ENVIRONMENTAL ACOUSTIC IMPACT ASSESSMENT

SULPHUR DIOXIDE ABATEMENT PLANT AT THE POLOKWANE SMELTER

CONFIDENTIAL

MAY 2017

ENVIRONMENTAL ACOUSTIC IMPACT ASSESSMENT

SULPHUR DIOXIDE ABATEMENT PLANT AT THE POLOKWANE SMELTER

Anglo American Platinum Limited

Final Report
Confidential

Project no: 31102
Date: May 2017

WSP | Parsons Brinckerhoff
Block A, 1 on Langford
Langford Road, Westville
Durban, 3029

Phone: +27 (0) 31 240 8873
Fax: +27 (0) 31 240 8861
www.wspgroup.com
www.pbworld.com

QUALITY MANAGEMENT

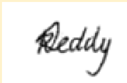
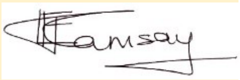
ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3
Remarks	Draft Report	Final Report		
Date	March 2017	May 2017		
Prepared by	N. Reddy	N. Reddy		
Signature				
Checked by	K. Collett	K. Collett		
Signature				
Authorised by	L. Ramsay	L. Ramsay		
Signature				
Project number	31102	31102		
Report number	01 of 01	01 of 01		
File reference	31102 Environmental Acoustic Impact Assessment for the Sulphur Dioxide Abatement Plant at the Polokwane Smelter 20170530.docx			

TABLE OF CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

WSP Environmental (Pty) Ltd (WSP) was appointed by Anglo American Platinum Limited (AAP) to conduct the Scoping and Environmental Impact Reporting (S&EIR) process for the installation of sulphur dioxide (SO_2) abatement plant at the Polokwane Smelter, located in the Limpopo Province. As part of this process, an Environmental Acoustic Impact Assessment is required. This report investigates the potential acoustic impacts associated with the operations of the proposed SO_2 abatement plant.

Ambient sound levels were measured at fourteen locations at and around the smelter on 17 May 2012. These locations were selected to be representative of current baseline conditions (industrial land use). All sound level measurements were free-field measurements (i.e. at least 3.5 m away from any vertical reflecting surfaces). Measurement procedures were in line with South African National Standards (SANS) 10103:2008. This guides the selection of monitoring locations, microphone positioning and equipment specifications.

The Polokwane Smelter on-site noise climate can be described as industrial with natural influences from the surrounding rural landscape. Average day-time and night-time (L_{Aeq}) sound levels from all the locations were below the day and night-time SANS 10103 industrial guidelines (70 dB(A) and 60 dB(A) respectively). Key noise sources included the flash dryer and other plant operations as well as vehicles travelling along the R37 main road (R37) from Polokwane to Lydenburg.

Sound power levels for all equipment were obtained using sound level data supplied by the Project Engineers (Hatch Africa (Pty) Ltd) as well as sound level data from the BSI British Standards (BS 5228-1:2009) (BSI, 2009) where no engineering data was available. Noise contours indicating the spatial extent of projected sound levels from the proposed site within a specified grid area as well as the noise levels at specific receivers were established using an acoustic model.

Cumulative day-time noise levels at all monitoring locations are predicted to be below the SANS industrial district rating level of 70 dB(A). Changes in noise levels ranging from 0 to +14.8 dB(A) are anticipated at the monitoring locations, with the largest change predicted at NS 05, located approximately 400 m southeast of the proposed SO_2 abatement plant. Such increases in noise can be attributed to the proposed lime silo, lime delivery truck and acid dispatch truck located in close proximity to this monitoring location. In line with the SANS categories of community/group responses, such increases are considered to have “little to medium” impact for the proposed development, with the exception of NS 05 and NS 06 which both resulted in a “medium to strong” estimated community response. Furthermore, increases in noise levels at NS 05, NS 06, NS 07, NS 09 and NS 11 exceed the 7 dB(A) threshold for annoyance as per the Noise Control Regulations. However, it is important to note that there are no communities in close vicinity to these receivers. Such receivers are industrial in nature and would not be perceptible to such annoyance. From ±35 m from the proposed SO_2 abatement plant, noise levels will reduce considerably, remaining below the industrial district rating level. Predicted noise levels at the nearest residential receptor (REC 03), located approximately 4 km from the proposed SO_2 abatement plant, are expected to be below the rural day-time guideline rating level of 45 dB(A). However, it must be noted that these noise levels are from proposed activities only and do not include baseline existing noise levels. Due to the proximity of the remaining sensitive receptors identified within a 10 km radius of the proposed development, the resultant impact on these receptors will likely be insignificant.

During the night-time, predicted cumulative noise levels are expected to be compliant with the SANS industrial district rating level of 60 dB(A), except for NS 14 which is slightly above the SANS industrial district rating level. This is predominantly due to the slightly higher existing baseline level at this location when compared to the other monitoring sites. Changes in noise levels ranging from 0 to +10.3 dB(A) are anticipated at the monitoring locations, with the largest change predicted at

NS 07, located approximately 540 m east northeast of the proposed SO_2 abatement plant. Such increases in noise can be attributed to the proposed lime silo located in close proximity to this monitoring location. The change in noise levels will result in “little to medium” estimated community response at all monitoring locations with the exception of NS 07 which resulted in a “medium to strong” estimated community response. Furthermore, increases in noise levels at NS 05, NS 06, NS 07 and NS 08 exceed the 7 dB(A) threshold for annoyance as per the Noise Control Regulations. However, it is important to note that there are no communities in close vicinity to these receivers. Such receivers are industrial in nature and would not be perceptible to such annoyance. From ±95 m from the proposed SO_2 abatement plant, noise levels will reduce considerably, remaining below the industrial district rating level. Predicted noise levels at residential receptors (REC 02 and REC 03), located approximately 1.5 km and 2.6 km, respectively from the proposed SO_2 abatement plant, are expected to be slightly above the rural night-time guideline rating level of 35 dB(A). It must be noted that these noise levels are from proposed activities only and do not include baseline existing noise levels. Based on this receptor’s location close to the existing smelter operations, it is envisaged that the current night-time noise climate is already influenced by such operations and is not typically “rural” in character. Due to the proximity of the remaining sensitive receptors identified within a 10 km radius of the proposed development, the resultant impact on these receptors, will likely be insignificant.

The acoustic impacts of the proposed development were evaluated using a risk matrix which assessed the nature, significance, extent, duration and probability of potentially significant impacts. Based on this rating system, it was calculated that the acoustic impacts of the proposed development on the surrounding residential receptors are deemed “low”. Since noise associated with the operation of the proposed development will not impact significantly on any surrounding receptors, no specific noise mitigation interventions are recommended.

GLOSSARY OF TERMS

Sound	Sound is small fluctuations in air pressure, measured in Newtons per square meter (N/m^2) or Pascals (Pa) that are transmitted as vibrational energy via a medium (air) from the source to the receiver. The human ear is a pressure transducer, which converts these small fluctuations in air pressure into electrical signals, which the brain then interprets as sound.
Noise	Noise is generally defined as unwanted sound.
Sound or noise level	A sound or noise level is a sound measurement that is expressed in Decibels (dB or dB(A)).
dB or dB(A)	The human ear is a sensitive instrument that can detect fluctuations in air pressure over a wide range of amplitudes. This limits the usefulness of sound quantities in absolute terms. For this reason a sound measurement is expressed as ten times the logarithm of the ratio of the sound measurement to a reference value, 20 micro (millionth) Pa. This process converts a scale of constant increases to a scale of constant ratios and considerably simplifies the handling of sound measurement quantities. The attached 'A' indicates that the sound measurement has been A-weighted.
dB(Z)	Historically sound levels were read off a hand held meter and the noise levels were noted in dB, after the development of different weighting curves sound levels were noted as Z-weighting or dB(Z) to reduce the confusion with different type of weighting applied noise levels. dB(Z) refers to linear noise levels.
A-weighting	The human ear is not equally sensitive to sound of all frequencies, i.e. it is less sensitive to low pitched (or 'bass') than high pitched (or 'treble') sounds. In order to compensate when making sound measurements, the measured value is passed through a filter that simulates the human hearing characteristic. Internationally this is an accepted procedure when working with measurements that relate to human responses to sound/noise.
Ambient sound level	Ambient noise is the totally encompassing sound in a given situation at a given time, and is usually composed of sound from many sources, both near and far.
Annoyance	General negative reaction of the community or person to a condition creating displeasure or interference with specific activities.
Sound pressure	Sound pressure is the force of sound exerted on a surface area perpendicular to the direction of the sound and is measured in N/m^2 or Pa. The human ear perceives sound pressure as loudness and can also be expressed as the number of air pressure fluctuations that a noise source creates.
Sound pressure level	The sound pressure level is a relative quantity as it is a ratio between the actual sound pressure and a fixed reference pressure. The reference pressure is usually the threshold of hearing, namely 20 microPascals (µPa).
Sound power	Sound power is the rate of sound energy transferred from a noise source per unit of time in Joules per second (J/s) or Watts (W).

Sound power level The sound power level is a relative quantity as it relates the sound power of a source to the threshold of human hearing (10^{-12} W). Sound power levels are expressed in dB (A), as they are referenced to sound detected by the human ear (A-weighted).

Noise nuisance Any sound which disturbs or impairs or may disturb or impair the convenience or peace of any person.

Octave bands The octave bands refer to the frequency groups that make a sound. The sound is generally divided in to nine groups (octave bands) ranging from 32 Hertz (Hz) to 8,000 Hz. The lower frequency ranges of a sound have a vibrating character where the higher frequency of sound has the character of high pitched sound. In viewing the total octave bands scale from 32 Hz to 8000 Hz the character of the sound can be described.

ACRONYMS AND ABBREVIATIONS

AAP	Anglo American Platinum Ltd
CadnaA	Computer Aided Noise Abatement
dB	Decibel
dB(A)	A-weighted sound measurement
dB(Z)	Z-weighted sound measurement
ECA	Environmental Conservation Act 73 of 1989
EIA	Environmental Impact Assessment
Hz	Hertz
L_{Aeq}	Equivalent continuous sound pressure level
$L_{R,dn}$	Equivalent continuous day/night rating level
$L_{Req,d}$	Equivalent continuous rating level for day-time
$L_{Req,n}$	Equivalent continuous rating level for night-time
$L_{Req,T}$	Typical noise rating levels
NEMA	National Environmental Management Act
NEMAQA	National Environmental Management: Air Quality Act 39 of 2004
OECD	Organisation for Economic Co-operation and Development
PWL	Sound Power Level
S&EIR	Scoping and Environmental Impact Reporting
SABS	South African Bureau of Standards
SANS	South African National Standards
SO_2	Sulphur Dioxide
SPL	Sound Pressure Level
WESP	Wet Electrostatic Precipitator
WHO	World Health Organisation
WSA	Wet Gas Sulphuric Acid
WSP	WSP Environmental (Pty) Ltd

1 INTRODUCTION

Anglo American Platinum Limited (AAP) is the largest primary platinum producer in the world. The company operates three smelters in South Africa, namely, Waterval, Mortimer and Polokwane. AAP proposes to reduce the sulphur dioxide (SO_2) emissions at the Polokwane Smelter, located in the North-West Province, by introducing SO_2 abatement plant and hence improving the ambient air quality. WSP Environmental (Pty) Ltd (WSP) was appointed by AAP to conduct the Scoping and Environmental Impact Reporting (S&EIR) process for the proposed project, and as part of this process an Environmental Acoustic Impact Assessment is required.

This report details the findings of the Environmental Acoustic Impact Assessment undertaken for the Polokwane Smelter. Included in this report is a background to the project; fundamentals and principles of environmental noise; an overview of the legal framework for environmental noise; an acoustic inventory for the proposed noise sources, the identification of sensitive receptors; and acoustic modelling outputs and results.

1.1 SCOPE OF WORK

Below is a summary of the scope of work performed by WSP in fulfilment of the requirements of the Environmental Acoustic Impact Assessment:

- Description of the receiving environment, specifically relating to sensitive receptors;
- Development of a comprehensive acoustic inventory detailing sound power levels of all proposed noise sources at the facility during the operational phase;
- Evaluation of the noise propagation potential using the CadnaA acoustic modelling software;
- An assessment of the acoustic impacts of the operation of the proposed SO_2 abatement plant on the surrounding communities; and
- Compilation of an Environmental Acoustic Impact Assessment report, inclusive of all information listed above.

1.2 DECLARATION OF INDEPENDENCE

Novania Reddy is a consultant with over 3 years' experience in the environmental industry. Her area of expertise lies within the air quality and acoustics fields related to sectors ranging from mining to the oil and gas industry. She holds the responsibility of data collection, inventory development, compilation of air emission licence and scientific modelling and reporting. Novania has a broad understanding of the various laws and regulations associated with the air quality and noise procedures. Please see **Appendix A** for a short CV detailing project experience.

I hereby declare that I am fully aware of my responsibilities in terms of the National Environmental Management Act: Environmental Impact Assessment Regulations of 2014 and that I have no financial or other interest in the undertaking of the proposed activity other than the imbursement of consultants fees.

Name:	Novania Reddy
Company:	WSP Environmental (Pty) Ltd
Contact Details:	+27 31 240 8875
	Novania.Reddy@wspgroup.co.za
Signature:	

2 PROJECT BACKGROUND

2.1 LOCALITY AND STUDY AREA

The Polokwane Smelter is located within the Lepelle-Nkumpi Municipality, which lies in the Capricorn District of the Limpopo Province. The smelter is located off the R37 main road to Burgersfort, on the Eastern Limb of the Bushveld Igneous Complex on portions 6 and 49 of the farm Palmietfontein 24KS, and is approximately 12 km south of the city of Polokwane. The portions, on which the Smelter is situated, are located to the east of the Kopermyn road. The location of the Polokwane Smelter is presented in **Figure 2-1** with the plan layout of the SO_2 abatement plant presented in **Figure 2-2** .

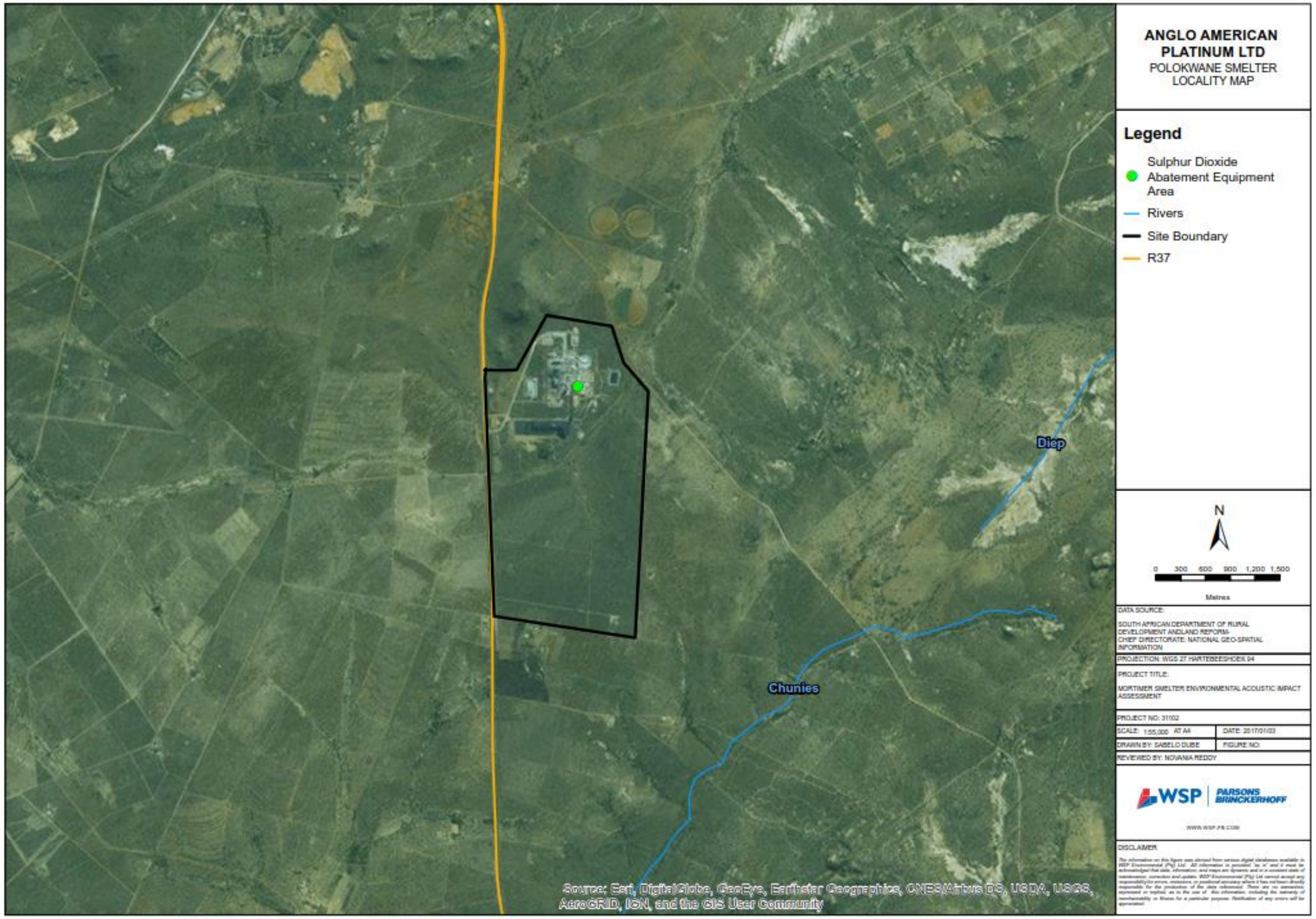


Figure 2-1: Polokwane Smelter locality map

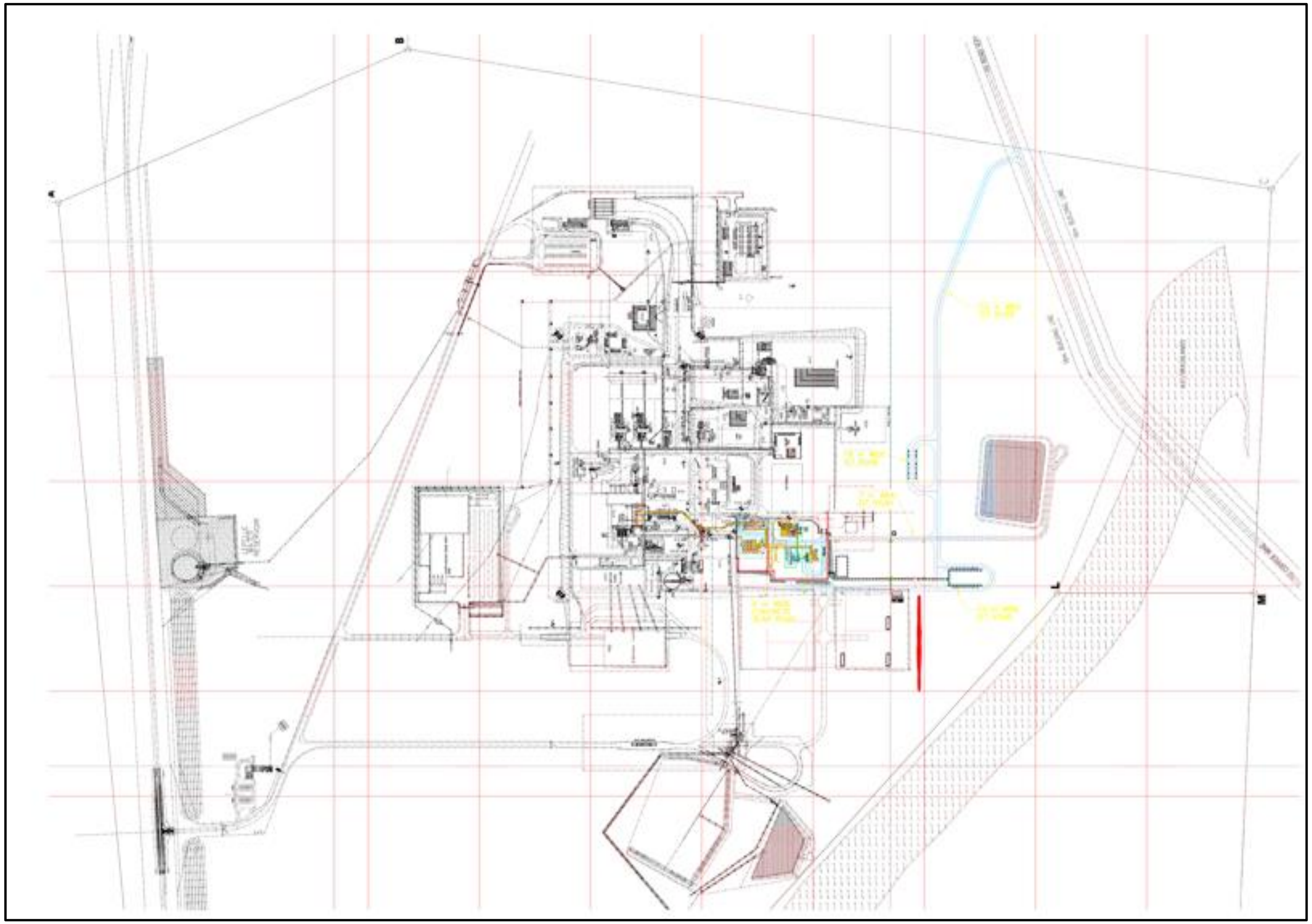


Figure 2-2: Plan layout of SO_2 abatement plant

2.2 PROJECT DESCRIPTION

CONSTRUCTION PHASE

The construction phase is expected to occur only during the day-time. Construction noise is considered to be transient and as such, is not expected to be continuous or constant in terms of its origin. However, insufficient information is available for the construction phase and therefore a detailed assessment could not be carried out. Based on similar construction works and given the proximity of the surrounding receptors to the construction site, it is not expected that construction noise will cause any significant impact to the surrounding area and is hence deemed to be “low.”

OPERATIONAL PHASE

The operation of the SO_2 abatement plant will have the following noise sources:

- Gas Cooling Tower (x1) – the cooling tower is an enclosed vessel, which features internal water sprays that are used to cool down the process gas to the desired WSA inlet temperature;
- Wet Electrostatic Precipitator (WESP) (x2) – uses electrostatic forces to remove particulates and contains four-off small purge air blowers fitted to each WESP;
- Acid Plant Cooling Water Tower (x10) – a heat rejection device through the cooling of a water stream to a lower temperature;
- WSA Plant Feed Fan (x1) – a mechanical device for moving gases;
- WSA Recirculating Gas Fan (x1) – involves the recirculation of gas in the fan;
- WSA Cold Air Intake Fan (x1) – used for the circulation of air;
- WSA Clean Gas Fan (x1) – device for moving gases;
- LPG Burner (x2) – the burner is a gas heater that is mounted internal to the ductwork;
- Lime Silo (x1) – method used for the storage of lime;
- Lime Delivery Truck (x1) – truck which is predominantly used for the transportation of lime; and
- Acid Dispatch Truck (x1) – truck which involves dispatching of acid.

2.3 BACKGROUND

EXISTING NOISE CLIMATE

The noise levels experienced at the Polokwane Smelter are typically industrial, with natural influences from the surrounding rural landscape. Major noise sources at the facility include the flash dryer, furnace off-gas handling system, smelter operations, as well as heavy trucks entering and exiting the site. The noise in the region is also influenced by traffic on the R37 main road, travelling from Polokwane in the north to Lydenburg further south.

SENSITIVE RECEPTORS

Sensitive receptors are identified as areas that may be impacted negatively due to noise associated with the proposed operations at the Polokwane Smelter. Examples of receptors include, but are not limited to, schools, shopping centres, hospitals, office blocks and residential areas. The Polokwane Smelter is surrounded by natural and agricultural land uses with a few residential settlements and some roads Sensitive receptors within a 10 km radius of the site boundary are presented in **Table 2-1** and illustrated in **Figure 2-3.**

Table 2-1: Locations and distances of the noise receivers surrounding the proposed development

Sensitive Receptor	Description	Distance from Nearest Site Boundary (km)	Latitude (S)	Longitude (E)
REC 01	Small holdings north-northwest	4.68	29° 27' 15.88"	23° 59' 09.51"
REC 02	Farm house northeast	2.44	29° 29' 33.45"	24° 00' 58.76"
REC 03	Farm house north-northeast	1.00	29° 28' 24.90"	24° 01' 00.85"
REC 04	Industry northwest	2.83	29° 26' 33.97"	24° 00' 32.45"
REC 05	Farm house southwest	3.58	29° 26' 06.80"	24° 02' 26.27"
REC 06	Farm house south-southwest	2.08	29° 27' 08.84"	24° 02' 35.95"
REC 07	Farm house South- southwest	2.95	29° 27' 33.54"	24° 03' 19.24"
REC 08	Farm house south	3.15	29° 27' 48.96"	24° 03' 52.66"
REC 09	Farm souse southeast	4.21	29° 28' 50.12"	24° 04' 00.61"
REC 10	Farm house south-southeast	2.81	29° 28' 28.41"	24° 03' 15.14"

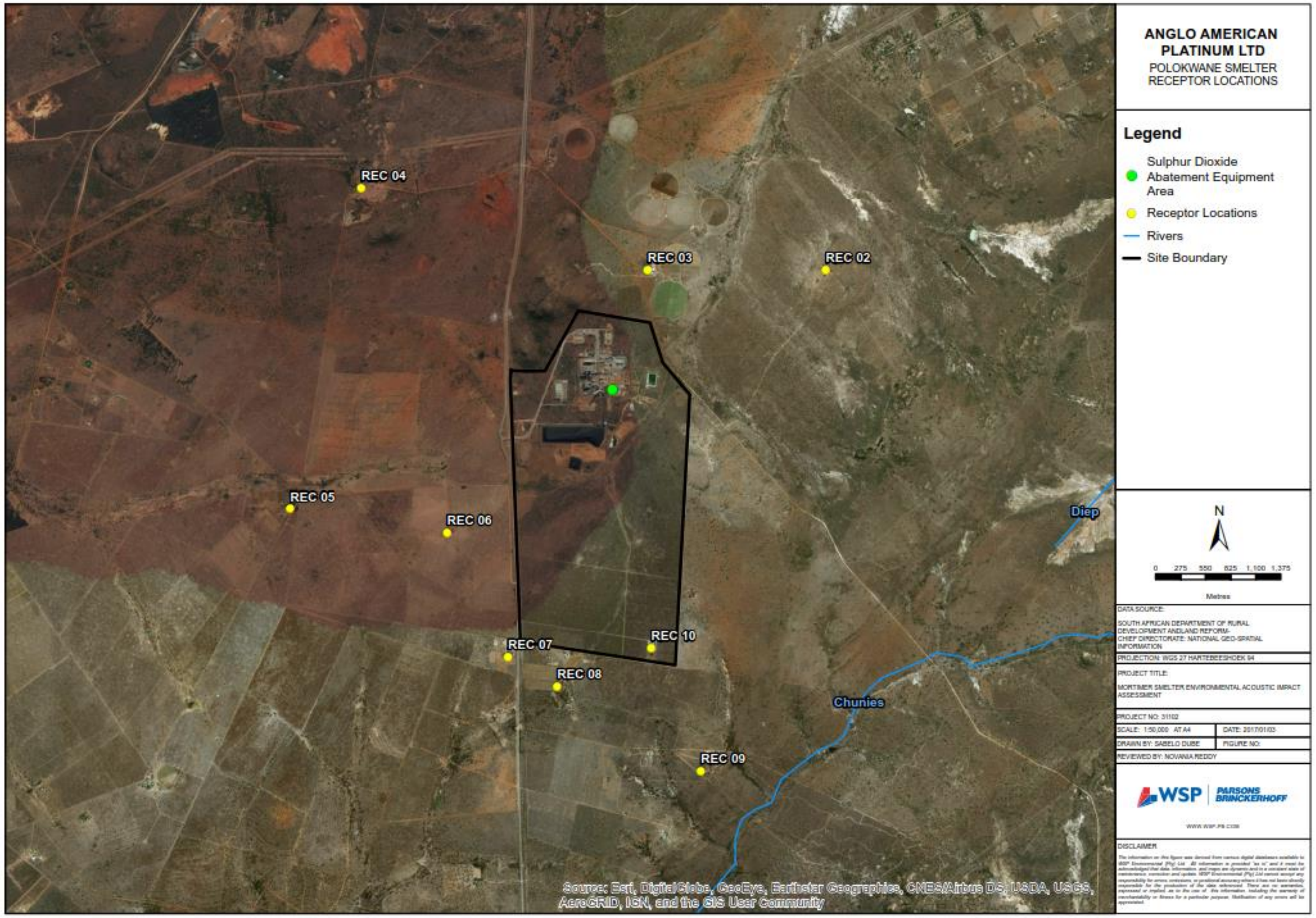


Figure 2-3: Sensitive receptor locations

3 ACOUSTIC FUNDAMENTALS

3.1 PRINCIPLES

Sound is defined as any pressure variation (in air, water or other medium) that the human ear can detect. Noise is defined as “unwanted sound”. Noise can lead to health impacts and can negatively affect people’s quality of life. Hearing impairment is typically defined as a decrease in the threshold of hearing. Severe hearing deficits may be accompanied by tinnitus (ringing in the ears). Noise-induced hearing impairment occurs predominantly in the higher frequency range of 3,000 to 6,000 Hertz (Hz), with the largest effect at 4,000 Hz. With increasing $L_{Aeq,8h}$ and increasing exposure time, noise-induced hearing impairment occurs even at frequencies as low as 2,000 Hz. However, hearing impairment is not expected to occur at $L_{Aeq,8h}$ levels of 75 dB(A) or below, even for prolonged occupational noise exposure.

Speech intelligibility is adversely affected by noise. Most of the acoustical energy of speech is in the frequency range of 100 to 6,000 Hz, with the most important cue-bearing energy being between 300 and 3,000 Hz. Speech interference is basically a masking process in which simultaneous interfering noise renders speech incapable of being understood. Environmental noise may also mask other acoustical signals that are important for daily life such as doorbells, telephone signals, alarm clocks, music, fire alarms and other warning signals.

Sleep disturbance is a major effect of environmental noise. It may cause primary effects during sleep and secondary effects that can be assessed the day after night-time noise exposure. Uninterrupted sleep is a prerequisite for good physiological and mental functioning and the primary effects of sleep disturbance are: (a) difficulty in falling asleep; and (b) awakenings and alterations of sleep stages or depth. The difference between the sound levels of a noise event and background sound levels, rather than the absolute noise level, may determine the reaction probability.

The annoyance due to a given noise source is subjective, and is dependent upon many non-acoustic factors such as the prominence of the source, its importance to the listener’s economy (wellbeing), and his or her personal opinion of the source. The result of increased exposure to noise on individuals can have negative effects, both physiological (influence on communication, productivity and even impaired hearing) and psychological effects (stress, frustration and disturbed sleep). As such, noise impacts need to be understood to mean one or a combination of negative physical, physiological or psychological responses experienced by individuals, whether consciously or unconsciously, caused by exposure to noise.

More technically, noise impacts are defined as the capacity of noise to induce annoyance depending upon its physical characteristics including the sound pressure level, spectral characteristics and variations of these properties with time. During day-time, individuals may be annoyed at L_{Aeq} levels below 55 dB(A), while very few individuals are moderately annoyed at L_{Aeq} levels below 50 dB(A). Sound levels during the evening and night should be 5 to 10 dB(A) lower than during the day (World Health Organisation, 1999). Typical noise levels are presented in **Table 3-1**.

Table 3-1: Typical noise levels

Sound Pressure Level (dB(A))	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120 110	Heavy rock concert grinding on steel	Extremely noisy
100 90	Loud car horn at 3m Construction site with pneumatic hammering	Very noisy
80 70	Kerbside of busy street Loud radio or television	Loud
60 50	Department store General office	Moderate to quiet
40 30	Inside private office Inside bedroom	Quiet to very quiet
20	Unoccupied recording studio	Almost silent

3.2 NOISE PROPAGATION

Sound is a pressure wave that diminishes with distance from source. Depending on the nature of the noise source, sound propagates at different rates. The three most common categories of noise are point sources (specified single point of noise generation) line sources (multiple linear noise generating points, such as a road) and area sources (specified single area of noise generation). The most important factors affecting noise propagation are:

- The type of source (point, line or area);
- Obstacles such as barriers and buildings;
- Distance from source;
- Atmospheric absorption;
- Ground absorption; and
- Reflections.

Research has shown that doubling the distance from a noise source results in a proportional decline in noise level. Sound propagation in air can be compared to ripples on a pond. The ripples spread out uniformly in all directions, decreasing in amplitude as they move further from the source. An acoustically hard site exists where sound travels away from the source over a generally flat, hard surface such as water, concrete, or hard-packed soil. These are examples of reflective ground, where the ground cover provides little or no attenuation. The standard attenuation rate for hard site conditions is 6 dB(A) per doubling of distance for point sources. Thus, if you are at a position one meter from the source and move one meter further away from the source, the sound pressure level will drop by 6 dB(A), moving to 4 meters, the drop will be a further 6 dB(A), and so on. When ground cover or normal unpacked earth (i.e. a soft site) exists between the source and receptor, the ground becomes absorptive to sound energy. Absorptive ground results in an additional noise reduction of approximately 1.5 dB(A) per doubling of distance.

This methodology is only applicable when there are no reflecting or screening objects in the sound path. When an obstacle is in the sound path, part of the sound may be reflected or absorbed, and the remainder may be transmitted through the object. How much sound is reflected, absorbed or transmitted depends on many factors, including the properties of the object. When receptor locations are not in the line of sight of the noise source, there may be up to 20 dB(A) attenuation for broadband noise, with a further 10 to 15 dB(A) attenuation when inside the average residence and the windows are open.

3.3 CHARACTERISTICS OF NOISE

The human ear simultaneously receives sound (normal un-weighted sound or Z-weighting dB(Z)) at many frequencies (octave bands) at different amplitudes. The ear then adjusts its sensitivity based on the amplitude of the sound observed. This focuses the sound and makes it audible by adjusting the amplitude of the low, middle and high frequencies. To measure how a person experiences sound, an electronic weighting adjusted to the Z-weighted sound was developed, including three different weighting curves, namely:

- **A-weighting** - This measurement is often noted as dB(A) and this weighting curve attempts to make the noise level meter respond closely to the characteristics of a human ear. It adjusts the frequencies at low and high frequencies. Various national and international standards relate to measurements recorded in the A-weighting of sound pressure levels;
- **B-weighting** - is similar to A-weighting but with less attenuation. The B-weighting is very seldom, if ever, used. The B-weighting follows the C-weighted trend;
- **C-weighting** - is intended to represent how the ear perceives sound at high decibel levels. C-weighted measurements are reported as dB(C); and
- **Z-weighting** - this refers to linear, un-weighted noise levels.

The weighting is employed by arithmetically adding a table of values **(Table 3-2)**, listed by octave bands, to the measured linear sound pressure levels for each specific octave band. The resulting octave band measurements are logarithmically added to provide a single weighted value describing the sound, based on the applied weighting curve (**Figure 3-1**). Thus, if the A-weighted curve was applied to the sound, the noise level is noted as dB(A).

Table 3-2: Frequency weighting table for the different weighting curves

Frequency (Hz)	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz
A-weighting	-39.4	-26.2	-16.1	-8.6	-3.2	0	1.2	1	1.1
B-weighting	-17.1	-9.3	-4.2	-1.3	-0.3	0	-0.1	-0.7	-2.9
C-weighting	-3	-0.8	-0.2	0	0	0	-0.2	-0.8	-3
Z-weighting	0	0	0	0	0	0	0	0	0

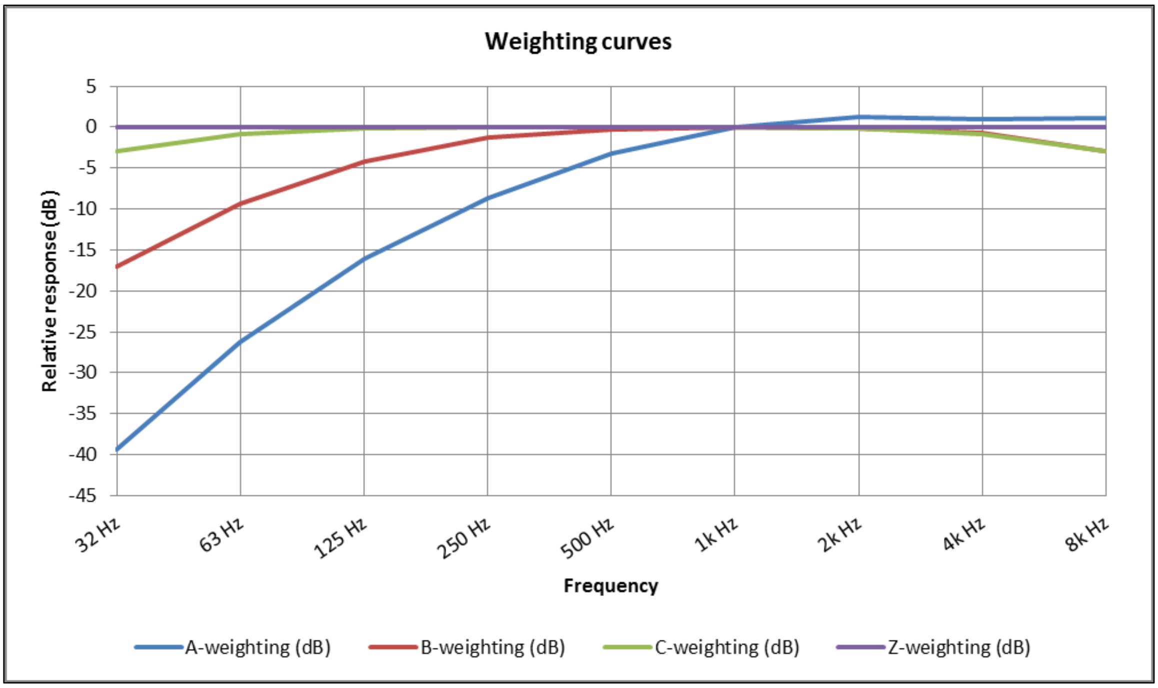


Figure 3-1: Weighting curves

4 LEGISLATIVE FRAMEWORK

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 (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. Where province-specific regulations have not been promulgated, acoustic impact assessments must follow the Noise Control Regulations. These regulations define the following:

- **Ambient Sound Level:** the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes, after such meter had been put into operation;
- **Zone Sound Level**: a derived dB(A) value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area; and
- **Disturbing Noise**: a noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dB(A) or more.

With the above definitions in mind, regulation 4 of the Noise Control Regulations stipulate that no person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof.

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 discussed in the sections that follow.

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. This standard defines that the purpose of an Environmental Acoustic Impact Assessment is to determine and quantify the acoustical impact of, or on, a proposed development. It also stipulates the methods used to assess impacts as well as the minimum requirements to be investigated and included in the Environmental Acoustic Impact Assessment report as part of the Environmental Impact Assessment EIA. These minimum requirements include:

- The purpose of the investigation;
- A brief description of the planned development or the changes that are being considered;
- A brief description of the existing environment including, where relevant, the topography, surface conditions and meteorological conditions during measurements;
- The identified noise sources together with their respective sound pressure levels or sound power levels (or both) and, where applicable, the operating cycles, the nature of sound emission, the spectral composition and the directional characteristics;
- The identified noise sources that were not taken into account and the reasons as to why they were not investigated;
- The identified noise-sensitive developments and the noise impact on them;
- Where applicable, any assumptions, with references, made with regard to any calculations or determination of source and propagation characteristics;
- An explanation, either by a brief description or by reference, of all measuring and calculation procedures that were followed, as well as any possible adjustments to existing measuring methods that had to be made, together with the results of calculations;
- An explanation, either by description or by reference, of all measuring or calculation methods (or both) that were used to determine existing and predicted rating levels, as well as other relevant information, including a statement of how the data were obtained and applied to determine the rating level for the area in question;
- The location of measuring or calculating points in a sketch or on a map;
- Quantification of the noise impact with, where relevant, reference to the literature consulted and the assumptions made;
- Alternatives that were considered and the results of those that were investigated;
- A list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation;
- A detailed summary of all the comments received from interested or affected parties as well as the procedures and discussions followed to deal with them;
- Conclusions that were reached;
- Proposed recommendations;
- If remedial measures will provide an acceptable solution which would prevent a significant impact, these remedial measures should be outlined in detail and included in the final record of decision if the approval is obtained from the relevant authority. If the remedial measures deteriorate after time and a follow-up auditing or maintenance programme (or both) is instituted, this programme should be included in the final recommendations and accepted in the record of decision if the approval is obtained from the relevant authority; and
- Any follow-up investigation which should be conducted at completion of the project as well as at regular intervals after the commissioning of the project so as to ensure that the recommendations of this report will be maintained in the future.

The SANS 10103:2008 document (*The measurement and rating of environmental noise with respect to speech communication*) provides methods and guidelines to assess working and living environments with respect to acoustic comfort as well as respect to possible annoyance by noise. As applicable to this assessment, SANS 10103 provides guideline typical rating levels for noise in different districts. These rating levels are presented in **Table 4-1**.

Table 4-1: Typical rating levels for noise in districts (adapted from SANS 10103:2008)

Type of District	Classification	Equivalent Continuous Rating level for Noise ($L_{Req,T}$) (dB(A)) Outdoors	
		Day-time ($L_{Req,d}$)	Night-time ($L_{Req,n}$)
a) Rural	A	45	35
b) Suburban (with little road traffic)	B	50	40
c) Urban	C	55	45
d) Urban (with one or more of the following: workshops, business premises and main roads)	D	60	50
e) Central Business Districts	E	65	55
f) Industrial District	F	70	60
Guidelines in red are applicable to this acoustic impact assessment			

As stipulated in SANS 10103:2008, noise can pose as an annoyance to a community if the increase in average noise levels exceeds the ambient noise by a certain degree. These specified increases together with the relevant estimated community responses are presented in **Table 4-2**. Such changes in ambient (residual) noise levels are assessed in this report with the resultant community response determined.

Table 4-2: Categories of community/group response (adapted from SANS 10103:2008)

Excess ($\Delta L_{Req,T}$)[a] dB(A)	Estimated Community or Group Response	
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

Overlapping ranges for the excess values are given because a spread in the community reaction might be anticipated.

[a] $\Delta L_{Req,T}$ should be calculated from the appropriate of the following:

1) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS $L_{Req,T}$ of the residual noise (determined in the absence of the specific noise under investigation);

2) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the maximum rating level of the ambient noise given in Table 1 of the code;

3) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the typical rating level for the applicable district as determined from Table 2 of the code; or

4) $L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in the area because of the proposed development under investigation.

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 the outdoor day-time equivalent continuous A-weighted sound pressure level (L_{Aeq}) 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 L_{Aeq} 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 L_{Aeq} 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 guideline for industrial noise is set at 70 dB(A) over a period of 24 hours. Anything above this level would cause hearing impairment, however, a peak noise level of 110 dB(A) is allowable on a fast response measurement.

5 STUDY METHODOLOGY

To the environmental acoustic impacts of the proposed operations at the Polokwane Smelter, both baseline (monitored) and proposed (modelled) noise levels were assessed. Comparisons of the existing and proposed noise levels at various specified noise receivers enabled an assessment of changes in noise levels at these locations as a result of the proposed development operations. Such changes can then be measured against the SANS community or group responses (**Table 4-2**) in order to assess the anticipated impacts/responses as a result of such increases.

It is important to note that noise associated with roads has not been considered in this assessment as the increase in traffic along the roads will be minimal and as such, the acoustic impact is negligible.

5.1 ENVIRONMENTAL ACOUSTIC MONITORING

Ambient sound level measurements were undertaken at fourteen locations in and around the smelter on 17 May 2012 as presented **Table 5-1** and illustrated in **Figure 5-1**. These locations were selected to be representative of current baseline conditions of industrial land use at various distances from acoustic sources. All sound level measurements were free-field measurements (i.e. at least 3.5 m away from any vertical reflecting surfaces). Measurement procedures were undertaken according to the relevant South African Code of Practice SANS 10103:2008. This guides the selection of monitoring locations, microphone positioning and equipment specifications.

Table 5-1: Location of acoustic monitoring points

Receiver	Latitude (S)	Longitude (E)
NS 01	24° 03' 15.00"	29° 27' 37.60"
NS 02	24° 03' 16.84"	29° 27' 51.04"
NS 03	24° 02' 22.78"	29° 27' 39.71"
NS 04	24° 02' 11.85"	29° 27' 46.87"
NS 05	24° 01' 57.19"	29° 28' 20.20"
NS 06	24° 01' 48.01"	29° 28' 28.72"
NS 07	24° 01' 36.82"	29° 28' 32.72"
NS 08	24° 01' 55.99"	29° 28' 41.62"
NS 09	24° 02' 39.84"	29° 28' 40.58"
NS 10	24° 03' 21.82"	29° 28' 37.48"
NS 11	24° 01' 56.64"	29° 27' 56.73"
NS 12	24° 01' 49.98"	29° 27' 54.04"
NS 13	24° 01' 30.93"	29° 27' 50.81"
NS 14	24° 01' 22.95"	29° 27' 57.92"

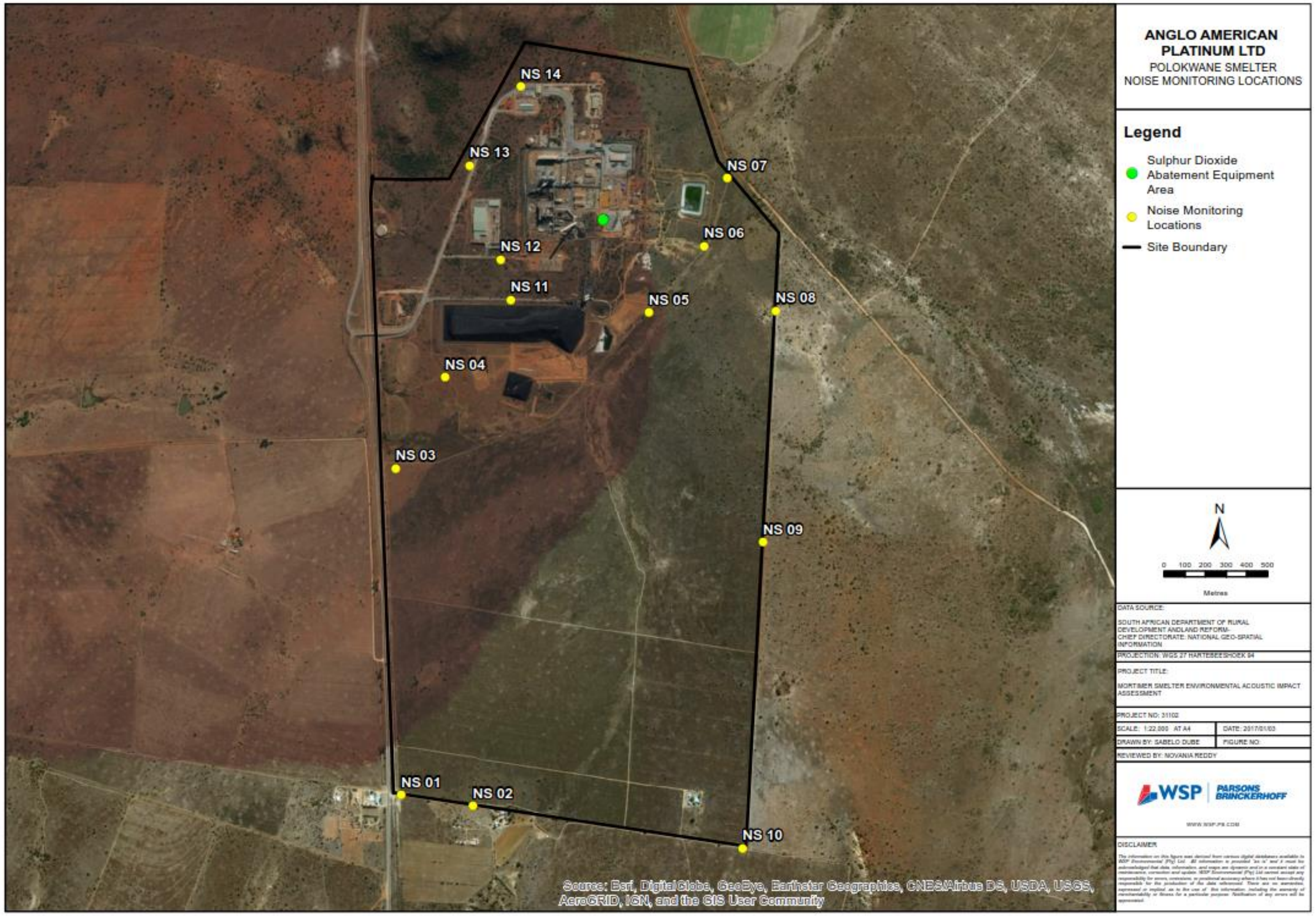


Figure 5-1: Location of acoustic monitoring points

Sound level measurements were taken with a SABS-calibrated Type 1 Integrating Sound Level Meter. The make and model as well as serial number and calibration validity of the sound level meter and calibrator are presented in **Table 5-2**.

Measurements were taken during the prescribed timeframes in SANS 10103:2008, with day-time monitoring between 06:00 and 22:00 and night-time between 22:00 and 06:00. Measurements were conducted for fifteen minutes at each monitoring location.

The noise parameters recorded included:

- → L_{Aeq} The equivalent continuous sound level, normally measured (A-weighted);
- → L_{Amax} The maximum sound pressure level of a noise event measured (A-weighted);
- → L_{Amin} The minimum sound pressure level measured at the location (A-weighted); and
- → L_{A90} The average noise level the receptor is exposed to for 90% of the monitoring period.

Table 5-2: Sound level meter and calibrator specifications

Sound level meter	Calibrator
Make & Model: CEL Instruments – CEL480	**Make & Model:** CEL Instruments – CEL 284/2
Serial No.: 043303, 5184	**Serial No.:** 4/03326337
Calibration valid until: December 2012	**Calibration valid until**: December 2012

5.2 ENVIRONMENTAL ACOUSTIC MODELLING

ACOUSTIC INVENTORY

A detailed inventory of all noise sources during the operational phase was compiled using sound level data supplied by the Project Engineers (Hatch Africa (Pty) Ltd) as well as sound level data from the BSI British Standards (BS 5228-1:2009) (BSI, 2009) where no engineering data was provided.

The sound pressure levels (SPL) for each source were then converted to sound power levels (PWL), using **Equation 1** for input to the acoustic model. **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, reflecting surfaces). The 'r' value represents the distance from the source that the SPL was recorded.

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

Full descriptions of the noise sources and relevant sound power levels of each source during both construction and operational phases are presented below.

CADNA ACOUSTIC MODELLING SOFTWARE

Acoustic modelling was used to calculate noise contours indicating the spatial extent of projected sound levels from the proposed wind energy facility within a specified grid area (10 km x 10 km) as well as the noise levels at specific receivers. The acoustic modelling software used in this study is the internationally recognised package, CadnaA (Computer Aided Noise Abatement). The CadnaA software provides an integrated environment for noise predictions under varying scenarios and calculates the cumulative effects of various sources. The model uses ground elevations in the calculation of the noise levels in a grid and uses standard meteorological parameters that have an effect on the propagation of noise. CadnaA has been utilised in many countries across the globe for the modelling of environmental noise and town planning. It is comprehensive software for three-dimensional calculations, presentation, assessment and prediction of environmental noise emitted from industrial plants, parking lots, roads, railway schemes or entire towns and urbanized areas.

OPERATIONAL PHASE

Table 5-3 presents the noise sources identified and modelled during the operational phase of the project together with the number in operation distance from source and sound pressure and power levels that were utilised in the acoustic model. **Table 5-4** presents the proposed buildings at the Polokwane Smelter.

Table 5-3: Acoustic model inputs for proposed equipment sources on site

Sources	Number in Operation	Sound Pressure Level (dB(A)) per unit	Distance from Source (m)	Calculated Sound Power Level (dB(A)) per unit
Gas cooling tower	1	85	1	92.98
Wet electrostatic precipitator	2	85	1	92.98
[1]**Acid plant cooling water tower**	10	96	1	104.00
[2]**WSA plant feed fan**	1	85	1	92.98
[2]**WSA recirculating gas fan**	1	85	1	92.98
[2]**WSA cold air intake fan**	1	85	1	92.98
[2]**WSA clean gas fan**	1	85	1	92.98
[2]**LPG burner**	2	85	1	92.98
Lime silo	1	85	1	92.98
Lime delivery truck	1	80	10	107.98
Acid dispatch truck	1	85	1	92.98

[1]The PWL from all equipment, were summed (logarithmically) to obtain a cumulative PWL for the cooling water tower (114.00 dB(A)).

[2]The PWL from all equipment, were summed (logarithmically) to obtain a cumulative PWL for the WSA cover structure (100.76 dB(A)).

Table 5-4: Acoustic model inputs for proposed building sources on site

Source	Source Type	Source Height Above Ground Level (m)
MCC building	Building	7
Transformer bay building	Building	3

6 ASSUMPTIONS

In this Environmental Acoustic Impact Assessment, various assumptions were made that may impact on the results obtained. These assumptions include:

- The operational phase noise sources are based on estimated quantities using sound level data supplied by the Project Engineers (Hatch Africa (Pty) Ltd) as well as BSI British Standards (BS 5228-1:2009) (BSI, 2009) where no engineering data was available;
- The information provided regarding the operational phase are assumed to be representative of what will occur in reality;
- All proposed SO_2 abatement plant will be operational 24 hours a day, seven days a week with the exception of the trucks that will operate between 08:00 to 17:00;
- Noise associated with roads has not been considered in this assessment as the increase in traffic along the roads will be minimal and as such, the acoustic impact is negligible;
- The PWL from all WSA equipment, were summed (logarithmically) to obtain a cumulative PWL for the WSA cover structure; and
- The PWL from the cooling water towers, were summed (logarithmically) to obtain a cumulative PWL for the cooling water tower.

7 RESULTS AND DISCUSSION

7.1 ACOUSTIC MONITORING

Ambient sound level monitoring results are presented in **Table 7-1** and **Table 7-2**. Average day-time and night-time (L_{Aeq}) sound levels from all the locations adhere to the day and night-time SANS 10103 industrial guidelines (70 dB(A) and 60 dB(A) respectively). The Polokwane Smelter onsite noise climate can be described as industrial with natural influences from the surrounding rural landscape. Major noise sources at the facility include the flash dryer (at NS 03 and NS 13), smelter operations (at NS 04 – NS 09, NS 11 – NS 12 and NS 14), heavy trucks entering and exiting the site as well as traffic on the R37 main road, travelling from Polokwane in the north to Lydenburg further south (at NS 01 – NS 03, NS 08 – NS 10 and NS 14).

Table 7-1: Day-time noise monitoring results

ID	L_{Aeq} (dBA)	L_{Amax} (dBA)	L_{Amin} (dBA)	SANS guideline (dBA)
NS 01	62.6	77.3	37.0	70
NS 02	42.6	59.3	31.8	70
NS 03	51.4	65.6	33.9	70
NS 04	52.4	77.3	36.1	70
NS 05	42.3	61.8	36.8	70
NS 06	43.8	57.6	35.8	70
NS 07	43.9	54.3	39.4	70
NS 08	45.7	76.7	36.2	70
NS 09	35.8	53.6	29.1	70
NS 10	41.0	59.6	28.0	70
NS 11	46.8	54.8	41.2	70
NS 12	51.8	59.2	48.6	70
NS 13	59.5	72.5	55.0	70
NS 14	60.1	82.1	45.2	70

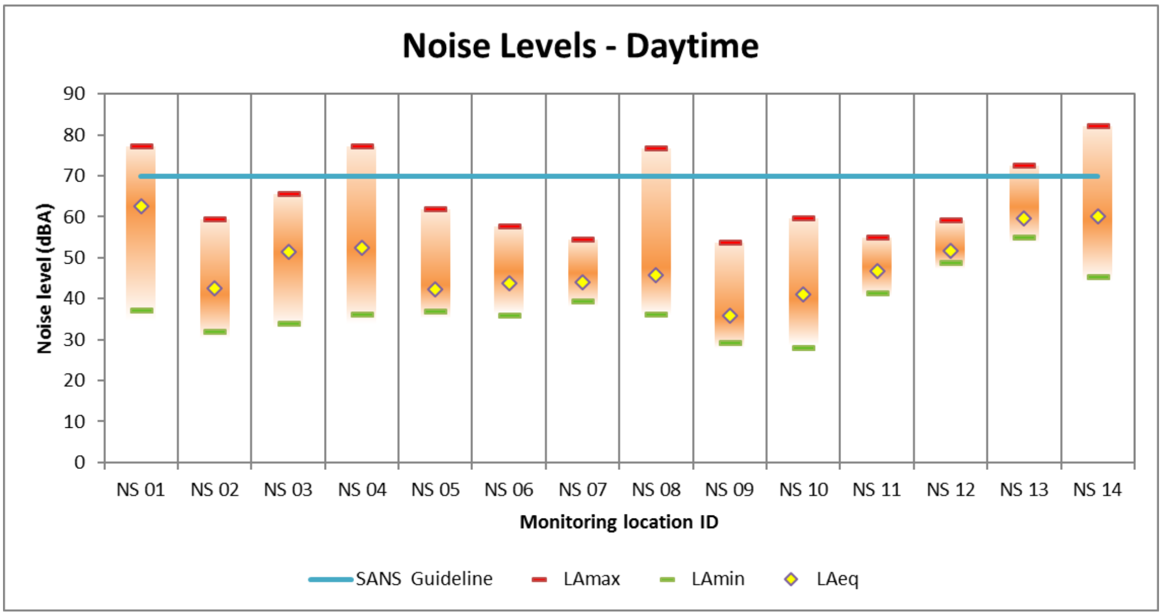


Figure 7-1: Day-time environmental baseline noise measurement results

Table 7-2: Night-time noise monitoring results

ID	L_{Aeq} (dBA)	L_{Amax} (dBA)	L_{Amin} (dBA)	SANS guideline (dBA)
NS 01	55.9	75.4	55.9	60
NS 02	27.6	53.4	27.6	60
NS 03	54.3	70.5	54.3	60
NS 04	43.8	58.1	43.8	60
NS 05	49.0	55.6	49.0	60
NS 06	46.1	54.7	46.1	60
NS 07	43.0	53.9	43.0	60
NS 08	42.1	61.5	42.1	60
NS 09	39.5	47.5	39.5	60
NS 10	31.4	43.5	31.4	60
NS 11	52.1	56.1	52.1	60
NS 12	56.9	64.6	56.9	60
NS 13	57.2	66.0	57.2	60
NS 14	59.2	77.1	59.2	60

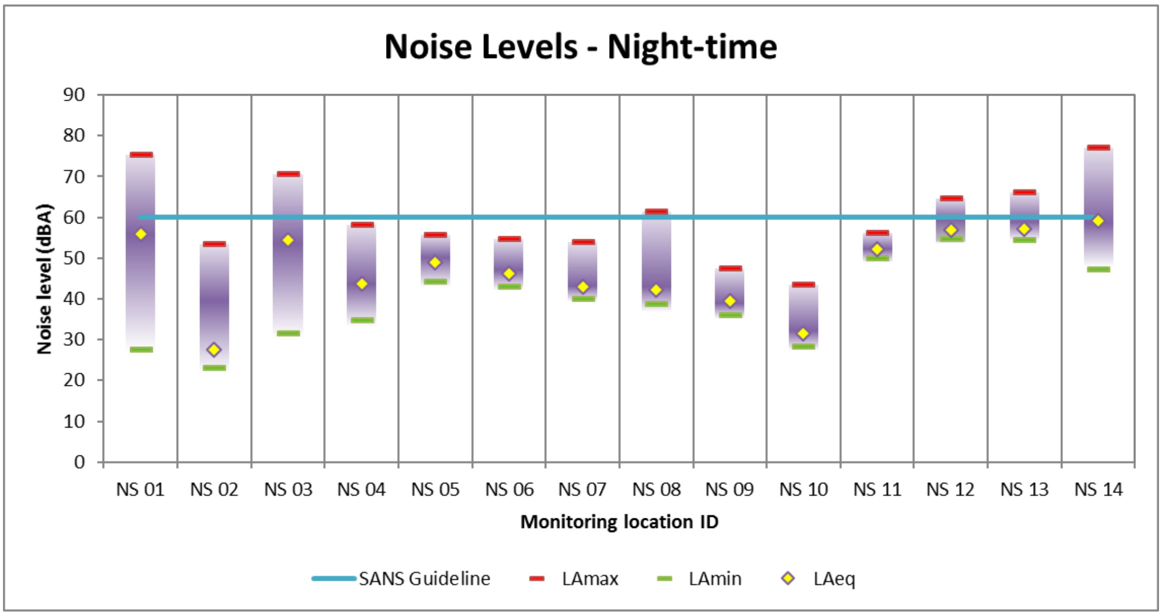


Figure 7-2: Night-time environmental baseline noise measurement results

7.2 ACOUSTIC MODELLING

Predicted day-time and night-time noise levels from the proposed SO_2 abatement plant at the fourteen monitoring locations during the operational phase are presented in **Table 7-3** and **Table 7-4**. During the operational phase, all activities will be operational 24 hours a day, seven days a week with the exception of the trucks, which operate from 08:00 to 17:00. Predicted noise levels are compared with the existing baseline noise levels to assess the change in sound levels as a result of the proposed SO_2 abatement plant. Cumulative sound levels (existing and predicted together) are also presented for each monitoring location, however, it must be noted that since sound levels are represented in logarithmic units, simple addition cannot be applied to obtain the cumulative sound levels, but rather logarithmic addition. Graphical outputs of the modelled results for the operational phase are presented in **Figure 7-3** and **Figure 7-4.** It must be noted that the visual outputs presented here are for the proposed SO_2 abatement plant operations only and are not cumulative (i.e. not taking the existing background noise levels into account).

Cumulative day-time noise levels at all monitoring locations are predicted to be below the SANS industrial district rating level of 70 dB(A). Changes in noise levels ranging from 0 to +14.8 dB(A) are anticipated at the monitoring locations, with the largest change predicted at NS 05, located approximately 400 m southeast of the proposed SO_2 abatement plant. Such increases in noise can be attributed to the proposed lime silo, lime delivery truck and acid dispatch truck located in close proximity to this monitoring location. In line with the SANS categories of community/group responses, such increases are considered to have “little to medium” impact for the proposed development, with the exception of NS 05 and NS 06 which both resulted in a “medium to strong” estimated community response. Furthermore, increases in noise levels at NS 05, NS 06, NS 07, NS 09 and NS 11 exceed the 7 dB(A) threshold for annoyance as per the Noise Control Regulations. However, it is important to note that there are no communities in close vicinity to these receivers. Such receivers are industrial in nature and would not be perceptible to such annoyance. From ±35 m from the proposed SO_2 abatement plant, noise levels will reduce considerably, remaining below the industrial district rating level. Predicted noise levels at the nearest residential receptor (REC 03), located approximately 4 km from the proposed SO_2 abatement plant, are expected to be below the rural day-time guideline rating level of 45 dB(A). However, it must be noted that these noise levels are from proposed activities only and do not include baseline existing noise levels. Due to the proximity of the remaining sensitive receptors identified within a 10 km radius of the proposed development, the resultant impact on these receptors will likely be insignificant.

During the night-time, predicted cumulative noise levels are expected to be compliant with the SANS industrial district rating level of 60 dB(A), except for NS 14 which is slightly above the SANS industrial district rating level. This is predominantly due to the slightly higher existing baseline level at this location when compared to the other monitoring sites. Changes in noise levels ranging from 0 to +10.3 dB(A) are anticipated at the monitoring locations, with the largest change predicted at NS 07, located approximately 540 m east northeast of the proposed SO_2 abatement plant. Such increases in noise can be attributed to the proposed lime silo located in close proximity to this monitoring location. The change in noise levels will result in “little to medium” estimated community response at all monitoring locations with the exception of NS 07 which resulted in a “medium to strong” estimated community response. Furthermore, increases in noise levels at NS 05, NS 06, NS 07 and NS 08 exceed the 7 dB(A) threshold for annoyance as per the Noise Control Regulations. However, it is important to note that there are no communities in close vicinity to these receivers. Such receivers are industrial in nature and would not be perceptible to such annoyance. From ±95 m from the proposed SO_2 abatement plant, noise levels will reduce considerably, remaining below the industrial district rating level. Predicted noise levels at residential receptors (REC 02 and REC 03), located approximately 1.5 km and 2.6 km, respectively from the proposed SO_2 abatement plant, are expected to be slightly above the rural night-time guideline rating level of 35 dB(A). However, it must be noted that these noise levels are from proposed activities only and do not include baseline existing noise levels. Based on this receptor’s location close to the existing smelter operations, it is envisaged that the current night-time noise climate is already influenced by such operations and is not typically “rural” in character. Due to the proximity of the remaining sensitive receptors identified within a 10 km radius of the proposed development, the resultant impact on these receptors, will likely be insignificant.

Table 7-3: Day-time acoustic model results during the operational phase of the proposed SO_2 abatement plant

Receiver	Predicted Noise Level associated with the SO_2 abatement plant (dB(A))	Existing Day-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change in Noise Level (dB(A))	Estimated Community Response
NS 01	25.3	62.6	62.6	+0.0	Little
NS 02	25.5	42.6	42.7	+0.1	Little
NS 03	43.8	51.4	52.1	+0.7	Little
NS 04	48.5	52.4	53.9	+1.5	Little
NS 05	57.0	42.3	57.1	+14.8	Medium to strong
NS 06	54.2	43.8	54.6	+10.8	Medium to strong
NS 07	53.0	43.9	53.5	+9.6	Little to medium
NS 08	50.0	45.7	51.4	+5.7	Little to medium
NS 09	44.0	35.8	44.6	+8.8	Little to medium
NS 10	28.2	41.0	41.2	+0.2	Little
NS 11	53.4	46.8	54.3	+7.5	Little to medium
NS 12	54.5	51.8	56.4	+4.6	Little
NS 13	54.0	59.5	60.6	+1.1	Little
NS 14	53.3	60.1	60.9	+0.8	Little

Table 7-4: Night-time acoustic model results during the operational phase of the proposed SO_2 abatement plant

Receiver	Predicted Noise Level associated with the SO_2 abatement plant (dB(A))	Existing Night-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change in Noise Level (dB(A))	Estimated Community Response
NS 01	24.8	55.9	55.9	+0.0	Little
NS 02	25.1	27.6	29.5	+1.9	Little
NS 03	43.2	54.3	54.6	+0.3	Little
NS 04	48.4	43.8	49.7	+5.9	Little to medium
NS 05	56.4	49.0	57.1	+8.1	Little to medium
NS 06	53.0	46.1	53.8	+7.7	Little to medium
NS 07	52.9	43.0	53.3	+10.3	Medium to strong
NS 08	49.3	42.1	50.1	+8.0	Little to medium
NS 09	43.6	39.5	45.0	+5.5	Little to medium
NS 10	28.0	31.4	33.0	+1.6	Little
NS 11	53.3	52.1	55.8	+3.7	Little
NS 12	54.5	56.9	58.9	+2.0	Little
NS 13	53.6	57.2	58.8	+1.6	Little
NS 14	53.0	59.2	60.1	+0.9	Little

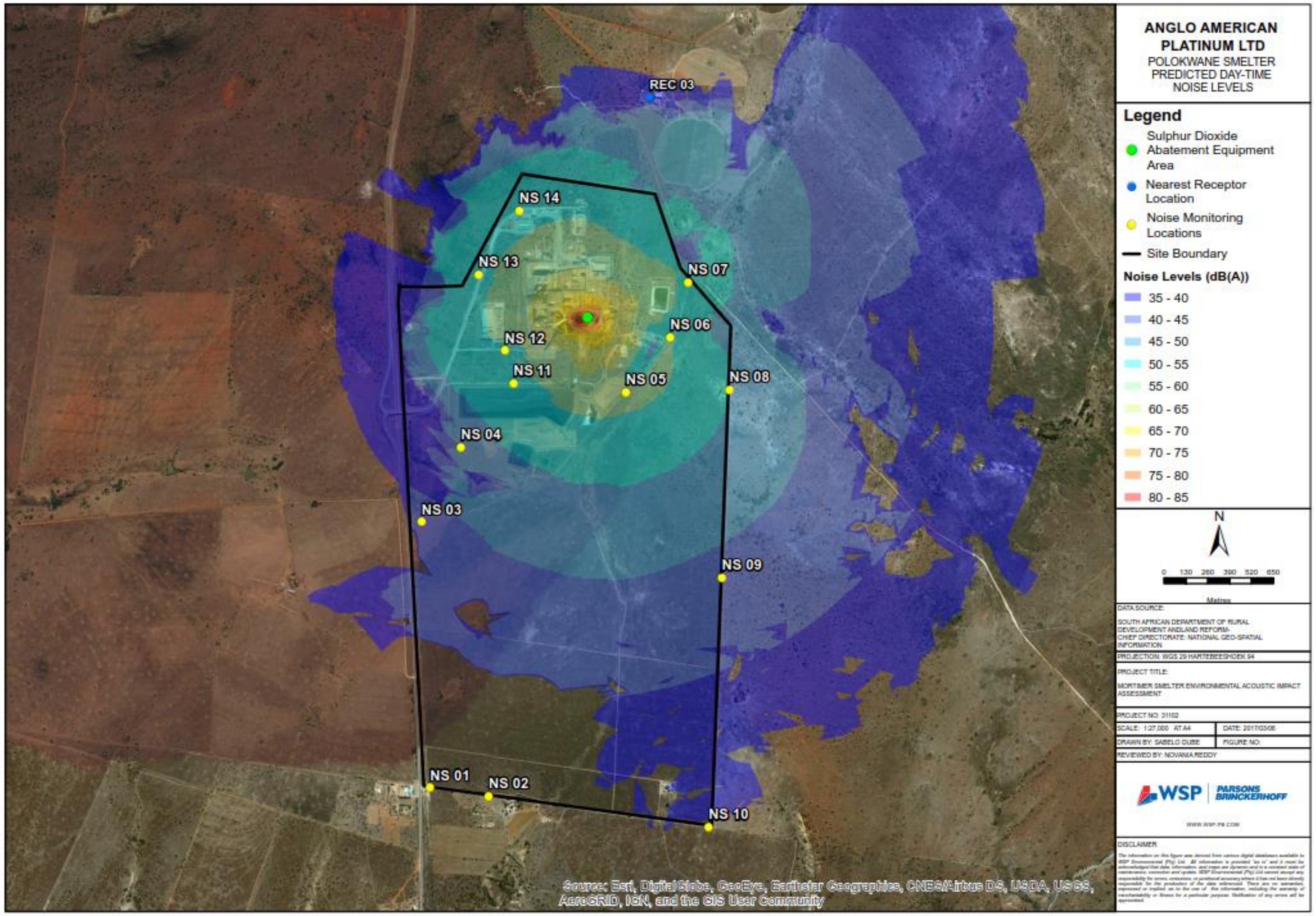


Figure 7-3: Predicted day-time noise levels during the operational phase of the proposed SO_2 abatement project

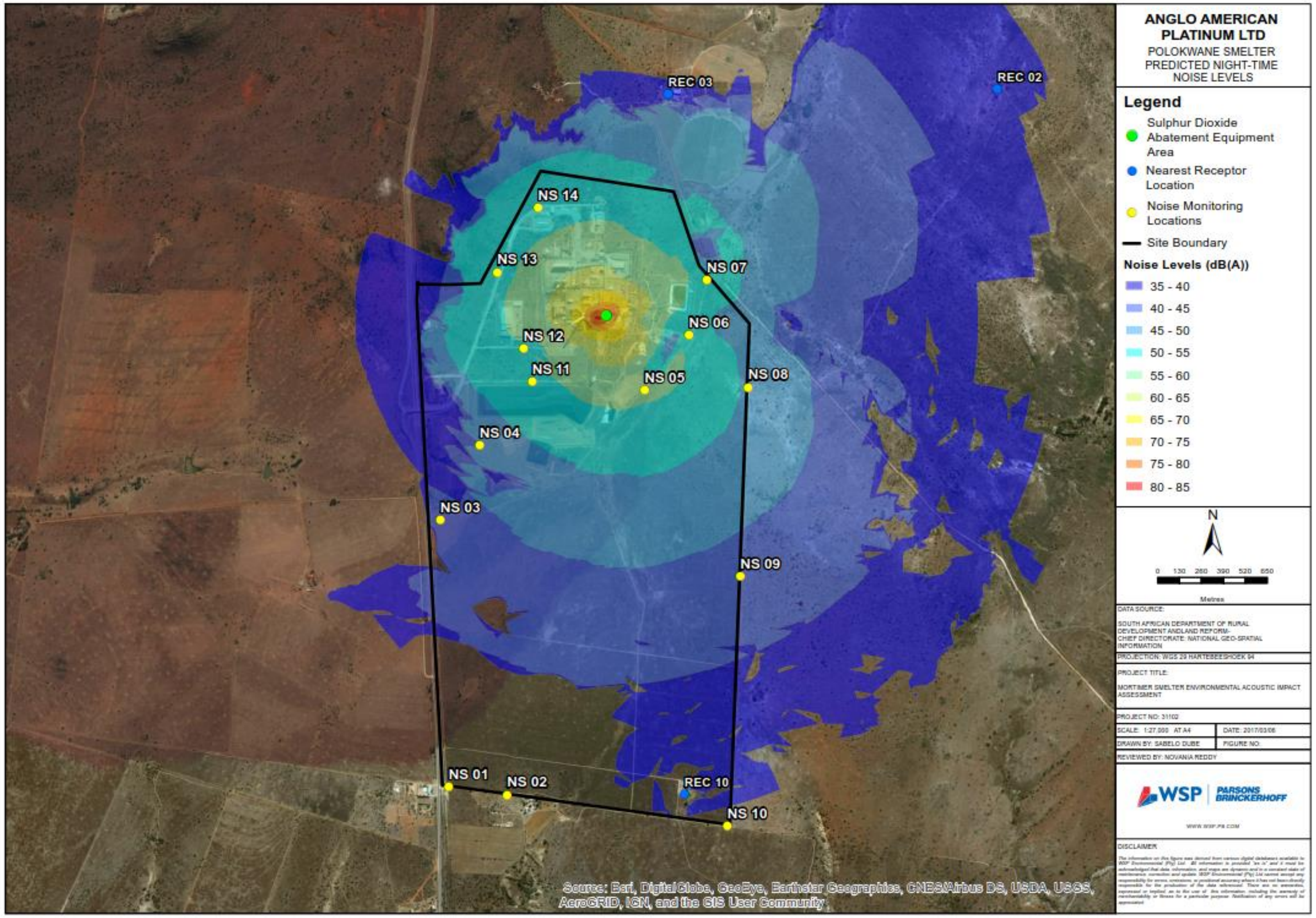


Figure 7-4: Predicted night-time noise levels during the operational phase of the proposed SO_2 abatement project

8 ASSESSMENT OF IMPACTS

The purpose of this Environmental Acoustic Impact Assessment is to identify the potential impacts of the operation of the proposed SO_2 abatement plant on the noise climate of the area. The outcomes of the impact assessment provide a basis to make informed decisions to ensure that there is not unacceptable social or environmental impact of the proposed facility. The impact assessment was evaluated using a risk matrix. A detailed description of the impact assessment methodology is provided in **Appendix B**.

During the operational phase, the resultant environmental acoustic impacts on the surrounding residential receptors are deemed “low”. The detailed impact assessment results are presented in **Appendix C**.

MITIGATION RECOMMENDATIONS

Since noise associated with the operation of the proposed development will not impact significantly on any surrounding receptors, no specific noise mitigation interventions are recommended.

9 CONCLUSIONS

This Environmental Acoustic Impact Assessment investigated the potential acoustic impacts associated with the operations of the proposed SO_2 abatement plant at the Polokwane Smelter, located in the Limpopo Province.

Ambient sound levels were measured at fourteen locations at and around the smelter on 17 May 2012. These locations were selected to be representative of current baseline conditions of industrial land use at various distances from acoustic sources. All sound level measurements were free-field measurements (i.e. at least 3.5 m away from any vertical reflecting surfaces). Measurement procedures were undertaken according to the relevant South African National Standards (SANS) 10103:2008. This guides the selection of monitoring locations, microphone positioning and equipment specifications.

The Polokwane Smelter on-site noise climate can be described as industrial with natural influences from the surrounding rural landscape. Average day-time and night-time (L_{Aeq}) sound levels from all the locations were below the day and night-time SANS 10103 industrial guidelines (70 dB(A) and 60 dB(A) respectively). Key noise sources included the flash dryer and other plant operations as well as vehicles travelling along the R37 main road (R37) from Polokwane to Lydenburg.

Current sound power levels for all equipment was obtained using sound level data supplied by the Project Engineers (Hatch Africa (Pty) Ltd) as well as sound level data from the BSI British Standards (BS 5228-1:2009) (BSI, 2009) where no engineering data was available. Acoustic modelling was then used to calculate noise contours indicating the spatial extent of projected sound levels from the proposed site within a specified grid area as well as the noise levels at specific receivers.

Cumulative day-time noise levels at all monitoring locations are predicted to be below the SANS industrial district rating level of 70 dB(A). Changes in noise levels ranging from 0 to +14.8 dB(A) are anticipated at the monitoring locations, with the largest change predicted at NS 05, located approximately 400 m southeast of the proposed SO_2 abatement plant. Such increases in noise can be attributed to the proposed lime silo, lime delivery truck and acid dispatch truck located in close proximity to this monitoring location. In line with the SANS categories of community/group responses, such increases are considered to have "little to medium" impact for the proposed development, with the exception of NS 05 and NS 06 which both resulted in a "medium to strong" estimated community response. Furthermore, increases in noise levels at NS 05, NS 06, NS 07, NS 09 and NS 11 exceed the 7 dB(A) threshold for annoyance as per the Noise Control Regulations. However, it is important to note that there are no communities in close vicinity to these receivers. Such receivers are industrial in nature and would not be perceptible to such annoyance. From ±35 m from the proposed SO_2 abatement plant, noise levels will reduce considerably, remaining below the industrial district rating level. Predicted noise levels at the nearest residential receptor (REC 03), located approximately 4 km from the proposed SO_2 abatement plant, are expected to be below the rural day-time guideline rating level of 45 dB(A). It must be noted that these noise levels are from proposed activities only and do not include baseline existing noise levels. Due to the proximity of the remaining sensitive receptors identified within a 10 km radius of the proposed development, the resultant impact on these receptors will likely be insignificant.

During the night-time, predicted cumulative noise levels are expected to be compliant with the SANS industrial district rating level of 60 dB(A), except for NS 14 which is slightly above the SANS industrial district rating level. This is predominantly due to the slightly higher existing baseline level at this location when compared to the other monitoring sites. Changes in noise levels ranging from 0 to +10.3 dB(A) are anticipated at the monitoring locations, with the largest change predicted at NS 07, located approximately 540 m east northeast of the proposed SO_2 abatement plant. Such increases in noise can be attributed to the proposed lime silo located in close proximity to this monitoring location. The change in noise levels will result in "little to medium" estimated community response at all monitoring locations with the exception of NS 07 which resulted in a "medium to strong" estimated community response. Furthermore, increases in noise levels at NS 05, NS 06, NS 07 and NS 08 exceed the 7 dB(A) threshold for annoyance as per the Noise Control Regulations. However, it is important to note that there are no communities in close vicinity to these receivers. Such receivers are industrial in nature and would not be perceptible to such annoyance. From ±95 m from the proposed SO_2 abatement plant, noise levels will reduce considerably, remaining below the industrial district rating level. Predicted noise levels at residential receptors (REC 02 and REC 03), located approximately 1.5 km and 2.6 km, respectively from the proposed SO_2 abatement plant, are expected to be slightly above the rural night-time guideline rating level of 35 dB(A). However, it must be noted that these noise levels are from proposed activities only and do not include baseline existing noise levels. Based on this receptor's location close to the existing smelter operations, it is envisaged that the current night-time noise climate is already influenced by such operations and is not typically "rural" in character. Due to the proximity of the remaining sensitive receptors identified within a 10 km radius of the proposed development, the resultant impact on these receptors, will likely be insignificant.

The acoustic impacts of the proposed development were evaluated using a risk matrix which assessed the nature, significance, extent, duration and probability of potentially significant impacts. Based on this rating system, it was calculated that the acoustic impacts of the proposed development on the surrounding residential receptors are deemed "low". Since noise associated with the operation of the proposed development will not impact significantly on any surrounding receptors, no specific noise mitigation interventions are recommended.

REFERENCES

- Hatch Africa (Pty) Ltd, Environmental Acoustic Information, 2017.
- WSP Baseline Data, Noise Monitoring, 2012.
- BSI British Standards (2009): Code of practice for noise and vibration control on construction and open sites – Part1: Noise. British Standard: BS 5228-1:2009.
- Noise Advisory Council – Great Britain (1978): A Guide to Measurement and Prediction of Equivalent Continuous Sound Level L_{eq}.
- 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).
- World Health Organisation (WHO) (1999): Guidelines for Community Noise. Available online at: http://www.who.int/docstore/peh/noise/guidelines2.html.

Appendix A

CURRICULUM VITAE

NOVANIA REDDY, B.Sc.

CONSULTANT (AIR QUALITY SPECIALIST), ENVIRONMENT & ENERGY

YEARS WITH THE FIRM

<1

YEARS TOTAL

4

AREAS OF PRACTICE

Air Quality

Acoustics

CAREER SUMMARY

Novania is a consultant with over 3 years' experience in the environmental industry. Her area of expertise lies within the air quality and acoustics fields related to sectors ranging from mining to the oil and gas industry. She holds the responsibility of data collection, inventory development, compilation of air emission licence and scientific modelling and reporting.

Novania has a broad understanding of the various laws and regulations associated with the air quality and noise procedures. Novania has also obtained a certificate in the Greenhouse Gas Reporting Training Course and was involved in the development of a municipality wide greenhouse gas evaluation in South Africa which included two major refineries.

Additionally, Novania has a year of experience within the petrochemical industry at Total SA where she has learnt prominent aspects such as communication skills, having attended a 3 day course for a communication workshop and leadership traits, by training fellow staff members. These characteristics along with her sound knowledge of the petrochemical industry has attained her to become the consultant she is today.

EDUCATION

Bachelor of Science in Engineering (Chemical Engineering), University of KwaZulu-Natal, KwaZulu-Natal, South Africa	2011

PROFESSIONAL EXPERIENCE

Air Quality

- Atmospheric Impact Report for the ArcelorMittal South Africa Newcastle Works facility within the Amajuba District Municipality (2016): Air Quality Consultant. In support of their AEL review, the report included an Air Quality Impact Assessment using the AERMOD atmospheric dispersion model in order to assess the potential ambient air quality impacts and the results were assessed against the South African Ambient Air Quality Standards. Client: ArcelorMittal South Africa Newcastle Works.
- Air Quality Impact Assessment for the Boseto Mine in Botswana (2016): Air Quality Consultant. The study comprised a screening level assessment, using a Level 1 dispersion modelling platform (SCREEN3), to predict the potential air quality impacts associated with the mine for a current throughput of 2 mtpa and an increased throughput of 3.6 mtpa. Ambient PM_{10} and TSP were identified to be the key pollutants of concern from the mining operations. Client: Loci Environmental (Pty) Ltd.
- Air Quality Impact Assessment for the proposed development at the Amasundu Quarry in KwaZulu-Natal (2016): Air Quality Consultant. A screening-level air quality impact assessment of the proposed development of a staged mobile crushing plant at the Amasundu Quarry, near Mtunzini was undertaken. This assessment evaluated the potential air quality impacts associated with the establishment and operational phases of the proposed crushing on the surrounding residential receptors, using a Level 1 dispersion model (SCREEN3). Ambient $PM_{2.5}$, PM_{10} and TSP were identified to be the key pollutants of concern from the proposed operations. Client: JG Afrika (Pty) Ltd.

NOVANIA REDDY, B.Sc.

- Annual Reporting for the Weir Heavy Bay Foundry (2016): Air Quality Consultant. This entailed reporting of their 2015 emissions on the National Atmospheric Emission Inventory System (NAEIS). This included the development of an emissions inventory for the foundry and the subsequent reporting of this information onto NAEIS. An Annual Report for the 2015 reporting period was also compiled. Annual reporting of emissions, auditing and upgrades of the facility are an important component of tracking progress on air pollution and for tracking performance and relative contributions of pollution sources which will in turn assist in assessing historic trends. This report included key items such as operations at the facility, legal framework, pollutant emission trends, compliance audit reports, major upgrades projects (abatement or process equipment) and greenhouse gas emissions. Client: Weir Heavy Bay Foundry.
- Annual Reporting for the Weir Minerals Isando Foundry (2016): Air Quality Consultant. An Annual Report for the 2015 reporting period in the heavy industrial zone of Isando in Ekurhuleni Metropolitan Municipality in the Gauteng Province was compiled. Annual reporting of emissions, auditing and upgrades of the facility are an important component of tracking progress on air pollution and for tracking performance and relative contributions of pollution sources which will in turn assist in assessing historic trends. This report included key items such as operations at the facility, legal framework, pollutant emission trends, compliance audit reports, major upgrades projects (abatement or process equipment) and greenhouse gas emissions.
- Annual Reporting for the Weir Minerals Isando Foundry (2017): Air Quality Consultant. This entailed reporting of their 2016 emissions on the National Atmospheric Emission Inventory System (NAEIS). This included the development of an emissions inventory for the foundry and the subsequent reporting of this information onto NAEIS. An Annual Report for the 2016 reporting period in the heavy industrial zone of Isando in Ekurhuleni Metropolitan Municipality in the Gauteng Province was also compiled. Annual reporting of emissions, auditing and upgrades of the facility are an important component of tracking progress on air pollution and for tracking performance and relative contributions of pollution sources which will in turn assist in assessing historic trends. This report included key items such as operations at the facility, legal framework, pollutant emission trends, compliance audit reports, major upgrades projects (abatement or process equipment) and greenhouse gas emissions.
- Annual Reporting for the Weir Heavy Bay Foundry (2017): Air Quality Consultant. This entailed reporting of their 2016 emissions on the National Atmospheric Emission Inventory System (NAEIS). This included the development of an emissions inventory for the foundry and the subsequent reporting of this information onto NAEIS. An Annual Report for the 2016 reporting period was also compiled. Annual reporting of emissions, auditing and upgrades of the facility are an important component of tracking progress on air pollution and for tracking performance and relative contributions of pollution sources which will in turn assist in assessing historic trends. This report included key items such as operations at the facility, legal framework, pollutant emission trends, compliance audit reports, major upgrades projects (abatement or process equipment) and greenhouse gas emissions. Client: Weir Heavy Bay Foundry.

NOVANIA REDDY, B.Sc.

Acoustics

- Acoustic Impact Assessment for the Boseto Mine in Botswana (2016): Air Quality Consultant. A screening-level acoustic impact assessment of the proposed 3.6 mtpa operations att he Boseto Mine was undertaken in order to determine the acoustic impacts of the Proposed Project on the nearby residential receptors. Client: Loci Environmental (Pty) Ltd.
- Acoustic Impact Assessment for the proposed development at the Amasundu Quarry in KwaZulu-Natal (2016): Air Quality Consultant. A screening-level acoustic impact assessment of the proposed development of a staged mobile crushing plant at the Amasundu Quarry, near Mtunzini was undertaken. This assessment evaluated the potential acoustic impacts associated with the establishment and operational phases of the proposed crushing on the nearby residential receptors. Client: JG Afrika (Pty) Ltd.
- Acoustic Impact Assessment for the Mortimer Smelter in the Limpopo province (2017): Air Quality Consultant. An acoustic impact assessment for the proposed SO_2 abatement equipment at the Mortimer Smelter was performed. CadnaA was used as the advanced modelling platform to assess the impact of the proposed noisy sources. Client: Anglo American Platinum Limited.
- Acoustic Impact Assessment for the Polokwane Smelter in the Limpopo province (2017): Air Quality Consultant. An acoustic impact assessment for the proposed SO_2 abatement equipment, during the operational phase, at the Polokwane Smelter was performed. CadnaA was used as the advanced modelling platform to assess the impact of the proposed noisy sources. Client: Anglo American Platinum Limited.

Appendix B

IMPACT ASSESSMENT METHODOLOGY

The EIA uses a methodological framework developed by WSP | Parsons Brinckerhoff to meet the combined requirements of international best practice and NEMA, Environmental Impact Assessment Regulations, 2014 (GN No. 982) (the “EIA Regulations”).

As required by the EIA Regulations (2014), the determination and assessment of impacts will be based on the following criteria:

- Nature of the Impact
- Significance of the Impact
- Consequence of the Impact
- Extent of the impact
- Duration of the Impact
- Probability if the impact
- Degree to which the impact:
  - can be reversed;
  - may cause irreplaceable loss of resources; and
  - can be avoided, managed or mitigated.

Following international best practice, additional criteria have been included to determine the significant effects. These include the consideration of the following:

- Magnitude: to what extent environmental resources are going to be affected;
- Sensitivity of the resource or receptor (rated as high, medium and low) by considering the importance of the receiving environment (international, national, regional, district and local), rarity of the receiving environment, benefits or services provided by the environmental resources and perception of the resource or receptor); and
- Severity of the impact, measured by the importance of the consequences of change (high, medium, low, negligible) by considering inter alia magnitude, duration, intensity, likelihood, frequency and reversibility of the change.

It should be noted that the definitions given are for guidance only, and not all the definitions will apply to all of the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

METHODOLOGY

Impacts are assessed in terms of the following criteria:

→ The **nature**, a description of what causes the effect, what will be affected and how it will be affected:

Nature or Type of Impact	Definition
Beneficial / Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Adverse / Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct	Impacts that arise directly from activities that form an integral part of the Project (e.g. new infrastructure).
Indirect	Impacts that arise indirectly from activities not explicitly forming part of the Project (e.g. noise changes due to changes in road or rail traffic resulting from the operation of Project).
Secondary	Secondary or induced impacts caused by a change in the Project environment (e.g. employment opportunities created by the supply chain requirements).
Cumulative	Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.

→ The physical **extent**, wherein it is indicated whether:

Score	Description
1	the impact will be limited to the site;
2	the impact will be limited to the local area;
3	the impact will be limited to the region;
4	the impact will be national; or
5	the impact will be international;

→ The **duration**, wherein it is indicated whether the lifetime of the impact will be:

Score	Description
1	of a very short duration (0 to 1 years)
2	of a short duration (2 to 5 years)
3	medium term (5–15 years)
4	long term (> 15 years)
5	permanent

→ The **magnitude of impact on ecological processes**, quantified on a scale from 0-10, where a score is assigned:

Score	Description
0	small and will have no effect on the environment.
2	minor and will not result in an impact on processes.
4	low and will cause a slight impact on processes.
6	moderate and will result in processes continuing but in a modified way.
8	high (processes are altered to the extent that they temporarily cease).
10	very high and results in complete destruction of patterns and permanent cessation of processes.

- → The **probability of occurrence**, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale where:

Score	Description
1	very improbable (probably will not happen).
2	improbable (some possibility, but low likelihood).
3	probable (distinct possibility).
4	highly probable (most likely).
5	definite (impact will occur regardless of any prevention measures).

- → the **significance**, which is determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high;
- → the **status**, which is described as either positive, negative or neutral;
- → the degree to which the impact can be reversed;
- → the degree to which the impact may cause irreplaceable loss of resources; and
- → the *degree* to which the impact can be mitigated.

The **significance** is determined by combining the criteria in the following formula:

$$S = (E+D+M)*P$$

S = Significance weighting

E = Extent

D = Duration

M = Magnitude

P = Probability

The **significance weightings** for each potential impact are as follows:

Overall Score	Significance Rating	Description
< 30 points	**Low**	where this impact would not have a direct influence on the decision to develop in the area
31-60 points	**Medium**	where the impact could influence the decision to develop in the area unless it is effectively mitigated
> 60 points	**High**	where the impact must have an influence on the decision process to develop in the area

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the Project's actual extent of impact, and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures, and is thus the final level of impact associated with the development of the Project. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this EIA Report.

Appendix C

IMPACT ASSESSMENT SIGNIFICANCE RATING TABLES

Operational Phase

Polokwane Smelter

Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Acoustic impact on REC 02 and REC 03	Nature of impact:	Direct							
	Without Mitigation	2	4	4	3	30	Low	-	High
	degree to which impact can be reversed:	High							
	degree of impact on irreplaceable resources:	None							
	Mitigation Measures	None							
	With Mitigation	2	4	4	3	30	Low	-	High
Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence

Polokwane Smelter

Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Acoustic impact on remaining residential receptors	Nature of impact:	Direct							
	Without Mitigation	2	4	2	2	16	Low	-	High
	degree to which impact can be reversed:	High							
	degree of impact on irreplaceable resources:	None							
	Mitigation Measures	None							
	With Mitigation	2	4	2	2	16	Low	-	High
Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence