survey station.

17(7) The employer must take reasonable measures to ensure that -

(a) no mining operations are carried out within a horizontal distance of 100 (one hundred) metres from reserve land, buildings, roads, railways, dams, waste dumps, or any other structure whatsoever including such structures beyond the mining boundaries, or any surface, which it may be necessary to protect in order to prevent any significant risk, unless a lesser distance has been determined safe by risk assessment and all restrictions and conditions determined in terms of the risk assessment are complied with;

(b) workings coming within 50 (fifty) metres, from any other excavation, workings, restricted area or any other place where there is, or is likely to be a dangerous accumulation of fluid material, noxious or flammable gas are mined subject to such restrictions and stopped at such positions as determined by risk assessment.

(c) where ground movement, as a result of mining operations, poses significant risk, an effective ground movement monitoring system is in place.

(d) survey records and plans relating to conditions described in paragraphs (a) and (b) above, are made available to the persons doing the risk assessment.

- **MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT 28 OF 2002**

(Gazette No. 23922, Notice No. 1273 dated 10 October 2002. Commencement date: 1 May 2004 [Proc. No. R25, Gazette No. 26264])

MINERAL AND PETROLEUM RESOURCES DEVELOPMENT REGULATIONS

67. Blasting, vibration and shock management and control

(1) A holder of a right or permit in terms of the Act must comply with the provisions of the Mine Health and Safety Act, 1996, (Act No. 29 of 1996), as well as other applicable law regarding blasting, vibration and shock management and control.

(2) An assessment of impacts relating to blasting, vibration and shock management and control, where applicable, must form part of the environmental impact assessment report and environmental management programme or the environmental management plan, as the case may be.

The current pit layout indicates a prospect that planned pit areas may be close private installations. The Mine Health and Safety Act has specific requirements regarding blasting within 500 m from private installations. This condition will be addressed in the recommendations as well.

11 Sensitivity of Project

A review of the project and the surrounding areas is done before any specific analysis is undertaken and sensitivity mapping is done, based on typical areas and distance from the proposed mining area. This sensitivity map uses distances normally associated where possible influences may occur and where influence is expected to be very low or none. Two different areas were identified in this regard:

- A highly sensitive area of 500 m around the mining area. Normally, this 500 m area is considered an area that should be cleared of all people and animals prior to blasting. Levels of ground vibration and air blast are also expected to be higher closer to the pit area.
- An area 500 m to 1500 m around the pit area can be considered as being a medium sensitive area. In this area, the possibility of impact is still expected, but it is lower. The expected level of influence may be low, but there may still be reason for concern, as levels could be low enough not to cause structural damage but still upset people.
- An area greater than 1500 m is considered low sensitivity area. In this area, it is relatively certain that influences will be low with low possibility of damages and limited possibility to upset people.

Figure 4 shows the sensitivity mapping with the identified points of interest (POI) in the surrounding areas for the proposed Rietkol Project area. The specific influences will be determined through the work done for this project in this report.

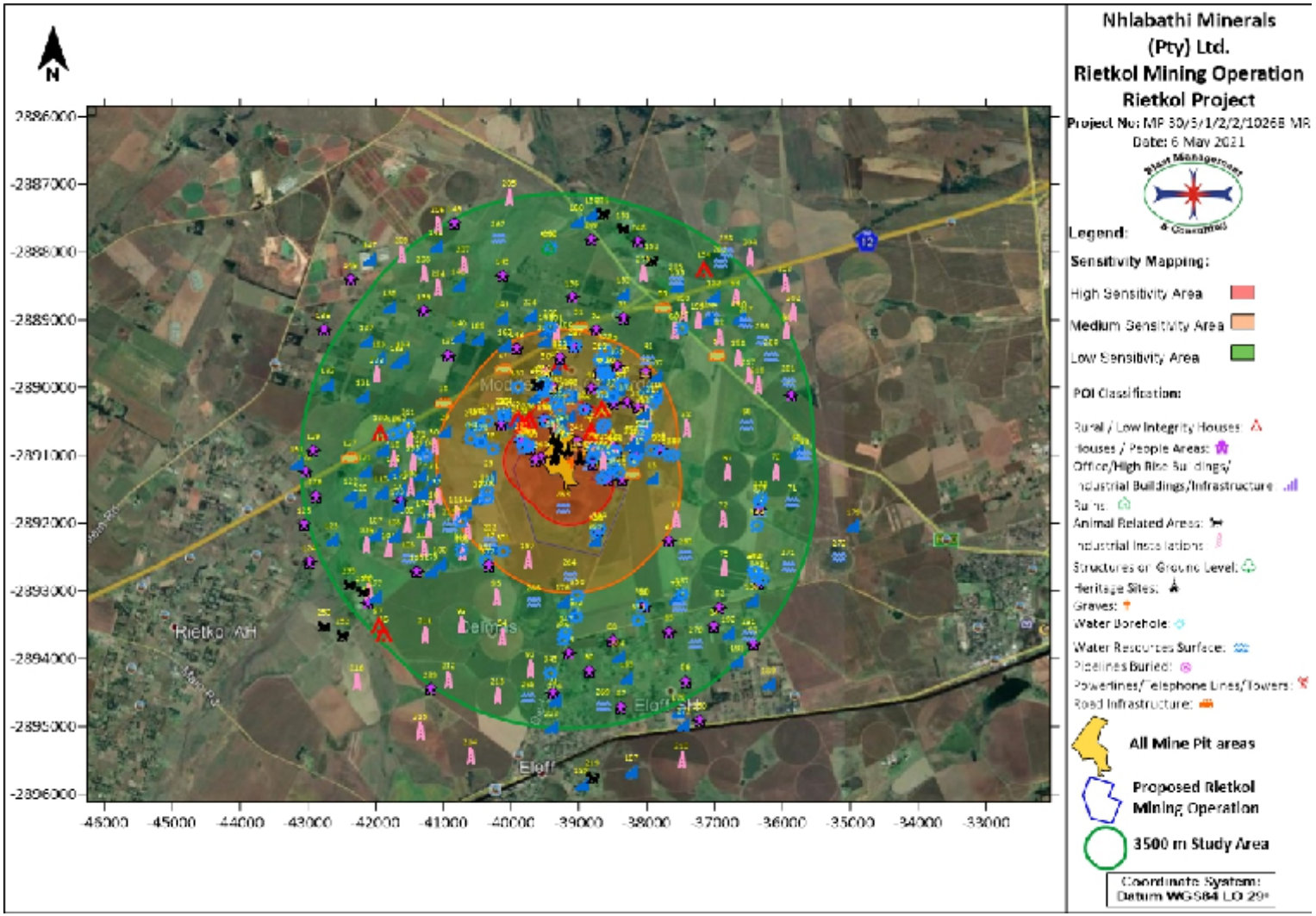

Figure 4: Identified sensitive areas for All Mine Pit areas

12 Consultation process

No specific consultation with external parties was utilised. The work done is based on the author's knowledge and information provided by the client.

13 Influence from blasting operations

Blasting operations are required to break rock for excavation to access the targeted ore material. Explosives in blast holes provide the required energy to conduct the work. Ground vibration, air blast and fly rock are a result from the blasting process. Based on the regulations of the different acts consulted and international accepted standards these effects are required to be within certain limits. The following sections provide guidelines on these limits. As indicated there are no specific South African ground vibration and air blast limit standard.

13.1 Ground vibration limitations on structures

Ground vibration is measured in velocity with units of millimetres per second (mm/s). Ground vibration can also be reported in units of acceleration or displacement if required. Different types of structures have different tolerances to ground vibration. A steel structure or a concrete structure will have a higher resistance to vibrations than a well-built brick and mortar house. A brick and mortar house will be more resistant to vibrations than a poorly constructed or a traditionally built mud house. Different limits are then applicable to the different types of structures. Limitations on ground vibration take the form of maximum allowable levels or intensity for different installations or structures. Ground vibration limits are also dependent on the frequency of the ground vibration. Frequency is the rate at which the vibration oscillates. Faster oscillation is synonymous with higher frequency and lower oscillation is synonymous with lower frequency. Lower frequencies are less acceptable than higher frequencies because structures have a low natural frequency. Significant ground vibration at low frequencies could cause increased structure vibrations due to the natural low frequency of the structure and this may lead to crack formation or damages.

Currently, the USBM criteria for safe blasting are applied as the industry standard where private structures are of concern. Ground vibration amplitude and frequency is recorded and analysed. The data is then evaluated accordingly. The USBM graph is used for plotting of data and evaluating the data. Figure 5 below provides a graphic representation of the USBM analysis for safe ground vibration levels. The USBM graph is divided mainly into two parts. The red lines in the figure are the USBM criteria:

- Analysed data displayed in the bottom half of the graph shows safe ground vibration levels,

- Analysed data displayed in the top half of the graph shows potentially unsafe ground vibration levels:

Added to the USBM graph is a blue line and green dotted line that represents 6 mm/s and 12.5 mm/s additional criteria that are used by BM&C.

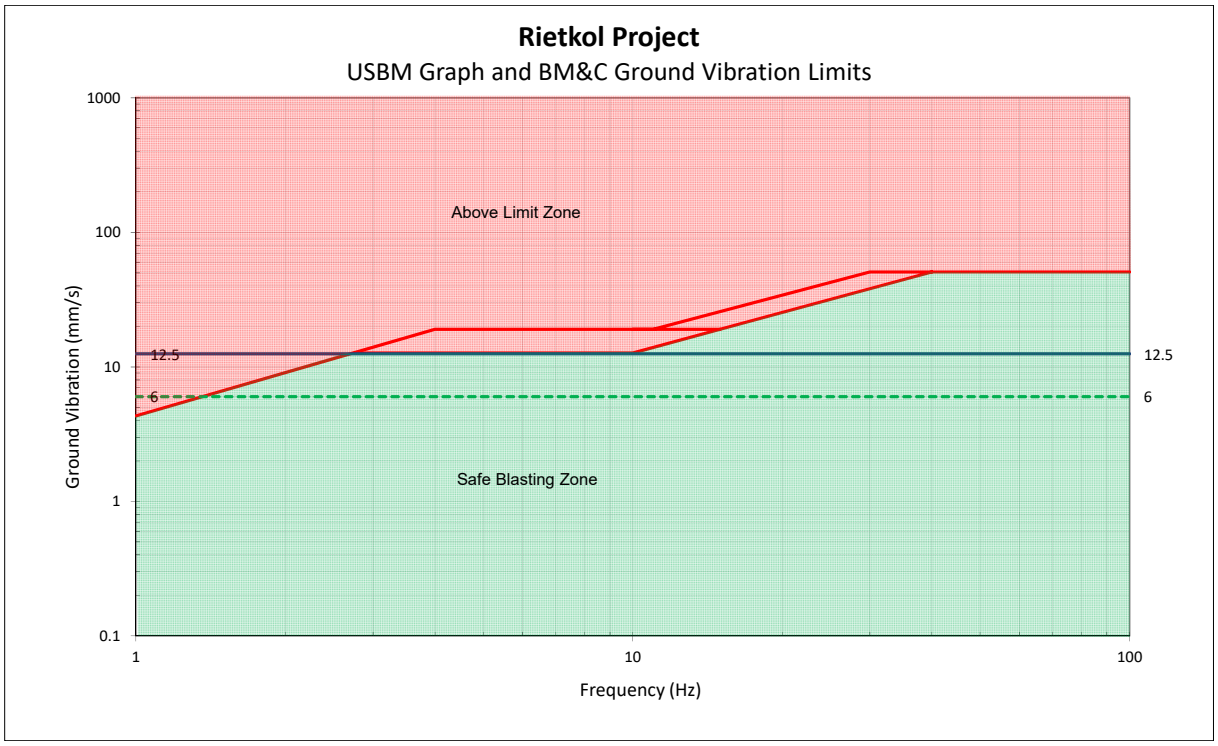

Figure 5: USBM Analysis Graph

Additional limitations that should be considered were determined through research and prescribed by the various institutions; these are as follows:

- National roads/tar roads: 150 mm/s BM&C;
- Steel pipelines: 50 mm/s (Rand Water Board);
- Electrical lines: 75 mm/s (Eskom);
- Sasol Pipelines: 25 mms/s (Sasol);
- Railways: 150 mm/s BM&C;
- Concrete less than 3 days old: 5 mm/s [1];

[1] Chiapetta F., Van Vreden A., 2000. Vibration/Air blast Controls, Damage Criteria, Record Keeping and Dealing with Complaints. 9th Annual BME Conference on Explosives, Drilling and Blasting Technology, CSIR Conference Centre, Pretoria, 2000.

- Concrete after 10 days: 200 mm/s [2];
- Sensitive plant equipment: 12 mm/s or 25 mm/s, depending on type. (Some switches could trip at levels of less than 25 mm/s.)[2];
- Waterwells or Boreholes: 50 mm/s [3];

Considering the above limitations, BM&C work is based on the following:

- USBM criteria for safe blasting;
- The additional limits provided above;
- Consideration of private structures in the area of influence;
- Should structures be in poor condition, the basic limit of 25 mm/s is halved to 12.5 mm/s or when structures are in very poor condition limits will be restricted to 6 mm/s. It is a standard accepted method to reduce the limit allowed with poorer condition of structures;
- Traditionally built mud houses are limited to 6 mm/s. The 6 mm/s limit is used due to unknowns on how these structures will react to blasting. There is also no specific scientific data available that would indicate otherwise;
- Input from other consultants in the field locally and internationally.

13.2 Ground vibration limitations and human perceptions

A further aspect of ground vibration and frequency of vibration that must be considered is human perceptions. It should be realized that the legal limit set for structures is significantly greater than the comfort zone of human beings. Humans and animals are sensitive to ground vibration and the vibration of structures. Research has shown that humans will respond to different levels of ground vibration at different frequencies.

Ground vibration is experienced at different levels; BM&C considers only the levels that are experienced as “Perceptible”, “Unpleasant” and “Intolerable”. This is indicative of the human being’s perceptions of ground vibration and clearly indicates that humans are sensitive to ground vibration and humans perceive ground vibration levels of 4.5 mm/s as unpleasant (See Figure 6).

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[2] Chiapetta F., Van Vreden A., 2000. Vibration/Air blast Controls, Damage Criteria, Record Keeping and Dealing with Complaints. 9th Annual BME Conference on Explosives, Drilling and Blasting Technology, CSIR Conference Centre, Pretoria, 2000.

[3] Berger P. R., & Associates Inc., Bradfordwoods, Pennsylvania, 15015, Nov 1980, Survey of Blasting Effects on Ground Water Supplies in Appalachia., Prepared for United States Department of Interior Bureau of Mines.

This guideline helps with managing ground vibration and the complaints that could be received due to blast induced ground vibration.
Indicated on Figure 6 is a blue solid line that indicates a ground vibration level of 12.5 mm/s and a green dotted line that indicates a ground vibration level of 6 mm/s. These are levels that are used in the evaluation.

Generally, people also assume that any vibration of a structure - windows or roofs rattling - will cause damage to the structure. An air blast is one of the causes of vibration of a structure and is the cause of nine out of ten complaints.

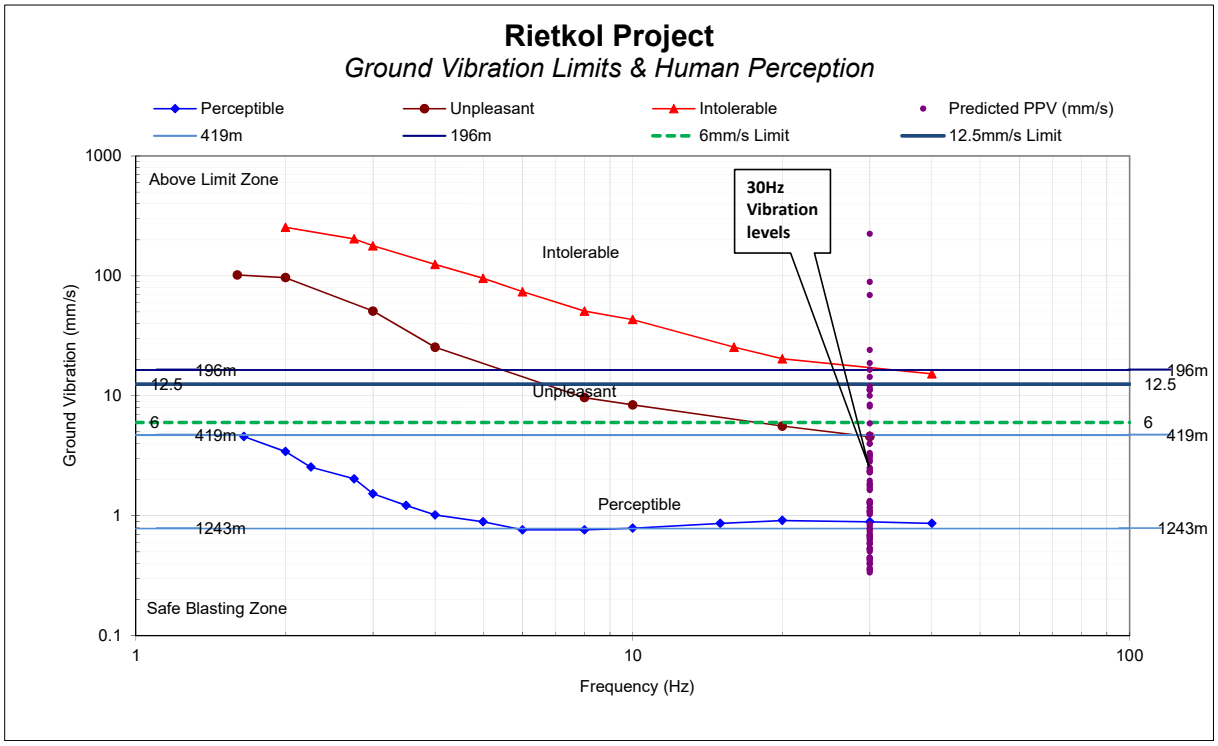


Figure 6: USBM Analysis with Human Perception

13.3 Air blast limitations on structures

Air blast or air-overpressure is a pressure wave generated from the blasting process. Air blast is measured as pressure in pascal (Pa) and reported as a decibel value (dBL). Air blast is normally associated with frequency levels less than 20 Hz, which is at the threshold for hearing. Air blast can be influenced by meteorological conditions such as, the final blast layout, timing, stemming, accessories used, blast covered by a layer of soil or not, etc. Air blast should not be confused with sound that is within the audible range (detected by the human ear). A blast does generate sound as well but for the purpose of possible damage capability we are only concerned with air blast in this report. The three main causes of air blasts can be observed as:

- Direct rock displacement at the blast; the air pressure pulse (APP);
- Vibrating ground some distance away from the blast; rock pressure pulse (RPP);
- Venting of blast holes or blowouts; the gas release pulse (GRP).

The general recommended limit for air blast currently applied in South Africa is 134dB. This is based on work done by the USBM. The USBM also indicates that the level is reduced to 128 dB in proximity of hospitals, schools and sensitive areas where people congregate. Based on work carried out by Siskind *et al.* (1980), monitored air blast amplitudes up to 135dB are safe for structures, provided the monitoring instrument is sensitive to low frequencies. Persson *et al.* (1994) have published estimates of damage thresholds based on empirical data (Table 2). Levels given in Table 2 are at the point of measurement. The weakest points on a structure are the windows and ceilings.

Table 2: Damage Limits for Air Blast

Level	**Description**
>130 dB	Resonant response of large surfaces (roofs, ceilings). Complaints start.
150 dB	Some windows break
170 dB	Most windows break
180 dB	Structural Damage

All attempts should be made to keep air blast levels from blasting operations well below 120dB where the public is of concern.

13.4 Air blast limitations and human perceptions

Considering human perceptions and the misunderstanding about ground vibration and air blast, BM&C generally recommends that blasting be done in such a way that air blast levels are kept below 120dB. This will ensure fewer complaints regarding blasting operations. The effect of air blast on structures that startle people will also be reduced, which in turn reduces the reasons for complaints. It is the effect on structures (like rattling windows, doors or a large roof surface) that startles people. These effects are sometimes erroneously identified as ground vibration and considered to be damaging the structure.

In this report, initial limits for evaluating conditions have been set at 120dB, 120 dB to 134dB and greater than 134dB. The USBM limits for nuisance are 134dB.

13.5 Fly rock

Blasting practices require some movement of rock to facilitate the excavation process. The extent of movement is dependent on the scale and type of operation. For example, blasting activities at large coal mines are designed to cast the blasted material over a greater distance than in quarries

or hard rock operations. The movement should be in the direction of the free face, and therefore the orientation of the blast is important. Material or elements travelling outside of this expected range would be considered to be fly rock. Figure 7 shows schematic of fly rock definitions.

Fly rock can be categorised as follows:

- Throw - the planned forward movement of rock fragments that form the muck pile within the blast zone;
- Fly rock - the undesired propulsion of rock fragments through the air or along the ground beyond the blast zone by the force of the explosion that is contained within the blast clearance (exclusion) zone. When using this definition, fly rock, while undesirable, is only a safety hazard if a breach of the blast clearance (exclusion) zone occurs;
- Wild fly rock - the unexpected propulsion of rock fragments that travels beyond the blast clearance (exclusion) zone when there is some abnormality in a blast or a rock mass.

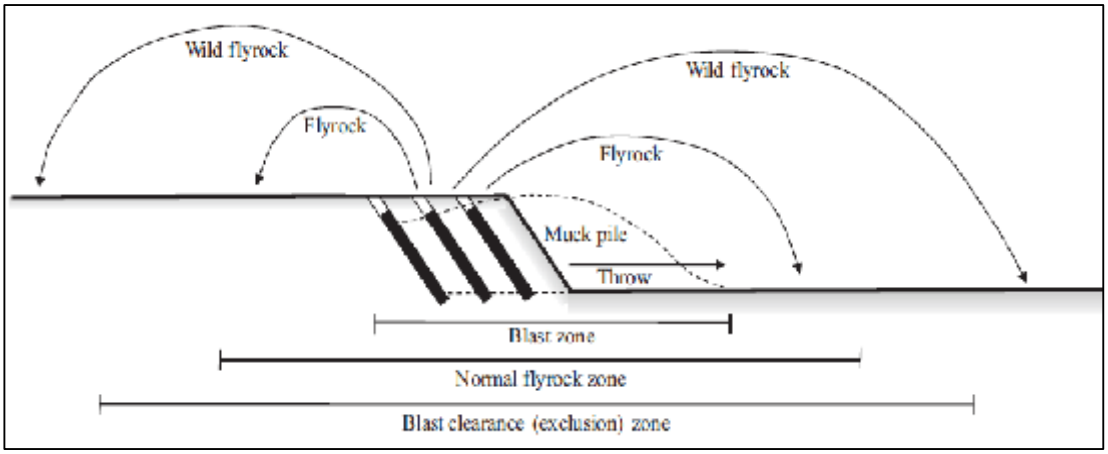


Figure 7: Schematic of fly rock terminology

Fly rock from blasting can result under the following conditions:
When burdens are too small, rock elements can be propelled out of the free face area of the blast;
When burdens are too large and movement of blast material is restricted and stemming length is not correct, rock elements can be forced upwards creating a crater forming fly rock;
If the stemming material is of poor quality or too little stemming material is applied, the stemming is ejected out of the blast hole, which can result in fly rock.

Stemming of correct type and length is required to ensure that explosive energy is efficiently used to its maximum and to control fly rock.

The occurrence of fly rock in any form will have impact if found to travel outside the safe boundary. If a road or structure or people or animals are within the safe boundary of a blast, irrespective of

the possibility of fly rock or not, precautions should be taken to stop the traffic, remove people or animals for the period of the blast. The fact is that fly rock will cause damage to the road, vehicles or even death to people or animals. This safe boundary is determined by the appointed blaster or as per mine code of practice. BM&C uses a prediction calculation defined by the International Society of Explosives Engineers (ISEE) to assist with determining minimum distance.

13.6 Noxious Fumes

Explosives used in the mining environment are required to be oxygen balanced. Oxygen balance refers to the stoichiometry of the chemical reaction and the nature of gases produced from the detonation of the explosives. The creation of poisonous fumes such as nitrous oxides and carbon monoxide are particular undesirable. These fumes present themselves as red brown cloud after the blast has detonated. It has been reported that 10ppm to 20ppm can be mildly irritating. Exposure to 150 ppm or more (no time period given) has been reported to cause death from pulmonary oedema. It has been predicted that 50% lethality would occur following exposure to 174ppm for 1 hour. Anybody exposed must be taken to hospital for proper treatment.

Factors contributing to undesirable fumes are typically: poor quality control on explosive manufacture, damage to explosive, lack of confinement, insufficient charge diameter, excessive sleep time, water in blast holes, incorrect product used or product not loaded properly and specific types of rock/geology can also contribute to fumes.

13.7 Vibration impact on provincial and national roads

The influence of ground vibration on tarred roads are expected when levels is in the order of 150 mm/s and greater. Or when there is actual movement of ground when blasting is done to close to the road or subsidence is caused due to blasting operations. Normally 100 blast hole diameters are a minimum distance between structure and blast hole to prevent any cracks being formed into the surrounds of a blast hole. Crack forming is not restricted to this distance. Improper timing arrangements may also cause excessive back break and cracks further than expected. Fact remain that blasting must be controlled in the vicinity of roads. Air blast from blasting does not have influence on road surfaces. There is no record of influence on gravel roads due to ground vibration. The only time damage can be induced is when blasting is done next to the road and there is movement of ground. Fly rock will have greater influence on the road as damage from falling debris may impact on the road surface if no control on fly rock is considered.

13.8 Vibration will upset adjacent communities

The effects of ground vibration and air blast will have influence on people. These effects tend to create noises on structures in various forms and people react to these occurrences even at low levels. As with human perception given above – people will experience ground vibration at very low levels. These levels are well below damage capability for most structures.
Much work has also been done in the field of public relations in the mining industry. Most probably one aspect that stands out is “Promote good neighbour ship”. This is achieved through communication and more communication with the neighbours. Consider their concerns and address in a proper manner.

The first level of good practice is to avoid unnecessary problems. One problem that can be reduced is the public's reaction to blasting. Concern for a person's home, particularly where they own it, could be reduced by a scheme of precautionary, compensatory and other measures which offer guaranteed remedies without undue argument or excuse.

In general, it is also in an operator's financial interests not to blast where there is a viable alternative. Where there is a possibility of avoiding blasting, perhaps through new technology, this should be carefully considered in the light of environmental pressures. Historical precedent may not be a helpful guide to an appropriate decision.

Independent structural surveys are one way of ensuring good neighbour ship. There is a part of inherent difficulty in using surveys as the interpretation of changes in crack patterns that occur may be misunderstood. Cracks open and close with the seasonal changes of temperature, humidity and drainage, and numbers increase as buildings age. Additional actions need to be done in order to supplement the surveys as well.

The means of controlling ground vibration, overpressure and fly rock have many features in common and are used by the better operators. It is said that many of the practices also aid cost-effective production. Together these introduce a tighter regime which should reduce the incidence of fly rock and unusually high levels of ground vibration and overpressure. The measures include the need for the following:

- Correct blast design is essential and should include a survey of the face profile prior to design, ensuring appropriate burden to avoid over-confinement of charges which may increase vibration by a factor of two,
- The setting-out and drilling of blasts should be as accurate as possible and the drilled holes should be surveyed for deviation along their lengths and, if necessary, the blast design adjusted,

- Correct charging is obviously vital, and if free poured bulk explosive is used, its rise during loading should be checked. This is especially important in fragmented ground to avoid accidental overcharging,
- Correct stemming will help control air blast and fly rock and will also aid the control of ground vibration. Controlling the length of the stemming column is important; too short and premature ejection occurs, too long and there can be excessive confinement and poor fragmentation. The length of the stemming column will depend on the diameter of the hole and the type of material being used,
- Monitoring of blasting and re-optimising the blasting design in the light of results, changing conditions and experience should be carried out as standard.

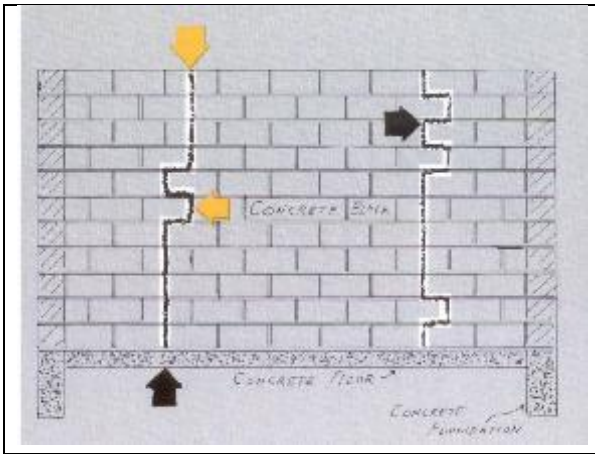
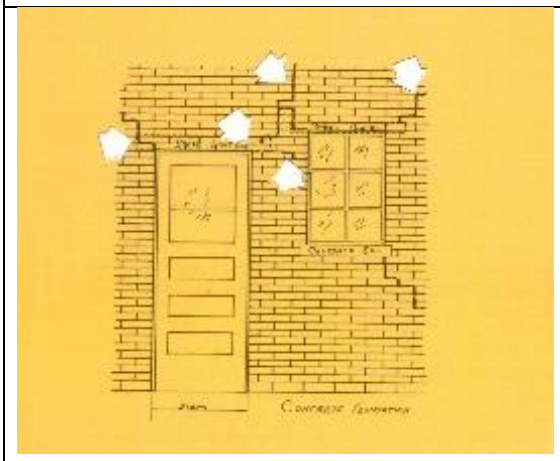
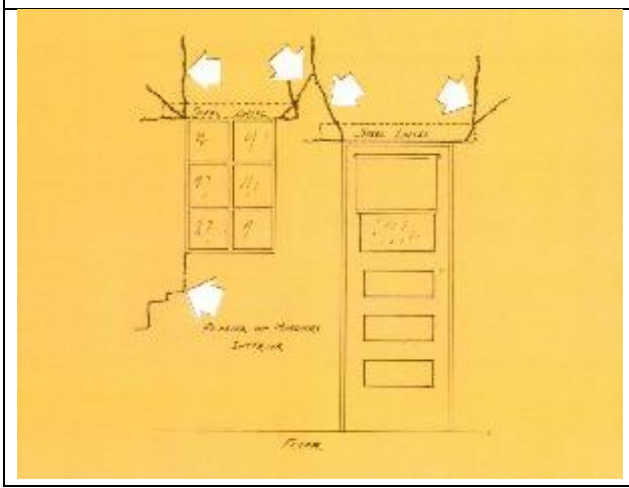
13.9 Cracking of houses and consequent devaluation

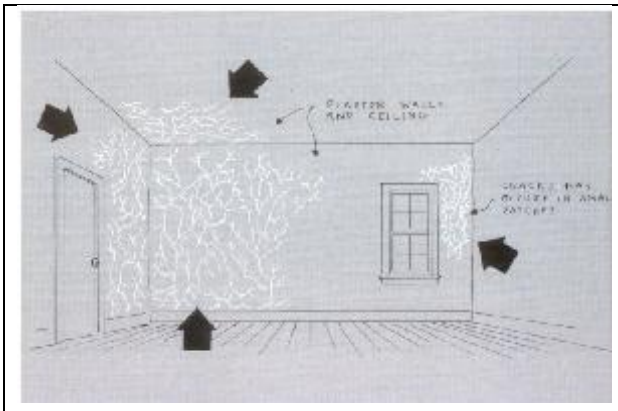
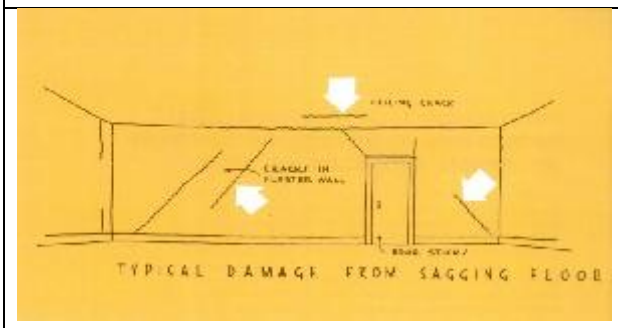
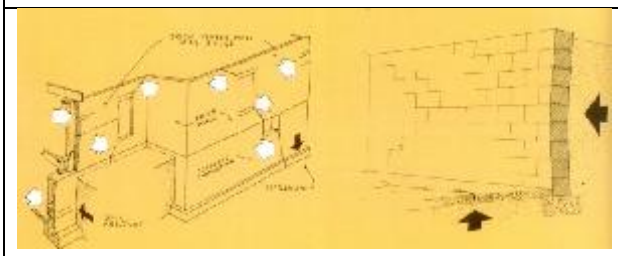
Houses in general have cracks. It is reported that a house could develop up to 15 cracks a year. Ground vibration will be mostly responsible for cracks in structures if high enough and at continued high levels. The influences of environmental forces such as temperature, water, wind etc. are more reason for cracks that have developed. Visual results of actual damage due to blasting operations are limited. There are cases where it did occur and a result is shown in Figure 8 below. A typical X crack formation is observed.

Figure 8: Example of blast induced damage.

The table below with figures show illustrations of non-blasting damage that could be found.

Table 3: Examples of typical non-blasting cracks

	Cracks Resulting from Shrinkage of Concrete Blocks
	Typical Lintel Cracks
	Typical Lintel Cracks

	"Crazing" Cracks on Plaster
	Plaster Cracks Caused by Sagging Floors
	Cracks Resulting from Foundational Failure

Observing cracks in the form indicated in Figure 8 on a structure will certainly influence the value as structural damage has occurred. The presence of general vertical cracks or horizontal cracks that are found in all structures does not need to indicate devaluation due to blasting operations but rather devaluation due to construction, building material, age, standards of building applied. Proper building standards are not always applied and the general existence of cracks may be due to materials used. Thus, damage in the form of cracks will be present. Exact costing of devaluation for normal cracks observed is difficult to estimate. A property valuator will be required for this and I do believe that property value will include the total property and not just the house alone. Mining operations may not have influence to change the status quo of any property.

13.10 Water well Influence from Blasting Activities

Domestic, agricultural and monitoring boreholes are present around the proposed site. The author has not had much experience on the effect of blasting on water wells but specific research was done and results from this research work are presented.

Case 1 looked at 36 case histories. Vibration levels up 50 mm/s were measured. The well yield and aquifer storage improved as the mining neared the wells, because of the opening of the fractures from loss of lateral confinement, not blasting. This is similar to how stress-relief fractures form. At one site, the process was reversed after the mine was backfilled. It was more likely the fractures were recompressed. It was stated that blasting may cause some temporary (transient) turbidity similar to those events that cause turbidity without blasting.

Such as:

1. Natural sloughing off inside of the well bore due to inherent rock instability. This can be accelerated by frequent over pumping. This is common to wells completed through considerable thickness of poorly consolidated and/or highly fractured clay stones and shales.
2. Significant rainfall events. The apertures of the shallow fractures that are intersected by a domestic well are commonly highly transmissive, thus will transmit substantial amounts of shallow flowing and rapidly recharging water. This water will commonly be turbid and can enter the well in high volumes. The lack of grouting of the near surface casing commonly allows this to happen. Also, if the top of the well is not grouted properly surface water can enter along the side of the casing and flow down the annulus.

The Berger Study observed ground-water impacts from manmade stress-release caused the rock mass removal during mining, but nothing from the blasting. The water quality and water levels were unaffected by the blasting. The “opening up” of the fractures lowered the ground-water levels by increasing the storage or porosity.

A study tested wells 50 m from a blast. Wells exhibited no quality or quantity impacts. Blast pressure surges ranged from 3 cm to 10 cm. Blasting caused no noticeable water table fluctuations and the hydraulic conductivity was unchanged. The pumping of the pit and encroachment of the high wall toward the wells dewatered the water table aquifer.

It may then be concluded from the studies researched as follows: Depending on the well construction, litho logic units encountered, and proximity to the blasting, it is believed that large shots could act as a catalyst for some well sloughing or collapse. However, the well would have to be inherently weak to begin with. The small to moderate shots will not show to impact wells. The minor water fluctuations attributed to blasting may cause a short-term turbidity problem, but do not pose any long-term problems. This fluctuation would not cause well collapse, as fluctuations from recharge and pumping occurs frequently. Long term changes to the well yield are more likely due to the opening of fractures from loss of lateral confinement. Short term dewatering of wells is caused by the opening of the fractures creating additional storage. A longer-term dewatering is caused by encroachment of the high wall and pumping of the pit water. The pit acts like a large pumping well. It is not believed that long term water quality problems will be caused by blasting

alone. The possible exception is the introduction of residual nitrates, from the blasting materials, into the ground water system. This is only possible through wells that are hydro logically connected to a blasting site. Most of the long-term impacts on water quality are due to the mining (the breakup of the rocks). The influence will also be dependent if wells are beneath the excavation. Stress relief effects occur at shorter distances in this instance.

The results observed and levels recorded during research done showed that levels up to 50 mm/s or even higher in certain cases did not have any noticeable effect. It seems that safe conditions will be in the order of the 50 mm/s. In addition to this there are certain aspects that will need to be addressed prior to blasting operations.

13.11 Blast impacts on domestic animals and wildlife

Scoping report comments clearly indicated concerns regarding blasting operations and the possible influence on domestic animals and wildlife. Direct research experience regarding this aspect and literature information that relates directly to blasting operations is limited. There is not much research done in the field of farm animals in relation to blasting operations specifically with regards to social interaction defects or changes or the influence on wellbeing of animals. Much work has been done regarding noise and animal response. Research related to impact from air blast in nuclear blasts or bombs exploding are probably the most accurate in relation to physical influence on animals. This work was mainly indication of mid-air detonations occurring and the respective effect. Various other research work done concentrates on possible influences from humans, aircraft, noise etc. Some of this information is applied in this report. Considered in this report is also personal experience and observations made. The information provided is intended to assist with better understanding of the possible influences if any and providing mitigation measures where possible. The aspect of influences from blasting operations is by no means a clear and specific researched topic. There is also no direct code of practice, standard or regulation that gives guidelines for animals, birds, wildlife etc. with regards to allowable ground vibration or air blast limits in South Africa. The guidelines and research from other countries has been used and applied in good faith.

Personal experience as observed on projects can be summarised as follows:
Cattle: Cattle seem to be very accommodating with regards to blasting operations. We have seen that for a first-time blast, the blast will upset them. Reaction is shown in taking freight and running a short distance – maybe 10m to 20m – and then carries on grazing. Second blast they will only lift their heads and carry on grazing. Third blast no specific reaction was shown most of the time.

Chickens: It has been observed that chickens at different ages and in different environments will react differently. Generally, chickens will react to sudden noises. Chickens in a broiler will run into opposite corner of the broiler than the noise source and actually trample each other to death.

Chickens in a broiler are considered a problem when blasting is done in close proximity without specific mitigation measures. In other cases young chicks do show reaction but significantly less than grown chickens. It was observed that these chickens reacted, did a short run and then carry on grazing.

House animals: Dogs are sensitive to vibration much more than humans and most probably all animals. Significant vibration levels will have them reacting in barking, getting anxious and possibly running away in opposite direction. One can relate to what typically happens when crackers are fired over Christmas and Guy faux days. Loud noises will certainly have an influence.

The Animal Research Centre at Onderstepoort, South Africa does not have information on any studies conducted.

The possible influence of blasting operations on a dairy farm is also considered an unknown. There is no scientific evidence that deterioration of milk production exists due to certain levels of ground vibration and air blast. However, previous projects done by BM&C in the vicinity of dairies, it was considered that it is possible that milk production will be hampered when blasting is done during the milking process. In this instance, no blasting was allowed prior to milking time. Thus, blasting was only done after the daily milking period. In this specific instance blasting was done at quarry approximately 800 m away from the dairy.

One may consider various mining operations where wildlife is kept in reservation areas next to the mining areas. A mine in Botswana – Jwaneng Diamond mine – a large opencast mine has a nature reserve as part of the mine operations. Apart from the more general wildlife, rhinos are also found in this area.
New Vaal colliery – coal mine near Vereeniging is located in close proximity – less than 2km from – form the Vaal Racecourse for horses. New Vaal also kept small game wildlife in an area near the mine.
Littleton Dolomite mine in Pretoria is located within the Doornkloof suburb. The Centurion SPCA falls within the 500m boundary of the quarry.
In Kwazulu-Natal quarries can be found within areas where chicken broilers are a mainstream business.
A mine in North-west, west of the Pilanesberg Nature reserve, has a clear warning of roaming leopard in the area. On a site visit for work not too long ago a leopard and pups were observed in the mining area.
A further example is the Alkantpan test range in the Northern Cape where large calibre canons are tested. Small antelope like Springbok is also found on the test range.

Presentation of these examples are by no means indicating that no influences were ever possibly experienced but rather indicators that over time means were found that co-existence is possible.

Literature research work done presented the following information.
Work done by Richmond, Damon, Fletcher, Bowen and White[4] considered the effect of air blast on animals from air blast in specific conditions. Animals were tested in shock tubes as well as research from other encompassed into the report. In this research work that was done to define the influence of air blast pressure and the resulting effect on different types and size of animals. Mice, rabbits, Guinea Pig, hamsters, rat, dog, goat, sheep, cat and cattle were the subjects of this research. The research concentrated on the effect of short duration and long duration pressure pulses, orientation of subject, reflected shock or not and investigated the effect with regards to lethality, lung injury and eardrum rupture. This work was basis for estimates of pressure and possible influence on humans and the required protection of humans in blast situations. Without going into all the detail of the report the following is a summary of the findings. Long duration and fast rising pressure pulses seem to have most influence on the wellbeing of animals. Long duration pressure pulses are also found in the blasting environment. Long duration pressure pulses are defined as pulses beyond 20msec, and short duration as pulses having duration of less than 5msec. Lungs are considered the critical organs in such a situation. The release of air bubbles from disrupted alveoli of the lungs into the vascular systems accounted for the rapid deaths. The degree of lung haemorrhage was related to the increase in lung weight and blast dosage. Smaller lung sizes were damaged easier. Larger animals showed threshold of petechial haemorrhage was near 10psi to 15psi (68.9476kPa to 103.421kPa) at long durations. Ear damage recorded in sheep showed 38% rupture were recorded at 21.4psi (147.548kPa) for long durations and severity of damage increased with the intensity of the blast. The following figure (Figure 9) shows the mortality curves for the various animals exposed to long duration pressure pulses.

[4] Richmond, D. R., Damon, E. G., Fletcher, E. R., Bowen, I. G. And White, C. S. (1968), The Relationship Between Selected Blast-Wave Parameters And The Response Of Mammals Exposed To Air Blast*. Annals of The New York Academy of Sciences, 152: 103–121. Doi:10.1111/J.1749-6632.1968.Tb11970.X

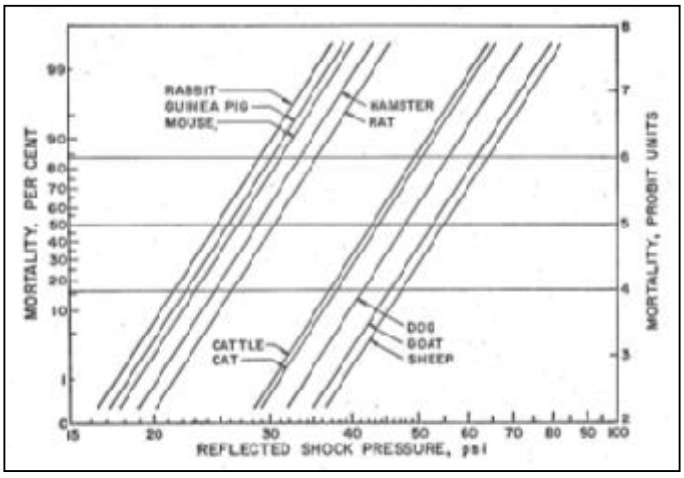


Figure 9: Mortality curve for long duration pressure exposure on animals.

In order to relate to air blast, the following table (Table 4) shows the corresponding air blast level in dB and Pascal. Air blast is measured in Pascal (Pa) but converted to the dB scale for ease of use.

Table 4: Corresponding pressure levels to air blast values in the dB scale.

dB	P (Pa)	kPa	PSI
100.0	2.0	0.002	0.000
120.0	20.0	0.020	0.003
140.0	200.0	0.200	0.029
150.0	632.5	0.632	0.092
155.0	1124.7	1.12	0.163
160.0	2000.0	2.00	0.290
165.0	3556.6	3.56	0.516
170.0	6324.6	6.32	0.917
175.0	11246.8	11.25	1.631
180.0	20000.0	20.00	2.901
185.0	35565.6	35.57	5.158
190.0	63245.6	63.25	9.173
195.0	112468.3	112.47	16.312
200.0	200000.0	200.00	29.008
205.0	355655.9	355.66	51.584
210.0	632455.5	632.46	91.730

Distance between source and receptor will certainly be a major consideration. The greater the distance, the lesser will the effect be of noise or air blast.

Noise affects wildlife differently from humans and the effects of noise on wildlife vary from serious to non-existent responses in different species and situations. Risk of hearing damage in wildlife is

probably greater from exposure to nearby blast noise from bombs and large weapons than from long-lasting exposure to continuous noise or from muzzle blast of small arms fire. Direct physiological effects of noise on wildlife, if present, are difficult to measure in the field. Behavioural effects that might decrease chances of surviving and reproducing could include retreat from favourable habitat near noise sources and reduction of time spent feeding with resulting energy depletion. Serious effects such as decreased reproductive success have apparently been documented in some studies. Decreased responsiveness after repeated noises is frequently observed and usually attributed to habituation. Military and civilian blast noise had no unusual effects (beyond other human-generated noise) on wildlife in most studies, although hearing damage was not an issue in the situations studied and animals were often probably habituated to blasts.

The Animal Research centre at Onderstepoort, South Africa was contacted in the past for information as well but no studies in this field exist at Onderstepoort. There have been claims in the past from farmers stating that the reproductively of pigs were severely hampered due to mining operations but no scientific evidence were presented for this.

14 Baseline Results

The base line information for the project is based on zero influence with regards to blast impacts. The project is currently not active with any blasting operations being done. As part of the baseline all possible structures in a possible influence area is identified.

14.1 Structure profile

As part of the baseline, all possible structures in a possible influence area are identified. The site was reviewed and detailed here. The site was reviewed using Google Earth imagery. Information sought during the review was to identify surface structures present in a 3500 m radius from the proposed mine boundary which will require consideration during modelling of blasting operations, e.g. houses, general structures, power lines, pipelines, reservoirs, mining activity, roads, shops, schools, gathering places, possible historical sites, etc. A list was prepared of all structures in the vicinity of the North Block and Main Block Mine Pit areas. The list includes structures and points of interest (POI) within the 3500 m boundary – see Table 6 below. A list of structure locations was required in order to determine the allowable ground vibration limits and air blast limits. Figure 10 shows an aerial view of the pit areas and surroundings with POIs. The type of POIs identified is grouped into different classes. These classes are indicated as “Classification” in Table 5. The classification used is a BM&C classification and does not relate to any standard or national or international code or practice. Table 5 shows the descriptions for the classifications used.

Table 5: POI Classification used

Class	Description
1	Rural Building and structures of poor construction
2	Private Houses and people sensitive areas
3	Office, High-rise buildings and Industrial buildings / Infrastructure
4	Ruins
5	Animal related installations and animal sensitive areas
6	Industrial Installations
7	Earth like structures – no surface structure
8	Heritage sites (buildings, infrastructure, activity)
9	Graves
10	Water Borehole
11	Water Resources Surface
12	Pipelines Buried
13	Powerlines / Telephone Lines / Towers
14	Road Infrastructure

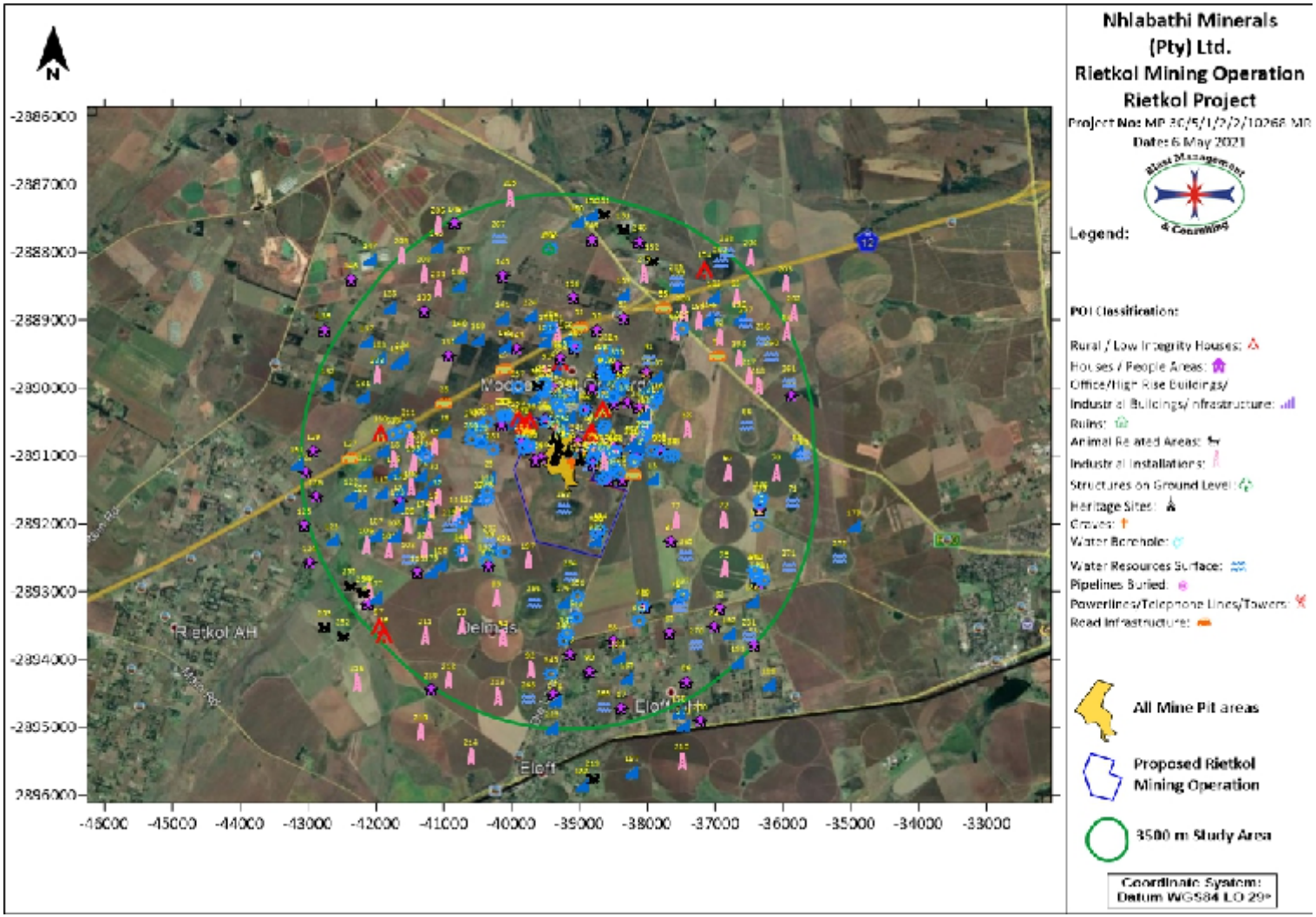


Figure 10: Aerial view and surface plan of the proposed mining area with points of interest identified

Table 6: List of points of interest identified (WGS – LO 29°)

Tag	Description	Classification	Y	X
1	Farm Buildings/Structures	2	39857.56	2890812.70
2	Informal Housing Settlement	1	39780.62	2890543.43
3	Farm Buildings/Structures	2	39462.71	2890491.43
4	Hot Houses/Nursery/Orchards	3	39286.02	2890483.45
5	Informal Housing Settlement	1	38840.89	2890686.41
6	Buildings/Structures	2	38507.44	2890854.88
7	Farm Buildings/Structures	2	38455.13	2890945.72
8	Farm Buildings/Structures	2	38153.11	2890961.79
9	Farm Buildings/Structures	2	38648.40	2891074.82
10	Agricultural Buildings	3	38518.36	2891198.53
11	Farm Buildings/Structures	2	38355.91	2891366.03
12	Road	14	38207.97	2891272.44
13	Agricultural Buildings/Broilers	3	37919.28	2891349.06
14	Buildings/Structures	2	37793.06	2890908.67
15	Farm Buildings/Structures	2	38570.69	2891357.46
16	Farm Buildings/Structures	2	40142.94	2890542.56
17	Farm Buildings/Structures (Business Commercial)	3	40086.63	2890396.00
18	Farm Buildings/Structures (Agricultural Buildings)	3	39659.03	2890159.28
19	Agricultural Buildings	3	39314.07	2890221.96
20	Farm Buildings/Structures	2	38899.72	2890313.38
21	Farm Buildings/Structures	2	38491.41	2890231.76
22	Hot Houses/Flower Tunnels	3	38558.02	2890103.43
23	Farm Buildings/Structures	2	38040.85	2890540.29
24	Farm Buildings/Structures	2	38073.30	2890677.42
25	Agricultural Buildings/Broilers (Rossgro Group)	3	40325.74	2891321.36
26	Buildings/Structures (Business Commercial)	3	40453.05	2890766.46
27	N12 Road	14	40109.29	2889716.16
28	N12 Road	14	40986.45	2890223.64
29	Farm Buildings/Structures (Agricultural Buildings)	3	40974.04	2890647.65
30	Pivot Irrigation	6	41135.93	2890862.46
31	Agricultural Buildings	3	41133.05	2891356.75
32	Pivot Irrigation	6	41085.55	2891602.41
33	Farm Buildings/Structures (Agricultural Buildings)	3	40485.39	2891638.98
34	Pivot Irrigation	6	40641.61	2892100.86
35	Agricultural Buildings/Veg Tunnels	3	40309.15	2892378.49
36	Farm Buildings/Structures/Farm Dam	2	38720.78	2892121.11
37	Cement Dam& Agricultural Building	2	37662.97	2892261.32
38	Pivot Irrigation	6	37417.49	2890605.56
39	Farm Buildings/Structures (Agricultural Buildings)	3	37856.16	2890095.12
40	Farm Buildings/Structures	2	38016.17	2889776.28
41	Pan	11	37974.71	2889592.56

Tag	Description	Classification	Y	X
42	Agricultural Buildings	3	38022.38	2890022.17
43	Farm Buildings/Structures	2	38813.10	2890011.79
44	Farm Buildings/Structures	2	38693.20	2889765.72
45	Farm Buildings/Structures (Agricultural Buildings)	3	38493.51	2889475.49
46	Farm Buildings/Structures	2	39377.32	2889997.35
47	Farm Buildings/Structures (Agricultural Buildings)	3	39599.31	2889938.89
48	Farm Buildings/Structures (Agricultural Buildings)	3	39354.29	2889714.77
49	Farm Buildings/Structures	2	39076.87	2889404.87
50	Farm Buildings/Structures	2	39480.71	2889749.27
51	N12 Road	14	38993.50	2889093.25
52	Farm Buildings/Structures	2	38741.56	2889148.26
53	Farm Buildings/Structures	2	38353.38	2888980.45
54	R50 Road	14	36958.20	2889534.09
55	R50 Road	14	37752.35	2888819.12
60	Pivot Irrigation	6	37590.29	2889160.79
61	Dam	11	37022.70	2888957.35
62	Pivot Irrigation	6	36928.83	2889244.02
63	Pivot Irrigation	6	36692.08	2888667.20
64	Pivot Irrigation	6	35941.23	2889173.67
65	Farm Buildings/Structures	2	35877.12	2890112.75
66	Pan	11	36525.96	2890555.77
67	Pivot Irrigation	6	36804.97	2891242.82
68	Industrial Structures	3	35784.97	2890940.36
69	Reservoirs	11	35676.25	2891005.75
70	Pivot Irrigation	6	36097.68	2891233.73
71	Pan	11	35851.68	2891690.70
72	Pivot Irrigation	6	36868.14	2891939.13
73	Dam	11	36330.73	2891847.56
74	Buildings/Structures	2	36338.94	2891790.83
75	Pivot Irrigation	6	36859.91	2892663.81
76	Farm Buildings/Structures	2	36348.81	2892888.30
77	Pivot Irrigation	6	37575.91	2891946.64
78	Agricultural Buildings/Broilers	3	37572.96	2893108.34
79	Reservoirs	11	37508.25	2893223.88
80	Farm Buildings/Structures	2	38030.16	2893233.37
81	Agricultural Buildings (Rossgro Group)	3	39119.35	2893361.70
82	Farm Buildings/Structures	2	36921.68	2893241.42
83	Farm Buildings/Structures	2	36432.16	2893787.66
84	Farm Buildings/Structures	2	37006.56	2893527.56
85	Farm Buildings/Structures	2	37663.58	2893603.24
86	Farm Buildings/Structures	2	37423.22	2894330.49
87	Farm Buildings/Structures	2	38373.02	2894716.89
88	Farm Buildings/Structures	2	38505.54	2893734.21
89	Farm Buildings/Structures	2	39138.56	2893916.57

Tag	Description	Classification	Y	X
90	Farm Buildings/Structures	2	38847.00	2894182.57
91	Farm Buildings/Structures	2	39382.09	2894513.98
92	Pivot Irrigation	6	39717.46	2894149.99
93	Pivot Irrigation	6	40728.54	2893507.99
94	Pivot Irrigation	6	40121.27	2893681.95
95	Pivot Irrigation	6	40216.05	2893100.80
96	Informal Housing Settlement	1	41881.15	2893629.85
97	Informal Housing Settlement	1	41953.89	2893500.96
98	Farm Buildings/Structures	2	42110.92	2893183.44
99	Cement Dam	6	42103.83	2893010.46
100	Agricultural Buildings	3	41041.85	2892601.29
101	Pivot Irrigation	6	40721.58	2892443.64
102	Pivot Irrigation	6	41285.22	2892377.43
103	Dam	11	41516.34	2892524.52
104	Pivot Irrigation	6	41805.36	2892391.25
105	Buildings/Structures	2	41385.22	2892718.18
106	Pivot Irrigation	6	42136.91	2892311.36
107	Agricultural Buildings	3	41991.42	2892170.23
108	Agricultural Buildings	3	41722.25	2892196.30
109	Pivot Irrigation	6	41530.19	2892020.62
110	Pivot Irrigation	6	41176.52	2891795.95
111	Pivot Irrigation	6	40810.91	2891859.41
112	Agricultural Buildings	3	40663.81	2891847.32
113	Agricultural Buildings	3	41317.64	2891549.32
114	Buildings/Structures	2	41627.92	2891673.57
115	Agricultural Buildings/Broilers	3	41910.42	2891556.29
116	Agricultural Buildings	3	41735.45	2891258.55
117	Dam	11	41313.16	2890982.99
118	Pivot Irrigation	6	41742.63	2891044.98
119	Pivot Irrigation	6	41504.44	2890763.85
120	Buildings/Structures(Business Commercial)	3	41890.47	2890938.80
121	Buildings/Structures (Business Commercial)	3	42155.21	2891237.18
122	Agricultural Buildings	3	42360.63	2891592.57
123	Agricultural Buildings	3	42646.63	2892250.51
124	Farm Buildings/Structures	2	42971.84	2892577.29
125	Buildings/Structures	2	43049.43	2892022.62
126	Buildings/Structures	2	42883.34	2891601.88
127	N12 Road	14	42373.11	2891029.93
128	Buildings/Structures	2	43031.09	2891237.06
129	Buildings/Structures	2	42909.33	2890931.24
130	Informal Housing	1	41927.37	2890657.15
131	Agricultural Buildings	3	42181.59	2890139.92
132	Agricultural Buildings	3	42699.99	2889956.15
133	Buildings/Structures (Business Commercial)	3	41678.73	2889630.82

Tag	Description	Classification	Y	X
134	Hot House/Nursery/Orchards	3	41595.86	2889570.84
135	Farm Buildings/Structures	2	40921.03	2889523.19
136	Farm Buildings/Structures	2	42766.96	2889147.82
137	Farm Buildings/Structures (Agricultural Buildings)	3	42129.33	2889324.29
138	Farm Buildings/Structures (Agricultural Buildings)	3	41786.99	2888816.27
139	Farm Buildings/Structures	2	41283.28	2888871.01
140	Farm Buildings/Structures (Agricultural Buildings)	3	40760.63	2889257.80
141	Farm Buildings/Structures (Agricultural Buildings)	3	40125.47	2888981.11
142	Farm Buildings/Structures (Agricultural Buildings)	3	40772.93	2888499.82
143	Buildings/Structures	2	39913.72	2889424.01
144	Farm Buildings/Structures (Agricultural Buildings)	3	39485.22	2889168.06
145	Farm Buildings/Structures	2	40123.94	2888346.32
146	Farm Buildings/Structures	2	42363.10	2888404.82
147	Agricultural Buildings/Broilers	3	42082.60	2888110.88
148	Agricultural Buildings	3	41103.15	2887921.52
149	Farm Buildings/Structures	2	40832.42	2887573.14
150	Agricultural Buildings/Business Commercial	3	38809.43	2887449.15
151	Broilers	5	38346.76	2887667.98
152	Broilers	5	37926.20	2888130.65
153	Industrial Structures	3	38341.80	2888624.44
154	Informal Housing	1	37152.30	2888244.14
155	Agricultural Buildings	3	37542.93	2888515.73
156	Farm Buildings/Structures	2	39096.29	2888670.33
157	Agricultural Buildings	3	37858.12	2889842.99
158	Agricultural Buildings/Flower Tunnels	3	38413.51	2890032.22
159	Agricultural Buildings	3	38564.37	2889872.75
160	Agricultural Buildings/Veg Tunnels	3	38627.83	2889606.19
161	Agricultural Buildings	3	40515.58	2890553.92
162	Agricultural Buildings	3	39336.72	2890096.81
163	Agricultural Buildings/Flower Tunnels	3	39111.41	2890131.42
164	Agricultural Buildings/Flower Tunnels	3	39331.10	2890465.86
165	Agricultural Buildings	3	38831.56	2891058.56
166	Agricultural Buildings	3	39191.01	2889280.42
167	Agricultural Buildings/Veg Tunnels	3	39503.16	2889317.85
168	Agricultural Buildings	3	40087.85	2889390.19
169	Agricultural Buildings	3	40491.28	2889294.67
170	Agricultural Buildings	3	41366.19	2890899.21
171	Agricultural Buildings	3	41334.00	2891300.06
172	Agricultural Buildings	3	41634.02	2891518.30
173	Agricultural Buildings	3	41672.70	2891748.72
174	Agricultural Buildings	3	41301.42	2891915.57
175	Agricultural Buildings/Business Commercial	3	41177.11	2892706.34
176	Agricultural Buildings	3	39235.39	2893158.56
177	Agricultural Buildings	3	42000.80	2893096.14

Tag	Description	Classification	Y	X
178	Agricultural Buildings/Veg Tunnels	3	37529.31	2894783.83
179	Agricultural Buildings	3	34946.32	2892044.53
180	Agricultural Buildings	3	39029.50	2887556.13
181	Agricultural Buildings/Veg Tunnels	3	37098.44	2888985.56
182	Agricultural Buildings	3	37006.39	2888669.56
183	Agricultural Buildings	3	41945.70	2889570.69
184	Agricultural Buildings	3	38424.26	2893983.44
185	Agricultural Buildings	3	38288.67	2894294.68
186	Agricultural Buildings	3	36451.15	2893146.25
187	Agricultural Buildings	3	38223.03	2895669.03
188	Agricultural Buildings/Broilers	3	38958.68	2895859.18
189	Agricultural Buildings	3	36203.40	2894380.88
190	Agricultural Veg Tunnels	3	36639.85	2888973.77
191	Agricultural Veg Tunnels	3	43157.99	2891120.97
192	Agricultural Veg Tunnels	3	36791.45	2893628.11
193	Agricultural Veg Tunnels	3	36660.40	2894051.91
194	Pivot Irrigation	6	41473.25	2891473.22
195	Pivot Irrigation	6	41443.02	2891099.93
196	Pivot Irrigation	6	41210.84	2892097.06
197	Pivot Irrigation	6	39753.83	2892544.14
198	Pivot Irrigation	6	36648.89	2889555.64
199	Pivot Irrigation	6	37245.87	2889010.35
200	Pivot Irrigation	6	37462.50	2888890.97
201	Pivot Irrigation	6	39333.72	2889177.22
202	Pivot Irrigation	6	35834.37	2888889.61
203	Pivot Irrigation	6	35960.61	2888462.39
204	Pivot Irrigation	6	36476.24	2888067.56
205	Pivot Irrigation	6	40023.31	2887191.15
206	Pivot Irrigation	6	41079.96	2887589.86
207	Pivot Irrigation	6	40707.17	2888172.56
208	Pivot Irrigation	6	41292.84	2888314.31
209	Pivot Irrigation	6	41615.70	2888035.78
210	Pivot Irrigation	6	37487.71	2895490.77
211	Pivot Irrigation	6	41268.50	2893651.24
212	Pivot Irrigation	6	40919.03	2894310.82
213	Pivot Irrigation	6	40201.94	2894540.07
214	Pivot Irrigation	6	40599.80	2895431.89
215	Pivot Irrigation	6	41336.34	2895062.68
216	Pivot Irrigation	6	42270.16	2894343.52
217	Pivot Irrigation	6	36500.11	2889831.30
218	Pivot Irrigation	6	36362.70	2889954.36
219	Broilers	5	38801.79	2895748.32
220	Buildings (Business Commercial)	3	42221.33	2891691.58
221	Buildings (Business Commercial)	3	39972.18	2890509.25

Tag	Description	Classification	Y	X
222	Buildings (Business Commercial)	3	39146.27	2890421.02
223	Eloff Buildings/Structures (Business Commercial)	3	39399.92	2895017.19
224	Buildings/Business Commercial	3	39721.60	2888947.87
225	Dam	11	40910.68	2892047.14
226	Dam	11	38586.18	2890985.86
227	Cement Dam	6	38044.46	2890573.82
228	Dam	11	40371.56	2891628.32
229	Buildings/Structures/Dam	2	39344.57	2890593.77
230	Dam	11	38851.58	2891161.93
231	Dam	11	36496.41	2893661.28
232	Dam	11	40311.47	2892276.65
233	Cement Dam	6	41974.42	2889806.69
234	Cement Dam	6	41073.04	2888533.99
235	Dam	11	37565.97	2888429.59
236	Dam	11	36293.63	2889300.87
237	Dam	11	36540.38	2889052.58
238	Dam	11	36824.63	2888001.54
239	Farm Buildings/Structures	2	41187.95	2894450.53
240	Farm Buildings/Structures	2	39711.31	2890901.64
241	Farm Buildings/Structures	2	39027.16	2890793.25
242	Farm Buildings/Structures	2	38816.95	2890907.28
243	Farm Buildings/Structures	2	38797.26	2891112.87
244	Farm Buildings/Structures (Inside Pit Area)	2	39558.27	2891041.93
245	Farm Buildings/Structures	2	39638.27	2891071.31
246	Farm Buildings/Structures	2	39507.41	2890456.49
247	Farm Buildings/Structures	2	38126.78	2890292.59
248	Farm Buildings/Structures	2	38113.24	2887846.21
249	Farm Buildings/Structures	2	38816.63	2887810.56
250	Farm Buildings/Structures	2	37214.18	2894909.26
251	Farm Animal Structures (Feedlot)	5	38648.08	2887443.51
252	Farm Animal Structures (Feedlot)	5	42481.15	2893659.34
253	Farm Animal Structures (Feedlot)	5	42752.54	2893523.10
254	Farm Animal Structures (Feedlot)	5	42182.20	2893026.51
255	Farm Animal Structures (Feedlot)	5	42384.34	2892911.72
256	Informal Housing Settlement	1	39738.99	2890484.42
257	Informal Housing Settlement	1	39901.52	2890443.75
258	Informal Housing Settlement	1	39843.10	2890538.47
259	Informal Housing Settlement	1	38821.04	2890629.68
260	Pan	11	36164.25	2889543.21
261	Pan	11	35908.96	2889923.77
262	Pan	11	36917.45	2888168.66
263	Pan	11	39230.28	2891778.40
264	Pan	11	39133.58	2892786.17
265	Pan	11	37423.34	2892473.66

Tag	Description	Classification	Y	X
266	Pan	11	39665.91	2893165.80
267	Pan	11	40188.53	2887794.92
268	Pan	11	39746.08	2894582.43
269	Pan	11	38644.06	2894702.03
270	Pan	11	37270.81	2893787.26
271	Pan	11	35913.67	2892641.46
272	Pan	11	35157.14	2892504.64
273	Industrial Structures	3	37456.05	2894971.59
274	Industrial Structures	3	39355.50	2894606.80
275	Mine Activity	6	38046.35	2888311.07
276	Hydrocencus Borehole 1	10	40465.42	2890568.84
277	Hydrocencus Borehole 2	10	40585.37	2890591.37
278	Hydrocencus Borehole 3	10	40345.64	2890490.91
279	Hydrocencus Borehole 4	10	40444.69	2890801.44
280	Hydrocencus Borehole 5	10	40594.85	2890757.59
281	Hydrocencus Borehole 6	10	40264.33	2890911.67
282	Hydrocencus Borehole 7	10	39844.67	2890777.43
283	Hydrocencus Borehole 8	10	40125.85	2890412.68
284	Hydrocencus Borehole 9	10	40085.84	2890412.55
285	Hydrocencus Borehole 10	10	39536.88	2890034.18
286	Hydrocencus Borehole 11	10	39419.64	2889114.25
287	Hydrocencus Borehole 12	10	39048.72	2889390.11
288	Hydrocencus Borehole 13	10	39156.55	2890121.66
289	Hydrocencus Borehole 14	10	39285.93	2890332.56
290	Hydrocencus Borehole 15	10	39486.97	2890000.79
291	Hydrocencus Borehole 16	10	39506.78	2890067.33
292	Hydrocencus Borehole 17	10	39346.24	2890233.03
293	Hydrocencus Borehole 18	10	39495.46	2890499.38
294	Hydrocencus Borehole 19 - Inside Pit Area	10	39244.96	2890653.73
295	Hydrocencus Borehole 20	10	39754.38	2890865.79
296	Hydrocencus Borehole 21	10	39724.41	2890854.61
297	Hydrocencus Borehole 22	10	39824.32	2890888.16
298	Hydrocencus Borehole 23	10	38803.71	2891051.26
299	Hydrocencus Borehole 24	10	38774.10	2890918.22
300	Hydrocencus Borehole 25	10	38655.04	2890596.57
301	Hydrocencus Borehole 26	10	38625.17	2890552.17
302	Hydrocencus Borehole 27	10	38915.87	2890331.45
303	Hydrocencus Borehole 28	10	37933.97	2890926.83
304	Hydrocencus Borehole 29	10	38636.62	2890064.71
305	Hydrocencus Borehole 30	10	38496.40	2890130.77
306	Hydrocencus Borehole 31	10	38386.87	2889964.26
307	Hydrocencus Borehole 32	10	38346.92	2889941.98
308	Hydrocencus Borehole 33	10	38647.47	2889776.69
309	Hydrocencus Borehole 34	10	38617.37	2889809.83

Tag	Description	Classification	Y	X
310	Hydrocencus Borehole 35	10	38577.39	2889798.64
311	Hydrocencus Borehole 36	10	41515.57	2890572.14
312	Hydrocencus Borehole 37	10	41635.31	2890661.16
313	Hydrocencus Borehole 38	10	41735.25	2890683.64
314	Hydrocencus Borehole 39	10	41254.09	2891025.56
315	Hydrocencus Borehole 40	10	40352.07	2891643.17
316	Hydrocencus Borehole 41	10	37856.15	2890173.21
317	Hydrocencus Borehole 42	10	37905.97	2890239.83
318	Hydrocencus Borehole 43	10	38005.02	2890572.50
319	Hydrocencus Borehole 44	10	38024.95	2890594.72
320	Hydrocencus Borehole 45	10	38024.69	2890683.35
321	Hydrocencus Borehole 46	10	38064.54	2890738.86
322	Hydrocencus Borehole 47	10	38474.03	2890928.41
323	Hydrocencus Borehole 48	10	38493.32	2891172.21
324	Hydrocencus Borehole 49	10	38613.66	2891061.78
325	Hydrocencus Borehole 50	10	38664.06	2890928.98
326	Hydrocencus Borehole 51	10	38413.05	2891260.61
327	Hydrocencus Borehole 52	10	37479.09	2889130.67
328	Hydrocencus Borehole 53	10	38608.42	2889455.27
329	Hydrocencus Borehole 54	10	38688.01	2889599.54
330	Hydrocencus Borehole 55	10	38067.31	2893209.54
331	Hydrocencus Borehole 56	10	38116.62	2893442.35
332	Hydrocencus Borehole 57	10	39036.75	2893378.61
333	Hydrocencus Borehole 58	10	40352.38	2891543.46
334	Hydrocencus Borehole 59	10	37663.75	2890992.52
335	Hydrocencus Borehole 60	10	36331.66	2891686.72
336	Hydrocencus Borehole 61	10	36311.81	2891631.27
337	Hydrocencus Borehole 62	10	37477.79	2893052.72
338	Hydrocencus Borehole 63	10	37813.89	2890948.64
339	Hydrocencus Borehole 64	10	37603.74	2890992.34
340	Hydrocencus Borehole 65	10	36388.84	2892695.09
341	Hydrocencus Borehole 66	10	36288.47	2892827.76
342	Hydrocencus Borehole 67	10	36418.84	2892695.17
343	Hydrocencus Borehole 68	10	36378.53	2892805.85
344	Hydrocencus Borehole 69	10	36370.67	2892041.36
345	Hydrocencus Borehole 70	10	39414.20	2894210.69
346	Hydrocencus Borehole 71	10	39235.73	2893711.58
347	Hydrocencus Borehole 72	10	39186.00	2893622.80
348	Hydrocencus Borehole 73	10	40741.02	2891987.84
349	Hydrocencus Borehole 74	10	40739.70	2892408.85
350	Hydrocencus Borehole 75	10	39017.65	2893079.41
351	Hydrocencus Borehole 76	10	40109.66	2892417.97
352	Hydrocencus Borehole 77	10	40379.22	2892562.84
353	Hydrocencus Borehole 78	10	39423.20	2887939.86

Tag	Description	Classification	Y	X
354	Hydrocencus Borehole 79	10	38690.60	2892092.38
355	Hydrocencus Borehole 80	10	38740.47	2892136.84
356	Hydrocencus Borehole 81	10	39513.21	2889927.75
357	Hydrocencus Borehole 82	10	39906.07	2890000.96
358	Hydrocencus Borehole 83	10	38182.62	2891061.61
359	Hydrocencus Borehole 84	10	38145.80	2890999.46
360	Hydrocencus Borehole 85	10	38460.98	2890949.42
361	Hydrocencus Borehole 86	10	38606.99	2891288.88
362	Hydrocencus Borehole 87	10	38659.81	2891352.19
363	Heritage Site (Informal Graveyard - 20 graves)	9	39109.17	2891095.88
364	Heritage Site (Ruins of a house/outbuilding constructed)	8	38993.57	2891028.57
365	Heritage Site (Stacked large stones) - Inside Pit Area	8	39370.51	2891032.04
366	Heritage Site (Fowl-House structure) - Inside Pit Area	8	39354.06	2890958.13
367	Heritage Site (Pigsty constructed with cement blocks) - Inside Pit Area	8	39295.91	2890896.40
368	Heritage Site (Water trough/livestock pen) - Inside Pit Area	8	39304.54	2890797.94
369	Heritage Site (Ruins of a house/outbuilding)	8	39382.51	2890736.63
370	Heritage Site (Old Trigonometrical beacon)	8	39162.50	2890914.46
371	Farm Animals (Horses - Goudhoek SA Boerperd Stoet)	5	39612.80	2889963.03
372	Farm Buildings/Structures	2	40339.57	2892627.81
373	Informal Housing	1	38651.42	2890309.99
374	Farm Buildings/Structures	2	38300.39	2890212.93
375	Farm Buildings/Structures	2	38431.80	2889679.75
376	Underground cave	7	39459.17	2887955.48
377	Fuel Storage (Underground Fuel Tank)	6	38001.85	2890371.57
378	Fuel Storage (Underground Fuel Tank)	6	38216.26	2890808.22
379	Fuel Storage (Underground Fuel Tank)	6	38637.43	2891079.17
380	Industrial Structure (Agricultural Packhouse-Rossgro)	3	38756.22	2892258.67
381	Industrial Structures (Coal transport facility)	3	38237.38	2890849.20
382	Industrial Structures (Coal transport facility)	3	38134.98	2890871.22
383	Industrial Structures	3	38050.43	2890398.93
384	Informal Housing (Labour Tenants)	1	39279.42	2889611.06
385	Farm Buildings/Structures	2	39276.72	2889560.76

During the site visit the structures were observed and the initial POI list ground-truthed and finalised as represented in this section. Structures ranged from well-built structures to informal building styles. Table 7 shows photos of structures found in the area. Please note that various media was used to portray the surroundings and types of structures. Most of the photos are from vehicle cam and Google Earth imagery. Taking photos openly is a sensitive process and without proper permissions it is not always welcomed to take pictures openly. The following photos are certain to provide insight to the surroundings of the planned project.

Table 7: Structure Profile

Structure Photo	Description
	House on agricultural lot
	House on agricultural lot
	House on agricultural lot

	House on agricultural lot closest to pit area
	Agricultural buildings
	House on agricultural lot

	House on agricultural lot
	House on agricultural lot
	House on agricultural lot

	House on agricultural lot
	Rossgro operations
	House in Eloff

	Houses in Eloff
	Houses in Eloff
	House in Eloff

	Agricultural buildings
	Business next to N12
	Houses on agricultural lot

	Partial built structure on agricultural lot
	Informal settlement
	Tunnels / hothouses

	Houses on agricultural lot
	Houses on agricultural lot
	Houses on agricultural lot

	Informal settlement
	Nearest hot houses to pit area
	Hot houses / tunnels

	Hot houses / tunnels
	Vegetable farming
	Old structure on agricultural lot

	Houses on agricultural lot
	Informal settlement - mud house
	Informal settlement

	Agricultural business
	Agricultural business
	Eloff Houses and businesses

	Farmstall on R50
	Rossgro Chickens

	Cellular tower

15 Blasting Operations

The following mining process is envisaged.

Silica will be mined through an opencast bench mining method. The benches will be mined at a width of 30 m and a height of 5 m. Final mining depth will be between 30 and 50 mbs. Mining will commence in the northern portion of the MRA area and will progress in a south-easterly direction.

Drilling and blasting of the rock face will be conducted on a predetermined schedule in accordance with projected volumes of production and will be undertaken by blast professionals and with the required safety procedures applied.

The mining method will include:

- Vegetation and topsoil will be stripped ahead of mining. At least one cut (30m) should already be stripped and available for drilling between the active topsoil stripping operation and the open void;
- The topsoil will be loaded onto dump trucks by excavators and hauled to areas that require rehabilitation;
- Drilling operations will commence in the front of the advancing pit after the topsoil has been removed;
- The blasted Run of Mine (RoM) will be stockpiled with excavators; and

- Thereafter RoM will be transported to the crushing plant by means of haul trucks with a loading capacity of approximately 40 tons.

In order to evaluate the possible influence from blasting operations with regards to ground vibration, air blast and fly rock a planned blast design is required to determine possible influences. In the mining process blasting is anticipated for the overburden material. The overburden blasts are then considered as a worst-case scenario and is used as indicator of possible influence.

Information provided of planned blasting was used and applied. Based on the information provided JKSimblast blast design software was used to design and simulate the blast. This designed blast was applied for the evaluation done in this report. The simulation of the blast provided the best prediction possible. Table 8 shows summary technical information of the blast designed. Outcome of the design on JKSimblast is summarised in Table 9. Figure 11 below shows the blast layout with blast holes, simulation and maximum charge mass per delay. Figure 12 shows simulation timing contours with number of blast holes per delay from the typical timing applied.

Table 8: Blast design technical information

Bench Height (m):	7.5	**Stemming Length – (m):**	1.5
B/H Depth - Min (m):	7.5	**Type of Stemming:**	Crushed Stone
B/H Diameter (mm):	102	**Accessories Type:**	Shock Tube
Sub Drill Length (m):	0	**Down hole Timing (ms):**	350
Burden (m):	2.5	**Surface Timing - I/H (ms):**	42
Spacing (m):	2.5	**Surface Timing - I/R (ms):**	17
Drill Pattern:	Square	**Booster / Primer:**	400 gr.
Quantity Blast Holes:	100	**Delay Pattern:**	V
Explosive Type:	Hef100	**Charge per delay (kg/delay):**	226
Charge per b/h - (kg):	56	**Powder Factor (kg/m3):**	0.96

Table 9: Blast design information from simulation

DESIGN FACTORS FOR:			
Blast Name:	Rietkol Blast01		
Scenario:	10	Scenario 10	
Area Option:	Rietkol Blast01	40	
Hole Option:	Rietkol Blast01	36	
Deck Option:	Rietkol Blast01	37	
Downhole Delay Option:	Rietkol Blast01	38	
Surface Delay Option:	Rietkol Blast01	39	
Using Marked Holes and blast Parameters:			
	Av. Burden	2.5	m
	Av. Spacing	2.5	m

	All Hole Lengths	1 500.000	m
	Volume	9 375.000	m³
	Rock SG	2.69	
	Tonnage	25 218.750	tonnes
	Marked Holes	200	
	Charge Mass	11 276.370	kg
	Charge Energy	28 754.743	MJ
	POWDER FACTOR	1.203	kg/m³
	POWDER FACTOR	0.447	kg/t
	ENERGY FACTOR	3.067	MJ/m³
	ENERGY FACTOR	1.14	MJ/t

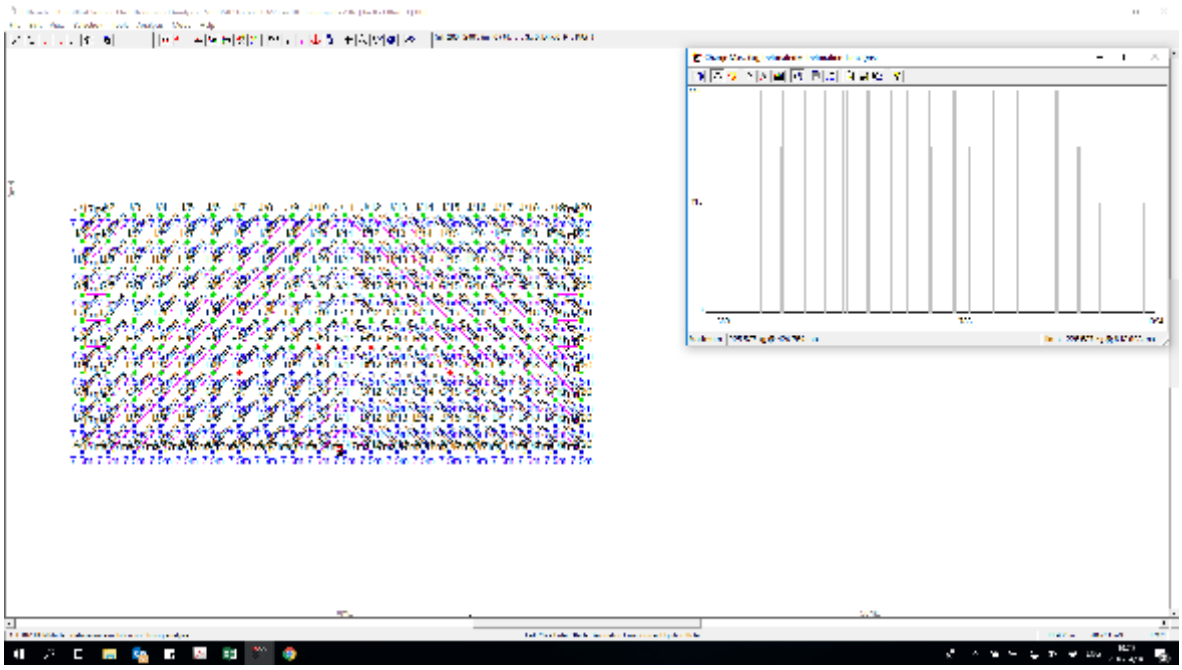


Figure 11: Blast holes layout with length and charge mass

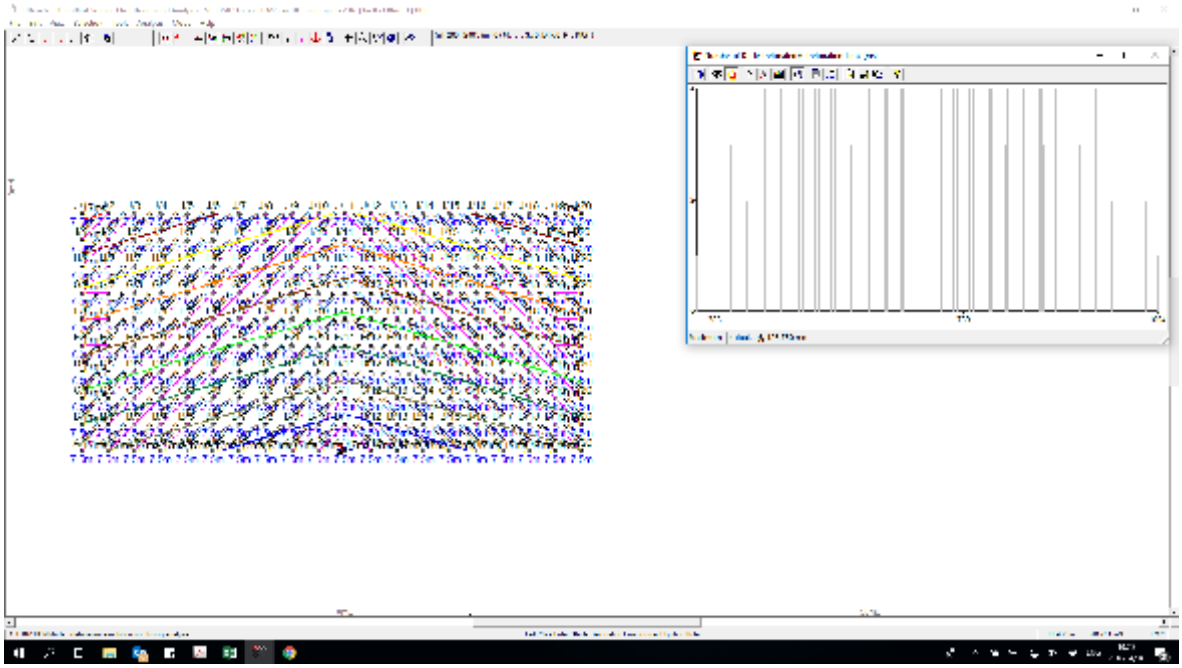


Figure 12: Simulation and decks per delay graph

The simulation work done provided information that is applied for predicting ground vibration and air blast. Evaluation of the blasting operations considered a minimum charge and a maximum charge. The minimum charge was derived from the 102 mm diameter single blast hole and the maximum charge was extracted from the blast simulation in JKSimblast. The maximum charge relates to the total number of blast holes that detonates simultaneously based on the blast layout and initiation timing of the blast. Thus, the maximum mass of explosives detonating at once. The minimum charge relates to 56 kg and the maximum charge relates to 226 kg. These values were applied in all predictions for ground vibration and air blast.

15.1 Ground Vibration

Predicting ground vibration and possible decay, a standard accepted mathematical process of scaled distance is used. The equation applied (Equation 1) uses the charge mass and distance with two site constants. The site constants are specific to a site where blasting is to be done. In the absence of measured values an acceptable standard set of constants is applied.

Equation 1:

$$PPV = a\left(\frac{D}{\sqrt{E}}\right)^{-b}$$

Where:

PPV = Predicted ground vibration (mm/s)

a = Site constant

b = Site constant
D = Distance (m)
E = Explosive Mass (kg)

Applicable and accepted factors a&b for new operations is as follows:
Factors:
a = 1143
b = -1.65

Utilizing the abovementioned equation and the given factors, allowable levels for specific limits and expected ground vibration levels can then be calculated for various distances.

Review of the type of structures that are found within the possible influence zone of the proposed mining area and the limitations that may be applicable, different limiting levels of ground vibration will be required. This is due to the typical structures and installations observed surrounding the site and location of the project area. Structure types and qualities vary greatly and this calls for limits to be considered as follows: 6 mm/s, 12.5 mm/s levels and 25 mm/s at least.

Based on the designs presented on expected drilling and charging design, the following Table 10 shows expected ground vibration levels (PPV) for various distances calculated at the two different charge masses. The charge masses are 56 kg and 226 kg for the Mine Pit areas.

Table 10: Expected Ground Vibration at Various Distances from Charges Applied in this Study

No.	Distance (m)	Expected PPV (mm/s) for 56 kg Charge	Expected PPV (mm/s) for 226 kg Charge
1	50.0	49.8	157.4
2	100.0	25.5	80.6
3	150.0	8.1	25.7
4	200.0	5.1	16.0
5	250.0	3.5	11.1
6	300.0	2.6	8.2
7	400.0	1.6	5.1
8	500.0	1.1	3.5
9	600.0	0.8	2.6
10	700.0	0.6	2.0
11	800.0	0.5	1.6
12	900.0	0.4	1.3
13	1000.0	0.4	1.1
14	1250.0	0.2	0.8
15	1500.0	0.2	0.6
16	1750.0	0.1	0.4

No.	Distance (m)	Expected PPV (mm/s) for 56 kg Charge	Expected PPV (mm/s) for 226 kg Charge
17	2000.0	0.1	0.4
18	2500.0	0.1	0.2
19	3000.0	0.1	0.2
20	3500.0	0.0	0.1

15.2 Air blast

The prediction of air blast as a pre-operational effect is difficult to define exactly. There are many variables that have influence on the outcome of air blast. Air blast is the direct result from the blast process, although influenced by meteorological conditions, wind strength and direction, the final blast layout, timing, stemming, accessories used, covered or not covered etc. all has an influence on the outcome of the result. Air blast is also an aspect that can be controlled to a great degree by applying basic rules.
In most cases mainly an indication of typical levels can be obtained. The indication of levels or the prediction of air blast in this report is used to predefine possible indicators of concern.

Standard accepted prediction equations are applied for the prediction of air blast. A standard cube root scaling prediction formula is applied for air blast predictions. The following Equation 2 was used to calculate possible air blast values in millibar. This equation does not take temperature or any weather conditions into account.

Equation 2:

$$P = \mathrm{A} \times \left(\frac{\mathrm{D}}{\mathrm{E}^{\frac{1}{3}}}\right)^{-B}$$

Where:

P = Air blast level (mB)
D = Distance from source (m)
E = Maximum charge mass per delay (kg)
A = Constant - (37.1)
B = Constant – (-0.97)

The constants for A and B were then selected according to the information as provided in Figure 13 below. Various types of mining operations are expected to yield different results. The information provided in Figure 13 is based on detailed research that was conducted for each of the different types of mining environments. In this report, the data for “Quarry face” was applied in the prediction or air blast.

Air Overpressure Prediction Equations				
Blasting	**Metric Equations mb**	**U.S. Equations psi**	**Statistical Type**	**Source**
Open air (no confinement)	$P = 3589 \times SD_3^{-1.20}$	$P = 187 \times SD_2^{-1.88}$	Best Fit	Perkins
Coal mines (parting)	$P = 2596 \times SD_3^{-1.62}$	$P = 169 \times SD_2^{-1.62}$	Best Fit	USBM RI 8485
Coal mines (highwall)	$P = 5.37 \times SD_3^{-0.79}$	$P = 0.162 \times SD_2^{-0.79}$	Best Fit	USBM RI 8485
Quarry face	$P = 37.1 \times SD_3^{-0.97}$	$P = 1.32 \times SD_2^{-0.97}$	Best Fit	USBM RI 8485
Metal Mine	$P = 14.3 \times SD_3^{-0.71}$	$P = 0.401 \times SD_2^{-0.71}$	Best Fit	USBM RI 8485
Construction (average)	$P = 24.8 \times SD_3^{-1.5}$	$P = 1 \times SD_3^{-1.5}$	Best Fit	Oriard (2005)
Construction (highly confined)	$P = 2.48 \times SD_3^{-1.5}$	$P = 0.1 \times SD_3^{-1.5}$	Best Fit	Oriard (2005)
Buried (total confinement)	$P = 1.73 \times SD_3^{-0.95}$	$P = 0.061 \times SD_2^{-0.95}$	Best Fit	USBM RI 8485

Table 26.7 - Air overpressure prediction equations.

Figure 13: Proposed prediction equations

The air pressure calculated in Equation 2 is converted to decibels in Equation 3. The reporting of air blast in the decibel scale is more readily accepted in the mining industry.

Equation 3:

$$p_s = 20 \text{ x } \log \frac{P}{P_o}$$

Where:

p_s = Air blast level (dB)

P = Air blast level (Pa (mB x 100))

P_o = Reference Pressure (2 x 10^{-5} Pa)

Although the above equation was applied for prediction of air blast levels, additional measures are also recommended to ensure that air blast and associated fly-rock possibilities are minimized as best possible.

As discussed earlier the prediction of air blast is very subjective. Following in Table 11 below is a summary of values predicted according to Equation 2.

Table 11: Air Blast Predicted Values

No.	Distance (m)	Air blast (dB) for 56 kg Charge	Air blast (dB) for 226 kg Charge
1	50.0	143.7	147.6
2	100.0	140.3	144.2
3	150.0	134.5	138.4
4	200.0	132.0	136.0

No.	Distance (m)	Air blast (dB) for 56 kg Charge	Air blast (dB) for 226 kg Charge
5	250.0	130.2	134.1
6	300.0	128.6	132.5
7	400.0	126.2	130.1
8	500.0	124.3	128.2
9	600.0	122.8	126.7
10	700.0	121.5	125.4
11	800.0	120.4	124.3
12	900.0	119.4	123.3
13	1000.0	118.5	122.4
14	1250.0	116.7	120.5
15	1500.0	115.1	119.0
16	1750.0	113.8	117.7
17	2000.0	112.7	116.6
18	2500.0	110.8	114.7
19	3000.0	109.2	113.2
20	3500.0	108.0	111.9

16 Construction Phase: Impact Assessment and Mitigation Measures

During the construction phase no mining drilling and blasting operations is expected. No detail impact evaluation was done the construction phase.

17 Operational Phase: Impact Assessment and Mitigation Measures

The area surrounding the proposed mining areas was reviewed for structures, traffic, roads, human interface, animals' interface etc. Various installations and structures were observed. These are listed in Table 6. This section concentrates on the outcome of modelling the possible effects of ground vibration, air blast and fly rock specifically to these points of interest or possible interfaces. In evaluation, the charge mass scenarios selected as indicated in section 14.1 is considered with regards to ground vibration and air blast.

Ground vibration and air blast was calculated from the edge of the pit outline and modelled accordingly. Blasting further away from the pit edge will certainly have lesser influence on the surroundings. A worst case is then applicable with calculation from pit edge. As explained previously reference is only made to some structures and these references covers the extent of all structures surrounding the mine.

The following aspects with comments are addressed for each of the evaluations done:

- Ground Vibration Modelling Results
- Ground Vibration and human perception

- Vibration impact on national and provincial road
- Vibration will upset adjacent communities
- Cracking of houses and consequent devaluation
- Air blast Modelling Results
- Impact of fly rock
- Noxious fumes Influence Results

Please note that this analysis does not take geology, topography or actual final drill and blast pattern into account. The data is based on good practise applied internationally and considered very good estimates based on the information provided and supplied in this document.

17.1 Review of expected ground vibration

Presented herewith are the expected ground vibration level contours and discussion of relevant influences. Expected ground vibration levels were calculated for each POI identified surrounding the mining area and evaluated with regards to possible structural concerns and human perception. Tables are provided for each of the different charge models done with regards to:

- "Tag" No. is the number corresponding to the POI figures;
- "Description" indicates the type of the structure;
- "Distance" is the distance between the structure and edge of the pit area;
- "Specific Limit" is the maximum limit for ground vibration at the specific structure or installation;
- "Predicted PPV (mm/s)" is the calculated ground vibration at the structure;
- The "Structure Response @ 10Hz and Human Tolerance @ 30Hz" indicates the possible concern and if there is any concern for structural damage or potential negative human perception respectively. Indicators used are "perceptible"," unpleasant", "intolerable" which stems from the human perception information given and indicators such as "high" or "low" is given for the possibility of damage to a structure. Levels below 0.76 mm/s could be considered to have negligible possibility of influence.

Ground vibration is calculated and modelled for the pit area at the minimum and maximum charge mass at specific distances from the opencast mining area. The charge masses applied are according to blast designs discussed in Section 15. These levels are then plotted and overlaid with current mining plans to observe possible influences at structures identified. Structures or POI's for consideration are also plotted in this model. Ground vibration predictions were done considering distances ranging from 50 m to 3500 m around the opencast mining area.

The simulation provided shows ground vibration contours only for a limited number of levels. The levels used are considered the basic limits that will be applicable for the type of structures observed surrounding the pit area. These levels are: 6 mm/s, 12.5 mm/s, 25 mm/s and 50 mm/s. This enables immediate review of possible concerns that may be applicable to any of the privately-owned structures, social gathering areas or sensitive installations.

Data is provided as follows: Vibration contours; a table with predicted ground vibration values and evaluation for each POI. Additional colour codes used in the tables are as follows:

Structure Evaluations:
Vibration levels higher than proposed limit applicable to Structures / Installations is coloured "Red"
People's Perception Evaluation:
Vibration levels indicated as Intolerable on human perception scale is coloured "Red"
Vibration levels indicated as Unpleasant on human perception scale is coloured "Mustard"
Vibration levels indicated as Perceptible on human perception scale is coloured "Light Green"
POI's that are found inside the pit area is coloured "Olive Green"

Simulations for expected ground vibration levels from minimum and maximum charge mass are presented below.

Minimum charge mass per delay – 56 kg

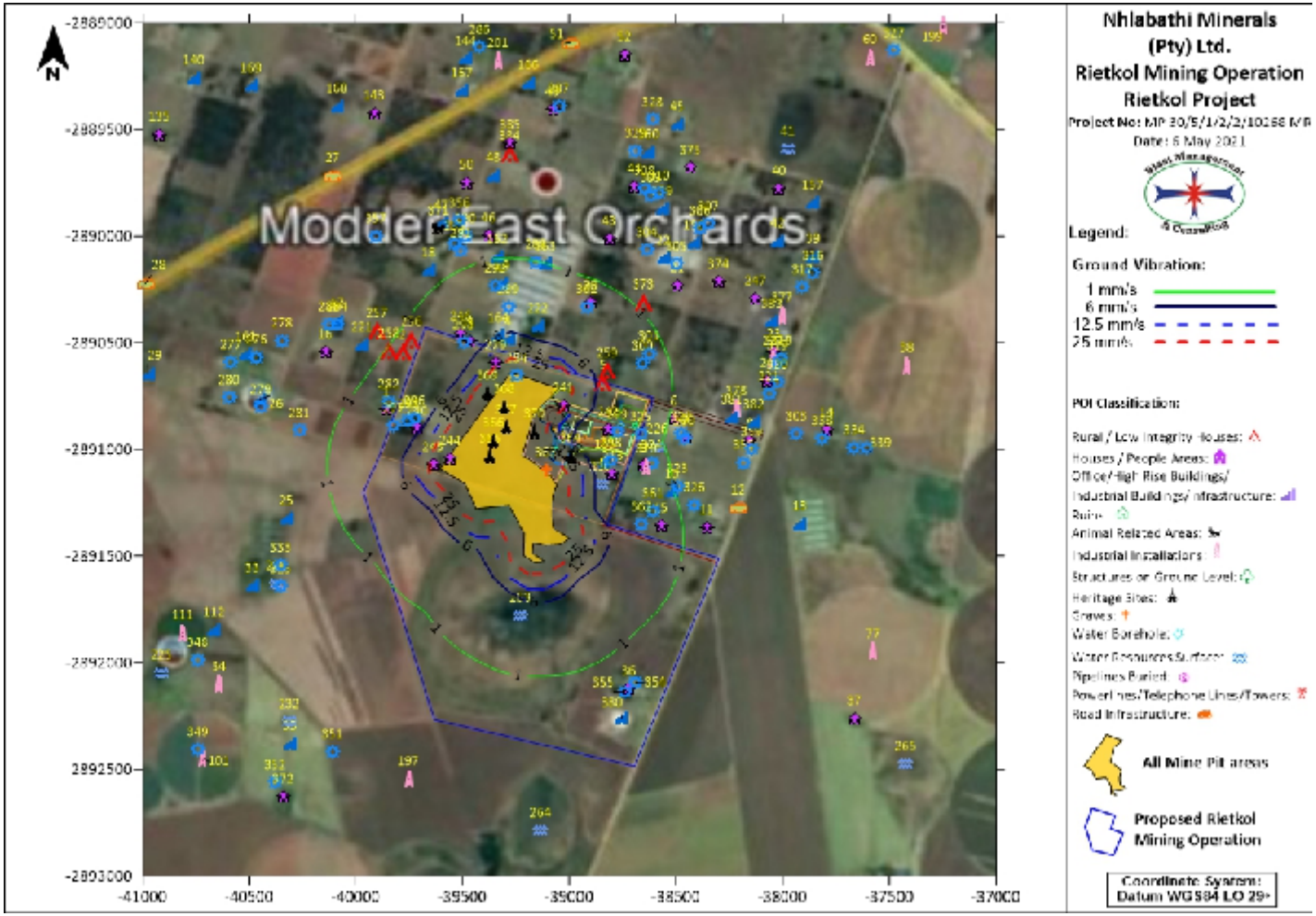


Figure 14: Ground vibration influence from minimum charge for the Mine Pit areas

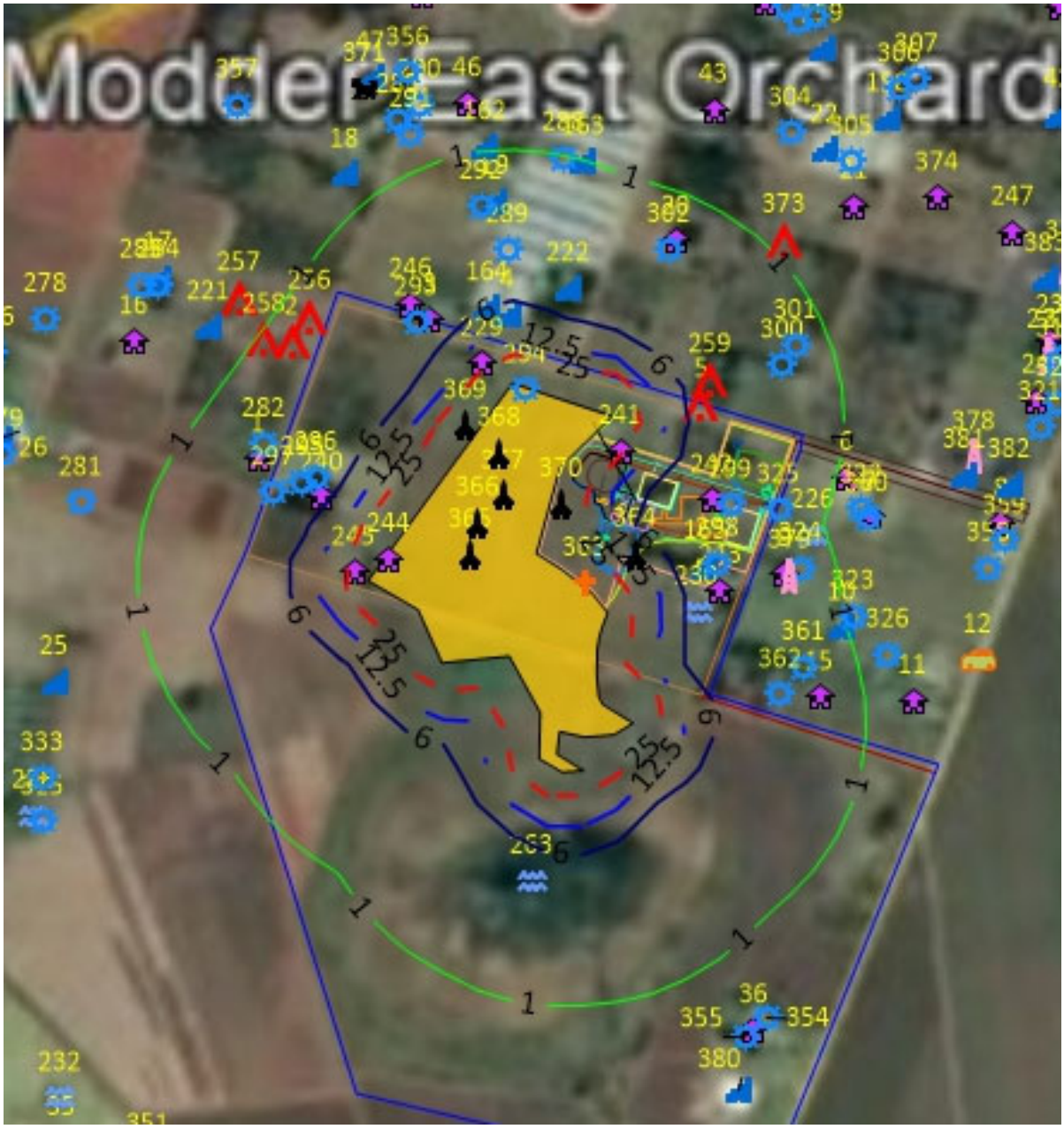


Figure 15: Ground vibration influence from minimum charge for the Mine Pit areas (Zoomed)

Table 12: Ground vibration evaluation for minimum charge for the Mine Pit areas

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
1	Farm Buildings/Structures	12.5	367	56	1.9	Acceptable	Perceptible
2	Informal Housing Settlement	6	464	56	1.3	Acceptable	Perceptible
3	Farm Buildings/Structures	12.5	238	56	3.8	Acceptable	Perceptible
4	Hot Houses/Nursery/Orchards	25	156	56	7.6	Acceptable	N/A

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
5	Informal Housing Settlement	6	214	56	4.5	Acceptable	Perceptible
6	Buildings/Structures	12.5	561	56	0.9	Acceptable	Perceptible
7	Farm Buildings/Structures	12.5	638	56	0.7	Acceptable	Too Low
8	Farm Buildings/Structures	12.5	927	56	0.4	Acceptable	Too Low
9	Farm Buildings/Structures	12.5	419	56	1.5	Acceptable	Perceptible
10	Agricultural Buildings	25	528	56	1.0	Acceptable	Perceptible
11	Farm Buildings/Structures	12.5	645	56	0.7	Acceptable	Too Low
12	Road	150	804	56	0.5	Acceptable	N/A
13	Agricultural Buildings/Broilers	25	1082	56	0.3	Acceptable	Too Low
14	Buildings/Structures	12.5	1273	56	0.2	Acceptable	Too Low
15	Farm Buildings/Structures	12.5	433	56	1.4	Acceptable	Perceptible
16	Farm Buildings/Structures	12.5	757	56	0.6	Acceptable	Too Low
17	Farm Buildings/Structures (Business Commercial)	12.5	798	56	0.5	Acceptable	Too Low
18	Farm Buildings/Structures (Agricultural Buildings)	25	614	56	0.8	Acceptable	Perceptible
19	Agricultural Buildings	25	419	56	1.5	Acceptable	Perceptible
20	Farm Buildings/Structures	12.5	427	56	1.4	Acceptable	Perceptible
21	Farm Buildings/Structures	12.5	743	56	0.6	Acceptable	Too Low
22	Hot Houses/Flower Tunnels	25	788	56	0.5	Acceptable	N/A
23	Farm Buildings/Structures	12.5	1027	56	0.3	Acceptable	Too Low
24	Farm Buildings/Structures	12.5	980	56	0.4	Acceptable	Too Low
25	Agricultural Buildings/Broilers (Rossgro Group)	25	764	56	0.6	Acceptable	Too Low
26	Buildings/Structures (Business Commercial)	12.5	910	56	0.4	Acceptable	Too Low
27	N12 Road	150	1244	56	0.2	Acceptable	N/A
28	N12 Road	150	1631	56	0.2	Acceptable	N/A
29	Farm Buildings/Structures (Agricultural Buildings)	25	1442	56	0.2	Acceptable	Too Low
30	Pivot Irrigation	150	1552	56	0.2	Acceptable	N/A
31	Agricultural Buildings	25	1559	56	0.2	Acceptable	Too Low
32	Pivot Irrigation	150	1574	56	0.2	Acceptable	N/A
33	Farm Buildings/Structures (Agricultural Buildings)	25	1042	56	0.3	Acceptable	Too Low
34	Pivot Irrigation	150	1450	56	0.2	Acceptable	N/A
35	Agricultural Buildings/Veg Tunnels	25	1405	56	0.2	Acceptable	Too Low
36	Farm Buildings/Structures/Farm Dam	12.5	715	56	0.6	Acceptable	Too Low
37	Cement Dam& Agricultural Building	50	1581	56	0.2	Acceptable	Too Low
38	Pivot Irrigation	150	1638	56	0.2	Acceptable	N/A
39	Farm Buildings/Structures (Agricultural Buildings)	25	1349	56	0.2	Acceptable	Too Low
40	Farm Buildings/Structures	12.5	1401	56	0.2	Acceptable	Too Low
41	Pan	150	1559	56	0.2	Acceptable	N/A
42	Agricultural Buildings	25	1243	56	0.2	Acceptable	Too Low
43	Farm Buildings/Structures	12.5	740	56	0.6	Acceptable	Too Low
44	Farm Buildings/Structures	12.5	1013	56	0.3	Acceptable	Too Low
45	Farm Buildings/Structures (Agricultural Buildings)	25	1358	56	0.2	Acceptable	Too Low
46	Farm Buildings/Structures	12.5	650	56	0.7	Acceptable	Too Low

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
47	Farm Buildings/Structures (Agricultural Buildings)	25	771	56	0.5	Acceptable	Too Low
48	Farm Buildings/Structures (Agricultural Buildings)	25	928	56	0.4	Acceptable	Too Low
49	Farm Buildings/Structures	12.5	1250	56	0.2	Acceptable	Too Low
50	Farm Buildings/Structures	12.5	913	56	0.4	Acceptable	Too Low
51	N12 Road	150	1572	56	0.2	Acceptable	N/A
52	Farm Buildings/Structures	12.5	1582	56	0.2	Acceptable	Too Low
53	Farm Buildings/Structures	12.5	1868	56	0.1	Acceptable	Too Low
54	R50 Road	150	2406	56	0.1	Acceptable	N/A
55	R50 Road	150	2299	56	0.1	Acceptable	N/A
60	Pivot Irrigation	150	2136	56	0.1	Acceptable	N/A
61	Dam	50	2688	56	0.1	Acceptable	N/A
62	Pivot Irrigation	150	2585	56	0.1	Acceptable	N/A
63	Pivot Irrigation	150	3127	56	0.1	Acceptable	N/A
64	Pivot Irrigation	150	3474	56	0.0	Acceptable	N/A
65	Farm Buildings/Structures	12.5	3232	56	0.1	Acceptable	Too Low
66	Pan	150	2531	56	0.1	Acceptable	N/A
67	Pivot Irrigation	150	2201	56	0.1	Acceptable	N/A
68	Industrial Structures	50	3249	56	0.1	Acceptable	Too Low
69	Reservoirs	50	3348	56	0.0	Acceptable	N/A
70	Pivot Irrigation	150	2907	56	0.1	Acceptable	N/A
71	Pan	150	3160	56	0.1	Acceptable	N/A
72	Pivot Irrigation	150	2194	56	0.1	Acceptable	N/A
73	Dam	50	2703	56	0.1	Acceptable	N/A
74	Buildings/Structures	12.5	2687	56	0.1	Acceptable	Too Low
75	Pivot Irrigation	150	2477	56	0.1	Acceptable	N/A
76	Farm Buildings/Structures	12.5	3032	56	0.1	Acceptable	Too Low
77	Pivot Irrigation	150	1519	56	0.2	Acceptable	N/A
78	Agricultural Buildings/Broilers	25	2210	56	0.1	Acceptable	Too Low
79	Reservoirs	50	2338	56	0.1	Acceptable	N/A
80	Farm Buildings/Structures	12.5	2024	56	0.1	Acceptable	Too Low
81	Agricultural Buildings (Rossgro Group)	25	1833	56	0.1	Acceptable	Too Low
82	Farm Buildings/Structures	12.5	2765	56	0.1	Acceptable	Too Low
83	Farm Buildings/Structures	12.5	3495	56	0.0	Acceptable	Too Low
84	Farm Buildings/Structures	12.5	2903	56	0.1	Acceptable	Too Low
85	Farm Buildings/Structures	12.5	2535	56	0.1	Acceptable	Too Low
86	Farm Buildings/Structures	12.5	3276	56	0.1	Acceptable	Too Low
87	Farm Buildings/Structures	12.5	3277	56	0.1	Acceptable	Too Low
88	Farm Buildings/Structures	12.5	2292	56	0.1	Acceptable	Too Low
89	Farm Buildings/Structures	12.5	2387	56	0.1	Acceptable	Too Low
90	Farm Buildings/Structures	12.5	2670	56	0.1	Acceptable	Too Low
91	Farm Buildings/Structures	12.5	2993	56	0.1	Acceptable	Too Low
92	Pivot Irrigation	150	2680	56	0.1	Acceptable	N/A
93	Pivot Irrigation	150	2518	56	0.1	Acceptable	N/A
94	Pivot Irrigation	150	2358	56	0.1	Acceptable	N/A
95	Pivot Irrigation	150	1890	56	0.1	Acceptable	N/A
96	Informal Housing Settlement	6	3392	56	0.0	Acceptable	Too Low
97	Informal Housing Settlement	6	3358	56	0.0	Acceptable	Too Low

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
98	Farm Buildings/Structures	12.5	3268	56	0.1	Acceptable	Too Low
99	Cement Dam	50	3155	56	0.1	Acceptable	N/A
100	Agricultural Buildings	25	2080	56	0.1	Acceptable	Too Low
101	Pivot Irrigation	150	1735	56	0.1	Acceptable	N/A
102	Pivot Irrigation	150	2120	56	0.1	Acceptable	N/A
103	Dam	50	2393	56	0.1	Acceptable	N/A
104	Pivot Irrigation	150	2561	56	0.1	Acceptable	N/A
105	Buildings/Structures	12.5	2415	56	0.1	Acceptable	Too Low
106	Pivot Irrigation	150	2817	56	0.1	Acceptable	N/A
107	Agricultural Buildings	25	2626	56	0.1	Acceptable	Too Low
108	Agricultural Buildings	25	2394	56	0.1	Acceptable	Too Low
109	Pivot Irrigation	150	2144	56	0.1	Acceptable	N/A
110	Pivot Irrigation	150	1729	56	0.1	Acceptable	N/A
111	Pivot Irrigation	150	1435	56	0.2	Acceptable	N/A
112	Agricultural Buildings	25	1306	56	0.2	Acceptable	Too Low
113	Agricultural Buildings	25	1781	56	0.1	Acceptable	Too Low
114	Buildings/Structures	12.5	2113	56	0.1	Acceptable	Too Low
115	Agricultural Buildings/Broilers	25	2360	56	0.1	Acceptable	Too Low
116	Agricultural Buildings	25	2144	56	0.1	Acceptable	Too Low
117	Dam	50	1717	56	0.1	Acceptable	N/A
118	Pivot Irrigation	150	2144	56	0.1	Acceptable	N/A
119	Pivot Irrigation	150	1932	56	0.1	Acceptable	N/A
120	Buildings/Structures (Business Commercial)	12.5	2296	56	0.1	Acceptable	Too Low
121	Buildings/Structures (Business Commercial)	12.5	2561	56	0.1	Acceptable	Too Low
122	Agricultural Buildings	25	2808	56	0.1	Acceptable	Too Low
123	Agricultural Buildings	25	3262	56	0.1	Acceptable	Too Low
124	Farm Buildings/Structures	12.5	3687	56	0.0	Acceptable	Too Low
125	Buildings/Structures	12.5	3576	56	0.0	Acceptable	Too Low
126	Buildings/Structures	12.5	3325	56	0.0	Acceptable	Too Low
127	N12 Road	150	2775	56	0.1	Acceptable	N/A
128	Buildings/Structures	12.5	3436	56	0.0	Acceptable	Too Low
129	Buildings/Structures	12.5	3314	56	0.0	Acceptable	Too Low
130	Informal Housing	6	2367	56	0.1	Acceptable	Too Low
131	Agricultural Buildings	25	2749	56	0.1	Acceptable	Too Low
132	Agricultural Buildings	25	3299	56	0.0	Acceptable	Too Low
133	Buildings/Structures (Business Commercial)	12.5	2536	56	0.1	Acceptable	Too Low
134	Hot House/Nursery/Orchards	25	2503	56	0.1	Acceptable	N/A
135	Farm Buildings/Structures	12.5	1987	56	0.1	Acceptable	Too Low
136	Farm Buildings/Structures	12.5	3711	56	0.0	Acceptable	Too Low
137	Farm Buildings/Structures (Agricultural Buildings)	25	3080	56	0.1	Acceptable	Too Low
138	Farm Buildings/Structures (Agricultural Buildings)	25	3103	56	0.1	Acceptable	Too Low
139	Farm Buildings/Structures	12.5	2675	56	0.1	Acceptable	Too Low
140	Farm Buildings/Structures (Agricultural Buildings)	25	2028	56	0.1	Acceptable	Too Low

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
141	Farm Buildings/Structures (Agricultural Buildings)	25	1863	56	0.1	Acceptable	Too Low
142	Farm Buildings/Structures (Agricultural Buildings)	25	2611	56	0.1	Acceptable	Too Low
143	Buildings/Structures	12.5	1373	56	0.2	Acceptable	Too Low
144	Farm Buildings/Structures (Agricultural Buildings)	25	1486	56	0.2	Acceptable	Too Low
145	Farm Buildings/Structures	12.5	2445	56	0.1	Acceptable	Too Low
146	Farm Buildings/Structures	12.5	3811	56	0.0	Acceptable	Too Low
147	Agricultural Buildings/Broilers	25	3778	56	0.0	Acceptable	Too Low
148	Agricultural Buildings	25	3275	56	0.1	Acceptable	Too Low
149	Farm Buildings/Structures	12.5	3439	56	0.0	Acceptable	Too Low
150	Agricultural Buildings/Business Commercial	25	3224	56	0.1	Acceptable	Too Low
151	Broilers	25	3113	56	0.1	Acceptable	Too Low
152	Broilers	25	2817	56	0.1	Acceptable	Too Low
153	Industrial Structures	50	2205	56	0.1	Acceptable	Too Low
154	Informal Housing	6	3118	56	0.1	Acceptable	Too Low
155	Agricultural Buildings	25	2668	56	0.1	Acceptable	Too Low
156	Farm Buildings/Structures	12.5	1977	56	0.1	Acceptable	Too Low
157	Agricultural Buildings	25	1481	56	0.2	Acceptable	Too Low
158	Agricultural Buildings/Flower Tunnels	25	937	56	0.4	Acceptable	Too Low
159	Agricultural Buildings	25	973	56	0.4	Acceptable	Too Low
160	Agricultural Buildings/Veg Tunnels	25	1185	56	0.3	Acceptable	Too Low
161	Agricultural Buildings	25	1057	56	0.3	Acceptable	Too Low
162	Agricultural Buildings	25	546	56	1.0	Acceptable	Perceptible
163	Agricultural Buildings/Flower Tunnels	25	534	56	1.0	Acceptable	Perceptible
164	Agricultural Buildings/Flower Tunnels	25	182	56	5.9	Acceptable	Unpleasant
165	Agricultural Buildings	25	249	56	3.5	Acceptable	Perceptible
166	Agricultural Buildings	25	1362	56	0.2	Acceptable	Too Low
167	Agricultural Buildings/Veg Tunnels	25	1341	56	0.2	Acceptable	Too Low
168	Agricultural Buildings	25	1490	56	0.2	Acceptable	Too Low
169	Agricultural Buildings	25	1812	56	0.1	Acceptable	Too Low
170	Agricultural Buildings	25	1776	56	0.1	Acceptable	Too Low
171	Agricultural Buildings	25	1749	56	0.1	Acceptable	Too Low
172	Agricultural Buildings	25	2081	56	0.1	Acceptable	Too Low
173	Agricultural Buildings	25	2177	56	0.1	Acceptable	Too Low
174	Agricultural Buildings	25	1892	56	0.1	Acceptable	Too Low
175	Agricultural Buildings/Business Commercial	25	2252	56	0.1	Acceptable	Too Low
176	Agricultural Buildings	25	1631	56	0.2	Acceptable	Too Low
177	Agricultural Buildings	25	3128	56	0.1	Acceptable	Too Low
178	Agricultural Buildings/Veg Tunnels	25	3624	56	0.0	Acceptable	Too Low
179	Agricultural Buildings	25	4101	56	0.0	Acceptable	Too Low
180	Agricultural Buildings	25	3093	56	0.1	Acceptable	Too Low
181	Agricultural Buildings/Veg Tunnels	25	2612	56	0.1	Acceptable	Too Low
182	Agricultural Buildings	25	2896	56	0.1	Acceptable	Too Low
183	Agricultural Buildings	25	2791	56	0.1	Acceptable	Too Low
184	Agricultural Buildings	25	2554	56	0.1	Acceptable	Too Low

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
185	Agricultural Buildings	25	2891	56	0.1	Acceptable	Too Low
186	Agricultural Buildings	25	3080	56	0.1	Acceptable	Too Low
187	Agricultural Buildings	25	4239	56	0.0	Acceptable	Too Low
188	Agricultural Buildings/Broilers	25	4334	56	0.0	Acceptable	Too Low
189	Agricultural Buildings	25	4075	56	0.0	Acceptable	Too Low
190	Agricultural Veg Tunnels	25	2978	56	0.1	Acceptable	Too Low
191	Agricultural Veg Tunnels	25	3559	56	0.0	Acceptable	Too Low
192	Agricultural Veg Tunnels	25	3125	56	0.1	Acceptable	Too Low
193	Agricultural Veg Tunnels	25	3523	56	0.0	Acceptable	Too Low
194	Pivot Irrigation	150	1915	56	0.1	Acceptable	N/A
195	Pivot Irrigation	150	1844	56	0.1	Acceptable	N/A
196	Pivot Irrigation	150	1900	56	0.1	Acceptable	N/A
197	Pivot Irrigation	150	1175	56	0.3	Acceptable	N/A
198	Pivot Irrigation	150	2670	56	0.1	Acceptable	N/A
199	Pivot Irrigation	150	2487	56	0.1	Acceptable	N/A
200	Pivot Irrigation	150	2422	56	0.1	Acceptable	N/A
201	Pivot Irrigation	150	1463	56	0.2	Acceptable	N/A
202	Pivot Irrigation	150	3702	56	0.0	Acceptable	N/A
203	Pivot Irrigation	150	3828	56	0.0	Acceptable	N/A
204	Pivot Irrigation	150	3697	56	0.0	Acceptable	N/A
205	Pivot Irrigation	150	3528	56	0.0	Acceptable	N/A
206	Pivot Irrigation	150	3543	56	0.0	Acceptable	N/A
207	Pivot Irrigation	150	2852	56	0.1	Acceptable	N/A
208	Pivot Irrigation	150	3078	56	0.1	Acceptable	N/A
209	Pivot Irrigation	150	3500	56	0.0	Acceptable	N/A
210	Pivot Irrigation	150	4287	56	0.0	Acceptable	N/A
211	Pivot Irrigation	150	2979	56	0.1	Acceptable	N/A
212	Pivot Irrigation	150	3289	56	0.0	Acceptable	N/A
213	Pivot Irrigation	150	3186	56	0.1	Acceptable	N/A
214	Pivot Irrigation	150	4160	56	0.0	Acceptable	N/A
215	Pivot Irrigation	150	4148	56	0.0	Acceptable	N/A
216	Pivot Irrigation	150	4175	56	0.0	Acceptable	N/A
217	Pivot Irrigation	150	2702	56	0.1	Acceptable	N/A
218	Pivot Irrigation	150	2796	56	0.1	Acceptable	N/A
219	Broilers	25	4234	56	0.0	Acceptable	Too Low
220	Buildings (Business Commercial)	12.5	2692	56	0.1	Acceptable	Too Low
221	Buildings (Business Commercial)	12.5	639	56	0.7	Acceptable	Too Low
222	Buildings (Business Commercial)	12.5	247	56	3.6	Acceptable	Perceptible
223	Eloff Buildings/Structures (Business Commercial)	12.5	3496	56	0.0	Acceptable	Too Low
224	Buildings/Business Commercial	12.5	1749	56	0.1	Acceptable	Too Low
225	Dam	50	1623	56	0.2	Acceptable	N/A
226	Dam	50	504	56	1.1	Acceptable	N/A
227	Cement Dam	50	1018	56	0.3	Acceptable	N/A
228	Dam	50	941	56	0.4	Acceptable	N/A
229	Buildings/Structures/Dam	12.5	82	56	21.8	Problematic	Intolerable
230	Dam	50	207	56	4.8	Acceptable	N/A
231	Dam	50	3362	56	0.0	Acceptable	N/A
232	Dam	50	1328	56	0.2	Acceptable	N/A

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
233	Cement Dam	50	2696	56	0.1	Acceptable	N/A
234	Cement Dam	50	2768	56	0.1	Acceptable	N/A
235	Dam	50	2726	56	0.1	Acceptable	N/A
236	Dam	50	3102	56	0.1	Acceptable	N/A
237	Dam	50	3014	56	0.1	Acceptable	N/A
238	Dam	50	3512	56	0.0	Acceptable	N/A
239	Farm Buildings/Structures	12.5	3552	56	0.0	Acceptable	Too Low
240	Farm Buildings/Structures	12.5	197	56	5.2	Acceptable	Perceptible
241	Farm Buildings/Structures	12.5	71	56	28.1	Problematic	Intolerable
242	Farm Buildings/Structures	12.5	301	56	2.6	Acceptable	Perceptible
243	Farm Buildings/Structures	12.5	266	56	3.2	Acceptable	Perceptible
244	Farm Buildings/Structures (Inside Pit Area)	12.5	-	-	-	-	-
245	Farm Buildings/Structures	12.5	40	56	70.6	Problematic	Intolerable
246	Farm Buildings/Structures	12.5	295	56	2.7	Acceptable	Perceptible
247	Farm Buildings/Structures	12.5	1019	56	0.3	Acceptable	Too Low
248	Farm Buildings/Structures	12.5	3016	56	0.1	Acceptable	Too Low
249	Farm Buildings/Structures	12.5	2866	56	0.1	Acceptable	Too Low
250	Farm Buildings/Structures	12.5	3882	56	0.0	Acceptable	Too Low
251	Farm Animal Structures (Feedlot)	25	3257	56	0.1	Acceptable	Too Low
252	Farm Animal Structures (Feedlot)	25	3859	56	0.0	Acceptable	Too Low
253	Farm Animal Structures (Feedlot)	25	3982	56	0.0	Acceptable	Too Low
254	Farm Animal Structures (Feedlot)	25	3227	56	0.1	Acceptable	Too Low
255	Farm Animal Structures (Feedlot)	25	3327	56	0.0	Acceptable	Too Low
256	Informal Housing Settlement	6	465	56	1.3	Acceptable	Perceptible
257	Informal Housing Settlement	6	621	56	0.8	Acceptable	Perceptible
258	Informal Housing Settlement	6	517	56	1.1	Acceptable	Perceptible
259	Informal Housing Settlement	6	248	56	3.5	Acceptable	Perceptible
260	Pan	150	3118	56	0.1	Acceptable	N/A
261	Pan	150	3242	56	0.1	Acceptable	N/A
262	Pan	150	3325	56	0.0	Acceptable	N/A
263	Pan	150	259	56	3.3	Acceptable	N/A
264	Pan	150	1257	56	0.2	Acceptable	N/A
265	Pan	150	1898	56	0.1	Acceptable	N/A
266	Pan	150	1713	56	0.1	Acceptable	N/A
267	Pan	150	2987	56	0.1	Acceptable	N/A
268	Pan	150	3109	56	0.1	Acceptable	N/A
269	Pan	150	3212	56	0.1	Acceptable	N/A
270	Pan	150	2919	56	0.1	Acceptable	N/A
271	Pan	150	3320	56	0.0	Acceptable	N/A
272	Pan	150	3993	56	0.0	Acceptable	N/A
273	Industrial Structures	50	3825	56	0.0	Acceptable	Too Low
274	Industrial Structures	50	3084	56	0.1	Acceptable	Too Low
275	Mine Activity	200	2604	56	0.1	Acceptable	N/A
276	Hydrocencus Borehole 1	50	1007	56	0.4	Acceptable	N/A
277	Hydrocencus Borehole 2	50	1101	56	0.3	Acceptable	N/A
278	Hydrocencus Borehole 3	50	951	56	0.4	Acceptable	N/A
279	Hydrocencus Borehole 4	50	891	56	0.4	Acceptable	N/A
280	Hydrocencus Borehole 5	50	1047	56	0.3	Acceptable	N/A

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
281	Hydrocencus Borehole 6	50	687	56	0.7	Acceptable	N/A
282	Hydrocencus Borehole 7	50	378	56	1.8	Acceptable	N/A
283	Hydrocencus Borehole 8	50	820	56	0.5	Acceptable	N/A
284	Hydrocencus Borehole 9	50	788	56	0.5	Acceptable	N/A
285	Hydrocencus Borehole 10	50	659	56	0.7	Acceptable	N/A
286	Hydrocencus Borehole 11	50	1532	56	0.2	Acceptable	N/A
287	Hydrocencus Borehole 12	50	1270	56	0.2	Acceptable	N/A
288	Hydrocencus Borehole 13	50	531	56	1.0	Acceptable	N/A
289	Hydrocencus Borehole 14	50	307	56	2.5	Acceptable	N/A
290	Hydrocencus Borehole 15	50	673	56	0.7	Acceptable	N/A
291	Hydrocencus Borehole 16	50	617	56	0.8	Acceptable	N/A
292	Hydrocencus Borehole 17	50	412	56	1.5	Acceptable	N/A
293	Hydrocencus Borehole 18	50	260	56	3.3	Acceptable	N/A
294	Hydrocencus Borehole 19 - Inside Pit Area	50	-	-	-	-	-
295	Hydrocencus Borehole 20	50	253	56	3.4	Acceptable	N/A
296	Hydrocencus Borehole 21	50	235	56	3.9	Acceptable	N/A
297	Hydrocencus Borehole 22	50	296	56	2.6	Acceptable	N/A
298	Hydrocencus Borehole 23	50	278	56	2.9	Acceptable	N/A
299	Hydrocencus Borehole 24	50	342	56	2.1	Acceptable	N/A
300	Hydrocencus Borehole 25	50	416	56	1.5	Acceptable	N/A
301	Hydrocencus Borehole 26	50	458	56	1.3	Acceptable	N/A
302	Hydrocencus Borehole 27	50	405	56	1.6	Acceptable	N/A
303	Hydrocencus Borehole 28	50	1137	56	0.3	Acceptable	N/A
304	Hydrocencus Borehole 29	50	772	56	0.5	Acceptable	N/A
305	Hydrocencus Borehole 30	50	809	56	0.5	Acceptable	N/A
306	Hydrocencus Borehole 31	50	1005	56	0.4	Acceptable	N/A
307	Hydrocencus Borehole 32	50	1049	56	0.3	Acceptable	N/A
308	Hydrocencus Borehole 33	50	1020	56	0.3	Acceptable	N/A
309	Hydrocencus Borehole 34	50	1003	56	0.4	Acceptable	N/A
310	Hydrocencus Borehole 35	50	1031	56	0.3	Acceptable	N/A
311	Hydrocencus Borehole 36	50	1983	56	0.1	Acceptable	N/A
312	Hydrocencus Borehole 37	50	2079	56	0.1	Acceptable	N/A
313	Hydrocencus Borehole 38	50	2173	56	0.1	Acceptable	N/A
314	Hydrocencus Borehole 39	50	1656	56	0.2	Acceptable	N/A
315	Hydrocencus Borehole 40	50	933	56	0.4	Acceptable	N/A
316	Hydrocencus Borehole 41	50	1315	56	0.2	Acceptable	N/A
317	Hydrocencus Borehole 42	50	1242	56	0.2	Acceptable	N/A
318	Hydrocencus Borehole 43	50	1057	56	0.3	Acceptable	N/A
319	Hydrocencus Borehole 44	50	1035	56	0.3	Acceptable	N/A
320	Hydrocencus Borehole 45	50	1028	56	0.3	Acceptable	N/A
321	Hydrocencus Borehole 46	50	988	56	0.4	Acceptable	N/A
322	Hydrocencus Borehole 47	50	615	56	0.8	Acceptable	N/A
323	Hydrocencus Borehole 48	50	562	56	0.9	Acceptable	N/A
324	Hydrocencus Borehole 49	50	456	56	1.3	Acceptable	N/A
325	Hydrocencus Borehole 50	50	441	56	1.4	Acceptable	N/A
326	Hydrocencus Borehole 51	50	607	56	0.8	Acceptable	N/A
327	Hydrocencus Borehole 52	50	2235	56	0.1	Acceptable	N/A
328	Hydrocencus Borehole 53	50	1333	56	0.2	Acceptable	N/A

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
329	Hydrocencus Borehole 54	50	1171	56	0.3	Acceptable	N/A
330	Hydrocencus Borehole 55	50	1984	56	0.1	Acceptable	N/A
331	Hydrocencus Borehole 56	50	2162	56	0.1	Acceptable	N/A
332	Hydrocencus Borehole 57	50	1853	56	0.1	Acceptable	N/A
333	Hydrocencus Borehole 58	50	879	56	0.4	Acceptable	N/A
334	Hydrocencus Borehole 59	50	1401	56	0.2	Acceptable	N/A
335	Hydrocencus Borehole 60	50	2681	56	0.1	Acceptable	N/A
336	Hydrocencus Borehole 61	50	2696	56	0.1	Acceptable	N/A
337	Hydrocencus Borehole 62	50	2235	56	0.1	Acceptable	N/A
338	Hydrocencus Borehole 63	50	1259	56	0.2	Acceptable	N/A
339	Hydrocencus Borehole 64	50	1459	56	0.2	Acceptable	N/A
340	Hydrocencus Borehole 65	50	2907	56	0.1	Acceptable	N/A
341	Hydrocencus Borehole 66	50	3056	56	0.1	Acceptable	N/A
342	Hydrocencus Borehole 67	50	2880	56	0.1	Acceptable	N/A
343	Hydrocencus Borehole 68	50	2966	56	0.1	Acceptable	N/A
344	Hydrocencus Borehole 69	50	2702	56	0.1	Acceptable	N/A
345	Hydrocencus Borehole 70	50	2693	56	0.1	Acceptable	N/A
346	Hydrocencus Borehole 71	50	2184	56	0.1	Acceptable	N/A
347	Hydrocencus Borehole 72	50	2094	56	0.1	Acceptable	N/A
348	Hydrocencus Borehole 73	50	1451	56	0.2	Acceptable	N/A
349	Hydrocencus Borehole 74	50	1725	56	0.1	Acceptable	N/A
350	Hydrocencus Borehole 75	50	1556	56	0.2	Acceptable	N/A
351	Hydrocencus Borehole 76	50	1287	56	0.2	Acceptable	N/A
352	Hydrocencus Borehole 77	50	1582	56	0.2	Acceptable	N/A
353	Hydrocencus Borehole 78	50	2704	56	0.1	Acceptable	N/A
354	Hydrocencus Borehole 79	50	709	56	0.6	Acceptable	N/A
355	Hydrocencus Borehole 80	50	718	56	0.6	Acceptable	N/A
356	Hydrocencus Borehole 81	50	750	56	0.6	Acceptable	N/A
357	Hydrocencus Borehole 82	50	897	56	0.4	Acceptable	N/A
358	Hydrocencus Borehole 83	50	882	56	0.4	Acceptable	N/A
359	Hydrocencus Borehole 84	50	927	56	0.4	Acceptable	N/A
360	Hydrocencus Borehole 85	50	634	56	0.8	Acceptable	N/A
361	Hydrocencus Borehole 86	50	413	56	1.5	Acceptable	N/A
362	Hydrocencus Borehole 87	50	346	56	2.1	Acceptable	N/A
363	Heritage Site (Informal Graveyard - 20 graves)	50	11	56	630.1	Problematic	N/A
364	Heritage Site (Ruins of a house/outbuilding constructed)	6	135	56	9.7	Problematic	N/A
365	Heritage Site (Stacked large stones) - Inside Pit Area	6	-	-	-	-	-
366	Heritage Site (Fowl-House structure) - Inside Pit Area	6	-	-	-	-	-
367	Heritage Site (Pigsty constructed with cement blocks) - Inside Pit Area	6	-	-	-	-	-
368	Heritage Site (Water trough/livestock pen) - Inside Pit Area	6	-	-	-	-	-
369	Heritage Site (Ruins of a house/outbuilding)	6	29	56	120.7	Problematic	N/A
370	Heritage Site (Old Trigonometrical beacon)	6	28	56	132.0	Problematic	N/A

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
371	Farm Animals (Horses - Goudhoek SA Boerperd Stoet)	12.5	756	56	0.6	Acceptable	Too Low
372	Farm Buildings/Structures	12.5	1598	56	0.2	Acceptable	Too Low
373	Informal Housing	6	573	56	0.9	Acceptable	Perceptible
374	Farm Buildings/Structures	12.5	906	56	0.4	Acceptable	Too Low
375	Farm Buildings/Structures	12.5	1207	56	0.3	Acceptable	Too Low
376	Underground cave	25	2690	56	0.1	Acceptable	N/A
377	Fuel Storage (Underground Fuel Tank)	50	1106	56	0.3	Acceptable	N/A
378	Fuel Storage (Underground Fuel Tank)	50	840	56	0.5	Acceptable	N/A
379	Fuel Storage (Underground Fuel Tank)	50	429	56	1.4	Acceptable	N/A
380	Industrial Structure (Agricultural Packhouse-Rossgro)	25	817	56	0.5	Acceptable	Too Low
381	Industrial Structures (Coal transport facility)	25	825	56	0.5	Acceptable	Too Low
382	Industrial Structures (Coal transport facility)	25	930	56	0.4	Acceptable	Too Low
383	Industrial Structures	50	1052	56	0.3	Acceptable	Too Low
384	Informal Housing (Labour Tenants)	6	1028	56	0.3	Acceptable	Too Low
385	Farm Buildings/Structures	12.5	1079	56	0.3	Acceptable	Too Low

Maximum charge per delay 226 kg

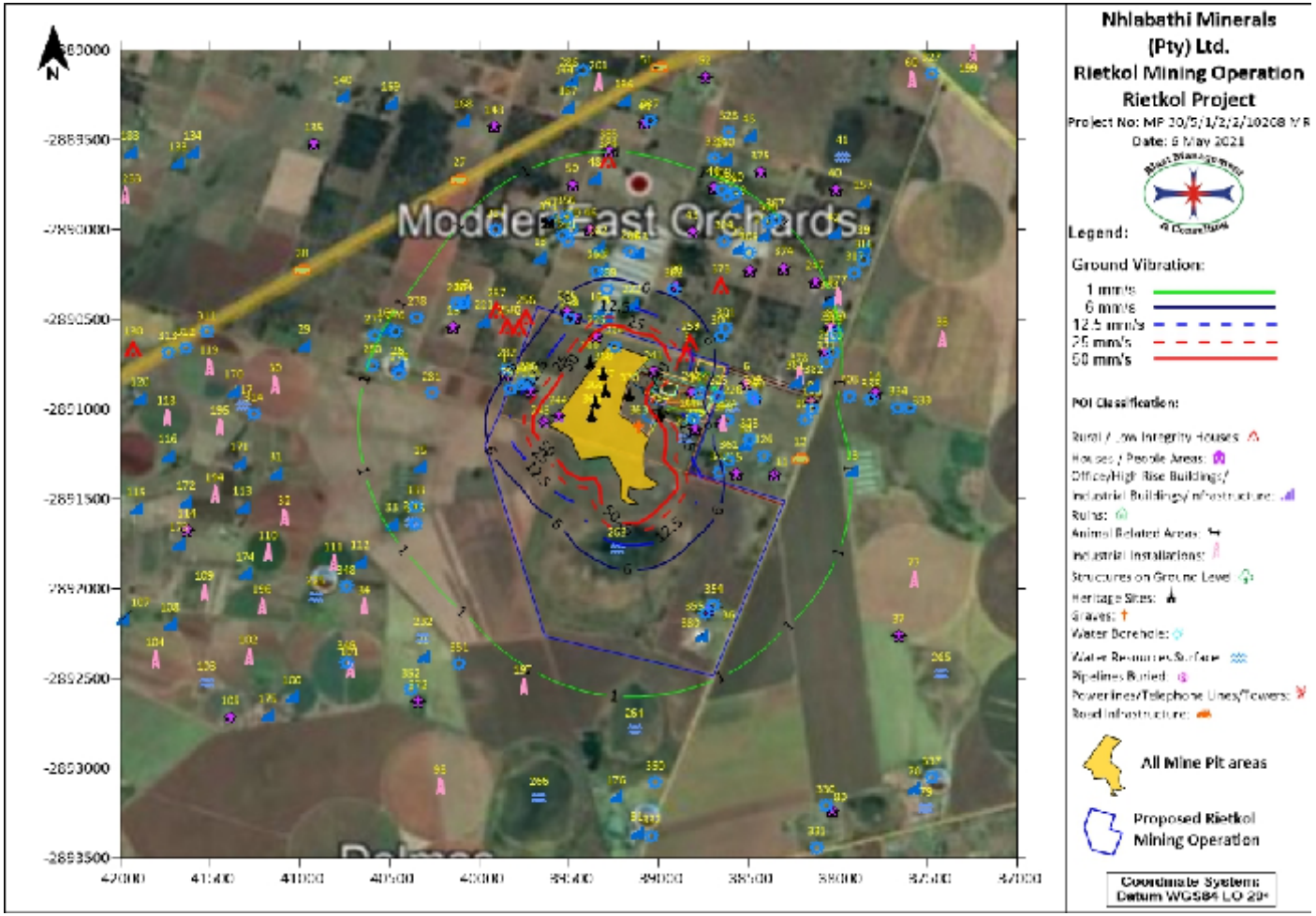


Figure 16: Ground vibration influence from maximum charge for the Mine Pit areas

Following figure shows zoomed area to 1 mm/s vibration contour

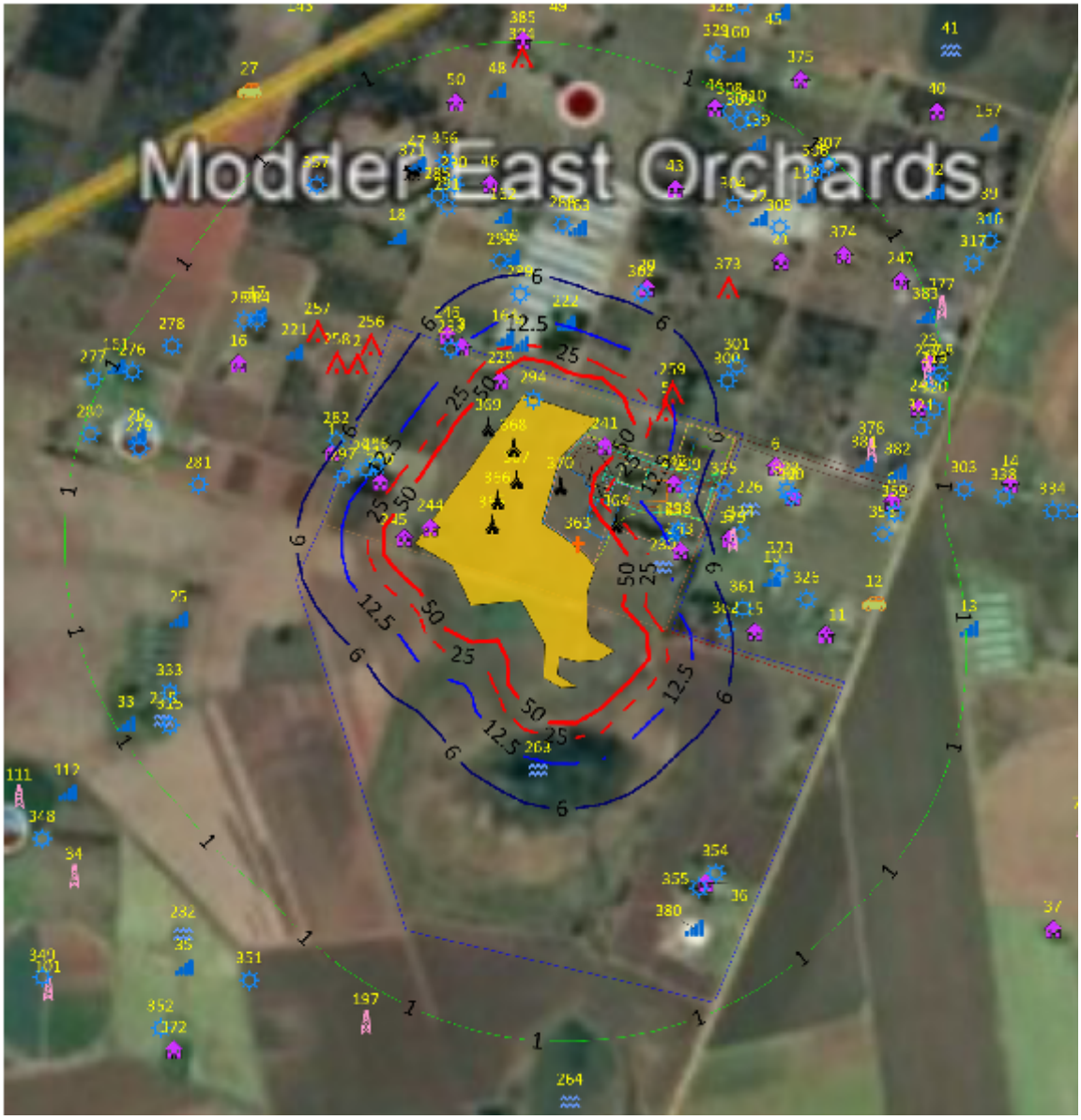


Figure 17: Ground vibration influence from maximum charge for the Mine Pit areas (Zoomed)

Table 13: Ground vibration evaluation for maximum charge for the Mine Pit areas

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
1	Farm Buildings/Structures	12.5	367	226	5.9	Acceptable	Unpleasant
2	Informal Housing Settlement	6	464	226	4.0	Acceptable	Perceptible
3	Farm Buildings/Structures	12.5	238	226	12.0	Acceptable	Unpleasant
4	Hot Houses/Nursery/Orchards	25	156	226	24.0	Acceptable	N/A
5	Informal Housing Settlement	6	214	226	14.3	Problematic	Unpleasant
6	Buildings/Structures	12.5	561	226	2.9	Acceptable	Perceptible
7	Farm Buildings/Structures	12.5	638	226	2.4	Acceptable	Perceptible
8	Farm Buildings/Structures	12.5	927	226	1.3	Acceptable	Perceptible
9	Farm Buildings/Structures	12.5	419	226	4.7	Acceptable	Perceptible
10	Agricultural Buildings	25	528	226	3.2	Acceptable	Perceptible
11	Farm Buildings/Structures	12.5	645	226	2.3	Acceptable	Perceptible
12	Road	150	804	226	1.6	Acceptable	N/A
13	Agricultural Buildings/Broilers	25	1082	226	1.0	Acceptable	Perceptible
14	Buildings/Structures	12.5	1273	226	0.8	Acceptable	Too Low
15	Farm Buildings/Structures	12.5	433	226	4.5	Acceptable	Perceptible
16	Farm Buildings/Structures	12.5	757	226	1.8	Acceptable	Perceptible
17	Farm Buildings/Structures (Business Commercial)	12.5	798	226	1.6	Acceptable	Perceptible
18	Farm Buildings/Structures (Agricultural Buildings)	25	614	226	2.5	Acceptable	Perceptible
19	Agricultural Buildings	25	419	226	4.7	Acceptable	Perceptible
20	Farm Buildings/Structures	12.5	427	226	4.6	Acceptable	Perceptible
21	Farm Buildings/Structures	12.5	743	226	1.8	Acceptable	Perceptible
22	Hot Houses/Flower Tunnels	25	788	226	1.7	Acceptable	N/A
23	Farm Buildings/Structures	12.5	1027	226	1.1	Acceptable	Perceptible
24	Farm Buildings/Structures	12.5	980	226	1.2	Acceptable	Perceptible
25	Agricultural Buildings/Broilers (Rossgro Group)	25	764	226	1.7	Acceptable	Perceptible
26	Buildings/Structures (Business Commercial)	12.5	910	226	1.3	Acceptable	Perceptible
27	N12 Road	150	1244	226	0.8	Acceptable	N/A
28	N12 Road	150	1631	226	0.5	Acceptable	N/A
29	Farm Buildings/Structures (Agricultural Buildings)	25	1442	226	0.6	Acceptable	Too Low
30	Pivot Irrigation	150	1552	226	0.5	Acceptable	N/A
31	Agricultural Buildings	25	1559	226	0.5	Acceptable	Too Low
32	Pivot Irrigation	150	1574	226	0.5	Acceptable	N/A
33	Farm Buildings/Structures (Agricultural Buildings)	25	1042	226	1.0	Acceptable	Perceptible
34	Pivot Irrigation	150	1450	226	0.6	Acceptable	N/A
35	Agricultural Buildings/Veg Tunnels	25	1405	226	0.6	Acceptable	Too Low
36	Farm Buildings/Structures/Farm Dam	12.5	715	226	2.0	Acceptable	Perceptible
37	Cement Dam& Agricultural Building	50	1581	226	0.5	Acceptable	Too Low
38	Pivot Irrigation	150	1638	226	0.5	Acceptable	N/A
39	Farm Buildings/Structures (Agricultural Buildings)	25	1349	226	0.7	Acceptable	Too Low
40	Farm Buildings/Structures	12.5	1401	226	0.6	Acceptable	Too Low

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
41	Pan	150	1559	226	0.5	Acceptable	N/A
42	Agricultural Buildings	25	1243	226	0.8	Acceptable	Perceptible
43	Farm Buildings/Structures	12.5	740	226	1.8	Acceptable	Perceptible
44	Farm Buildings/Structures	12.5	1013	226	1.1	Acceptable	Perceptible
45	Farm Buildings/Structures (Agricultural Buildings)	25	1358	226	0.7	Acceptable	Too Low
46	Farm Buildings/Structures	12.5	650	226	2.3	Acceptable	Perceptible
47	Farm Buildings/Structures (Agricultural Buildings)	25	771	226	1.7	Acceptable	Perceptible
48	Farm Buildings/Structures (Agricultural Buildings)	25	928	226	1.3	Acceptable	Perceptible
49	Farm Buildings/Structures	12.5	1250	226	0.8	Acceptable	Perceptible
50	Farm Buildings/Structures	12.5	913	226	1.3	Acceptable	Perceptible
51	N12 Road	150	1572	226	0.5	Acceptable	N/A
52	Farm Buildings/Structures	12.5	1582	226	0.5	Acceptable	Too Low
53	Farm Buildings/Structures	12.5	1868	226	0.4	Acceptable	Too Low
54	R50 Road	150	2406	226	0.3	Acceptable	N/A
55	R50 Road	150	2299	226	0.3	Acceptable	N/A
60	Pivot Irrigation	150	2136	226	0.3	Acceptable	N/A
61	Dam	50	2688	226	0.2	Acceptable	N/A
62	Pivot Irrigation	150	2585	226	0.2	Acceptable	N/A
63	Pivot Irrigation	150	3127	226	0.2	Acceptable	N/A
64	Pivot Irrigation	150	3474	226	0.1	Acceptable	N/A
65	Farm Buildings/Structures	12.5	3232	226	0.2	Acceptable	Too Low
66	Pan	150	2531	226	0.2	Acceptable	N/A
67	Pivot Irrigation	150	2201	226	0.3	Acceptable	N/A
68	Industrial Structures	50	3249	226	0.2	Acceptable	Too Low
69	Reservoirs	50	3348	226	0.2	Acceptable	N/A
70	Pivot Irrigation	150	2907	226	0.2	Acceptable	N/A
71	Pan	150	3160	226	0.2	Acceptable	N/A
72	Pivot Irrigation	150	2194	226	0.3	Acceptable	N/A
73	Dam	50	2703	226	0.2	Acceptable	N/A
74	Buildings/Structures	12.5	2687	226	0.2	Acceptable	Too Low
75	Pivot Irrigation	150	2477	226	0.3	Acceptable	N/A
76	Farm Buildings/Structures	12.5	3032	226	0.2	Acceptable	Too Low
77	Pivot Irrigation	150	1519	226	0.6	Acceptable	N/A
78	Agricultural Buildings/Broilers	25	2210	226	0.3	Acceptable	Too Low
79	Reservoirs	50	2338	226	0.3	Acceptable	N/A
80	Farm Buildings/Structures	12.5	2024	226	0.4	Acceptable	Too Low
81	Agricultural Buildings (Rossgro Group)	25	1833	226	0.4	Acceptable	Too Low
82	Farm Buildings/Structures	12.5	2765	226	0.2	Acceptable	Too Low
83	Farm Buildings/Structures	12.5	3495	226	0.1	Acceptable	Too Low
84	Farm Buildings/Structures	12.5	2903	226	0.2	Acceptable	Too Low
85	Farm Buildings/Structures	12.5	2535	226	0.2	Acceptable	Too Low
86	Farm Buildings/Structures	12.5	3276	226	0.2	Acceptable	Too Low
87	Farm Buildings/Structures	12.5	3277	226	0.2	Acceptable	Too Low
88	Farm Buildings/Structures	12.5	2292	226	0.3	Acceptable	Too Low
89	Farm Buildings/Structures	12.5	2387	226	0.3	Acceptable	Too Low
90	Farm Buildings/Structures	12.5	2670	226	0.2	Acceptable	Too Low

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
91	Farm Buildings/Structures	12.5	2993	226	0.2	Acceptable	Too Low
92	Pivot Irrigation	150	2680	226	0.2	Acceptable	N/A
93	Pivot Irrigation	150	2518	226	0.2	Acceptable	N/A
94	Pivot Irrigation	150	2358	226	0.3	Acceptable	N/A
95	Pivot Irrigation	150	1890	226	0.4	Acceptable	N/A
96	Informal Housing Settlement	6	3392	226	0.1	Acceptable	Too Low
97	Informal Housing Settlement	6	3358	226	0.2	Acceptable	Too Low
98	Farm Buildings/Structures	12.5	3268	226	0.2	Acceptable	Too Low
99	Cement Dam	50	3155	226	0.2	Acceptable	N/A
100	Agricultural Buildings	25	2080	226	0.3	Acceptable	Too Low
101	Pivot Irrigation	150	1735	226	0.5	Acceptable	N/A
102	Pivot Irrigation	150	2120	226	0.3	Acceptable	N/A
103	Dam	50	2393	226	0.3	Acceptable	N/A
104	Pivot Irrigation	150	2561	226	0.2	Acceptable	N/A
105	Buildings/Structures	12.5	2415	226	0.3	Acceptable	Too Low
106	Pivot Irrigation	150	2817	226	0.2	Acceptable	N/A
107	Agricultural Buildings	25	2626	226	0.2	Acceptable	Too Low
108	Agricultural Buildings	25	2394	226	0.3	Acceptable	Too Low
109	Pivot Irrigation	150	2144	226	0.3	Acceptable	N/A
110	Pivot Irrigation	150	1729	226	0.5	Acceptable	N/A
111	Pivot Irrigation	150	1435	226	0.6	Acceptable	N/A
112	Agricultural Buildings	25	1306	226	0.7	Acceptable	Too Low
113	Agricultural Buildings	25	1781	226	0.4	Acceptable	Too Low
114	Buildings/Structures	12.5	2113	226	0.3	Acceptable	Too Low
115	Agricultural Buildings/Broilers	25	2360	226	0.3	Acceptable	Too Low
116	Agricultural Buildings	25	2144	226	0.3	Acceptable	Too Low
117	Dam	50	1717	226	0.5	Acceptable	N/A
118	Pivot Irrigation	150	2144	226	0.3	Acceptable	N/A
119	Pivot Irrigation	150	1932	226	0.4	Acceptable	N/A
120	Buildings/Structures (Business Commercial)	12.5	2296	226	0.3	Acceptable	Too Low
121	Buildings/Structures (Business Commercial)	12.5	2561	226	0.2	Acceptable	Too Low
122	Agricultural Buildings	25	2808	226	0.2	Acceptable	Too Low
123	Agricultural Buildings	25	3262	226	0.2	Acceptable	Too Low
124	Farm Buildings/Structures	12.5	3687	226	0.1	Acceptable	Too Low
125	Buildings/Structures	12.5	3576	226	0.1	Acceptable	Too Low
126	Buildings/Structures	12.5	3325	226	0.2	Acceptable	Too Low
127	N12 Road	150	2775	226	0.2	Acceptable	N/A
128	Buildings/Structures	12.5	3436	226	0.1	Acceptable	Too Low
129	Buildings/Structures	12.5	3314	226	0.2	Acceptable	Too Low
130	Informal Housing	6	2367	226	0.3	Acceptable	Too Low
131	Agricultural Buildings	25	2749	226	0.2	Acceptable	Too Low
132	Agricultural Buildings	25	3299	226	0.2	Acceptable	Too Low
133	Buildings/Structures (Business Commercial)	12.5	2536	226	0.2	Acceptable	Too Low
134	Hot House/Nursery/Orchards	25	2503	226	0.2	Acceptable	N/A
135	Farm Buildings/Structures	12.5	1987	226	0.4	Acceptable	Too Low
136	Farm Buildings/Structures	12.5	3711	226	0.1	Acceptable	Too Low

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
137	Farm Buildings/Structures (Agricultural Buildings)	25	3080	226	0.2	Acceptable	Too Low
138	Farm Buildings/Structures (Agricultural Buildings)	25	3103	226	0.2	Acceptable	Too Low
139	Farm Buildings/Structures	12.5	2675	226	0.2	Acceptable	Too Low
140	Farm Buildings/Structures (Agricultural Buildings)	25	2028	226	0.3	Acceptable	Too Low
141	Farm Buildings/Structures (Agricultural Buildings)	25	1863	226	0.4	Acceptable	Too Low
142	Farm Buildings/Structures (Agricultural Buildings)	25	2611	226	0.2	Acceptable	Too Low
143	Buildings/Structures	12.5	1373	226	0.7	Acceptable	Too Low
144	Farm Buildings/Structures (Agricultural Buildings)	25	1486	226	0.6	Acceptable	Too Low
145	Farm Buildings/Structures	12.5	2445	226	0.3	Acceptable	Too Low
146	Farm Buildings/Structures	12.5	3811	226	0.1	Acceptable	Too Low
147	Agricultural Buildings/Broilers	25	3778	226	0.1	Acceptable	Too Low
148	Agricultural Buildings	25	3275	226	0.2	Acceptable	Too Low
149	Farm Buildings/Structures	12.5	3439	226	0.1	Acceptable	Too Low
150	Agricultural Buildings/Business Commercial	25	3224	226	0.2	Acceptable	Too Low
151	Broilers	25	3113	226	0.2	Acceptable	Too Low
152	Broilers	25	2817	226	0.2	Acceptable	Too Low
153	Industrial Structures	50	2205	226	0.3	Acceptable	Too Low
154	Informal Housing	6	3118	226	0.2	Acceptable	Too Low
155	Agricultural Buildings	25	2668	226	0.2	Acceptable	Too Low
156	Farm Buildings/Structures	12.5	1977	226	0.4	Acceptable	Too Low
157	Agricultural Buildings	25	1481	226	0.6	Acceptable	Too Low
158	Agricultural Buildings/Flower Tunnels	25	937	226	1.2	Acceptable	Perceptible
159	Agricultural Buildings	25	973	226	1.2	Acceptable	Perceptible
160	Agricultural Buildings/Veg Tunnels	25	1185	226	0.8	Acceptable	Perceptible
161	Agricultural Buildings	25	1057	226	1.0	Acceptable	Perceptible
162	Agricultural Buildings	25	546	226	3.0	Acceptable	Perceptible
163	Agricultural Buildings/Flower Tunnels	25	534	226	3.2	Acceptable	Perceptible
164	Agricultural Buildings/Flower Tunnels	25	182	226	18.7	Acceptable	Unpleasant
165	Agricultural Buildings	25	249	226	11.1	Acceptable	Unpleasant
166	Agricultural Buildings	25	1362	226	0.7	Acceptable	Too Low
167	Agricultural Buildings/Veg Tunnels	25	1341	226	0.7	Acceptable	Too Low
168	Agricultural Buildings	25	1490	226	0.6	Acceptable	Too Low
169	Agricultural Buildings	25	1812	226	0.4	Acceptable	Too Low
170	Agricultural Buildings	25	1776	226	0.4	Acceptable	Too Low
171	Agricultural Buildings	25	1749	226	0.4	Acceptable	Too Low
172	Agricultural Buildings	25	2081	226	0.3	Acceptable	Too Low
173	Agricultural Buildings	25	2177	226	0.3	Acceptable	Too Low
174	Agricultural Buildings	25	1892	226	0.4	Acceptable	Too Low
175	Agricultural Buildings/Business Commercial	25	2252	226	0.3	Acceptable	Too Low
176	Agricultural Buildings	25	1631	226	0.5	Acceptable	Too Low
177	Agricultural Buildings	25	3128	226	0.2	Acceptable	Too Low
178	Agricultural Buildings/Veg Tunnels	25	3624	226	0.1	Acceptable	Too Low

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
179	Agricultural Buildings	25	4101	226	0.1	Acceptable	Too Low
180	Agricultural Buildings	25	3093	226	0.2	Acceptable	Too Low
181	Agricultural Buildings/Veg Tunnels	25	2612	226	0.2	Acceptable	Too Low
182	Agricultural Buildings	25	2896	226	0.2	Acceptable	Too Low
183	Agricultural Buildings	25	2791	226	0.2	Acceptable	Too Low
184	Agricultural Buildings	25	2554	226	0.2	Acceptable	Too Low
185	Agricultural Buildings	25	2891	226	0.2	Acceptable	Too Low
186	Agricultural Buildings	25	3080	226	0.2	Acceptable	Too Low
187	Agricultural Buildings	25	4239	226	0.1	Acceptable	Too Low
188	Agricultural Buildings/Broilers	25	4334	226	0.1	Acceptable	Too Low
189	Agricultural Buildings	25	4075	226	0.1	Acceptable	Too Low
190	Agricultural Veg Tunnels	25	2978	226	0.2	Acceptable	Too Low
191	Agricultural Veg Tunnels	25	3559	226	0.1	Acceptable	Too Low
192	Agricultural Veg Tunnels	25	3125	226	0.2	Acceptable	Too Low
193	Agricultural Veg Tunnels	25	3523	226	0.1	Acceptable	Too Low
194	Pivot Irrigation	150	1915	226	0.4	Acceptable	N/A
195	Pivot Irrigation	150	1844	226	0.4	Acceptable	N/A
196	Pivot Irrigation	150	1900	226	0.4	Acceptable	N/A
197	Pivot Irrigation	150	1175	226	0.9	Acceptable	N/A
198	Pivot Irrigation	150	2670	226	0.2	Acceptable	N/A
199	Pivot Irrigation	150	2487	226	0.2	Acceptable	N/A
200	Pivot Irrigation	150	2422	226	0.3	Acceptable	N/A
201	Pivot Irrigation	150	1463	226	0.6	Acceptable	N/A
202	Pivot Irrigation	150	3702	226	0.1	Acceptable	N/A
203	Pivot Irrigation	150	3828	226	0.1	Acceptable	N/A
204	Pivot Irrigation	150	3697	226	0.1	Acceptable	N/A
205	Pivot Irrigation	150	3528	226	0.1	Acceptable	N/A
206	Pivot Irrigation	150	3543	226	0.1	Acceptable	N/A
207	Pivot Irrigation	150	2852	226	0.2	Acceptable	N/A
208	Pivot Irrigation	150	3078	226	0.2	Acceptable	N/A
209	Pivot Irrigation	150	3500	226	0.1	Acceptable	N/A
210	Pivot Irrigation	150	4287	226	0.1	Acceptable	N/A
211	Pivot Irrigation	150	2979	226	0.2	Acceptable	N/A
212	Pivot Irrigation	150	3289	226	0.2	Acceptable	N/A
213	Pivot Irrigation	150	3186	226	0.2	Acceptable	N/A
214	Pivot Irrigation	150	4160	226	0.1	Acceptable	N/A
215	Pivot Irrigation	150	4148	226	0.1	Acceptable	N/A
216	Pivot Irrigation	150	4175	226	0.1	Acceptable	N/A
217	Pivot Irrigation	150	2702	226	0.2	Acceptable	N/A
218	Pivot Irrigation	150	2796	226	0.2	Acceptable	N/A
219	Broilers	25	4234	226	0.1	Acceptable	Too Low
220	Buildings (Business Commercial)	12.5	2692	226	0.2	Acceptable	Too Low
221	Buildings (Business Commercial)	12.5	639	226	2.4	Acceptable	Perceptible
222	Buildings (Business Commercial)	12.5	247	226	11.3	Acceptable	Unpleasant
223	Eloff Buildings/Structures (Business Commercial)	12.5	3496	226	0.1	Acceptable	Too Low
224	Buildings/Business Commercial	12.5	1749	226	0.4	Acceptable	Too Low
225	Dam	50	1623	226	0.5	Acceptable	N/A
226	Dam	50	504	226	3.5	Acceptable	N/A

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
227	Cement Dam	50	1018	226	1.1	Acceptable	N/A
228	Dam	50	941	226	1.2	Acceptable	N/A
229	Buildings/Structures/Dam	12.5	82	226	69.1	Problematic	Intolerable
230	Dam	50	207	226	15.1	Acceptable	N/A
231	Dam	50	3362	226	0.2	Acceptable	N/A
232	Dam	50	1328	226	0.7	Acceptable	N/A
233	Cement Dam	50	2696	226	0.2	Acceptable	N/A
234	Cement Dam	50	2768	226	0.2	Acceptable	N/A
235	Dam	50	2726	226	0.2	Acceptable	N/A
236	Dam	50	3102	226	0.2	Acceptable	N/A
237	Dam	50	3014	226	0.2	Acceptable	N/A
238	Dam	50	3512	226	0.1	Acceptable	N/A
239	Farm Buildings/Structures	12.5	3552	226	0.1	Acceptable	Too Low
240	Farm Buildings/Structures	12.5	197	226	16.4	Problematic	Unpleasant
241	Farm Buildings/Structures	12.5	71	226	88.9	Problematic	Intolerable
242	Farm Buildings/Structures	12.5	301	226	8.1	Acceptable	Unpleasant
243	Farm Buildings/Structures	12.5	266	226	10.0	Acceptable	Unpleasant
244	Farm Buildings/Structures (Inside Pit Area)	12.5	-	-	-	-	-
245	Farm Buildings/Structures	12.5	40	226	223.2	Problematic	Intolerable
246	Farm Buildings/Structures	12.5	295	226	8.4	Acceptable	Unpleasant
247	Farm Buildings/Structures	12.5	1019	226	1.1	Acceptable	Perceptible
248	Farm Buildings/Structures	12.5	3016	226	0.2	Acceptable	Too Low
249	Farm Buildings/Structures	12.5	2866	226	0.2	Acceptable	Too Low
250	Farm Buildings/Structures	12.5	3882	226	0.1	Acceptable	Too Low
251	Farm Animal Structures (Feedlot)	25	3257	226	0.2	Acceptable	Too Low
252	Farm Animal Structures (Feedlot)	25	3859	226	0.1	Acceptable	Too Low
253	Farm Animal Structures (Feedlot)	25	3982	226	0.1	Acceptable	Too Low
254	Farm Animal Structures (Feedlot)	25	3227	226	0.2	Acceptable	Too Low
255	Farm Animal Structures (Feedlot)	25	3327	226	0.2	Acceptable	Too Low
256	Informal Housing Settlement	6	465	226	4.0	Acceptable	Perceptible
257	Informal Housing Settlement	6	621	226	2.5	Acceptable	Perceptible
258	Informal Housing Settlement	6	517	226	3.3	Acceptable	Perceptible
259	Informal Housing Settlement	6	248	226	11.2	Problematic	Unpleasant
260	Pan	150	3118	226	0.2	Acceptable	N/A
261	Pan	150	3242	226	0.2	Acceptable	N/A
262	Pan	150	3325	226	0.2	Acceptable	N/A
263	Pan	150	259	226	10.4	Acceptable	N/A
264	Pan	150	1257	226	0.8	Acceptable	N/A
265	Pan	150	1898	226	0.4	Acceptable	N/A
266	Pan	150	1713	226	0.5	Acceptable	N/A
267	Pan	150	2987	226	0.2	Acceptable	N/A
268	Pan	150	3109	226	0.2	Acceptable	N/A
269	Pan	150	3212	226	0.2	Acceptable	N/A
270	Pan	150	2919	226	0.2	Acceptable	N/A
271	Pan	150	3320	226	0.2	Acceptable	N/A
272	Pan	150	3993	226	0.1	Acceptable	N/A
273	Industrial Structures	50	3825	226	0.1	Acceptable	Too Low
274	Industrial Structures	50	3084	226	0.2	Acceptable	Too Low

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
275	Mine Activity	200	2604	226	0.2	Acceptable	N/A
276	Hydrocencus Borehole 1	50	1007	226	1.1	Acceptable	N/A
277	Hydrocencus Borehole 2	50	1101	226	1.0	Acceptable	N/A
278	Hydrocencus Borehole 3	50	951	226	1.2	Acceptable	N/A
279	Hydrocencus Borehole 4	50	891	226	1.4	Acceptable	N/A
280	Hydrocencus Borehole 5	50	1047	226	1.0	Acceptable	N/A
281	Hydrocencus Borehole 6	50	687	226	2.1	Acceptable	N/A
282	Hydrocencus Borehole 7	50	378	226	5.6	Acceptable	N/A
283	Hydrocencus Borehole 8	50	820	226	1.6	Acceptable	N/A
284	Hydrocencus Borehole 9	50	788	226	1.7	Acceptable	N/A
285	Hydrocencus Borehole 10	50	659	226	2.2	Acceptable	N/A
286	Hydrocencus Borehole 11	50	1532	226	0.6	Acceptable	N/A
287	Hydrocencus Borehole 12	50	1270	226	0.8	Acceptable	N/A
288	Hydrocencus Borehole 13	50	531	226	3.2	Acceptable	N/A
289	Hydrocencus Borehole 14	50	307	226	7.9	Acceptable	N/A
290	Hydrocencus Borehole 15	50	673	226	2.2	Acceptable	N/A
291	Hydrocencus Borehole 16	50	617	226	2.5	Acceptable	N/A
292	Hydrocencus Borehole 17	50	412	226	4.8	Acceptable	N/A
293	Hydrocencus Borehole 18	50	260	226	10.4	Acceptable	N/A
294	Hydrocencus Borehole 19 - Inside Pit Area	50	-	-	-	-	-
295	Hydrocencus Borehole 20	50	253	226	10.9	Acceptable	N/A
296	Hydrocencus Borehole 21	50	235	226	12.2	Acceptable	N/A
297	Hydrocencus Borehole 22	50	296	226	8.4	Acceptable	N/A
298	Hydrocencus Borehole 23	50	278	226	9.3	Acceptable	N/A
299	Hydrocencus Borehole 24	50	342	226	6.6	Acceptable	N/A
300	Hydrocencus Borehole 25	50	416	226	4.8	Acceptable	N/A
301	Hydrocencus Borehole 26	50	458	226	4.1	Acceptable	N/A
302	Hydrocencus Borehole 27	50	405	226	5.0	Acceptable	N/A
303	Hydrocencus Borehole 28	50	1137	226	0.9	Acceptable	N/A
304	Hydrocencus Borehole 29	50	772	226	1.7	Acceptable	N/A
305	Hydrocencus Borehole 30	50	809	226	1.6	Acceptable	N/A
306	Hydrocencus Borehole 31	50	1005	226	1.1	Acceptable	N/A
307	Hydrocencus Borehole 32	50	1049	226	1.0	Acceptable	N/A
308	Hydrocencus Borehole 33	50	1020	226	1.1	Acceptable	N/A
309	Hydrocencus Borehole 34	50	1003	226	1.1	Acceptable	N/A
310	Hydrocencus Borehole 35	50	1031	226	1.1	Acceptable	N/A
311	Hydrocencus Borehole 36	50	1983	226	0.4	Acceptable	N/A
312	Hydrocencus Borehole 37	50	2079	226	0.3	Acceptable	N/A
313	Hydrocencus Borehole 38	50	2173	226	0.3	Acceptable	N/A
314	Hydrocencus Borehole 39	50	1656	226	0.5	Acceptable	N/A
315	Hydrocencus Borehole 40	50	933	226	1.3	Acceptable	N/A
316	Hydrocencus Borehole 41	50	1315	226	0.7	Acceptable	N/A
317	Hydrocencus Borehole 42	50	1242	226	0.8	Acceptable	N/A
318	Hydrocencus Borehole 43	50	1057	226	1.0	Acceptable	N/A
319	Hydrocencus Borehole 44	50	1035	226	1.1	Acceptable	N/A
320	Hydrocencus Borehole 45	50	1028	226	1.1	Acceptable	N/A
321	Hydrocencus Borehole 46	50	988	226	1.1	Acceptable	N/A
322	Hydrocencus Borehole 47	50	615	226	2.5	Acceptable	N/A

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
323	Hydrocencus Borehole 48	50	562	226	2.9	Acceptable	N/A
324	Hydrocencus Borehole 49	50	456	226	4.1	Acceptable	N/A
325	Hydrocencus Borehole 50	50	441	226	4.3	Acceptable	N/A
326	Hydrocencus Borehole 51	50	607	226	2.6	Acceptable	N/A
327	Hydrocencus Borehole 52	50	2235	226	0.3	Acceptable	N/A
328	Hydrocencus Borehole 53	50	1333	226	0.7	Acceptable	N/A
329	Hydrocencus Borehole 54	50	1171	226	0.9	Acceptable	N/A
330	Hydrocencus Borehole 55	50	1984	226	0.4	Acceptable	N/A
331	Hydrocencus Borehole 56	50	2162	226	0.3	Acceptable	N/A
332	Hydrocencus Borehole 57	50	1853	226	0.4	Acceptable	N/A
333	Hydrocencus Borehole 58	50	879	226	1.4	Acceptable	N/A
334	Hydrocencus Borehole 59	50	1401	226	0.6	Acceptable	N/A
335	Hydrocencus Borehole 60	50	2681	226	0.2	Acceptable	N/A
336	Hydrocencus Borehole 61	50	2696	226	0.2	Acceptable	N/A
337	Hydrocencus Borehole 62	50	2235	226	0.3	Acceptable	N/A
338	Hydrocencus Borehole 63	50	1259	226	0.8	Acceptable	N/A
339	Hydrocencus Borehole 64	50	1459	226	0.6	Acceptable	N/A
340	Hydrocencus Borehole 65	50	2907	226	0.2	Acceptable	N/A
341	Hydrocencus Borehole 66	50	3056	226	0.2	Acceptable	N/A
342	Hydrocencus Borehole 67	50	2880	226	0.2	Acceptable	N/A
343	Hydrocencus Borehole 68	50	2966	226	0.2	Acceptable	N/A
344	Hydrocencus Borehole 69	50	2702	226	0.2	Acceptable	N/A
345	Hydrocencus Borehole 70	50	2693	226	0.2	Acceptable	N/A
346	Hydrocencus Borehole 71	50	2184	226	0.3	Acceptable	N/A
347	Hydrocencus Borehole 72	50	2094	226	0.3	Acceptable	N/A
348	Hydrocencus Borehole 73	50	1451	226	0.6	Acceptable	N/A
349	Hydrocencus Borehole 74	50	1725	226	0.5	Acceptable	N/A
350	Hydrocencus Borehole 75	50	1556	226	0.5	Acceptable	N/A
351	Hydrocencus Borehole 76	50	1287	226	0.7	Acceptable	N/A
352	Hydrocencus Borehole 77	50	1582	226	0.5	Acceptable	N/A
353	Hydrocencus Borehole 78	50	2704	226	0.2	Acceptable	N/A
354	Hydrocencus Borehole 79	50	709	226	2.0	Acceptable	N/A
355	Hydrocencus Borehole 80	50	718	226	1.9	Acceptable	N/A
356	Hydrocencus Borehole 81	50	750	226	1.8	Acceptable	N/A
357	Hydrocencus Borehole 82	50	897	226	1.3	Acceptable	N/A
358	Hydrocencus Borehole 83	50	882	226	1.4	Acceptable	N/A
359	Hydrocencus Borehole 84	50	927	226	1.3	Acceptable	N/A
360	Hydrocencus Borehole 85	50	634	226	2.4	Acceptable	N/A
361	Hydrocencus Borehole 86	50	413	226	4.8	Acceptable	N/A
362	Hydrocencus Borehole 87	50	346	226	6.5	Acceptable	N/A
363	Heritage Site (Informal Graveyard - 20 graves)	50	11	226	1992.2	Problematic	N/A
364	Heritage Site (Ruins of a house/outbuilding constructed)	6	135	226	30.7	Problematic	N/A
365	Heritage Site (Stacked large stones) - Inside Pit Area	6	-	-	-	-	-
366	Heritage Site (Fowl-House structure) - Inside Pit Area	6	-	-	-	-	-

Tag	Description	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
367	Heritage Site (Pigsty constructed with cement blocks) - Inside Pit Area	6	-	-	-	-	-
368	Heritage Site (Water trough/livestock pen) - Inside Pit Area	6	-	-	-	-	-
369	Heritage Site (Ruins of a house/outbuilding)	6	29	226	381.6	Problematic	N/A
370	Heritage Site (Old Trigonometrical beacon)	6	28	226	417.2	Problematic	N/A
371	Farm Animals (Horses - Goudhoek SA Boerperd Stoet)	12.5	756	226	1.8	Acceptable	Perceptible
372	Farm Buildings/Structures	12.5	1598	226	0.5	Acceptable	Too Low
373	Informal Housing	6	573	226	2.8	Acceptable	Perceptible
374	Farm Buildings/Structures	12.5	906	226	1.3	Acceptable	Perceptible
375	Farm Buildings/Structures	12.5	1207	226	0.8	Acceptable	Perceptible
376	Underground cave	25	2690	226	0.2	Acceptable	N/A
377	Fuel Storage (Underground Fuel Tank)	50	1106	226	1.0	Acceptable	N/A
378	Fuel Storage (Underground Fuel Tank)	50	840	226	1.5	Acceptable	N/A
379	Fuel Storage (Underground Fuel Tank)	50	429	226	4.5	Acceptable	N/A
380	Industrial Structure (Agricultural Packhouse-Rossgro)	25	817	226	1.6	Acceptable	Perceptible
381	Industrial Structures (Coal transport facility)	25	825	226	1.5	Acceptable	Perceptible
382	Industrial Structures (Coal transport facility)	25	930	226	1.3	Acceptable	Perceptible
383	Industrial Structures	50	1052	226	1.0	Acceptable	Perceptible
384	Informal Housing (Labour Tenants)	6	1028	226	1.1	Acceptable	Perceptible
385	Farm Buildings/Structures	12.5	1079	226	1.0	Acceptable	Perceptible

17.2 Summary of ground vibration levels

The opencast operation was evaluated for expected levels of ground vibration from future blasting operations. Review of the site and the surrounding installations / houses / buildings showed that structures vary in distances from the pit areas for North Block and Main Block Mine Pit Areas. The influences will also vary with distance from the pit areas. The model used for evaluation does indicate significant levels. It will be imperative to ensure that a monitoring program is implemented to confirm levels of ground vibration to ensure that ground vibration levels are not exceeded.

The distances between structures and the pit areas are a contributing factor to the levels of ground vibration expected and the subsequent possible influences. It is observed that for the different charge masses evaluated that levels of ground vibration will change as well. In view of the maximum charge specific attention will need to be given to specific areas. The ground vibration levels predicted ranged between 0.1 mm/s and 1992.2 mm/s for structures surrounding the open pit areas including installations / structures found within the MRA. The nearest house (inside the MRA) is located 40 m from the pit boundaries. Ground vibration level predicted at this is 223.2 mm/s. The

nearest structures outside the MRA are the Hothouses at 156 m and nearest houses are 214 m. The predicted levels of ground vibrations at the nearest house from maximum charge is 14.3 mm/s.

The minimum charge used indicated thirteen POI's of concern. Six of these POI's are located inside the pit area, seven are located inside the MRA with no POI's located outside the MRA. The maximum charge indicated sixteen POI's of concern. Six of these POI's are inside the pit area, eight are located inside the MRA and two are located outside the MRA and regarded as private.

Various Heritage Sites which include an Informal graveyard, Ruins (House/outbuilding/pigsty/fowl-house) and an old trigonometrical beacon were identified by the Heritage Specialist. Several of these sites fall within the pit areas. The Heritage Specialist recommended that the informal graveyard must be relocated as if falls within the mining activity area. Apart from the informal graveyard, no other significant heritage resources were recorded in the project area. No impact is expected on palaeological or archaeological remains. With regard to the built environment, the recorded ruins have no cultural significance and are judged to be less than 60 years old – they contain no intrinsic architecture design or pioneer building material and building methods that require further assessment. The trigonometrical beacon will also be impacted on.

Structure conditions ranged from industrial construction to poor condition structures. Water boreholes identified are at close proximity for the Pit areas. One borehole (POI 294) is inside of the Pit area; therefore, ground vibration influences on this borehole is foreseen or even destruction due to the mining process. There are a significant number of water boreholes within the MRA area with ground vibration levels predicted to be within acceptable range for these boreholes.

Mitigation of ground vibration was considered and discussed in Section 17.13. A detail inspection of the area and accurate identification of structures will also need to be done to ensure the levels of ground vibration allowable and limit to be applied.

17.3 Ground Vibration and human perception

Considering the effect of ground vibration with regards to human perception, vibration levels calculated were applied to an average of 30Hz frequency and plotted with expected human perceptions on the safe blasting criteria graph (see Figure 18 below). The frequency range selected is the expected average range for frequencies that will be measured for ground vibration when blasting is done. Based on the maximum charge and ground vibration predicted over distance it can be seen from Figure 18 that up to a distance of 1243 m people may experience levels of ground vibration as perceptible. At 419 m and closer the perception of ground vibration could be unpleasant. Closer than 196 m the levels will be intolerable and generally greater than limits applied for structures in the areas.

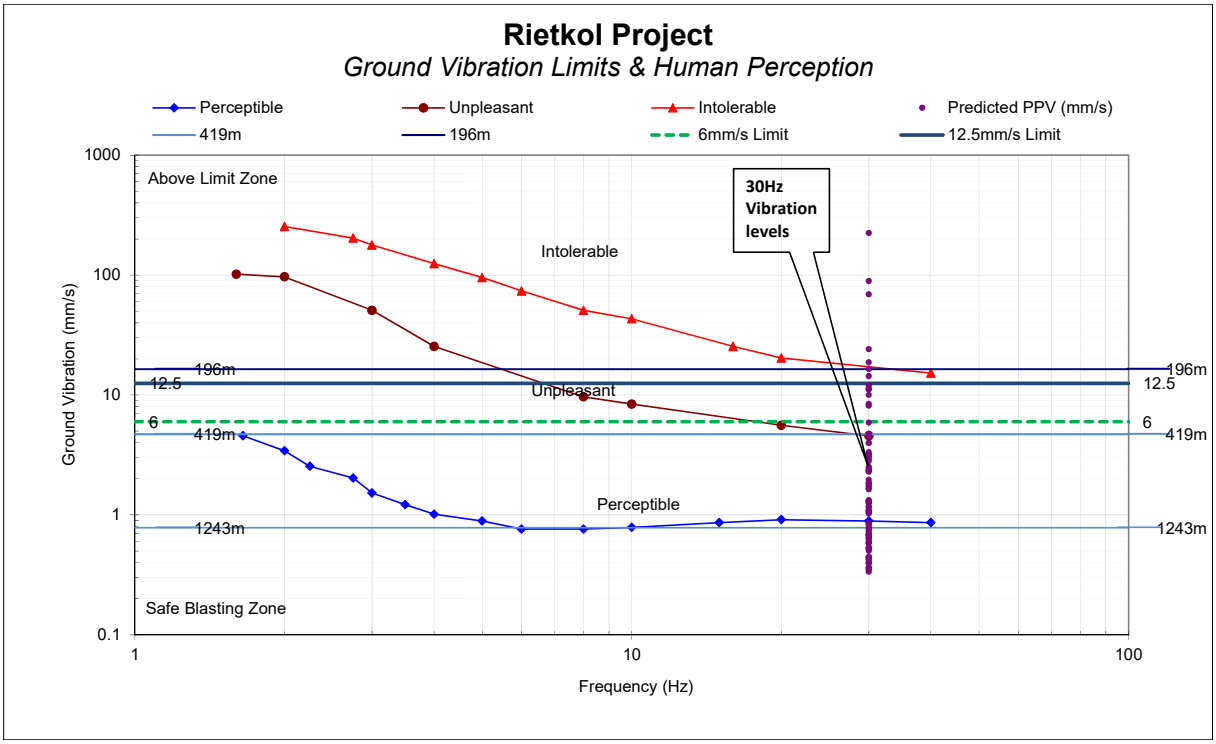


Figure 18: The effect of ground vibration with human perception and vibration limits

17.4 Vibration impact on roads

There are National and provincial roads in the vicinity of the project areas to be considered. The N12 road on the northern side of the pit area is located at 1244 m. The R50 road to the North-east of the pit area is located at 2299 m. Expected ground vibration levels at all roads are within the recommended limits. No specific actions are required for these roads.

17.5 Potential that vibration will upset adjacent communities

Ground vibration and air blast generally upset people living in the vicinity of mining operations. There area is a rural farming community with various types of farming activities taking place. It consists mainly of farmsteads and gravel roads that are within the evaluated area of influence. There are no formal community settlements but farmsteads and informal houses are found within 500 m from both pit areas. The houses are located such that levels of ground vibration predicted could be perceived as intolerable and could be problematic.

Ground vibration levels expected from maximum charge has possibility to be perceptible up to 1243 m. It is certain that lesser charges will reduce this distance for instance at minimum charge this

distance is expected to be 621 m. Within these distance ranges there are a number of houses. The anticipated ground vibration levels are certain to have possibility of upsetting the house holds within these ranges. Intolerable levels are expected up to a distance of 196 m.

The importance of good public relations cannot be under stressed. People tend to react negatively on experiencing of effects from blasting such as ground vibration and air blast. Even at low levels when damage to structures is out of the question it may upset people. Proper and appropriate communication with neighbours about blasting, monitoring and actions done for proper control will be required.

17.6 Review of expected air blast

Presented herewith are the expected air blast level contours and discussion of relevant influences. Expected air blast levels were calculated for each POI identified surrounding the mining area and evaluated with regards to possible structural concerns. Tables are provided for each of the different charge models done with regards to:

- "Tag" No. is number corresponding to the location indicated on POI figures;
- "Description" indicates the type of the structure;
- "Distance" is the distance between the structure and edge of the pit area;
- "Air Blast (dB)" is the calculated air blast level at the structure;
- "Possible concern" indicates if there is any concern for structural damage or human perception. Indicators used are:
    - "Problematic" where there is real concern for possible damage – at levels greater than 134 dB;
    - "Complaint" where people will be complaining due to the experienced effect on structures at levels of 120 dB and higher (not necessarily damaging);
    - "Acceptable" if levels are less than 120 dB;
    - "Low" where there is very limited possibility that the levels will give rise to any influence on people or structures. Levels below 115 dB could be considered to have low or negligible possibility of influence.

Presented are simulations for expected air blast levels from two different charge masses at each pit area. Colour codes used in tables are as follows:

Air blast levels higher than proposed limit is coloured "Red"
Air blast levels indicated as possible Complaint is coloured "Mustard"
POI's that are found inside the pit area is coloured "Olive Green"

Minimum charge mass per delay – 56 kg

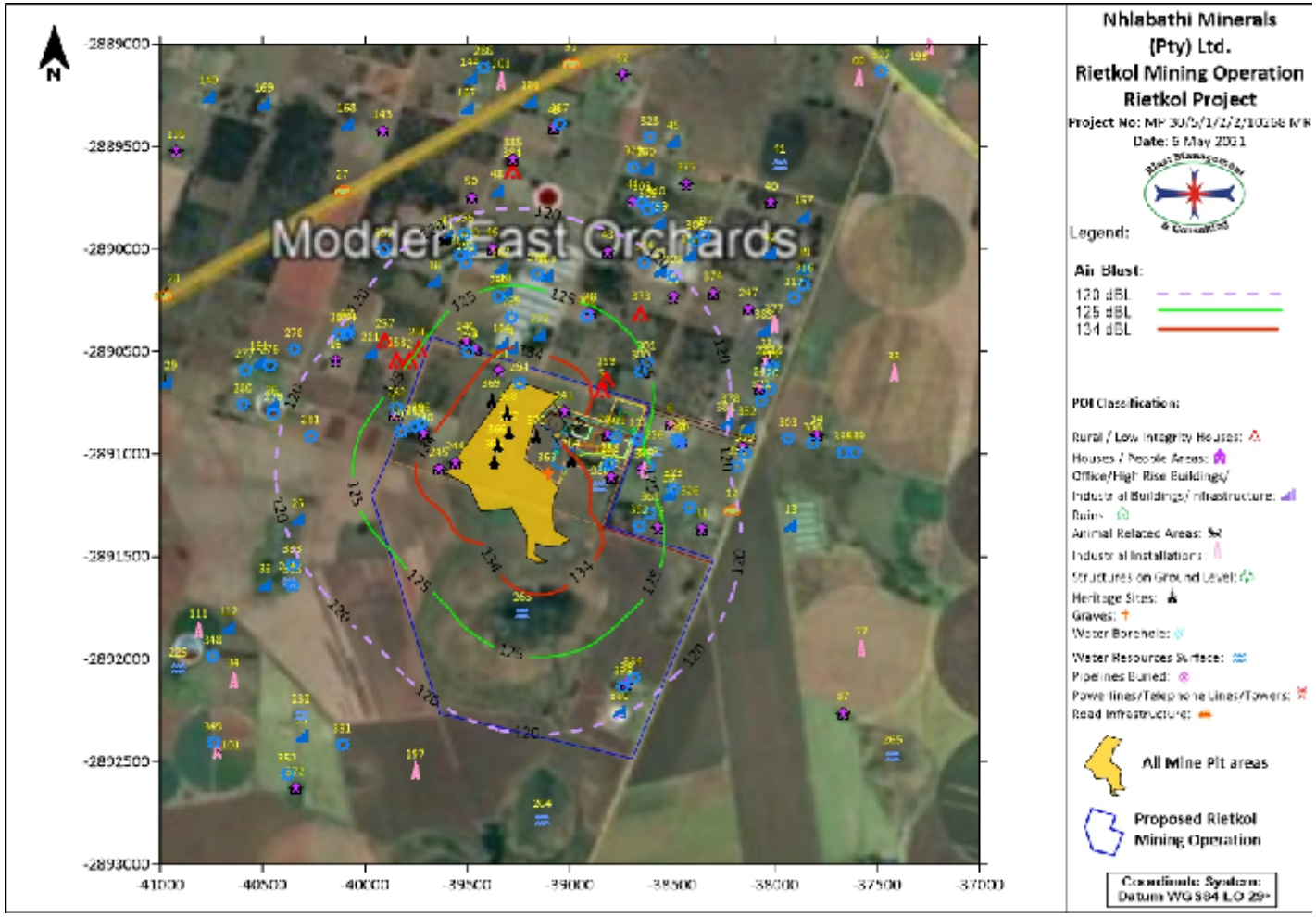


Figure 19: Air blast influence from minimum charge for the Mine Pit areas

Table 14: Air blast evaluation for minimum charge for the Mine Pit areas

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
1	Farm Buildings/Structures	367	126.9	Complaint
2	Informal Housing Settlement	464	125.0	Complaint
3	Farm Buildings/Structures	238	130.6	Complaint
4	Hot Houses/Nursery/Orchards	156	134.1	Problematic
5	Informal Housing Settlement	214	131.5	Complaint
6	Buildings/Structures	561	123.3	Complaint
7	Farm Buildings/Structures	638	122.3	Complaint
8	Farm Buildings/Structures	927	119.1	Acceptable
9	Farm Buildings/Structures	419	125.8	Complaint
10	Agricultural Buildings	528	123.9	Complaint
11	Farm Buildings/Structures	645	122.2	Complaint
12	Road	804	120.3	N/A
13	Agricultural Buildings/Broilers	1082	117.8	Acceptable
14	Buildings/Structures	1273	116.5	Acceptable
15	Farm Buildings/Structures	433	125.6	Complaint
16	Farm Buildings/Structures	757	120.8	Complaint
17	Farm Buildings/Structures (Business Commercial)	798	120.4	Complaint
18	Farm Buildings/Structures (Agricultural Buildings)	614	122.6	Complaint
19	Agricultural Buildings	419	125.8	Complaint
20	Farm Buildings/Structures	427	125.6	Complaint
21	Farm Buildings/Structures	743	121.0	Complaint
22	Hot Houses/Flower Tunnels	788	120.5	Complaint
23	Farm Buildings/Structures	1027	118.3	Acceptable
24	Farm Buildings/Structures	980	118.7	Acceptable
25	Agricultural Buildings/Broilers (Rossgro Group)	764	120.7	Complaint
26	Buildings/Structures (Business Commercial)	910	119.3	Acceptable
27	N12 Road	1244	116.7	N/A
28	N12 Road	1631	114.4	N/A
29	Farm Buildings/Structures (Agricultural Buildings)	1442	115.4	Acceptable
30	Pivot Irrigation	1552	114.8	N/A
31	Agricultural Buildings	1559	114.8	Acceptable
32	Pivot Irrigation	1574	114.7	N/A
33	Farm Buildings/Structures (Agricultural Buildings)	1042	118.2	Acceptable
34	Pivot Irrigation	1450	115.3	N/A
35	Agricultural Buildings/Veg Tunnels	1405	115.6	Acceptable
36	Farm Buildings/Structures/Farm Dam	715	121.3	Complaint
37	Cement Dam& Agricultural Building	1581	114.6	N/A
38	Pivot Irrigation	1638	114.3	N/A
39	Farm Buildings/Structures (Agricultural Buildings)	1349	116.0	Acceptable
40	Farm Buildings/Structures	1401	115.6	Acceptable

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
41	Pan	1559	114.8	N/A
42	Agricultural Buildings	1243	116.7	Acceptable
43	Farm Buildings/Structures	740	121.0	Complaint
44	Farm Buildings/Structures	1013	118.4	Acceptable
45	Farm Buildings/Structures (Agricultural Buildings)	1358	115.9	Acceptable
46	Farm Buildings/Structures	650	122.1	Complaint
47	Farm Buildings/Structures (Agricultural Buildings)	771	120.7	Complaint
48	Farm Buildings/Structures (Agricultural Buildings)	928	119.1	Acceptable
49	Farm Buildings/Structures	1250	116.7	Acceptable
50	Farm Buildings/Structures	913	119.3	Acceptable
51	N12 Road	1572	114.7	N/A
52	Farm Buildings/Structures	1582	114.6	Acceptable
53	Farm Buildings/Structures	1868	113.3	Acceptable
54	R50 Road	2406	111.1	N/A
55	R50 Road	2299	111.5	N/A
60	Pivot Irrigation	2136	112.1	N/A
61	Dam	2688	110.2	N/A
62	Pivot Irrigation	2585	110.5	N/A
63	Pivot Irrigation	3127	108.9	N/A
64	Pivot Irrigation	3474	108.1	N/A
65	Farm Buildings/Structures	3232	108.6	Acceptable
66	Pan	2531	110.8	N/A
67	Pivot Irrigation	2201	111.9	N/A
68	Industrial Structures	3249	108.6	Acceptable
69	Reservoirs	3348	108.3	N/A
70	Pivot Irrigation	2907	109.5	N/A
71	Pan	3160	108.8	N/A
72	Pivot Irrigation	2194	111.9	N/A
73	Dam	2703	110.1	N/A
74	Buildings/Structures	2687	110.2	Acceptable
75	Pivot Irrigation	2477	110.9	N/A
76	Farm Buildings/Structures	3032	109.2	Acceptable
77	Pivot Irrigation	1519	115.0	N/A
78	Agricultural Buildings/Broilers	2210	111.8	Acceptable
79	Reservoirs	2338	111.4	N/A
80	Farm Buildings/Structures	2024	112.6	Acceptable
81	Agricultural Buildings (Rossgro Group)	1833	113.4	Acceptable
82	Farm Buildings/Structures	2765	110.0	Acceptable
83	Farm Buildings/Structures	3495	108.0	Acceptable
84	Farm Buildings/Structures	2903	109.5	Acceptable
85	Farm Buildings/Structures	2535	110.8	Acceptable
86	Farm Buildings/Structures	3276	108.6	Acceptable

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
87	Farm Buildings/Structures	3277	108.6	Acceptable
88	Farm Buildings/Structures	2292	111.6	Acceptable
89	Farm Buildings/Structures	2387	111.2	Acceptable
90	Farm Buildings/Structures	2670	110.2	Acceptable
91	Farm Buildings/Structures	2993	109.2	Acceptable
92	Pivot Irrigation	2680	110.2	N/A
93	Pivot Irrigation	2518	110.8	N/A
94	Pivot Irrigation	2358	111.2	N/A
95	Pivot Irrigation	1890	113.2	N/A
96	Informal Housing Settlement	3392	108.3	Acceptable
97	Informal Housing Settlement	3358	108.3	Acceptable
98	Farm Buildings/Structures	3268	108.6	Acceptable
99	Cement Dam	3155	108.9	N/A
100	Agricultural Buildings	2080	112.4	Acceptable
101	Pivot Irrigation	1735	113.9	N/A
102	Pivot Irrigation	2120	112.1	N/A
103	Dam	2393	111.1	N/A
104	Pivot Irrigation	2561	110.6	N/A
105	Buildings/Structures	2415	111.1	Acceptable
106	Pivot Irrigation	2817	109.8	N/A
107	Agricultural Buildings	2626	110.4	Acceptable
108	Agricultural Buildings	2394	111.1	Acceptable
109	Pivot Irrigation	2144	112.1	N/A
110	Pivot Irrigation	1729	113.9	N/A
111	Pivot Irrigation	1435	115.5	N/A
112	Agricultural Buildings	1306	116.3	Acceptable
113	Agricultural Buildings	1781	113.6	Acceptable
114	Buildings/Structures	2113	112.3	Acceptable
115	Agricultural Buildings/Broilers	2360	111.2	Acceptable
116	Agricultural Buildings	2144	112.1	Acceptable
117	Dam	1717	114.0	N/A
118	Pivot Irrigation	2144	112.1	N/A
119	Pivot Irrigation	1932	113.0	N/A
120	Buildings/Structures (Business Commercial)	2296	111.5	Acceptable
121	Buildings/Structures (Business Commercial)	2561	110.6	Acceptable
122	Agricultural Buildings	2808	109.8	Acceptable
123	Agricultural Buildings	3262	108.6	Acceptable
124	Farm Buildings/Structures	3687	107.6	Acceptable
125	Buildings/Structures	3576	107.8	Acceptable
126	Buildings/Structures	3325	108.5	Acceptable
127	N12 Road	2775	110.0	N/A
128	Buildings/Structures	3436	108.1	Acceptable

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
129	Buildings/Structures	3314	108.5	Acceptable
130	Informal Housing	2367	111.2	Acceptable
131	Agricultural Buildings	2749	110.0	Acceptable
132	Agricultural Buildings	3299	108.5	Acceptable
133	Buildings/Structures (Business Commercial)	2536	110.8	Acceptable
134	Hot House/Nursery/Orchards	2503	110.8	Acceptable
135	Farm Buildings/Structures	1987	112.8	Acceptable
136	Farm Buildings/Structures	3711	107.6	Acceptable
137	Farm Buildings/Structures (Agricultural Buildings)	3080	109.1	Acceptable
138	Farm Buildings/Structures (Agricultural Buildings)	3103	108.9	Acceptable
139	Farm Buildings/Structures	2675	110.2	Acceptable
140	Farm Buildings/Structures (Agricultural Buildings)	2028	112.6	Acceptable
141	Farm Buildings/Structures (Agricultural Buildings)	1863	113.3	Acceptable
142	Farm Buildings/Structures (Agricultural Buildings)	2611	110.5	Acceptable
143	Buildings/Structures	1373	115.8	Acceptable
144	Farm Buildings/Structures (Agricultural Buildings)	1486	115.2	Acceptable
145	Farm Buildings/Structures	2445	111.0	Acceptable
146	Farm Buildings/Structures	3811	107.2	Acceptable
147	Agricultural Buildings/Broilers	3778	107.4	Acceptable
148	Agricultural Buildings	3275	108.6	Acceptable
149	Farm Buildings/Structures	3439	108.1	Acceptable
150	Agricultural Buildings/Business Commercial	3224	108.6	Acceptable
151	Broilers	3113	108.9	Acceptable
152	Broilers	2817	109.8	Acceptable
153	Industrial Structures	2205	111.8	Acceptable
154	Informal Housing	3118	108.9	Acceptable
155	Agricultural Buildings	2668	110.2	Acceptable
156	Farm Buildings/Structures	1977	112.8	Acceptable
157	Agricultural Buildings	1481	115.2	Acceptable
158	Agricultural Buildings/Flower Tunnels	937	119.0	Acceptable
159	Agricultural Buildings	973	118.7	Acceptable
160	Agricultural Buildings/Veg Tunnels	1185	117.1	Acceptable
161	Agricultural Buildings	1057	118.0	Acceptable
162	Agricultural Buildings	546	123.6	Complaint
163	Agricultural Buildings/Flower Tunnels	534	123.8	Problematic
164	Agricultural Buildings/Flower Tunnels	182	132.8	Problematic
165	Agricultural Buildings	249	130.2	Complaint
166	Agricultural Buildings	1362	115.9	Acceptable
167	Agricultural Buildings/Veg Tunnels	1341	116.1	Acceptable
168	Agricultural Buildings	1490	115.1	Acceptable
169	Agricultural Buildings	1812	113.5	Acceptable
170	Agricultural Buildings	1776	113.7	Acceptable

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
171	Agricultural Buildings	1749	113.8	Acceptable
172	Agricultural Buildings	2081	112.4	Acceptable
173	Agricultural Buildings	2177	111.9	Acceptable
174	Agricultural Buildings	1892	113.2	Acceptable
175	Agricultural Buildings/Business Commercial	2252	111.7	Acceptable
176	Agricultural Buildings	1631	114.4	Acceptable
177	Agricultural Buildings	3128	108.9	Acceptable
178	Agricultural Buildings/Veg Tunnels	3624	107.8	Acceptable
179	Agricultural Buildings	4101	106.6	Acceptable
180	Agricultural Buildings	3093	109.1	Acceptable
181	Agricultural Buildings/Veg Tunnels	2612	110.5	Acceptable
182	Agricultural Buildings	2896	109.5	Acceptable
183	Agricultural Buildings	2791	109.8	Acceptable
184	Agricultural Buildings	2554	110.6	Acceptable
185	Agricultural Buildings	2891	109.5	Acceptable
186	Agricultural Buildings	3080	109.1	Acceptable
187	Agricultural Buildings	4239	106.4	Acceptable
188	Agricultural Buildings/Broilers	4334	106.2	Acceptable
189	Agricultural Buildings	4075	106.6	Acceptable
190	Agricultural Veg Tunnels	2978	109.4	Acceptable
191	Agricultural Veg Tunnels	3559	107.8	Acceptable
192	Agricultural Veg Tunnels	3125	108.9	Acceptable
193	Agricultural Veg Tunnels	3523	108.0	Acceptable
194	Pivot Irrigation	1915	113.1	N/A
195	Pivot Irrigation	1844	113.3	N/A
196	Pivot Irrigation	1900	113.1	N/A
197	Pivot Irrigation	1175	117.1	N/A
198	Pivot Irrigation	2670	110.2	N/A
199	Pivot Irrigation	2487	110.9	N/A
200	Pivot Irrigation	2422	111.1	N/A
201	Pivot Irrigation	1463	115.3	N/A
202	Pivot Irrigation	3702	107.6	N/A
203	Pivot Irrigation	3828	107.2	N/A
204	Pivot Irrigation	3697	107.6	N/A
205	Pivot Irrigation	3528	108.0	N/A
206	Pivot Irrigation	3543	108.0	N/A
207	Pivot Irrigation	2852	109.7	N/A
208	Pivot Irrigation	3078	109.1	N/A
209	Pivot Irrigation	3500	108.0	N/A
210	Pivot Irrigation	4287	106.2	N/A
211	Pivot Irrigation	2979	109.4	N/A
212	Pivot Irrigation	3289	108.5	N/A

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
213	Pivot Irrigation	3186	108.8	N/A
214	Pivot Irrigation	4160	106.6	N/A
215	Pivot Irrigation	4148	106.6	N/A
216	Pivot Irrigation	4175	106.4	N/A
217	Pivot Irrigation	2702	110.1	N/A
218	Pivot Irrigation	2796	109.8	N/A
219	Broilers	4234	106.4	Acceptable
220	Buildings (Business Commercial)	2692	110.2	Acceptable
221	Buildings (Business Commercial)	639	122.3	Complaint
222	Buildings (Business Commercial)	247	130.3	Complaint
223	Eloff Buildings/Structures (Business Commercial)	3496	108.0	Acceptable
224	Buildings/Business Commercial	1749	113.8	Acceptable
225	Dam	1623	114.4	N/A
226	Dam	504	124.2	N/A
227	Cement Dam	1018	118.3	N/A
228	Dam	941	119.0	N/A
229	Buildings/Structures/Dam	82	139.5	Problematic
230	Dam	207	131.7	N/A
231	Dam	3362	108.3	N/A
232	Dam	1328	116.1	N/A
233	Cement Dam	2696	110.2	N/A
234	Cement Dam	2768	110.0	N/A
235	Dam	2726	110.1	N/A
236	Dam	3102	108.9	N/A
237	Dam	3014	109.2	N/A
238	Dam	3512	108.0	N/A
239	Farm Buildings/Structures	3552	108.0	Acceptable
240	Farm Buildings/Structures	197	132.2	Complaint
241	Farm Buildings/Structures	71	140.8	Problematic
242	Farm Buildings/Structures	301	128.6	Complaint
243	Farm Buildings/Structures	266	129.6	Complaint
244	Farm Buildings/Structures (Inside Pit Area)	-	-	-
245	Farm Buildings/Structures	40	145.5	Problematic
246	Farm Buildings/Structures	295	128.8	Complaint
247	Farm Buildings/Structures	1019	118.3	Acceptable
248	Farm Buildings/Structures	3016	109.2	Acceptable
249	Farm Buildings/Structures	2866	109.7	Acceptable
250	Farm Buildings/Structures	3882	107.2	Acceptable
251	Farm Animal Structures (Feedlot)	3257	108.6	Acceptable
252	Farm Animal Structures (Feedlot)	3859	107.2	Acceptable
253	Farm Animal Structures (Feedlot)	3982	106.8	Acceptable
254	Farm Animal Structures (Feedlot)	3227	108.6	Acceptable

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
255	Farm Animal Structures (Feedlot)	3327	108.5	Acceptable
256	Informal Housing Settlement	465	124.9	Complaint
257	Informal Housing Settlement	621	122.5	Complaint
258	Informal Housing Settlement	517	124.0	Complaint
259	Informal Housing Settlement	248	130.2	Complaint
260	Pan	3118	108.9	N/A
261	Pan	3242	108.6	N/A
262	Pan	3325	108.5	N/A
263	Pan	259	129.9	N/A
264	Pan	1257	116.6	N/A
265	Pan	1898	113.2	N/A
266	Pan	1713	114.0	N/A
267	Pan	2987	109.4	N/A
268	Pan	3109	108.9	N/A
269	Pan	3212	108.8	N/A
270	Pan	2919	109.5	N/A
271	Pan	3320	108.5	N/A
272	Pan	3993	106.8	N/A
273	Industrial Structures	3825	107.2	Acceptable
274	Industrial Structures	3084	109.1	Acceptable
275	Mine Activity	2604	110.5	N/A
276	Hydrocencus Borehole 1	1007	118.4	N/A
277	Hydrocencus Borehole 2	1101	117.7	N/A
278	Hydrocencus Borehole 3	951	118.9	N/A
279	Hydrocencus Borehole 4	891	119.5	N/A
280	Hydrocencus Borehole 5	1047	118.1	N/A
281	Hydrocencus Borehole 6	687	121.7	N/A
282	Hydrocencus Borehole 7	378	126.7	N/A
283	Hydrocencus Borehole 8	820	120.2	N/A
284	Hydrocencus Borehole 9	788	120.5	N/A
285	Hydrocencus Borehole 10	659	122.0	N/A
286	Hydrocencus Borehole 11	1532	114.9	N/A
287	Hydrocencus Borehole 12	1270	116.5	N/A
288	Hydrocencus Borehole 13	531	123.8	N/A
289	Hydrocencus Borehole 14	307	128.4	N/A
290	Hydrocencus Borehole 15	673	121.8	N/A
291	Hydrocencus Borehole 16	617	122.6	N/A
292	Hydrocencus Borehole 17	412	126.0	N/A
293	Hydrocencus Borehole 18	260	129.8	N/A
294	Hydrocencus Borehole 19 - Inside Pit Area	-	-	-
295	Hydrocencus Borehole 20	253	130.1	N/A
296	Hydrocencus Borehole 21	235	130.7	N/A

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
297	Hydrocencus Borehole 22	296	128.7	N/A
298	Hydrocencus Borehole 23	278	129.3	N/A
299	Hydrocencus Borehole 24	342	127.5	N/A
300	Hydrocencus Borehole 25	416	125.9	N/A
301	Hydrocencus Borehole 26	458	125.1	N/A
302	Hydrocencus Borehole 27	405	126.1	N/A
303	Hydrocencus Borehole 28	1137	117.4	N/A
304	Hydrocencus Borehole 29	772	120.7	N/A
305	Hydrocencus Borehole 30	809	120.3	N/A
306	Hydrocencus Borehole 31	1005	118.4	N/A
307	Hydrocencus Borehole 32	1049	118.1	N/A
308	Hydrocencus Borehole 33	1020	118.3	N/A
309	Hydrocencus Borehole 34	1003	118.5	N/A
310	Hydrocencus Borehole 35	1031	118.2	N/A
311	Hydrocencus Borehole 36	1983	112.8	N/A
312	Hydrocencus Borehole 37	2079	112.4	N/A
313	Hydrocencus Borehole 38	2173	112.0	N/A
314	Hydrocencus Borehole 39	1656	114.2	N/A
315	Hydrocencus Borehole 40	933	119.1	N/A
316	Hydrocencus Borehole 41	1315	116.2	N/A
317	Hydrocencus Borehole 42	1242	116.7	N/A
318	Hydrocencus Borehole 43	1057	118.0	N/A
319	Hydrocencus Borehole 44	1035	118.2	N/A
320	Hydrocencus Borehole 45	1028	118.3	N/A
321	Hydrocencus Borehole 46	988	118.6	N/A
322	Hydrocencus Borehole 47	615	122.6	N/A
323	Hydrocencus Borehole 48	562	123.3	N/A
324	Hydrocencus Borehole 49	456	125.1	N/A
325	Hydrocencus Borehole 50	441	125.4	N/A
326	Hydrocencus Borehole 51	607	122.7	N/A
327	Hydrocencus Borehole 52	2235	111.7	N/A
328	Hydrocencus Borehole 53	1333	116.1	N/A
329	Hydrocencus Borehole 54	1171	117.1	N/A
330	Hydrocencus Borehole 55	1984	112.8	N/A
331	Hydrocencus Borehole 56	2162	112.0	N/A
332	Hydrocencus Borehole 57	1853	113.3	N/A
333	Hydrocencus Borehole 58	879	119.6	N/A
334	Hydrocencus Borehole 59	1401	115.6	N/A
335	Hydrocencus Borehole 60	2681	110.2	N/A
336	Hydrocencus Borehole 61	2696	110.2	N/A
337	Hydrocencus Borehole 62	2235	111.7	N/A
338	Hydrocencus Borehole 63	1259	116.6	N/A

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
339	Hydrocencus Borehole 64	1459	115.3	N/A
340	Hydrocencus Borehole 65	2907	109.5	N/A
341	Hydrocencus Borehole 66	3056	109.1	N/A
342	Hydrocencus Borehole 67	2880	109.7	N/A
343	Hydrocencus Borehole 68	2966	109.4	N/A
344	Hydrocencus Borehole 69	2702	110.1	N/A
345	Hydrocencus Borehole 70	2693	110.2	N/A
346	Hydrocencus Borehole 71	2184	111.9	N/A
347	Hydrocencus Borehole 72	2094	112.3	N/A
348	Hydrocencus Borehole 73	1451	115.3	N/A
349	Hydrocencus Borehole 74	1725	113.9	N/A
350	Hydrocencus Borehole 75	1556	114.8	N/A
351	Hydrocencus Borehole 76	1287	116.4	N/A
352	Hydrocencus Borehole 77	1582	114.6	N/A
353	Hydrocencus Borehole 78	2704	110.1	N/A
354	Hydrocencus Borehole 79	709	121.4	N/A
355	Hydrocencus Borehole 80	718	121.3	N/A
356	Hydrocencus Borehole 81	750	120.9	N/A
357	Hydrocencus Borehole 82	897	119.4	N/A
358	Hydrocencus Borehole 83	882	119.6	N/A
359	Hydrocencus Borehole 84	927	119.1	N/A
360	Hydrocencus Borehole 85	634	122.3	N/A
361	Hydrocencus Borehole 86	413	125.9	N/A
362	Hydrocencus Borehole 87	346	127.4	N/A
363	Heritage Site (Informal Graveyard - 20 graves)	11	156.7	N/A
364	Heritage Site (Ruins of a house/outbuilding constructed)	135	135.4	N/A
365	Heritage Site (Stacked large stones) - Inside Pit Area	-	-	-
366	Heritage Site (Fowl-House structure) - Inside Pit Area	-	-	-
367	Heritage Site (Pigsty constructed with cement blocks) - Inside Pit Area	-	-	-
368	Heritage Site (Water trough/livestock pen) - Inside Pit Area	-	-	-
369	Heritage Site (Ruins of a house/outbuilding)	29	148.2	N/A
370	Heritage Site (Old Trigonometrical beacon)	28	148.7	N/A
371	Farm Animals (Horses - Goudhoek SA Boerperd Stoet)	756	120.9	Complaint
372	Farm Buildings/Structures	1598	114.6	Acceptable
373	Informal Housing	573	123.2	Complaint
374	Farm Buildings/Structures	906	119.3	Acceptable
375	Farm Buildings/Structures	1207	116.9	Acceptable
376	Underground cave	2690	110.2	N/A
377	Fuel Storage (Underground Fuel Tank)	1106	117.7	N/A
378	Fuel Storage (Underground Fuel Tank)	840	120.0	N/A
379	Fuel Storage (Underground Fuel Tank)	429	125.6	N/A

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
380	Industrial Structure (Agricultural Packhouse-Rossgro)	817	120.2	Complaint
381	Industrial Structures (Coal transport facility)	825	120.1	Complaint
382	Industrial Structures (Coal transport facility)	930	119.1	Acceptable
383	Industrial Structures	1052	118.1	Acceptable
384	Informal Housing (Labour Tenants)	1028	118.3	Acceptable
385	Farm Buildings/Structures	1079	117.8	Acceptable

Maximum charge per delay 226 kg

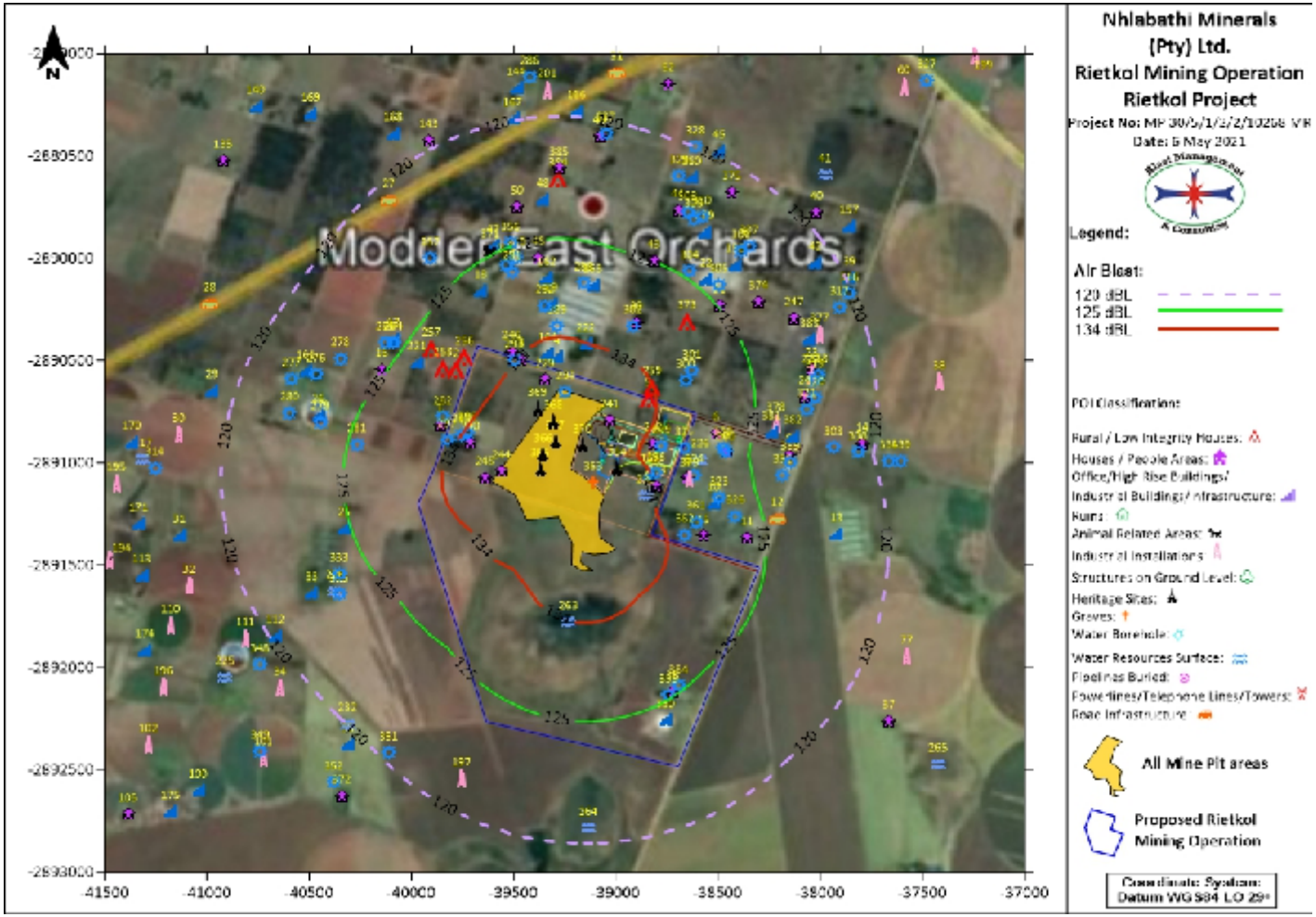


Figure 20: Air blast influence from maximum charge for the Mine Pit areas

Following figure shows zoomed area to 115 dBL air blast contour

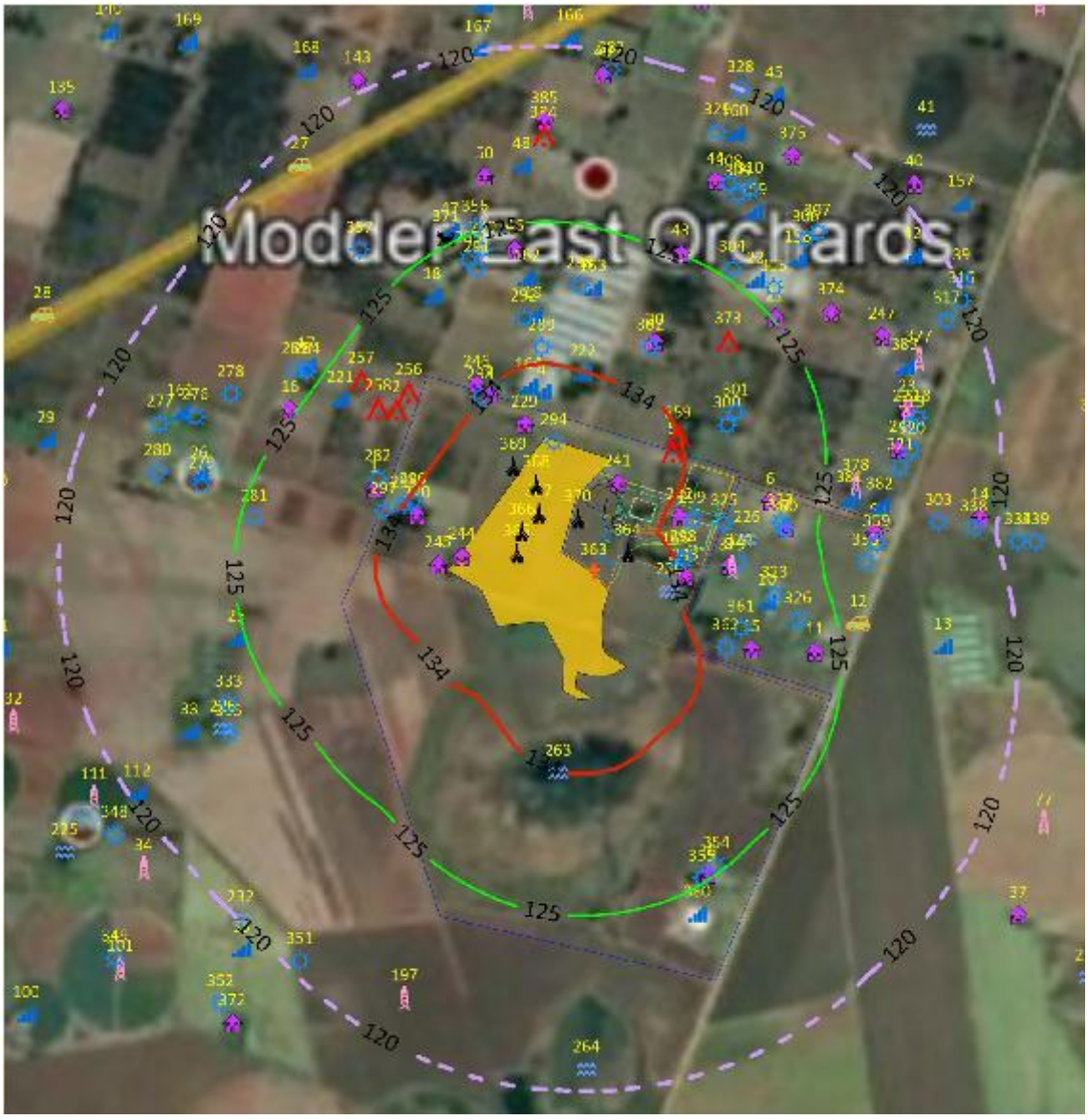


Figure 21: Air blast influence from maximum charge for the Mine Pit areas (zoomed)

Table 15: Air blast influence from maximum charge for the Mine Pit areas

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
1	Farm Buildings/Structures	367	130.8	Complaint
2	Informal Housing Settlement	464	128.9	Complaint
3	Farm Buildings/Structures	238	134.5	Problematic
4	Hot Houses/Nursery/Orchards	156	138.0	Problematic
5	Informal Housing Settlement	214	135.4	Problematic

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
6	Buildings/Structures	561	127.3	Complaint
7	Farm Buildings/Structures	638	126.2	Complaint
8	Farm Buildings/Structures	927	123.0	Complaint
9	Farm Buildings/Structures	419	129.7	Complaint
10	Agricultural Buildings	528	127.8	Complaint
11	Farm Buildings/Structures	645	126.1	Complaint
12	Road	804	124.2	N/A
13	Agricultural Buildings/Broilers	1082	121.7	Complaint
14	Buildings/Structures	1273	120.4	Complaint
15	Farm Buildings/Structures	433	129.5	Complaint
16	Farm Buildings/Structures	757	124.7	Complaint
17	Farm Buildings/Structures (Business Commercial)	798	124.3	Complaint
18	Farm Buildings/Structures (Agricultural Buildings)	614	126.5	Complaint
19	Agricultural Buildings	419	129.7	Complaint
20	Farm Buildings/Structures	427	129.6	Complaint
21	Farm Buildings/Structures	743	124.9	Complaint
22	Hot Houses/Flower Tunnels	788	124.4	Problematic
23	Farm Buildings/Structures	1027	122.2	Complaint
24	Farm Buildings/Structures	980	122.6	Complaint
25	Agricultural Buildings/Broilers (Rossgro Group)	764	124.7	Complaint
26	Buildings/Structures (Business Commercial)	910	123.2	Complaint
27	N12 Road	1244	120.6	N/A
28	N12 Road	1631	118.3	N/A
29	Farm Buildings/Structures (Agricultural Buildings)	1442	119.3	Acceptable
30	Pivot Irrigation	1552	118.7	N/A
31	Agricultural Buildings	1559	118.7	Acceptable
32	Pivot Irrigation	1574	118.6	N/A
33	Farm Buildings/Structures (Agricultural Buildings)	1042	122.1	Complaint
34	Pivot Irrigation	1450	119.3	N/A
35	Agricultural Buildings/Veg Tunnels	1405	119.6	Acceptable
36	Farm Buildings/Structures/Farm Dam	715	125.2	Complaint
37	Cement Dam& Agricultural Building	1581	118.5	N/A
38	Pivot Irrigation	1638	118.3	N/A
39	Farm Buildings/Structures (Agricultural Buildings)	1349	119.9	Acceptable
40	Farm Buildings/Structures	1401	119.6	Acceptable
41	Pan	1559	118.7	N/A
42	Agricultural Buildings	1243	120.6	Complaint
43	Farm Buildings/Structures	740	124.9	Complaint
44	Farm Buildings/Structures	1013	122.3	Complaint
45	Farm Buildings/Structures (Agricultural Buildings)	1358	119.8	Acceptable
46	Farm Buildings/Structures	650	126.0	Complaint
47	Farm Buildings/Structures (Agricultural Buildings)	771	124.6	Complaint

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
48	Farm Buildings/Structures (Agricultural Buildings)	928	123.0	Complaint
49	Farm Buildings/Structures	1250	120.5	Complaint
50	Farm Buildings/Structures	913	123.2	Complaint
51	N12 Road	1572	118.6	N/A
52	Farm Buildings/Structures	1582	118.5	Acceptable
53	Farm Buildings/Structures	1868	117.1	Acceptable
54	R50 Road	2406	115.0	N/A
55	R50 Road	2299	115.4	N/A
60	Pivot Irrigation	2136	116.1	N/A
61	Dam	2688	114.1	N/A
62	Pivot Irrigation	2585	114.4	N/A
63	Pivot Irrigation	3127	112.9	N/A
64	Pivot Irrigation	3474	111.9	N/A
65	Farm Buildings/Structures	3232	112.6	Acceptable
66	Pan	2531	114.6	N/A
67	Pivot Irrigation	2201	115.8	N/A
68	Industrial Structures	3249	112.5	Acceptable
69	Reservoirs	3348	112.3	N/A
70	Pivot Irrigation	2907	113.4	N/A
71	Pan	3160	112.8	N/A
72	Pivot Irrigation	2194	115.8	N/A
73	Dam	2703	114.1	N/A
74	Buildings/Structures	2687	114.1	Acceptable
75	Pivot Irrigation	2477	114.8	N/A
76	Farm Buildings/Structures	3032	113.1	Acceptable
77	Pivot Irrigation	1519	118.9	N/A
78	Agricultural Buildings/Broilers	2210	115.8	Acceptable
79	Reservoirs	2338	115.3	N/A
80	Farm Buildings/Structures	2024	116.5	Acceptable
81	Agricultural Buildings (Rossgro Group)	1833	117.3	Acceptable
82	Farm Buildings/Structures	2765	113.9	Acceptable
83	Farm Buildings/Structures	3495	111.9	Acceptable
84	Farm Buildings/Structures	2903	113.4	Acceptable
85	Farm Buildings/Structures	2535	114.6	Acceptable
86	Farm Buildings/Structures	3276	112.5	Acceptable
87	Farm Buildings/Structures	3277	112.5	Acceptable
88	Farm Buildings/Structures	2292	115.4	Acceptable
89	Farm Buildings/Structures	2387	115.1	Acceptable
90	Farm Buildings/Structures	2670	114.2	Acceptable
91	Farm Buildings/Structures	2993	113.2	Acceptable
92	Pivot Irrigation	2680	114.2	N/A
93	Pivot Irrigation	2518	114.6	N/A

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
94	Pivot Irrigation	2358	115.2	N/A
95	Pivot Irrigation	1890	117.1	N/A
96	Informal Housing Settlement	3392	112.1	Acceptable
97	Informal Housing Settlement	3358	112.3	Acceptable
98	Farm Buildings/Structures	3268	112.5	Acceptable
99	Cement Dam	3155	112.8	N/A
100	Agricultural Buildings	2080	116.3	Acceptable
101	Pivot Irrigation	1735	117.8	N/A
102	Pivot Irrigation	2120	116.1	N/A
103	Dam	2393	115.0	N/A
104	Pivot Irrigation	2561	114.5	N/A
105	Buildings/Structures	2415	115.0	Acceptable
106	Pivot Irrigation	2817	113.7	N/A
107	Agricultural Buildings	2626	114.3	Acceptable
108	Agricultural Buildings	2394	115.0	Acceptable
109	Pivot Irrigation	2144	116.0	N/A
110	Pivot Irrigation	1729	117.8	N/A
111	Pivot Irrigation	1435	119.4	N/A
112	Agricultural Buildings	1306	120.2	Complaint
113	Agricultural Buildings	1781	117.6	Acceptable
114	Buildings/Structures	2113	116.1	Acceptable
115	Agricultural Buildings/Broilers	2360	115.2	Acceptable
116	Agricultural Buildings	2144	116.0	Acceptable
117	Dam	1717	117.8	N/A
118	Pivot Irrigation	2144	116.0	N/A
119	Pivot Irrigation	1932	116.9	N/A
120	Buildings/Structures (Business Commercial)	2296	115.4	Acceptable
121	Buildings/Structures (Business Commercial)	2561	114.5	Acceptable
122	Agricultural Buildings	2808	113.7	Acceptable
123	Agricultural Buildings	3262	112.5	Acceptable
124	Farm Buildings/Structures	3687	111.5	Acceptable
125	Buildings/Structures	3576	111.7	Acceptable
126	Buildings/Structures	3325	112.4	Acceptable
127	N12 Road	2775	113.8	N/A
128	Buildings/Structures	3436	112.0	Acceptable
129	Buildings/Structures	3314	112.4	Acceptable
130	Informal Housing	2367	115.2	Acceptable
131	Agricultural Buildings	2749	113.9	Acceptable
132	Agricultural Buildings	3299	112.4	Acceptable
133	Buildings/Structures (Business Commercial)	2536	114.6	Acceptable
134	Hot House/Nursery/Orchards	2503	114.7	Acceptable
135	Farm Buildings/Structures	1987	116.7	Acceptable

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
136	Farm Buildings/Structures	3711	111.4	Acceptable
137	Farm Buildings/Structures (Agricultural Buildings)	3080	113.0	Acceptable
138	Farm Buildings/Structures (Agricultural Buildings)	3103	112.9	Acceptable
139	Farm Buildings/Structures	2675	114.2	Acceptable
140	Farm Buildings/Structures (Agricultural Buildings)	2028	116.5	Acceptable
141	Farm Buildings/Structures (Agricultural Buildings)	1863	117.2	Acceptable
142	Farm Buildings/Structures (Agricultural Buildings)	2611	114.3	Acceptable
143	Buildings/Structures	1373	119.7	Acceptable
144	Farm Buildings/Structures (Agricultural Buildings)	1486	119.1	Acceptable
145	Farm Buildings/Structures	2445	114.9	Acceptable
146	Farm Buildings/Structures	3811	111.1	Acceptable
147	Agricultural Buildings/Broilers	3778	111.2	Acceptable
148	Agricultural Buildings	3275	112.5	Acceptable
149	Farm Buildings/Structures	3439	112.0	Acceptable
150	Agricultural Buildings/Business Commercial	3224	112.6	Acceptable
151	Broilers	3113	112.9	Acceptable
152	Broilers	2817	113.7	Acceptable
153	Industrial Structures	2205	115.8	Acceptable
154	Informal Housing	3118	112.9	Acceptable
155	Agricultural Buildings	2668	114.2	Acceptable
156	Farm Buildings/Structures	1977	116.7	Acceptable
157	Agricultural Buildings	1481	119.1	Acceptable
158	Agricultural Buildings/Flower Tunnels	937	123.0	Problematic
159	Agricultural Buildings	973	122.6	Complaint
160	Agricultural Buildings/Veg Tunnels	1185	121.0	Problematic
161	Agricultural Buildings	1057	121.9	Complaint
162	Agricultural Buildings	546	127.5	Complaint
163	Agricultural Buildings/Flower Tunnels	534	127.7	Problematic
164	Agricultural Buildings/Flower Tunnels	182	136.7	Problematic
165	Agricultural Buildings	249	134.1	Problematic
166	Agricultural Buildings	1362	119.8	Acceptable
167	Agricultural Buildings/Veg Tunnels	1341	120.0	Acceptable
168	Agricultural Buildings	1490	119.0	Acceptable
169	Agricultural Buildings	1812	117.4	Acceptable
170	Agricultural Buildings	1776	117.6	Acceptable
171	Agricultural Buildings	1749	117.7	Acceptable
172	Agricultural Buildings	2081	116.3	Acceptable
173	Agricultural Buildings	2177	115.8	Acceptable
174	Agricultural Buildings	1892	117.0	Acceptable
175	Agricultural Buildings/Business Commercial	2252	115.6	Acceptable
176	Agricultural Buildings	1631	118.3	Acceptable
177	Agricultural Buildings	3128	112.9	Acceptable

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
178	Agricultural Buildings/Veg Tunnels	3624	111.6	Acceptable
179	Agricultural Buildings	4101	110.5	Acceptable
180	Agricultural Buildings	3093	113.0	Acceptable
181	Agricultural Buildings/Veg Tunnels	2612	114.3	Acceptable
182	Agricultural Buildings	2896	113.4	Acceptable
183	Agricultural Buildings	2791	113.8	Acceptable
184	Agricultural Buildings	2554	114.6	Acceptable
185	Agricultural Buildings	2891	113.5	Acceptable
186	Agricultural Buildings	3080	113.0	Acceptable
187	Agricultural Buildings	4239	110.2	Acceptable
188	Agricultural Buildings/Broilers	4334	110.1	Acceptable
189	Agricultural Buildings	4075	110.6	Acceptable
190	Agricultural Veg Tunnels	2978	113.3	Acceptable
191	Agricultural Veg Tunnels	3559	111.7	Acceptable
192	Agricultural Veg Tunnels	3125	112.9	Acceptable
193	Agricultural Veg Tunnels	3523	111.8	Acceptable
194	Pivot Irrigation	1915	117.0	N/A
195	Pivot Irrigation	1844	117.3	N/A
196	Pivot Irrigation	1900	117.0	N/A
197	Pivot Irrigation	1175	121.1	N/A
198	Pivot Irrigation	2670	114.2	N/A
199	Pivot Irrigation	2487	114.7	N/A
200	Pivot Irrigation	2422	115.0	N/A
201	Pivot Irrigation	1463	119.2	N/A
202	Pivot Irrigation	3702	111.4	N/A
203	Pivot Irrigation	3828	111.1	N/A
204	Pivot Irrigation	3697	111.5	N/A
205	Pivot Irrigation	3528	111.8	N/A
206	Pivot Irrigation	3543	111.8	N/A
207	Pivot Irrigation	2852	113.6	N/A
208	Pivot Irrigation	3078	113.0	N/A
209	Pivot Irrigation	3500	111.9	N/A
210	Pivot Irrigation	4287	110.2	N/A
211	Pivot Irrigation	2979	113.3	N/A
212	Pivot Irrigation	3289	112.4	N/A
213	Pivot Irrigation	3186	112.7	N/A
214	Pivot Irrigation	4160	110.5	N/A
215	Pivot Irrigation	4148	110.5	N/A
216	Pivot Irrigation	4175	110.4	N/A
217	Pivot Irrigation	2702	114.1	N/A
218	Pivot Irrigation	2796	113.8	N/A
219	Broilers	4234	110.2	Acceptable

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
220	Buildings (Business Commercial)	2692	114.1	Acceptable
221	Buildings (Business Commercial)	639	126.2	Complaint
222	Buildings (Business Commercial)	247	134.2	Problematic
223	Eloff Buildings/Structures (Business Commercial)	3496	111.9	Acceptable
224	Buildings/Business Commercial	1749	117.7	Acceptable
225	Dam	1623	118.3	N/A
226	Dam	504	128.2	N/A
227	Cement Dam	1018	122.2	N/A
228	Dam	941	122.9	N/A
229	Buildings/Structures/Dam	82	143.4	Problematic
230	Dam	207	135.7	N/A
231	Dam	3362	112.3	N/A
232	Dam	1328	120.0	N/A
233	Cement Dam	2696	114.1	N/A
234	Cement Dam	2768	113.9	N/A
235	Dam	2726	114.0	N/A
236	Dam	3102	112.9	N/A
237	Dam	3014	113.2	N/A
238	Dam	3512	111.8	N/A
239	Farm Buildings/Structures	3552	111.8	Acceptable
240	Farm Buildings/Structures	197	136.1	Problematic
241	Farm Buildings/Structures	71	144.7	Problematic
242	Farm Buildings/Structures	301	132.5	Complaint
243	Farm Buildings/Structures	266	133.6	Problematic
244	Farm Buildings/Structures (Inside Pit Area)	-	-	-
245	Farm Buildings/Structures	40	149.4	Problematic
246	Farm Buildings/Structures	295	132.7	Complaint
247	Farm Buildings/Structures	1019	122.2	Complaint
248	Farm Buildings/Structures	3016	113.2	Acceptable
249	Farm Buildings/Structures	2866	113.5	Acceptable
250	Farm Buildings/Structures	3882	111.0	Acceptable
251	Farm Animal Structures (Feedlot)	3257	112.5	Acceptable
252	Farm Animal Structures (Feedlot)	3859	111.1	Acceptable
253	Farm Animal Structures (Feedlot)	3982	110.8	Acceptable
254	Farm Animal Structures (Feedlot)	3227	112.6	Acceptable
255	Farm Animal Structures (Feedlot)	3327	112.4	Acceptable
256	Informal Housing Settlement	465	128.8	Complaint
257	Informal Housing Settlement	621	126.4	Complaint
258	Informal Housing Settlement	517	128.0	Complaint
259	Informal Housing Settlement	248	134.2	Problematic
260	Pan	3118	112.9	N/A
261	Pan	3242	112.6	N/A

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
262	Pan	3325	112.4	N/A
263	Pan	259	133.8	N/A
264	Pan	1257	120.5	N/A
265	Pan	1898	117.0	N/A
266	Pan	1713	117.9	N/A
267	Pan	2987	113.3	N/A
268	Pan	3109	112.9	N/A
269	Pan	3212	112.6	N/A
270	Pan	2919	113.4	N/A
271	Pan	3320	112.4	N/A
272	Pan	3993	110.8	N/A
273	Industrial Structures	3825	111.1	Acceptable
274	Industrial Structures	3084	113.0	Acceptable
275	Mine Activity	2604	114.4	N/A
276	Hydrocencus Borehole 1	1007	122.3	N/A
277	Hydrocencus Borehole 2	1101	121.6	N/A
278	Hydrocencus Borehole 3	951	122.8	N/A
279	Hydrocencus Borehole 4	891	123.4	N/A
280	Hydrocencus Borehole 5	1047	122.0	N/A
281	Hydrocencus Borehole 6	687	125.6	N/A
282	Hydrocencus Borehole 7	378	130.6	N/A
283	Hydrocencus Borehole 8	820	124.1	N/A
284	Hydrocencus Borehole 9	788	124.4	N/A
285	Hydrocencus Borehole 10	659	125.9	N/A
286	Hydrocencus Borehole 11	1532	118.8	N/A
287	Hydrocencus Borehole 12	1270	120.4	N/A
288	Hydrocencus Borehole 13	531	127.7	N/A
289	Hydrocencus Borehole 14	307	132.4	N/A
290	Hydrocencus Borehole 15	673	125.7	N/A
291	Hydrocencus Borehole 16	617	126.5	N/A
292	Hydrocencus Borehole 17	412	129.9	N/A
293	Hydrocencus Borehole 18	260	133.8	N/A
294	Hydrocencus Borehole 19 - Inside Pit Area	-	-	-
295	Hydrocencus Borehole 20	253	134.0	N/A
296	Hydrocencus Borehole 21	235	134.6	N/A
297	Hydrocencus Borehole 22	296	132.7	N/A
298	Hydrocencus Borehole 23	278	133.2	N/A
299	Hydrocencus Borehole 24	342	131.4	N/A
300	Hydrocencus Borehole 25	416	129.8	N/A
301	Hydrocencus Borehole 26	458	129.0	N/A
302	Hydrocencus Borehole 27	405	130.0	N/A
303	Hydrocencus Borehole 28	1137	121.3	N/A

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
304	Hydrocencus Borehole 29	772	124.6	N/A
305	Hydrocencus Borehole 30	809	124.2	N/A
306	Hydrocencus Borehole 31	1005	122.4	N/A
307	Hydrocencus Borehole 32	1049	122.0	N/A
308	Hydrocencus Borehole 33	1020	122.2	N/A
309	Hydrocencus Borehole 34	1003	122.4	N/A
310	Hydrocencus Borehole 35	1031	122.1	N/A
311	Hydrocencus Borehole 36	1983	116.7	N/A
312	Hydrocencus Borehole 37	2079	116.3	N/A
313	Hydrocencus Borehole 38	2173	115.9	N/A
314	Hydrocencus Borehole 39	1656	118.2	N/A
315	Hydrocencus Borehole 40	933	123.0	N/A
316	Hydrocencus Borehole 41	1315	120.1	N/A
317	Hydrocencus Borehole 42	1242	120.6	N/A
318	Hydrocencus Borehole 43	1057	121.9	N/A
319	Hydrocencus Borehole 44	1035	122.1	N/A
320	Hydrocencus Borehole 45	1028	122.2	N/A
321	Hydrocencus Borehole 46	988	122.5	N/A
322	Hydrocencus Borehole 47	615	126.5	N/A
323	Hydrocencus Borehole 48	562	127.3	N/A
324	Hydrocencus Borehole 49	456	129.0	N/A
325	Hydrocencus Borehole 50	441	129.3	N/A
326	Hydrocencus Borehole 51	607	126.6	N/A
327	Hydrocencus Borehole 52	2235	115.6	N/A
328	Hydrocencus Borehole 53	1333	120.0	N/A
329	Hydrocencus Borehole 54	1171	121.1	N/A
330	Hydrocencus Borehole 55	1984	116.7	N/A
331	Hydrocencus Borehole 56	2162	115.9	N/A
332	Hydrocencus Borehole 57	1853	117.2	N/A
333	Hydrocencus Borehole 58	879	123.5	N/A
334	Hydrocencus Borehole 59	1401	119.6	N/A
335	Hydrocencus Borehole 60	2681	114.2	N/A
336	Hydrocencus Borehole 61	2696	114.1	N/A
337	Hydrocencus Borehole 62	2235	115.6	N/A
338	Hydrocencus Borehole 63	1259	120.5	N/A
339	Hydrocencus Borehole 64	1459	119.2	N/A
340	Hydrocencus Borehole 65	2907	113.4	N/A
341	Hydrocencus Borehole 66	3056	113.1	N/A
342	Hydrocencus Borehole 67	2880	113.5	N/A
343	Hydrocencus Borehole 68	2966	113.3	N/A
344	Hydrocencus Borehole 69	2702	114.1	N/A
345	Hydrocencus Borehole 70	2693	114.1	N/A

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
346	Hydrocencus Borehole 71	2184	115.8	N/A
347	Hydrocencus Borehole 72	2094	116.2	N/A
348	Hydrocencus Borehole 73	1451	119.3	N/A
349	Hydrocencus Borehole 74	1725	117.8	N/A
350	Hydrocencus Borehole 75	1556	118.7	N/A
351	Hydrocencus Borehole 76	1287	120.3	N/A
352	Hydrocencus Borehole 77	1582	118.5	N/A
353	Hydrocencus Borehole 78	2704	114.1	N/A
354	Hydrocencus Borehole 79	709	125.3	N/A
355	Hydrocencus Borehole 80	718	125.2	N/A
356	Hydrocencus Borehole 81	750	124.8	N/A
357	Hydrocencus Borehole 82	897	123.3	N/A
358	Hydrocencus Borehole 83	882	123.5	N/A
359	Hydrocencus Borehole 84	927	123.0	N/A
360	Hydrocencus Borehole 85	634	126.2	N/A
361	Hydrocencus Borehole 86	413	129.9	N/A
362	Hydrocencus Borehole 87	346	131.4	N/A
363	Heritage Site (Informal Graveyard - 20 graves)	11	160.6	N/A
364	Heritage Site (Ruins of a house/outbuilding constructed)	135	139.3	N/A
365	Heritage Site (Stacked large stones) - Inside Pit Area	-	-	-
366	Heritage Site (Fowl-House structure) - Inside Pit Area	-	-	-
367	Heritage Site (Pigsty constructed with cement blocks) - Inside Pit Area	-	-	-
368	Heritage Site (Water trough/livestock pen) - Inside Pit Area	-	-	-
369	Heritage Site (Ruins of a house/outbuilding)	29	152.2	N/A
370	Heritage Site (Old Trigonometrical beacon)	28	152.6	N/A
371	Farm Animals (Horses - Goudhoek SA Boerperd Stoet)	756	124.8	Complaint
372	Farm Buildings/Structures	1598	118.5	Acceptable
373	Informal Housing	573	127.1	Complaint
374	Farm Buildings/Structures	906	123.2	Complaint
375	Farm Buildings/Structures	1207	120.8	Complaint
376	Underground cave	2690	114.1	N/A
377	Fuel Storage (Underground Fuel Tank)	1106	121.5	N/A
378	Fuel Storage (Underground Fuel Tank)	840	123.9	N/A
379	Fuel Storage (Underground Fuel Tank)	429	129.5	N/A
380	Industrial Structure (Agricultural Packhouse-Rossgro)	817	124.1	Complaint
381	Industrial Structures (Coal transport facility)	825	124.0	Complaint
382	Industrial Structures (Coal transport facility)	930	123.0	Complaint
383	Industrial Structures	1052	122.0	Complaint
384	Informal Housing (Labour Tenants)	1028	122.2	Complaint
385	Farm Buildings/Structures	1079	121.8	Complaint

17.7 Summary of findings for air blast

Review of the air blast levels indicates the same concerns for opencast blasting. Air blast predicted for the maximum charge ranges between 110.1 and 160.1 dB for all the POI's considered. This includes the nearest points inside the MRA and outside the MRA. These levels may contribute to effects such as rattling of roofs or door or windows with limited points that are expected to be damaging and others could lead to complaints. The closest structures at 40 m showed concerns of possible damage at minimum and maximum charge. Minimum charge predictions identified that thirty-eight POI's could experience levels of air blast that could lead to complaints and eight POI's where levels expected are greater than the limits applied. Four of these eight are located inside the MRA and four is located outside the MRA on private land. The POI's identified outside the MRA are hothouse / tunnels with a lower limit than normal house structures. Maximum charge predictions indicate that forty-six POI's could experience air blast that could lead to complaints and seventeen POI's are identified where levels are greater than applied limit. Six POI's are located inside the MRA and eleven are located outside the MRA on private land which include six hothouse / tunnels with a lower limit than normal house structures.

The following POI's are a concern: POI 3 Farm Buildings/Structures, POI 4 Hot Houses / Nursery / Orchards, POI 5 Informal Housing Settlement, POI 22 Hot Houses/Flower Tunnels, POI 158 Agricultural Buildings/Flower Tunnels, POI 160 Agricultural Buildings/Veg Tunnels, POI 163 Agricultural Buildings/Flower Tunnels, POI 164 Agricultural Buildings/Flower Tunnels, POI 165 Agricultural Buildings, POI 222 Buildings (Business Commercial), POI 259 Informal Housing Settlement, POI 229 Buildings/Structures/Dam (inside MRA), POI 240 Farm Buildings/Structures (inside MRA), POI 243 Farm Buildings/Structures (inside MRA), POI 241 Farm Buildings/Structures (inside MRA), POI 244 Farm Buildings/Structures (Inside Pit Area) (inside MRA), POI 245 Farm Buildings/Structures (inside MRA).

The current accepted limit on air blast is 134 dB. Damages are only expected to occur at levels greater than 134 dBL. Prediction shows that air blast will be greater than 134 dB at distance of 266 m and closer to pit boundaries for maximum charge. Concern is hot houses and tunnels. Regarding the agricultural tunnels on previous projects a basic limit of 120 dB was applied. There is some uncertainty at what pressure levels these sheets of plastic will get damaged. The problem is that the plastic deteriorates over time and air blast could be considered a cause should any damage occur. The standard is that these sheets need to be replaced from time to time.

The possible negative effects from air blast are expected to be the same than that of ground vibration. It is maintained that if stemming control is not exercised this effect could be greater with greater range of complaints or damage. The proposed mining operation is located such that "free blasting" – meaning no controls on blast preparation – will not be possible.

17.8 Fly-rock unsafe zone

The occurrence of fly rock in any form will have a negative impact if found to travel outside the unsafe zone. This unsafe zone may be anything between 10 m or 1000 m. A general unsafe zone applied by most mines is normally considered to be within a radius of 500 m from the blast; but needs to be qualified and determined as best possible.

Calculations are also used to help and assist determining safe distances. A safe distance from blasting is calculated following rules and guidelines from the International Society of Explosives Engineers (ISEE) Blasters Handbook. Using this calculation, the minimum safe distances can be determined that should be cleared of people, animals and equipment. Figure 22 shows the results from the ISEE calculations for fly rock range based on a 102 mm diameter blast hole and 1.5 m stemming length. Based on these values a possible fly rock range with a safety factor of 2 was calculated to be 526 m. The absolute minimum unsafe zone is then the 526 m. This calculation is a guideline and any distance cleared should not be less. The occurrence of fly rock can however never be 100% excluded. Best practices should be implemented at all times. The occurrence of fly rock can be mitigated but the possibility of the occurrence thereof can never be eliminated.

Figure 23 shows the area around North Block and Main Block Mine Pit areas that incorporates the 526 m unsafe zone.

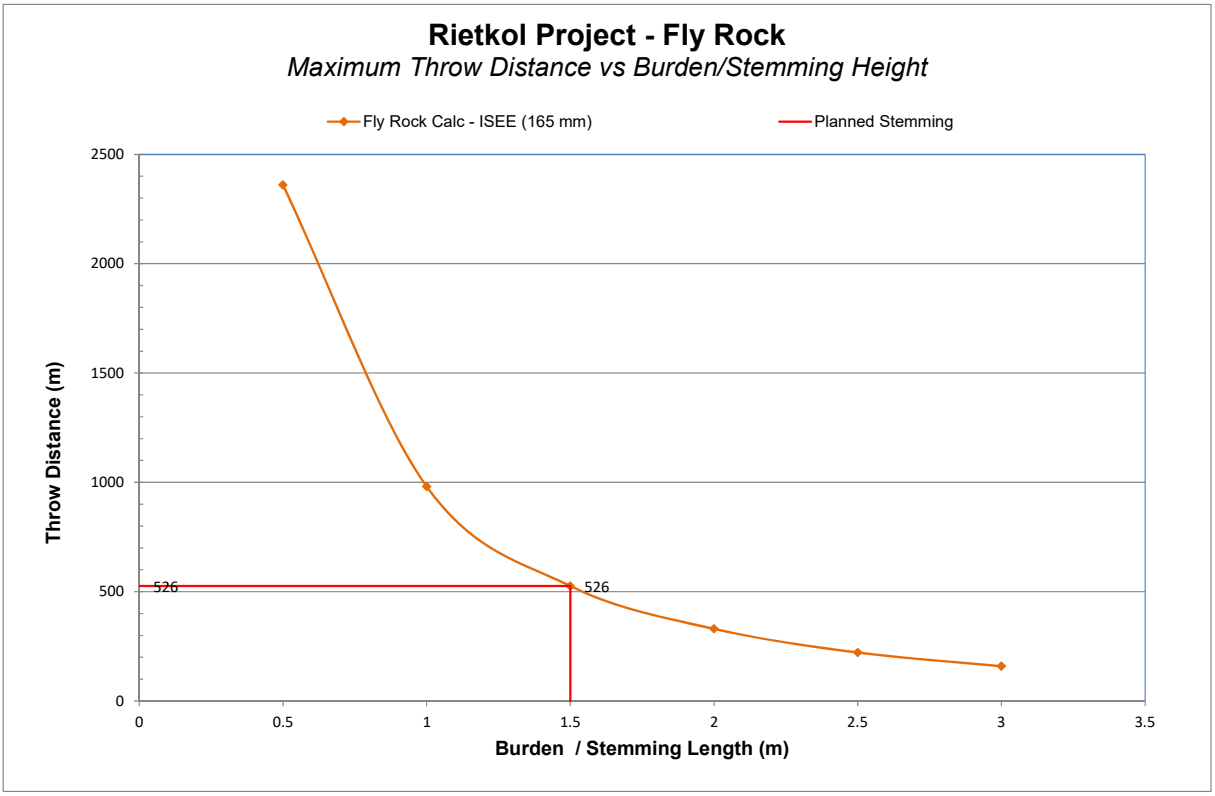


Figure 22: Fly rock prediction calculation

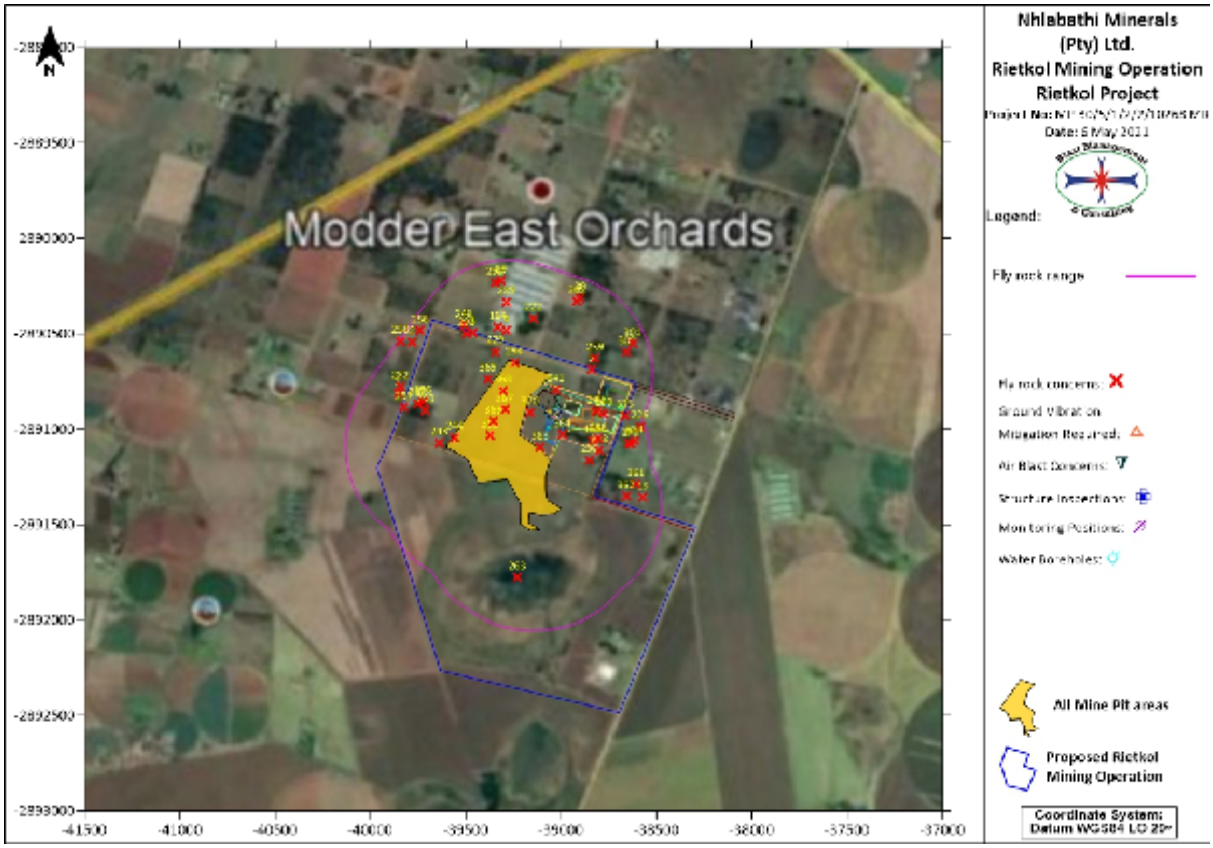


Figure 23: Predicted Fly Rock Exclusion Zone for the Mine Pit areas

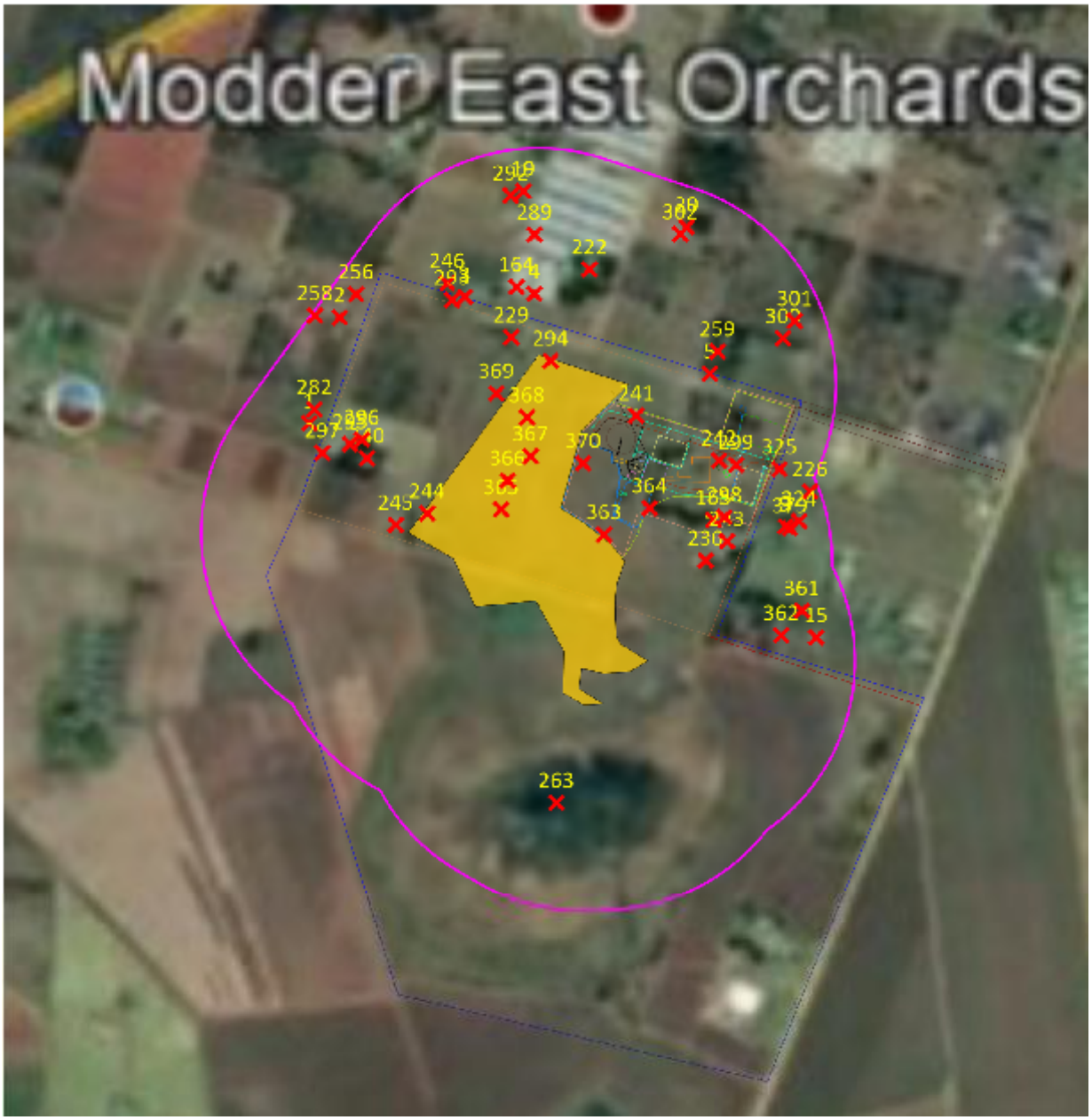


Figure 24: Predicted Fly Rock Exclusion Zone for the Mine Pit areas (zoomed)

Review of the calculated unsafe zone showed fifty-two for the Mine Pit areas (including six POI's inside the pit area at this stage), are within the unsafe zone. This includes mainly the Farm Buildings/Structures, Informal Housing Settlement, Hot Houses/Nursery/Orchards, Agricultural Buildings/Flower Tunnels, Hydrocencus Boreholes and Heritage Sites. Table 16 below shows the POI's of concern and coordinates.

Table 16: Fly rock concern POI's

Tag	Description	Y	X
1	Farm Buildings/Structures	39857.56	2890812.70
2	Informal Housing Settlement	39780.62	2890543.43
3	Farm Buildings/Structures	39462.71	2890491.43
4	Hot Houses/Nursery/Orchards	39286.02	2890483.45
5	Informal Housing Settlement	38840.89	2890686.41
9	Farm Buildings/Structures	38648.40	2891074.82
15	Farm Buildings/Structures	38570.69	2891357.46
19	Agricultural Buildings	39314.07	2890221.96
20	Farm Buildings/Structures	38899.72	2890313.38
164	Agricultural Buildings/Flower Tunnels	39331.10	2890465.86
165	Agricultural Buildings	38831.56	2891058.56
222	Buildings (Business Commercial)	39146.27	2890421.02
226	Dam	38586.18	2890985.86
229	Buildings/Structures/Dam	39344.57	2890593.77
230	Dam	38851.58	2891161.93
240	Farm Buildings/Structures	39711.31	2890901.64
241	Farm Buildings/Structures	39027.16	2890793.25
242	Farm Buildings/Structures	38816.95	2890907.28
243	Farm Buildings/Structures	38797.26	2891112.87
244	Farm Buildings/Structures (Inside Pit Area)	39558.27	2891041.93
245	Farm Buildings/Structures	39638.27	2891071.31
246	Farm Buildings/Structures	39507.41	2890456.49
256	Informal Housing Settlement	39738.99	2890484.42
258	Informal Housing Settlement	39843.10	2890538.47
259	Informal Housing Settlement	38821.04	2890629.68
263	Pan	39230.28	2891778.40
282	Hydrocencus Borehole 7	39844.67	2890777.43
289	Hydrocencus Borehole 14	39285.93	2890332.56
292	Hydrocencus Borehole 17	39346.24	2890233.03
293	Hydrocencus Borehole 18	39495.46	2890499.38
294	Hydrocencus Borehole 19 - Inside Pit Area	39244.96	2890653.73
295	Hydrocencus Borehole 20	39754.38	2890865.79
296	Hydrocencus Borehole 21	39724.41	2890854.61
297	Hydrocencus Borehole 22	39824.32	2890888.16
298	Hydrocencus Borehole 23	38803.71	2891051.26
299	Hydrocencus Borehole 24	38774.10	2890918.22
300	Hydrocencus Borehole 25	38655.04	2890596.57
301	Hydrocencus Borehole 26	38625.17	2890552.17
302	Hydrocencus Borehole 27	38915.87	2890331.45
324	Hydrocencus Borehole 49	38613.66	2891061.78
325	Hydrocencus Borehole 50	38664.06	2890928.98

Tag	Description	Y	X
361	Hydrocencus Borehole 86	38606.99	2891288.88
362	Hydrocencus Borehole 87	38659.81	2891352.19
363	Heritage Site (Informal Graveyard - 20 graves)	39109.17	2891095.88
364	Heritage Site (Ruins of a house/outbuilding constructed)	38993.57	2891028.57
365	Heritage Site (Stacked large stones) - Inside Pit Area	39370.51	2891032.04
366	Heritage Site (Fowl-House structure) - Inside Pit Area	39354.06	2890958.13
367	Heritage Site (Pigsty constructed with cement blocks) - Inside Pit Area	39295.91	2890896.40
368	Heritage Site (Water trough/livestock pen) - Inside Pit Area	39304.54	2890797.94
369	Heritage Site (Ruins of a house/outbuilding)	39382.51	2890736.63
370	Heritage Site (Old Trigonometrical beacon)	39162.50	2890914.46
379	Fuel Storage (Underground Fuel Tank)	38637.43	2891079.17

17.9 Noxious fumes

The occurrence of fumes in the form the NOx gas is not a given and very dependent on various factors as discussed in Section 13.6. However, the occurrence of fumes should be closely monitored. Furthermore, nothing can be stated as to fume dispersal to nearby farmsteads, but if anybody is present in the path of the fume cloud it could be problematic.

17.10 Water borehole influence

Location of boreholes for water was evaluated for possible influence from blasting. Eighty-Seven Hydrocensus boreholes were identified within the influence area at the Pit areas. There are boreholes that are in close proximity of the blasting areas but are found to be within acceptable limits. There is one borehole that falls within the North Block Pit area. This borehole will have to be relocated. The ground water specialist will need to make recommendations regarding relocation of the boreholes. At all other identified boreholes, the expected levels of ground vibration were found to be within acceptable limits.

Table 17 shows all the identified boreholes. Figure 25 shows the location of the boreholes in the area.

Table 17: Identified water boreholes

Tag	Description	Y	X	Specific Limit (mm/s)	Distance (m) to nearest Pit	Predicted PPV (mm/s)
276	Hydrocencus Borehole 1	40465.42	2890568.84	50	1007	1.1
277	Hydrocencus Borehole 2	40585.37	2890591.37	50	1101	1.0
278	Hydrocencus Borehole 3	40345.64	2890490.91	50	951	1.2

Tag	Description	Y	X	Specific Limit (mm/s)	Distance (m) to nearest Pit	Predicted PPV (mm/s)
279	Hydrocencus Borehole 4	40444.69	2890801.44	50	891	1.4
280	Hydrocencus Borehole 5	40594.85	2890757.59	50	1047	1.0
281	Hydrocencus Borehole 6	40264.33	2890911.67	50	687	2.1
282	Hydrocencus Borehole 7	39844.67	2890777.43	50	378	5.6
283	Hydrocencus Borehole 8	40125.85	2890412.68	50	820	1.6
284	Hydrocencus Borehole 9	40085.84	2890412.55	50	788	1.7
285	Hydrocencus Borehole 10	39536.88	2890034.18	50	659	2.2
286	Hydrocencus Borehole 11	39419.64	2889114.25	50	1532	0.6
287	Hydrocencus Borehole 12	39048.72	2889390.11	50	1270	0.8
288	Hydrocencus Borehole 13	39156.55	2890121.66	50	531	3.2
289	Hydrocencus Borehole 14	39285.93	2890332.56	50	307	7.9
290	Hydrocencus Borehole 15	39486.97	2890000.79	50	673	2.2
291	Hydrocencus Borehole 16	39506.78	2890067.33	50	617	2.5
292	Hydrocencus Borehole 17	39346.24	2890233.03	50	412	4.8
293	Hydrocencus Borehole 18	39495.46	2890499.38	50	260	10.4
294	Hydrocencus Borehole 19 - Inside Pit Area	39244.96	2890653.73	50	-	-
295	Hydrocencus Borehole 20	39754.38	2890865.79	50	253	10.9
296	Hydrocencus Borehole 21	39724.41	2890854.61	50	235	12.2
297	Hydrocencus Borehole 22	39824.32	2890888.16	50	296	8.4
298	Hydrocencus Borehole 23	38803.71	2891051.26	50	278	9.3
299	Hydrocencus Borehole 24	38774.10	2890918.22	50	342	6.6
300	Hydrocencus Borehole 25	38655.04	2890596.57	50	416	4.8
301	Hydrocencus Borehole 26	38625.17	2890552.17	50	458	4.1
302	Hydrocencus Borehole 27	38915.87	2890331.45	50	405	5.0
303	Hydrocencus Borehole 28	37933.97	2890926.83	50	1137	0.9
304	Hydrocencus Borehole 29	38636.62	2890064.71	50	772	1.7
305	Hydrocencus Borehole 30	38496.40	2890130.77	50	809	1.6
306	Hydrocencus Borehole 31	38386.87	2889964.26	50	1005	1.1
307	Hydrocencus Borehole 32	38346.92	2889941.98	50	1049	1.0
308	Hydrocencus Borehole 33	38647.47	2889776.69	50	1020	1.1
309	Hydrocencus Borehole 34	38617.37	2889809.83	50	1003	1.1
310	Hydrocencus Borehole 35	38577.39	2889798.64	50	1031	1.1
311	Hydrocencus Borehole 36	41515.57	2890572.14	50	1983	0.4
312	Hydrocencus Borehole 37	41635.31	2890661.16	50	2079	0.3
313	Hydrocencus Borehole 38	41735.25	2890683.64	50	2173	0.3
314	Hydrocencus Borehole 39	41254.09	2891025.56	50	1656	0.5
315	Hydrocencus Borehole 40	40352.07	2891643.17	50	933	1.3
316	Hydrocencus Borehole 41	37856.15	2890173.21	50	1315	0.7
317	Hydrocencus Borehole 42	37905.97	2890239.83	50	1242	0.8
318	Hydrocencus Borehole 43	38005.02	2890572.50	50	1057	1.0
319	Hydrocencus Borehole 44	38024.95	2890594.72	50	1035	1.1
320	Hydrocencus Borehole 45	38024.69	2890683.35	50	1028	1.1
321	Hydrocencus Borehole 46	38064.54	2890738.86	50	988	1.1
322	Hydrocencus Borehole 47	38474.03	2890928.41	50	615	2.5
323	Hydrocencus Borehole 48	38493.32	2891172.21	50	562	2.9
324	Hydrocencus Borehole 49	38613.66	2891061.78	50	456	4.1
325	Hydrocencus Borehole 50	38664.06	2890928.98	50	441	4.3
326	Hydrocencus Borehole 51	38413.05	2891260.61	50	607	2.6
327	Hydrocencus Borehole 52	37479.09	2889130.67	50	2235	0.3
328	Hydrocencus Borehole 53	38608.42	2889455.27	50	1333	0.7
329	Hydrocencus Borehole 54	38688.01	2889599.54	50	1171	0.9
330	Hydrocencus Borehole 55	38067.31	2893209.54	50	1984	0.4
331	Hydrocencus Borehole 56	38116.62	2893442.35	50	2162	0.3

Tag	Description	Y	X	Specific Limit (mm/s)	Distance (m) to nearest Pit	Predicted PPV (mm/s)
332	Hydrocencus Borehole 57	39036.75	2893378.61	50	1853	0.4
333	Hydrocencus Borehole 58	40352.38	2891543.46	50	879	1.4
334	Hydrocencus Borehole 59	37663.75	2890992.52	50	1401	0.6
335	Hydrocencus Borehole 60	36331.66	2891686.72	50	2681	0.2
336	Hydrocencus Borehole 61	36311.81	2891631.27	50	2696	0.2
337	Hydrocencus Borehole 62	37477.79	2893052.72	50	2235	0.3
338	Hydrocencus Borehole 63	37813.89	2890948.64	50	1259	0.8
339	Hydrocencus Borehole 64	37603.74	2890992.34	50	1459	0.6
340	Hydrocencus Borehole 65	36388.84	2892695.09	50	2907	0.2
341	Hydrocencus Borehole 66	36288.47	2892827.76	50	3056	0.2
342	Hydrocencus Borehole 67	36418.84	2892695.17	50	2880	0.2
343	Hydrocencus Borehole 68	36378.53	2892805.85	50	2966	0.2
344	Hydrocencus Borehole 69	36370.67	2892041.36	50	2702	0.2
345	Hydrocencus Borehole 70	39414.20	2894210.69	50	2693	0.2
346	Hydrocencus Borehole 71	39235.73	2893711.58	50	2184	0.3
347	Hydrocencus Borehole 72	39186.00	2893622.80	50	2094	0.3
348	Hydrocencus Borehole 73	40741.02	2891987.84	50	1451	0.6
349	Hydrocencus Borehole 74	40739.70	2892408.85	50	1725	0.5
350	Hydrocencus Borehole 75	39017.65	2893079.41	50	1556	0.5
351	Hydrocencus Borehole 76	40109.66	2892417.97	50	1287	0.7
352	Hydrocencus Borehole 77	40379.22	2892562.84	50	1582	0.5
353	Hydrocencus Borehole 78	39423.20	2887939.86	50	2704	0.2
354	Hydrocencus Borehole 79	38690.60	2892092.38	50	709	2.0
355	Hydrocencus Borehole 80	38740.47	2892136.84	50	718	1.9
356	Hydrocencus Borehole 81	39513.21	2889927.75	50	750	1.8
357	Hydrocencus Borehole 82	39906.07	2890000.96	50	897	1.3
358	Hydrocencus Borehole 83	38182.62	2891061.61	50	882	1.4
359	Hydrocencus Borehole 84	38145.80	2890999.46	50	927	1.3
360	Hydrocencus Borehole 85	38460.98	2890949.42	50	634	2.4
361	Hydrocencus Borehole 86	38606.99	2891288.88	50	413	4.8
362	Hydrocencus Borehole 87	38659.81	2891352.19	50	346	6.5

Figure 25: Location of the Boreholes for the Mine Pit areas

17.11 Blast operations impacts on farm animals and wildlife

The influence on productivity of animals over period of time due to blasting operations is not clearly defined and difficult to estimate. Social behaviour and change of social behaviour are unfortunately problematic. It is however the author's opinion that influence will be experienced when animals are located permanently in close proximity of blasting operations. At larger distances, estimated in the region of 500 m and greater, cattle or game will get accustomed to the blasting and related noise. This is based in observations made personally when blasting is done and cattle are present.

Review of the charging configurations and air blast levels expected it is clear that in order to induce lung / ear injury or death, animals will have to very close to the blast. This is excluding fright and secondary injury or from flying debris. I do believe that cattle will get used to the blasting operations and fly rock may be the most likely cause of injury or death if not removed to safe distance. As an example, review of the pressures required to cause lung damage in larger animals is at 10 psi (68.59 kPa) to 15 psi (103.4 kPa). This relates to air blast levels in the order of 190 dB (L) and 195 dB (L). Table 18 below shows that it will be required that animals be on the blast and again showing that factors apart from air blast would cause death. The following table (Table 30) show air blast levels

in dB and kPa at short increment distances from the blast based on the maximum charge used in this report.

Table 18: Expected air blast levels in dB and kilopascals for short distance increments.

Distance (m)	Max. Charge / Delay	Air Blast Pressure Levels for Maximum Charge in dB	Air Blast Pressure Levels for Maximum Charge in kPa
5.0	226	167.0	4.493
10.0	226	161.2	2.294
20.0	226	157.8	1.548
30.0	226	155.4	1.171
40.0	226	153.5	0.943
50.0	226	151.9	0.790
60.0	226	150.6	0.681
70.0	226	149.5	0.598
80.0	226	148.5	0.533
90.0	226	147.6	0.482
100.0	226	146.8	0.439

Considering the above information, it is certain that injury to animals such as cattle is highly unlikely due to the fact that cattle should never be allowed on top of a blast area. The effect from the blast itself is then more likely to be lethal. It is anticipated that the mining area will be fenced off and animals should not be present inside the mining area and cleared to outside the exclusion zone for safe blasting.

Based on the background information with regards to wildlife it is certain that there is uncertainty whether ground vibration from blasting operations will contribute to deaths and if so at what rate. The same can be argued for air blast at distances further than what is normally considered safe from a blast operation. In general, there is indication that animals will habituate to the effects. Pressure levels from air blast as calculated for maximum charge is significantly less than where any injury is expected.

Social behaviour or changes of social behaviour in these circumstances are unknown at this stage.

Having said this, it is a known fact that with blasting there is a noise component as well. This noise component is seldom if at all properly predicted because of the many variables that contribute to the fact whether there will be noise or not. The noise may vary from load bangs to a rumble sound

and is very dependent on the preparation of the blast. These noises from blasting will also at worst last as long as the blast itself. Thus, no more than a few seconds. In some cases, these noises will be very short in time frame. Review of the calculated and predicted data it is observed that due to the proximity of installations where animals are kept could give rise to concern in this regard. In particular the horse breeding and training school that are found in the area. It must be accepted that horses are sensitive to sudden loud noises. There is significant information of horses that gets spooked by noises and other impetus. It is unfortunately not always 100 % clear what levels of noise contribute to this. There are however examples where blasting is done at large opencast mining operations near racehorse facilities. The observation is that reaction to blasting is variable. It is not a case that when blast is done all horses suddenly react negative and run wild but reactions have been observed. There is also evidence of horses reacting negatively at times when least expected, examples of horses that were part of a cart race in an arena showed negative reaction and ran wild, and very uncontrollable.

Horses are also used in various aspects of life and have been over years also subjected to load noises in other forms. Horses are used for hunting, racing, pleasure, equestrian activities, etc. The Goudhoek horse facility is located 756 m from the nearest point of the pit area. Expected levels of ground vibration is low. Air blast prediction do show levels within limits for structures but at levels that could give rise to rattling of large roof surfaces. This could cause disturbance. These factors are considerate of the maximum charge and blasting design currently proposed. Thus, with mitigation these values may be reduced further.

A mutual understanding and possible specific arrangements of when blasting is done, e.g. not when riding is done or during competitions, could help as mitigation. Horses is believed to also habituate to the surroundings and it is envisaged that over time the horses will become accustomed to the additional noises if any. Specific levels of noise expected is definitely not easy to predict from blasting. The specific influence of any noise is also very unpredictable. There is no clear research specifically indicating what levels of noise will contribute to what level of reaction.

17.12 Blast operations impacts on dolomitic structure

As a measure of possible damage to dolomite or possible causing of sink holes it can be said that blasting is not a primary cause of sinkholes. Water accumulation in the dolomite structure is the main cause of sinkholes.

A flat dipping dolerite sill of approximately 30 m thick cuts through the deposit and divides it into an Upper and a Lower Quartzite band. Due to the thickness of the sill, mining will not cut through the sill and only the Upper Quartzite band will be mined to a depth of approximately 30 to 50 meters. Below the sill at least 50 m thickness of Quartzite is found that is not included in the mining plan.

Considering the blast design used and the blast simulated there is no expected influence on any dolomitic structure further than 3m away. The typical charge in a blast hole will yield nearfield shock energy of less than a 1000 mm/s at a distance less than 3 m. This level of vibration or impact is less than what will be required to fracture dolomite. At distances of 20 m the nearfield energy from the blast is significantly less at 100 mm/s form a single blast hole. Blasting in dolomite requires blast holes with charges spaced at 1.5 to 2.5 m to induce proper fracture of the dolomite. It can then be accepted that any occurrence of dolomite at distances of 20 m vertically or horizontally and further will certainly not be fractured. The main target material to be mined is the top layer quartzite above the 30 m dolerite sill.

The underground cave as indicated at POI 376 is located 2690 m from the open pit area. Evaluation of the expected ground vibration levels for this distance indicate predicted level of ground vibration of 0.2 mm/s. This level can be considered as insignificant. There is no influence from blasting operations expected at the location of the cave.

17.13 Potential Environmental Impact Assessment: Operational Phase

The following is the impact assessment of the various concerns covered by this report. The matrix below in Table 19 to Table 25 was used for analysis and evaluation of aspects discussed in this report. The outcome of the analysis is provided in Table 26 with before mitigation and after mitigation. This risk assessment is a one-sided analysis and needs to be discussed with role players in order to obtain a proper outcome and mitigation.

17.13.1 Impact Significance

17.13.2 Nature and Status

The 'nature' of the impact describes what is being affected and how. The 'status' is based on whether the impact is positive, negative or neutral.

17.13.3 Spatial Extent

'Spatial Extent' defines the spatial or geographical scale of the impact.

Table 19: Spatial Extent of the impact

Category	Rate	Descriptor
Site	1	Site of the proposed development
Local	2	Limited to site and/or immediate surrounds
District	3	Victor Khanye Local Municipal Area
Region	4	Nkangala District Municipal Area
Provincial	5	Mpumalanga Province
National	6	South Africa

International	7	Beyond South African borders

17.13.4 Duration

'Duration' gives the temporal scale of the impact.

Table 20: Duration of the impact

Category	Rate	Descriptor
Temporary	1	0 – 1 years
Short term	2	1 – 5 years
Medium term	3	5 – 15 years
Long term	4	Where the impact will cease after the operational life of the activity either because of natural process or by human intervention
Permanent	5	Where mitigation either by natural processes or by human intervention will not occur in such a way or in such a time span that the impact can be considered as transient

17.13.5 Probability

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

Table 21: Probability of the impact

Category	Rate	Descriptor
Rare	1	Where the impact may occur in exceptional circumstances only
Improbable	2	Where the possibility of the impact materialising is very low either because of design or historic experience
Probable	3	Where there is a distinct possibility that the impact will occur
Highly probable	4	Where it is most likely that the impact will occur
Definite	5	Where the impact will occur regardless of any prevention measures

17.13.6 Intensity

'Intensity' defines whether the impact is destructive or benign, in other words the level of impact on the environment.

Table 22: Level of Impact on the Environment

Category	Rate	Descriptor
Insignificant	1	Where the impact affects the environment is such a way that natural, cultural and social functions and processes are not affected. Localised impact and a small percentage of the population is affected
Low	2	Where the impact affects the environment is such a way that natural, cultural and social functions and processes are affected to a limited extent
Medium	3	Where the affected environment is altered in terms of natural, cultural and social functions and processes continue albeit in a modified way

High	4	Where natural, cultural or social functions or processes are altered to the extent that they will temporarily or permanently cease
Very High	5	Where natural, cultural or social functions or processes are altered to the extent that they will permanently cease and it is not possible to mitigate or remedy the impact

17.13.7 Ranking, Weighting and Scaling

The weight of significance defines the level or limit at which point an impact changes from low to medium significance, or medium to high significance. The purpose of assigning such weights serves to highlight those aspects that are considered the most critical to the various stakeholders and ensure that the element of bias is considered. These weights are often determined by current societal values or alternatively by scientific evidence (norms, etc.) that define what would be acceptable or unacceptable to society and may be expressed in the form of legislated standards, guidelines or objectives.

The weighting factor provides a means whereby the impact assessor can successfully deal with the complexities that exist between the different impacts and associated aspect criteria.

Table 23: Ranking, Weighting and Scaling

Spatial Extent	**Duration**	**Intensity / Severity**	**Probability**	**Weighting factor**	**Significance Rating (SR - WOM) Pre-mitigation**	**Mitigation Efficiency (ME)**	**Significance Rating (SR-WM) Post Mitigation**
Site (1)	Short term (1)	Insignificant (1)	Rare (1)	Low (1)	Low (0 – 19)	High (0.2)	Low (0 – 19)
Local (2)	Short to Medium term (2)	Minor (2)	Unlikely (2)	Low to Medium (2)	Low to Medium (20 – 39)	Medium to High (0.4)	Low to Medium (20 – 39)
District (3)							
Regional (4)	Medium term (3)	Medium (3)	Possible (3)	Medium (3)	Medium (40 – 59)	Medium (0.6)	Medium (40 – 59)
Provincial (5)	Long term (4)	High (4)	Likely (4)	Medium to High (4)	Medium to High (60 – 79)	Low to Medium (0.8)	Medium to High (60 – 79)
National (6)							
International (7)	Permanent (5)	Very high (5)	Almost certain (5)	High (5)	High (80 – 110)	Low (1.0)	High (80 – 110)

17.13.8 Impact significance without mitigation (WOM)

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned weightings, resulting in a value for each impact (prior to the implementation of mitigation measures).

Equation 1:
Significance Rating (WOM) = (Extent + Intensity + Duration + Probability) x Weighting Factor

17.13.9 Effect of Significance on Decision- makings

Significance is determined through a synthesis of impact characteristics as described in the above paragraphs. It provides an indication of the importance of the impact in terms of both tangible and intangible characteristics. The significance of the impact "without mitigation" is the prime determinant of the nature and degree of mitigation required.

Table 24: Significance of the Impact

Rating	Rate	Descriptor
Negligible	0	The impact is non-existent or insignificant, is of no or little importance to decision making.
Low	1-19	The impact is limited in extent, even if the intensity is major; the probability of occurrence is low and the impact will not have a significant influence on decision-making and is unlikely to require management intervention bearing significant costs.
Low to Medium	20 – 39	The impact is of importance, however, through the implementation of the correct mitigation measures such potential impacts can be reduced to acceptable levels. The impact and proposed mitigation measures can be considered in the decision-making process
Medium	40 – 59	The impact is significant to one or more affected stakeholder, and its intensity will be medium or high; but can be avoided or mitigated and therefore reduced to acceptable levels. The impact and mitigation proposed should have an influence on the decision.
Medium to High	60 -79	The impact is of major importance but through the implementation of the correct mitigation measures, the negative impacts will be reduced to acceptable levels.
High	80 – 110	The impact could render development options controversial or the entire project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor and must influence decision- making.

17.13.10 Mitigation

"Mitigation" is a broad term that covers all components of the 'mitigation hierarchy' defined hereunder. It involves selecting and implementing measures, amongst others, to conserve biodiversity and to protect, the users of biodiversity and other affected stakeholders from potentially adverse impacts because of mining or any other land use. The aim is to prevent adverse impacts from occurring or, where this is unavoidable, to limit their significance to an acceptable level. Offsetting of impacts is considered the last option in the mitigation hierarchy for any project.

The mitigation hierarchy in general consists of the following in order of which impacts should be mitigated:

- Avoid/prevent impact: can be done through utilising alternative sites, technology and scale of projects to prevent impacts. In some cases, if impacts are expected to be too high, the "no project" option should also be considered, especially where it is expected that the lower levels of mitigation will not be adequate to limit environmental damage and eco-service provision to suitable levels.
- Minimise (reduce) impact: can be done through utilisation of alternatives that will ensure that impacts on biodiversity and eco-services provision are reduced. Impact minimisation is considered an essential part of any development project.
- Rehabilitate (restore) impact is applicable to areas where impact avoidance and minimisation are unavoidable where an attempt to re-instate impacted areas and return them to conditions which are ecologically similar to the pre-project condition or an agreed post project land use, for example arable land. Rehabilitation can however not be considered as the primary mitigation toll as even with significant resources and effort rehabilitation that usually does not lead to adequate replication of the diversity and complexity of the natural system. Rehabilitation often only restores ecological function to some degree to avoid ongoing negative impacts and to minimise aesthetic damage to the setting of a project. Practical rehabilitation should consist of the following phases in best practice:
    - Structural rehabilitation which includes physical rehabilitation of areas by means of earthworks, potential stabilisation of areas as well as any other activities required to develop a long terms sustainable ecological structure;
    - Functional rehabilitation, which focuses on ensuring that the ecological functionality of the ecological resources on the subject property supports the intended post-closure land use. In this regard, special mention is made of the need to ensure the continued functioning and integrity of wetland and riverine areas throughout and after the rehabilitation phase;

- Biodiversity reinstatement that focuses on ensuring that a reasonable level of biodiversity is re-instated to a level that supports the local post-closure land uses. In this regard, special mention is made of re-instating vegetation to levels which will allow the natural climax vegetation community of community suitable for supporting the intended post- closure land use; and
- Species reinstatement that focuses on the re-introduction of any ecologically important species, which may be important for socio-cultural reasons, ecosystem functioning reasons and for conservation reasons. Species re-instatement need only occur if deemed necessary.

- Offset impact: refers to compensating for latent or unavoidable negative impacts on biodiversity. Offsetting should take place to address any impacts deemed unacceptable which cannot be mitigated through the other mechanisms in the mitigation hierarchy. The objective of biodiversity offsets should be to ensure no net loss of biodiversity. Biodiversity offsets can be considered a last resort to compensate for residual negative impacts on biodiversity.

According to the DMR (2013) "Closure" refers to the process for ensuring that mining operations are closed in an environmentally responsible manner, usually with the dual objectives of ensuring sustainable post-mining land uses and remedying negative impacts on biodiversity and ecosystem services.

The significance of residual impacts should be identified on a regional as well as national scale when considering biodiversity conservation initiatives. If the residual impacts lead to irreversible loss or irreplaceable biodiversity, the residual impacts should be considered to be of very high significance and when residual impacts are considered to be of very high significance, offset initiatives are not considered an appropriate way to deal with the magnitude and/or significance of the biodiversity loss. In the case of residual impacts determined to have medium to high significance, an offset initiative may be investigated. If the residual biodiversity impacts are considered of low significance, no biodiversity offset is required.

17.13.11 Impact significance with mitigation measures (WM)

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it is necessary to re-evaluate the impact.

17.13.12 Mitigation Efficiency (ME)

The most effective means of deriving a quantitative value of mitigated impacts is to assign each significance rating value (WOM) a mitigation effectiveness (ME) rating. The allocation of such a rating is a measure of the efficiency and effectiveness, as identified through professional experience and empirical evidence of how effectively the proposed mitigation measures will manage the impact. Thus, the lower the assigned value the greater the effectiveness of the proposed mitigation measures and subsequently, the lower the impacts with mitigation.

Equation 2: Significance Rating (WM) = Significance Rating (WOM) x Mitigation Efficiency (ME)

Mitigation Efficiency is rated out of 1 as follows:

Table 25: Mitigation Efficiency

Category	Rate	Descriptor
Not Efficient (Low)	1	Mitigation cannot make a difference to the impact
Low to Medium	0.8	Mitigation will minimize impact slightly
Medium	0.6	Mitigation will minimize impact to such an extent that it becomes within acceptable standards
Medium to High	0.4	Mitigation will minimize impact to such an extent that it is below acceptable standards
High	0.2	Mitigation will minimize impact to such an extent that it becomes insignificant

17.13.13 Significance Following Mitigation (SFM)

The significance of the impact after the mitigation measures are taken into consideration. The efficiency of the mitigation measure determines the significance of the impact. The level of impact is therefore seen in its entirety with all considerations considered.

17.13.14 Assessment

Table 26: Impact Assessment Outcome

ID	Environmental (Social) Aspect	Potential Impact	Nature of Impact	Duration	Extent	Probability	Intensity	Weighting factor	Impact Significance	Significant Points	Proposed Mitigation measures	Mitigation Efficiency	Efficiency value	Impact Significance	Significant Points
1	Blasting	Ground vibration Impact on houses	Negative	Medium Term	Local	Definite	High	High	Medium to High	70	Re-define blast design, re-define mining area	Medium to High	0.4	Low to Medium	28
2	Blasting	Ground vibration Impact on Boreholes	Negative	Medium Term	Local	Definite	High	High	Medium to High	70	Re-define blast design, re-define mining area	Medium to High	0.4	Low to Medium	28
3	Blasting	Ground vibration Impact on graves	Negative	Medium Term	Local	Definite	High	High	Medium to High	70	Re-define blast design, re-define mining area	Medium to High	0.4	Low to Medium	28
4	Blasting	Ground vibration Impact on Roads	Negative	Medium Term	Local	Improbable	Insignificant	Low	Low	8		Medium to High	0.4	Low	3.2
5	Blasting	Ground vibration impact on animals	Negative	Medium Term	Local	Probable	Medium	Medium	Low to Medium	33	Re-define blast design, re-define mining area	Medium to High	0.4	Low	13.2
6	Blasting	Air blast Impact on houses	Negative	Medium Term	Local	Definite	High	High	Medium to High	70	Re-define blast design, re-define	Medium to High	0.4	Low to Medium	28

											mining area				
7	Blasting	Air Blast Impact on Boreholes	Negative	Medium Term	Local	Improbable	Low	Low	Low	9		Medium to High	0.4	Low	3.6
8	Blasting	Air Blast Impact on graves	Negative	Medium Term	Local	Probable	Low	Low	Low	10		Medium to High	0.4	Low	4
9	Blasting	Air Blast Impact on Roads	Negative	Medium Term	Local	Improbable	Insignificant	Low	Low	8		High	0.2	Low	1.6
10	Blasting	Fly rock Impact on houses	Negative	Medium Term	Local	Definite	High	High	Medium to High	70	Re-define blast design, re-define mining area	Medium to High	0.4	Low to Medium	28
11	Blasting	Fly rock Impact on Boreholes	Negative	Medium Term	Local	Probable	High	Medium	Low to Medium	36	Re-define blast design, re-define mining area	Medium to High	0.4	Low	14.4
12	Blasting	Fly rock Impact on graves	Negative	Medium Term	Local	Definite	High	High	Medium to High	70	Re-define blast design, re-define mining area	Medium to High	0.4	Low to Medium	28
13	Blasting	Fly rock Impact on Roads	Negative	Medium Term	Local	Definite	High	Medium	Medium	42	Re-define blast design, re-define mining area	Medium to High	0.4	Low	16.8

17.14 Mitigations

17.14.1 Required mitigations

In review of the evaluations made in this report it is certain that specific mitigation will be required with regards to ground vibration. Ground vibration is the primary possible cause of structural damage and requires more detailed planning in preventing damage and maintaining levels within accepted norms. Air blast and fly rock can be controlled using proper charging methodology irrespective of the blast hole diameter and patterns used. Ground vibration requires more detailed planning and forms the focus for mitigation measures.

Specific concerns were identified and for the following POI's identified. Table 27 shows list of POI's that will need to be considered. Figure 26 and Figure 27 shows the location of these POI's in relation to the pit areas with regards to ground vibration mitigation required. Figure 28 and Figure 29 shows the location of these POI's in relation to the pit areas with regards to air blast mitigation required. This required mitigation is based on the maximum charge evaluated for the project.

Table 27: Structures at the Mine Pit of the Project Area identified as problematic with expected high ground vibration levels and air blast.

Tag	Description	Y	X	Specific Limit (mm/s)	Distance (m)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Air blast (dB)	Possible Concern?
3	Farm Buildings/Structures	39462.71	2890491.43	12.5	238	12.0	Acceptable	134.5	Problematic
4	Hot Houses/Nursery/Orchards	39286.02	2890483.45	25	156	24.0	Acceptable	138.0	Problematic
5	Informal Housing Settlement	38840.89	2890686.41	6	214	14.3	Problematic	135.4	Problematic
22	Hot Houses/Flower Tunnels	38558.02	2890103.43	25	788	1.7	Acceptable	124.4	Complaint
158	Agricultural Buildings/Flower Tunnels	38413.51	2890032.22	25	937	1.2	Acceptable	123.0	Complaint
163	Agricultural Buildings/Flower Tunnels	39111.41	2890131.42	25	534	3.2	Acceptable	127.7	Complaint
164	Agricultural Buildings/Flower Tunnels	39331.10	2890465.86	25	182	18.7	Acceptable	136.7	Problematic
165	Agricultural Buildings	38831.56	2891058.56	25	249	11.1	Acceptable	134.1	Problematic
222	Buildings (Business Commercial)	39146.27	2890421.02	12.5	247	11.3	Acceptable	134.2	Problematic
229	Buildings/Structures/Dam	39344.57	2890593.77	12.5	82	69.1	Problematic	143.4	Problematic
240	Farm Buildings/Structures	39711.31	2890901.64	12.5	197	16.4	Problematic	136.1	Problematic
241	Farm Buildings/Structures	39027.16	2890793.25	12.5	71	88.9	Problematic	144.7	Problematic
243	Farm Buildings/Structures	38797.26	2891112.87	12.5	266	10.0	Acceptable	133.6	Problematic
244	Farm Buildings/Structures (Inside Pit Area)	39558.27	2891041.93	12.5	11	1820.2	Problematic	160.1	Problematic
245	Farm Buildings/Structures	39638.27	2891071.31	12.5	40	223.2	Problematic	149.4	Problematic

Tag	Description	Y	X	Specific Limit (mm/s)	Distance (m)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Air blast (dB)	Possible Concern?
259	Informal Housing Settlement	38821.04	2890629.68	6	248	11.2	Problematic	134.2	Problematic
294	Hydrocencus Borehole 19 - Inside Pit Area	39244.96	2890653.73	50	11	1920.5	Problematic	160.4	N/A
363	Heritage Site (Informal Graveyard - 20 graves)	39109.17	2891095.88	6	11	1992.2	Problematic	160.6	N/A
364	Heritage Site (Ruins of a house/outbuilding constructed)	38993.57	2891028.57	6	135	30.7	Problematic	139.3	N/A
365	Heritage Site (Stacked large stones) - Inside Pit Area	39370.51	2891032.04	6	155	24.3	Problematic	138.1	N/A
366	Heritage Site (Fowl-House structure) - Inside Pit Area	39354.06	2890958.13	6	125	34.6	Problematic	139.9	N/A
367	Heritage Site (Pigsty constructed with cement blocks) - Inside Pit Area	39295.91	2890896.40	6	108	44.0	Problematic	141.1	N/A
368	Heritage Site (Water trough/livestock pen) - Inside Pit Area	39304.54	2890797.94	6	71	89.1	Problematic	144.7	N/A
369	Heritage Site (Ruins of a house/outbuilding)	39382.51	2890736.63	6	29	381.6	Problematic	152.2	N/A
370	Heritage Site (Old Trigonometrical beacon)	39162.50	2890914.46	6	28	417.2	Problematic	152.6	N/A

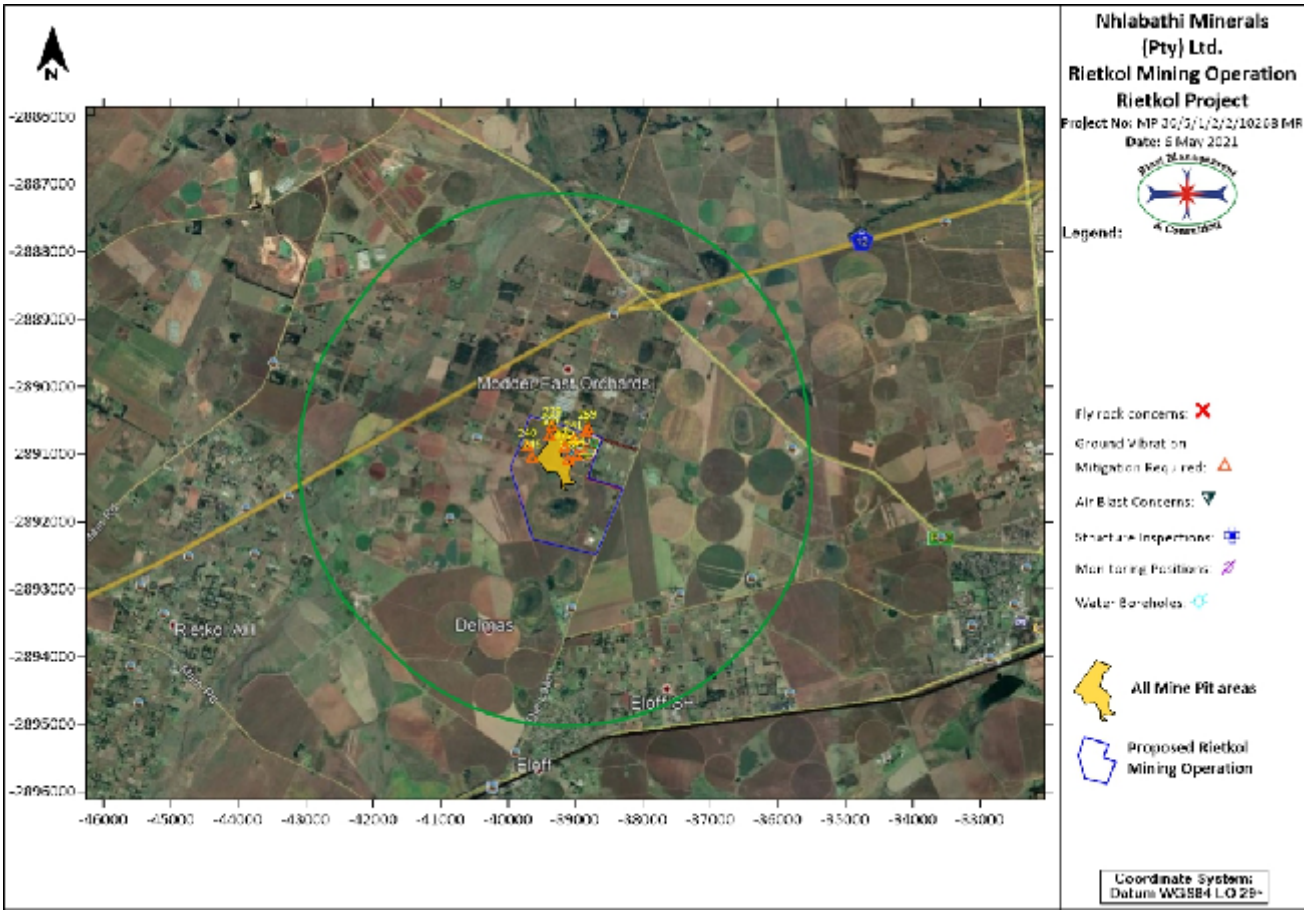


Figure 26: Structures identified at the Mine Pit areas where ground vibration mitigation will be required.

Figure 27: Structures identified at the Mine Pit areas where ground vibration mitigation will be required. (Zoomed)

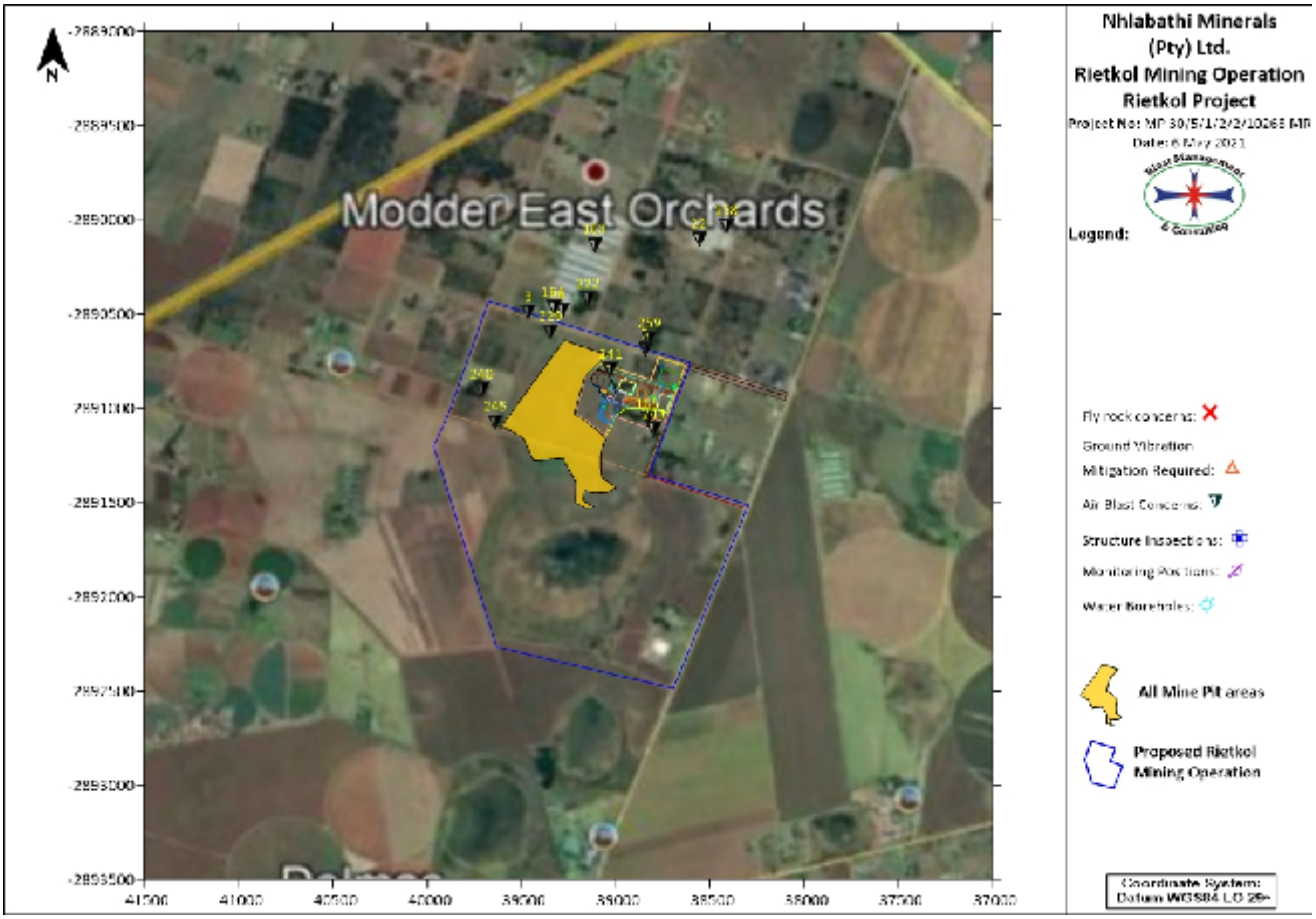


Figure 28: Structures identified at the Mine Pit areas where air blast is of concern.

Figure 29: Structures identified at the Mine Pit areas where air blast is of concern (zoomed)

17.14.2 Proposed mitigations

There are various ways mitigation of ground vibration for this can be done by applying the following methods:

- Do blast design that considers the actual blasting and the ground vibration levels to be adhered too.
- Only apply electronic initiation systems to facilitate single hole firing.
- Do design for smaller diameter blast holes that will use fewer explosives per blast hole.
- Relocate the POI / acquire the POI of concern – mined owned.

The Table 27 below shows quick view of initial mitigation to be considered. Table shows maximum charge expected to facilitate the permitted ground vibration limits and minimum distance required to yield the allowed limits from the evaluated maximum and for the minimum charge.

The following Table 28 below shows quick view of initial mitigation to be considered. Table shows maximum charge expected to facilitate the permitted ground vibration limits and minimum distance required to yield the allowed limits from the evaluated maximum and for the minimum charge.

Table 28: Initial mitigation suggestions

Maximum Charge allowed								
Tag	**Description**	**Y**	**X**	**Specific Limit (mm/s)**	**Distance (m)**	**Total Mass/Delay (kg)**	**Predicted PPV (mm/s)**	**Structure Response @ 10Hz**
5	Informal Housing Settlement	38840.89	2890686.41	6	214	79	6.0	Acceptable
229	Buildings/Structures/Dam	39344.57	2890593.77	12.5	82	28	12.5	Acceptable
240	Farm Buildings/Structures	39711.31	2890901.64	12.5	197	162	12.5	Acceptable
241	Farm Buildings/Structures	39027.16	2890793.25	12.5	71	21	12.5	Acceptable
245	Farm Buildings/Structures	39638.27	2891071.31	12.5	40	7	12.5	Acceptable
259	Informal Housing Settlement	38821.04	2890629.68	6	248	106	6.0	Acceptable
363	Heritage Site (Informal Graveyard - 20 graves)	39109.17	2891095.88	6	11	0	6.0	Acceptable
364	Heritage Site (Ruins of a house/outbuilding constructed)	38993.57	2891028.57	6	135	31	6.0	Acceptable
369	Heritage Site (Ruins of a house/outbuilding)	39382.51	2890736.63	6	29	1	6.0	Acceptable
370	Heritage Site (Old Trigonometrical beacon)	39162.50	2890914.46	6	28	1	6.0	Acceptable
Minimum distance required from maximum charge								

Tag	Description	Y	X	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz
5	Informal Housing Settlement	38840.89	2890686.41	6	362	226.0	6.0	Acceptable
229	Buildings/Structures/Dam	39344.57	2890593.77	12.5	232	226.0	12.5	Acceptable
240	Farm Buildings/Structures	39711.31	2890901.64	12.5	232	226.0	12.5	Acceptable
241	Farm Buildings/Structures	39027.16	2890793.25	12.5	232	226.0	12.5	Acceptable
245	Farm Buildings/Structures	39638.27	2891071.31	12.5	232	226.0	12.5	Acceptable
259	Informal Housing Settlement	38821.04	2890629.68	6	362	226.0	6.0	Acceptable
363	Heritage Site (Informal Graveyard - 20 graves)	39109.17	2891095.88	6	362	226.0	6.0	Acceptable
364	Heritage Site (Ruins of a house/outbuilding constructed)	38993.57	2891028.57	6	362	226.0	6.0	Acceptable
369	Heritage Site (Ruins of a house/outbuilding)	39382.51	2890736.63	6	362	226.0	6.0	Acceptable
370	Heritage Site (Old Trigonometrical beacon)	39162.50	2890914.46	6	362	226.0	6.0	Acceptable
Minimum Distance required for minimum Charge								
Tag	**Description**	**Y**	**X**	**Specific Limit (mm/s)**	**Distance (m)**	**Total Mass/Delay (kg)**	**Predicted PPV (mm/s)**	**Structure Response @ 10Hz**
5	Informal Housing Settlement	38840.89	2890686.41	6	180	56.0	6.0	Acceptable
229	Buildings/Structures/Dam	39344.57	2890593.77	12.5	116	56.0	12.5	Acceptable
240	Farm Buildings/Structures	39711.31	2890901.64	12.5	116	56.0	12.5	Acceptable
241	Farm Buildings/Structures	39027.16	2890793.25	12.5	116	56.0	12.5	Acceptable
245	Farm Buildings/Structures	39638.27	2891071.31	12.5	116	56.0	12.5	Acceptable
259	Informal Housing Settlement	38821.04	2890629.68	6	180	56.0	6.0	Acceptable
363	Heritage Site (Informal Graveyard - 20 graves)	39109.17	2891095.88	6	180	56.0	6.0	Acceptable
364	Heritage Site (Ruins of a house/outbuilding constructed)	38993.57	2891028.57	6	180	56.0	6.0	Acceptable
369	Heritage Site (Ruins of a house/outbuilding)	39382.51	2890736.63	6	180	56.0	6.0	Acceptable
370	Heritage Site (Old Trigonometrical beacon)	39162.50	2890914.46	6	180	56.0	6.0	Acceptable

Applying normal mitigatory measures there are installations and structures that are too close to the pit area causing the allowed charge mass to be very little. Additional measures to acquire some of these structures that are within the Mining rights area is recommended, relocation of graves will be required and management of heritage related installations will be required.

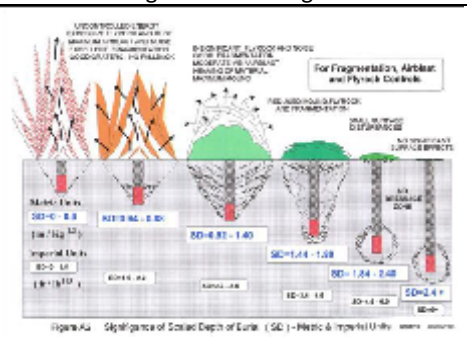
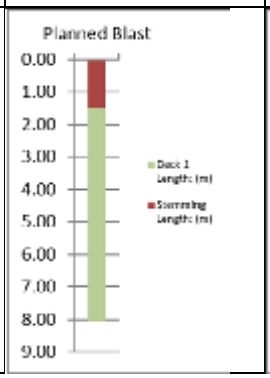
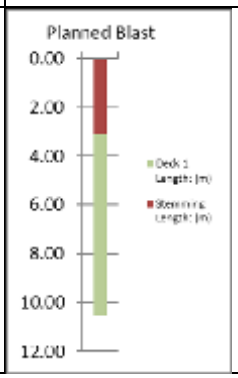
However, in view of the specific concerns regarding the project a reviewed blast design will be required. A proposed new design is suggested below with review of impacts from this design. The design is considering specific measures to address the possible impacts and provide outcomes that will be better suited for the project. These will need to be considered by the client as part of the final EIA.
Summary of measures to be put in place:

- New blast design consideration with change blast hole diameter
- Changed stemming lengths and material
- Changed initiation systems with initiation sequence changes
- Third party assessment on blast preparation in order to ensure control measures are in place.
- It is further accepted that all structures and installations within the mining rights area could be excluded from concerns as these infrastructure and structures will be taken over by the client.

A new blast design is then proposed and presented in Table 28 below with notes on specific requirements. Please note that though a new blast design is presented it will remain a process to ensure a final optimal design. There are still means to make further changes but this will need to be tested using the recommended as baseline.

Table 29: Recommended blast design

	Old Design	**Option 1 - Recommended**	**Notes**
B/H Diameter (mm)	102	89	Smaller diameter
Explosive Type	Emulsion	Emulsion	
Explosive Description	Hef 100	Hef 100	
Explosive Density (1.0 - 1.25 g/cm^3)	1.12	1.12	
Burden (m)	2.5	2	Changed burden and spacing
Spacing (m)	2.5	2.3	
Pattern	Staggered	Staggered	
Min Depth (m)	7.5	10	Changed depth of blast holes, less blasting required. More volumes for same areas.
Maximum Depth (m)	7.5	10	
Average Depth (m)	8.07	10.50	
Stemming Length (m)	1.50	3.10	Stemming is crucial. This recommended is better for fly rock and air blast control. Original stemming length is much too short.
Stemming Material:		Crushed aggregate	Crushed aggregate with size +6-13 to be used as stemming material.
Stemming: BH Diameter Ratio	14.0	34.0	Ratio required to have high level of control on fly rock
Explosives Per B/H (incl. Sub drill) (kg)	60.1	51.5	Smaller diameter blast hole reduces the charge mass per blast hole

P/F Blast hole (kg/m$^{3)}$	1.19	1.07	
Initiation systems to be used	Not defined	Electronic	Electronic initiators should be used. This allows for firing times of the blast holes so that a single hole firing can be achieved. Single blast hole firing will help management of the charge mass per delay and thus management of ground vibration.
SD = D/W1/3	1.1	1.8	Factor of ground breaking calculated that relates to fly rock and air blast. Higher valuer signifies higher control on fly rock and air blast. See figure below for guideline.
Fly Rock Control:	Not Good	Very Good	
Clearance Calc - ISEE			
Clearance Distance (m)	526	105	Recommended minimum distance to be cleared. Final clearance distance will remain the responsibility of the blaster as the legal appointed person and the client / mine final standard operating procedure as submitted to DMR. This does not alleviate the mine from other requirements as specified in the various applicable acts and regulations associated with mining operations.
			

Applying the proposed design, the influence areas was reviewed.

The following Table 30 show installations and structures that remains problematic based on the factors from a proposed new design. These structures and installations are however all located within the Mining Rights areas and inside the pit area.

Table 30: Mitigation measures for ground vibration

Pit Area	Tag	Description	Y	X	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz
POI	229	Buildings/Structures/Dam	39344.57	2890593.77	12.5	82	51.5	20.4	Problematic
POI	241	Farm Buildings/Structures	39027.16	2890793.25	12.5	71	51.5	26.3	Problematic
POI	244	Farm Buildings/Structures (Inside Pit Area)	39558.27	2891041.93	12.5	11	51.5	537.3	Problematic
POI	245	Farm Buildings/Structures	39638.27	2891071.31	12.5	40	51.5	65.9	Problematic
POI	294	Hydrocencus Borehole 19 - Inside Pit Area	39244.96	2890653.73	50	11	51.5	566.9	Problematic
POI	363	Heritage Site (Informal Graveyard - 20 graves)	39109.17	2891095.88	6	11	51.5	588.1	Problematic
POI	364	Heritage Site (Ruins of a house/outbuilding constructed)	38993.57	2891028.57	6	135	51.5	9.1	Problematic
POI	365	Heritage Site (Stacked large stones) - Inside Pit Area	39370.51	2891032.04	6	155	51.5	7.2	Problematic
POI	366	Heritage Site (Fowl-House structure) - Inside Pit Area	39354.06	2890958.13	6	125	51.5	10.2	Problematic
POI	367	Heritage Site (Pigsty constructed with cement blocks) - Inside Pit Area	39295.91	2890896.40	6	108	51.5	13.0	Problematic
POI	368	Heritage Site (Water trough/livestock pen) - Inside Pit Area	39304.54	2890797.94	6	71	51.5	26.3	Problematic
POI	369	Heritage Site (Ruins of a house/outbuilding)	39382.51	2890736.63	6	29	51.5	112.6	Problematic
POI	370	Heritage Site (Old Trigonometrical beacon)	39162.50	2890914.46	6	28	51.5	123.2	Problematic

Notes:

1. Olive Coloured = POI within Pit Area
2. Reddish = POI within Mining Rights Area

The following figure shows the Problematic POI's as identified above excluding those inside the pit area. It is accepted that a separate plan of action will need to be defined for these POI's as most of them are heritage related.

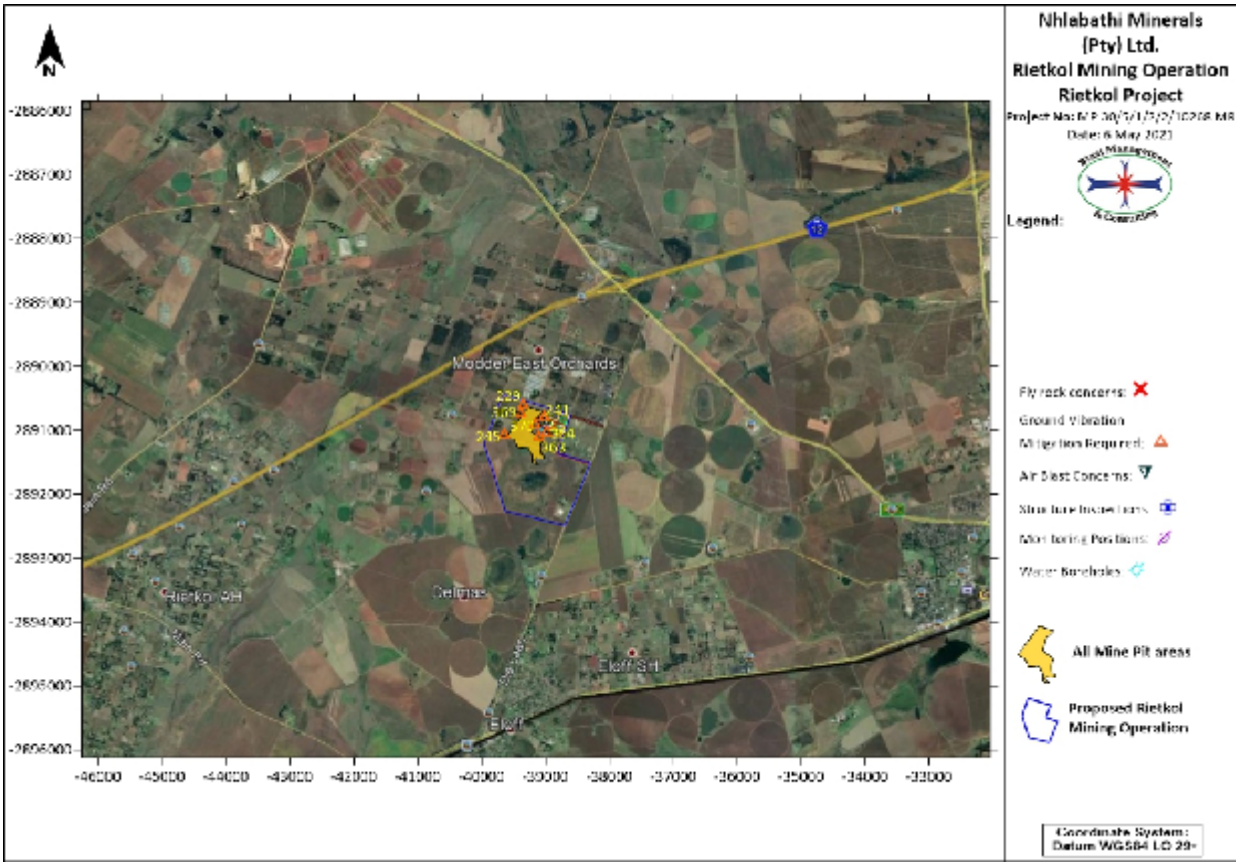


Figure 30: Structures identified with ground vibration mitigation review from proposed blast design

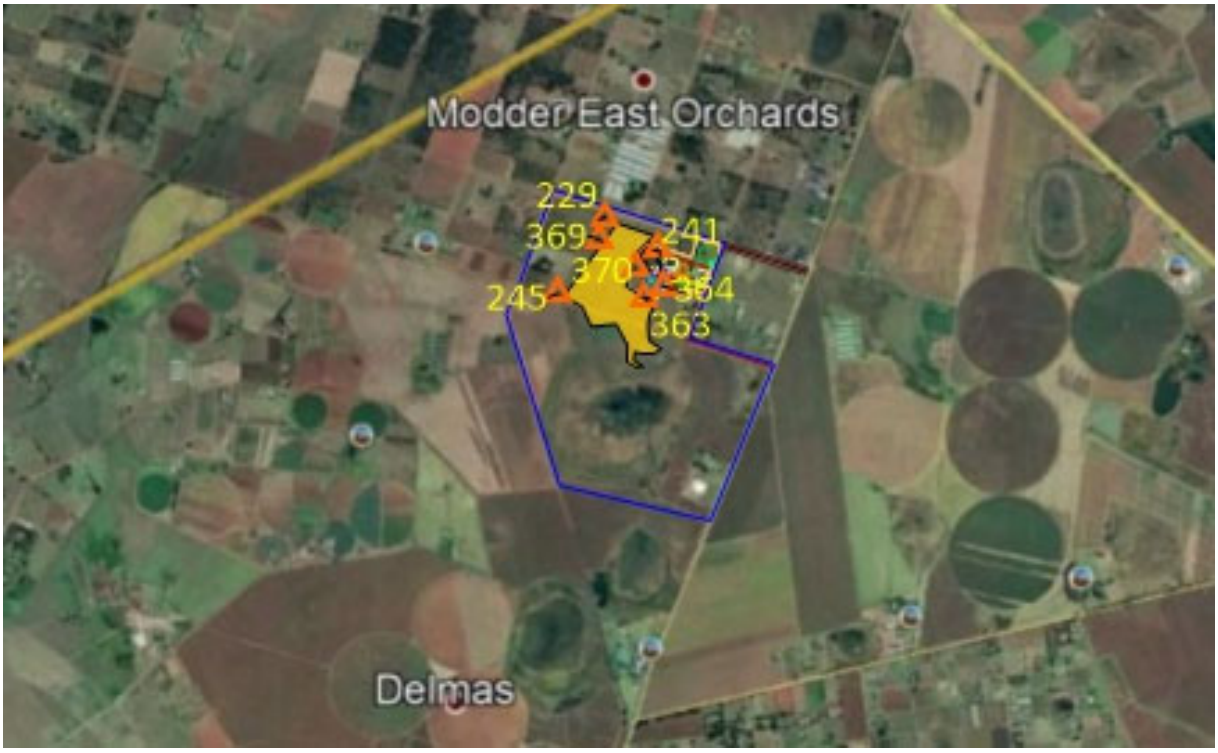


Figure 31: Structures identified with ground vibration mitigation review from proposed blast design (zoomed)

Air blast mitigation is required for two reasons. Considering the normal concern for high air blast – greater than limits applied for South Africa, as well as concern for the agricultural tunnels made of plastic. Review of levels where general houses are of concern there are houses identified where expected levels are greater than current limits applied in South Africa.

Regarding the agricultural tunnels on previous projects a basic limit of 120 dB was applied. There is some uncertainty at what pressure levels these sheets of plastic will get damaged. The problem is that the plastic deteriorates over time and air blast could be considered a cause should any damage occur. The standard is that these sheets need to be replaced from time to time.

Table 31: Mitigation required for air blast

Tag	Description	Y	X	Distance (m)	Air blast (dB)	Possible Concern?
4	Hot Houses/Nursery/Orchards	39286.02	2890483.45	156	120.5	On the edge of proposed limit

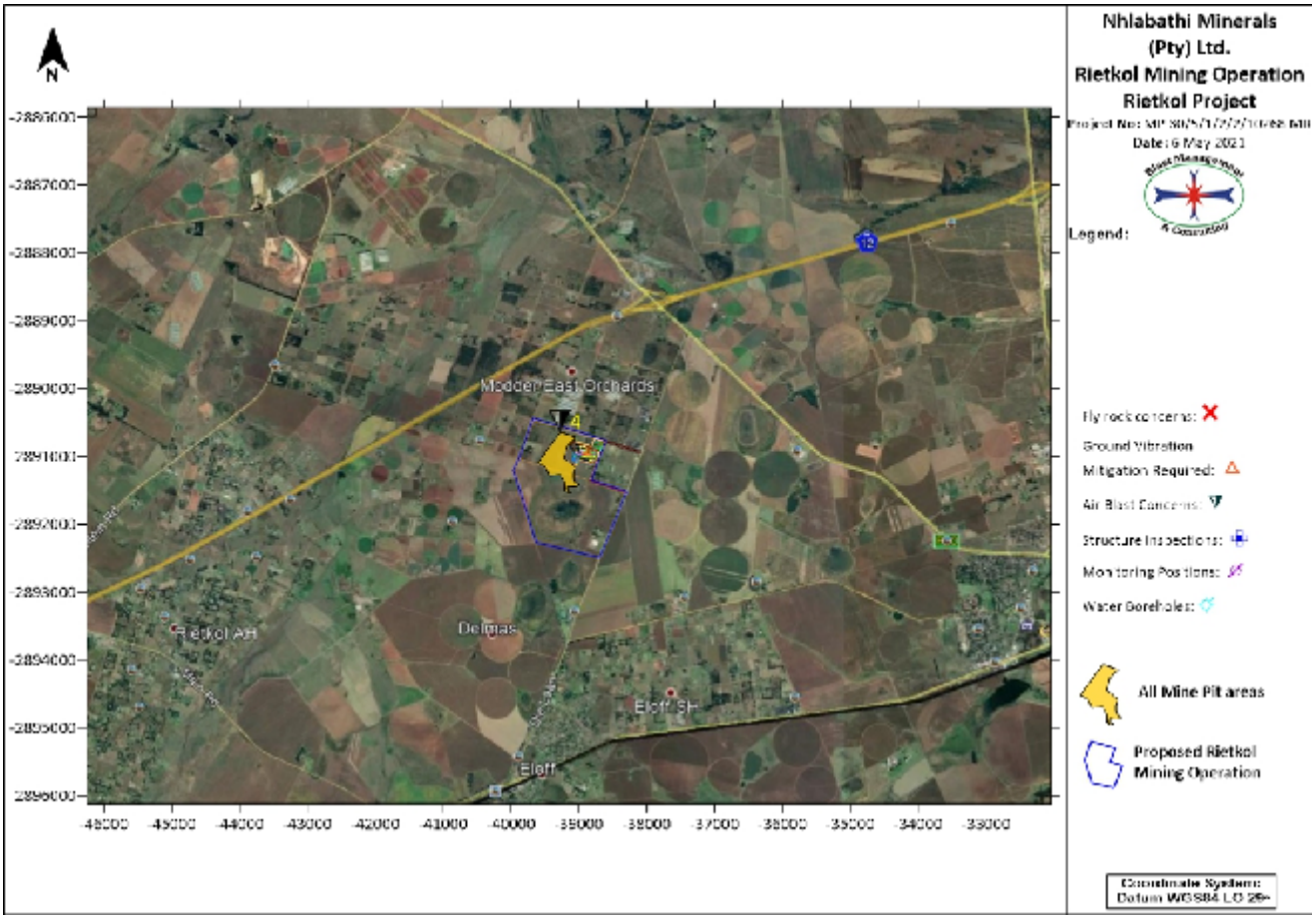


Figure 32: Structures identified with air blast concern after review from proposed blast design

Figure 33: Structures identified with air blast concern after review from proposed blast design (zoomed)

Mitigation of air blast is however a more complex process to predict but yet simple to address. The main mitigation is to conduct redesign of blasting operations with specific attention to the stemming process, material used for stemming and import stemming length.

Management of stemming length and material for control on air blast will also help reduce the fly rock concern. Applying the proposed blast design and managing the stemming length and material with increased length to at least 3.1 m the clearance distance is reduced to 105 m. The following figure show POI's of concern and area for fly rock based on the proposed design.

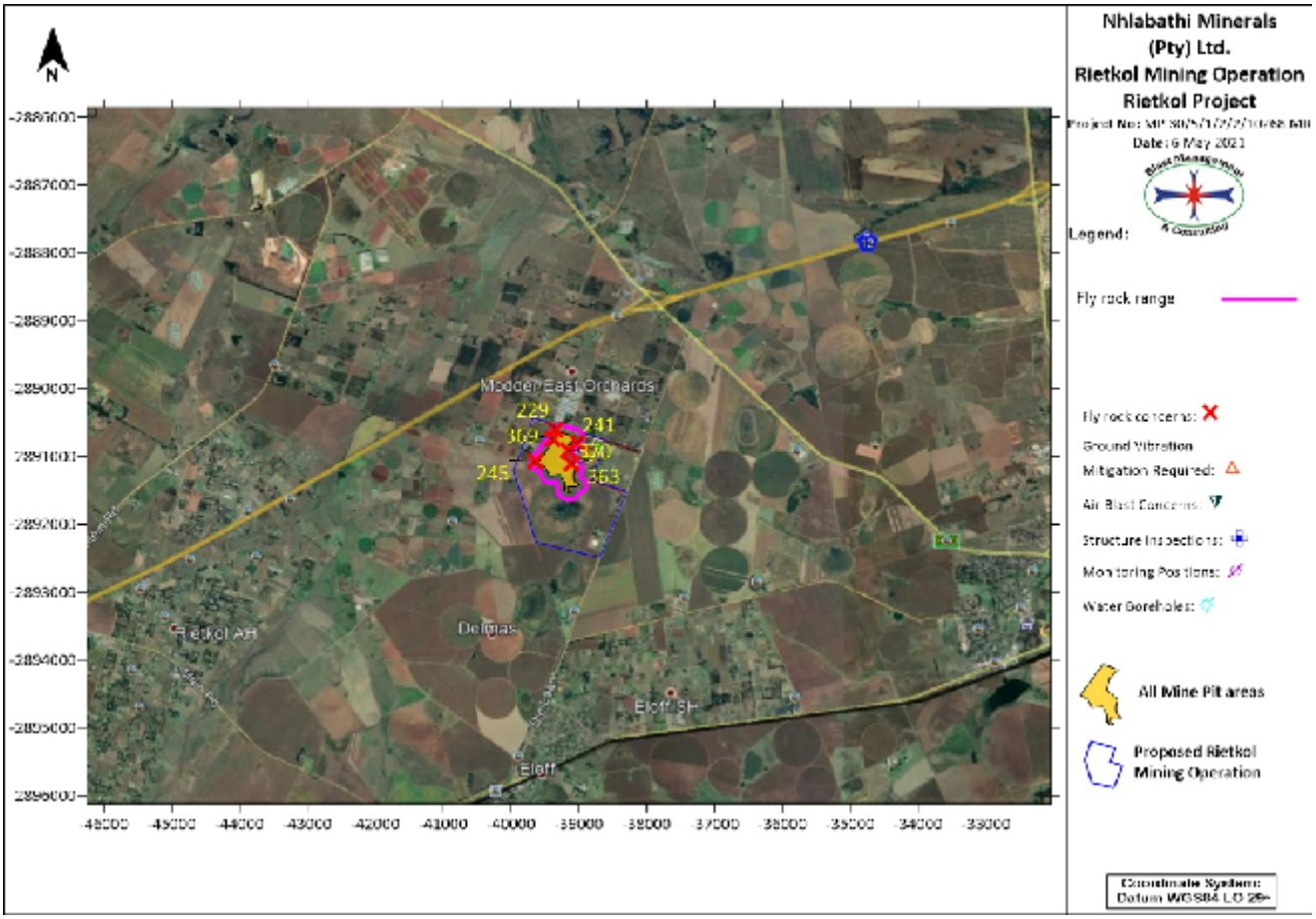


Figure 34: POI's identified for fly rock concern after review from proposed blast design

Figure 35: POI's identified for fly rock concern after review from proposed blast design (zoomed)

In conclusion of mitigation it is believed that there is no other option than to consider a completely new blast design with specific controls to be put in place. Mitigation of ground vibration, air blast and fly rock can be done very effectively. However, it must be indicated that though we predict and evaluate as best possible the probability of fly rock can never be eliminated. Caution should always be considered with best practice blasting operations.

18 Closure Phase: Impact Assessment and Mitigation Measures

During the closure phase no mining, drilling and blasting operations are expected. It is uncertain if any blasting will be done for demolition. If any demolition blasting will be required it will be reviewed as civil blasting and addressed accordingly.

19 Alternatives (Comparison and Recommendation)

No specific alternative mining methods are currently under discussion or considered for drilling and blasting.

20 Monitoring

A monitoring programme for recording blasting operations is recommended. The following elements should be part of such a monitoring program:

- Ground vibration and air blast results;
- Blast Information summary;
- Meteorological information at time of the blast;
- Video Recording of the blast;
- Fly rock observations.

Most of the above aspects do not require specific locations of monitoring. Ground vibration and air blast monitoring requires identified locations for monitoring. Monitoring of ground vibration and air blast is done to ensure that the generated levels of ground vibration and air blast comply with recommendations. Proposed positions were selected to indicate the nearest points of interest at which levels of ground vibration and air blast should be within the accepted norms and standards as proposed in this report. The monitoring of ground vibration will also qualify the expected ground vibration and air blast levels and assist in mitigating these aspects properly. This will also contribute to proper relationships with the neighbours.

Eleven monitoring positions were identified for North Block and Main Block Mine Pit areas. Some of these points may be applicable to more than one installation. Monitoring positions are indicated in Figure 36 and Table 32 lists the positions with coordinates. These points will need to be re-defined after the first blasts done and the monitoring programme defined.

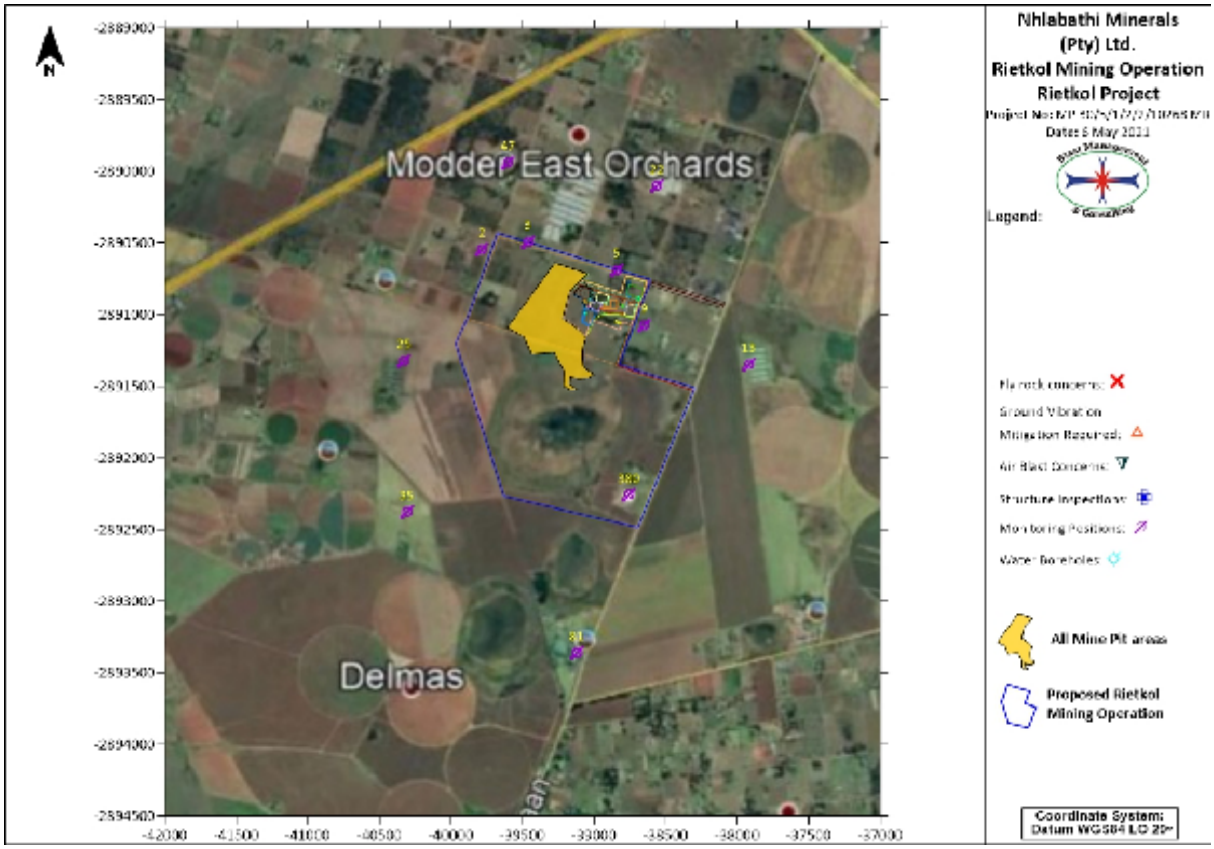


Figure 36: Monitoring Positions suggested for the Mine Pit areas

Table 32: List of possible monitoring positions

Tag	Description	Y	X
2	Informal Housing Settlement	39780.62	2890543.43
3	Farm Buildings/Structures	39462.71	2890491.43
5	Informal Housing Settlement	38840.89	2890686.41
9	Farm Buildings/Structures	38648.40	2891074.82
13	Agricultural Buildings/Broilers	37919.28	2891349.06
22	Hot Houses/Flower Tunnels	38558.02	2890103.43
25	Agricultural Buildings/Broilers (Rossgro Group)	40325.74	2891321.36
35	Agricultural Buildings/Veg Tunnels	40309.15	2892378.49
47	Farm Buildings/Structures (Agricultural Buildings)	39599.31	2889938.89
81	Agricultural Buildings (Rossgro Group)	39119.35	2893361.70
380	Industrial Structure (Agricultural Packhouse-Rossgro)	38756.22	2892258.67

21 Recommendations

The following recommendations are proposed.

21.1 Neighbourhood Communication

It is highly recommended that a neighbourhood communication process is applied. This will establish communication with landowners regarding actions in the operation i.e. blasting dates and times.

21.2 Regulatory requirements

Regulatory requirements indicate specific requirements for all non-mining structures and installations within 500 m from the mining operation. POI's at the Mine Pit areas are observed within the 500 m. The mine will have to apply for the necessary authorisations as prescribed in the various acts, and specifically Mine Health and Safety Act Reg 4.16.
Table 33 shows list of these installations. Figure 37 below shows the 500 m boundary around the Mine Pit areas. The location of non-mining installations is clearly observed.

Table 33: List of possible installations within the regulatory 500 m

Tag	Description	Y	X
1	Farm Buildings/Structures	39857.56	2890812.70
2	Informal Housing Settlement	39780.62	2890543.43
3	Farm Buildings/Structures	39462.71	2890491.43
4	Hot Houses/Nursery/Orchards	39286.02	2890483.45
5	Informal Housing Settlement	38840.89	2890686.41
9	Farm Buildings/Structures	38648.40	2891074.82
15	Farm Buildings/Structures	38570.69	2891357.46
19	Agricultural Buildings	39314.07	2890221.96
20	Farm Buildings/Structures	38899.72	2890313.38
164	Agricultural Buildings/Flower Tunnels	39331.10	2890465.86
165	Agricultural Buildings	38831.56	2891058.56
222	Buildings (Business Commercial)	39146.27	2890421.02
229	Buildings/Structures/Dam	39344.57	2890593.77
230	Dam	38851.58	2891161.93
240	Farm Buildings/Structures	39711.31	2890901.64
241	Farm Buildings/Structures	39027.16	2890793.25
242	Farm Buildings/Structures	38816.95	2890907.28
243	Farm Buildings/Structures	38797.26	2891112.87
245	Farm Buildings/Structures	39638.27	2891071.31
246	Farm Buildings/Structures	39507.41	2890456.49

256	Informal Housing Settlement	39738.99	2890484.42
259	Informal Housing Settlement	38821.04	2890629.68
263	Pan	39230.28	2891778.40
282	Hydrocencus Borehole 7	39844.67	2890777.43
289	Hydrocencus Borehole 14	39285.93	2890332.56
292	Hydrocencus Borehole 17	39346.24	2890233.03
293	Hydrocencus Borehole 18	39495.46	2890499.38
295	Hydrocencus Borehole 20	39754.38	2890865.79
296	Hydrocencus Borehole 21	39724.41	2890854.61
297	Hydrocencus Borehole 22	39824.32	2890888.16
298	Hydrocencus Borehole 23	38803.71	2891051.26
299	Hydrocencus Borehole 24	38774.10	2890918.22
300	Hydrocencus Borehole 25	38655.04	2890596.57
301	Hydrocencus Borehole 26	38625.17	2890552.17
302	Hydrocencus Borehole 27	38915.87	2890331.45
324	Hydrocencus Borehole 49	38613.66	2891061.78
325	Hydrocencus Borehole 50	38664.06	2890928.98
361	Hydrocencus Borehole 86	38606.99	2891288.88
362	Hydrocencus Borehole 87	38659.81	2891352.19
363	Heritage Site (Informal Graveyard - 20 graves)	39109.17	2891095.88
364	Heritage Site (Ruins of a house/outbuilding constructed)	38993.57	2891028.57
369	Heritage Site (Ruins of a house/outbuilding)	39382.51	2890736.63
370	Heritage Site (Old Trigonometrical beacon)	39162.50	2890914.46
379	Fuel Storage (Underground Fuel Tank)	38637.43	2891079.17

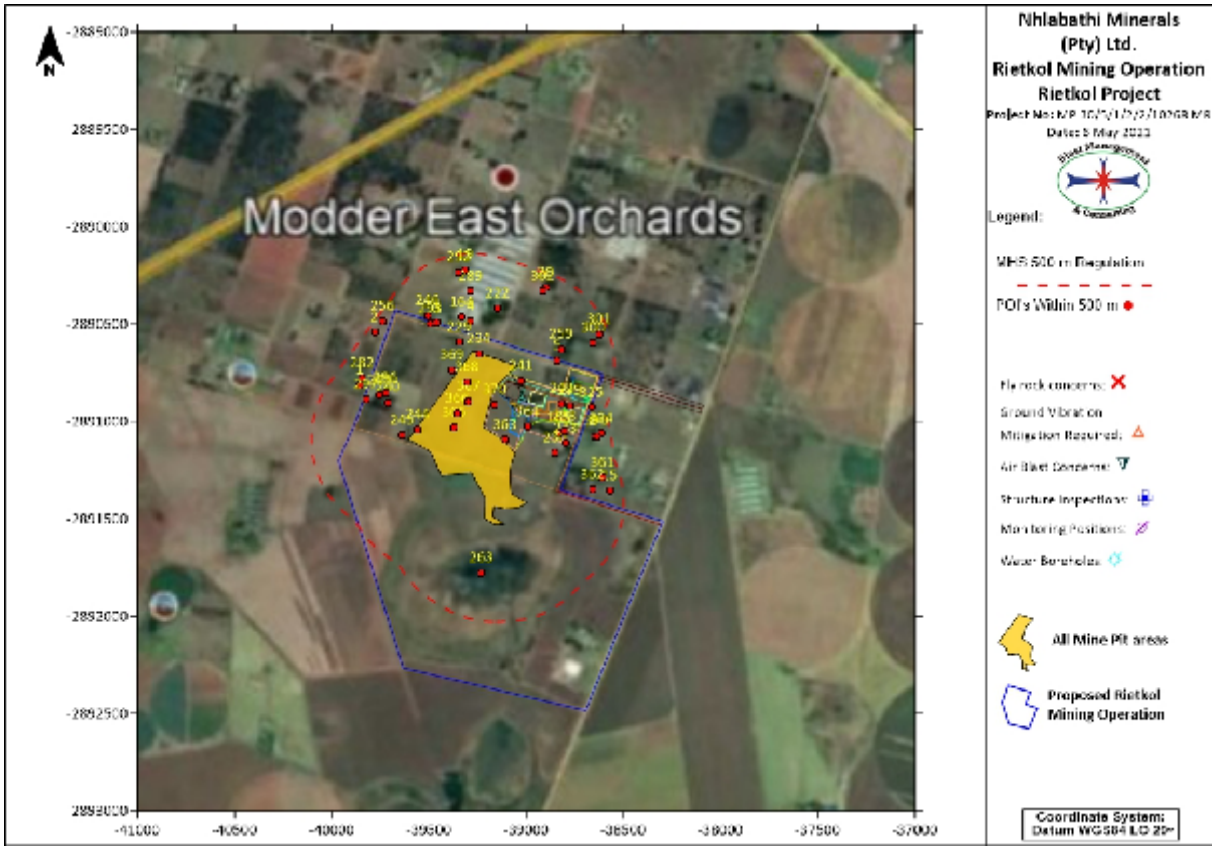


Figure 37: Regulatory 500 m range for the Mine Pit areas

21.3 Mining Sequence

Review of the site and the planned mining areas the Northern Pit area is closest to some of the critical points of concern. It may well be worthwhile to consider starting mining from the centre of the south pit rea. This creates more distance between the residential areas and will help alleviate some stress about blasting operations.

21.4 Alternative Mining operations

The northern pit has residential and light industrial close to the operations. Blasting operations is a main concern with the neighbours. Alternative mining instead of drilling and blasting should be considered for this area. Alternative mining making use of vibrating rippers instead. Vibrating rippers have been successful in many cases and has no vibration impact.

21.5 Blast Designs

The current blast design proposed by the applicant will not be sufficient to manage effects from blasting operations properly. A new blast design is recommended as provided and discussed under mitigations.

21.6 Test Blasting

A test blast must be done to confirm levels of ground vibration and air blast. It is recommended that such a blast be done and detail monitoring done to assist in defining blasting operations going forward. This test blast should be based on a new design, which should inform further changes required to achieve the stated ground vibration and air blast levels.

21.7 Stemming length

The current proposed stemming lengths used provides for insufficient control on fly rock. Consideration should be given to increase this length for better control. Specific designs where distances between blast and point of concern are known should be considered. Recommended stemming length should range between 30 and 34 times the blast hole diameter.

21.8 Safe blasting distance and evacuation

Calculated minimum safe distance is 526 m for initial evaluation but with proposed new design this is reduced to 105 m. The final blast designs that will be used will determine the final decision on safe distance to evacuate people and animals. This distance may be greater pending the final code of practice of the mine and responsible blaster's decision on safe distance. The blaster has a legal obligation concerning the safe distance and he needs to determine this distance.

21.9 Road Closure

There are National and provincial roads in the vicinity of the project area. The N12 road on the northern side of the pit area is located at 1244 m. The R50 road to the North-east of the pit area is located at 2299 m. No road closures are proposed for these roads due to the distance from the mine.

There are however smaller local roads that are used by the local community that should be considered for closures when blasting is done. During blasting care must be taken to ensure all people and animals are cleared to outside the unsafe area as determined by the blaster.

Negotiations will be required with the local community regarding evacuation and road closures during blasting. It will be imperative to do this with great care and mutual understanding.

21.10 Photographic Inspections

The option of photographic survey of all structures up to 1200 m from the pit areas is recommended. The mine will be operating for a significant number of years. This will give advantage on any negotiations with regards to complaints from neighbours on structural issues due to blasting. This process can however only succeed if done in conjunction with a proper monitoring program. It is expected that ground vibration levels will be significantly less than the proposed limits at 1200 m, but this process will ensure records of the pre-blasting status of the nearest structures to the pit areas. At 1243 m the expected level of ground vibration will be perceptible. Figure 38 shows extent of the range of 1200 m around North Block and Main Block Mine Pit areas with POI's identified. It must be noted that a point may represent a group of structures found in the vicinity of the point identified.

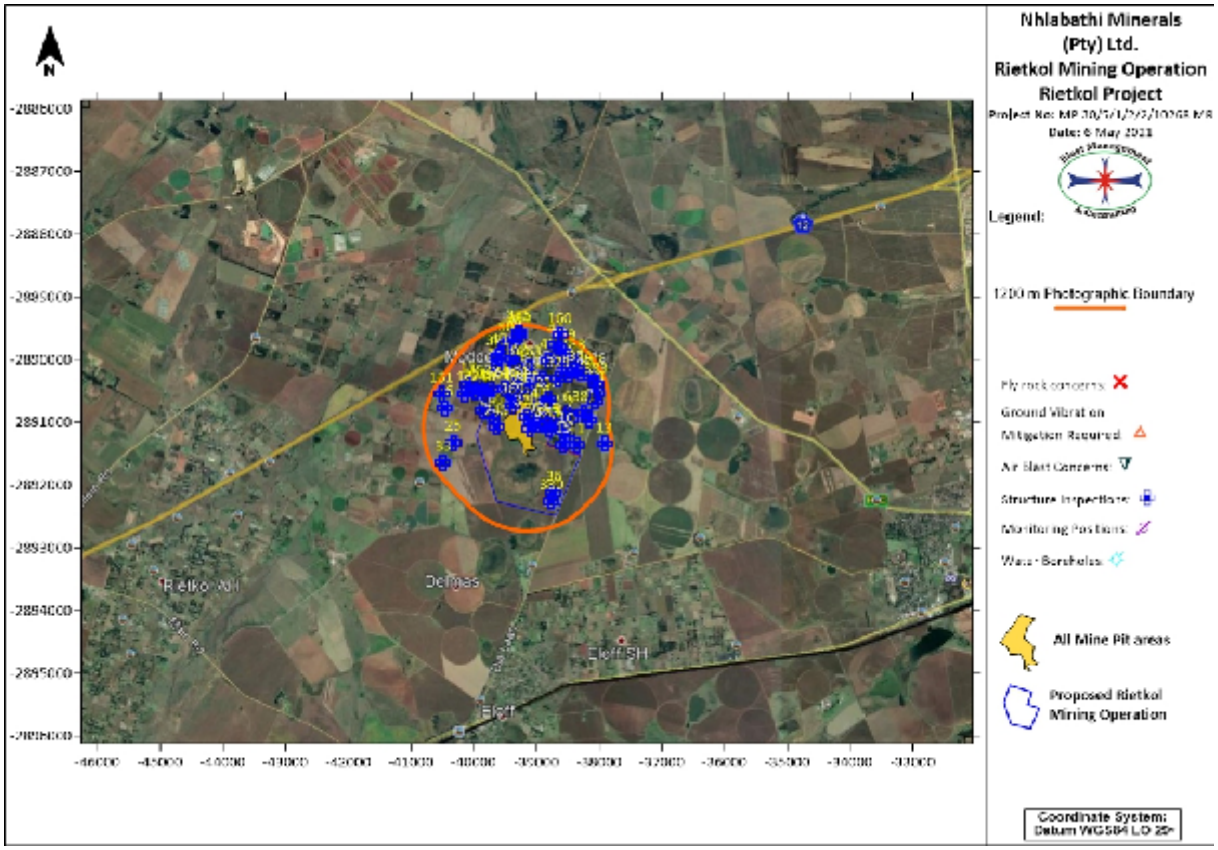


Figure 38: 1200 m area around the Mine Pit areas identified for structure inspections.

Table 34: Combined list of structures identified for inspections

Tag	Description	Y	X
1	Farm Buildings/Structures	39857.56	2890812.70
2	Informal Housing Settlement	39780.62	2890543.43
3	Farm Buildings/Structures	39462.71	2890491.43
4	Hot Houses/Nursery/Orchards	39286.02	2890483.45
5	Informal Housing Settlement	38840.89	2890686.41
6	Buildings/Structures	38507.44	2890854.88
7	Farm Buildings/Structures	38455.13	2890945.72
8	Farm Buildings/Structures	38153.11	2890961.79
9	Farm Buildings/Structures	38648.40	2891074.82
10	Agricultural Buildings	38518.36	2891198.53
11	Farm Buildings/Structures	38355.91	2891366.03
13	Agricultural Buildings/Broilers	37919.28	2891349.06
15	Farm Buildings/Structures	38570.69	2891357.46
16	Farm Buildings/Structures	40142.94	2890542.56
17	Farm Buildings/Structures (Business Commercial)	40086.63	2890396.00
18	Farm Buildings/Structures (Agricultural Buildings)	39659.03	2890159.28
19	Agricultural Buildings	39314.07	2890221.96
20	Farm Buildings/Structures	38899.72	2890313.38
21	Farm Buildings/Structures	38491.41	2890231.76
22	Hot Houses/Flower Tunnels	38558.02	2890103.43
23	Farm Buildings/Structures	38040.85	2890540.29
24	Farm Buildings/Structures	38073.30	2890677.42
25	Agricultural Buildings/Broilers (Rossgro Group)	40325.74	2891321.36
26	Buildings/Structures (Business Commercial)	40453.05	2890766.46
33	Farm Buildings/Structures (Agricultural Buildings)	40485.39	2891638.98
36	Farm Buildings/Structures/Farm Dam	38720.78	2892121.11
43	Farm Buildings/Structures	38813.10	2890011.79
44	Farm Buildings/Structures	38693.20	2889765.72
46	Farm Buildings/Structures	39377.32	2889997.35
47	Farm Buildings/Structures (Agricultural Buildings)	39599.31	2889938.89
48	Farm Buildings/Structures (Agricultural Buildings)	39354.29	2889714.77
50	Farm Buildings/Structures	39480.71	2889749.27
158	Agricultural Buildings/Flower Tunnels	38413.51	2890032.22
159	Agricultural Buildings	38564.37	2889872.75
160	Agricultural Buildings/Veg Tunnels	38627.83	2889606.19
161	Agricultural Buildings	40515.58	2890553.92
162	Agricultural Buildings	39336.72	2890096.81
163	Agricultural Buildings/Flower Tunnels	39111.41	2890131.42
164	Agricultural Buildings/Flower Tunnels	39331.10	2890465.86
165	Agricultural Buildings	38831.56	2891058.56
221	Buildings (Business Commercial)	39972.18	2890509.25
222	Buildings (Business Commercial)	39146.27	2890421.02
229	Buildings/Structures/Dam	39344.57	2890593.77
240	Farm Buildings/Structures	39711.31	2890901.64
241	Farm Buildings/Structures	39027.16	2890793.25
242	Farm Buildings/Structures	38816.95	2890907.28
243	Farm Buildings/Structures	38797.26	2891112.87
245	Farm Buildings/Structures	39638.27	2891071.31
246	Farm Buildings/Structures	39507.41	2890456.49
247	Farm Buildings/Structures	38126.78	2890292.59

Tag	Description	Y	X
256	Informal Housing Settlement	39738.99	2890484.42
257	Informal Housing Settlement	39901.52	2890443.75
258	Informal Housing Settlement	39843.10	2890538.47
259	Informal Housing Settlement	38821.04	2890629.68
363	Heritage Site (Informal Graveyard - 20 graves)	39109.17	2891095.88
364	Heritage Site (Ruins of a house/outbuilding constructed)	38993.57	2891028.57
369	Heritage Site (Ruins of a house/outbuilding)	39382.51	2890736.63
370	Heritage Site (Old Trigonometrical beacon)	39162.50	2890914.46
371	Farm Animals (Horses - Goudhoek SA Boerperd Stoet)	39612.80	2889963.03
373	Informal Housing	38651.42	2890309.99
374	Farm Buildings/Structures	38300.39	2890212.93
380	Industrial Structure (Agricultural Packhouse-Rossgro)	38756.22	2892258.67
381	Industrial Structures (Coal transport facility)	38237.38	2890849.20
383	Industrial Structures	38050.43	2890398.93
384	Informal Housing (Labour Tenants)	39279.42	2889611.06
385	Farm Buildings/Structures	39276.72	2889560.76

21.11 Recommended ground vibration and air blast levels

The ground vibration and air blast levels limits recommended for blasting operations in this area are provided in Table 35.

Table 35: Recommended ground vibration and air blast limits

Structure Description	Ground Vibration Limit (mm/s)	Air Blast Limit (dBL)
National Roads/Tar Roads:	150	N/A
Electrical Lines:	75	N/A
Railway:	150	N/A
Transformers	25	N/A
Water Wells	50	N/A
Telecoms Tower	50	134
General Houses of proper construction	USBM Criteria or 25 mm/s	Shall not exceed 134dB at point of concern but 120 dB preferred
Houses of lesser proper construction	12.5	
Rural building – Mud houses	6	

21.12 Blasting times

A further consideration of blasting times is when weather conditions could influence the effects yielded by blasting operations. It is recommended not to blast too early in the morning when it is still cool or when there is a possibility of atmospheric inversion or too late in the afternoon in winter. Do not blast in fog. Do not blast in the dark. Refrain from blasting when wind is blowing strongly in the direction of an outside receptor. Do not blast with low overcast clouds. These 'do nots' stem

from the influence that weather has on air blast. The energy of air blast cannot be increased but it is distributed differently and therefore is difficult to mitigate.
It is recommended that a standard blasting time is fixed and blasting notice boards setup at various routes around the project area that will inform the community of blasting dates and times.

21.13 Third party monitoring

Third party consultation and monitoring should be considered for all ground vibration and air blast monitoring work. This will bring about unbiased evaluation of levels and influence from an independent group. Monitoring could be done using permanent installed stations. Audit functions may also be conducted to assist the mine in maintaining a high level of performance with regards to blast results and the effects related to blasting operations.

21.14 Video monitoring of each blast

Video of each blast will help to define if fly rock occurred and origin. Immediate mitigation measure can then be applied if necessary. The video will also be a record of blast conditions.

21.15 Relocation

There are various public houses and installations in close proximity of the pit area. The greatest concerns originate from houses that are located up to 526 m from the pit areas.
There is uncertainty to what level of negotiations there are with the local community. Any relocation or evacuation program should be considered very careful planning and execution.

22 Knowledge Gaps

The data provided from client and information gathered was sufficient to conduct this study. Surface surroundings change continuously and this should be considered prior to initial blasting operations considered. This report may need to be reviewed and updated if necessary. This report is based on data provided and internationally accepted methods and methodology used for calculations and predictions.

23 Final decision opinion

Review of the project clearly indicates that there are specific concerns that will require detailed evaluation and changed methodologies to be applied. The project's location in relation to the surrounding areas has the greatest influence. Blasting operations can be controlled and it has been proven in the industry that blasting can be done in the most sensitive areas and be successful. It is

a question of how the blasting operations is done and at what level the applicant is prepared to management and mitigate the concerns. The planned mining areas have structures and installations at relatively close distances to the open pit area. Blasting operations will require specific controls to manage the effects from blasting. Very conscious and sensitive negotiations with the local communities will be required to stipulate the execution of the project. The author is of opinion that the project will be possible but only under circumstances that will be acceptable by the neighbouring community.

24 Conclusion

Blast Management & Consulting (BM&C) was contracted as part of Environmental Impact Assessment (EIA) to perform an initial review of possible impacts with regards to blasting operations at the proposed Rietkol Mining Operation (Rietkol Project). Ground vibration, air blast, fly rock and fumes are some of the aspects that result from blasting operations. The report concentrates on the ground vibration and air blast and intends to provide information, calculations, predictions, possible influences and mitigations of blasting operations for this project.

The evaluation of effects yielded by blasting operations was evaluated over an area as wide as 3500 m from the mining area considered. The effects of ground vibration, air blast and fly rock specifically were evaluated. There are various structures and installations observed surrounding the project area ranging from typical roads (tar and gravel), low cost houses, corrugated iron structures, brick and mortar houses, Agricultural buildings, Hot Houses/Flower Tunnels, boreholes and heritage sites.

This project is a greenfields project with no existing blasting operations.

The location of structures around the open pit areas is such that the charges evaluated showed possible influences due to ground vibration. The closest structures observed are the Heritage Site (Informal Graveyard - 20 graves), Heritage Site (Old Trigonometrical beacon), Heritage Site (Ruins of a house/outbuilding), Farm Buildings/Structures, Hot Houses/Nursery/Orchards, Informal Housing Settlement, Agricultural Buildings and Buildings (Business Commercial).

Initial evaluation of ground vibration indicates that mitigation will be required for surrounding structures and installations. Ground vibrations predicted for all pit areas ranged between low and very high. The minimum charge used indicated thirteen POI's of concern. Six of these POI's are located inside the pit area, seven are located inside the MRA with no POI's located outside the MRA. The maximum charge indicated sixteen POI's of concern. Six of these POI's are inside the pit area, eight are located inside the MRA and two are located outside the MRA and regarded as private. Ground vibration at structures and installations other than the identified problematic structures is well below any specific concern for inducing damage.

Proposed mitigation reduces the range of influence significantly. Ground vibration exceedance predicted is only observed for structures inside the MRA. Expected levels of ground vibration at structures outside the MRA is expected to be within acceptable limits.

Air blast predicted showed some concerns for opencast blasting. Maximum air blast levels predicted showed levels greater than the limit for structures. The current accepted limit on air blast is 134 dB for house structures. Damages are only expected to occur at levels greater than 134dB. Limits for hot houses and tunnels are lower at 120 dB due to the plastic covering used. High levels may contribute to effects such as rattling of roofs or door or windows with limited points that are expected to be damaging and others could lead to complaints.
Initial charges considered indicates that air blast will be greater than 134 dB at a distance of 266 m and closer to pit boundaries. Maximum charge predictions indicate that forty-six POI's could experience air blast that could lead to complaints and seventeen POI's are identified where levels are greater than applied limit. Six POI's are located inside the MRA and eleven are located outside the MRA on private land which include six hothouses / tunnels with a lower limit than normal house structures. It is expected that structures within the mining right application (MRA) area may be relocated and thus not problematic. The Hot Houses/Nursery/Orchards (POI 4), Farm Buildings (POI

3), Informal Housing Settlement (POI 5 & 259), Agricultural Buildings/Flower Tunnels (POI 164), Agricultural Buildings (POI 165) and Buildings (Business Commercial) (POI 222) are a concern for the initial evaluation done. After mitigation possible influence is reduced to one structure (POI 4) outside the MRA. Based on levels greater than 120dB but less than the formal limit of 134 dB for possible structural damage, three POI's were identified where complaints may arise due to air blast.

Blast preparation and specific stemming controls will need to be exercised effectively. The pits are located such that "free blasting" – meaning no controls on blast preparation – will not be possible.

An exclusion zone for safe blasting was also calculated based on possible fly rock travel range. The exclusion zone was established to be at least 526 m. Generally, a minimum exclusion zone of 500 m for mining operations as a minimum but based on initial evaluation a minimum of at least 526 m should be used. This distance exclusion zone will include the Farm Buildings/Structures, Informal Housing Settlement, Hot Houses/Nursery/Orchards, Agricultural Buildings/Flower Tunnels, Hydrocensus Boreholes and Heritage Sites. Proposed mitigations reduces the exclusion zone to 105 m. This is due to the use of proper stemming lengths and stemming material. This reduction excludes all structures outside the MRA.

Eighty-Seven Hydrocensus boreholes were identified within the influence area at the Pit areas. There are boreholes that are in close proximity of the blasting areas but are found to be within acceptable limits. There is one borehole that falls within the North Block Pit area. This borehole will

be destroyed. At all other identified boreholes, the expected levels of ground vibration were found to be within acceptable limits.

Recommendations were made and should be considered. Specific actions will be required for all pit areas such as Mine Health and Safety Act requirements when blasting is done within 500 m from private structures. Structure inspections to be considered at least up to 1200 m from the pit area. People is expected to experience ground vibrations as perceptible to this distance.

A specific blast design was proposed as mitigation measure to be considered. The application of the design reduces the area of influence. Ground vibration levels are reduced to no levels greater than applied limit for any structure outside the MRA. Air blast levels are reduced to one agricultural tunnel outside the MRA being just greater than the proposed limit and fly rock exclusion zone reduced to 105 m.

No roads are negatively impacted with regards to ground vibration. The farming community around the pit areas must be considered when temporary closures of roads are required during blasting operations.

The probable influence of blasting operations on animals causing fatalities is none. Different animals will react different to the noise effect and in many cases gets used to the noise. There is however concern with regards to horses and their reaction to sudden noises. The noise effect expected is rather a rumble effect and not loud instant bangs. An understanding will need to be arranged between horse owners and the mine when blasting is done that that no riding is done for that short period. The reaction of horses and chickens are to be monitored from the onset of blasting operations. A mitigation process can then be further detailed to the satisfactory of both parties.

The pit areas are located such that specific concerns were identified and addressed in the report. The author is of opinion that the project will be possible but only under circumstances that will be acceptable by the client and the neighbouring community. A changed consideration of blast designs and possible bench levels will be required.

This concludes this investigation for the proposed Rietkol Project.

25 Curriculum Vitae of Author

J D Zeeman was a member of the Permanent Force - SA Ammunition Core for period January 1983 to January 1990. During this period, work involved testing at SANDF Ammunition Depots and Proofing ranges. Work entailed munitions maintenance, proofing and lot acceptance of ammunition.

From July 1992 to December 1995, Mr Zeeman worked at AECI Explosives Ltd. Initial work involved testing science on small scale laboratory work and large-scale field work. Later, work entailed managing various testing facilities and testing projects. Due to restructuring of the Technical Department, Mr Zeeman was retrenched but fortunately was able to take up an appointment with AECI Explosives Ltd.'s Pumpable Emulsion Explosives Group for underground applications.
From December 1995 to June 1997 Mr Zeeman provided technical support to the Underground Bulk Systems Technology business unit and performed project management on new products.
Mr Zeeman started Blast Management & Consulting in June 1997. The main areas of focus are Pre-blast monitoring, Insitu monitoring, Post-blast monitoring and specialized projects.

Mr Zeeman holds the following qualifications:

1985 - 1987	Diploma: Explosives Technology, Technikon Pretoria
1990 - 1992	BA Degree, University of Pretoria
1994	National Higher Diploma: Explosives Technology, Technikon Pretoria
1997	Project Management Certificate: Damelin College
2000	Advanced Certificate in Blasting, Technikon SA

Member: International Society of Explosives Engineers

Blast Management & Consulting has been active in the mining industry since 1997, with work being done at various levels for all the major mining companies in South Africa. Some of the projects in which BM&C has been involved include:
Iso-Seismic Surveys for Kriel Colliery in conjunction with Bauer & Crosby Pty Ltd.; Iso-Seismic surveys for Impala Platinum Limited; Iso-Seismic surveys for Kromdraai Opencast Mine; Photographic Surveys for Kriel Colliery; Photographic Surveys for Goedehoop Colliery; Photographic Surveys for Aquarius Kroondal Platinum – Klipfontein Village; Photographic Surveys for Aquarius – Everest South Project; Photographic Surveys for Kromdraai Opencast Mine; Photographic inspections for various other companies, including Landau Colliery, Platinum Joint Venture – three mini-pit areas; Continuous ground vibration and air blast monitoring for various coal mines; Full auditing and control with consultation on blast preparation, blasting and resultant effects for clients, e.g. Anglo Platinum Ltd, Kroondal Platinum Mine, Lonmin Platinum, Blast Monitoring Platinum Joint Venture – New Rustenburg N4 road; Monitoring of ground vibration induced on surface in underground mining environment; Monitoring and management of blasting in close relation to water pipelines in opencast mining environment; Specialized testing of explosives characteristics; Supply and service of seismographs and VOD measurement equipment and accessories; Assistance in protection of ancient mining works for Rhino Minerals (Pty) Ltd.; Planning, design, auditing and monitoring of blasting in new quarry on new road project, Sterkspruit, with Africon, B&E International and Group 5 Roads; Structure Inspections and Reporting for Lonmin Platinum Mine Limpopo Pandora Joint Venture 180 houses – whole village; Structure Inspections and Reporting for Lonmin Platinum Mine Limpopo Section - 1000 houses / structures.

BM&C have installed a world class calibration facility for seismographs, which is accredited by Instantel, Ontario Canada as an accredited Instantel facility. The projects listed above are only part of the capability and professional work that is done by BM&C.

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27 Appendix 1: Comments and Responses

The following table provides responses for the comments made in the comments and response report: 29-04-2021 CRR Rietkol - FSR V4

	Comments	Person / Institution	Response
	Blasting and Ground Vibration: The Environmental Specialist should investigate and evaluate the effect that blasting and ground vibration emanating from the proposed mine may have on the business of my client.	Johann Minnaar on behalf of Rossgro Group of Companies Rietkol 237 IR Ptn 2, RE/31, 71, RE/90, 103 and Geluk 234 IR Ptn 2 & 24 and others. MRA landowner Email 18 Mar 2018	Noted. The concerns raised will be forwarded to the blasting specialist for consideration during their assessments. As indicated above specific attention will be given to the question of influence on chickens. Possible impacts will need to be determined first and then evaluation made. JDZ: A detailed Impact assessment was done and possible impacts identified with recommendations for mitigations where required were made. The structures and structure types were identified during the evaluation phase and recommendations made regarding inspections and recommended ground vibration and air blast limits that will be appropriate. The close structures are defining the blast preparation to be applied to ensure compliance. All structures further away are then also within safe criteria.
	This blasting, with the rocks that we have here, will they look at damages to the houses and the potential for sinkholes?	Mr Wocke Plot 218 & 219 MRA Landowner Meeting 9 Mar 2018	This will be addressed in the specialist studies, with specific reference to sinkholes. JDZ: The assessment done considered possible impact on structures and recommendations were made. Blasting will have a low probability of creating sinkholes.
	BLASTING AND GROUND VIBRATION The Section in the DSR (Section 9.9) concerning blasting and ground vibration is merely a summary in general terms what normally occurs when a mine undertakes blasting operations. It lacks any specifics as to what the environmental effect of blasting and ground vibration will be in the case of this particular mining operation. No blasting and ground vibration modelling has been undertaken to determine the degradation to the environment due to blasting and ground vibration, and the	Johann Minnaar on behalf of Rossgro Group of Companies Rietkol 237 IR Ptn 2, RE/31, 71, RE/90, 103 and Geluk 234 IR Ptn 2 & 24 and others. MRA landowner 22 Apr 2021	A detail Blasting and Ground Vibration Impact Study are being conducted, as indicated in the Plan of Study. The DSR only provides details of the baseline environment and potential impacts that may be associated with the mining operation. The impact modelling will be addressed in the EIA and specialist reports. JDZ: A detailed Impact assessment was done and possible impacts identified with recommendations for mitigations where required. Grown chickens do get fright with sudden noises and tend to run into a corner of pen and trample each other. There is reason to believe that chicks are less responsive that grown chickens. The blasting is expected not to be

	mitigating measures that the mine will implement to prevent such environmental harm. A Blasting and Ground Vibration Impact Study should be undertaken by an environmental specialist. The above study should be amplified and should also study the effect which blasting and ground vibration will have on the well-being of chickens and egg laying hens, as such noise and vibration will in all probability have an impact on egg production and life span of the chickens and egg laying hens of my client.		sudden loud bangs but rather a rumbling effect. The impact was addressed in the report. The nearest broiler is 764 m from the nearest point of the quarry. Expected ground vibration is 1.7 mm/s. This level may be perceptible but not excessive. Air blast is expected is 124.7 dBL that could lead to be heard but not as a loud bang. Recommended mitigations have been made to manage the effects of ground vibration and air blast as much as possible. Other mitigation measures for infrastructure closer to the quarry was also recommended meaning that at this location the possible effect will be less than predicted in the report.
19	Is there a possibility that blasting will have an effect on the dolomitic aquifer?	Jakob Nkabinde Air Quality & Environment officer Victor Khanye Local Municipality Meeting 9 Mar 2018	At this stage it is envisaged highly unlikely, but we are doing a blasting specialist study, which will provide a more in-depth assessment. JDZ: The minable quartzite is underlain with 30 m of Dolerite sill followed by another 50 m of quartzite in depth. Mining will only occur above the dolerite sill. The separation between blasting area and any other dolomitic material is further than where damage to the dolomitic structure is expected.
50	Will the blasting impact the dolomitic structures and associated aquifer?	Martin van Zyl Unex Roses Plot 198, 201, 202, 204 Neighbouring landowner to the MRA area Meeting 9 Mar 2018	We are busy with the blasting impact assessment, which will specifically look at the potential for impacts on the dolomitic structures. JDZ: The minable quartzite is underlain with 30 m of Dolerite sill followed by another 50 m of quartzite in depth. Mining will only occur above the dolerite sill. The separation between blasting area and any other dolomitic material is further than where damage to the dolomitic structure is expected.
55	Apart from the above, the property is used for storage and training. An underground fuel tank is situated on the property which is utilized for company vehicles.	Raymond Roy Robertson Plot 278, 279 & 281 Modder East Orchards Email 16 Feb 2021	Noted. Any potential impacts on the underground fuel tank as a result of blasting will be investigated, assessed and presented in the blasting impact study and EIAR. JDZ: The expected ground vibration levels were calculated considering the fuel storage. A level of 4.5 mm/s was predicted which is well below any concern for possible damage.
79	BLASTING AND GROUND VIBRATION	Johann Minnaar on behalf of Unex Rose	A detail Blasting and Ground Vibration Impact Study are being conducted, as indicated in the Plan of Study.

	The Section in the DSR (Section 9.9) concerning blasting and ground vibration is merely a summary in general terms what normally occurs when a mine undertakes blasting operations. It lacks any specifics as to what the environmental effect of blasting and ground vibration will be in the case of this particular mining operation. No blasting and ground vibration modelling has been undertaken to determine the degradation to the environment due to blasting and ground vibration, and the mitigating measures that the mine will implement to prevent such environmental harm. A Blasting and Ground Vibration Impact Study should be undertaken by an environmental specialist.	Plot 198, 201, 202, 204 Neighbouring landowner to the MRA area Email 23 Apr 2021	The DSR only provides details of the baseline environment and potential impacts that may be associated with the mining operation. The impact modelling will be addressed in the EIA and specialist reports. JDZ: A detailed Impact assessment was done and possible impacts identified with recommendations for mitigations where required were made.
248	I do not agree with your statement, that there will not be an impact on the dolomitic cave because it is 2km away, as well as the impact of blasting on the dolomitic structures. We reside 6 – 8.5km from the closest coal mine, and when they blast we feel it here. The so-called expert must go back and do his homework. If we can feel the blasting vibrations from up to 8.5km away, what kind of an impact will something like that have on the dolomitic structures and associated aquifer. There has been no conclusive evidence that the so-called impenetrable layer of the dolerite cannot be broken. I tell you it is possible. We all know Joshua du Plessis, he has lost three (3) boreholes completely due to the coal mining including pumps at a R100,000 each. Therefore, if someone tell you there will not be a blasting impact surrounding the mine, then he must go back to school as he has wasted his money. We have to be honest with each other, when they blast there will be an impact, and this story of 500m, that is a lot of nonsense.	Pretorius, Leon Landowner Plot 285 Landowner within 1km MRA buffer Meeting 9 Mar 2018	Thank you for your comments, the groundwater and related blasting impact will be assessed and described in detail in the specialist studies and in the EIAR. JDZ: A detailed Impact assessment was done and possible impacts identified with recommendations for mitigations where required were made. The location of the cave is 2690 m from the planned quarry. Expected levels of vibration is 0.2 mm/s. This level will not contribute to damages in the cave.

249	Most of these blasting people do not give a damn about the weather conditions, blasting schedules and regulations, they just blast when they want to. How is that going to be monitored, and how will you guarantee people around the mine will not lose their water? If we lose our water source based on someone sucking his information. How are we going to be compensated, we sit with fresh produce, and other people have livestock. What impact will blasting have in the dolomitic structures and aquifer, we all know how big this aquifer is, it is one of the most important aquifers in the country. In South Africa, water is scarce. Therefore when someone tells me that there will not be an impact, he is just blatantly lying.	Pretorius, Leon Landowner Plot 285 Landowner within 1km MRA buffer Meeting 9 Mar 2018	Thank you for your comments, the groundwater and related blasting impact will be assessed and described in detail in the specialist studies and in the EIAR. JDZ: A detailed Impact assessment was done and possible impacts identified with recommendations for mitigations where required were made. A detailed monitoring program was recommended as well making use of third party consultants to ensure that impacts are mitigated properly. The minable quartzite is underlain with 30 m of Dolerite sill followed by another 50 m of quartzite in depth. Mining will only occur above the dolerite sill. The separation between blasting area and any other dolomitic material is further than where damage to the dolomitic structure is expected. Damages to dolomite structure requires significantly high shockwaves / ground vibration. At the distance between where blasting is to be done and dolomite structures it is not possible to create the shockwaves do damage the dolomite from the blasting planned.
266	5. Blasting (as per 3.3) a. Great concern exists about the blasting operation and its effect. Our experience is that the mines do not care about the regulations and the people and animals it affects. b. The structural integrity of our buildings are at risk. c. The effect of blasting on animals, especially horses, need to be investigated and report on.	Sarel Kritzinger Goudhoek SA Boerperd Stoet / Ovomart (Pty) Ltd / SJN Kritzinger cc Plot: 158, 160, 161, 162. Landowners within the 1km MRA buffer Email 19 Mar 2018	Noted. The concerns raised will be forwarded to the blasting specialist for consideration during their assessments. Impact of blasting on infrastructure and animals (horses) will be addressed as part of the blasting impact assessment. The structures and structure types will be identified as best possible and evaluation done accordingly. JDZ: Evaluation was done, and specific recommendations were made. The main recommendation was a changed blast design. Expected influences at POI 371 - Goudhoek SA Boerperd Stoet are: Ground vibration 0.5 mm/s and air blast 108.6 dBL. 0.5 mm/s is less than where it is perceptible and air blast is expected not to produce a loud bang noise. It may possibly be heard but with no specific concern as a loud noise. There are other POI's much closer that are considered in the designs for compliance and places more restrictions on blasting operations. Considering the distance from the mining area from

			POI 371 and the obstructions in between, the effects is expected to be very low. The structures and structure types were identified during the evaluation phase and recommendations made regarding inspections and recommended ground vibration and air blast limits that will be appropriate. The close structures are defining the blast preparation to be applied to ensure compliance. All structures further away are then also within safe criteria.
271	12. Noise (as per 8.9) a. what about the effect on animals. b. Horses hearing: can hear sounds up to 4km away and with a range of 14 hertz – 35 kilo hertz (human typical 20 hertz – 20 kilohertz).	Sarel Kritzinger Goudhoek SA Boerperd Stoet / Ovomart (Pty) Ltd / SJN Kritzinger cc Plot: 158, 160, 161, 162. Landowners within the 1km MRA buffer Email 19 Mar 2018	Noted. The concerns raised will be forwarded to the noise and blasting specialists for consideration during their assessment. It is important to note what the expected levels will be before we can make assumptions. We will address the concerns in the report. It must be mentioned that the concerns are understood but research on the exact matter may not always be directly associated but may be similar. JDZ: Yes it is true that sudden noises can startle horses but also true there are multiple situations that can contribute horse reactions. Regarding the noise from blasting it is expected that levels predicted are high than what will be experienced due to all the houses and trees between the quarry and the land of Mr. Kritzinger. Recommendations were made that when blasting is to be done it must be communicated to all IAP. This will assist to be active in observing reactions. It is believed that horses like other animals will habituate to the new sounds in the area. There are examples where blasting is done on must larger scale in the areas where horses are found. Blasting to be done is not expected to a loud bang but rather a rumbling sound.
273	14. Earth tremors and loud bangs causes horses to frighten and since they are prey animals they tend to flee which can result is injuries. (we experience this typically when fireworks are set off)	Sarel Kritzinger Goudhoek SA Boerperd Stoet / Ovomart (Pty) Ltd / SJN Kritzinger cc Plot: 158, 160, 161, 162. Landowners within the 1km MRA buffer	As indicated above, the concerns raised will be forwarded to the blasting specialist for consideration during their assessments. Impact of air blast and vibration on horses will be addressed as part of the blasting impact assessment. JDZ: Evaluation was done, and specific recommendations were made. The main recommendation was a changed blast design. Expected influences at POI 371 - Goudhoek SA Boerperd Stoet are: Ground vibration 0.5 mm/s

		Email 19 Mar 2018	and air blast 108.6 dBL. 0.5 mm/s is less than where it is perceptible and air blast is expected not to produce a loud bang noise. It may possibly be heard but with no specific concern as a loud noise. It was specifically addressed that the area is sensitive and thus blasting operations to be conducted in a required best practice method. Recommendation was also that a third party assist with the blast preparation. We have found that this does help mitigate the effects very effectively even at much closer distances.
282	5. I've got 2 boreholes on my plot. One existing borehole close to the main road, which has already caved in, and a new borehole on the bottom side of the plot. My big concern is that if this new borehole caves in or loses its water supply due to mining operations, where will I get water from? It is only a 1,0111hectare plot. Where will I drill?	Riaan Fisher Ptn 3 of Plot 282 Landowner within 1km MRA buffer Email 13-03-2018	Noted. Groundwater impacts, both on yield and levels will be investigated in detail by the groundwater specialists. This will include an assessment by the blasting specialist on the potential for impacts on boreholes associated with vibration and air blast. This will be dealt with in the EIAR. The new borehole on Mr Fisher's property was measured by the groundwater specialist on 20 March and the results will be included in the hydrocensus report. JDZ: All boreholes listed in the Ground water report was considered in the impact assessment. Except for one borehole within the quarry area all other boreholes are further away with expected levels of ground vibration significantly less than levels where damage to the borehole is expected. Loss boreholes are not expected outside of the quarry area.
285	8. I also can't understand that blasting will be done so close to my property. No structure will be able to withstand the blasting.	Riaan Fisher Ptn 3 of Plot 282 Landowner within 1km MRA buffer Email 13-03-2018	Noted. The concerns raised will be forwarded to the blasting specialist for consideration during their assessments. Impact of air blast and vibration on all structures within the blast impact zone will be addressed as part of the blasting impact assessment. JDZ: A detailed Impact assessment was done and possible impacts identified with recommendations for mitigations where required were made. Recommendations include structure inspections prior to blasting been done. These inspections also provide information to evaluate if any changes to allowable limits are required based on the structure conditions.

291	Water: This commodity cannot be replaced by humans. As you know the whole area, is depending on groundwater. Not only for farming but also more so for human consumption. Any disturbance of the ground formation will cause that the dolomite will cave in and boreholes included. That already happened at Bapsfontein, and to the east of Delmas. If the water is contaminated, it will affect quite a number of people and agriculture. Value of property: Our properties will have no value without clean water. Water is the main issue required if you want to sell your property. All banks have this requirement if one would apply for financing. Modder East Orchards is known for the underground lake and if for mining to start, they will have to pump a lot of water to somewhere. Where will that be? The mine will flood constantly, as the water will seep through all the time. Mining interference: Dust, trucks, road deteriorate. Explosions and vibrations will cause cracks in our homes with a tremendous amount of dust. Presently we enjoy wonderful clean air with no pollution. We have invested our life savings to enjoy this wonderful gift of nature. What impact will that have on our health, property value and general living standards? Especially in winter time. Conclusion: Does this mineral deposit justify the consequence it will create? We are all positive for job creation, but what will be done to compensate for our life investment? Will the mine even consider to buy our properties at Municipal valuation?	Dennis Webster Plot 266, 268, 263 Landowner within 1km MRA buffer Email 21-03-2018	Noted. Impacts associated with the proposed Rietkol Project will be identified during the EIA Phase, including impacts on groundwater levels and quality, air quality and property value. Other studies include a Health Impact Risk Assessment (HIRA), traffic impact assessment and a social impact assessment. Impact of air blast and vibration on all structures within the blast impact zone will be addressed as part of the blasting impact assessment. The potential impact on the existing economic activities and the benefits of the proposed mining activity will be assessed as part of the macro-economic impact assessment, including impacts/benefits on GDP and employment. A cumulative impact zone will be determined around the proposed mining activities once all the specialist studies have been completed, and only then will a decision be taken on the proposed buy-out of properties. JDZ: A detailed Impact assessment was done and possible impacts identified with recommendations for mitigations where required were made. Recommendations include structure inspections prior to blasting been done. These inspections also provide information to evaluate if any changes to allowable limits are required based on the structure conditions. Dust is addressed in the air quality report. From a blasting perspective proper blasting regime will limit the dust from the blast itself.
330	1. Property value will decrease after the mining start, due to the blasting noise, dust, and water usage. 2. Borehole water, the lack of water or decrease in water levels. The quality of our water. 3. More land invasions-to live closer to the mine and or waiting to be employed.	Karin Badenhorst-Brooks Landowner outside 1km MRA buffer Email 16-03-2018	Noted. Impacts associated with the proposed Rietkol Project will be identified during the EIA Phase, including impacts on groundwater levels and quality, air quality and property value. Impact of blasting on infrastructure and horses will be addressed as part of the blasting impact assessment. Influx of employment seekers will be addressed in the social impact assessment.

	4. Animals (Horses) that can be injured – due to the blasting. 5. Damage to our buildings due to blasting.		The concerns raised will be forwarded to the specialists for consideration during their assessments. JDZ: A detailed Impact assessment was done and possible impacts identified with recommendations for mitigations where required were made. Recommendations include structure inspections prior to blasting been done. These inspections also provide information to evaluate if any changes to allowable limits are required based on the structure conditions. The possible effect of blasting operations on animals was addressed in the report. Animals do habituate to blasting operations as well. Mitigation will be required for other infrastructure closer to the quarry and thus expected to be significantly less at this location. Blasting in the quarry is of short duration – few seconds. At 1km from the quarry the expected level of vibration is 1 mm/s – just perceptible and air blast expected is 122 dBL which may be heard. Blasting to be done is not a loud bang sound but rather a rumble sound. As indicated specific mitigations were recommended to assist with mitigation on the effects of ground vibration and air blast.
331	What happens to our horses and animals when you blast? When an animal is in a situation where they know there will be load noise, they can handle it. But like horses, if you blast, they will run and hurt themselves. Who will pay those costs, or must we change our land use activities. I have 11 horses with normal fencing, they will hurt themselves breaking through the fence.	Karin Badenhorst-Brooks Landowner outside 1km MRA buffer Meeting 9 Mar 2018	We will share your concerns with the noise and blasting specialists. The specialist will address your concerns in their studies.
336	What is the decibels when you blast? Are we going to walk around with earplugs?	Unknown landowner Meeting 9 Mar 2018	We currently don't know what the blasting plan will be, but we will try to blast as little as possible. One of the considerations is to limit the blasting to a minimum. JDZ: Earplugs will not be required for the blasting to be done unless very close to the blast which will not be possible.

338	As new buyers we really think these mining activities will have a negative impact not only on our livestock, crops and environment but to our own wellbeing especially for my little daughter who cannot be exposed to any kind of pollution due to some breathing issues. Having lived in mining towns previously, l know for a fact that there are no positive impacts mining brings to those who live near the mines, the blasting is bad for all animals, worse even for chickens which is my main line of business. Any sudden noise causes chickens to have heart attacks and die. Then there is the air pollution, thats nothing but poison, we cannot agree to have this dust right out our winds. Then the vehicles and the soil erosion. The quality and quantity of the water. The list is endless, if this was kms away from our residential areas, it could have been considerable but this is just a few ERFs from us. We cannot have a mine next to us.	James & Lesego Holding 77 Email 19 Mar 2021	Your concerns around environmental degradation are noted and will be considered during the EIA process and within the relevant specialist impact studies. Mitigation measures will be determined to deal with any of the concerns raised and impacts identified by the specialists for inclusion in the EMPr. JDZ: A detailed Impact assessment was done and possible impacts identified with recommendations for mitigations where required were made. Grown chickens do get fright with sudden noises and tend to run into a corner of pen and trample each other. There is reason to believe that chicks are less responsive that grown chickens. The blasting is expected not to be sudden loud bangs but rather a rumbling effect. The impact was addressed in the report.