SCREENING LEVEL NOISE IMPACT ASSESSMENT STUDY FOR THE PROPOSED DEVELOPMENT OF A CRUSHER PLANT ON PORTION 233 OF THE FARM KAFFERSKRAAL 342 JQ, RUSTENBURG LOCAL MUNICIPALITY, NORTH-WEST PROVINCE

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November 2017

DOCUMENT CONTROL

Client:	**Bobolele Consulting (Pty) Ltd**
Report Name:	**Screening-Level Noise Impact Assessment for the Proposed Development of Makwase Crusher Plant**
Report Type:	**Screening-level Noise Assessment Report**
Version:	**1.1**
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EXECUTIVE SUMMARY

SustainDev Services (Pty) Ltd was commissioned by Bobolele Consulting (Pty) Ltd to evaluate the possible increase in the prevailing ambient noise levels at the communities in the vicinity of the proposed Makwase Crusher Plant.

This report investigates the potential acoustic impacts associated with the establishment and operational phases of the proposed crushing plant.

The existing noise climate in the area surrounding the proposed Makwase Crusher Plant could not be established as no baseline data was available at the time of the assessment. However, a worst-case Suburban districts with little road traffic noise level of 50 dB(A) during the day was assumed to be representative of the current noise levels in the region. Additionally, no night-time results have been presented as the establishment and operational activities will only occur during day-time hours.

Current sound power levels for all equipment was obtained by using sound level data from the Noise Navigator™ sound level database (Berger et al., 2010). Noise propagation calculations were then applied in order to assess the noise climate at the receptor locations. The changes in noise levels at each receptor were calculated and the resultant impact on the communities determined.

It is estimated that from 500 m from the source, noise levels will reduce considerably, remaining below the SANAS Suburban districts with little road traffic rating level.

Based on the acoustic results, it is recommended that:

- Construction activities to take place during daytime periods only (sunrise to sunset);
- The noise levels generated by hauling vehicles, machinery, equipment must comply with the manufacturer's specifications and any deviation of these noise levels will have to be immediately addressed and rectified;
- A noise evaluation to be carried out before the crusher plant is operational to determine noise mitigatory measures;
- The existing roads must be utilized for hauling of rock before crushing and shipment off site. The speed along these roads may not exceed 40.0km/h;
- A maintenance plan for all equipment which may be used at the crushing plant must be in place to identify and rectify any noise sources within 5 working days after such noise source was identified; and
- Noise management plan to be used during the different phases of the project.

Contents

1. INTRODUCTION

Bobolele Consulting (Pty) Ltd has appointed SustainDev Services (Pty) Ltd to conduct a screening-level Environmental Acoustic Impact Assessment for the proposed development of a staged mobile crushing plant on Portion 233 of the farm Kafferskraal 342 JQ within the Rustenburg Local Municipality and the Bojanala Platinum District Municipality of the North West Province.. As such, this assessment evaluates the potential acoustic impacts of the proposed project on the nearby residential receptors.

This report details the findings of the Environmental Acoustic Specialist Study undertaken to investigate noise associated with the Makwase Crusher during both the establishment and operational phases.

The terms of reference for the screening-level noise impact assessment were to:

- Determine the baseline noise environment where the crusher plant will be established;
- Identify areas that should be avoided due to an increase in the prevailing ambient noise level which may result irreversible environmental impact, if any;
- Determine and assess the impacts (including cumulative impacts) to receptors in the vicinity of the proposed crusher plant;
- Develop additional environmental management measures to mitigate negative impacts and enhance positive benefits associated with the proposed project, as appropriate; and
- Assist in the provision of feedback to stakeholders.

Below is a description of the project; followed by a discussion on the fundamentals of noise; a description of the methodology utilised in the study; the results of the study; as well as the assessment of related impacts.

2. PROJECT DESCRIPTION

Makwase Projects (Pty) Ltd propose to develop a Crusher Plant on Portion 233 of the farm Kafferskraal 342 JQ within the Rustenburg Local Municipality and the Bojanala Platinum District Municipality of the North West Province. The site is situated north of the N4 Highway adjacent to the Buffelpoort / Marikana off-ramp, south of Tharisa Mine (Figure 1).

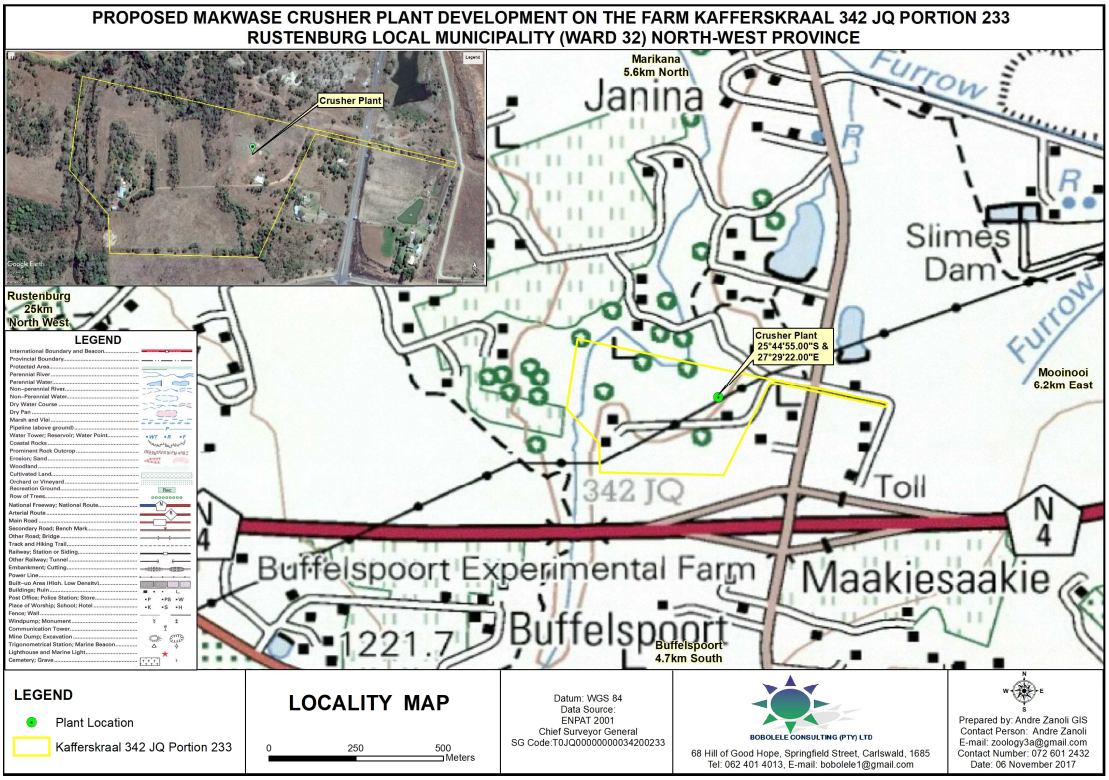

Figure 1: Project Area Locality map

The proposed crusher plant will be fed with waste rock from the existing Tharisa mine Waste Rock Dump (WRD) and will assist with providing crushed rock for supply of road aggregate and construction material. The crushing rate will be approximately 15 000 tons per week to produce various sizes of aggregate. The crushed waste rock will be temporarily stored on an already disturbed area before it is collected and removed.

3. BACKGROUND TO NOISE

Sound is a wave motion, which occurs when a sound source sets the nearest particles of air in motion. The movement gradually spreads to air particles further away from the source. Sound propagates in air with a speed of approximately 340 m/s.

The sound pressure level in free field conditions is inversely proportional to the square of the distance from the sound source – inverse square law. Expressed logarithmically as decibels, this means the sound level decrease 6 dB with the doubling of distance. This applies to a point source only. If the sound is uniform and linear then the decrease is only 3 dB per doubling of distance. The decibel scale is logarithmic therefore decibel levels cannot be added together in the normal arithmetic way, for example, two sound sources of 50 dB each do not produce 100 dB but 53 dB, nor does 50 dB and 30 dB equal 80 dB, but remains 50 dB. Air absorption is important over large distances at high frequencies, depends on the humidity but is typically about 40 dB/km @ 4000 Hz. Road traffic noise frequencies are mainly mid/low and will be unaffected below 200m.

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

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

For a source and receiver close to the ground quite large attenuation can be obtained at certain frequencies over absorbing surfaces, noticeably grassland. This attenuation is caused by a change in phase when the reflected wave strikes the absorbing ground and the destructive interference of that wave with the direct wave. The reduction in sound tends to be concentrated between 250 Hz and 600 Hz. Noise screening can be effective when there is a barrier between the receiver and the source i.e. walls, earth mounds, cuttings and buildings. The performance of barriers is frequency dependent. To avoid sound transmission through a barrier the superficial mass should be greater than 10 Kg/m^2.

There is a complex relation between subjective loudness and the sound pressure level and again between annoyance due to noise and the sound pressure level. In general the ear is less sensitive at low frequencies and the ear will only detect a difference in the sound pressure level when the ambient noise level is exceeded by 3-5 dBA.

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

- Long exposure to high levels of sound, which may damage the hearing or create a temporary threshold shift – in industry or at areas where music is played louder than 95 dBA. This will seldom happen in far-field conditions;
- Interference with speech where important information by the receiver cannot be analyzed due to loud noises;
- Excessive loudness; and
- Annoyance.

A number of factors for example clarity of speech, age of listener and the presence of noise induced threshold displacement will influence the comprehensibility of speech communication. The effect of noise on humans is limited to disturbance and/or annoyance and the accompanying emotional reaction. This reaction is very difficult to predict and is influenced by the emotional state of the complainant, his attitude towards the noisemaker, the time of day or night and the day of the week.

Types of noise exposure:

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

Depending upon the intensity of the sound, the length of time of exposure and how often over time the ear is exposed to it; noise may affects our human condition in a number of ways. Urban dwellers are besieged by noise, not only in the city streets but also in the busy workplaces and household noises.

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

- Leq: The Leq is the constant sound level that would contain the same acoustic energy as the varying sound level, during the same period of time.
- LMax: The instantaneous maximum noise level for a specified period of time.
- LMin: The instantaneous minimum noise level for a specified period of time.

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

- The trained healthy human ear is able to discern changes in sound levels of 1 dBA under controlled conditions in an acoustic laboratory;
- It is widely accepted that the average healthy ear can barely perceive noise level changes of 3 dBA;
- A change in sound level of 5 dBA is a readily perceptible increase in noise level;
- A 10-dBA change in the sound level is perceived as twice as loud as the original source.

The human perception of sound may be influenced by the acoustical characteristics of the noise (whether it has audible tones or other characteristics that may annoy the receptor) and how much

louder the propagated sound is above the prevailing ambient noise level. The perception of the noise is furthermore influenced by the attitude towards the noise source. One person may find the singing of birds in the morning delightful whereas another person may find the sound aggravating.

If a person has a negative attitude towards a noise source is much more likely to view the new noise itself negatively however low it is.

In Table 1 are some of the noise levels that a person is exposed to on a daily basis in and around the house. These noise levels will mask most of the environmental noise levels from outside the house as and when it occurs.

Table 1: General noise levels a person is exposed to on a daily basis.

	Activity	**dBA**
Communication	Whisper	30
Communication	Normal Conversation	55-65
Communication	Shouted Conversation	90
Communication	Baby Crying	110
Communication	Computer	37-45
Home/Office	Refrigerator	40-43
Home/Office	Radio Playing in Background	45-50
Home/Office	Background Music	50
Home/Office	Washing Machine	50-75
Home/Office	Microwave	55-59
Home/Office	Clothes Dryer	56-58
Home/Office	Alarm Clock	60-80
Home/Office	Vacuum Cleaner	70
Home/Office	TV Audio	70
Home/Office	Flush Toilet	75-85
Home/Office	Ringing Telephone	80
Home/Office	Hairdryer	80-95
Home/Office	Vacuum Cleaner	84-89
Home/Office	Maximum Output of Stereo	100-110

4. LEGISLATIVE AND POLICY CONTENTS

4.1 South African Noise Control Regulations

In South Africa, environmental noise control has been in place for three decades, beginning in the 1980s with codes of practice issued by the South African National Standards (SANS (then the South African Bureau of Standards, SABS)) to address noise pollution in various sectors of the country.

Under the previous generation of environmental legislation, specifically the Environmental Conservation Act 73 of 1989 (ECA), provisions were made to control noise in different districts from a national level. In later years, the ECA was replaced by the National Environmental Management Act 107 of 1998 (NEMA) as amended. The National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA) was published in line with NEMA and contains noise control provisions under Section 34:

"(1) The minister may prescribe essential national standards –
(a) for the control of noise, either in general or by specific machinery or activities or in specified places or areas; or
(b) for determining –
(i) a definition of noise; and
(ii) the maximum levels of noise.
(2) When controlling noise the provincial and local spheres of government are bound by any prescribed national standards."

Under NEMAQA, the noise control regulations were updated and are to be applied to all provinces in South Africa. The noise control regulations give all the responsibilities of enforcement to the local provincial authority, where location specific by-laws can be created and applied to the locations with approval of provincial government. Furthermore, NEMAQA prescribes that the Minister must publish maximum allowable noise levels for different districts and national noise standards. These have not yet been accomplished and as a result all monitoring and assessments are done in accordance with the SANS 10103:2008 and 10328:2008 as described below.

4.2 South African National Standards (Sans)

The SANS 10328:2008 Methods for environmental noise impact assessments presently inform environmental acoustic impact assessment in South Africa. The SANS 10103:2008 - Typical Rating Levels (LReq,T) for noise are presented in Table 2.

Table 2: Typical rating levels for ambient noise in districts

Type of district	Equivalent continuous rating level LReq.T for ambient noise dBA					
	Outdoors			Indoors, with open windows		
	Daynight *LRdn* 2)	Daytime *LRd* *1)*	Night-time *LRn* 1)	Daynight *LRdn* *2)*	Daytime *LRn* 1)	Night-time *LRn* *1)*
a) Rural districts	45	45	35			
b) Suburban districts with little road traffic	50	50	40	35	35	25
c) Urban districts	55	55	45	40	40	30
d) Urban districts with some workshops, with business premises and with main roads	60	60	50	45	45	35
e) Central business district	65	65	55	50	50	40
f) Industrial districts	70	70	60	55	55	45

The area surrounding Project Area cannot be considered a typical rural environment any more. In terms of SANS 10103 guidelines it falls in the category between Rural and Urban Districts, described as “Suburban – With little road traffic”. As such, one would expect typical ambient levels in most of the area to be in the order of 50 dBA (daytime) and 40 dBA night-time, respectively.

The response by groups and/or individuals when the ambient noise level is exceeded can be seen in Table 3 (which is Table 5 in SANS 10103 of 2008). The local noise regulations make provision for the ambient noise level to be exceeded by 7.0dBA, before a noise disturbance is created.

The above-mentioned reactions may differ from person to person and may depend on various factors such as where the noise is experienced i.e. inside a very quiet area and/or at a distance from the source.

The human perception of sound may be influenced by the acoustical characteristics of the noise (whether it has audible tones or other characteristics that may annoy the receptor) and how much louder the propagated sound is above the prevailing ambient noise level. The perception of the noise is furthermore influenced by the attitude towards the noise source. One person may find the singing of birds in the morning delightful whereas another person may find the sound aggravating. If a person has a negative attitude towards a noise source is much more likely to view the new noise itself negatively however low it is (Rogers and Manwell, 2002). The difference between the actual noise and the ambient noise level will determine how people will respond to sound.

Table 3: Response from people should the ambient noise level be exceeded

Increase above the prevailing ambient noise level	Estimated community/group response	
	Category	**Description**
0	None	No observed reaction
0-10	Little	Sporadic complaints
5-15	Medium	Widespread complaints
10-20	Strong	Threats of community/group action
>15	Very strong	Vigorous community/group action

4.3 World Health Organisation Guidelines for Community Noise

The World Health Organisation (WHO) together with the Organisation for Economic Co-operation and Development (OECD) are the main international bodies that have collected data and developed assessments on the effects of exposure to environmental noise. This has provided the following summary of thresholds for noise nuisance in terms of outdoor day-time LAeq in residential districts:

- At 55 - 60 dB(A) noise creates annoyance;
- At 60 - 65 dB(A) annoyance increases considerably; and
- Above 65 dB(A) constrained behaviour patterns, symptomatic of serious damage caused by noise.

The WHO recommends a maximum outdoor day-time LAeq of 55 dB(A) in residential areas and schools in order to prevent significant interference with normal activities. It further recommends a maximum night-time LAeq of 45 dB(A) outside dwellings. No distinction is made as to whether the noise originates from road traffic, from industry, or any other noise source.

The WHO also lists that the guideline for industrial noise is set to 70 dB(A) over a period of 24 hours. This would cause hearing impairment, where the peak noise level of 110 dB(A) is allowable on a fast response measurement.

5. METHODOLOGY OF THE STUDY

5.1 Baseline

An ambient acoustic monitoring campaign was not conducted at the site or at any nearby sensitive receptor locations. In order to quantify the existing noise climate for this assessment, a worst-case Suburban – With little road traffic noise level of 50 dB(A) during the day and 40 dB(A) at night (the SANS guideline rating level for Suburban – With little road traffic as presented in Table 2 is assumed to be a representative of the current noise levels in the region.

5.2 Noise Calculations

The sound pressure levels (SPL) for all noise sources during both the establishment and operational phases were compiled using sound level data from the Noise Navigator™ sound level database (Berger et al., 2010). These were then converted to sound power levels (PWL), using Equation 1.

Equation 1 calculates PWLs based on the hemispherical propagation of sound under free field conditions (i.e. it is assumed that the noise source is located in the vicinity of hard, reflectingsurfaces). The 'r' value represents the distance from the source that the SPL was recorded.

$$PWL = SPL - 10\ log\frac{2}{4\pi r^2} \qquad (1)$$

As a worst-case, the PWL from all equipment for each phase, were summed (logarithmically) together to obtain a cumulative PWL for the establishment and operational phase, assuming all equipment will be operational simultaneously. As a worst-case, this logarithmic total noise level was applied to the proposed development of Makwase Crusher Plant in relation to each sensitive receptor and resultant noise levels at specified distances from the site were calculated using Equation 1.

5.3 Noise Receivers

A sensitive receptor is defined as a person or place where involuntary exposure to pollutants released by the construction and operational activities associated with the proposed Makwase Crusher Plant occurs. The sensitive receptors nearest to proposed Makwase Crusher Plant are shown in Figure 2 and include the Madithlokwa/Silver City village and Tsilong village (in the north) and Piet Retief/President van Rensburg school and private dwellings/business (in the northwest). Lapologang village lies to the west of site. The Elandsdrift/Mamba settlement lies east of the site. Further away are Marikana to the north and Mooinooi to the east. Buffelspoort is located further to the south.

Figure 2: **Identified locations of sensitive receptors relative to proposed Makwase Crusher Plant.**

Table 4 presents potentially sensitive receptors surrounding the proposed Crusher Plant including school and various villages.

Table 4: Potential sensitive receptors situated within the modelling domain of proposed Makwase Crusher Plant.

Name of Receptor	Latitude (°S)	Longitude (°E)	Direction from Site Boundary	Distance from Site Boundary (km)
Mmadithlokwa	25.7253	27.48611	N	2.5
Mooinooi	25.7504	27.55014	E	6.1
School	25.7391	27.47679	NW	1.5
Lapologang Village	25.7378	27.46866	NW	2.3
Marikana	25.7008	27.47546	N	5.3
Buffelspoort	25.7899	27.48176	S	4.6
Tsilong Village	25.7261	27.47852	N	2.6
Elandsdrift	25.7240	27.54568	NE	6.4

6. RESULTS

6.1 Predicted Noise Climate

Predicted noise levels from the proposed development of Makwase Crusher Plant during both the establishment and operational phases are presented in this section. The establishment and operational activities will only occur during day-time hours, and as such, no night-time results are presented.

6.1.1 Establishment Phase

The resultant noise levels at specified distances from the source are presented in Table 5. Noise levels in the immediate vicinity of the site are predicted to be high, in excess of the SANS Suburban districts with little road traffic rating level of 50 dB(A), as would be expected. From 500 m from the source, noise levels will reduce considerably, remaining below the Suburban districts with little road traffic rating level. It must be noted that these noise levels are purely associated with noise related to the construction phase of the proposed staged mobile crushing plant and do not include baseline noise levels.

Table 5: Noise levels associated with the construction phase of the proposed Makwase Crusher Plant

Distance from the Crusher Plant (m)	Calculated Noise Level dB(A)
100	61
200	55
500	47
1000	41
2000	35
3000	32
4000	29
5000	27
6000	26

6.1.2 Operational Phase

The resultant noise levels at specified distances from the source are presented in Table 6. Noise levels in the immediate vicinity of the site are predicted to be high, in excess of the SANS Suburban districts with little road traffic rating level of 50 dB(A), as would be expected. From 500 m from the source, noise levels will reduce considerably, remaining below the Suburban districts with little road traffic rating level. It must be noted that these noise levels are purely associated with noise related to the operational phase of the proposed staged mobile crushing plant and do not include baseline noise levels.

Table 6: Noise levels associated with the operational phase of the proposed Makwase Crusher Plant

Distance from the Crusher Plant (m)	Calculated Noise Level dB(A)
100	56
200	50
500	42
1000	36
2000	30
3000	26
4000	24
5000	22
6000	20

6.2 Mitigation Recommendations

Since noise associated with the establishment and operational phases of the proposed development will not impact significantly on any surrounding receptors, no specific noise mitigation interventions are recommended. Should Makwase Projects (Pty) Ltd want to decrease the establishment noise even further; the following mitigation options can be employed:

- Construction activities to take place during daytime periods only (sunrise to sunset);
- The noise levels generated by hauling vehicles, machinery, equipment must comply with the manufacturer's specifications and any deviation of these noise levels will have to be immediately addressed and rectified;
- A noise evaluation to be carried out before the crusher plant is operational to determine noise mitigatory measures;
- The existing roads must be utilized for hauling of rock before crushing and shipment off site. The speed along these roads may not exceed 40.0km/h;
- A maintenance plan for all equipment which may be used at the crushing plant must be in place to identify and rectify any noise sources within 5 working days after such noise source was identified; and
- Noise management plan to be used during the different phases of the project.

7. ASSUMPTIONS AND LIMITATIONS

In this environmental acoustic impact assessment, various assumptions were made that may impact on the results obtained. These assumptions include:

- All activities operate during the day-time and hence no night-time operations have been considered;
- It must be noted that the establishment and operational phase noise sources are based on estimated quantities using sound level data from the Noise Navigator™ sound level database (Berger et al., 2010);
- The information provided regarding the establishment and operational activities is assumed to be representative of what will occur in reality;
- During the establishment phase, all equipment will be operational simultaneously;
- During the operational phase, all equipment will be operational simultaneously;
- The highest sound power levels for equipment were selected;
- An ambient acoustic monitoring campaign was not conducted at the site or at any nearby sensitive receptor locations. In order to quantify the existing noise climate for this assessment, a worst-case Suburban districts with little road traffic noise level of 50 dB(A) during the day (the SANS guideline rating level for Suburban districts with little road traffic) was assumed to be a representative of the current noise levels in the region.

8. CONCLUSIONS

This report investigated the potential acoustic impacts associated with the establishment and operational phases for the proposed development of Makwase Crusher Plant.

The existing noise climate in the area surrounding the Makwase Crusher Plant could not be established as no baseline data was available at the time of the assessment. However, a worst-case rural noise level of 50 dB(A) during the day was assumed to be a representative of the current noise levels in the region. Additionally, no night-time results have been presented as the establishment and operational activities will only occur during day-time hours.

Current sound power levels for all equipment was obtained by using sound level data from the Noise Navigator™ sound level database (Berger et al., 2010), Noise propagation calculations were then applied in order to assess the noise climate at the receptor locations. The changes in noise levels at each receptor were calculated and the resultant impact on the communities determined.

9. REFERENCES

1. South African National Standards (2008): SANS – Code of Practice 10103:2008, The measurement and rating of environmental noise with respect to annoyance and to speech communication, Standards South Africa, 6th Edition (ISBN 978-0-626-20832-5).
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