Coal of Africa Limited

# NOISE STUDY FOR ENVIRONMENTAL IMPACT ASSESSMENT

Development of the proposed Chapudi, Chapudi West and Wildebeesthoek Collieries, Limpopo Province

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# EXECUTIVE SUMMARY

The Gudani Consulting were contracted by Coal of Africa Limited to undertake a specialist study to determine the potential noise impact on the surrounding environment due to the development of the proposed Chapudi, Chapudi West and Wildebeesthoek Collieries. Gudani undertook the noise impact study in consortium with Enviro-Acoustic Research (EARES).

This report describes the noise levels and potential noise impact that the operation of the development may have on the surrounding sound environment, highlighting the methods used, potential issues identified, findings and recommendations. This report only briefly discusses low frequency, blasting, vibrations and potential noise impacts on wildlife.

The Chapudi Project forms part of the Greater Soutpansberg Project (GSP) situated just north of the Soutpansberg in the Limpopo Province. The Chapudi Project has the potential to produce good quality hard coking coal and a domestic thermal coal product. The Chapudi Project covers an area of more than 7,500 ha, divided into the Chapudi, Chapudi West and Wildebeesthoek Sections. Open cast pits will be developed to mine the financially desired resource to be beneficiated at plants proposed at all three sections. Transportation of the final product to markets will make use of rail sidings connecting to the Transnet Freight Rail network.

The Wildebeesthoek Section will be mined at 12.5 Mtpa, whilst the Chapudi and Chapudi West Sections combined will be mined at 12.5 Mtpa with the life of mine expected to exceed 30 years. Construction is anticipated to start in 2018.

The current planning is that construction and mining will commence at the Wildebeesthoek Section first where the coking coal yields are the highest. It is expected that mining operations at the Chapudi Sections will only commence much later (in terms of current data towards 2033) by which time the Transnet infrastructure will be have been enhanced to cope with the greater annual production of coal from the project.

Ambient sound levels were measured at 8 locations during a site visit 2 – 5 July 2013 using equipment and methodologies as defined in SANS 10103:2008. Measurements indicated significant variation in equivalent sound levels from location to location, with all locations experiencing noisy single events at times that impacted on the sound levels.

$L_{A90}$ levels indicate an area with potential to be quiet at times. Equivalent daytime ambient sound levels were measured around between 46 – 59 dBA, ranging between 25 and 77 dBA (10-minute measurements). Equivalent night-time ambient sound levels were measured around between 42 – 62 dBA, ranging between 19 and 69 dBA (10-minute measurements). Night-time measurements were generally higher than the day-time measurements, relating to increased faunal activity due to the spring (mating) season.

Due to the significant variance in ambient sound measurements it is recommended that the project consider the guideline levels for residential use as set by international institutions such as World Health Organization, World Bank and International Finance Corporation for residential areas as well as the South African SANS10103:2008 guidelines.

With the input data as used, this assessment indicated that there is a potential noise impact of moderate significance during the construction phase. The layout as evaluated will provide a number of berms and stockpiles that will assist in the attenuation of noises from the mining activities and during the operational phase. Subsequently, the potential noise impact would be of a moderate to high significance during the night-time period and during the operational phase.

It must be noted that commercial railway line functions are exempted from certain requirements of Government Notice R154 of 1992 (Noise Control Regulations) – Regulation 2.(c) - *"Provided that the provisions of this paragraph* (in reference to noise emanating from a development) *shall not apply in respect of a disturbing noise or noise nuisance caused by rail vehicles or aircraft which are not used as recreational vehicles"*. Furthermore the use of locomotive horns is exempt from the Government Notice R154 of 1992 (Noise Control Regulations) – Clause 7.(1) – *"the emission of sound is for the purposes of warning people of a dangerous situation".*

Mitigation measures are proposed that could reduce the noise levels as experienced by the closest noise-sensitive developments (the magnitude of the reduction depending on the selection of the mitigation measures). Since there exists a risk of a noise impact, noise monitoring is recommended. As there exists scope for further mitigation measures, such a noise monitoring program can only be designed after all mitigation measures are designed and known. Once designed it should be implemented on a quarterly basis for a period of one year before the construction processes start to define pre-mining ambient sound levels. Quarterly noise monitoring is also recommended to be conducted during the first year of operation, and, depending on the findings of the monitoring report, to be extended, reduced or stopped. Noise measurements should be conducted over a period of 24 hours as per the methodology employed in this report.

Measurements should be collected in 10-minute bins over the measurement period. Variables recommended to be analysed include $\mathbf{L_{AMin}}$, $\mathbf{L_{AIeq}}$, $\mathbf{L_{Aeq,f}}$, $\mathbf{L_{Aeq}}$, $\mathbf{L_{Ceq}}$, $\mathbf{L_{AMax}}$, $\mathbf{L_{A10}}$, $\mathbf{L_{A90}}$ and spectral analysis. If all potential noise-sensitive receptors living within the 40 dBA noise contour are relocated before the mining project starts, ambient sound measurements at their locations can be dispensed with.

Additional measurements should be collected at the location of any receptors that have complained to the mine regarding noise originating from the operation. Feedback regarding noise measurements should be presented to all stakeholders and other interested and affected parties in the area. This report should also be made available to all potentially sensitive receptors in the area, or the contents explained to them to ensure that they understand all the potential noise risks that the mining operation may have on them and their families.

Due to economic advantages, coal mining does provide valuable employment, local taxes and foreign currency. It must be noted when mining projects are near to potential noise-sensitive receptors, consideration must be given to ensuring a compatible co-existence. The potential sensitive receptors should not be adversely affected and yet, at the same time mining need to reach an optimal scale in terms of layout and production. It should be noted that this does not suggest that the sound from the mining activities should not be audible under all circumstances - this is an unrealistic expectation that is not required or expected from any other agricultural, commercial, industrial or transportation related noise source – but rather that the sound due to the mining activities should be at a reasonable level in relation to the ambient sound levels.

If the layout changes significantly from the layout (and assumptions) used in this report, that this Environmental Noise Impact Assessment be reviewed, with the appropriate information supplied by the mine, including:

- Locality of the noise source;
- Operational time of the noise source; and
- If possible specifications regarding the noise source.

**Title:**

Development of the proposed Chapudi, Chapudi West and Wildebeesthoek Collieries, Limpopo Province

**Client:**

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**Report no:**

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# TABLE OF CONTENTS

page

# LIST OF TABLES

# LIST OF FIGURES

# GLOSSARY OF ABBREVIATIONS

AZSL Acceptable Zone Sound Level (Rating Level)

| | |
|---|---|
| ADT | Articulated Dump Truck |
| bcm/h | Bank cubic meters per hours |
| dB | Decibel |
| DMS | Dense Medium Separation |
| EARES | Enviro-Acoustic Research cc |
| EAP | Environmental Assessment Practitioner |
| ECA | Environment Conservation Act (Act 78 of 1989) |
| ECO | Environmental Control Officer |
| EIA | Environmental Impact Assessment |
| EMP | Environmental Management Plan |
| FEL | Front End Loader |
| GSP | Greater Soutpansberg Project |
| IAPs | Interested and Affected Parties |
| i.e. | that is |
| IEM | Integrated Environmental Management |
| km | kilometres |
| LOM | Life of Mine |
| LHD | Load haul dumper |
| m | Meters (measurement of distance) |
| $m^2$ | Square meter |
| $m^3$ | Cubic meter |
| mamsl | Meters above mean sea level |
| Mtpa | Million Tons per Annum |
| NEMA | National Environmental Management Act, 1998 (Act 107 of 1998) |
| NCR | Noise Control Regulations (under Section 25 of the ECA) |
| NGO | Non-government Organisation |
| NSD | Noise-sensitive Development |
| PPE | Personal Protective Equipment |
| PPP | Public Participation Process |
| RBCT | Richards Bay Coal Terminal |
| ROM | Run of Mine |
| SABS | South African Bureau of Standards |
| SANS | South African National Standards |
| SHEQ | Safety Health Environment and Quality |
| TFR | Transnet Freight Rail |
| UTM | Universal Transverse Mercator |
| WHO | World Health Organisation |

# 1 INTRODUCTION

## 1.1 INTRODUCTION AND PURPOSE

The Gudani Consulting were contracted by Coal of Africa Limited to undertake a specialist study to determine the potential noise impact on the surrounding environment due to the development of the proposed Greater Soutpansberg Chapudi Project. Gudani undertook the noise impact study in consortium with Enviro-Acoustic Research (EARES).

This report describes the noise levels and potential noise impact that the operation of the development may have on the surrounding sound environment, highlighting the methods used, potential issues identified, findings and recommendations. This report only briefly discusses low frequency, vibrations and potential noise impacts on wildlife.

## 1.2 BRIEF PROJECT DESCRIPTION

### 1.2.1 Project Overview

The Chapudi Project forms part of the Greater Soutpansberg Project (GSP) situated just north of the Soutpansberg in the Limpopo Province. The Chapudi Project has the potential to produce good quality hard coking coal and a domestic thermal coal product. The Chapudi Project covers an area of more than 7,500 ha, divided into the Chapudi, Chapudi West and Wildebeesthoek Sections. The mining location is presented in **Figure 1-1** with the proposed infrastructure layouts illustrated in **Figure 1-2**, **Figure 1-3** and **Figure 1-4** for the various sections.

The current planning is that construction and mining will commence at the Wildebeesthoek Section first where the coking coal yields are the highest. It is expected that mining operations at the Chapudi Sections will only commence much later (in terms of current data towards 2033) by which time the Transnet infrastructure will be have been enhanced to cope with the greater annual production of coal from the Project.

The Wildebeesthoek Section will be mined at 12.5 Mtpa, whilst the Chapudi and Chapudi West Sections combined will be mined at 12.5 Mtpa and the life of mine (LOM) is expected to exceed 30 years. Construction is anticipated to start in 2018.

### 1.2.2 Mining Overview

The Chapudi Project is planned as open pit operations where the extraction of coal is a total extraction mining method using conventional truck and shovel. The mining process involves stripping, drilling, blasting, loading and hauling of overburden to the waste dumped and run of mine (ROM) stockpile or processing plant area.

The mining and infrastructure layouts are shown in **Figure 1-2, Figure 1-3** and **Figure 1-4** for the various sections. This picture demonstrates the full extent of mining and is not a moment in time. The pits will be backfilled concurrent to mining and it is anticipated that no more than 600 ha will be open at any one time.

Each of the Wildebeesthoek, Chapudi and Chapudi West Sections will require a dedicated coal beneficiation plant. The total ROM capacity for the Wildebeesthoek beneficiation plant is 12.5 Mtpa. Two mining areas will be exploited for Chapudi coals with the Chapudi Section supplying 8 Mtpa to a large beneficiation plant and the Chapudi West Section supplying 4.5 Mtpa to a smaller beneficiation plant.

The individual mining sections will be provided with workshops and other necessary infrastructure required for the mining operation. The centrally located infrastructure will comprise a coal beneficiation plant, personnel support structures, vehicle support structures, water management structures and management and monitoring systems. Buildings will include management offices, production offices, change house, medical and fire fighting facility, shift changing facility, security and access control, training centre, control room and contractors accommodation camp (during construction only).

The Wildebeesthoek Section is to be developed first (construction projected for 2018 - ± 30 years operation) with further feasibility studies on Chapudi and Chapudi West to be undertaken during the life of the Wildebeesthoek Section.  Chapudi Section is projected to start mining operations only in 2033 with Chapudi West Section in 2041.

A total extraction open pit mining method has been selected, where the open pit will be mined through conventional truck and shovel. The process involves stripping, drilling, blasting, loading and hauling of overburden to the waste dump and ROM stockpile or processing plant area. Drilling of blast holes is carried out by pneumatic or hydraulic crawler mounted drills and blasting will make use of commercial, emulsion type explosives delivered on site by an explosives manufacturer.

Recovery operations are intended to be conducted by large hydraulic excavators in backhoe configuration to manage the complexity of the deposit. A fleet of trucks at 220 tonne payload has been allocated for waste movement. Coal mining and reject haulage has been modelled with a fleet of trucks at 150 tonne payload. The scheduled waste demand to meet a 2.5 Mtpa coal product production rate is such that 1 coal excavator is required with 3 interburden excavators and 2 overburden excavators. The fleet will be exclusively diesel powered.

### 1.2.3 Plant Infrastructure

Each of the Wildebeesthoek, Chapudi and Chapudi West Sections will require a dedicated coal beneficiation plant, situated on the farms Mountain View 706 MS, Woodlands 701 MS and Albert 686 MS, respectively. The necessary conveyor systems will be put in place to transport the run of mine (ROM) from the open pits to the respective beneficiation plants.

The total run of mine (ROM) capacity for the Wildebeesthoek beneficiation plant is 12.5 Mtpa. Two mining areas will be exploited for Chapudi coals with the Chapudi Section supplying 8 Mtpa to a large beneficiation plant and the Chapudi West Section supplying 4.5 Mtpa to a smaller beneficiation plant.

Each coal beneficiation plant will produce two products namely a middlings product with an ash content of 30% and a coking product with an ash content of 10%. The processing plants will therefore use the following technologies:

- Two-stage dense medium separation coal (DMS) for coarse coal beneficiation using cyclone separators to produce a coking and middlings product;
- Two-stage of up-flow classification for recovery of fine coal using reflux classifiers to produce a coking and middlings product; and
- Two-stage flotation using micro-bubble and conventional mechanical technologies for the recovery of ultra-fine coking coal product.

Fine tails will be dewatered using a thickener followed by tailings filtration before being discharged on a common discard conveyor feeding the discards stockpile. The development of the discards stockpile will be done in phases.

### 1.2.4 Product Transport

The primary domestic destination for coking coal is located at ArcelorMittal, Vanderbijlpark. The intent is to export an initial 1 Mtpa (of coking coal) and transport 2.1 Mtpa to ArcelorMittal.

Up to 3.6 Mtpa of middlings will be railed to local destinations. The volumes increase later when other mines come into production with export growing to 1.6 Mtpa of coking coal, 3.8 Mtpa coking coal to ArcelorMittal and 8 Mtpa of middlings coal to local destinations. The primary domestic location for middlings coal is Eskom's Tutuka, Majuba, Camden and Grootvlei Power Stations in Mpumalanga Province.

The Chapudi Project is close to the railway line running southwards from Beitbridge / Musina and is an important link to the main hub of the Transnet Freight Rail (TFR) network connecting at Pyramid South, near Pretoria. From Pyramid South links are available to Richards Bay Coal Terminal (RBCT), Maputo or Durban. The export route through Mozambique to the Port of Maputo is in the process of being upgraded for the planned increase in volumes. Through agreements reached to expand the port facility as well as on-going negotiations with Transnet Freight Rail, the Port of Maputo is the export port of destination.

Three RLT's are planned on the balloon lines on the farms Bushy Rise 702 MS, Woodlands 701 MS and Sandpan 687 MS. The balloon layouts allow for continuous loading of rail wagons, without un-coupling the TFR locomotives, providing a seamless transition from the loading siding to a direct link to TFR mainline network. The balloons are designed to cater ultimately for 100 CCL wagon trains. These rail links originates at the turn-outs on the Waterpoort – Huntleigh mainline section.

In light of higher volumes the rail siding is designed to have 100 wagons waiting off the main line at the entrance of the RLT and once train in the RLT has completed loading the second train can be received in the RLT prior to the first loaded train departing.

## 1.3 STUDY AREA

The study area (also refer to **Figure 1-2**, **Figure 1-3** and **Figure 1-4**) concerns a number of farms and potential noise-sensitive receptors in the vicinity of the proposed development. The study area is further described in terms of environmental components that may contribute or change the sound character in the area.

### 1.3.1 Topography

ENPAT (1998) describes the topography as Extremely Irregular Plains, with the project located on the north-facing slopes of the Soutpansberg that forms major regional topographic feature in the area. The southern section of the Chapudi Project area is characterised by high hills and ridges with flatter, gently undulating topography to the north. Some ridges occur on the north-eastern side of the area. The highest altitude is around 1,300 meters above mean sea level with the plains at around 700 to 800 mamsl (Jacana, 2013).

### 1.3.2 Surrounding Land Use

Most of the Chapudi region can be classified as rural with commercial farming as the main activity. Land use within the project area is varied and includes commercial crops (i.e. along the Sand River at Waterpoort), cattle and game farming, a number of game lodges which also host foreign visitors and a creosote operation (providing wooden stakes to the ZZ2 tomato enterprise). Some farms within the area serve as weekend retreats and therefore no active farming occurs. It was found that most farms have tenants which comprise of farm workers and their families (Jacana, 2013).

### 1.3.3 Roads and Railways

Access to the Wildebeesthoek Section is by way of the N1 towards Musina, turning west onto a new proposed intersection with the N1 where the D745 intersects east towards the Nzhelele Dam. Access to the Chapudi Section site is by way of the N1 towards Musina, turning west onto the R523.

The Musina – Makhado Railway Line transects the project area between the Chapudi and Chapudi-west Sections. The railway line is aligned in a north-south direction and reported to carry 4 trains per day that is likely to increase in the years following the start of the mining in the area.

### 1.3.4 Residential areas

Residential areas and potential noise-sensitive developments/receptors were identified using GoogleEarth® with the areas up to a distance of 2,000 meters from closest mining infrastructure in **Figure 1-5**. Localities of receptors are defined in **Appendix C**.

An accommodation camp is planned near the Wildebeesthoek, Chapudi and Chapudi West collieries. These camps will likely house the development employees and sub-contractors. Although the camp is not considered as a receptor in this document, mitigation options will be supplied for the developer to consider to reduce potential noise levels.

### 1.3.5 Other industrial and commercial processes

Most of the site is rural with little significant industrial noise sources.

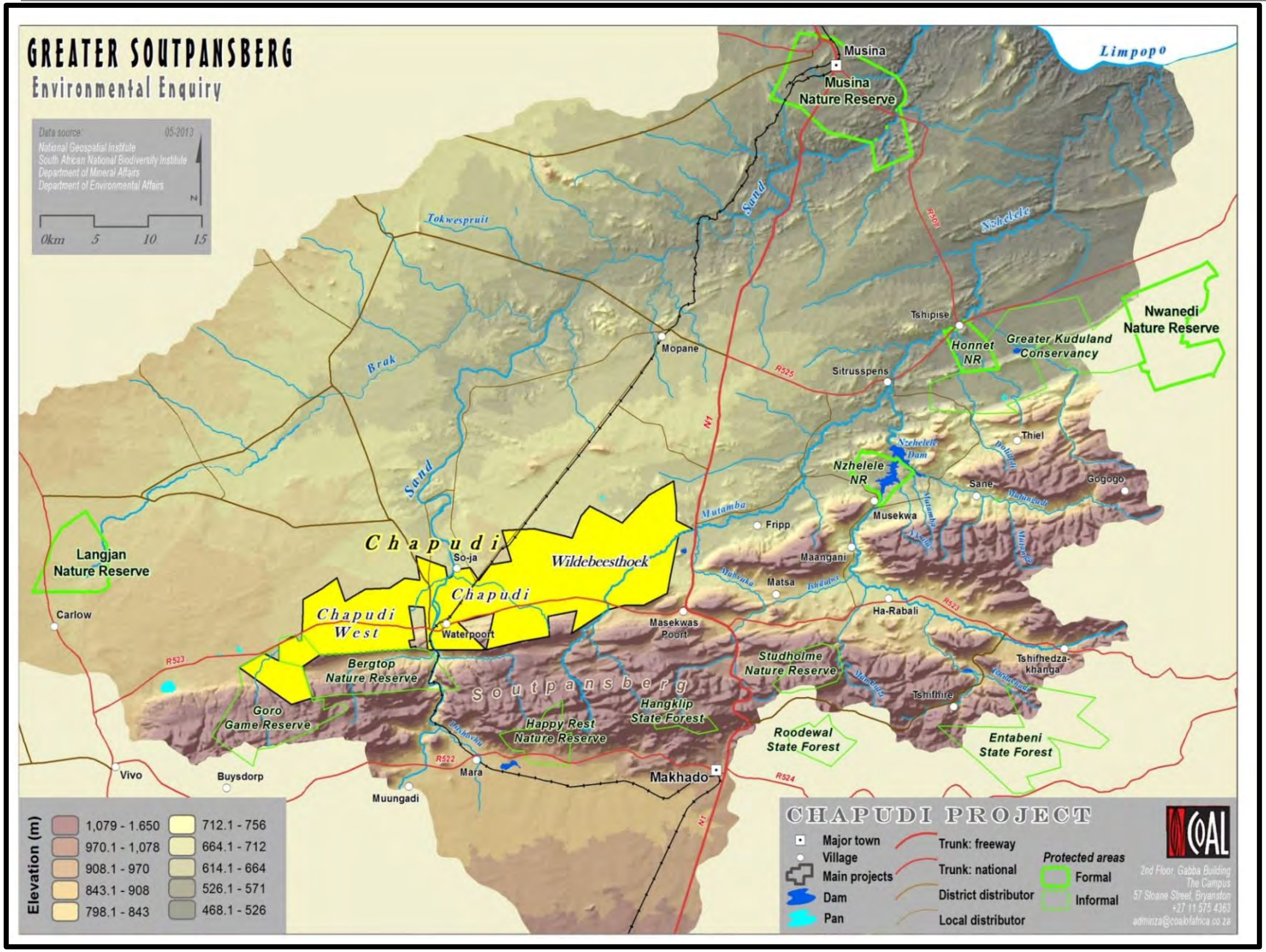



**Figure 1-1: Site map indicating the location of the proposed mining development**

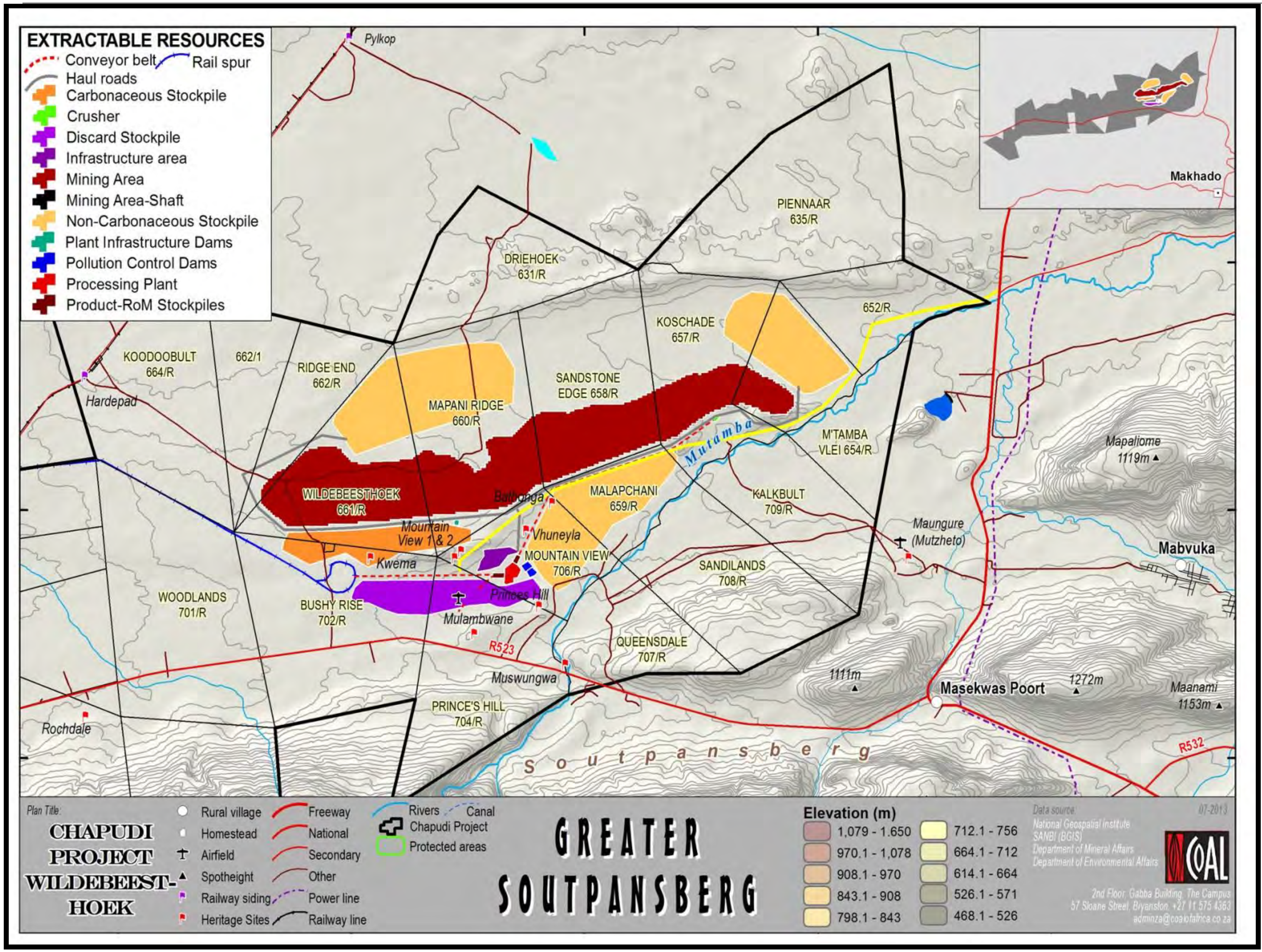



**Figure 1-2: Mining layout and schedule for the Wildebeesthoek Section**

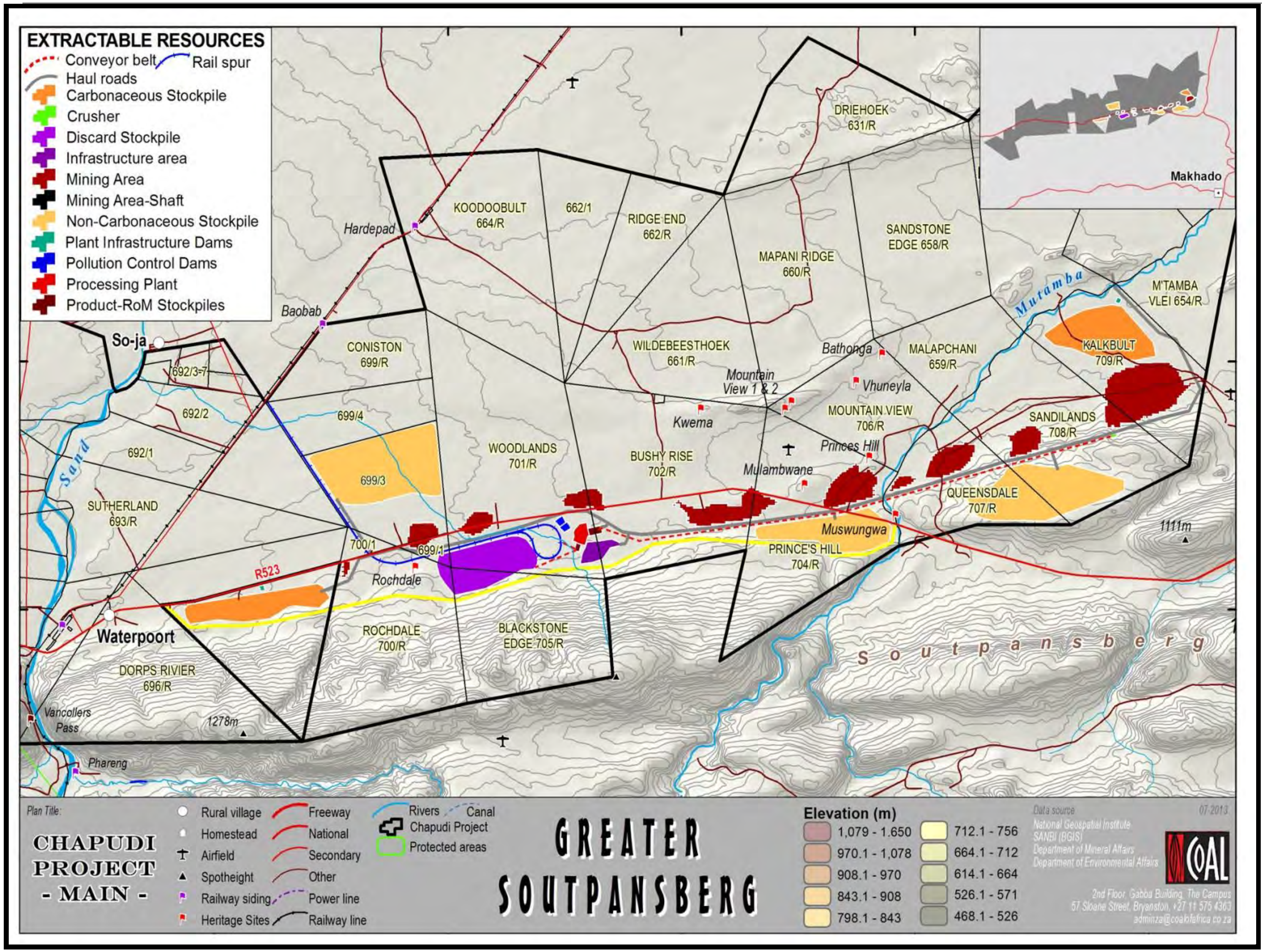



**Figure 1-3: Mining layout and schedule for the Chapudi Section**

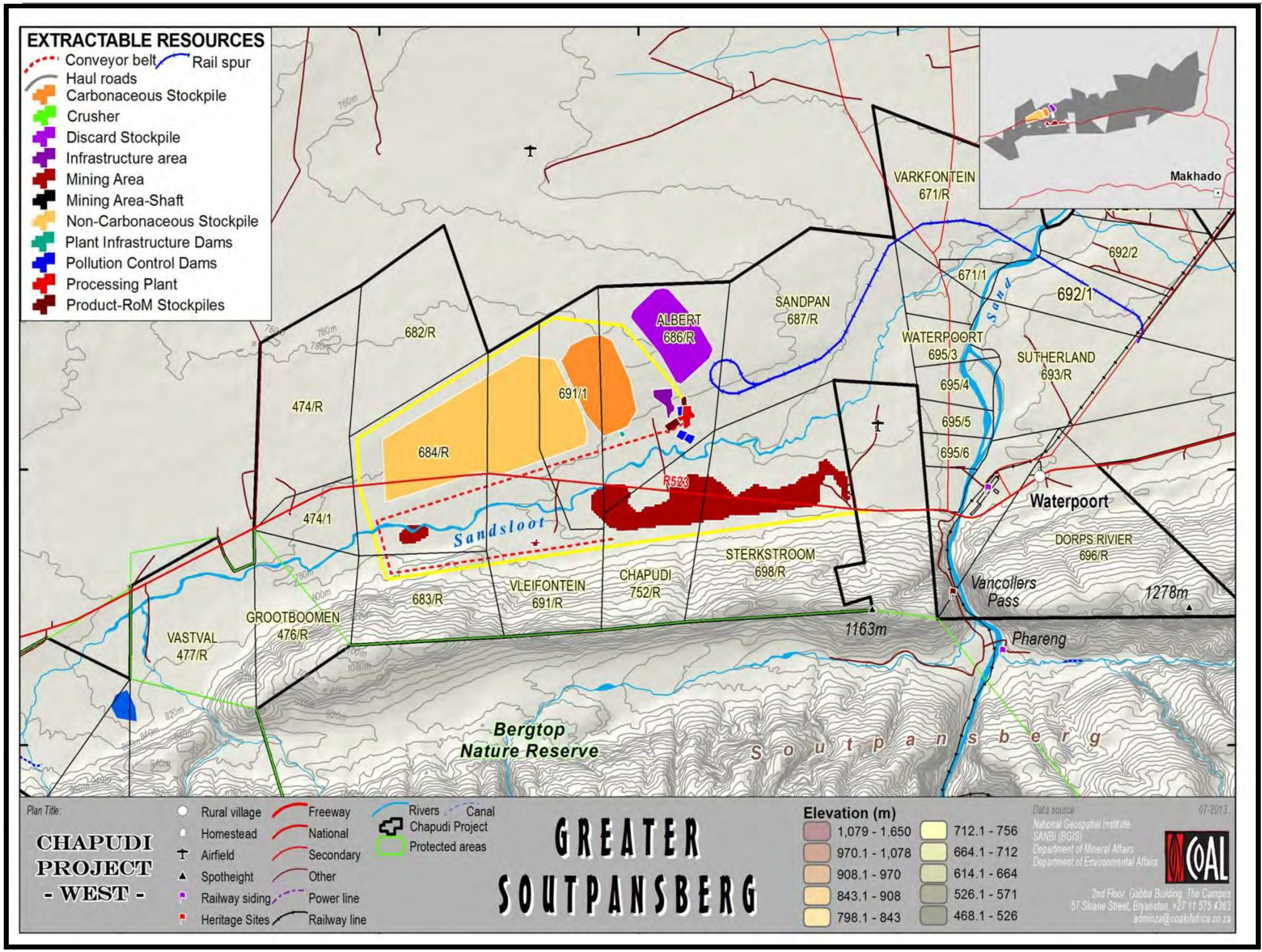



**Figure 1-4: Mining layout and schedule for the Chapudi-west Section**

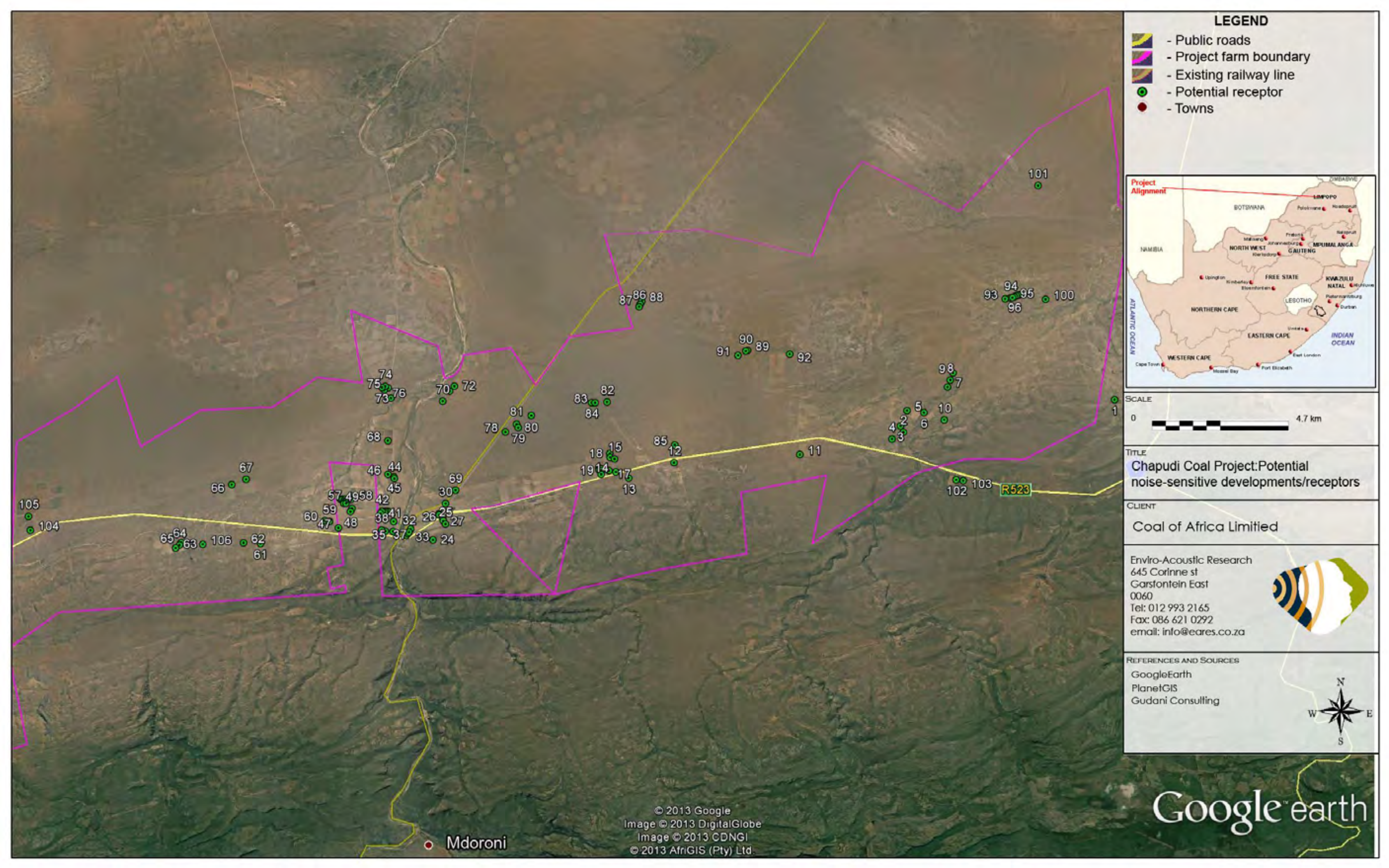



**Figure 1-5: Study area potential noise-sensitive developments / receptors**

### 1.3.6 Ground conditions and vegetation

The proposed Chapudi Project is located within the Savannah biome, characterized by a grassy ground layer and a distinct upper layer of woody plants (trees and shrubs). Where this upper layer is near the ground (low growing) the vegetation may be referred to as Shrubveld, where it is tall and dense, as Woodland, and the intermediate stages are locally known as Bushveld (BGIS, 2011). The natural veldt has been significantly disturbed in areas due to agriculture and game farming. It is the opinion of the author that the ground surface is sufficiently covered to assume 50% soft ground conditions for modelling purposes. It should be noted that this factor is only relevant for sound waves being reflected from the ground surface, with certain frequencies slightly absorbed by the vegetation.

## 1.4 AVAILABLE INFORMATION

Acoustical assessments are available for three other work package for the proposed railway line and include:

- *"Chapudi Project Scoping Report. 2013"*. The document defines the Chapudi mining layout, boundaries, infrastructure, *modus operandi,* etc.
- *"Coal of Africa Mining Design Report Greater Soutpansberg Project. 2013"*. The capacity of waste, ROM, and finished product for markets as well as colliery equipment specifications was sourced from this document *;*
- SANRAL annual report and traffic monitoring data on the N1 and R523 public roads supplied courtesy of Syntell and Mikros Traffic Monitoring (Pty) Ltd;
- *"Francois Malherbe. Baseline Noise Study for the Chapudi Coal Project. 2009, Revision2."* A baseline acoustical study conducted in the surrounding environment.

## 1.5 TERMS OF REFERENCE

SANS 10328:2008 (Edition 3) specifies the methods to be used to assess the noise impacts on the environment as result of a proposed *or* existing activity. The standard also stipulates the minimum requirements to be assessed for an EIA. These minimum requirements are:

1. the purpose of the investigation;
2. a brief description of the planned *or* existing development or the changes that are being considered;
3. a brief description of the existing environment including, where relevant, the topography, surface conditions and meteorological conditions during measurements;

4. 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;
5. the identified noise sources that were not taken into account and the reasons as to why they were not assessed;
6. the identified noise-sensitive developments and the noise impact on them;
7. where applicable, any assumptions, with references, made with regard to any calculations or determination of source and propagation characteristics;
8. 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;
9. 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;
10. the location of measuring or calculating points in a sketch or on a map;
11. quantification of the noise impact with, where relevant, reference to the literature consulted and the assumptions made;
12. alternatives that were considered and the results of those that were assessed;
13. a list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation;
14. 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;
15. conclusions that were reached;
16. proposed recommendations;
17. whether 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
18. 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.

# 2 LEGAL CONTEXT, POLICIES AND GUIDELINES

## 2.1 THE REPUBLIC OF SOUTH AFRICA CONSTITUTION ACT ("THE CONSTITUTION")

The environmental rights contained in section 24 of the Constitution provide that everyone is entitled to an environment that is not harmful to his or her well-being. In the context of noise, this requires a determination of what level of noise is harmful to well-being. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate in the particular circumstances. The subjectivity of this approach can be problematic which has led to the development of noise standards (see **Section 2.6**).

"Noise pollution" is specifically included in Part B of Schedule 5 of the Constitution, which means that noise pollution control is a local authority competence, provided that the local authority concerned has the capacity to carry out this function.

## 2.2 THE ENVIRONMENT CONSERVATION ACT (ACT 73 OF 1989)

The Environment Conservation Act ("ECA") allows the Minister of Environmental Affairs and Tourism ("now the Ministry of Water and Environmental Affairs") to make regulations regarding noise, among other concerns. See also **section 2.2.1**.

### 2.2.1 National Noise Control Regulations (GN R154 of 1992)

In terms of section 25 of the ECA, the national Noise Control Regulations (GN R154 in *Government Gazette* No. 13717 dated 10 January 1992) were promulgated. The NCRs were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations.

Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996 legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. Provincial Noise Control Regulations exist in the Free State, Gauteng and Western Cape provinces. The Limpopo Province currently has no provincial noise control regulations and the National Regulations will be in effect.

The National Noise Control Regulations (GN R154 1992) defines:
"**controlled area**" as:
a piece of land designated by a local authority where, in the case of--
c) industrial noise in the vicinity of an industry-

i. the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or
ii. the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 meters, but not more than 1,4 meters, above the ground for a period of 24 hours, exceeds 61 dBA;

"**disturbing noise**" as:
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 dBA or more.

"**zone sound level**" as:
a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. *This is the same as the Rating Level as defined in SANS 10103.*

***In addition:***
In terms of Regulation 2 -
*"A local authority may –*
*(c): if a noise emanating from a building, premises, vehicle, recreational vehicle or street is a disturbing noise or noise nuisance, or may in the opinion of the local authority concerned be a disturbing noise or noise nuisance, instruct in writing the person causing such noise or who is responsible therefor, or the owner or occupant of such building or premises from which or from where such noise emanates or may emanate, or all such persons, to discontinue or cause to be discontinued such noise, or to take steps to lower the lever of the noise to a level conforming to the requirements of these Regulations within the period stipulated in the instruction: Provided that the provisions of this paragraph shall not apply in respect of a disturbing noise or noise nuisance caused by rail vehicles or aircraft which are not used as recreational vehicles;*
*(d): before changes are made to existing facilities or existing uses of land or buildings, or before new buildings are erected, in writing require that noise impact assessments or tests are conducted to the satisfaction of that local authority by the owner, developer, tenant or occupant of the facilities, land or buildings or that, for the purposes of regulation 3(b) or (c), reports or certificates in relation to the noise impact to the satisfaction of that local authority are submitted by the owner, developer, tenant or occupant to the local authority on written demand";*

In terms of Regulation 4 of the Noise Control Regulations:

*"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"*.

## 2.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT 107 OF 1998)

The National Environmental Management Act ("NEMA") defines "pollution" to include any change in the environment, including noise. A duty therefore arises under section 28 of NEMA to take reasonable measures while establishing and operating any facility to prevent noise pollution occurring. NEMA sets out measures which may be regarded as reasonable. They include the following measures:

1. to investigate, assess and evaluate the impact on the environment
2. to inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed to avoid causing significant pollution or degradation of the environment
3. to cease, modify or control any act, activity or process causing the pollution or degradation
4. to contain or prevent the movement of the pollution or degradation
5. to eliminate any source of the pollution or degradation
6. to remedy the effects of the pollution or degradation

## 2.4 NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT ("AQA" – ACT 39 OF 2004)

Section 34 of the National Environmental Management: Air Quality Act (Act 39 of 2004) makes provision for:

(1) the Minister to prescribe essential national noise standards -

(a) for the control of noise, either in general or by specified machinery or activities or in specified places or areas; or

(b) for determining –

(i) a definition of noise

(ii) the maximum levels of noise

(2) When controlling noise the provincial and local spheres of government are bound by any prescribed national standards.

This section of the Act is in force, but no such standards have yet been promulgated. Draft regulations have however, been promulgated for adoption by Local Authorities.

An atmospheric emission licence issued in terms of section 22 may contain conditions in respect of noise.

### 2.4.1 Model Air Quality Management By-law for adoption and adaptation by Municipalities (GN 579 of 2010)

Model Air Quality Management By-Laws for adoption and adaptation by municipalities was published by the Department of Water and Environmental Affairs in the Government Gazette of 2 July 2010 as Government Notice 579 of 2010. The main aim of the model air quality management by-law is to assist municipalities in the development of their air quality management by-law within their jurisdictions. It is also the aim of the model by-law to ensure uniformity across the country when dealing with air quality management challenges. Therefore, the model by-law is developed to be generic to deal with most of the air quality management challenges. With Noise Control being covered under the Air Quality Act (Act 39 of 2004), noise is also managed in a separate section under this Government Notice.

- **IT IS NOT** the aim of the model by-law to have legal force and effect on municipalities when published in the Gazette; and
- **IT IS NOT** the aim of the model by-law to impose the by-law on municipalities.

Therefore, a municipality will have to follow the legal process set out in the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000) when adopting and adapting the model by-law to its local jurisdictions.

## 2.5 ROAD TRAFFIC ACT, 1996 (ACT NO 93 OF 1996)

The Road Traffic Act of 1996 provides, *inter alia*, that *no person shall operate or permit to be operated on a public road and vehicle causing noise in excess of the prescribed noise level.* The Act, however, does not prescribe noise levels, but empowers the Minister of Transport to issue regulations prescribing them. The consolidated Road Traffic Regulations in terms of the Act do not prescribe any such noise levels, although the noise levels specified in the South African National Standard SANS 10181 (SABS 0181) have been specified as control standards.

## 2.6 NOISE STANDARDS

There are a few South African scientific standards (SABS) relevant to noise from mines, industry and roads. They are:

- SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.

- SANS 10210:2004. 'Calculating and predicting road traffic noise'.
- SANS 10328:2008. 'Methods for environmental noise impact assessments'.
- SANS 10357:2004. 'The calculation of sound propagation by the Concave method'.
- SANS 10181:2003. 'The Measurement of Noise Emitted by Road Vehicles when Stationary'.
- SANS 10205:2003. 'The Measurement of Noise Emitted by Motor Vehicles in Motion'.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account, but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. With regards to SANS 10103:2008, the recommendations are likely to inform decisions by authorities, but non-compliance with the standard will not necessarily render an activity unlawful *per se.*

## 2.7 NATIONAL TRANSPORT POLICY (SEPTEMBER 1996)

The White Paper sets the vision for transport in South Africa that provides for *safe, reliable, effective, efficient and fully integrated transport operations and infrastructure which are environmentally and economically sustainable*. The White Paper further states that "*the provision of transportation infrastructure and the operation of the transportation system have the potential for causing damage to the physical and social environment, inter alia, through atmospheric and noise pollution, ecological damage and severance. … The Department of Transport is committed to an integrated environmental management approach in the provision of transport*". It is also stated that "*As part of the overall long-term vision for the South African transport system, transport infrastructure will, inter alia, be structured to ensure environmental sustainability and internationally accepted standards*". One of the strategic objectives for transport infrastructure to achieve this vision is to promote environmental protection and resource conservation.

## 2.8 INTERNATIONAL GUIDELINES

While a number of international guidelines and standards exist, those selected below are used by numerous countries for environmental noise management.

### 2.8.1 Guidelines for Community Noise (WHO, 1999)

The World Health Organization's (WHO) document on the *Guidelines for Community Noise* is the outcome of the WHO- expert task force meeting held in London, United Kingdom, in

April 1999. It is based on the document entitled "Community Noise" that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute.

The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments. It discusses the specific effects of noise on communities including:

- Interference with communication, noise-induced hearing impairment, sleep disturbance effects, cardiovascular and psychophysiological effects, mental health effects, effects on performance, annoyance responses and effects on social behavior.

It further discusses how noise can impact (and propose guideline noise levels) on specific environments such as:

- Residential dwellings, schools and preschools, hospitals, ceremonies, festivals and entertainment events, sounds through headphones, impulsive sounds from toys, fireworks and firearms, and parklands and conservation areas.

To protect the majority of people from being affected by noise during the daytime, it propose that sound levels at outdoor living areas should not exceed 55 dB $L_{Aeq}$ for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB LAeq. At night, equivalent sound levels at the outside façades of the living spaces should not exceed 45 dBA and 60 dBA LAmax so that people may sleep with bedroom windows open.

It is critical to note that this guideline requires the sound level measuring instrument to be set on the "fast" detection setting.

### 2.8.2 Night Noise Guidelines for Europe (WHO, 2009)

Refining previous Community Noise Guidelines issued in 1999, and incorporating more recent research, the World Health Organization has released a comprehensive report on the health effects of night time noise, along with new (non-mandatory) guidelines for use in Europe. Rather than a maximum of 30 dB inside at night (which equals 45-50 dB max outside), the WHO now recommends a maximum year-round outside night-time noise average of 40 db to avoid sleep disturbance and its related health effects. The report notes that only below 30 dB (outside annual average) are "*no significant biological effects* *observed*," and that between 30 and 40 dB, several effects are observed, with the chronically ill and children being more susceptible; however, "*even in the worst cases the effects seem modest*." Elsewhere, the report states more definitively, "*There is no sufficient evidence that the biological effects observed at the level below 40 dB (night, outside) are harmful to health*." At levels over 40 dB, "*Adverse health effects are observed*" and "*many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected*."

The 184-page report offers a comprehensive overview of research into the various effects of noise on sleep quality and health (including the health effects of non-waking sleep arousal), and is recommended reading for anyone working with noise issues. The use of an outdoor noise standard is in part designed to acknowledge that people do prefer to leave windows open when sleeping, though the year-long average may be difficult to obtain (it would require longer-term sound monitoring than is usually budgeted for by either industry or neighbourhood groups).

While recommending the use of the average level, the report notes that some instantaneous effects occur in relation to specific maximum noise levels, but that the health effects of these "cannot be easily established."

### 2.8.3 Equator Principles

The **Equator Principles** (EPs) are a voluntary set of standards for determining, assessing and managing social and environmental risk in project financing. Equator Principles Financial Institutions (EPFIs) commit to not providing loans to projects where the borrower will not or is unable to comply with their respective social and environmental policies and procedures that implement the EPs.

The Equator Principles were developed by private sector banks and were launched in June 2003. The banks chose to model the Equator Principles on the environmental standards of the World Bank (1999) and the social policies of the International Finance Corporation (IFC). Sixty-seven financial institutions (October 2009) have adopted the Equator Principles, which have become the de facto standard for banks and investors on how to assess major development projects around the world. The environmental standards of the World Bank have been integrated into the social policies of the IFC since April 2007 as the International Finance Corporation Environmental, Health and Safety (EHS) Guidelines.

#### 2.8.4 IFC: General EHS Guidelines – Environmental Noise Management

These guidelines are applicable to noise created beyond the property boundaries of a development that conforms to the Equator Principle.

It states that noise prevention and mitigation measures should be applied where predicted or measured noise impacts from project facilities/operations exceed the applicable noise level guideline at the most sensitive point of reception. The preferred method for controlling noise from stationary sources is to implement noise control measures at source.

It goes as far as to proposed methods for the prevention and control of noise emissions, including:

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment casing radiating noise;
- Improving the acoustic performance of constructed buildings, apply sound insulation;
- Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 $kg/m^2$ in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective;
- Installing vibration isolation for mechanical equipment;
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas ;
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding;
- Placement of permanent facilities away from community areas if possible;
- Taking advantage of the natural topography as a noise buffer during facility design;
- Reducing project traffic routing through community areas wherever possible;
- Planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas; and
- Developing a mechanism to record and respond to complaints.

It sets noise level guidelines (see **Table 2-1**) as well as highlighting the certain monitoring requirements pre- and post-development. It adds another criterion in that the existing background ambient noise level should not rise by more than 3 dBA. This criterion will effectively sterilize large areas of any development. It is therefore the considered opinion that this criterion was introduced to address cases where the existing ambient noise level is already at, or in excess of the recommended limits.

**Table 2-1: IFC Table .7.1-Noise Level Guidelines**

| Receptor type | One hour $L_{Aeq}$ (dBA) | |
|---|---|---|
| | Daytime 07:00 - 22:00 | Night-time 22:00 – 07:00 |
| **Residential; institutional; educational** | 55 | 45 |
| **Industrial; commercial** | 70 | 70 |

The document uses the $L_{Aeq,1\ hr}$ noise descriptors to define noise levels. It does not determine the detection period, but refers to the IEC standards, which requires the fast detector setting on the Sound Level Meter during measurements in Europe.

### 2.8.5 International Paper – Future Noise Policy European Commission Green Paper

The green paper highlights the need for mitigation measures to be implemented in the European Union regarding air pollution and includes – "More attention needs to be paid to rail noise where some Member States are planning national legislation and where there is considerable opposition to the expansion of rail capacity due to excessive noise[1]**".**

### 2.8.6 International Guidelines - Appropriate Noise Limits for Railway Lines

Noise reception limits exist on a national level in various forms for new and upgraded railway lines. Limits for existing railway lines are only in force in Switzerland, Denmark, and Italy and will be in Sweden from 2015 on. Mandatory reception limits or insulation standards for new buildings along existing railway lines are, for example, in force in Finland, France and Switzerland. Recommended International Standards relating to the $\mathbf{L_{Aeq,T}}$ (dBA)whereby the T varies depending on the country is illustrated in **Figure 2-1** and **Table 2-2**.

[1] European Commission Green Paper (Com (96) 540).

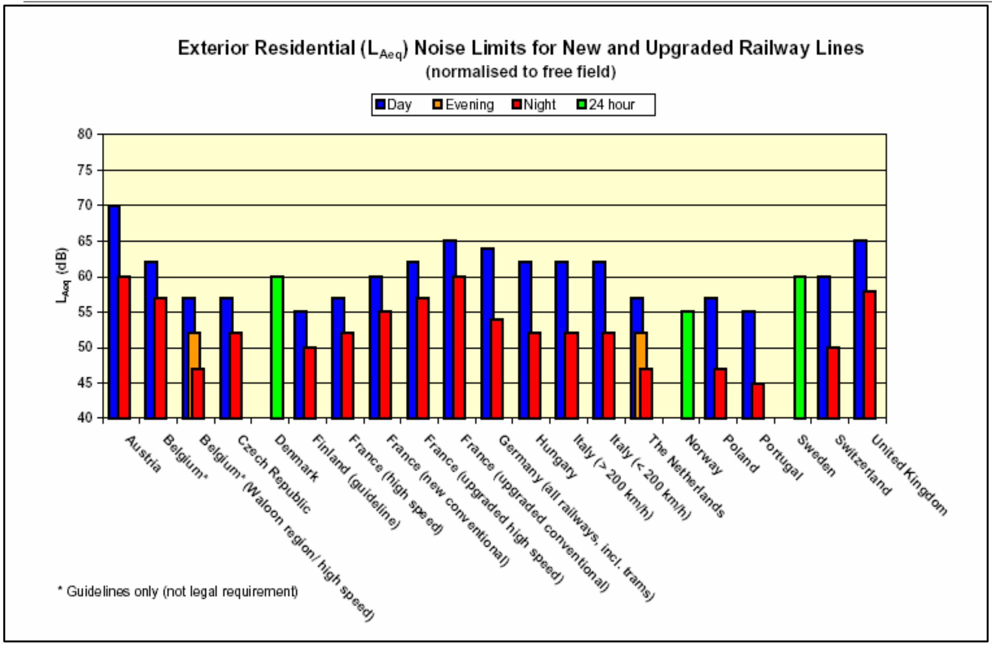



**Figure 2-1: Residential Noise Limits for New and Upgraded Railway Lines[2]**

These limits are however not completely comparable, as they differ in terms of:

- Indicators;
- Reference time intervals;
- Receiver locations (free-field (reflection at the building not considered) or at the façade);
- The difference in levels amounts to 3 dB(A));
- Emission assumptions (levels, location);
- Transmission factors (e.g. weather conditions etc);
- Definition of substantial upgrading; and
- Sometimes the limits are increased depending on existing exposure levels (Austria, France). In Italy limits depend on the distance from the track.

### 2.8.7 International Guidelines - Appropriate $L_{Amax}$ limits

The single noise events (**$L_{Amax}$**) magnitude and number of events have been investigated in various International documents including the World Health Organization, 2009: "*Night Noise Guidelines for Europe"*[3] briefly discussed in **Section2.8.2**. International countries **$L_{Amax}$** outdoor values generally range between 73 to 88 dBA[4].

Several railway activities, including train pass-bys, emit repetitive noises of a significant level for brief periods of time that can interfere with sleep, communications, and the wellbeing of the residents of neighbouring properties (WHO 1999). A brief overview of

[2] European Commission, 2003
[3] World Health Organization, 2009: "*Night Noise Guidelines for Europe*
[4] Environmental Impact Assessment: Proposed Gautrain Rapid Rail Link Volume 3: Socio-Economic Environment

International Standards and guidelines relating to the magnitude of the **$L_{Amax}$** singular event (source *"Environmental Impact Assessment: Proposed Gautrain Rapid Rail Link Volume 3: Socio-Economic Environment"* [5]) is presented in **Table 2-2.**

| COUNTRY | PERIOD (T) | $L_{Amax}$ (dBA) | $L_{Aeq,T}$ (dBA) |
|---|---|---|---|
| Australia | 06h00 – 06h00 | 85 | 60 |
| Austria | 06h00 – 22h00 | | 60 |
| | 22h00 – 06h00 | | 50 |
| Denmark | 06h00 – 06h00 | 88 | 60 |
| France | 06h00 – 22h00 | | 60 |
| | 22h00 – 06h00 | | 55 |
| Germany | 06h00 – 22h00 | | 59 |
| | 22h00 – 06h00 | | 49 |
| Hong Kong | 07h00 – 23h00 | | 65 - 70 |
| | 23h00 – 07h00 | | 55 - 60 |
| Italy | 06h00 – 22h00 | | 55 |
| | 22h00 – 06h00 | | 45 |
| Japan | 07h00 – 22h00 | 70 | 60 |
| | 22h00 – 07h00 | 70 | 55 |
| Netherlands | 07h00 – 19h00 | 73 | 55 (60) |
| | 19h00 – 23h00 | 73 | 50 |
| | 23h00 – 07h00 | 73 | 45 (50) |
| Norway | 06h00 – 06h00 | | 60 |
| South Korea | 06h00 – 22h00 | | 65 |
| | 22h00 – 06h00 | | 55 |
| Sweden | 06h00 – 06h00 | | 63 |
| Switzerland | 06h00 – 22h00 | | 55 – 60 |
| | 22h00 – 06h00 | | 45 – 50 |
| UK | 06h00 – 24h00 | 85 | 68 |
| | 24h00 – 06h00 | 85 | 63 |
| USA | 1hr | | 67 |
| | 06h00 – 06h00 | | 55 ($L_{dn}$) |

**Table 2-2: International Railway ($L_{Amax}$) magnitude**

### 2.8.8 National and International Guidelines - Appropriate limits for game parks and wilderness

#### *2.8.8.1 United States National Park Services[6]*

This document identifies that "intrusive" un-natural sounds are concern for the National Park Services (United States) as many visitors go to parks to enjoy the soundscape (interpreted as natural soundscape). Naturally quiet places will not mean (as per interpretation of the author and available information) that the noise levels in the area will be low. Rather that the soundscape contributors are of a natural origin (faunal communication, wind shear etc.).

Although game park visitors, receptors in "natural" areas and hospitality industries may not seek intrusive un-natural sounds, the operation of the game park/hospitality industry

[5]Environmental Impact Assessment: Proposed Gautrain Rapid Rail Link Volume 3: Socio-Economic Environment
[6] US National Park Service, 2000

or receptors dwelling itself is source of anthropogenic noise (vehicles, game park electrical and mechanical infrastructure etc.).

The United States National Park Service's efforts include attempts to reduce the flights over the Grand Canyon due to the introduction of non-natural sounds to this park.

### *2.8.8.2 National and International Regulations and Guidelines*

Very little guidelines are available regarding industrial noise sources in a "natural" area in South Africa. Most guidelines available relate to visitors in the park such as the Nature Conservation Ordinance, 1975: Ordinance 4 (Namibia) [7]. Internationally there exists numerous International State (United States of America) and local laws to try and encourage industries near parks to keep within limits set out by the local authorities[8].

[7] Derek Cosjin.Jongens Keet Associates. Vele Colliery Noise Impact Assessment Appendix C.2009.
[8] E.g. State of Oregon's Environmental Standards for Wilderness Areas

# 3 CURRENT ENVIRONMENTAL SOUND CHARACTER

## 3.1 MEASUREMENT PROCEDURE

Ambient (background) noise levels were measured at appropriate times in accordance with the South African National Standard SANS 10103:2008 "***The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication***". The standard specifies the acceptable techniques for sound measurements including:

- type of equipment (Class 1);
- minimum duration of measurement;
- microphone positions and height above ground level;
- calibration procedures and instrument checks; and
- supplementary weather measurements and observations.

## 3.2 LIMITATIONS: ACOUSTICAL MEASUREMENTS AND ASSESSMENTS

Limitations due to environmental acoustical measurements include the following:

- Ambient sound levels are the cumulative effects of innumerable sounds generated at various instances both far and near. A high measurement may not necessarily mean that noise levels in the area are always high. Similarly, a low sound level measurement will not necessarily mean that the area is always quiet, as sound levels will vary over seasons, time of the day, faunal characteristics, vegetation in the area and meteorological conditions (especially wind). This is excluding the potential effect of sounds from anthropogenic origin. It is impossible to quantify and identify the numerous sources that influenced one 10-minute measurement using the reading result at the end of the measurement;
- Defining ambient sound levels using the result of one 10-minute measurement will be very inaccurate (very low confidence level in the results) for the reasons mentioned above. The more measurements that can be collected at a location the higher the confidence levels in the ambient sound level determined (at that location). The more complex the sound environment, the longer the required measurement (especially when at a community or house);
- Determination of existing road traffic and other noise sources of significance are important (traffic counts etc);
- Measurements over wind speeds of 3 m/s could provide data influenced by wind-induced noises;
- Ambient sound levels recorded near rivers, streams, wetlands, trees and bushy areas can be high due to faunal activity which can dominate the sound levels around the measurement point. This generally is still considered naturally quiet and

understood and accepted as features of the natural soundscape, and various cases sought after and pleasing;

- Considering one sound descriptor is not sufficient for and acoustical assessment. Parameters such as $L_{AMin}$, $L_{AIeq}$, $L_{Aeq}$, $L_{Ceq}$, $L_{AMax}$, $L_{A10}$, $L_{A90}$ and spectral analysis forms part of the many variables to be considered;
- It is technically difficult to correctly measure the spectral distribution of a large equipment in an industrial setting due to the other noise sources active in the area;
- Exact location of a sound level meter in an area in relation to structures, vegetation and external noise sources will impact on the measurements; and
- As a residential area develops the presence of people will result in increased sounds. These are generally a combination of traffic noise, voices, animals and equipment (incl. TV's and Radios). The result is that ambient sound levels will increase as an area matures.

## 3.3 AMBIENT SOUND LEVEL MEASUREMENTS - PREVIOUSLY MEASURED: MOPANE

Ambient sound measurements were collected for the Mopane Coal Project of COAL from the morning of 2 July to the afternoon of 5 July 2013. Illustrative measurements are summarized and included for the following reasons:

- It was collected in vicinity of the Chapudi Coal Project in an area with similar evaporation, rainfall, vegetation and climatic conditions. Land use character as well as animal and insect communities is sufficiently similar to concluded that these factors determine the ambient sound levels. Subsequently, everything else being similar, ambient sound levels at the Chapudi Project Area should be similar.
- Ambient sound measurements were collected at the Mopane Project area during the winter season, generally a period with significantly less faunal activities and communication. Measurements collected at the Capudi Project area were collected during the spring period, when faunal activities and communication frequently reaches a peak.

The locations where ambient sound measurements were collected are defined in **Table 3-1** below (EARES, 2013).

**Table 3-1: Day/night-time measurement locations (Datum type: WGS 84)**

| Point name | Latitude | Longitude |
|---|---|---|
| **MAS01** | -22.616632° | 29.855353° |
| **MAS02** | -22.608796° | 29.852377° |
| **MAS03** | -22.608797° | 29.838052° |
| **MAS04** | -22.653268° | 29.759507° |
| **MAS05** | -22.561271° | 29.741831° |
| **MAS06** | -22.643518° | 29.810733° |

| | | |
|---|---|---|
| **MAS07** | -22.592321° | 29.813782° |

### 3.3.1 Measurement Point MAS01: Assembly area, Mopane School

There were no identifiable noise sources close to the measurement location and the location should provide a very overview of the sound character in the Mopane area. The limestone plant was clearly audible even though the school building broke the line of sight. The microphone was located in an open area further than 5 meters from any vegetation or reflective surfaces (excluding the ground itself). Soundscape were dominated by bird sounds, with traffic, insects and the limestone plant audible at times. Ambient sound measurements are illustrated in **Figure 3-1**.

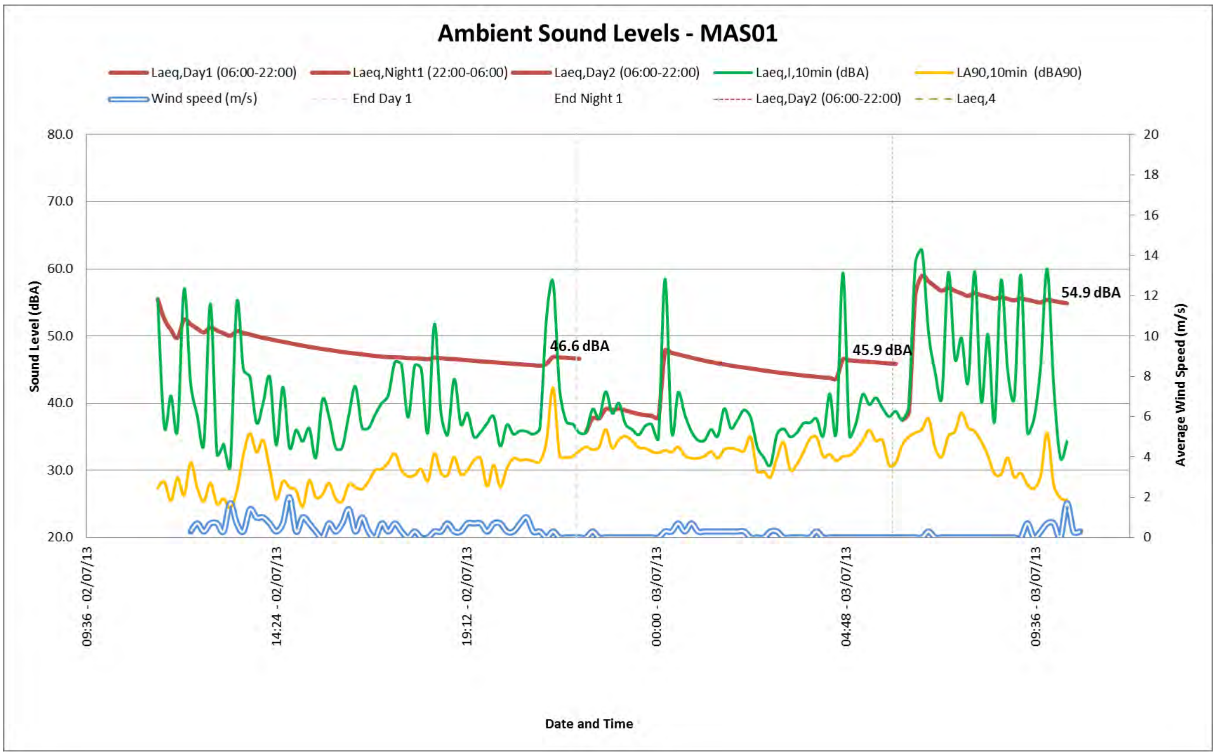



**Figure 3-1: Ambient Sound Levels at MAS01**

There were a number of different noise sources impacting on this location with no distinctive spectral character.

**SANS 10103:2008 Rating Level:** Daytime measured data indicate sound levels typical of an area with a rural district character. Night-time levels however are far higher than expected for a rural area, conforming more to an urban district zone sound level, confirmed by the 54.9 dBA $L_{Aeq,I}$ level measured the following day. Considering the $L_{A90}$ and the developmental character of the area it is the opinion of the author that a rating level typical for a sub-urban area would be acceptable. The constant noise from the limestone plant currently does have a slight noise impact on the location, but, combined with the cumulative effect of single events it raises the noises levels at the location (and surrounding area) from the expected rural to that of an urban area. The measured $L_{Aeq,f}$ levels during the day and night however conforms to the recommendation of 55 and 45 dBA respectively by the World Health Organization (**section 2.8.1**), World Bank (see **section 2.8.3**) and International Finance Corporation (see **section 2.8.4**) for residential areas.

### 3.3.2 Measurement point MAS02: Farm Erasmus (Mr. Meintjies)

The measurement location was chosen as it was a safe location for the equipment to be left for this period (people at the dwelling most of the time). The microphone was located away from the receptors dwelling close to the entrance gate. Building activities were taking place on the farm but were more than 50 meters away from the microphone. Bird communication was dominant, as well as single events of a quad bike driving in the area. Other audible sounds included insects and the building activities (voices and construction noises). Single events with loud noises did impact on the equivalent sound levels as shown on **Figure 3-2**. Measured $\mathbf{L_{A90,f}}$ data indicated an area that is generally very quiet, typical of a rural area with little industrial and commercial activities although there are a slight background noise that does impact on this measurement location (likely the barely audible limestone plant).

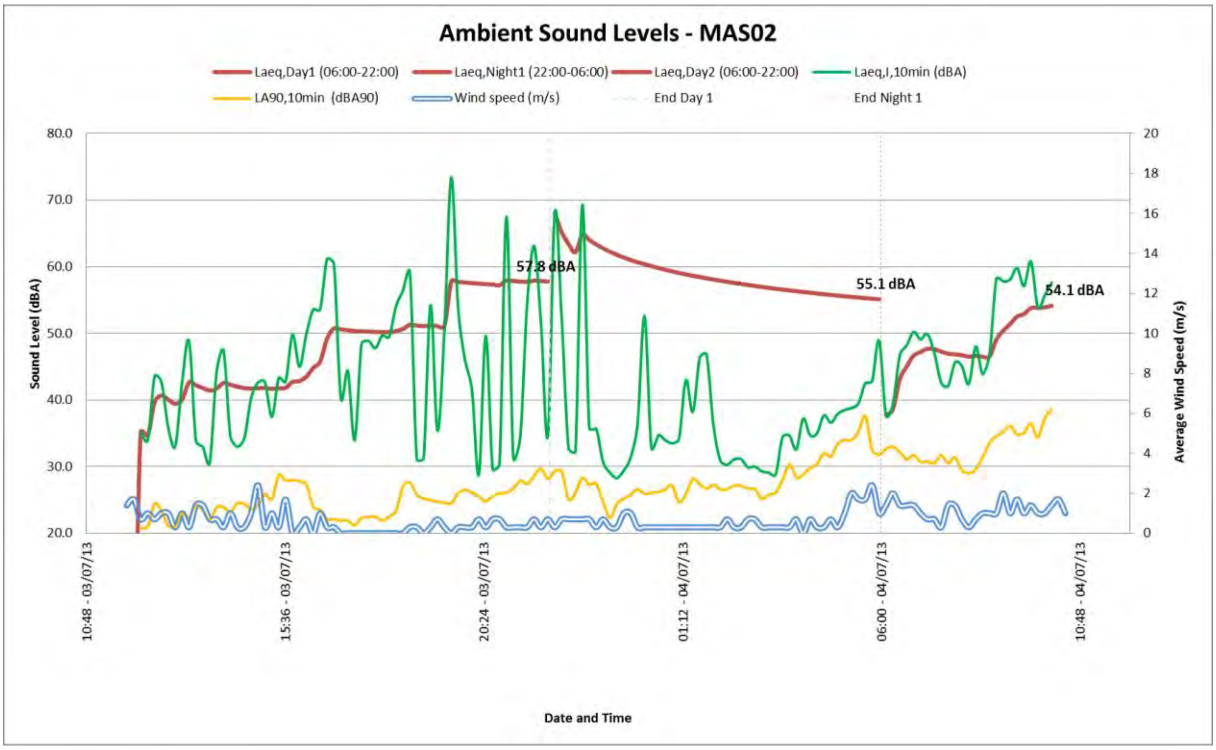



**Figure 3-2: Ambient Sound Levels at MAS02**

**SANS 10103:2008 Rating Level:** Measured data indicate sound levels typical of an Urban district. Based on the measured levels (statistical) and the development character of the area it is the opinion of the author that a rating level typical for a sub-urban area would be acceptable for this location as the average $L_{A90}$ indicates that the ambient noise level could have been lower in the absence of the noisy single events. The measured $L_{Aeq,f}$ levels during the day and night conforms to the recommended of 55 daytime sound level but not with the 45 dBA night-time sound levels of the World Health Organization (**section 2.8.1**), World Bank (see **section 2.8.3**) and International Finance Corporation (see **section 2.8.4**) for a residential areas.

### 3.3.3 Measurement Point MAS03: Farm Sonskyn, house of worker

The measurement location was slightly from the area where the residents spend their time (there were also kids playing in the area, although they were asked to stay away from the instrument). There was a chicken pen with chickens close to the microphone that would influence the measurements. There was no vegetation that can rustle in the wind within 10 meters of the microphone. Birds and chicken sounds dominated the area, with insects, voices defining the background sounds. Traffic on the dirt road was audible during passing. A significant number of single loud events did impact on the equivalent sound levels as shown on **Figure 3-3**. Measured $\mathbf{L_{A90,f}}$ data indicated an area that can be very quiet at periods but that single noisy events are of sufficient duration to impact on this statistical level.

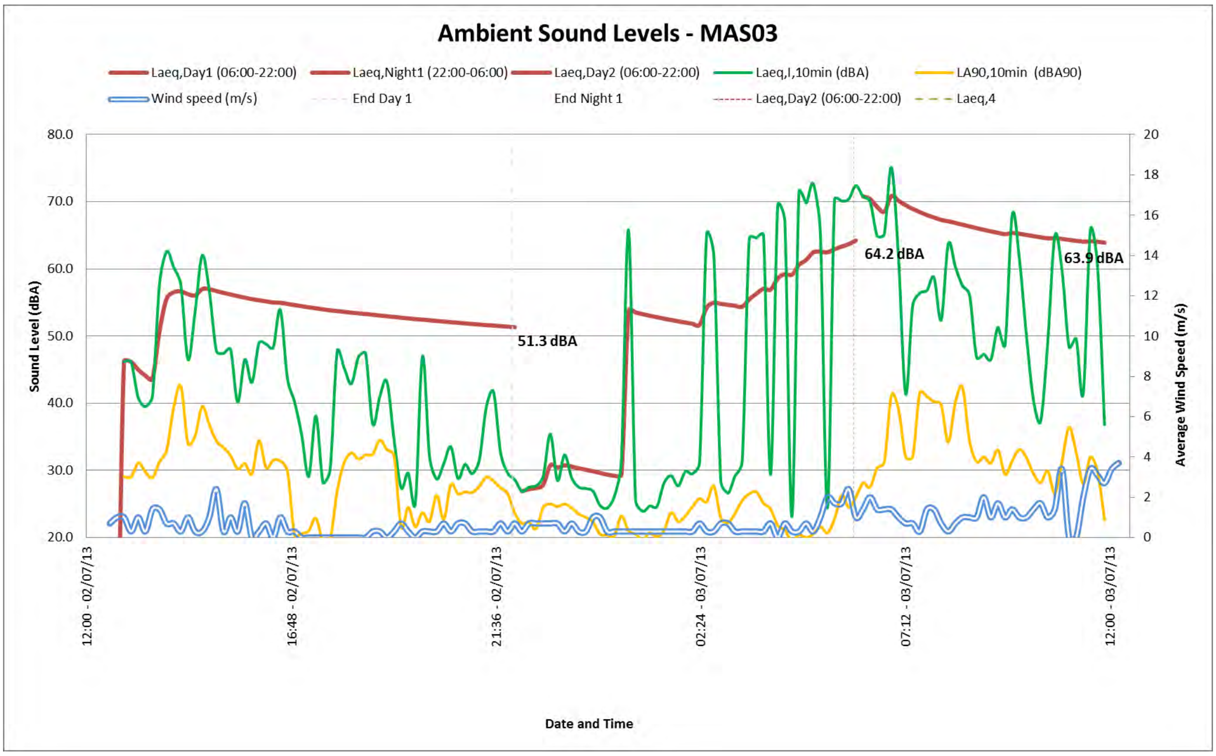



**Figure 3-3: Ambient Sound Levels at MAS03**

Third octave spectral measurements indicate a number of different noise sources with no particular distinctive character although a number of peaks can is clearly visible in a number of the measurements. Based on spectral signature and sound power levels these likely relate to an engine or pump located far from the microphone as well as the chickens.

The higher frequency bands are void of the characteristic peaks indicating insect and frog communication.

**SANS 10103:2008 Rating Level:** Daytime measured data indicate sound levels typical of an area with a urban district noise character. Night-time levels however are very high for a rural area, conforming more to a commercial district zone sound level. Considering the $L_{A90}$ and the developmental character of the area it is the opinion of the author that a rating level typical for a sub-urban area would be acceptable. The measured $L_{Aeq,f}$ levels during the day and night however does not conform to the recommendation of 55 and 45 dBA respectively by the World Health Organization, World Bank and International Finance Corporation for residential areas. It should be noted that the increased noise levels are directly related to the animals in the vicinity of the dwelling.

### 3.3.4 Measurement Point MAS04: Close to dwelling of Mr. Osners

The measurement location was at a quiet spot in the garden next to the fence away from the main dwelling. There were dogs on the property but they never barked during the site visits. There was a water pump operating in the background filling a dam. The microphone was located in a relatively open area further than 5 meters from any vegetation or reflective surfaces (excluding the ground itself). Sounds heard during the period the instrument was deployed and collected were mainly birds and insects, with the water pump faintly audible during quiet periods.

Equivalent sound levels for the day- and night-time periods are shown on **Figure 3-4**. Third octave spectral analysis indicates a very quiet location. This is likely due to the distance from the residential dwelling with little night-time noise sources. Noise sources were likely the water pump (peaks at 25, 50 and 100 – 125 Hz) and due to faunal communication (peaks in the 2 000 (day) and 3 150 – 5 000 Hz frequency bands). The 3 150 – 5 000 Hz frequency band is used by crickets and numerous frog species.

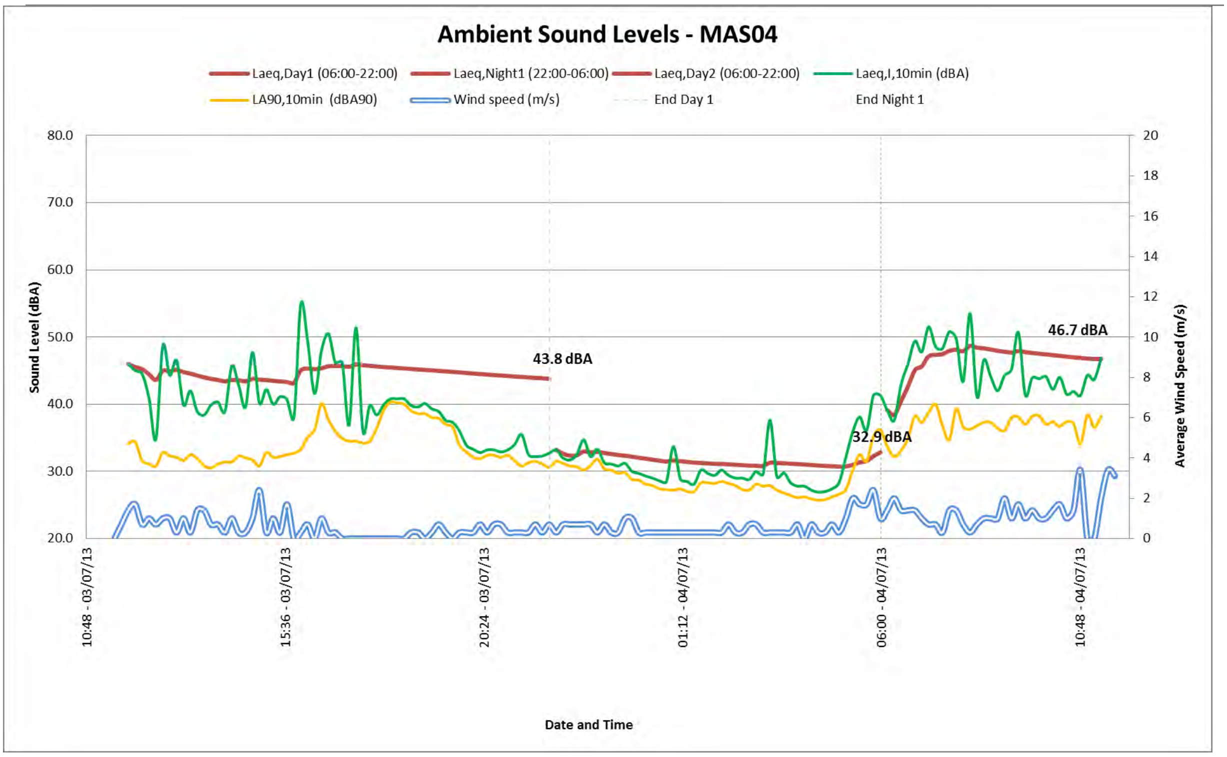



**Figure 3-4: Ambient Sound Levels at MAS04**

**SANS 10103:2008 Rating Level:** Measured data indicate sound levels typical of an area with a rural district sound character. The measured $L_{Aeq,f}$ levels conforms to the recommended 55 and 45 dBA (day and night respectively) by the World Health Organization, World Bank and International Finance Corporation for residential areas.

### 3.3.5 Measurement Point MAS05: Dwelling of Mr. Hanekom

The instruments were deployed at the fence between the house and the animal holding areas. There were goats roaming the property and it was reported that cattle is kept in the kraal at night. There was no vegetation that can rustle in the wind within 10 meters of the microphone. Bird sounds did dominate, with goats loudly audible at times. Voices and sounds from the house, as well as the sounds from insects were audible during quiet periods.

This location recorded a significant number of loud single events that impacted on the equivalent sound levels (see **Figure 3-5**). Considering the difference between the $\mathbf{L_{AIeq}}$ and $\mathbf{L_{Aeq,f}}$ values the single noise events had a highly impulsive character, likely due to sounds from natural sources.

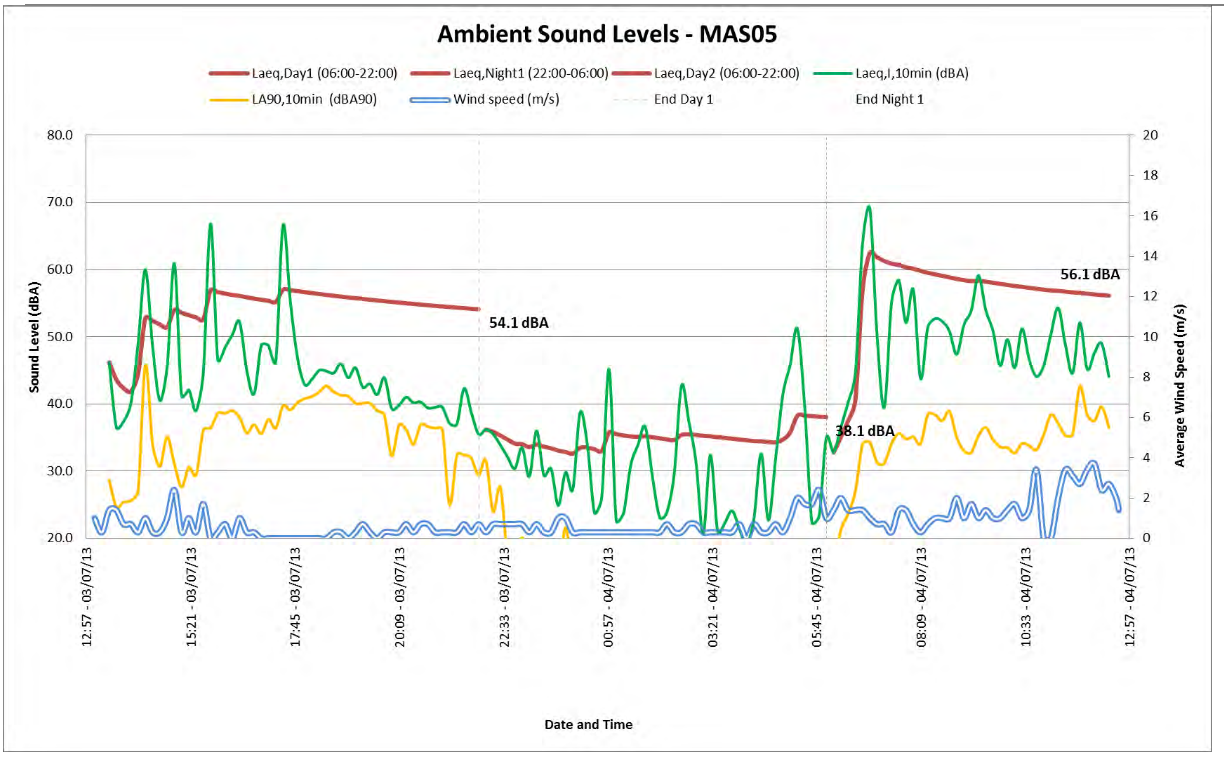



**Figure 3-5: Ambient Sound Levels at MAS05**

Third octave spectral analysis indicates a number of different noise sources, natural and likely of anthropogenic origin.

**SANS 10103:2008 Rating Level:** Daytime measured data indicate sound levels typical of an area with a urban district noise character although night-time levels are closer to a rural area. Considering the $L_{A90}$ and the developmental character of the area it is the opinion of the author that a rating level typical for a sub-urban area would be acceptable. The measured $L_{Aeq,f}$ levels during the day and night does conform to the recommendation of 55 and 45 dBA respectively by the World Health Organization, World Bank and International Finance Corporation for residential areas.

### 3.3.6 Measurement point MAS06: Unused vegetable garden - Mr. van der Merwe

The instrument was deployed inside a closed off area in a disused vegetable garden away from the receptors dwelling. The only clearly definable noise source was from birds in the area, with insects identified during very quiet periods. Wind induced noises were audible at times.

A number of single events with loud noises did impact on the day and night-time equivalent sound levels as shown on **Figure 3-6**. Due to the shape of the wind speed and the $L_{A90}$ graphs it is possible that wind induced noises (leaves rustling in wind) may have impacted on the ambient sound levels.

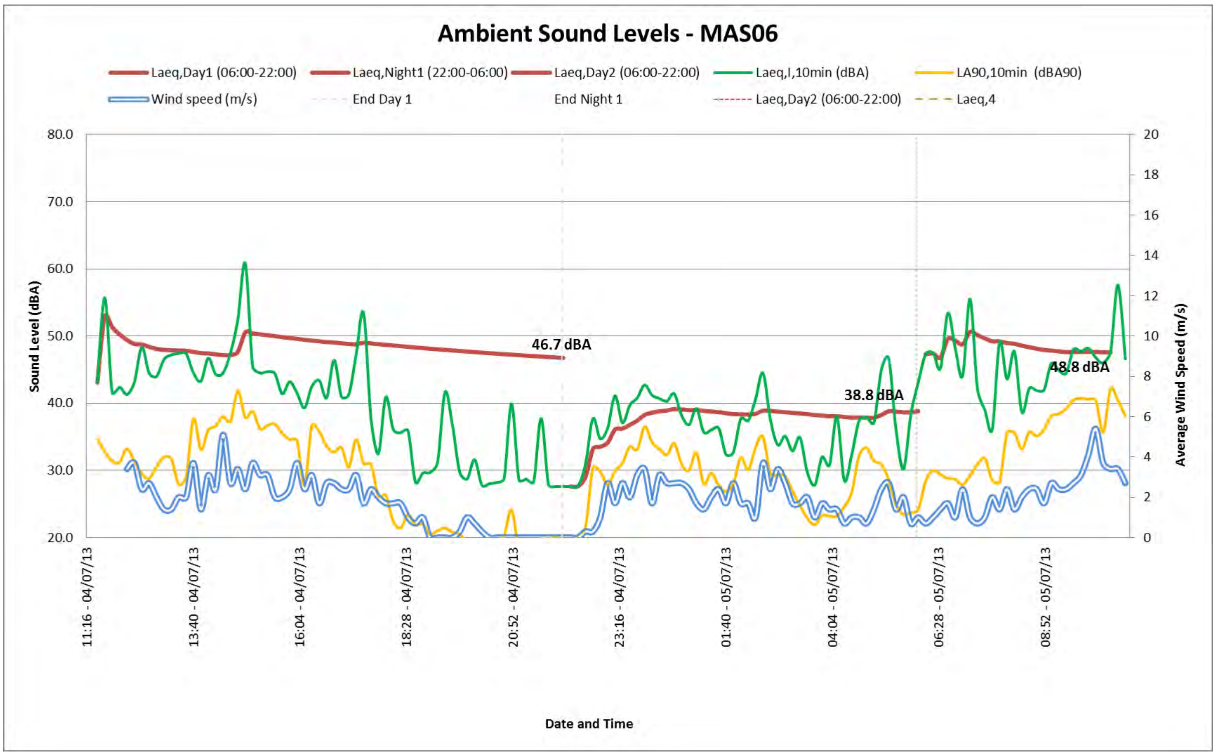



**Figure 3-6: Ambient Sound Levels at MAS06**

**SANS 10103:2008 Rating Level:** Measured data indicate sound levels typical of an rural district. Based on the measured levels (statistical) and the development character of the area it is the opinion of the author that a rating level typical for a sub-urban area would be acceptable for this location. The measured $L_{Aeq,f}$ levels during the day and night conforms to the recommended 55 and 45 sound level set by the World Health Organization, World Bank and International Finance Corporation for a residential area.

### 3.3.7 Measurement Point MAS07: Farm Sonskyn – Foreman's dwelling

The measurement location was at a quiet spot in the garden next to the fence close to the main dwelling. The location was very quiet and birds were mainly audible. The microphone was located in a relatively open area further than 5 meters from any vegetation or reflective surfaces (excluding the ground itself). As with the other locations bird sounds dominated the ambient sound levels, with sound from traffic clearly audible during passing.

Equivalent sound levels for the day- and night-time periods are shown on **Figure 3-7**.

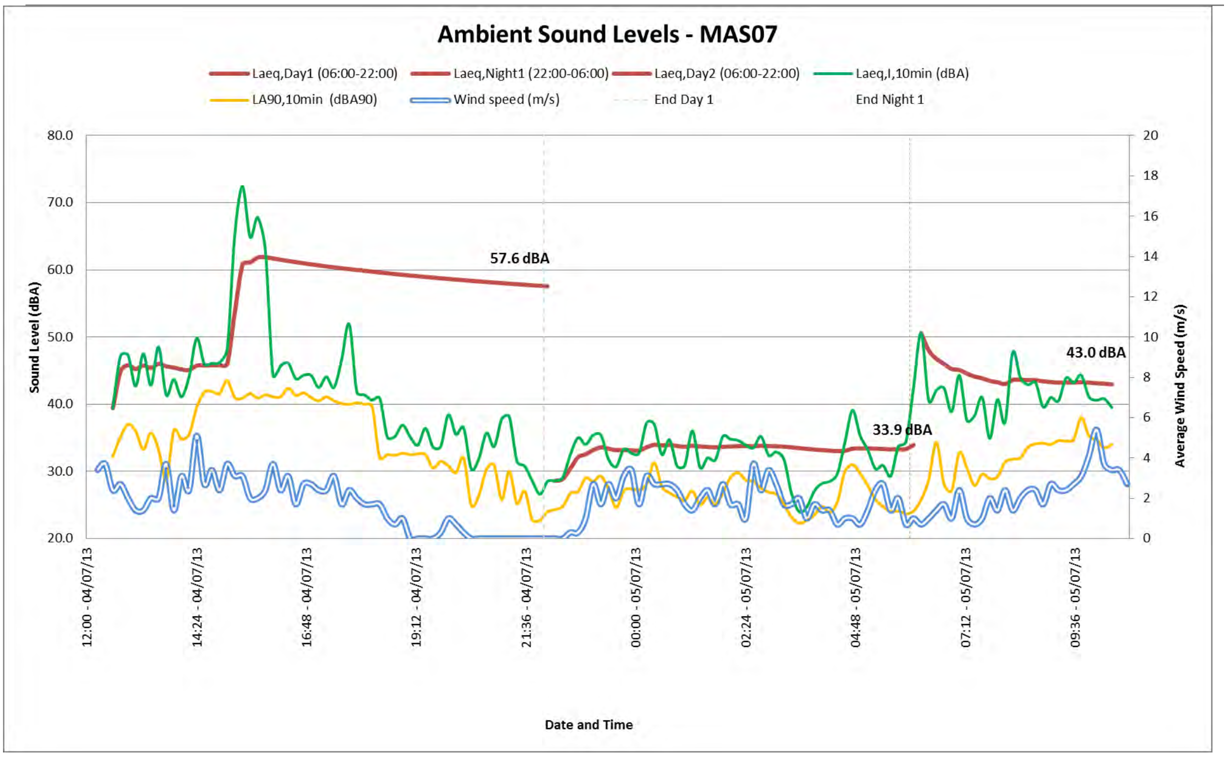



**Figure 3-7: Ambient Sound Levels at MAS07**

Third octave spectral analysis also show a number of different noise sources, with on the quietest measurements indicating the potential spectral character of a pump/engine and faunal communication. A number of measurements indicated wind induced noises.

**SANS 10103:2008 Rating Level:** Measured data indicate sound levels typical of an area with a rural district sound character, even though the first day recorded an equivalent sound level of 57.6 dBA (due to loud noises lasting 30 minutes). The measured $L_{Aeq,f}$ levels conforms to the recommended 55 and 45 dBA (day and night respectively) by the World Health Organization, World Bank and International Finance Corporation for residential areas.

### 3.3.8 Ambient Sound Levels – Summary of Mopane measurements

Equivalent sound levels varied significantly from location to location, with all locations experiencing noisy single events at times that impact on the sound levels (both $L_{Aeq}$ and $L_{A90}$). $L_{A90}$ levels however indicate an area with significant potential to be quiet at times. Equivalent daytime ambient sound levels were measured around between 43 – 64 dBA, ranging between 22 and 75 dBA (10-minute measurements) with equivalent night-time ambient sound levels were measured around between 33 – 64 dBA, ranging between 19 and 75 dBA (10-minute measurements).

The Mopane community and the NSD30 (Mr. Meintjies) currently experience slightly elevated ambient sound levels due to the Limestone Plant in the area. There are however little indication of any significant noise impacts from external sources of anthropogenic origin at other monitoring locations. While the gravel roads in the area does increase noise levels due to single events, the main source of noise appears to be originating from local dwellings. The source in most cases relates to faunal activity around the dwellings. This is specifically clear at measurement location MAS03 where chickens raised the noise levels to those similar of a commercial district. It is the opinion of the author that faunal communication was subdued due to the winter period, and that higher sound levels will be likely during the spring and summer months due to faunal communication.

Due to the significant variance in ambient sound measurements it is recommended that the project use the guideline levels for residential use as set by international institutions such as World Health Organization, World Bank and International Finance Corporation for residential areas (see **Table 2-1**). In areas where there are higher ambient sound levels the introduction of the project should aim to limit the change in ambient sound levels with less than 3 dBA.

## 3.4 AMBIENT SOUND LEVEL MEASUREMENTS – CHAPUDI PROJECT AREA

Ambient sound measurements were collected for the Chapudi Coal Project from the morning of 16 September to the afternoon of 19 September 2013. A total of five different class-1 sound level meters as well as two portable weather stations were used. The internal clocks were set to GMT+2. All the instruments were set to measure the appropriate variables in 10-minute bins till the measurements were stopped. The sound level meters therefore would measure "average" sound levels over a period of 10 minutes, save the data and start with a new 10-minute measurement till the instrument is stopped.

**Appendix B** presents photos taken of the measurement locations. Measurement locations were numbered as **CBN01** to **CBN09** in this report (see **Table 3-2**). These measurements were conducted over a period of approximately 20 – 24 hours.

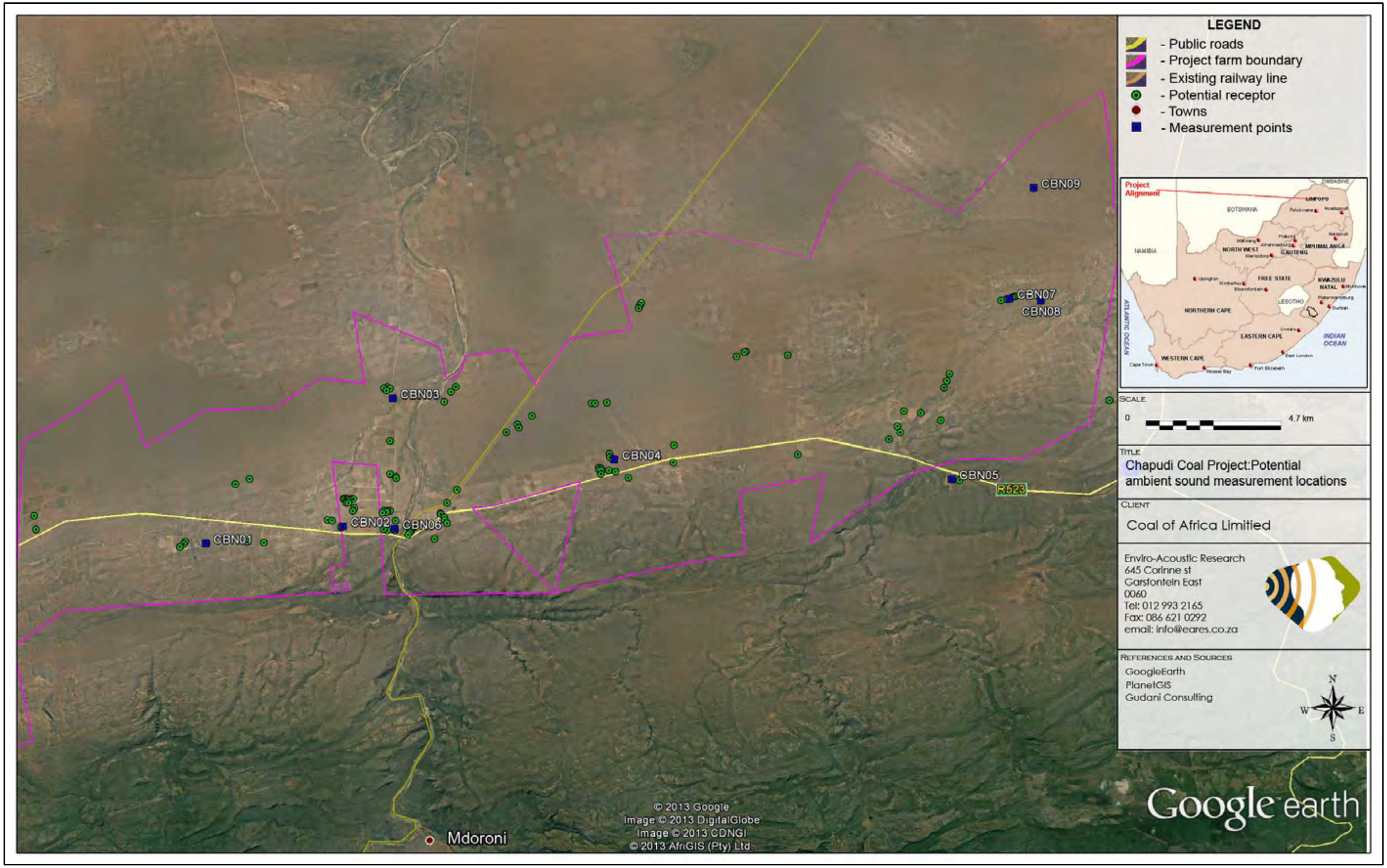



**Figure 3-8: Localities of ambient sound level measurements**

**Table 3-2: Chapudi Day/night-time measurement locations (Datum type: WGS 84)**

| Point name | Latitude | Longitude |
|---|---|---|
| **CBN01** | -22.910331° | 29.542404° |
| **CBN02** | -22.904723° | 29.591518° |
| **CBN03** | -22.862403° | 29.608919° |
| **CBN04** | -22.882683° | 29.688756° |
| **CBN05** | -22.889203° | 29.809701° |
| **CBN06** | -22.905588° | 29.609867° |
| **CBN07** | -22.829125° | 29.831294° |
| **CBN08** | -22.829789° | 29.842715° |
| **CBN09** | -22.791903° | 29.840518° |

### 3.4.1 Traffic Counts

Traffic counts were done on both the R523 and the N1. This is because road traffic is one of the major sources of noise in the world, especially in urban areas. In quiet rural areas traffic can be heard as far as 2 000 meters from a road, impacting on ambient sound levels up to 1 000 meters from that road.

Road Traffic has a relatively distinctive spectral character, illustrated in **Figure 3-9**. This figure illustrate the spectral character of road traffic noise collected over a period of more than 48 hours at a location approximately 20 meters from the road. Measurements indicated that road traffic was dominant at all times, slightly reducing at night. The measurements collected between 01:00 and 04:00 in the mornings were removed for clarity (ambient sound levels at this location were still higher than 64 dBA during this "quieter" period.

Road traffic generally dominates the frequency bands between 40 – 160 Hz as well as 630 – 2 500 Hz (peaking at 63 and 1 000 Hz – for road traffic travelling at ±120 km/h on a tar road). The 40 – 160 Hz frequency band is generally dominated by noises originating from the vehicle engine and exhaust (engine revolutions and harmonics). The 630 – 2 500 frequency band generally relates to noise generated due to the road surface/tyre surface interaction. While speed does impact on the shape of the graph, it still allows the identification of road traffic noises from roads in most cases.

Traffic counts on the R523 indicated that this road carries a significant portion of heavy vehicles, with the road reported to carry traffic (especially heavy vehicles till late in the evenings). Traffic counts during the site visit indicated that almost 50% of the vehicles being heavy articulated trucks. Total traffic ranges between 3 vehicles to 14 vehicles per 10 minute count. An hour count the afternoon of 17 September indicated 37 vehicles, of which 16 vehicles were large trucks. While this road were not busy enough to significantly impact on the spectral characteristics, the effect will still be noticeable in the measurements collected at locations within a few hundred meters from the road.

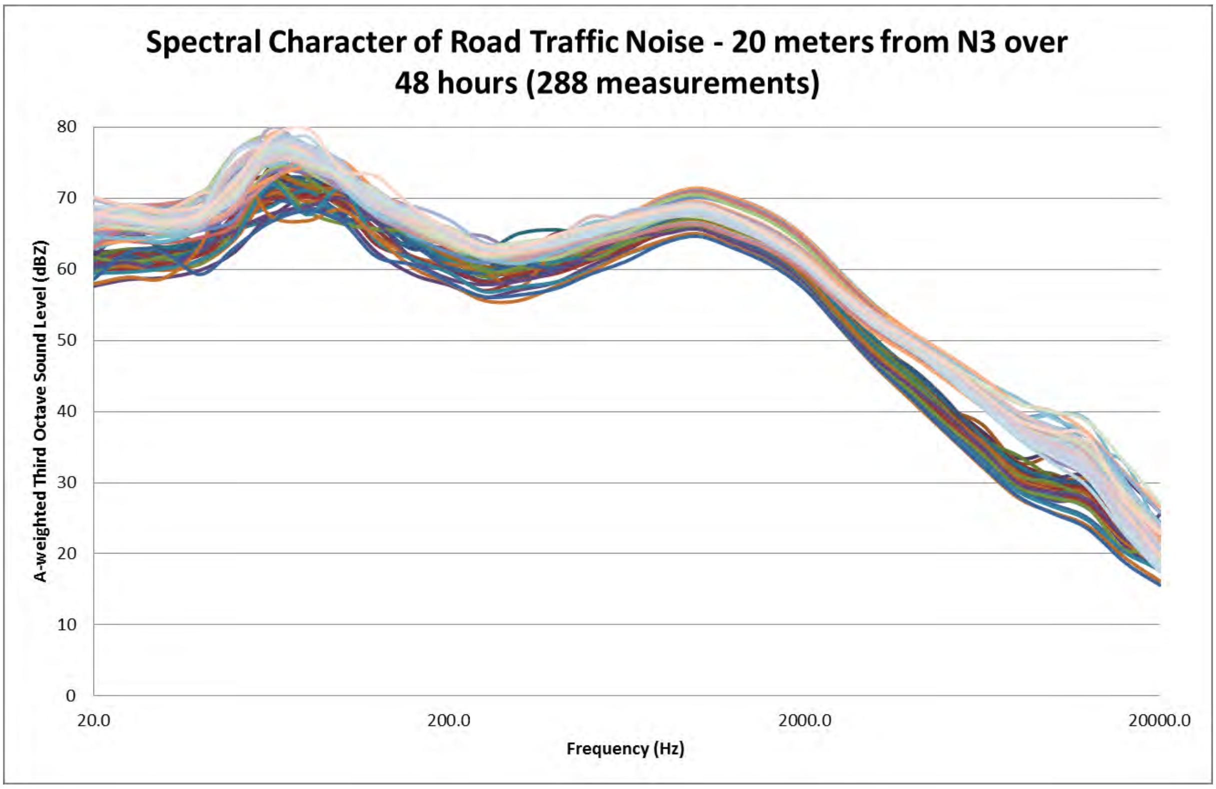



**Figure 3-9: Spectral frequency character of traffic on the N3 National Road**

Traffic counts (19 and 20 September 2013) on the N1 indicated a relatively busy road, with traffic ranging between 200 vehicles per hour during the afternoon) to less than 60 vehicles per hour (between 02:00 and 04:00). Approximately 10 – 15% of these vehicles are heavy articulated trucks. This road is busy enough to significantly impact on the sound levels (and spectral characteristics) up to a distance of up to 1,000 meters from the road.

### 3.4.2 Measurement Point CBN01: Farm Rietspruit (Mr. Koos Pauer)

A number of 10 minute measurements were taken over a day/night period on 16 – 17 September 2013. The equipment defined in **Table 3-3** was used for gathering data. Measured sound levels are presented in **Figure 3-10**.

**Table 3-3: Equipment used to gather data (SVAN 955)**

| Equipment | Model | Serial no | Calibration Date |
|---|---|---|---|
| SLM | Svan 955 | 27637 | 15 May 2013 |
| Microphone* | ACO 7052E | 52437 | 15 May 2013 |
| Calibrator | Rion NC-74 | 34494286 | 23 January 2013 |

* Microphone fitted with the RION WS-03 outdoor all-weather windshield.

The instrument was deployed in an area away from the residential dwelling at a location considered suitable to reflect the sound character of the area. There was unfortunately a large tree within ±10 meters of the microphone that would introduce wind-induced noises during elevated wind speeds. Refer to **Appendix B** for a photo of this measurement location.

**Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes):** Refer to **Table 3-4** indicating sounds heard at the measurement point by the acoustical consultant.

**Table 3-4: Noises/sounds heard during site visits at receptor CBN01**

| Ambient Sound Character -Sounds of Significance | |
|---|---|
| Magnitude Scale Code: Barely Audible, Audible, Dominating | **Faunal and Natural**<br>Slight wind induced-noises (at times during gusts). Insects. Birds. |
| | **Residential and other Anthropogenic**<br>Dog in kennel barking very loudly at times |
| | **Industries, Commercial and Road Traffic**<br>Nothing audible. |

**Impulse equivalent sound levels:** During the daytime $L_{AIeq}$ values ranged between 37.1 to 67.8 dBA. The night-time $L_{AIeq}$ values ranged between 41.1 to 60.3 dBA. The average value of the 94 10-minute equivalent daytime measurements was calculated at 49.8 dBA, while the average for the 48 night-time measurements were calculated at 53.8 dBA. Equivalent (average) sound levels for the day- and night-time periods are shown on **Figure 3-10**.

**Statistical sound levels ($L_{A90,f}$):** The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-10**. $L_{A90,f}$ daytime values ranged from 24.1 to 47.5 dBA90. The night-time $L_{A90,f}$ values ranged from 21.8 to 49.2 dBA90. Measured $L_{A90,f}$ data indicated an area where there is a constant noise that is impacting on the ambient sound levels. Comparing this site with data collected at a quiet location $L_{A90}$ levels could be less than 20 dBA90 at night.

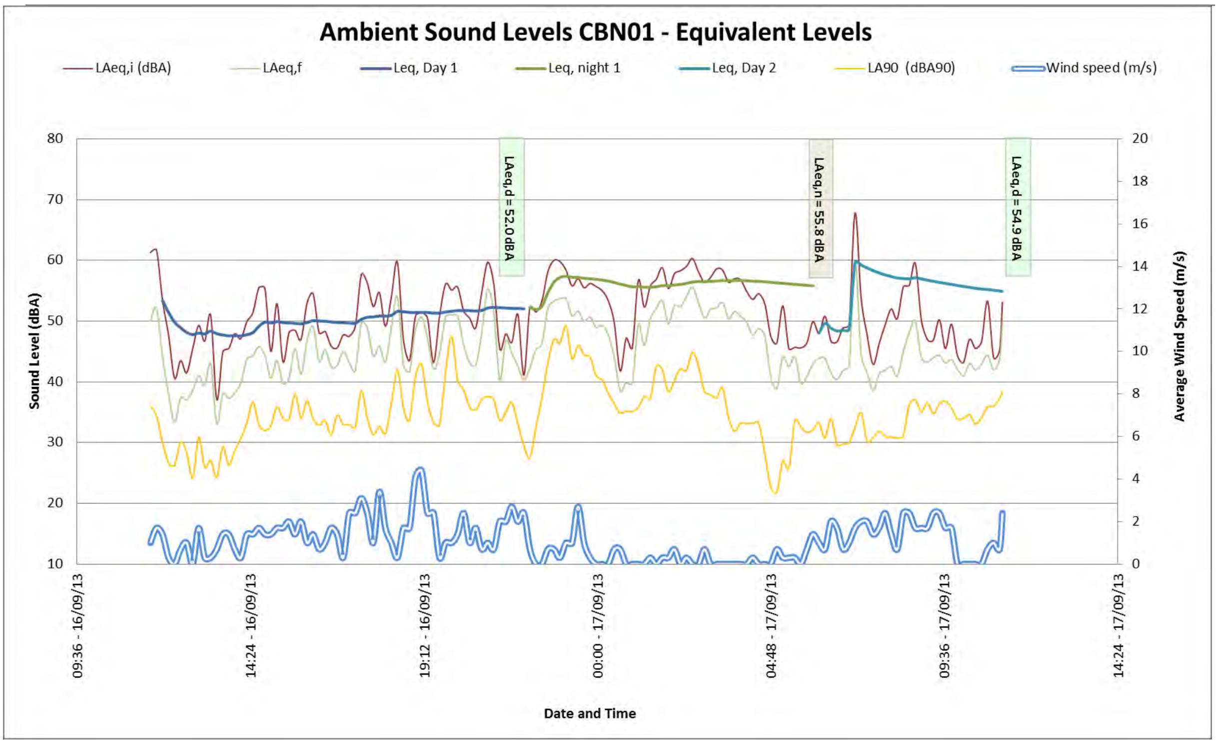



**Figure 3-10: Ambient Sound Levels at CBN01**

**Maximum noise levels:** Maximum noise levels are illustrated on **Figure 3-11**. The equivalent sound level graph has a shape similar to the maximum noise level graph, indicating that maximum noise events did influence the equivalent sound level readings. There is an average difference of ±17 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 7 and 30 dB. Considering the $L_{A90}$ and $L_{AIeq}$ graphs maximum noises were of sufficient duration (or a number of short events) to impact on the equivalent sound levels, but not long enough to impact statistical readings. The source of the maximum noises is undefined but likely of natural origin (chirp of bird, bark of dog, etc).

**Minimum noise levels:** Minimum noise levels are illustrated on **Figure 3-11**. Considering both the $L_{A90}$ and $L_{A,min}$ graphs shows an area where minimum noise levels averages at 27 dBA, indicating an area that is seldom very quiet.

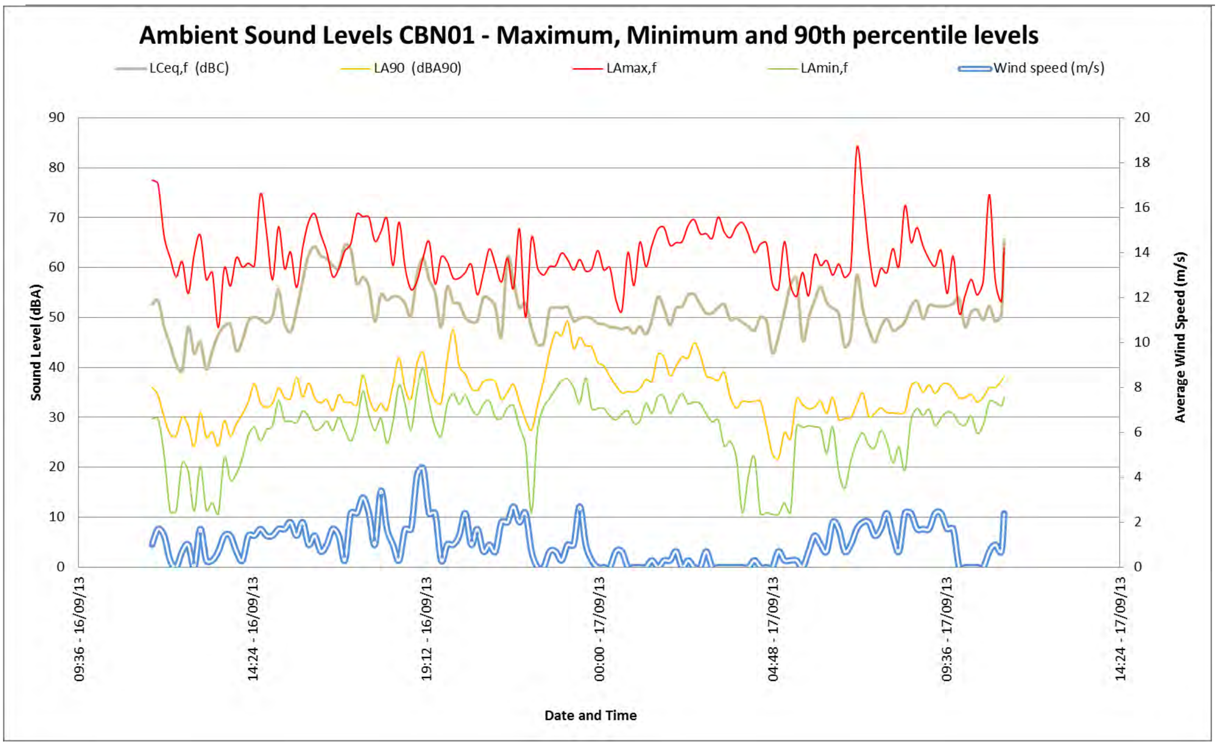



**Figure 3-11: Maximum, Minimum and Statistical sound levels at CBN01**

### Third octave spectral analysis

Lower frequency (20 – 250 Hz): This frequency band is generally dominated by noises originating from anthropogenic activities (vehicles idling and driving, pumps and motors, etc) as well as certain natural phenomena (wind and ocean surf). Motor vehicle engine revs per minute (rpm) convert to this range of frequency (not considering other motor car acoustical sources e.g. tyre to road interaction pumping and "horn effect")[9]. Most measurements (see **Figure 3-12**) illustrate the spectral character of a number of different noise sources with no particular distinctive character. A few measurements reflect a peak in the 25, 50 and 63 Hz frequency bands with the source unknown (see **Figure 3-13**). The loudest two measurements (63 Hz) occurred just before 06:00, likely a car engine.

Third octave surrounding 1000 Hz: This range contains energy mostly associated with human speech (mostly 350 Hz – 2,000 Hz, could be between 20 – 16,000 Hz), dwelling related sounds and road to tyre interaction from road traffic. This frequency band did not show any particular (consistent) peaks in this region, although the night-time measurements indicate a sound source that elevated the sound levels in the 400 to 2,000 Hz frequency bands. As this occurred during the hours of 02:00 and 04:00 it is unlikely to be due to human communication. At a sound power level of only 40 dB it is a relative soft source, considering other, louder noises (at higher frequencies) in the area.

[9] Mechanical Engineering Conversion Factors, Dr. K. Clark Midkiff

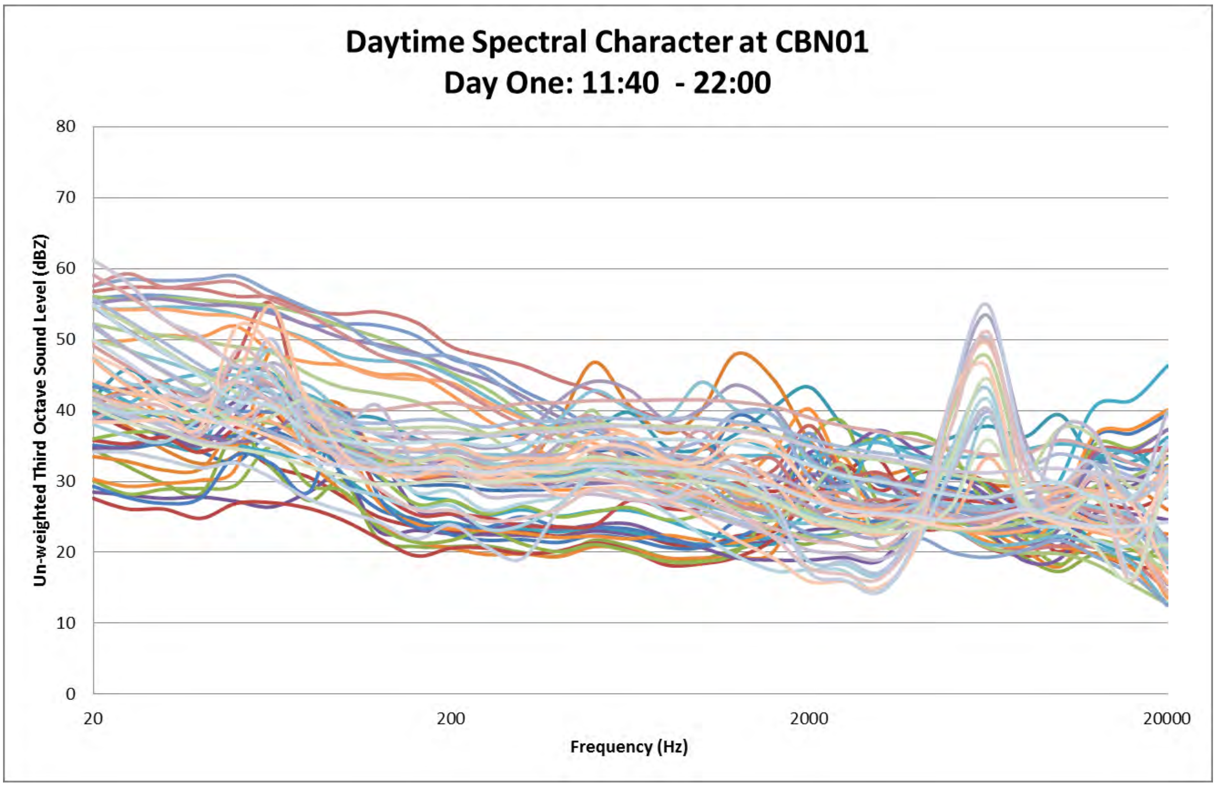



**Figure 3-12: Daytime spectral frequency distribution at CBN01, day one**

Higher frequency (2,000 Hz upwards): Most faunal species, including larger animals, birds, frogs, crickets and cicada would use this range to communicate and hunt etc.[10] Late afternoon and night measurements showed peaks in the 4,000 – 5,000, 6,300, 10,000 – 12,500 and 20,000 frequency bands, likely from faunal communication. These faunal noise sources were relatively loud and were the dominant sound in the area.

**Summary: Spectral Analysis**

The loudest equivalent sound levels recorded at this location were due to wind-induced noises, with faunal sounds dominating most of the measurements.

[10] A Paradoxical Problem. Can bush crickets discriminate frequency?, J.C Hartley, University of Nottingham. An Automatic Monitoring System for Recording Bat Activity, Colin O' Donnel and JAnd Sedgeley.Short Communication. The Scaling of song Frequency in Cicadas, H.C Bennet-Clark (1994).

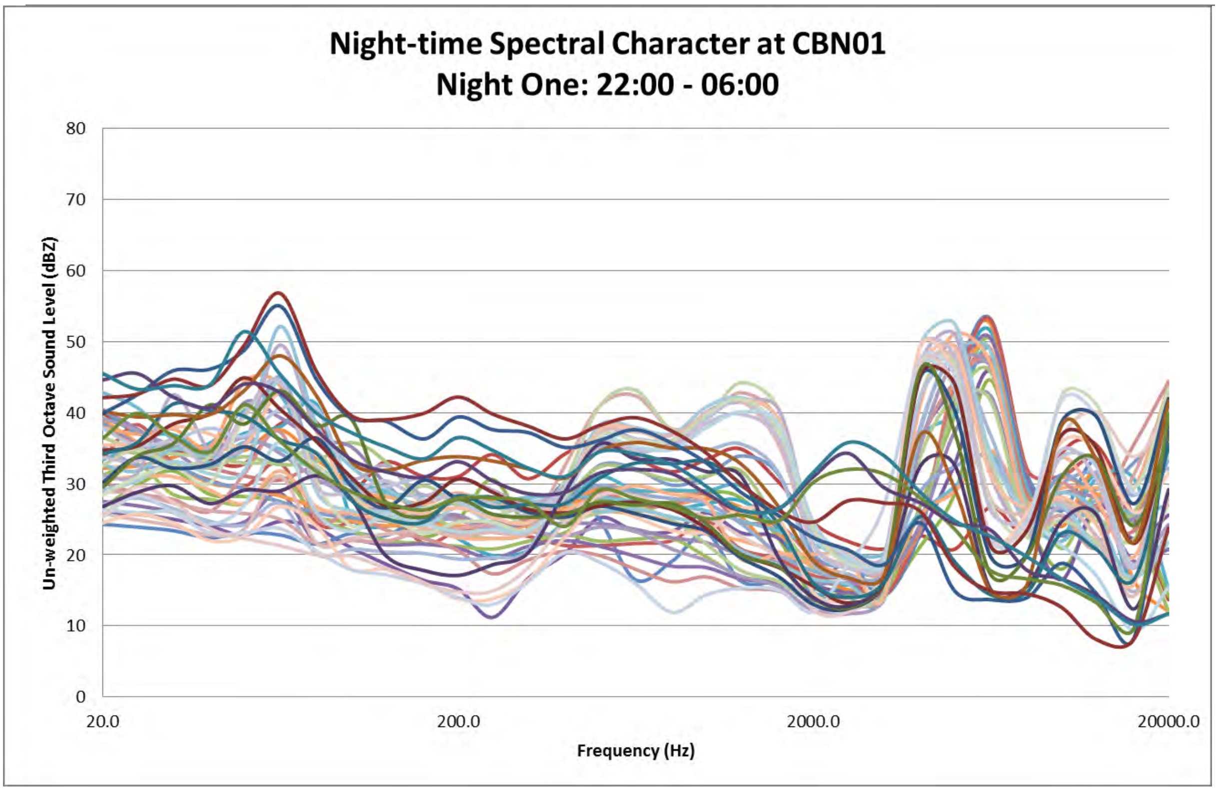



**Figure 3-13: Night-time spectral frequency distribution at CBN01, first night**

**SANS 10103:2008 Rating Level:** While the developmental character of the area conforms to a rural area, measured daytime data indicate sound levels typical of an area with a suburban to urban district character. Night-time levels however are far higher than expected for a rural area, conforming more to a commercial district zone sound level. Considering the spectral frequencies measured, the source of the noise were natural (wind and faunal). Considering the $L_{A90}$ and developmental character of the area it is the opinion of the author that a rating level typical for a sub-urban area would be acceptable. Daytime measured $L_{Aeq,f}$ levels during the day conforms to the recommendation of 55 dBA respectively by the World Health Organization (**section 2.8.1**), World Bank (see **section 2.8.3**) and International Finance Corporation (see **section 2.8.4**) for a residential area. Night-time levels however are higher than these guidelines, but, with the source being natural it will have a high acceptability to the receptors in the area.

### 3.4.3 Measurement point CBN02: Farm of Mr. Awie Wright

The measurement location was inside a vegetable garden enclosed in shade netting. Although not ideal, the shade netting was considered to be acoustically transparent. The measurement point was located away from the receptors dwelling due to the presence of one or more air conditioners, with one reported to run "24-hours" a day. Measurements were taken over a day/night period, 16 – 17 September 2013. Refer to **Appendix B** for photos of this measurement point.

The equipment defined in **Table 3-5** was used for gathering data. Measured data is presented in **Figure 3-14**.

**Table 3-5: Equipment used to gather data (SVAN 977)**

| Equipment | Model | Serial no | Calibration Date |
|---|---|---|---|
| SLM | Svan 977 | 34160 | 17 May 2013 |
| Microphone | ACO 7052E | 54645 | 17 May 2013 |
| Calibrator | Rion NC-74 | 34494286 | 23 January 2013 |

* Microphone fitted with the RION WS-03 all-weather outdoor windshield.

**Sounds heard during measurements dates:** Refer to **Table 3-6** indicating sounds heard at the measurement point by the acoustical consultant.

**Table 3-6: Noises/sounds heard during site visits at CBN02**

| Ambient Sound Character -Sounds of Significance | |
|---|---|
| Magnitude Scale Code: Barely Audible, Audible, Dominating | **Faunal and Natural**<br>Wind sheer, rustling of tree leaves. Insects. Birds (during call/communication). |
| | **Residential and other Anthropogenic**<br>Workers at the receptors dwelling, aircon, voices, water Sprayers in area. |
| | **Industries, Commercial and Road Traffic**<br>Road traffic (during passing). |

**Impulse equivalent sound levels:** During the daytime $L_{AIeq}$ values ranged between 44.5 to 61.6 dBA. The night-time $L_{AIeq}$ values ranged between 38.0 to 63.2 dBA. The average value of the 88 10-minute equivalent daytime measurements was calculated at 51.0 dBA, while the average for the 48 night-time measurements was calculated at 53.7 dBA. A number of single events with loud noises however impacted on the day and night-time equivalent sound levels as shown on **Figure 3-14**.

**Statistical sound levels ($L_{A90,f}$):** The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average and equivalent sound levels. It is illustrated on **Figure 3-14** and **Figure 3-15**. $L_{A90,f}$ daytime values ranged from 30.5 to 50.0 dBA90. The night-time $L_{A90,f}$ values ranged from 32.3 to 51.0 dBA90.

**Maximum noise levels:** Maximum noise levels are illustrated on **Figure 3-15**. The maximum noise level graph is quite different from the equivalent sound level graph, indicating that loud noise events were generally of short duration as it had a small influence on the equivalent sound levels. There is an average difference of almost 14 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 4 and 31 dB. The source of the maximum noises is undefined.

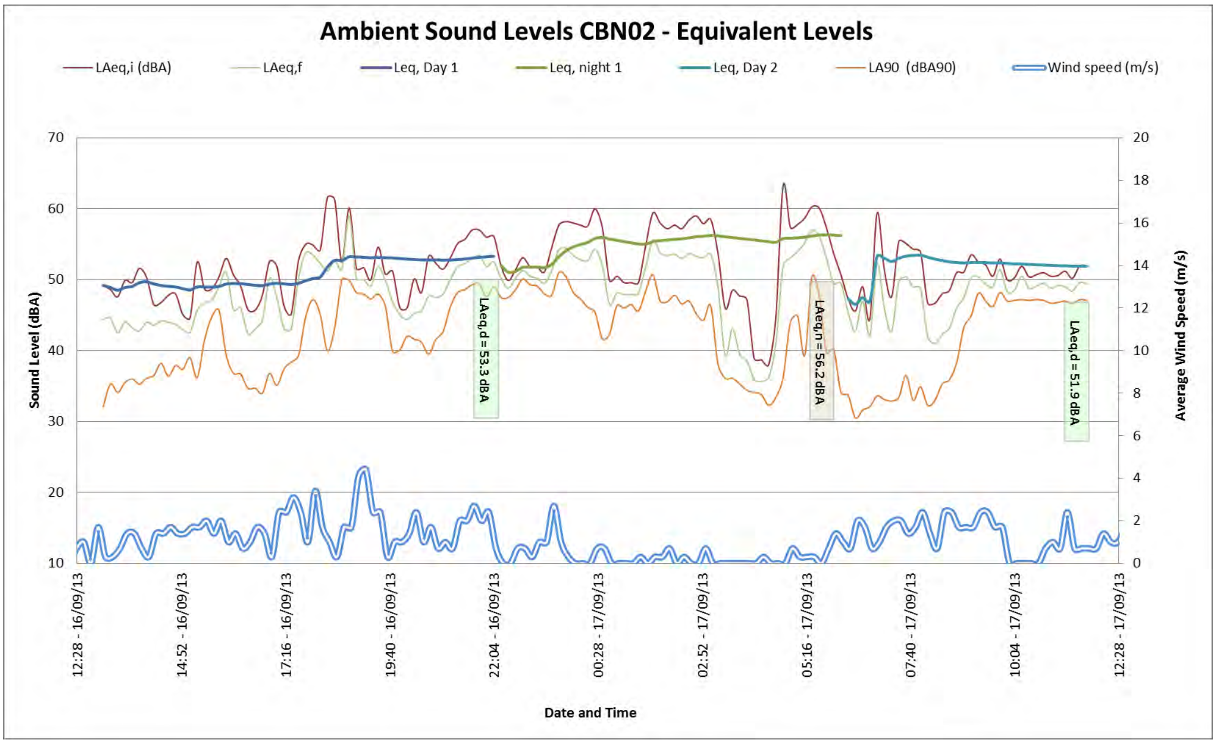



**Figure 3-14: Ambient Sound Levels at CBN02**

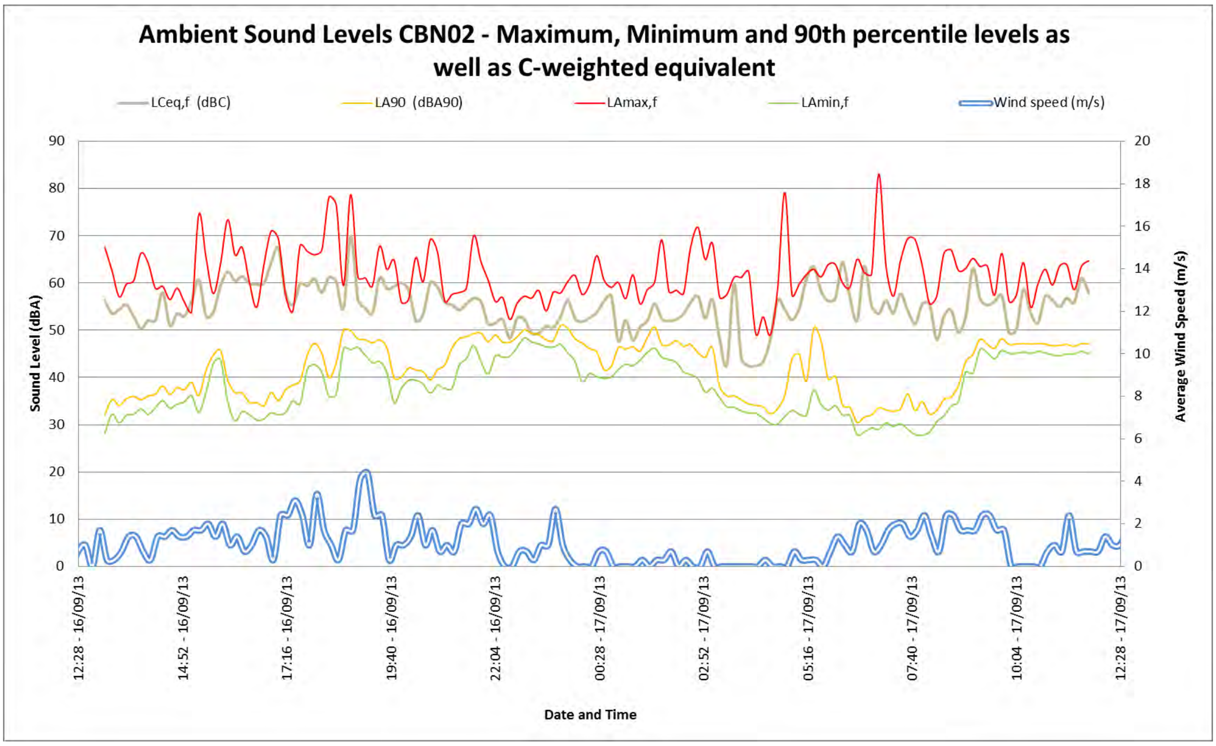



**Figure 3-15: Maximum, Minimum and Statistical sound levels at CBN02**

**Minimum noise levels:** Minimum noise levels are illustrated on **Figure 3-15**. Minimum noise levels ranged between 28 and 48 dBA, averaging at 38 dBA. Considering both the $L_{A90}$ and $L_{A,min}$ graphs shows an area that is noisy for the developmental character.

**Third octave spectral analysis**

Lower frequency (20 – 250 Hz): Most measurements (see **Figure 3-16**) illustrate the spectral character of a number of different noise sources with no particular distinctive character. A number of measurements indicate the potential impact from road traffic, although the lack of the peak at 1,000 Hz indicate traffic travelling at speeds lower than 60 – 80 km/h. Daytime measurements also indicate wind-induced noises. Night-time measurements is similar to the daytime measurements, with quieter measurements showing a peaks at 50 and 100 Hz, frequently associated with an electric motor (potentially the air conditioner) (see **Figure 3-17**).

Third octave surrounding 1000 Hz: This frequency band did not show any particular peaks in this region, with only the loudest night-time measurements indicating a slight bump in the 630 – 1,000 Hz frequency bands.

Higher frequency (2,000 Hz upwards): Late afternoon and night measurements showed peaks in the 2,500, 4,000, 10,000 – 12,500 and 20,000 frequency bands, likely of faunal origin. These faunal noise sources were relatively loud and were the dominant sound in the area[11].

**Summary: Spectral Analysis**

The loudest equivalent sound levels recorded at this location were due to faunal sounds (4,000 Hz) with sounds from the road impacting on the lower frequencies.

[11] Even though there were a number of measurements where various low frequency bands contained more acoustic energy, the human ear have difficulties in detecting the lower frequencies (there would be a reduction in the octave sound level when converting from the Z-weighting to A-weighting (between -50 dB @ 20 Hz to -26 @ 63 Hz)).

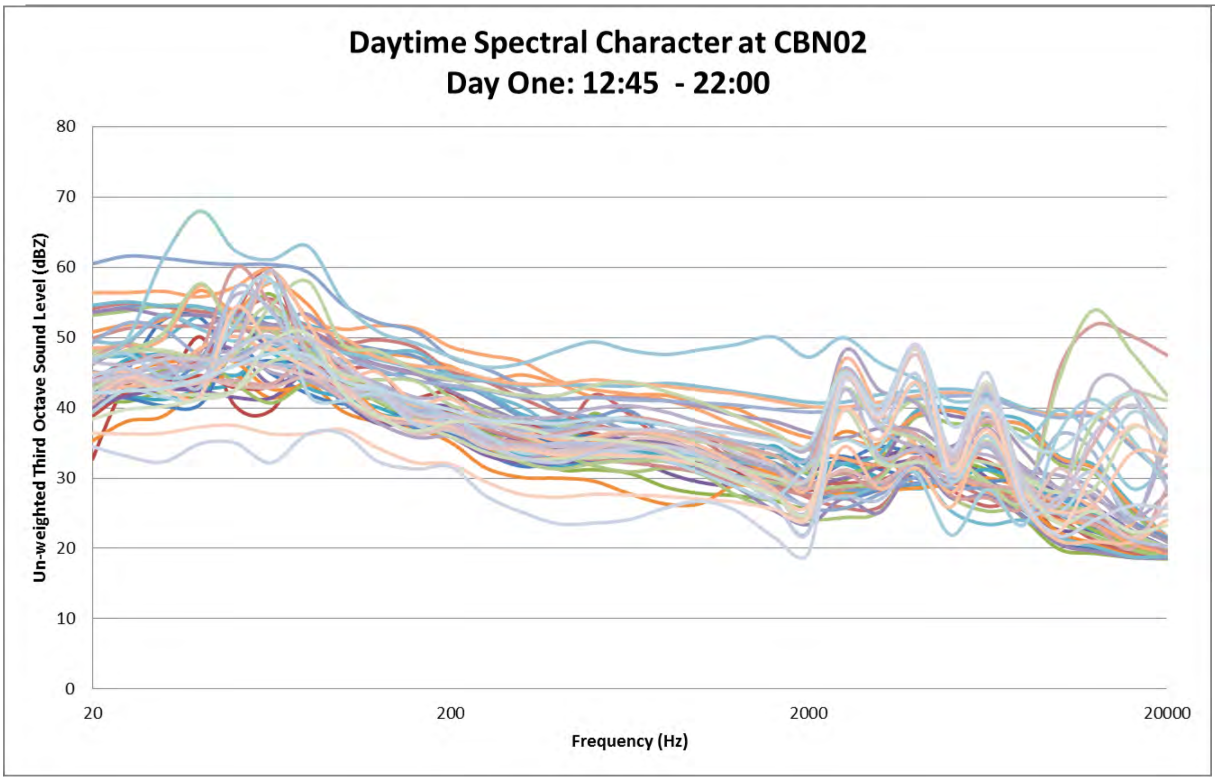



**Figure 3-16: Daytime spectral frequency distribution at CBN02, day one**

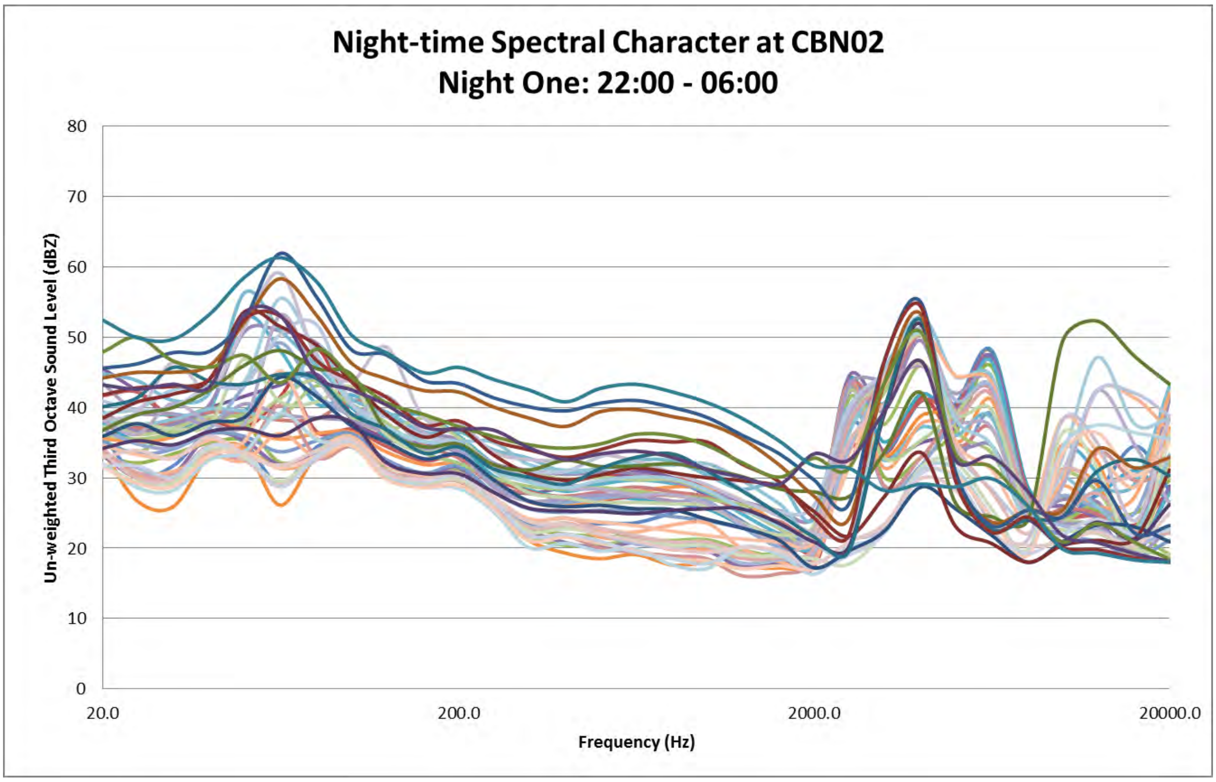



**Figure 3-17: Night-time spectral frequency distribution at CBN02, first night**

**SANS 10103:2008 Rating Level:** The proximity of the main road would likely change the SANS 10103:2008 district to urban (with one or more of the following; main roads, business or workshops). Measured daytime data indicate sound levels typical of an area with a suburban to urban district character. Night-time levels are also far higher than expected, conforming more to a commercial district zone sound level. Considering the spectral frequencies measured, the source of the noise was natural (faunal). Considering the $L_{A90}$ and developmental character of the area it is the opinion of the author that a rating level typical for an urban area (with one or more of the following; main roads, business or workshops) would be acceptable. Daytime measured $L_{Aeq,f}$ levels during the day conforms to the recommendation of 55 dBA respectively by the World Health Organization, World Bank and International Finance Corporation for a residential area. Night-time levels however are higher than these guidelines, but, with the source being natural it will have a high acceptability to the receptors in the area.

### 3.4.4 Measurement Point CBN03: Farm of Mr. Fleuriot

The instrument was deployed in the garden in front of the house of Mr. Fleuriot. An error with the data card resulted in no measurements being recorded to the memory card. Refer to **Appendix B** for a photo of this measurement location. It was selected not to redo the measurement due to the amount of birds in the vicinity of the dwelling (due to the presence of fig trees).

**Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes):** Refer to **Table 3-7** indicating sounds heard at the measurement point by the acoustical consultant.

**Table 3-7: Noises/sounds heard during site visits at receptor CBN03**

| Ambient Sound Character -Sounds of Significance | |
|---|---|
| Magnitude Scale Code: Barely Audible, Audible, Dominating | **Faunal and Natural**<br>Birds dominating. |
| | **Residential and other Anthropogenic**<br>Nothing |
| | **Industries, Commercial and Road Traffic**<br>During single events (Vehicles passing on the road). |

### 3.4.5 Measurement Point CBN04: Dwelling of Mr. Breytenbach

Measurements were taken over a day/night period, 16 – 17 September 2013. The equipment defined in **Table 3-8** was used for gathering data. Measured sound levels are presented in **Figure 3-18**.

**Table 3-8: Equipment used to gather data (SVAN 955)**

| Equipment | Model | Serial no | Calibration Date |
|---|---|---|---|
| SLM | Svan 955 | 27324 | 25 April 2013 |
| Microphone* | ACO 7052E | 49596 | 25 April 2013 |
| Calibrator | Rion NC-74 | 34494286 | 23 January 2013 |

* Microphone fitted with the RION WS-03 outdoor all-weather windshield.

The measurement location was at a quiet spot in the garden away from the area frequented by the family. There were large dogs on the property but they never barked during the site visits. The microphone unfortunately had a direct line of sight to a camp where geese were held. There was no vegetation that can rustle within 5 meters from the microphone. Refer to **Appendix B** for a photo of this measurement location.

**Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes):** Refer to **Table 3-9** indicating sounds heard at the measurement point by the acoustical consultant.

**Table 3-9: Noises/sounds heard during site visits at receptor CBN04**

| Ambient Sound Character -Sounds of Significance | |
|---|---|
| Magnitude Scale Code: Barely Audible, Audible, Dominating | **Faunal and Natural**<br>Wind induces noises. Geese, Insects and Birds. |
| | **Residential and other Anthropogenic**<br>Activities at house. A baby crying. |
| | **Industries, Commercial and Road Traffic**<br>Traffic on the road. |

**Impulse equivalent sound levels:** During the daytime $L_{AIeq}$ values ranged between 41.4 to 58.1 dBA. The night-time $L_{AIeq}$ values ranged between 42.3 to 59.5 dBA. The average value of the 82 10-minute equivalent daytime measurements was calculated at 49.5 dBA, while the average for the 48 night-time measurements calculated at 46.6 dBA. Equivalent sound levels for the day- and night-time periods are shown on **Figure 3-18**.

**Statistical sound levels ($L_{A90,f}$):** The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-18**. $L_{A90,f}$ daytime values ranged from 31.8 to 46.3 dBA90. The night-time $L_{A90,f}$ values ranged from 29.6 to 44.8 dBA90. Measured $L_{A90,f}$ data indicated an area where there is a constant background noise that is impacting on the ambient sound levels. Comparing this site with data collected at a quiet location $L_{A90}$ levels would be less than 20 dBA90 at night.

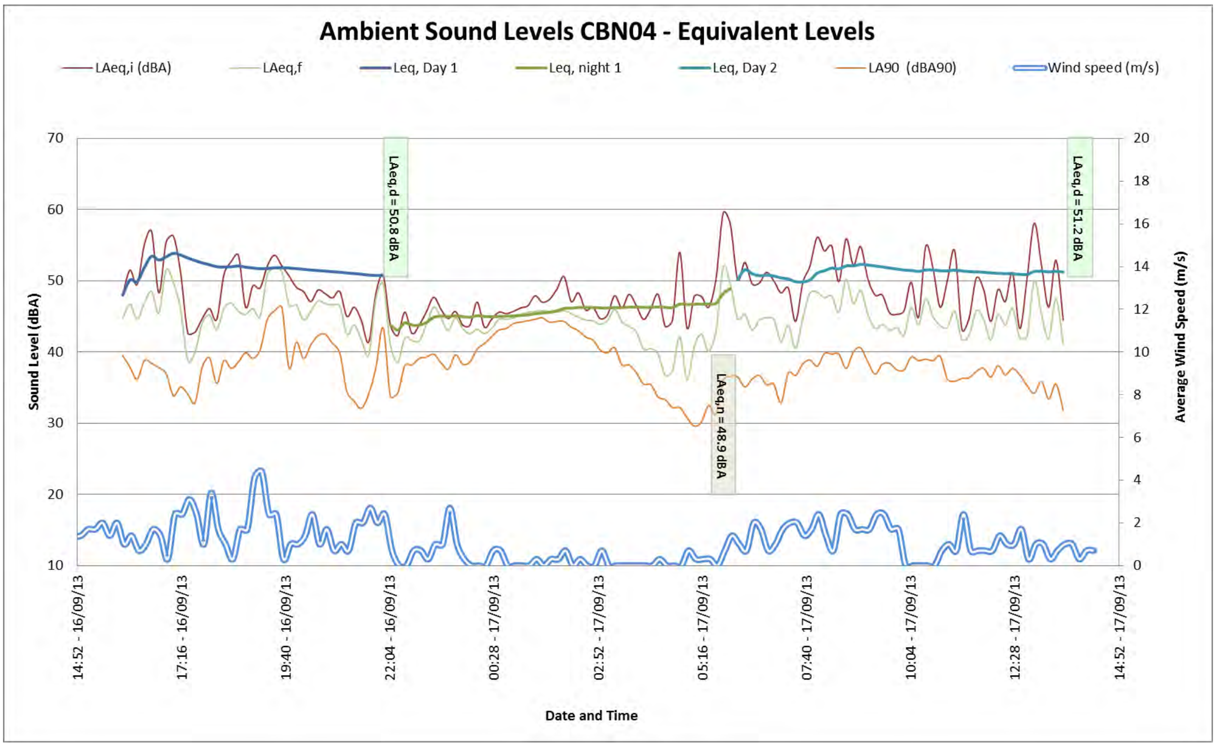



**Figure 3-18: Ambient Sound Levels at CBN04**

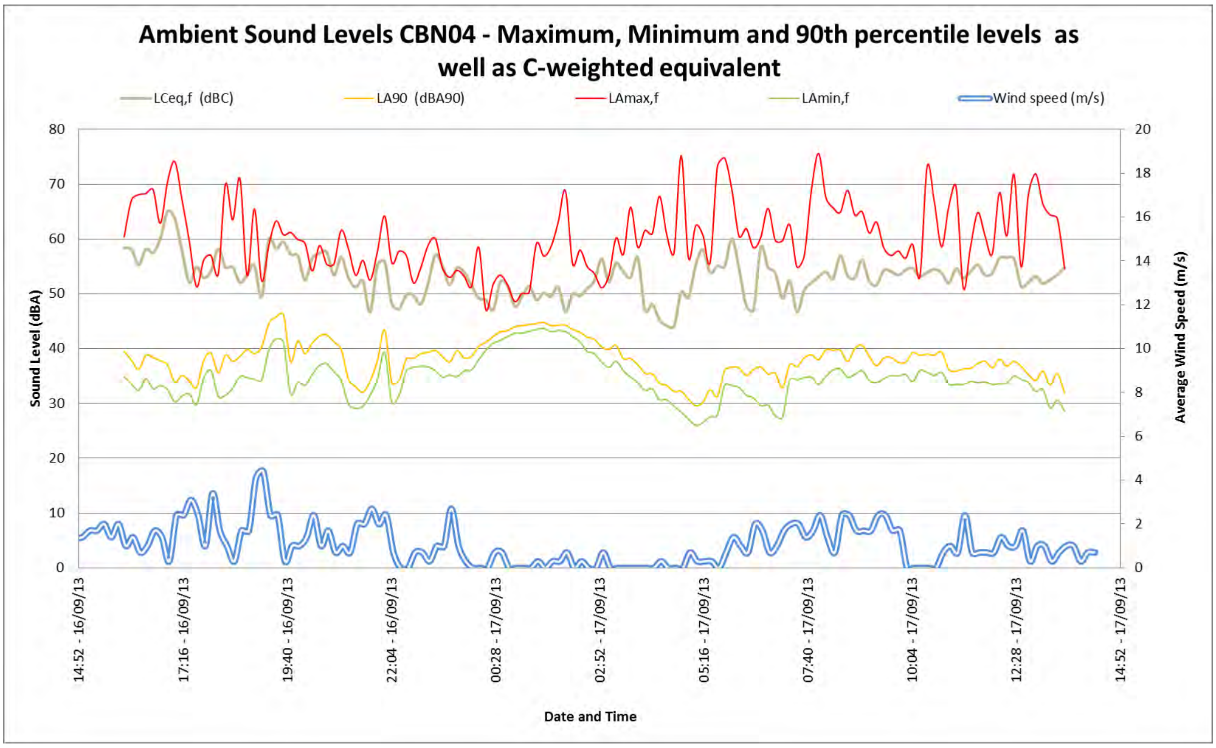



**Figure 3-19: Maximum, Minimum and Statistical sound levels at CBN04**

**Maximum noise levels:** Maximum noise levels are illustrated on **Figure 3-19**. The maximum noise level graph is quite different, indicating that there were loud noise events, generally of short duration. There is an average difference of almost 14 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 4 and 31 dB. The source of the maximum noises is undefined.

**Minimum noise levels:** Minimum noise levels are illustrated on **Figure 3-19**. Minimum noise levels ranged between 28 and 48 dBA, averaging at 38 dBA. Considering both the $L_{A90}$ and $L_{A,min}$ graphs shows an area that is noisy for the developmental character.

**Minimum noise levels:** As with the maximum noise levels minimum noise levels will not be discussed for this location.

**Third octave spectral analysis**

Lower frequency (20 – 250 Hz): Daytime measurements (see **Figure 3-20** and **Figure 3-22**) illustrate the spectral character of a number of different noise sources with quieter samples showing a distinct peak at 25, 50 and 10 – 125 Hz (likely the water pump). This is more visible in the night-time measurements (see **Figure 3-21**). Early morning (just before 06:00) and the following day (see **Figure 3-21** and **Figure 3-22**) shows a typical shape (straight line) where wind induced noise due to increased winds starts impacting on measurements (generally only observable in very quiet areas).

Third octave surrounding 1000 Hz: This range contains energy mostly associated with human speech (mostly 350 Hz – 2,000 Hz, could be between 20 – 16,000 Hz), dwelling related sounds and road to tyre interaction from road traffic. This frequency band did not show any particular (consistent) peaks in this region, with only a few measurements indicating a peaks at the 400, 500 and 630 Hz frequency bands (typical of road/tyre interaction).

Higher frequency (2,000 Hz upwards): A significant number of the night-time measurements shows peaks in the 4 000, 6 300, 10 000 – 16 000 and at 20 000 Hz frequency bands. It is distinctive and relate to faunal communication.

**Summary: Spectral Analysis**

The loudest equivalent sound levels recorded at this location were due to faunal and wind-induced sounds, with the road impacting on the lower frequencies (albeit not as loud as the other noise sources).

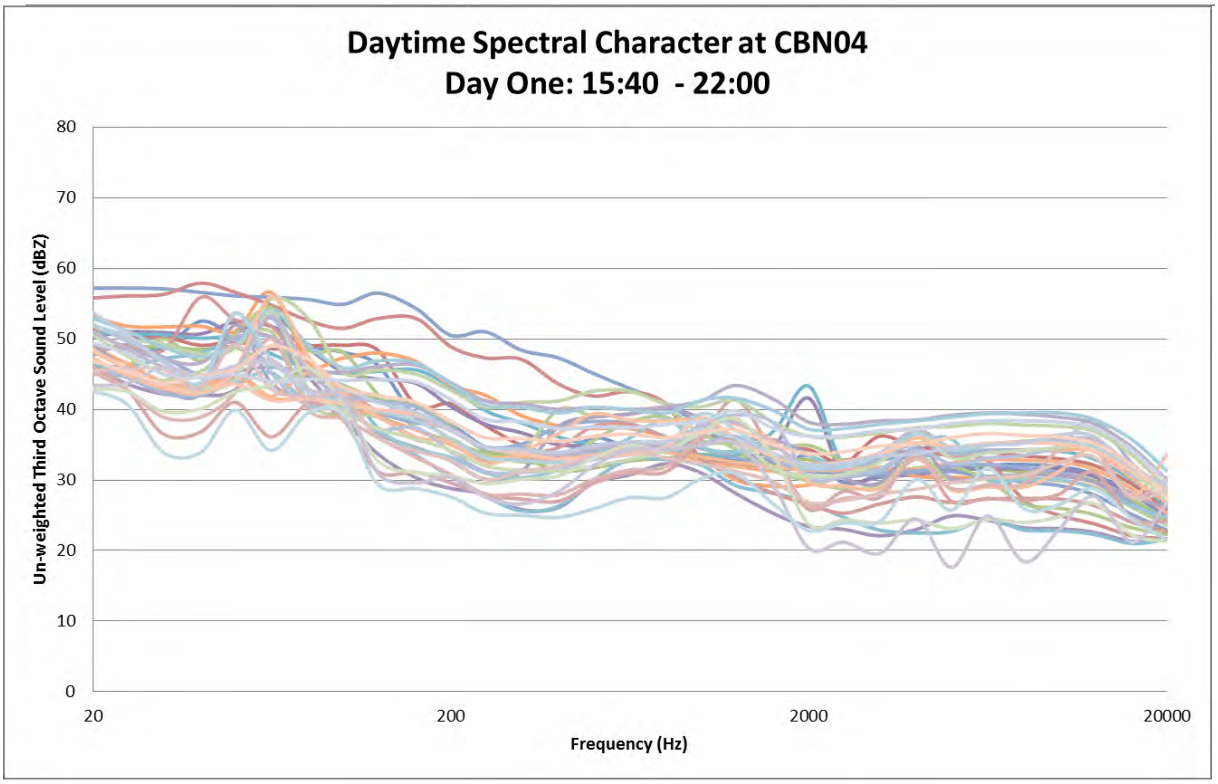



**Figure 3-20: Daytime spectral frequency distribution at CBN04, day one**

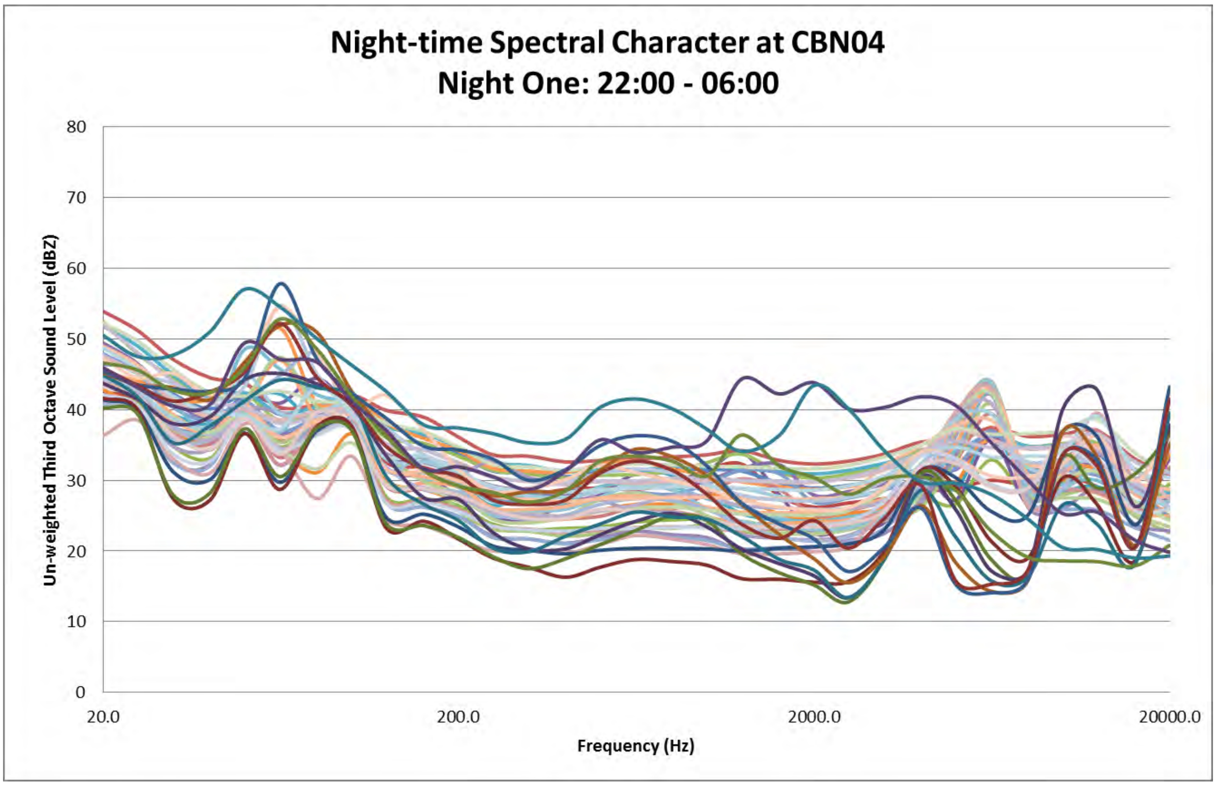



**Figure 3-21: Night-time spectral frequency distribution at CBN04, first night**

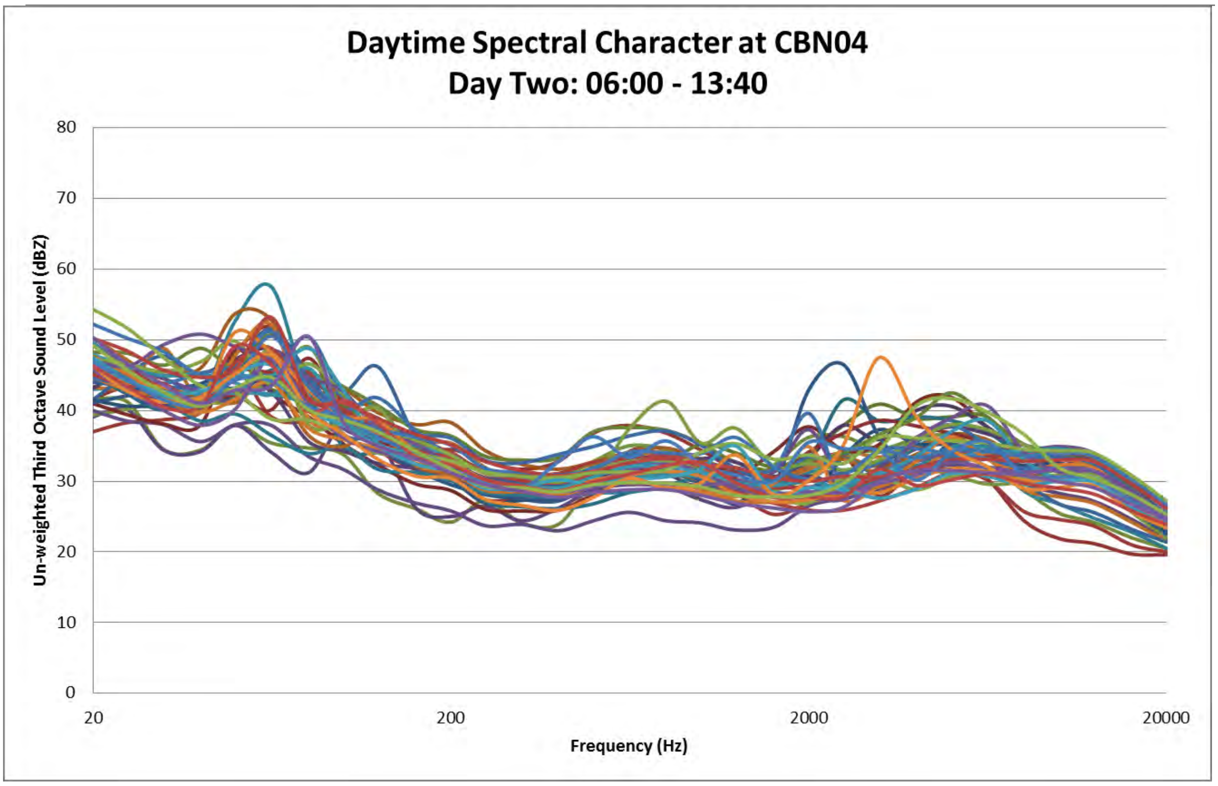



**Figure 3-22: Daytime spectral frequency distribution at CBN04, morning second day**

**SANS 10103:2008 Rating Level:** Measured daytime data indicate sound levels typical of an area with a suburban district character. Night-time levels are however higher than expected, conforming more to an urban (with one or more of the following; main roads, business or workshops) district zone sound level. Considering the spectral frequencies measured, the source of the noise was natural (faunal and wind-induced), and potentially seasonal. Considering the $L_{A90}$ and developmental character of the area it is the opinion of the author that a rating level typical for an urban area would be acceptable. Measured $L_{Aeq,f}$ levels conforms to the recommendation of 55 and 45 dBA by the World Health Organization, World Bank and International Finance Corporation for a residential area for the day and night-time periods respectively.

### 3.4.6 Measurement Point CBN05: Dwelling of Mrs. Joan Buitendag

A number of 10 minute measurements were taken over a day/night period on 16 to 18 September. The equipment defined in **Table 3-10** was used for gathering data. Measured sound levels are presented in **Figure 3-23** and **Figure 3-24**.

**Table 3-10: Equipment used to gather data (RION NL-32)**

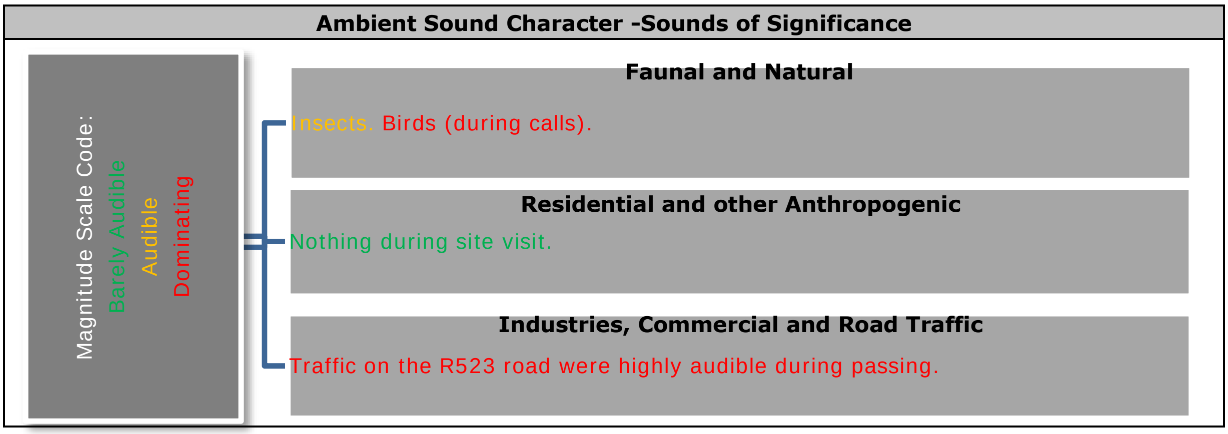
| Equipment | Model | Serial no | Calibration Date |
|---|---|---|---|
| SLM | Rion NL-32 | 01182945 | 03 April 2013 |
| Microphone* | Rion UC-53A | 315479 | 03 April 2013 |
| Calibrator | Rion NC-74 | 34494286 | 23 January 2013 |

* Microphone fitted with the RION WS-03 outdoor all-weather windshield.

The SLM instrument was deployed at the fence in an open area away from the main dwelling. There was no vegetation that can rustle in the wind within 6 meters of the microphone. Refer to **Appendix B** for a photo of this measurement location.

**Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes):** Refer to **Table 3-11** indicating sounds heard at the measurement point by the acoustical consultant.

**Table 3-11: Noises/sounds heard during site visits at receptor CBN05**




**Impulse equivalent sound levels:** During the daytime $\mathbf{L_{AIeq}}$ values ranged between 39.0 to 77.3 dBA. The night-time $\mathbf{L_{AIeq}}$ values ranged between 34.8 to 61.0 dBA. The average value of the 160 10-minute equivalent daytime measurements was calculated at 50.3 dBA, while the average for the 96 night-time measurements were calculated at 48.0 dBA. A significant number of single events with loud noises however impacted on the day and night-time equivalent sound levels as shown on **Figure 3-23**. Considering the difference between the $\mathbf{L_{AIeq}}$ and $\mathbf{L_{Aeq,f}}$ values a number of the single noise events was highly impulsive character.

**Statistical sound levels ($\mathbf{L_{A90,f}}$):** The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-23**. $\mathbf{L_{A90,f}}$ daytime values ranged from 24.7 to 55.1 dBA90. The night-time $\mathbf{L_{A90,f}}$ values ranged from 27.1 to 43.3 dBA90.

Considering the shape of the $L_{A90}$ and $L_{A,max}$ graphs, single noisy events did not influence this statistical level.

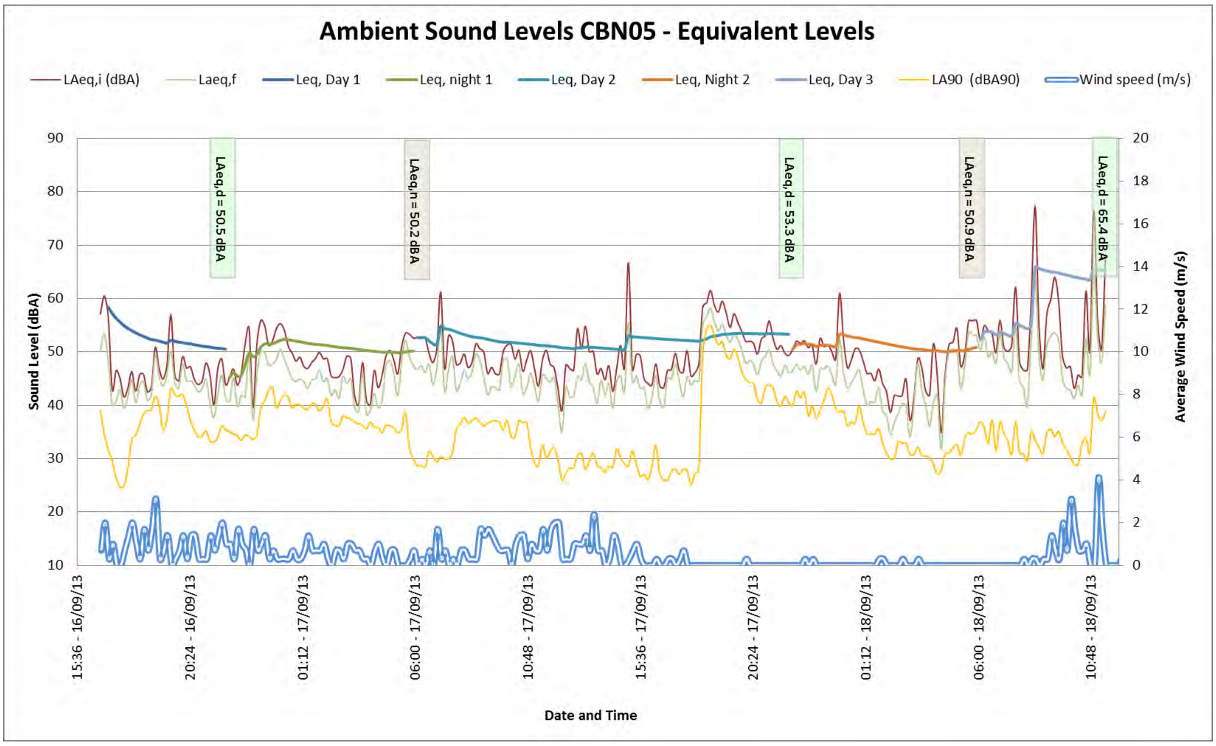



**Figure 3-23: Ambient Sound Levels at CBN05**

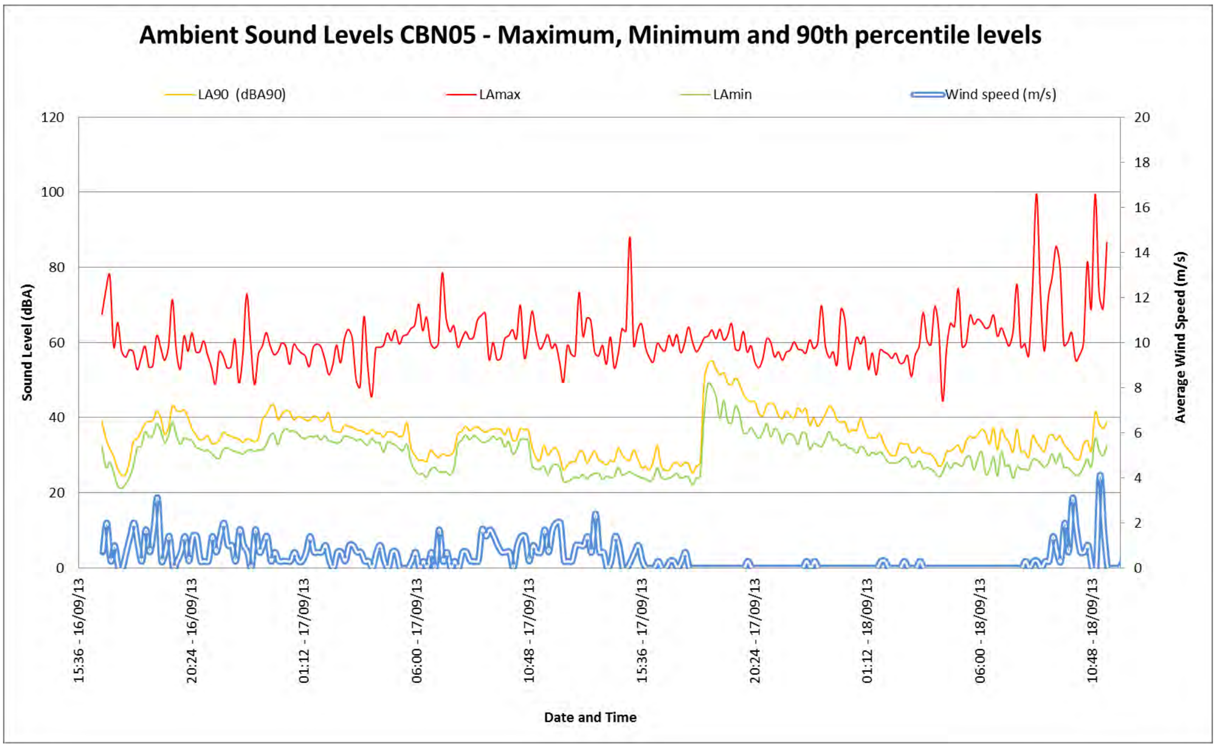



**Figure 3-24: Maximum, Statistical and Minimum Sound Levels at CBN05**

**Maximum noise levels:** Maximum noise levels are illustrated on **Figure 3-24**. The equivalent sound level graph generally has a shape similar to the maximum noise level graph, indicating that maximum noise events did influence the equivalent sound level readings at times. There is an average difference of more than 15.3 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 5 and 35 dB. Considering the $L_{A90}$ and $L_{AIeq}$ graphs maximum noises were of sufficient duration at times to impact on the equivalent and statistical readings, although there are a number of measurements indicating soft constant noises that influenced the ambient sound levels.

**Minimum noise levels:** Minimum noise levels are illustrated on **Figure 3-24**. Considering both the $L_{A90}$ and $L_{A,min}$ graphs shows an area that is relatively quiet at night-time with various noisy events impacting on the sound levels (equivalent, statistical, minimum). This is typical of an area where there are constant daytime noises impacting on the soundscape at night.

**Third octave spectral analysis**

The instrument was not fitted with a third octave filter.

**SANS 10103:2008 Rating Level:** Daytime measured data indicate sound levels typical of an area with a suburban district noise character although night-time levels are more typical of a urban area (with main roads). Considering the $L_{A90}$ and developmental character of the area it is the opinion of the author that a rating level typical for an urban area would be acceptable. Measured $L_{Aeq,f}$ levels conforms to the recommendation of 55 and 45 dBA by the World Health Organization, World Bank and International Finance Corporation for a residential area for the day and night-time periods respectively. Without sound recordings or spectral analysis it is not possible to define the origin, but, considering the data collected in the area it is likely a combination of road traffic noises and natural (both wind and faunal).

### 3.4.7 Measurement point CBN06: Dwelling, Mr. Swart

The instrument was deployed 17 – 18 September 2013 with the measurement location in front of the dwelling. Refer to **Appendix B** for photos of this measurement point.

The equipment defined in **Table 3-12** was used for gathering data. Measured data is presented in **Figure 3-25** and **Figure 3-26**.

**Table 3-12: Equipment used to gather data (SVAN 955)**

| Equipment | Model | Serial no | Calibration Date |
|---|---|---|---|
| SLM | Svan 955 | 27637 | 15 May 2013 |
| Microphone | ACO 7052E | 52437 | 15 May 2013 |
| Calibrator | Rion NC-74 | 34494286 | 23 January 2013 |

* Microphone fitted with the RION WS-03 all-weather outdoor windshield.

**Sounds heard during measurements dates:** Refer to **Table 3-13** indicating sounds heard at the measurement point by the acoustical consultant.

**Table 3-13: Noises/sounds heard during site visits at CBN06**

| Ambient Sound Character -Sounds of Significance | |
|---|---|
| Magnitude Scale Code: Barely Audible, Audible, Dominating | **Faunal and Natural**<br>Wind induced - rustling of tree leaves. Insects. Birds. |
| | **Residential and other Anthropogenic**<br>Voices of kids. Water sprayer. |
| | **Industries, Commercial and Road Traffic**<br>Traffic on the tar road (during passing) - only 3 vehicles during a 40 minute period. |

**Impulse equivalent sound levels:** During the daytime $L_{AIeq}$ values ranged between 43.1 to 62.4 dBA. The night-time $L_{AIeq}$ values ranged between 30.4 to 68.5 dBA. The average value of the 84 10-minute equivalent daytime measurements was calculated at 51.7 dBA, while the average for the 48 night-time measurements calculated at 46.0 dBA. A number of single events with loud noises did impact on the day and night-time equivalent sound levels as shown on **Figure 3-26**.

**Statistical sound levels ($L_{A90,f}$):** The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average and equivalent sound levels. It is illustrated on **Figure 3-25** and **Figure 3-26**. $L_{A90,f}$ daytime values ranged from 34.7 to 46.1 dBA90. The night-time $L_{A90,f}$ values ranged from 21.4 to 40.3 dBA90. Measured $L_{A90,f}$ and $L_{A,min}$ data indicated an area that have the potential to be very quiet. There was a constant noise the first day that increased this statistical measurement. Based on the sounds the author heard the first day this relates to the water sprayer.

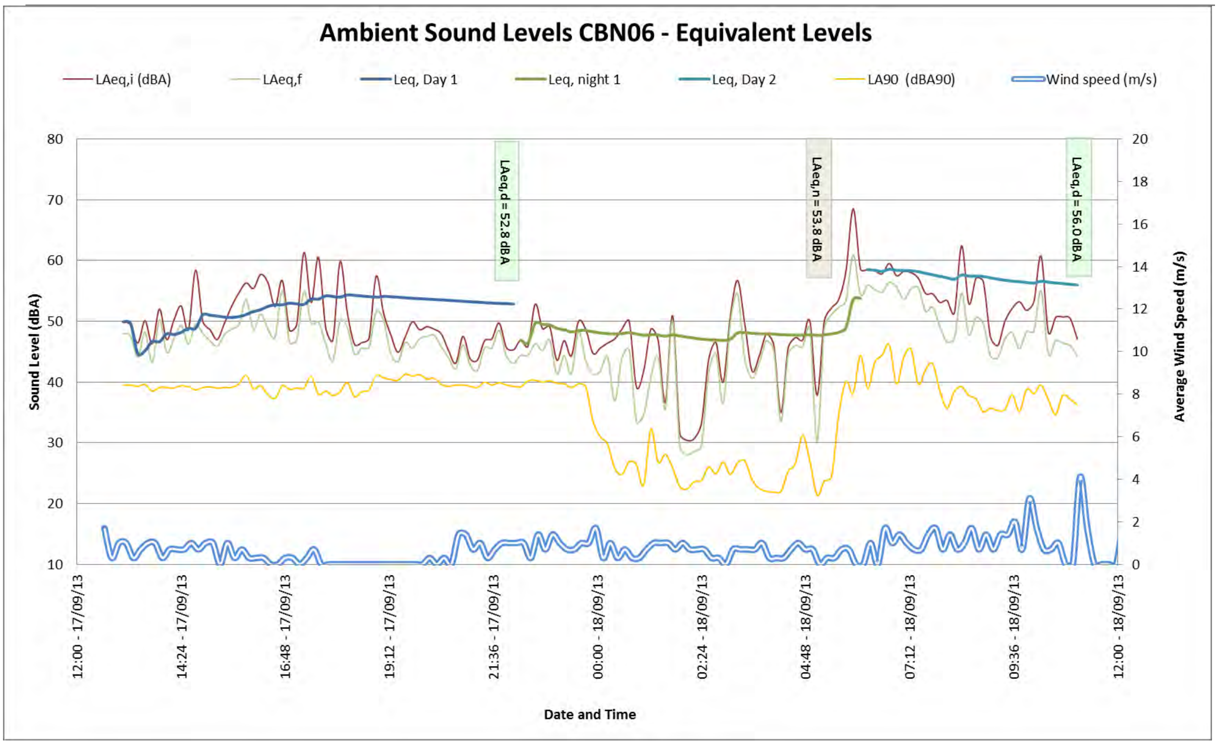



**Figure 3-25: Ambient Sound Levels at CBN06**

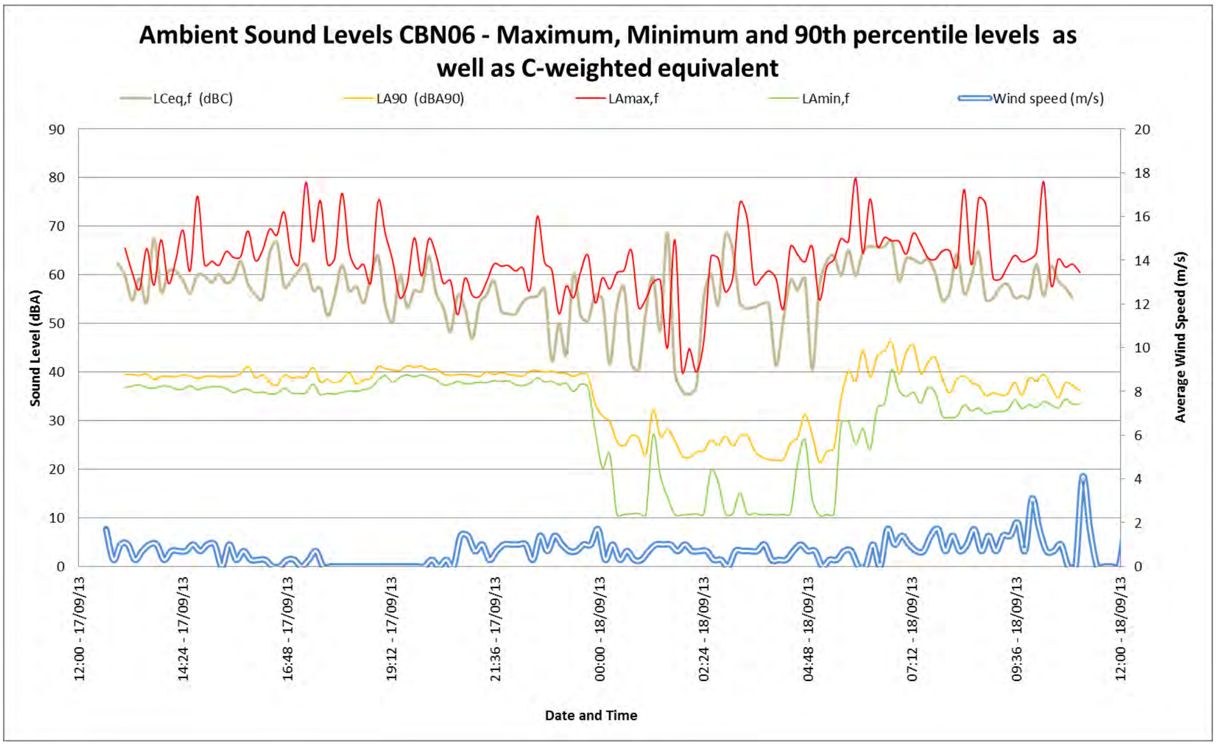



**Figure 3-26: Maximum, Minimum and Statistical sound levels at CBN06**

**Maximum noise levels:** Maximum noise levels are illustrated on **Figure 3-26**. The equivalent sound level graph has a shape similar to the maximum noise level graph, indicating that maximum noise levels did influence the equivalent sound level readings. There is an average difference of more than 16 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 9.5 and 28 dB. Considering the $L_{A90}$ and $L_{AIeq}$ graphs maximum noises were of sufficient duration to impact on the equivalent (and statistical readings on the second day). The source of the maximum noises is undefined.

**Minimum noise levels:** Minimum noise levels are illustrated on **Figure 3-26**. Considering both the $L_{A90}$ and $L_{A,min}$ graphs shows an area that can be very quiet at times, especially at night. Water spraying activities however did impact on the sound measurements to some extent during the first day up to just before midnight.

**Third octave spectral analysis**

Lower frequency (20 – 250 Hz): Most measurements (see **Figure 3-16**) illustrate the spectral character of a number of different noise sources with the character is quite typical of road traffic. Night-time measurements are similar to the daytime measurements, with a number of measurements indicating the potential spectral character of road traffic (see **Figure 3-17**).

Third octave surrounding 1000 Hz: A number of measurements did show the characteristic 630 – 1 600 Hz frequency band peak associated with road traffic.

Higher frequency (2,000 Hz upwards): Late afternoon and night measurements showed slight consistent peaks in the 2 500 and 12 500 – 16,000 frequency bands, likely of faunal origin. Other, more difficult to detect peaks include a slight bump in the 2 500 – 16 000 Hz, suspected to relate to the water sprayer.

**Summary: Spectral Analysis**

The loudest equivalent sound levels recorded at this location related to road traffic noise from the R523.

**SANS 10103:2008 Rating Level:** Daytime measured data indicate sound levels typical of an area with an urban district noise character although night-time levels are more typical of a urban area (with main roads). Considering the $L_{A90}$ and developmental character of the area it is the opinion of the author that a rating level typical for an urban area would be acceptable. Daytime measured $L_{Aeq,f}$ levels during the day conforms to the recommendation of 55 dBA respectively by the World Health Organization, World Bank and International Finance Corporation for a residential area. Night-time levels however are higher than these guidelines.

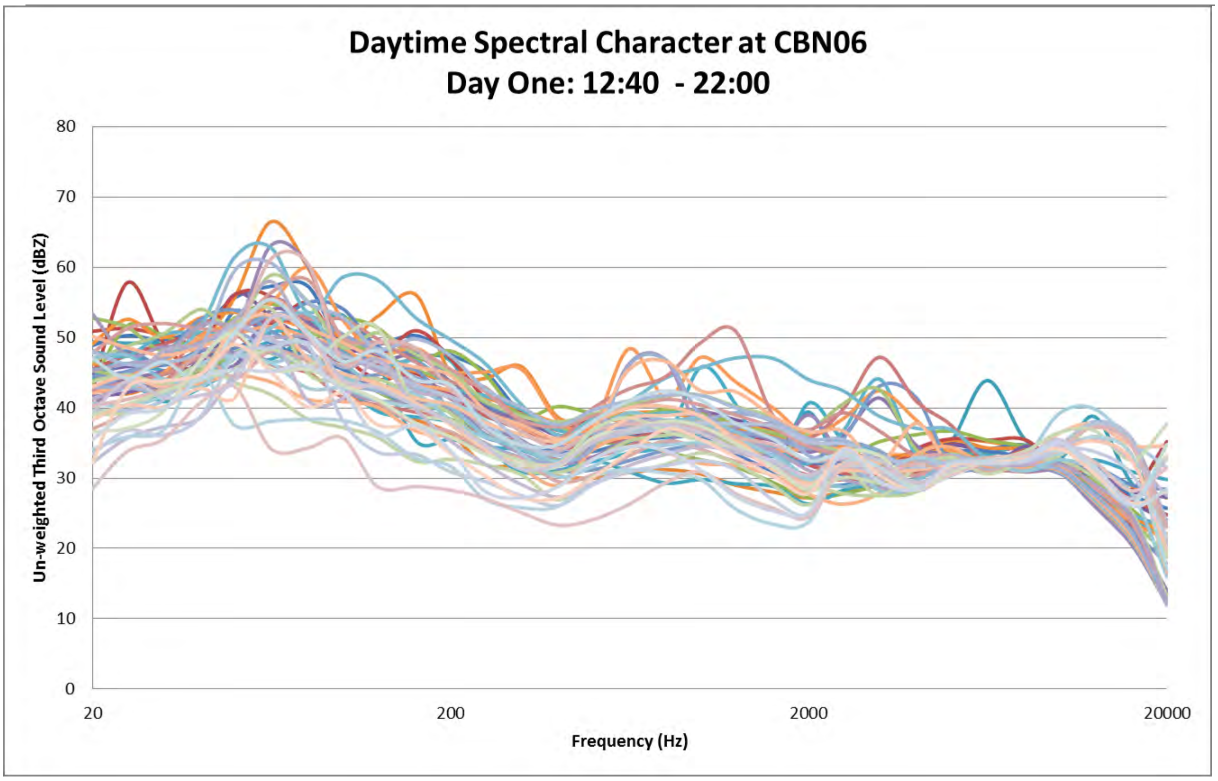



**Figure 3-27: Daytime spectral frequency distribution at CBN06, day one**

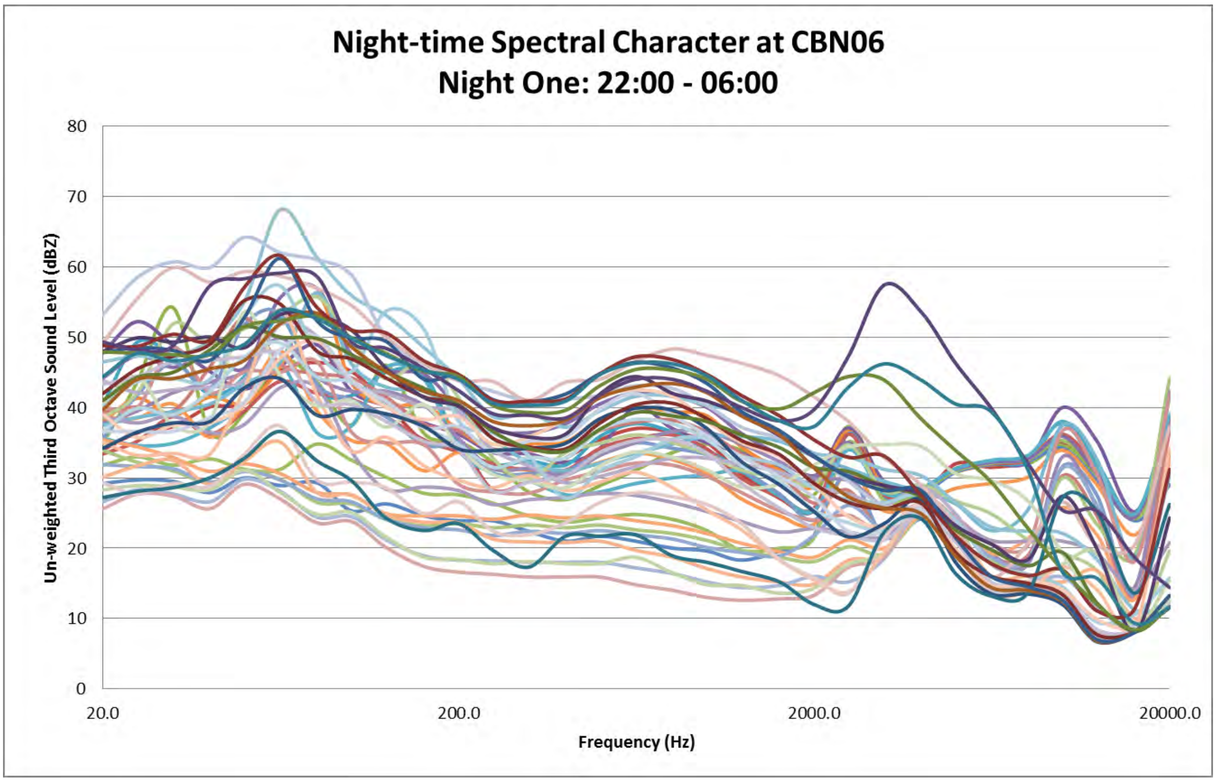



**Figure 3-28: Night-time spectral frequency distribution at CBN06, first night**

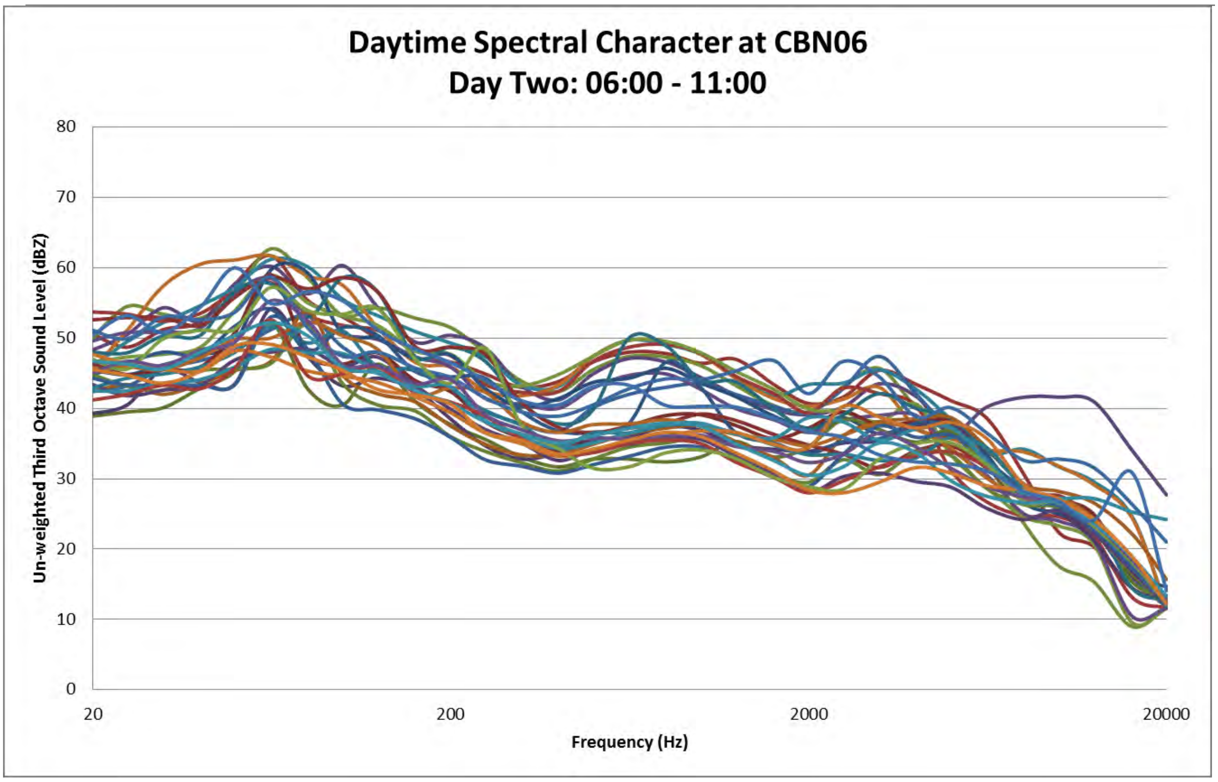



**Figure 3-29: Night-time spectral frequency distribution at CBN06, second day**

### 3.4.8 Measurement Point CBN07: Ekland farm – The Lodge

Measurements were taken over a two days from 18 to 20 September 2013. This location falls within the proposed mining opencast area and likely be relocated. The equipment defined in **Table 3-14** was used for gathering data. Measured sound levels are presented in **Figure 3-30**.

**Table 3-14: Equipment used to gather data (SVAN 955)**

| Equipment | Model | Serial no | Calibration Date |
|---|---|---|---|
| SLM | Svan 955 | 27324 | 25 April 2013 |
| Microphone* | ACO 7052E | 49596 | 25 April 2013 |
| Calibrator | Rion NC-74 | 34494286 | 23 January 2013 |

* Microphone fitted with the RION WS-03 outdoor all-weather windshield.

The measurement location was at a quiet spot in the garden close to the main dwelling. It should be noted that the instrument was moved two times due to the presence of a swimming pool pump. The microphone was located in a relatively open area further than 5 meters from any vegetation or reflective surfaces. Refer to **Appendix B** for a photo of this measurement location.

**Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes):** Refer to **Table 3-15** indicating sounds heard at the measurement point by the acoustical consultant.

**Table 3-15: Noises/sounds heard during site visits at receptor CBN07**

| Ambient Sound Character -Sounds of Significance | |
|---|---|
| Magnitude Scale Code: Barely Audible, Audible, Dominating | **Faunal and Natural**<br>Birds and Insects. |
| | **Residential and other Anthropogenic**<br>Voices and people moving around. Swimming pool pump. |
| | **Industries, Commercial and Road Traffic**<br>Nothing. |

**Impulse equivalent sound levels:** During the daytime $\mathbf{L_{AIeq}}$ values ranged between 30.8 to 59.9 dBA. The night-time $\mathbf{L_{AIeq}}$ values ranged between 29.1 to 53.5 dBA. The average value of the 218 10-minute equivalent daytime measurements was calculated at 44.4 dBA, while the average for the 96 night-time measurements were calculated at 39.1 dBA. Equivalent sound levels for the day- and night-time periods are shown on **Figure 3-30**.

**Statistical sound levels ($\mathbf{L_{A90,f}}$):** The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-30**. $\mathbf{L_{A90,f}}$ daytime values ranged from 22.7 to 43.5 dBA90. The night-time $\mathbf{L_{A90,f}}$ values ranged from 22.3 to 31.3 dBA90. Measured $\mathbf{L_{A90,f}}$ data indicated an area where there is a constant soft noise that is impacting on the ambient sound levels although increased wind speeds could have impacted on the sound levels measured.

**Maximum noise levels:** Maximum noise levels are illustrated on **Figure 3-31**. There is an average difference of more than 18 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 1.9 and 34 dB. Considering the $L_{A90}$ and $L_{AIeq}$ graphs maximum noises were of sufficient duration to impact on the equivalent (and statistical readings). The source of the maximum noises is undefined. The average $L_{Amax}$ level is only 55.6 dBA, making this the second "quietest" location of the Chapudi measurement locations.

**Minimum noise levels:** Minimum noise levels are illustrated on **Figure 3-31**. Considering both the $L_{A90}$ and $L_{A,min}$ graphs shows an area where there are a constant soft background noise, likely the swimming pool pump.

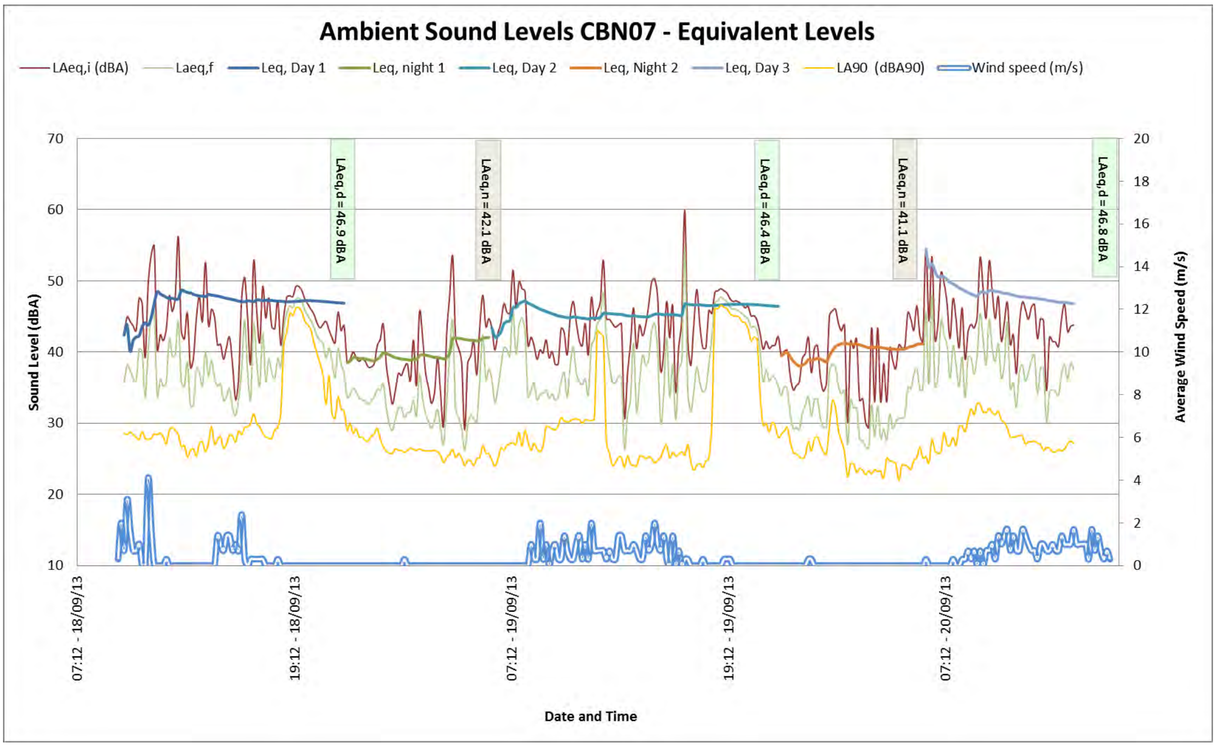



**Figure 3-30: Ambient Sound Levels at CBN07**

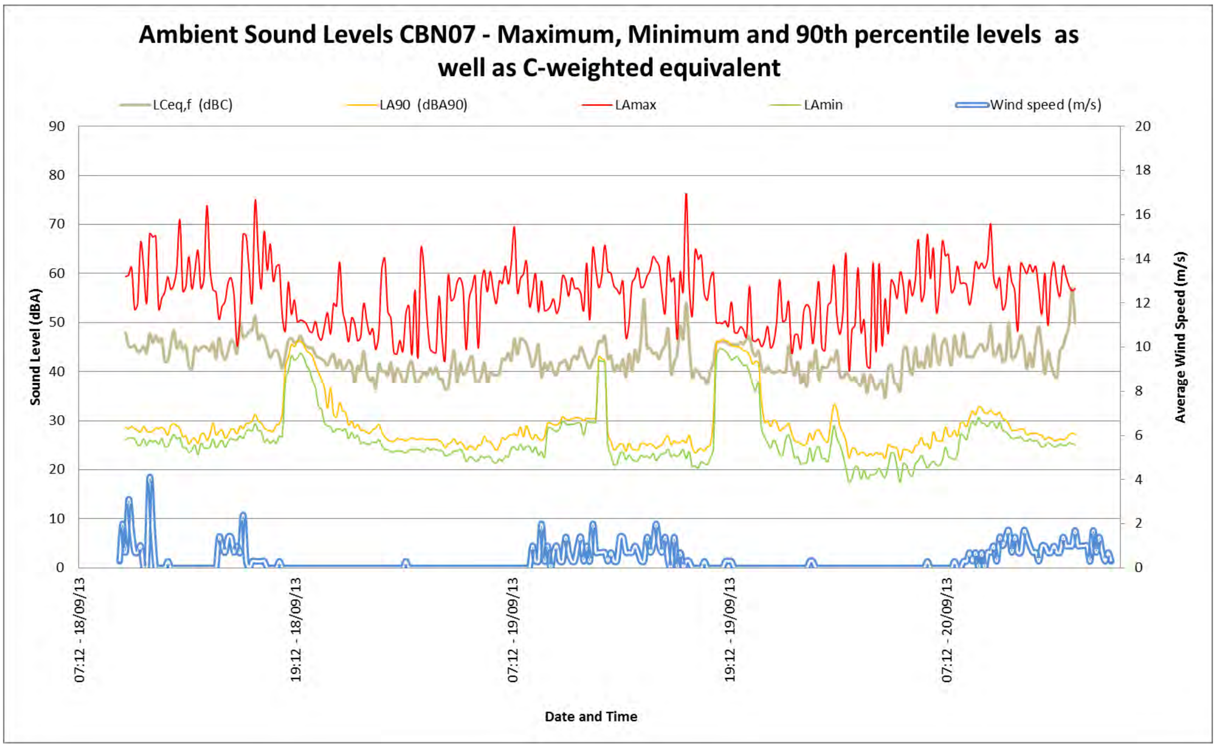



**Figure 3-31: Maximum, Minimum and Statistical sound at CBN07**

### Third octave spectral analysis

Because measurements were recorded over two days only three graphs are presented. Other graphs for the other days are similar for this measurement location.

Lower frequency (20 – 250 Hz): Daytime measurements (see **Figure 3-32**) illustrate the spectral character of a number of different noise sources. The quietest measurements show a peak at 50 Hz (swimming pool pump - see **Figure 3-33**), with distinctive peaks at the 63 (undefined) and 100 Hz (likely harmonic of swimming pool pump) frequency bands.

Third octave surrounding 1000 Hz: Daytime measurements (see **Figure 3-32**) illustrate the spectral character of a number of different noise sources, with most measurements showing a peak at 315[12] Hz (both night and day – unknown source).

Higher frequency (2,000 Hz upwards): This location showed a numerous different noise sources, with peaks at 3 150, 4 000, 5 000, 6 300, 10 000, 12 500 and 20 000. Most of these sounds would be of faunal origin, used by crickets, frogs, cicada and bats.

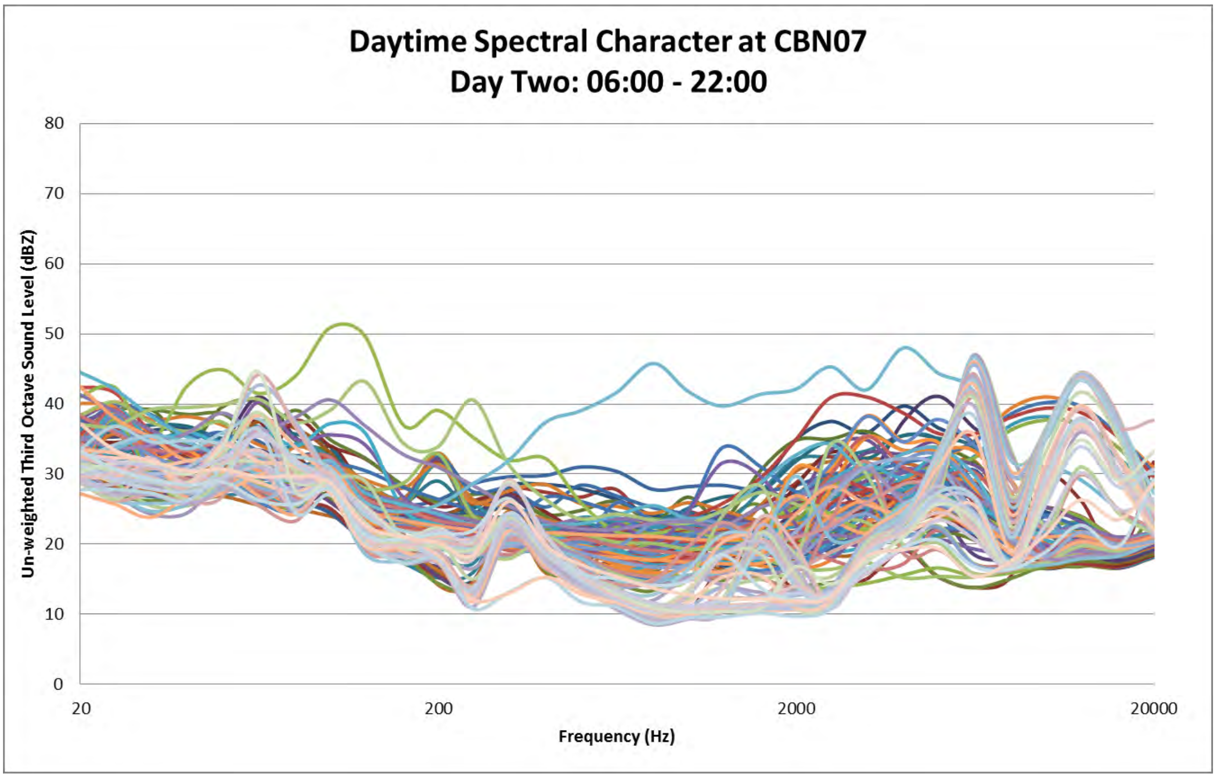



**Figure 3-32: Daytime spectral frequency distribution at CBN07, day two**

[12] At an octave sound power level of less than 20 dBA most people will not even hear it above other sounds

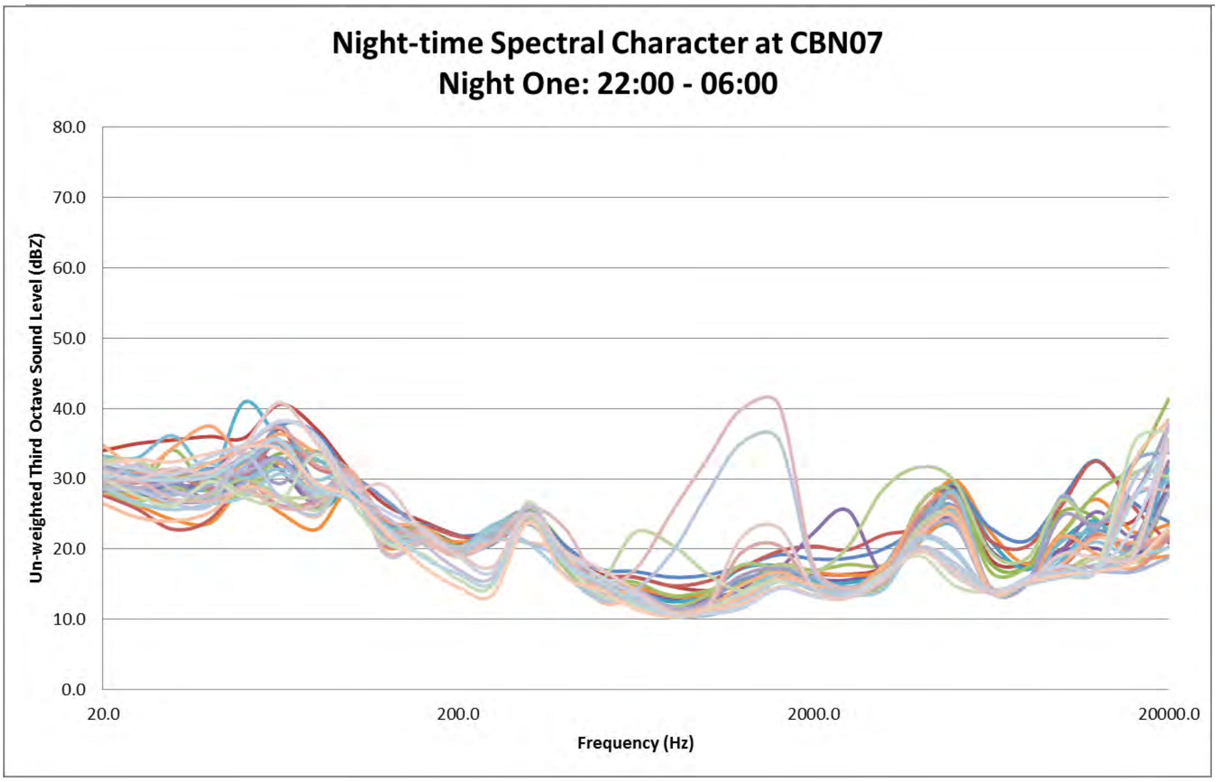



**Figure 3-33: Night-time spectral frequency distribution at CBN07, first night**

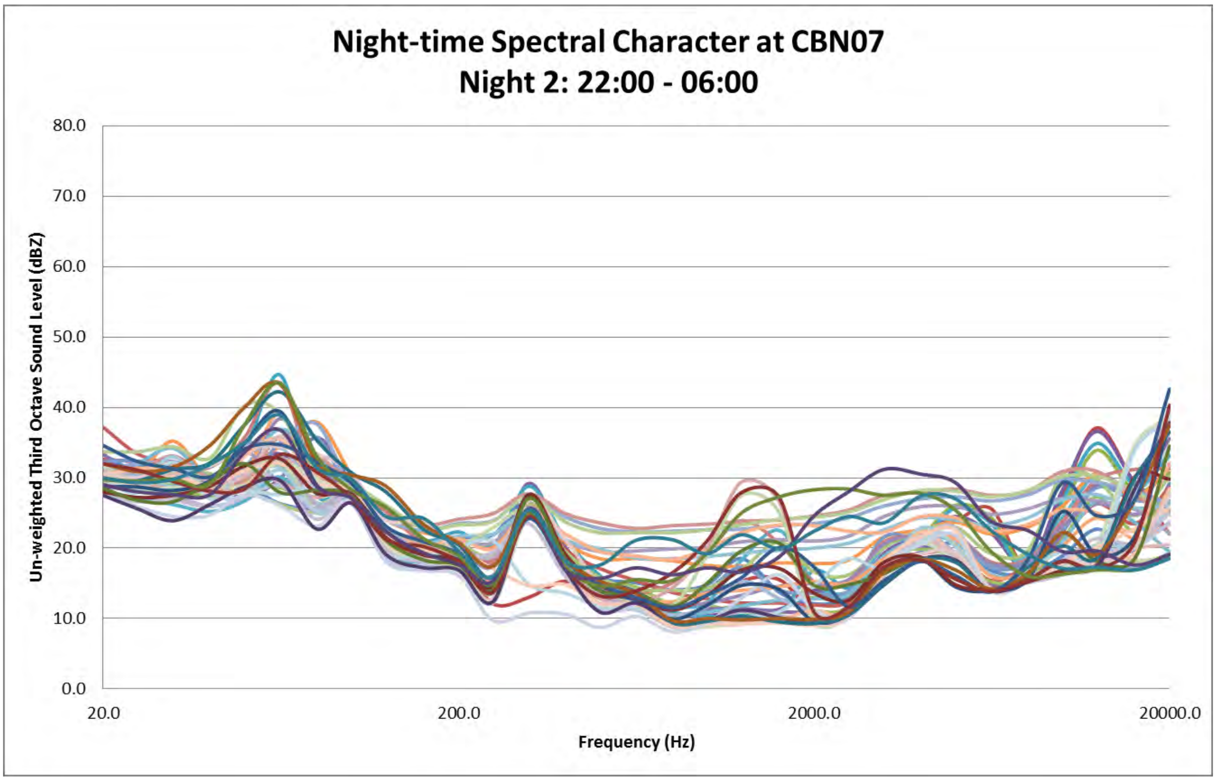



**Figure 3-34: Night-time spectral frequency distribution at CBN07, second night**

### Summary: Spectral Analysis

This location showed a number of different noise sources, with faunal sounds mostly dominant.

**SANS 10103:2008 Rating Level:** Daytime measured data indicate sound levels typical of an area with a rural district noise character although night-time levels are more typical of a suburban area. Considering the $L_{A90}$ and developmental character of the area it is the opinion of the author that a rating level typical for a suburban area would be acceptable. Daytime measured $L_{Aeq,f}$ levels conforms to the recommendation of 55 and 45 dBA respectively by the World Health Organization, World Bank and International Finance Corporation for a residential area (for the day and night time periods respectively).

### 3.4.9 Measurement Point CBN08: Ekland farm – Rock Lodge

Measurements were taken over a day/night period from 18 to 19 September 2013. This location falls within the proposed mining opencast area and likely be relocated. The equipment defined in **Table 3-16** was used for gathering data. Measured sound levels are presented in **Figure 3-35**.

**Table 3-16: Equipment used to gather data (RION NA-28)**

| Equipment | Model | Serial no | Calibration Date |
|---|---|---|---|
| SLM | Rion NA-28 | 00901489 | 24 May 2013 |
| Microphone* | Rion UC-59 | 02087 | 24 May 2013 |
| Calibrator | Rion NC-74 | 34494286 | 23 January 2013 |

* Microphone fitted with the RION WS-03 outdoor all-weather windshield.

The measurement location was on a rocky area in front of a lodge where visitors would relax. The lodge was uninhabited at the time of the measurement with no equipment or appliances audible. The microphone was located in a relatively open area further than 5 meters from any vegetation. Refer to **Appendix B** for a photo of this location.

**Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes):** Refer to **Table 3-17** indicating sounds heard at the measurement point by the acoustical consultant.

**Table 3-17: Noises/sounds heard during site visits at receptor CBN08**

| Ambient Sound Character -Sounds of Significance | |
|---|---|
| Magnitude Scale Code: Barely Audible / Audible / Dominating | **Faunal and Natural**<br>Birds (especially a dove) and Insects (Cicadidae). Wind-induced noises due to gusts. |
| | **Residential and other Anthropogenic**<br>Nothing |
| | **Industries, Commercial and Road Traffic**<br>Nothing. |

**Impulse equivalent sound levels:** During the daytime $\mathbf{L_{AIeq}}$ values ranged between 24.9 to 60.3 dBA. The night-time $\mathbf{L_{AIeq}}$ values ranged between 24.6 to 61.2 dBA. The average value of the 100 10-minute equivalent daytime measurements was calculated at 41.0 dBA, while the average for the 48 night-time measurements were calculated at 36.6 dBA. Equivalent sound levels for the day- and night-time periods are shown on **Figure 3-35**.

**Statistical sound levels ($\mathbf{L_{A90,f}}$):** The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-35**. $\mathbf{L_{A90,f}}$ daytime values ranged from 19.8 to 41.0 dBA90. The night-time $\mathbf{L_{A90,f}}$ values ranged from 19.1 to 29.6 dBA90. Measured $\mathbf{L_{A90,f}}$ data indicated a very quiet area.

**Maximum noise levels:** Maximum noise levels are illustrated on **Figure 3-36**. There is an average difference of more than 18 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 1.9 and 34 dB. Considering the $L_{A90}$ and $L_{AIeq}$ graphs maximum noises were of sufficient duration to impact on the equivalent (and statistical readings). The source of the maximum noises is undefined. The average $L_{Amax}$ level is only 55.6 dBA, making this the second "quietest" location of the Chapudi measurement locations.

**Minimum noise levels:** Minimum noise levels are illustrated on **Figure 3-36**. Considering both the $L_{A90}$ and $L_{A,min}$ graphs shows an area where there are a constant soft background noise, likely the swimming pool pump.

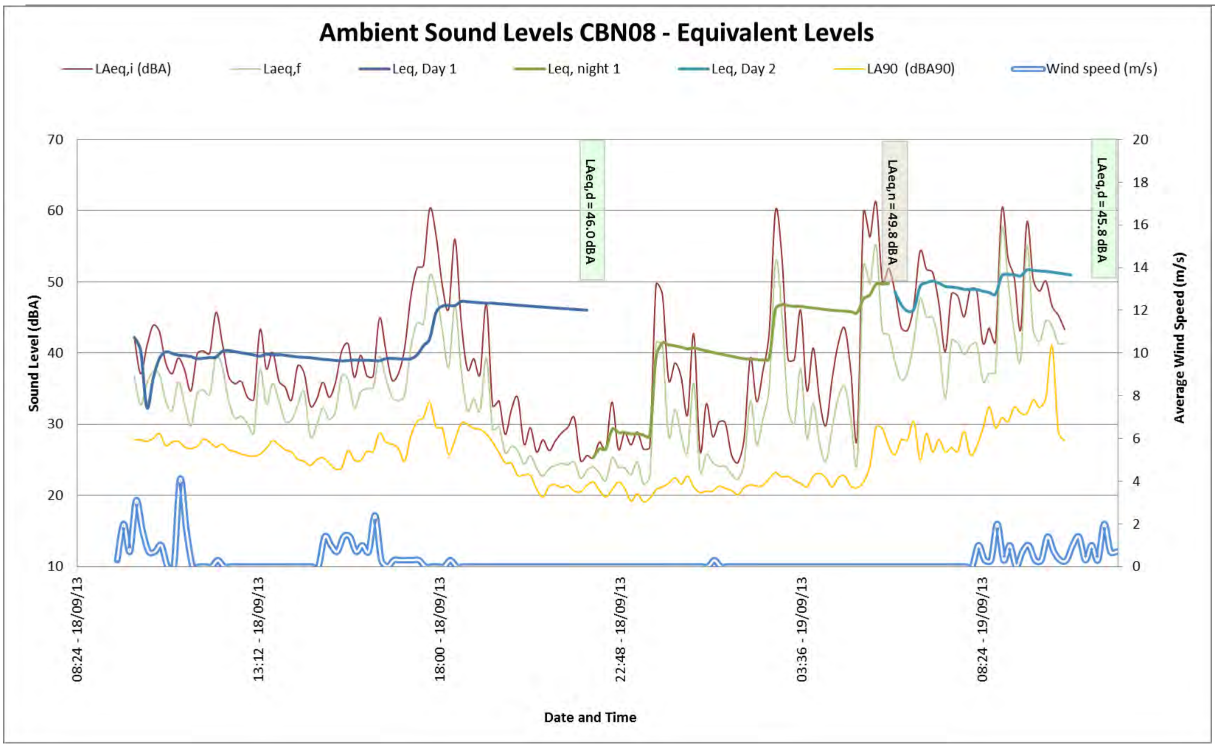



**Figure 3-35: Ambient Sound Levels at CBN08**

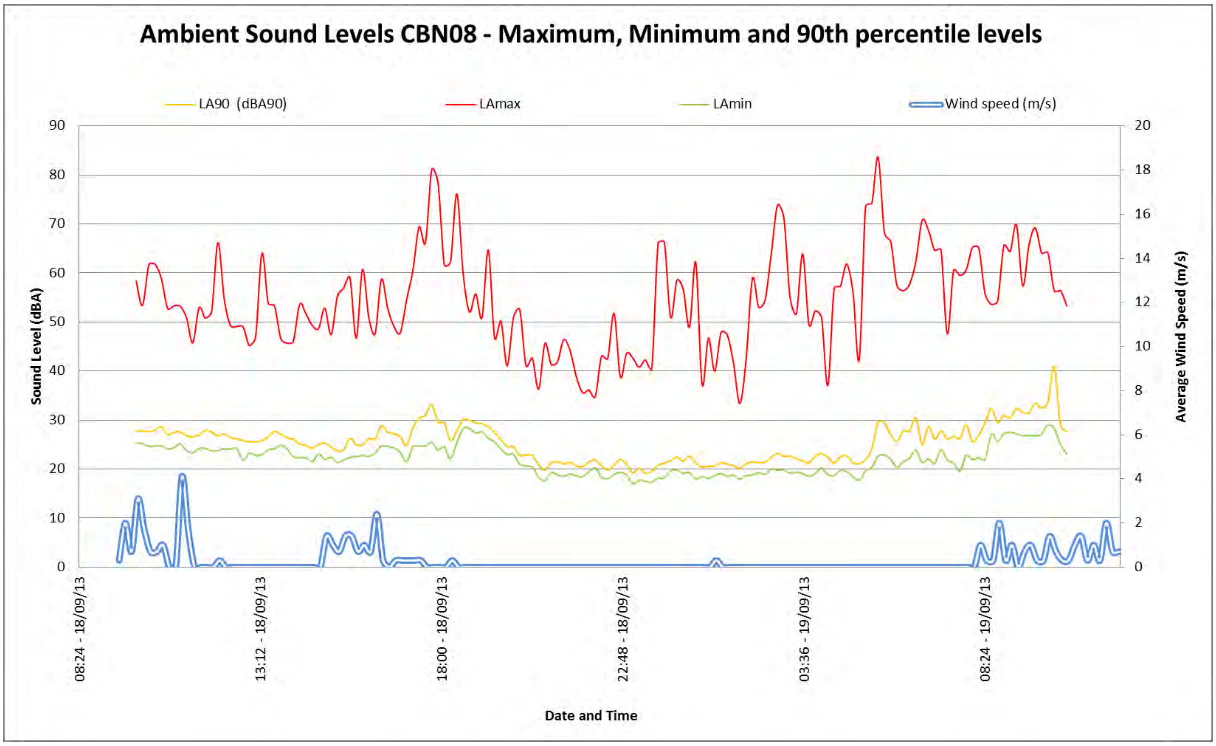



**Figure 3-36: Maximum, Minimum and Statistical sound at CBN08**

**Third octave spectral analysis**

Lower frequency (20 – 250 Hz): Daytime measurements (see **Figure 3-37** and **Figure 3-39**) illustrate the spectral character of a number of different noise sources, including wind induced noises (smooth curves, **Figure 3-37**) as well as faunal (irregular curves).

The most measurements show a peak at 63 Hz (undefined - see **Figure 3-38**) frequency bands.

Third octave surrounding 1000 Hz: Measurements (see **Figure 3-37** and **Figure 3-39**) illustrate the spectral character of a number of different noise sources, with most measurements showing a peak at 630 Hz (both night and second day – unknown source).

Higher frequency (2,000 Hz upwards): Measurements (see **Figure 3-37** and **Figure 3-39**) illustrate the spectral character of a number of different noise sources, with distinctive peaks at 2 500, 3 500, 4 000, 6 300 and 20 000 Hz. It is assumed to be faunal.

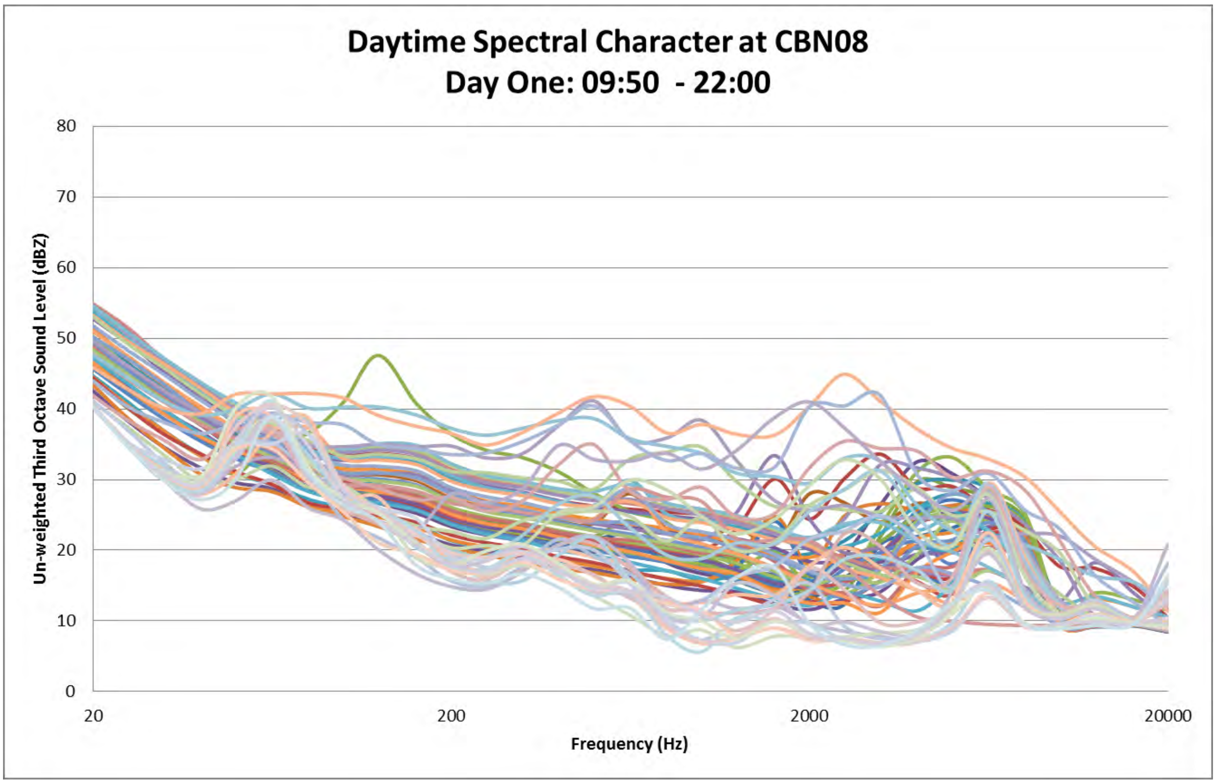



**Figure 3-37: Daytime spectral frequency distribution at CBN08, day one**

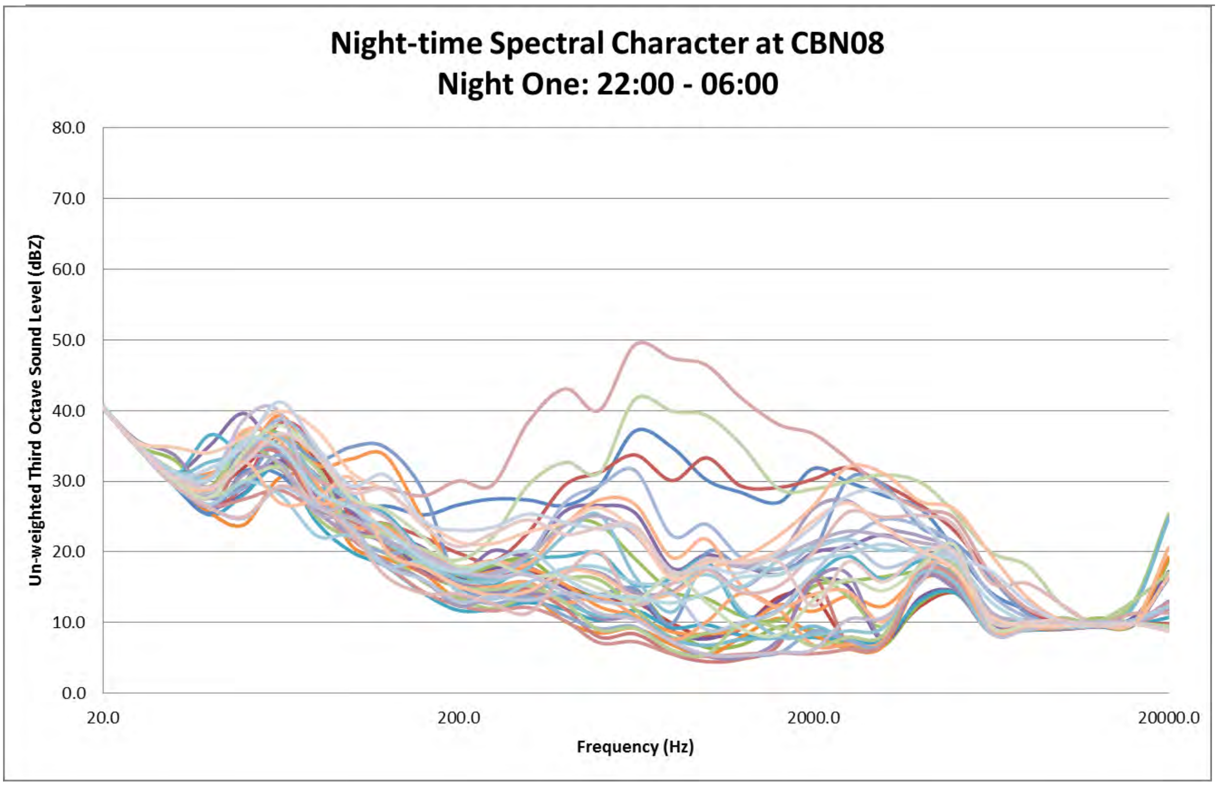



**Figure 3-38: Night-time spectral frequency distribution at CBN08, first night**

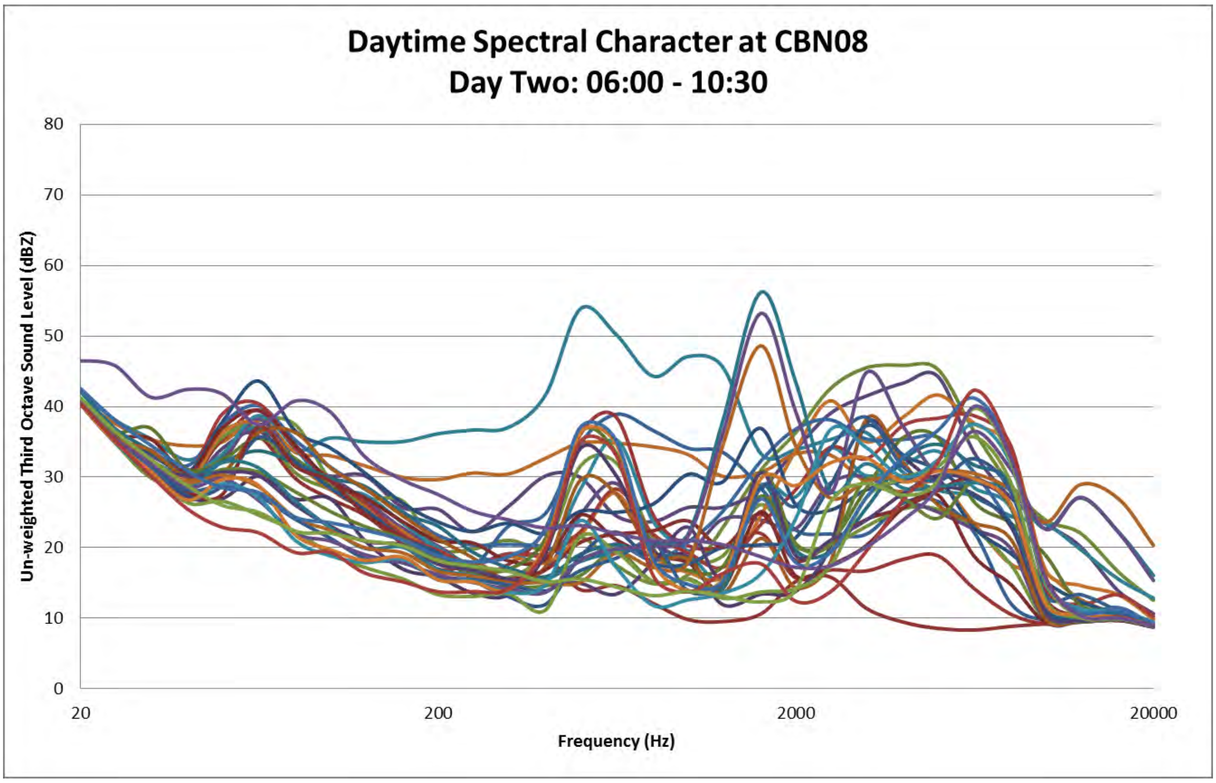



**Figure 3-39: Daytime spectral frequency distribution at CBN08, second day**

### Summary: Spectral Analysis

Spectral data illustrate a location that is relatively natural, showing a number of different noise sources, with faunal sounds and wind-induced noises (first day) dominant.

**SANS 10103:2008 Rating Level:** Daytime measured data indicate sound levels typical of an area with a rural district noise character although night-time levels are more typical of an urban area. Daytime measured $L_{Aeq,f}$ levels conforms to the recommendation of 55 and 45 dBA respectively by the World Health Organization, World Bank and International Finance Corporation for a residential area (for the day and night time periods respectively).

### 3.4.10 Measurement Point CBN09: Ekland farm – Pienaar Lodge

Measurements were taken over a day/night period from 18 to 19 September 2013. The equipment defined in **Table 3-18** was used for gathering data. Measured sound levels are presented in **Figure 3-40**.

**Table 3-18: Equipment used to gather data (SVAN 977)**

| Equipment | Model | Serial no | Calibration Date |
|---|---|---|---|
| SLM | Svan 977 | 34160 | 17 May 2013 |
| Microphone* | ACO 7052E | 54645 | 17 May 2013 |
| Calibrator | Rion NC-74 | 34494286 | 23 January 2013 |

* Microphone fitted with the RION WS-03 outdoor all-weather windshield.

The measurement location was at a quiet spot in the garden in front of the relaxation area. The microphone was moved to a location where natural features screened the swimming pool area due to an audible pump. The microphone was located in a relatively open area further than 5 meters from any vegetation or reflective surfaces. Refer to **Appendix B** for a photo of this measurement location.

**Sounds heard during the period the instrument was deployed and collected (approximately 60 – 80 minutes):** Refer to **Table 3-19** indicating sounds heard at the measurement point by the acoustical consultant.

**Table 3-19: Noises/sounds heard during site visits at receptor CBN09**

| Ambient Sound Character -Sounds of Significance | |
|---|---|
| Magnitude Scale Code: Barely Audible, Audible, Dominating | **Faunal and Natural**<br>Birds and Insects. |
| | **Residential and other Anthropogenic**<br>Voices and people moving around. Swimming pool pump. |
| | **Industries, Commercial and Road Traffic**<br>Nothing. |

**Impulse equivalent sound levels:** During the daytime $\mathbf{L_{AIeq}}$ values ranged between 43.7 to 65.6 dBA. The night-time $\mathbf{L_{AIeq}}$ values ranged between 51.4 to 64.0 dBA. The average value of the 100 10-minute equivalent daytime measurements was calculated at 53.9 dBA, while the average for the 48 night-time measurements were calculated at 62.1 dBA. Equivalent sound levels for the day- and night-time periods are shown on **Figure 3-40**. Measured $\mathbf{L_{AIeq}}$ data indicated an area where there is a constant noise that is impacting on the ambient sound levels.

**Statistical sound levels ($\mathbf{L_{A90,f}}$):** The $L_{A90,f}$ level is presented in this report as it is used internationally to define the "background sound level", or the sound level that can be expected it there were little single events (loud transient noises) that impacts on the average sound level. It is also illustrated on **Figure 3-40**. $\mathbf{L_{A90,f}}$ daytime values ranged from 31.6 to 58.0 dBA90. The night-time $\mathbf{L_{A90,f}}$ values ranged from 34.2 to 52.1 dBA90. Measured $\mathbf{L_{A90,f}}$ data indicated an area where there is a constant noise that is impacting on the ambient sound levels.

**Maximum noise levels:** Maximum noise levels are illustrated on **Figure 3-41**. At an average level of 63.1 dBA, this location presented the "noisiest" measurement location (when considering the average maximum sound level). There is an average difference of less than 12 dB between the maximum and equivalent noise levels (as recorded with the instrument on the "fast" setting), with these readings ranging between 5 and 26 dB. Considering the $L_{A,max}$, $L_{A90}$ and $L_{AIeq}$ graphs, one noise source determined the ambient sound levels and were also the source of the a significant portion of maximum noises. The source is undefined.

**Minimum noise levels:** Minimum noise levels are illustrated on **Figure 3-41**. Considering both the $L_{A90}$ and $L_{A,min}$ graphs shows an area where there are a constant background noise, the source unknown.

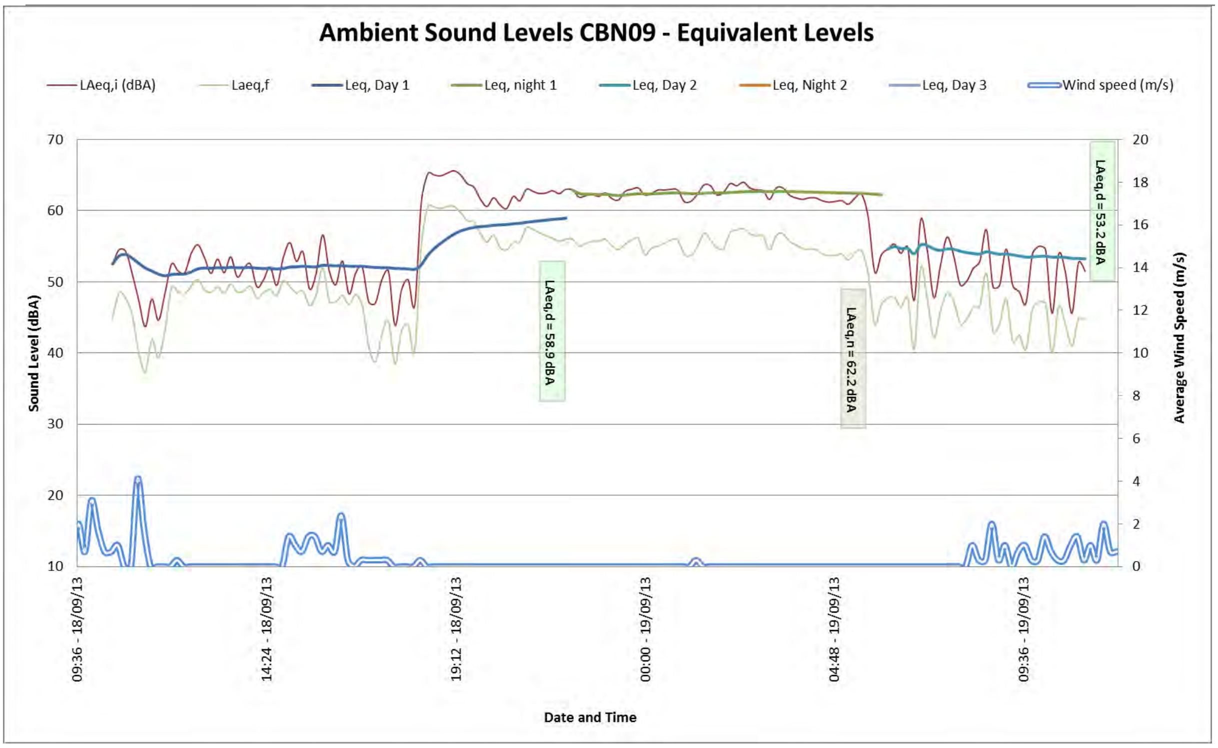



**Figure 3-40: Ambient Sound Levels at CBN09**

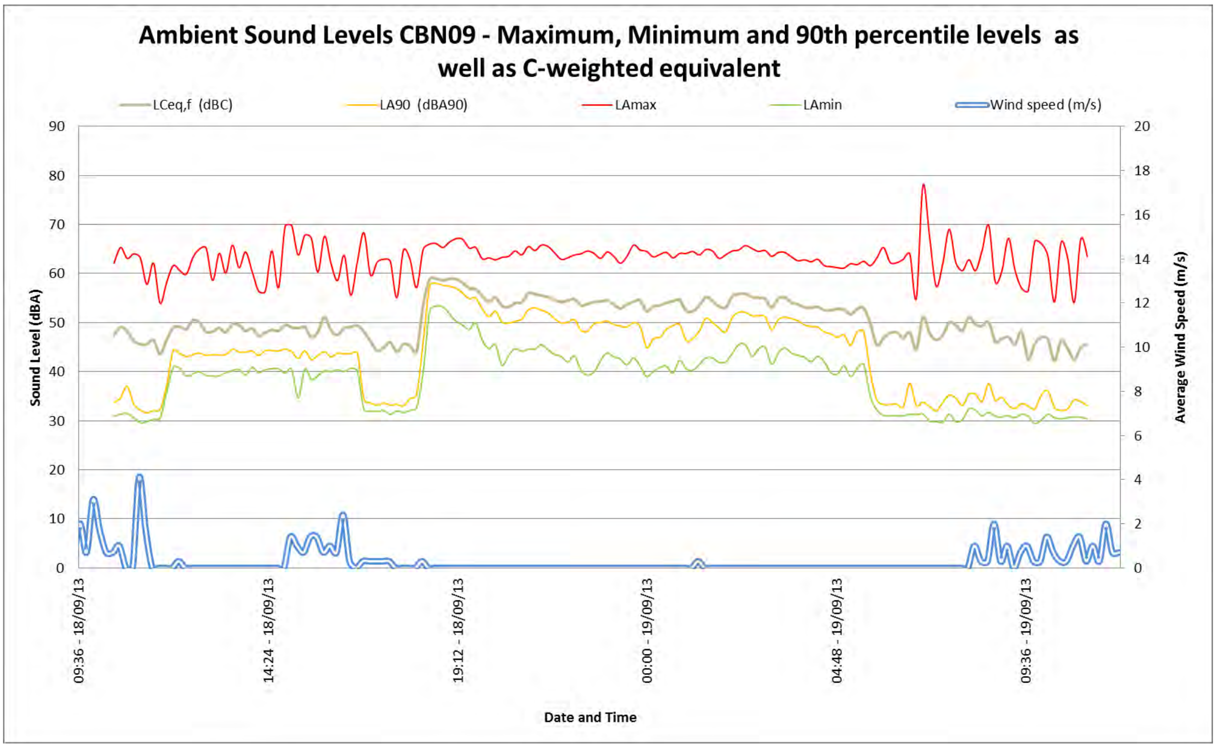



**Figure 3-41: Maximum, Minimum and Statistical sound at CBN09**

## Third octave spectral analysis

Lower frequency (20 – 250 Hz): Daytime measurements (see **Figure 3-42** and **Figure 3-44**) illustrate the spectral character of a number of different noise sources. A number of measurements shows a peak at 50 and 100 Hz (swimming pool pump - see **Figure 3-43**). There are also some undefined peaks at 63 Hz.

Third octave surrounding 1000 Hz: There are no distinctive frequency bands standing out in this frequency area.

Higher frequency (2,000 Hz upwards): This location showed peaks at 2 000, 4 000, 5 000, 6 300, 10 000 and 20 000. The sound at 4 000 Hz was completely dominating. The source was unfortunately not defined.

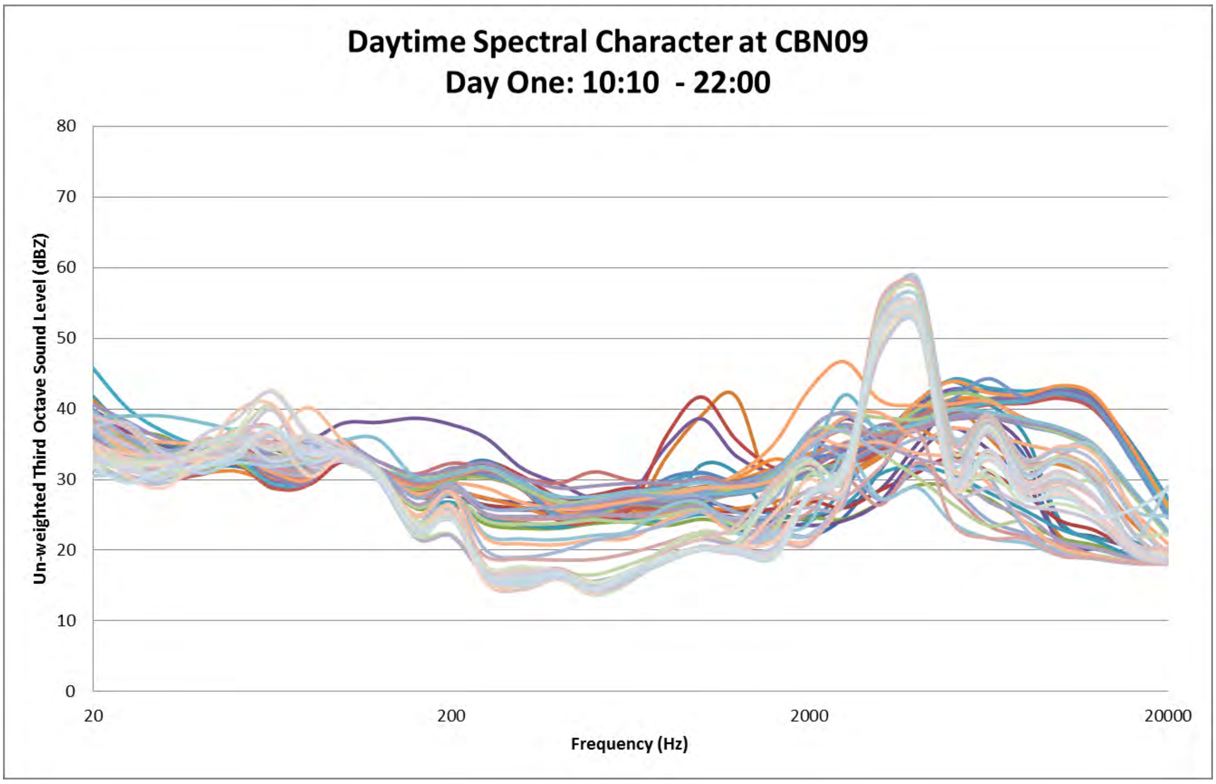



**Figure 3-42: Daytime spectral frequency distribution at CBN09, day one**

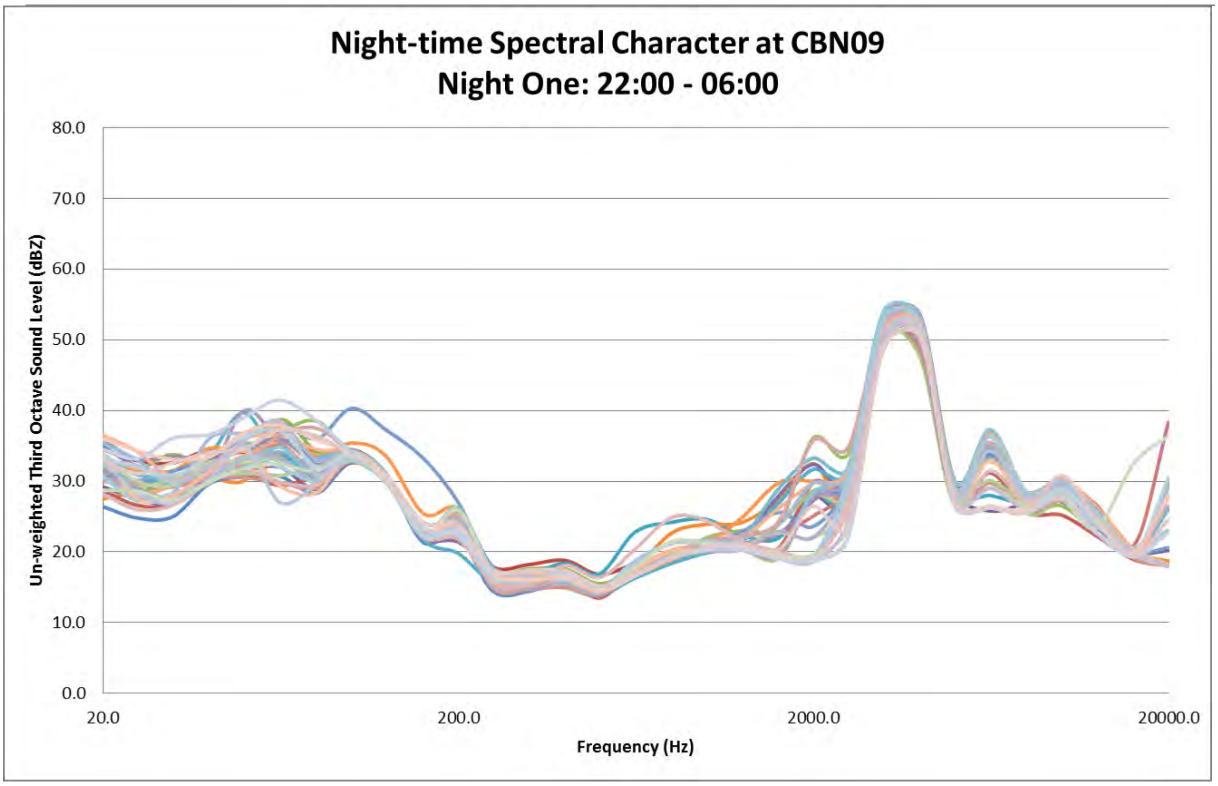



**Figure 3-43: Night-time spectral frequency distribution at CBN09, first night**

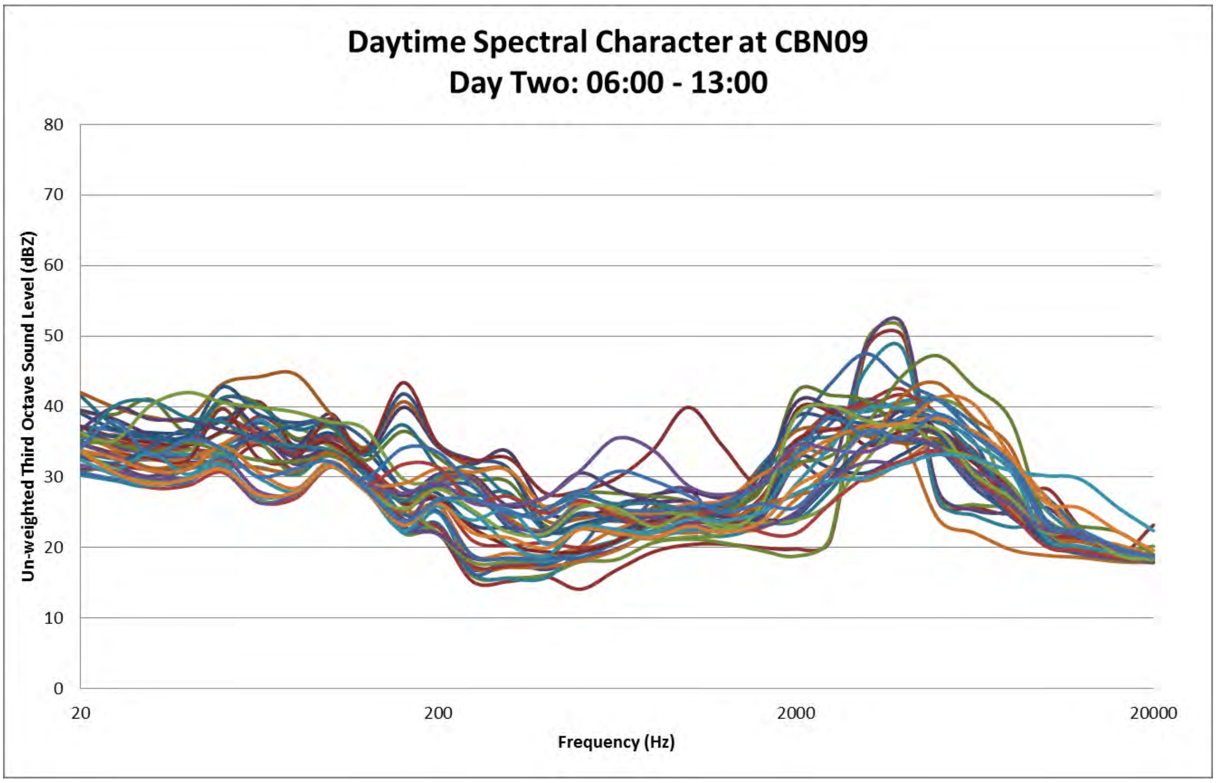



**Figure 3-44: Daytime spectral frequency distribution at CBN09, second day**

### Summary: Spectral Analysis

This location can be considered relative noisy, due to the presence of one dominant noise source. This noise source was unfortunately not identified. This noise source emitted a tonal sound (peaking at 4 000 Hz) with the sound pressure level ranging between 42 dBA ($L_{Amin,f}$) and 72 dBA ($L_{Apeak,i}$). The noise source is suspected to be a bird. A 1 second log of the sound pressure levels are illustrated in **Figure 3-45**.

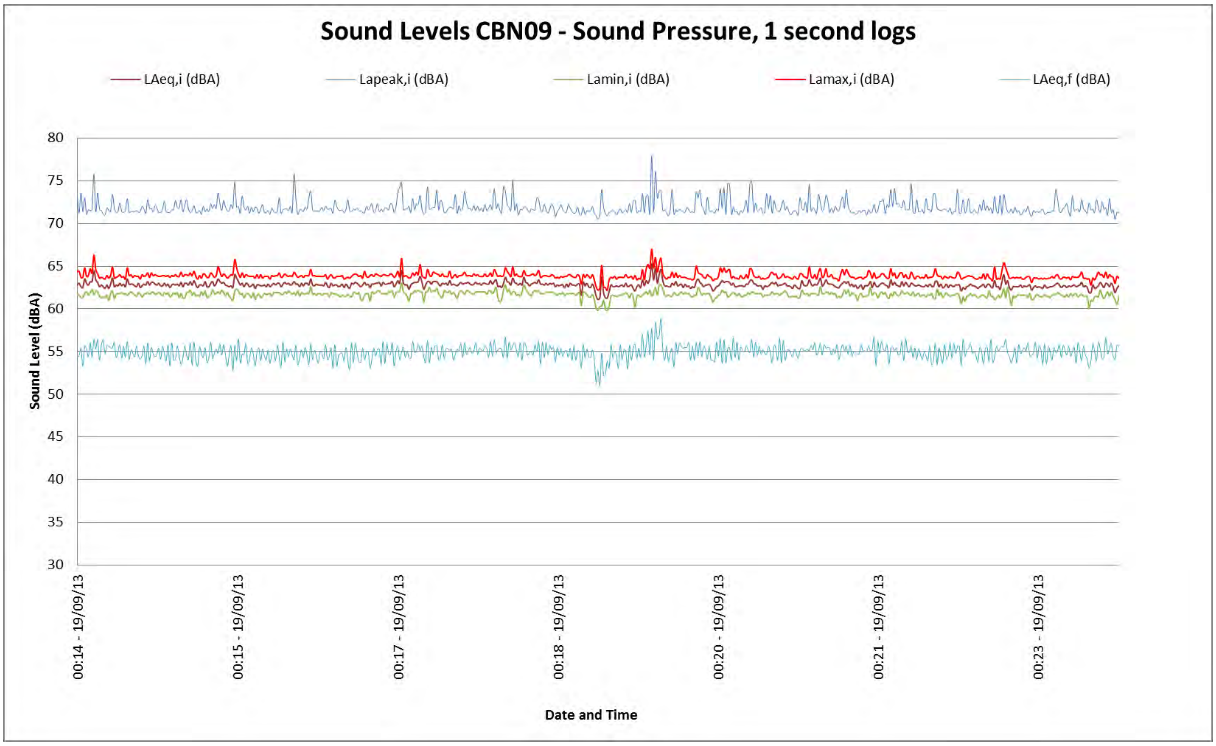



**Figure 3-45: Sound pressure levels – 1 second logs**

**SANS 10103:2008 Rating Level:** Daytime measured data indicate sound levels typical of an area with an urban character (with one of the following: business, workshops and/or main roads) with night-time levels being typical of a commercial area. Considering the $L_{A90}$ and developmental character of the area it is the opinion of the author that a rating level typical for a suburban area would be acceptable. Daytime measured $L_{Aeq,f}$ levels conforms to the recommendation of 55 dBA by the World Health Organization, World Bank and International Finance Corporation for a residential area. Night-time levels exceed their recommended level of 45 dBA.

## 3.5 AMBIENT SOUND LEVELS – SUMMARY

Equivalent sound levels varied significantly from location to location, with all locations experiencing noisy single events at times that impact on the sound levels (both $L_{Aeq}$ and $L_{A90}$). $L_{A90}$ levels indicate an area with potential to be quiet at times. Equivalent daytime ambient sound levels were measured around between 46 – 59 dBA, ranging between 25 and 77 dBA (10-minute measurements). Equivalent night-time ambient sound levels were measured around between 42 – 62 dBA, ranging between 19 and 69 dBA (10-minute measurements). Night-time measurements were generally higher than the day-time measurements, relating to increased faunal activity due to the spring (mating) season.

A summary of the SANS 10103:2008 noise districts are provided in **Table 3-20**.

**Table 3-20: Summary of noise district rating levels**

| Point name | Noise district rating based on $L_{Aeq}$ measurement data (Day / Night) | Noise district rating based on all data and character of area | Existing ambient sound levels conforming to international recommended levels? (Day / Night) |
|---|---|---|---|
| **CBN01** | Rural / urban | Suburban | Yes /no |
| **CBN02** | Urban / commercial | Urban | Yes /no |
| **CBN04** | Suburban / urban | Urban | Yes / yes |
| **CBN05** | Suburban / urban | Urban | Yes / yes |
| **CBN06** | Urban / Urban with roads | Urban | Yes / no |
| **CBN07** | Rural / suburban | Suburban | Yes / yes |
| **CBN08** | Rural / urban | Rural | Yes / yes |
| **CBN09** | Urban / commercial | Urban | Yes / no |

Due to the significant variance in ambient sound measurements it is recommended that the project use the guideline levels for residential use as set by international institutions such as World Health Organization, World Bank and International Finance Corporation for residential areas (see **Table 2-1**). Seasonal changes in ambient sound levels must however be considered as well as spectral character, especially in areas where the sound levels may be exceeded due to the activities of the proposed mine.

## 3.6 ASSESSED EXISTING AMBIENT SOUNDSCAPE

The existing night-time ambient soundscape is designed from available information, and is used for the impact assessment scenario. The result is a projected night-time ambient existing soundscape as illustrated in **Figure 3-46**. Only a night-time map is displayed as is is the most critical time when noise could become an issue.

### 3.6.1 Daytime Ambient Soundscape for Assessment Purpose

Data used in this section is based on available information (**Section 1.4**) as well information gathered during the site investigation dates.

The most distinguishable noise contributor to the daytime ambient soundscape is the existing N1 and R523 road traffic. Daytime calculated major ambient sound contributors included:

- An existing consistent ambient sound level of 20 dBA. This value is based on the lower $L_{A90}$ values measured during site investigation dates (refer to **Section** 3);

- Existing Transnet railway line operations were considered. The following rail corrections were implemented:
  - Train lines were split into sections for various corrections. The daytime operations of 2 x Class 43 electric locomotives and 100 CCL8 x 4-axle tread braked wagons per train with 3 trips per day. Trains were calculated as traveling at 40 km/h;
  - Ballast correction (acoustics attenuation due to ballast effect) was considered;
  - Intervening ground conditions of a medium ground nature, i.e. (50% hard ground conditions);
  - Continuous welded rail (CWR) corrections were considered;
- Façade corrections were not taken into account; and
- N1 and R523 daytime public road traffic volumes (roads illustrated in **Figure 1-5**) calculated from average traffic volume data as monitored on the roads (data courtesy of Syntell and Mikros Traffic Monitoring (Pty) Ltd). Roads considered as a double (two-lane) continuous paved route (non-porous i.e. semi dense air void of 9 – 14 %[13]). Traffic calculated at constant speed of 120 km/h[14] as per speed limits on national highways.

Potential increase in the future daytime traffic volumes for the public roads or existing railway lines were not considered.

### 3.6.2 Night-time Ambient Soundscape for Assessment Purpose

Data used in this section is based on available information (**Section 1.4**) as well information gathered during the site investigation dates.

The most distinguishable noise contributor to the night-time ambient soundscape is the existing N1 and R523 road traffic. Measured data as well as available traffic monitoring information of the road indicated traffic at all hours. Night-time calculated major ambient sound contributors include:

- An existing consistent ambient sound level of 20 dBA. This value is based on the lower $\mathbf{L_{A90}}$ values measured during site investigation dates (refer to **Section** 3);
- Existing Transnet railway line operations were considered. The following rail corrections were implemented:
  - Train lines were split into sections for various corrections. The night-time operations of 2 x Class 43 electric locomotives and 100 CCL8 x 4-axle tread braked wagons per train with 1 trip per night. Trains were calculated as traveling at 40 km/h;

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[13] SILVIA. *Guidance Manual for the Implementation of Low Noise Road Surface 2nd ed.* FEHRL Report
[14] NO. 93 OF 1996: NATIONAL ROAD TRAFFIC ACT, 1996.

  - Ballast correction (acoustics attenuation due to ballast effect) was considered;
  - Intervening ground conditions of a medium ground nature, i.e. (50% hard ground conditions);
  - Continuous welded rail (CWR) corrections were considered;
- Façade corrections were not taken into account;
- N1 and R523 public road traffic volumes (roads illustrated in **Figure 1-5**) calculated from average traffic volume data as monitored on the roads (data courtesy of Syntell and Mikros Traffic Monitoring (Pty) Ltd). Roads considered as a double continues paved route (non-porous i.e. semi dense air void of 9 – 14 %[15]). Traffic calculated at constant speed of 120 km/h[16] as per speed limits on national highways.

Potential increase in the future night-time traffic volumes for the public roads or existing railway lines were not considered.

[15] SILVIA. *Guidance Manual for the Implementation of Low Noise Road Surface 2nd ed.* FEHRL Report
[16] NO. 93 OF 1996: NATIONAL ROAD TRAFFIC ACT, 1996.

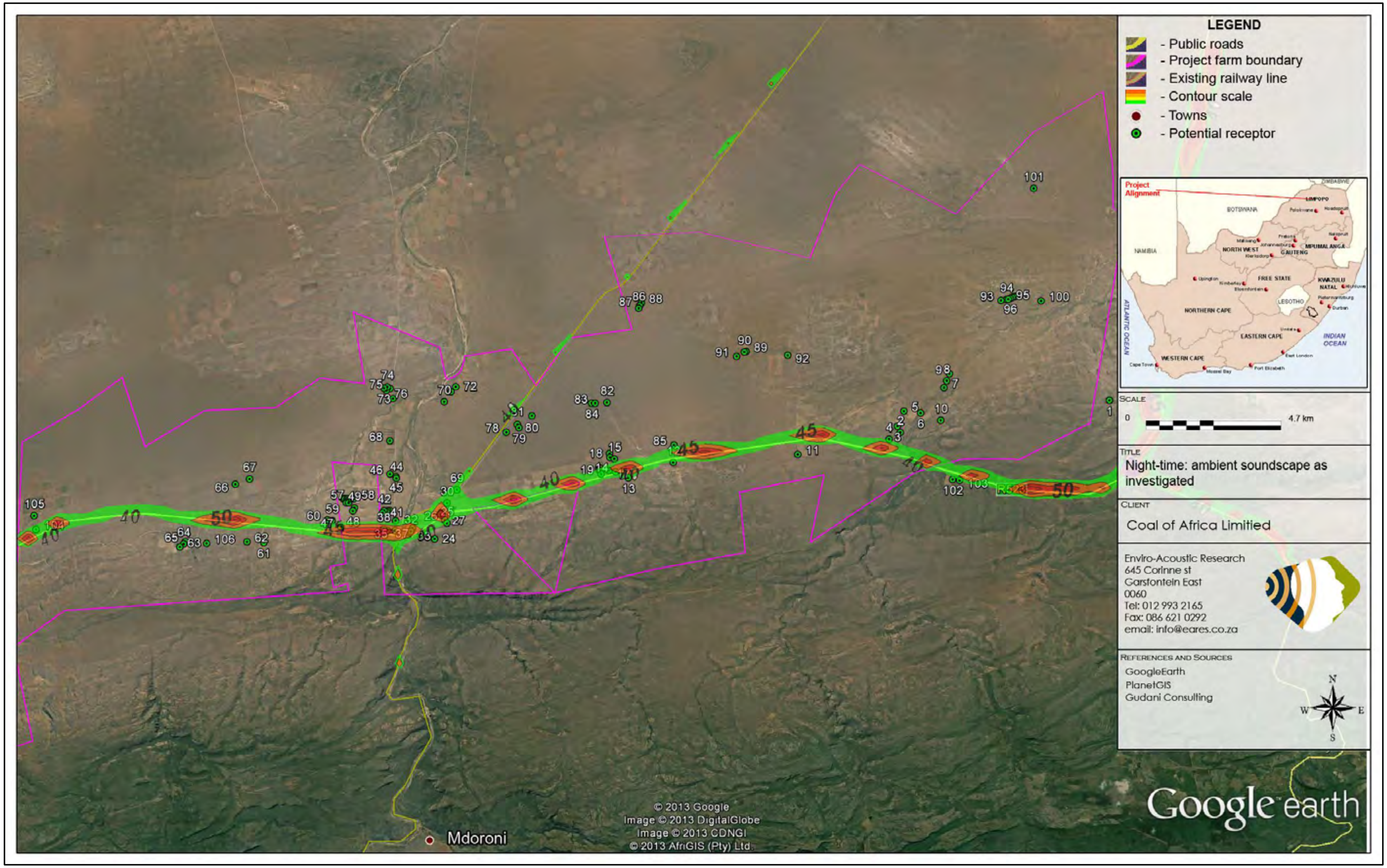


**Figure 3-46: Night-time ambient soundscape as considered**

# 4 INVESTIGATED NOISE SOURCES

Increased noise levels are directly linked with the various activities associated with the construction of the proposed mine and related infrastructure, as well as the operational phase of the activity.

## 4.1 POTENTIAL NOISE SOURCES: PRE-CONSTRUCTION PHASE

Noises generated during the pre-construction phase are of a low significance and was not considered in this document.

## 4.2 POTENTIAL NOISE SOURCES: CONSTRUCTION PHASE

### 4.2.1 Construction Activities

The following are possibly the main construction related sources of noise for a mine and its infrastructure:

- Vegetation removal and the stripping of topsoil at open cast pits by means of hydraulic shovels, articulated dump trucks (ADT), Front End Loaders (FEL), dozers etc.;
- Development of the topsoil, hards, softs, overburden, interburden and other berms (around mining pits and stockpiles);
- Construction camp establishment;
- Development of the internal and access roads;
- Activities related to the deployment and implementation of services (power lines, communication infrastructure, pipelines, conveyor systems);
- Excavation of building foundations and service trenches. Blasting may be required but in general pneumatic breakers will be used where rock is encountered;
- Development of initial box cuts (excavation of soft overburden, drilling and blasting of hard interburden/overburden, loading of blasted hard interburden/overburden as well as material transport);
- Piling operations for large buildings and structures;
- Construction of offices and other structures;
- Installation of crushing, screening and beneficiation plant infrastructure;
- General movement of heavy vehicles around the site; and,
- Construction material and equipment delivery vehicles coming/going.

The level and character of the construction noise will be highly variable as different activities with different equipment take place at different times, for different periods of time (operating cycles), in different combinations, in different sequences and on different parts of the construction site.

Potential maximum noise levels generated by construction equipment as well as the potential extent are presented in **Table 4-1**. The potential extent depends on a number of factors, including the prevailing ambient sound levels during the instance the maximum noise event occurred, as well as the spectral character of the noise as well as the ambient surroundings.

Average or equivalent sound levels are another factor that impacts on the ambient sound levels and is the constant sound level that the receptor can experience. Typical sound power levels associated with various activities that may be found at a construction site is presented in **Table 4-2**.

### 4.2.2 Traffic, Delivery Routes and Material Supply

A significant source of noise during the construction phase is additional traffic to and from the site, as well as traffic on the site. This will include trucks transporting equipment and machinery, as well as contractors. Construction traffic is expected to be generated throughout the entire construction period, however, the volume and type of traffic generated will be dependent upon the construction activities being conducted, which will vary during the construction period.

### 4.2.3 Blasting

Blasting may be required as part of the civil works to clear obstacles or to prepare foundations. However, blasting will not be considered during the Scoping or EIA phase for the following reasons:

- Blasting is highly regulated and control of blasting to protect human health, equipment and infrastructure will ensure that any blasts will use minimum explosives and will occur in a controlled manner.
- Blasting is a highly specialised field, and various management options are available to the blasting specialist. Options available to minimise the risk to equipment, people and infrastructure includes:
  - The use of different explosives that have a lower detonation speed, which reduces vibration, sound pressure levels as well as air blasts.
  - Blasting techniques such as blast direction and/or blast timings (both blasting intervals and sequence).
  - Reducing the total size of the blast.
  - Damping materials used to cover the explosives.

- People are generally more concerned over ground vibration and air blast levels that might cause building damage than the impact of the noise from the blast. This is normally associated with close proximity mining/quarrying.
- Blasts will be an infrequent occurrence, with a loud but a relative instantaneous character. Potentially affected parties normally receive sufficient notice (siren), and the knowledge that the duration of the siren noise as well as the blast will be over relative fast result in a higher acceptance of the noise.

**Table 4-1: Potential maximum noise levels generated by construction equipment**

| Equipment Description[17] | Impact Device? | Maximum Sound Power Levels (dBA) | Operational Noise Level at given distance considering potential **maximum** noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5 m | 10 m | 20 m | 50 m | 100 m | 150 m | 200 m | 300 m | 500 m | 750 m | 1000 m | 2000 m |
| Auger Drill Rig | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Backhoe | No | 114.7 | 89.7 | 83.7 | 77.6 | 69.7 | 63.7 | 60.1 | 57.6 | 54.1 | 49.7 | 46.2 | 43.7 | 37.6 |
| Chain Saw | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Compactor (ground) | No | 114.7 | 89.7 | 83.7 | 77.6 | 69.7 | 63.7 | 60.1 | 57.6 | 54.1 | 49.7 | 46.2 | 43.7 | 37.6 |
| Compressor (air) | No | 114.7 | 89.7 | 83.7 | 77.6 | 69.7 | 63.7 | 60.1 | 57.6 | 54.1 | 49.7 | 46.2 | 43.7 | 37.6 |
| Concrete Batch Plant | No | 117.7 | 92.7 | 86.7 | 80.6 | 72.7 | 66.7 | 63.1 | 60.6 | 57.1 | 52.7 | 49.2 | 46.7 | 40.6 |
| Concrete Mixer Truck | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Concrete Pump Truck | No | 116.7 | 91.7 | 85.7 | 79.6 | 71.7 | 65.7 | 62.1 | 59.6 | 56.1 | 51.7 | 48.2 | 45.7 | 39.6 |
| Concrete Saw | No | 124.7 | 99.7 | 93.7 | 87.6 | 79.7 | 73.7 | 70.1 | 67.6 | 64.1 | 59.7 | 56.2 | 53.7 | 47.6 |
| Crane | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Dozer | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Drill Rig Truck | No | 118.7 | 93.7 | 87.7 | 81.6 | 73.7 | 67.7 | 64.1 | 61.6 | 58.1 | 53.7 | 50.2 | 47.7 | 41.6 |
| Drum Mixer | No | 114.7 | 89.7 | 83.7 | 77.6 | 69.7 | 63.7 | 60.1 | 57.6 | 54.1 | 49.7 | 46.2 | 43.7 | 37.6 |
| Dump Truck | No | 118.7 | 93.7 | 87.7 | 81.6 | 73.7 | 67.7 | 64.1 | 61.6 | 58.1 | 53.7 | 50.2 | 47.7 | 41.6 |
| Excavator | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Flat Bed Truck | No | 118.7 | 93.7 | 87.7 | 81.6 | 73.7 | 67.7 | 64.1 | 61.6 | 58.1 | 53.7 | 50.2 | 47.7 | 41.6 |
| Front End Loader | No | 114.7 | 89.7 | 83.7 | 77.6 | 69.7 | 63.7 | 60.1 | 57.6 | 54.1 | 49.7 | 46.2 | 43.7 | 37.6 |
| Generator | No | 116.7 | 91.7 | 85.7 | 79.6 | 71.7 | 65.7 | 62.1 | 59.6 | 56.1 | 51.7 | 48.2 | 45.7 | 39.6 |
| Generator (<25KVA, VMS Signs) | No | 104.7 | 79.7 | 73.7 | 67.6 | 59.7 | 53.7 | 50.1 | 47.6 | 44.1 | 39.7 | 36.2 | 33.7 | 27.6 |
| Grader | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Impact Pile Driver | Yes | 129.7 | 104.7 | 98.7 | 92.6 | 84.7 | 78.7 | 75.1 | 72.6 | 69.1 | 64.7 | 61.2 | 58.7 | 52.6 |
| Jackhammer | Yes | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Man Lift | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Mounted Impact Hammer | Yes | 124.7 | 99.7 | 93.7 | 87.6 | 79.7 | 73.7 | 70.1 | 67.6 | 64.1 | 59.7 | 56.2 | 53.7 | 47.6 |

[17] Equipment list and Sound Power Level source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paver | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Pickup Truck | No | 89.7 | 64.7 | 58.7 | 52.6 | 44.7 | 38.7 | 35.1 | 32.6 | 29.1 | 24.7 | 21.2 | 18.7 | 12.6 |
| Pumps | No | 111.7 | 86.7 | 80.7 | 74.6 | 66.7 | 60.7 | 57.1 | 54.6 | 51.1 | 46.7 | 43.2 | 40.7 | 34.6 |
| Rivit Buster/Chipping Gun | Yes | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Rock Drill | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Roller | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Sand Blasting (single nozzle) | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Scraper | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Sheers (on backhoe) | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Slurry Plant | No | 112.7 | 87.7 | 81.7 | 75.6 | 67.7 | 61.7 | 58.1 | 55.6 | 52.1 | 47.7 | 44.2 | 41.7 | 35.6 |
| Slurry Trenching Machine | No | 116.7 | 91.7 | 85.7 | 79.6 | 71.7 | 65.7 | 62.1 | 59.6 | 56.1 | 51.7 | 48.2 | 45.7 | 39.6 |
| Soil Mix Drill Rig | No | 114.7 | 89.7 | 83.7 | 77.6 | 69.7 | 63.7 | 60.1 | 57.6 | 54.1 | 49.7 | 46.2 | 43.7 | 37.6 |
| Tractor | No | 118.7 | 93.7 | 87.7 | 81.6 | 73.7 | 67.7 | 64.1 | 61.6 | 58.1 | 53.7 | 50.2 | 47.7 | 41.6 |
| Vacuum Excavator (Vac-Truck) | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Vacuum Street Sweeper | No | 114.7 | 89.7 | 83.7 | 77.6 | 69.7 | 63.7 | 60.1 | 57.6 | 54.1 | 49.7 | 46.2 | 43.7 | 37.6 |
| Ventilation Fan | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Vibrating Hopper | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Vibratory Concrete Mixer | No | 114.7 | 89.7 | 83.7 | 77.6 | 69.7 | 63.7 | 60.1 | 57.6 | 54.1 | 49.7 | 46.2 | 43.7 | 37.6 |
| Vibratory Pile Driver | No | 129.7 | 104.7 | 98.7 | 92.6 | 84.7 | 78.7 | 75.1 | 72.6 | 69.1 | 64.7 | 61.2 | 58.7 | 52.6 |
| Warning Horn | No | 119.7 | 94.7 | 88.7 | 82.6 | 74.7 | 68.7 | 65.1 | 62.6 | 59.1 | 54.7 | 51.2 | 48.7 | 42.6 |
| Welder/Torch | No | 107.7 | 82.7 | 76.7 | 70.6 | 62.7 | 56.7 | 53.1 | 50.6 | 47.1 | 42.7 | 39.2 | 36.7 | 30.6 |

## 4.3 POTENTIAL NOISE SOURCES: OPERATIONAL PHASE

Noise emitted by proposed excavations of the open cast coal pits can be associated with various types of noises and noise sources.

These include mechanical sources due to operation of plant equipment, material impact noises (such as the noise made when materials are dropped at a height to ground level) and electrical noise (reverse hooters from mining equipment).

### 4.3.1 Truck and Shovel Open Cast Mining

The following noise generation activities will be modelled for the operational phase at the mine:

- Opencast activities:
    - Drilling of hard overburden (surface level to illustrate a potential worst case scenario);
    - Excavation and loading-hauling-dumping of overburden/interburden using Articulated Dump Trucks (ADTs), hydraulic shovels (excavators) and other mining equipment;
    - Compaction of subsoil for access routes to the pits;
    - Drilling of hard interburden (a few meters below surface);
    - Ore excavation from open cast pits and load-haul-dumping (at the material tip);
    - Dust suppression on haul routes and open cast pits by means of water dozers; and
    - Pit backfill with aggregate such as topsoil etc.

Typical sound power levels associated with various activities that may be found at an opencast pit is presented in **Table 4-1** (maximum noises) and **Table 4-2** (average or equivalent noises). As can be seen from this table there are a range of equipment, frequently with different sound power emission levels and spectral characteristics.

### 4.3.2 Mining Infrastructure

- Conveying of ROM via a conveyor belt system, ADT and other heavy haul vehicles on routes overland to beneficiation plants;
- Plant activities include;
    - Ore receipt and management (stockpiling);
    - Material handling, sorting and crushing (rotary crusher, grizzly etc);
    - High Gravity Dense Medium Separation process;

  - Low Gravity Dense Medium Separation process;
  - Discard management of spoils, tailings etc. (material handling);
  - Flotation and fines management;
  - Tailings thickening and tailing disposal;
  - Product handling.
- Transportation of the final product to markets by means of rail sidings. The coal is stockpiled in silos at rail loops (or rail balloons) until freight carriages from the main rail route are available to transport the coal to the required destinations.

Of these activities significant noise are associated with the opencast, material tip and plant activities. Typical sound power levels associated with various activities that may be found at an opencast mine is presented in **Table 4-2**. It is important to note that the list and number of equipment was not defined at the time this report was compiled. As can be seen from this table there are a range of equipment, frequently with different sound power emission levels and spectral characteristics. If the developer selected different equipment than used for modelling in this report, modelling results will be different.

### 4.3.3 Haul and Access Road Traffic

A source of noise during the operational phase is additional traffic to and from the colliery and open cast pits. Noise propagation due road traffic depends on various acoustical factors. The most important are briefly discussed below.

#### *4.3.3.1 Road tyre interaction and other vehicle noise sources*

The most significant noise contributor above 60 km p/h is the tyre interaction with the road surface. Tyre road impacts and shocks as well as tyre to road pumping (during standard rolling conditions, pumping is the compression of air under tyre tread) can contribute mainly below and above 1000 Hz respectively (up to 2000 Hz for pumping). The horn effect created by the geometry of the tyre and road surface can amplify at frequencies up to 10 000 Hz[18].

#### *4.3.3.2 Road vehicle type*

Vehicles noise emissions at speed vary from vehicle to vehicle. For acoustical purposes the classification of vehicles are considered as light or heavy. Heavy vehicles could be considered as articulated, tanker or other industrial haul trucks.

[18] *FEHRL Report 2006/02, Guidance manual for the implementation of low-noise road surfaces*

### Table 4-2: Potential equivalent noise levels generated by various equipment

| Equipment Description | Equivalent (average) Sound Levels (dBA) | Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5 m | 10 m | 20 m | 50 m | 100 m | 150 m | 200 m | 300 m | 500 m | 750 m | 1000 m | 2000 m |
| Bulldozer CAT D10 | 111.9 | 86.9 | 80.9 | 74.9 | 66.9 | 60.9 | 57.4 | 54.9 | 51.3 | 46.9 | 43.4 | 40.9 | 34.9 |
| Bulldozer CAT D11 | 113.3 | 88.4 | 82.3 | 76.3 | 68.4 | 62.3 | 58.8 | 56.3 | 52.8 | 48.4 | 44.8 | 42.3 | 36.3 |
| Bulldozer CAT D9 | 111.9 | 86.9 | 80.9 | 74.9 | 66.9 | 60.9 | 57.4 | 54.9 | 51.3 | 46.9 | 43.4 | 40.9 | 34.9 |
| Bulldozer CAT D6 | 108.2 | 83.3 | 77.3 | 71.2 | 63.3 | 57.3 | 53.7 | 51.2 | 47.7 | 43.3 | 39.8 | 37.3 | 31.2 |
| Bulldozer CAT D5 | 107.4 | 82.4 | 76.4 | 70.4 | 62.4 | 56.4 | 52.9 | 50.4 | 46.9 | 42.4 | 38.9 | 36.4 | 30.4 |
| Bulldozer Komatsu 375 | 114.0 | 89.0 | 83.0 | 77.0 | 69.0 | 63.0 | 59.5 | 57.0 | 53.4 | 49.0 | 45.5 | 43.0 | 37.0 |
| Crusher/Screen (MTC Mobile) | 109.6 | 84.6 | 78.6 | 72.6 | 64.6 | 58.6 | 55.1 | 52.6 | 49.0 | 44.6 | 41.1 | 38.6 | 32.6 |
| Coal crushing plant (50 tons/h) | 114.5 | 89.5 | 83.5 | 77.5 | 69.5 | 63.5 | 60.0 | 57.5 | 54.0 | 49.5 | 46.0 | 43.5 | 37.5 |
| Coal beneficiation plant | 107.5 | 82.5 | 76.5 | 70.5 | 62.5 | 56.5 | 53.0 | 50.5 | 46.9 | 42.5 | 39.0 | 36.5 | 30.5 |
| Coal silo (Material Transfer) | 103.2 | 78.3 | 72.2 | 66.2 | 58.3 | 52.2 | 48.7 | 46.2 | 42.7 | 38.3 | 34.7 | 32.2 | 26.2 |
| Coal Yard Equipment | 106.8 | 81.8 | 75.8 | 69.8 | 61.8 | 55.8 | 52.3 | 49.8 | 46.3 | 41.8 | 38.3 | 35.8 | 29.8 |
| Coal Screen | 105.1 | 80.1 | 74.1 | 68.1 | 60.1 | 54.1 | 50.6 | 48.1 | 44.6 | 40.1 | 36.6 | 34.1 | 28.1 |
| Diesel loco moving | 108.7 | 83.7 | 77.7 | 71.7 | 63.7 | 57.7 | 54.2 | 51.7 | 48.2 | 43.7 | 40.2 | 37.7 | 31.7 |
| Diesel loco idling | 100.7 | 75.7 | 69.7 | 63.7 | 55.7 | 49.7 | 46.2 | 43.7 | 40.1 | 35.7 | 32.2 | 29.7 | 23.7 |
| Drilling Machine | 109.6 | 84.6 | 78.6 | 72.6 | 64.6 | 58.6 | 55.1 | 52.6 | 49.1 | 44.6 | 41.1 | 38.6 | 32.6 |
| Dumper/Haul truck - CAT 700 | 115.9 | 91.0 | 85.0 | 78.9 | 71.0 | 65.0 | 61.4 | 58.9 | 55.4 | 51.0 | 47.5 | 45.0 | 38.9 |
| Dumper/Haul truck - Terex 30 ton | 112.2 | 87.2 | 81.2 | 75.2 | 67.2 | 61.2 | 57.7 | 55.2 | 51.7 | 47.2 | 43.7 | 41.2 | 35.2 |
| Excavator - Hitachi EX1200 | 113.1 | 88.1 | 82.1 | 76.1 | 68.1 | 62.1 | 58.6 | 56.1 | 52.6 | 48.1 | 44.6 | 42.1 | 36.1 |
| Excavator - Hitachi 870 (80 t) | 108.1 | 83.1 | 77.1 | 71.1 | 63.1 | 57.1 | 53.6 | 51.1 | 47.5 | 43.1 | 39.6 | 37.1 | 31.1 |
| FEL - Bell L1806C | 102.7 | 77.7 | 71.7 | 65.7 | 57.7 | 51.7 | 48.2 | 45.7 | 42.1 | 37.7 | 34.2 | 31.7 | 25.7 |
| FEL - CAT 950G | 102.1 | 77.2 | 71.2 | 65.1 | 57.2 | 51.2 | 47.6 | 45.1 | 41.6 | 37.2 | 33.7 | 31.2 | 25.1 |
| FEL - Komatsu WA380 | 100.7 | 75.7 | 69.7 | 63.7 | 55.7 | 49.7 | 46.2 | 43.7 | 40.1 | 35.7 | 32.2 | 29.7 | 23.7 |
| General noise | 108.8 | 83.8 | 77.8 | 71.8 | 63.8 | 57.8 | 54.2 | 51.8 | 48.2 | 43.8 | 40.3 | 37.8 | 31.8 |
| Grader - Operational Hitachi | 108.9 | 83.9 | 77.9 | 71.9 | 63.9 | 57.9 | 54.4 | 51.9 | 48.4 | 43.9 | 40.4 | 37.9 | 31.9 |
| Grader | 110.9 | 85.9 | 79.9 | 73.9 | 65.9 | 59.9 | 56.4 | 53.9 | 50.3 | 45.9 | 42.4 | 39.9 | 33.9 |
| Screening plant | 105.5 | 80.6 | 74.6 | 68.5 | 60.6 | 54.6 | 51.0 | 48.5 | 45.0 | 40.6 | 37.0 | 34.6 | 28.5 |
| Water Dozer, CAT | 113.8 | 88.8 | 82.8 | 76.8 | 68.8 | 62.8 | 59.3 | 56.8 | 53.3 | 48.8 | 45.3 | 42.8 | 36.8 |

#### *4.3.3.3 Road surface porosity and surface conditions*

Road surface design, construction and maintenance can play an important part on the acoustical emissions of road traffic noise levels. Unpaved roads cause much more vibration in/ on vehicle tyres than paved roads, with the results been higher noise levels. Similarly the porosity value of the paved roads makes a difference in the way the air pressure and acoustics interacts with road tyres at speed. The higher the porosity value of the tar road the less air will be "pumped" under the tyre tread. A smoothed tar road will also affect the vibration of the tyres less as bumps in the road will cause to the tyres to vibrate in a similar fashion to a drum on impact.

#### *4.3.3.4 Road traffic volume*

Road traffic with the volume and type of traffic generated may vary from day to day. Only noise levels due to traffic volumes from the proposed roads will be estimated using the methods stipulated in SANS 10210:2004 (Calculating and predicting road traffic noise).

#### *4.3.3.5 Other road noise contributors*

Other noise sources associated with motor vehicles include the exhaust outlet, engine motor and associated engine components (mostly audible below 60 km p/h. Many motor engine revs per minute (rpm) convert to a low range of frequency below the 100 Hz range. Wind shear can contribute to this range but at much faster speeds.

### 4.3.4 Railway Sidings

Rail traffic is considered as a line source of noise with a continuous area of impact both sides of and parallel to the railway line. Railway related noise is general acoustically characterised by high noise levels of relatively short duration.

The wayside noise radiated into a community is the function of a number of different factors, namely:

- Interaction of wheels and rails. This includes the type of railway and wheel design, wheel diameter and "roughness". The main cause of wheel roughness is due to the use of cast iron brakes[19]. Most worldwide railway lines consist of flat-bottom steel rails supported on timber or pre-stressed concrete sleepers. These are usually laid on crushed stone ballast. Railway lines with heavy traffic use continuous welded rails (CWR) attached to sleepers via baseplates which spread the load. Certain railway

[19] European Commission Directorate General Energy and Transport. Impact Assessment Study on Rail Noise Abatement Measures addressing the Existing Fleets. Reference Tren/A1/46-2005. December 10 2007.

lines make use of the jointed track, leaving (over time) small spacing between tracks. Jointed tracks are also used when a railway line breaks and repairs need to be made;

- Amount of axels per carriage. It is assumed that the colliery will run CCL/CCR wagon carriages on the line. These carriages consist of 4 axels per carriage. An example of a CCL 8 carriage is illustrated in **Figure 4-1**.
- The vehicle or locomotive propulsion system. For the purpose of this assessment the use of 2 class 43 diesel locomotives will be assessed (example in **Figure 4-2**);
- Type of locomotive and wagons. Refer to points above for locomotive and wagon specifications;
- Amount of trains per day/night. The trains per day/night period were calculated as 1 load (information gathered from **Section 1.4**). No return trains was considered;
- Braking technology employed on the wagons and locomotives. All trains will have to be fitted with electronic controlled pneumatic brakes (ENP). It is assumed that the brakes will be cast iron. Railway braking is also associated with brake squeal which may have an acoustical tonal element to it;
- Railway alignment, in particular the design radius of curves and turns. The minimum railway curve radius has an important bearing on construction costs and operating costs;
- Auxiliary equipment;
- Noise radiated from vibrating structures;
- Train speed. It is assumed that the trains will be limited to speeds of 15 km/h in the rail loop and 40 km/h in noise-sensitive areas;
- The length/amount of carriages. The envisage carriages was calculated as 100;
- Aerodynamics (for higher speed operations above 200 km/h); and
- Locomotive warning devices or horn noise.

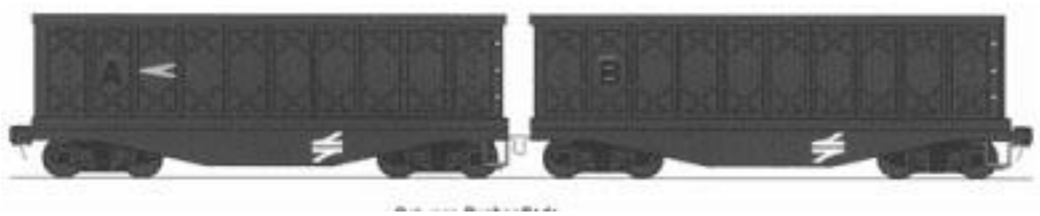


**Figure 4-1: CCL 8 Wagon**

**Figure 4-2: Class 43 diesel locomotives**

Train speed is a major influence parameter for noise emission. The noise due to traction and auxiliary systems (diesel units, electrically driven powertrains, cooling equipment, compressors), if present, tends to be predominant at low speeds, up to around 60 km/h. The relationship with speed is illustrated in **Figure 4-3**.

Wheel-rail rolling noise is dominant up to speeds around 200-300 km/h, after which aerodynamic noise takes over as dominant factor. The transition speeds from traction noise to rolling noise and from rolling noise to aerodynamics noise depend entirely on the relative strength of these sources. The rolling noise, for example, depends strongly on the surface condition (roughness) of wheels and rails, whereas aerodynamic noise depends on the streamlining of the vehicle.

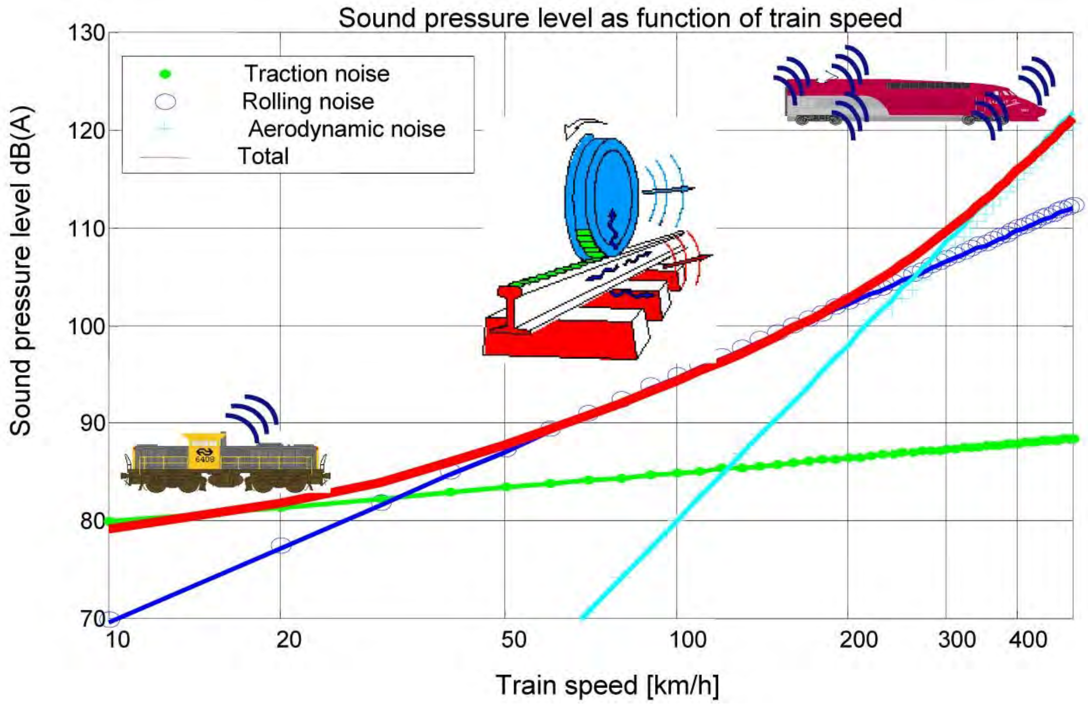


**Figure 4-3: Railway exterior sound sources and typical dependence on train speed**

Unfortunately there is no standard or guideline in South Africa stipulating the requirements to calculate or model the potential noise impacts from a railway operation. For this purpose it was selected to make use of the United Kingdom Department of Transport document, "Calculation of Railway Noise, 1995" (CRN).

#### *4.3.4.1 Vibrations from Railway operations*

South African Standards available are limited to the SABS ISO 4866:1990 and SABS ISO 2631-1 1991. These documents are based on human and building infrastructure that is exposed to vibrations. It is a trend in African countries to refer to International Standards and guidelines in terms of vibration criteria. Infrastructure vibrations predominately occur below 300 Hz, with many International guidelines highlighting the need to consider the measurement frequency weighting when assessing vibrations. These include the international $W_m$/KB and British $W_b$/$W_d$ standards, vibration decibel (VdB) measurements as well as the correlation between $\mathbf{L_{Aeq}}$ and $\mathbf{L_{Ceq}}$ for assessment of lower frequencies [20] (refer to **Section 2.6** for SANS methodology).

A ground-borne vibration is a system interlinking the noise source, vibration medium and receiver with one another. Several different mechanisms constitute this system including the distances, infrastructure specifications and railway *modus operandi*.

[20] RIVAS. Review of existing standards, regulations and guidelines, as well as laboratory and field studies concerning human exposure to vibration. 2011.

This report will only investigate airborne noise disturbances motivated by the following reasons:

- Vibration decibel's international criterion for annoyance includes the amount of trains per day and is generally based on railways used for commuting purposes (Error! eference source not found.) in urban areas. International countries where railways are used for commuting purposes is a far busier and a more complex system than what is required from this proposed industrial route;
- International documents based on commuter trains do focus a fair amount on built-up dense urban environments whereby potential vibration annoyance may increase. This proposed railway route assessment is in a fairly rural area when considering the surrounding land use;
- International guidelines also take into account high speed commuter trains, with commuter trains that can reach velocities up to 200 km/h[21]. The train route (railway siding) assessed will assumed to have trains operating at 40 km/h due to the relatively short span of rail. The levels of ground-borne vibration and noise vary approximately 20 times the logarithm of speed. This means that doubling train speed will increase the vibration levels approximately 6 decibels and halving train speed will reduce the levels by 6 decibels. Due to the directly proportional relationship between vibration and noise, the lower the rolling stock speeds the less likely there will be for a vibration annoyance[22];
- Ground-borne noise mainly applies at receiver locations above rail operations in tunnels where ground-borne noise levels from rail transport are likely to be greater than airborne noise levels (and at speed). This is particularly relevant internationally for commuter underground subway systems. Air-borne noise generally is far more annoying to a receptor than ground-borne vibrations;
- Only limited research into the impacts of ground-borne noise is available, and information and modelling on practices applied overseas is scarce[23]. There is currently no accepted model available to allow the extent of vibration and ground-born noise from railway vehicles. Such efforts as the CATdBTren [24] and ENVIB [25] projects whereby empirical calculations are proposed for the prediction of the complex ground-borne vibration;
- A ground-borne vibration is proportional of the distance from noise source to the receiver. In this instance, no receptors are adjacent to the newly proposed railway line (or close enough for this factors to be considered);

[21] http://en.wikipedia.org/wiki/High-speed_rail

[22] High-Speed Ground Transportation Noise and Vibration Impact Assessment.1998.

[23] M.J Griffin. The Handbook of Human Vibration. 1996

[24] The Sixteenth International Congress of Sound and Vibration. Krakow. 2009.

[25] Mehdi Bahrekazemi. Train-Induce Ground Vibration and its Prediction.2004

- Many proposed mitigation measures for consideration in this document due to air-borne noise (from trains) will similarly reduce ground vibrations[26]; and
- There are many factors involved in the sophisticated estimation of vibration and ground-borne vibration, including[27]:
  1. The medium - The surrounding geological strata, bedrock depth, soil type, bedrock contours, soil layering, depth of the water table etc.;
  2. The source - Condition of the track, design of the track, speed of the locomotive and carriage, track support, suspension, track alignment, weight of cargo, condition of the rail track and wheel, wheel axles etc.; and
  3. The receiver – Receptor's foundation design, building construction, interior acoustical absorption and location of building etc.

## 4.4 POTENTIAL NOISE SOURCES: CLOSURE PHASE

Closure activities will not be considered in this report. In general, closure activities have a significant lower noise impact than both the operational and closure phases. The closure phase will therefore not be considered during this document for the following reasons:

- Closure activities are generally less intense than construction and operational activities. Noise levels are lower and frequently limited to daylight hours. This reduces the significance of the noise impact.
- Most rehabilitation takes place con-currently with mining. It is therefore just another activity generating noise that could be considered as part of the operational phase,
- A closure EMP must be developed by the mining operation at the end of the mining operation, which is more specific and accurate. If required, noise could be addressed in this document.

[26] High-Speed Ground Transportation Noise and Vibration Impact Assessment.1998.

[27] David A. Towers, P.E. Rail Transit Noise and Vibration; Sinan Al Suhairy. Prediction of Ground Vibration from Railways.2000

# 5 METHODS: NOISE IMPACT ASSESSMENT

## 5.1 POTENTIAL NOISE IMPACT ON ANIMALS[28]

A great deal of research was conducted in the 1960's and 1970's on the effects of aircraft noise on animals. While aircraft noise have a specific characteristic that might not be comparable with industrial noise, the findings should be relevant to most noise sources.

Overall, the research suggests that species differ in their response to:

- Various types of noise, durations of noise, magnitude of the noise, characteristic of the noise and sources of noise.

A general animal behavioural reaction to aircraft noise is the startle response. However, the strength and length of the startle response appears to be dependent on:

- Which species is exposed;
- Whether there is one animal or a group; and
- Whether there have been some previous exposures.

There are numerous other factors in the environment of animals that also influence the effects of noise. These include predators, weather, changing prey/food base and ground-based disturbance, especially anthropogenic. This hinders the ability to define the real impact of noise on animals.

From these and other studies the following can be concluded:

- Animals respond to impulsive (sudden) noises (higher than 90 dBA) by running away. If the noises continue, animals would try to relocate. This is not relevant to wind energy facilities because the turbines do not generate impulsive noises close to these sound levels;
- Animals of most species exhibit adaptation with noise, including aircraft noise and sonic booms;
- More sensitive species would relocate to a more quiet area, especially species that depend on hearing to hunt or evade prey, or species that makes use of sound/hearing to locate a suitable mate; and
- Noises associated with helicopters, motor- and quad bikes significantly impact on animals.

[28] Report to Congressional Requesters, 2005; USEPA, 1971; Autumn, 2007; Noise quest, 2010

### 5.1.1 Wildlife

Potential noise impacts on wildlife are very highly species dependent. Studies showed that most animals adapt to noises and would even return to a site after an initial disturbance, even if the noise is continuous. The more sensitive animals that might be impacted by noise would most likely relocate to a quieter area.

There are a few specific studies discussing the potential impacts of noise associated construction, transportation and industrial facilities on wildlife. No method of calculation, guideline or legislation exists to determine the potential significance on any faunal species. Available information indicates that noises from transportation and industrial may mask the sounds of a predator approaching; similarly predators depending on hearing would not be able to locate their prey.

## 5.2 WHY NOISE CONCERNS COMMUNITIES[29]

Noise can be defined as "unwanted sound", and an audible acoustic energy that adversely affects the physiological and/or psychological well-being of people, or which disturbs or impairs the convenience or peace of any person. One can generalise by saying that sound becomes unwanted when it:

- Hinders speech communication;
- Impedes the thinking process;
- Interferes with concentration;
- Obstructs activities (work, leisure and sleeping); and
- Presents a health risk due to hearing damage.

However, it is important to remember that whether a given sound is "noise" depends on the listener or hearer. The driver playing loud rock music on their car radio hears only music, but the person in the traffic behind them hears nothing but noise.

Response to noise is unfortunately not an empirical absolute, as it is seen as a multi-faceted psychological concept, including behavioural and evaluative aspects. For instance, in some cases, annoyance is seen as an outcome of disturbances, in other cases it is seen as an indication of the degree of helplessness with respect to the noise source.

Noise does not need to be loud to be considered “disturbing”. One can refer to a dripping tap in the quiet of the night, or the irritating “thump-thump” of the music from a neighbouring house at night when one would prefer to sleep.

[29] World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009

Severity of the annoyance depends on factors such as:

- Background sound levels as well as the background sound levels the receptor is used to;
- The manner in which the receptor can control the noise (helplessness);
- The time, unpredictability, frequency distribution, duration, and intensity of the noise;
- The physiological state of the receptor; and
- The attitude of the receptor about the emitter (noise source).

### 5.2.1 Annoyance associated with Industrial Processes[30]

Annoyance is the most widely acknowledged effect of environmental noise exposure, and is considered to be the most widespread. It is estimated that less than a third of the individual noise annoyance is accounted for by acoustic parameters, and that the non-acoustic factors plays a major role. Non-acoustic factors that have been identified include age, economic dependence on the noise source, attitude towards the noise source and self-reported noise sensitivity.

On the basis of a number of studies into noise annoyance, exposure-response relationships were derived for high annoyance from different noise sources. These relationships, illustrated in **Figure 5-1**, are recommended in a European Union position paper published in 2002, stipulating policy regarding the quantification of annoyance. This can be used in Environmental Health Impact Assessment and cost-benefit analysis to translate noise maps into overviews of the numbers of persons that may be annoyed, thereby giving insight into the situation expected in the long term. It is not applicable to local complaint-type situations or to an assessment of the short-term effects of a change in noise climate.

[30] Van den Berg, 2011; Milieu, 2010.

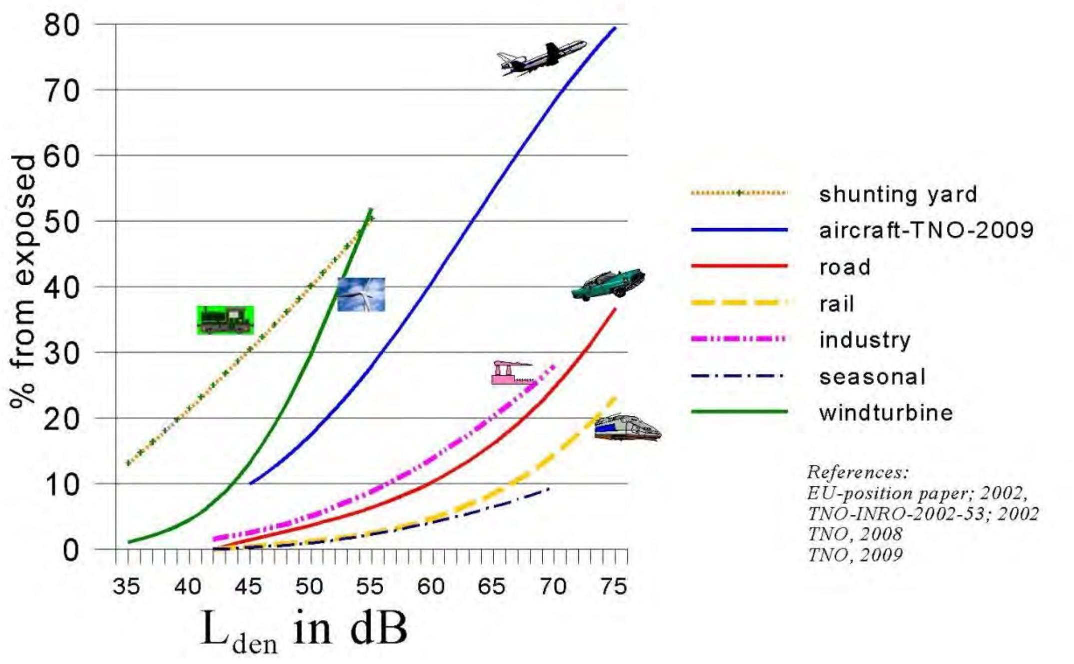


**Figure 5-1: Percentage of annoyed persons as a function of the day-evening-night noise exposure at the façade of a dwelling**

As shown in **Figure 5-1**, there is significant potential of annoyance associated with noise from shunting operations, mainly due to the highly impulsive character of the noises created.

## 5.3 IMPACT ASSESSMENT CRITERIA

### 5.3.1 Overview: The Common Characteristics

The word "noise" is generally used to convey a negative response or attitude to the sound received by a listener. There are four common characteristics of sound, any or all of which determine listener response and the subsequent definition of the sound as "noise". These characteristics are:

- Intensity;
- Loudness;
- Annoyance; and
- Offensiveness.

Of the four common characteristics of sound, intensity is the only one which is not subjective and can be quantified. Loudness is a subjective measure of the effect sound has on the human ear. As a quantity it is therefore complicated, but has been defined by experimentation on subjects known to have normal hearing.

The annoyance and offensive characteristics of noise are also subjective. Whether or not a noise causes annoyance mostly depends upon its reception by an individual, the environment in which it is heard, the type of activity and mood of the person and how acclimatised or familiar that person is to the sound.

### 5.3.2 Noise criteria of concern

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts from the EIA Regulations, published by the Department of Environmental Affairs (June 2006) in terms of the NEMA, SANS 10103:2008 as well as guidelines from the World Health Organization.

There are a number of criteria that are of concern for the assessment of noise impacts. These can be summarised in the following manner:

- *Increase in noise levels:* People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations, an increase of more than 7 dBA is considered a disturbing noise. See also **Figure 5-2**.
- *Zone Sound Levels:* Previously referred to as the acceptable rating levels, it sets acceptable noise levels for various areas. See also **Table 5-1**.
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA. Anything above this level will be considered unacceptable.

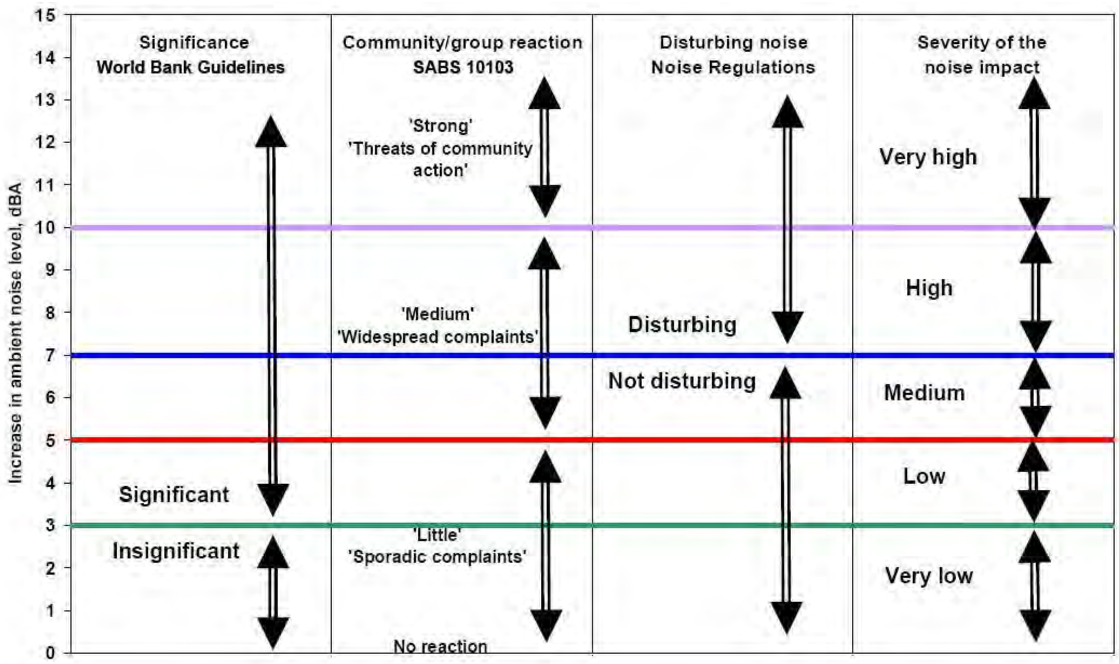


**Figure 5-2: Criteria to assess the significance of impacts stemming from noise**

In South Africa, the document that addresses the issues concerning environmental noise is SANS 10103:2008 (See also **Table 5-1**). It provides the equivalent ambient noise levels (referred to as Rating Levels), $L_{Req,D}$ and $L_{Req,N}$, during the day and night respectively to which different types of developments may be exposed.

Due to the significant variance in ambient sound measurements it is recommended that the project consider the guideline levels for residential use as set by international institutions such as World Health Organization, World Bank and International Finance Corporation for residential areas as well as the South African SANS10103:2008 guidelines.

Taking a precautious stance the following SANS1010:2008 rating levels (zone sound levels for a quieter area than measured during the site visit) will be considered:

- "Sub-urban Districts" (50 and 40 dBA day/night-time Rating).

The International IFC (Equator Principle) Residential; institutional and educational referenced areas includes ratings of:

- Use of $L_{Req,D}$ of 55 dBA during the daytimes; and
- Use of $L_{Req,N}$ of 45 dBA during the night-times.

SANS 10103:2008 also provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If Δ is the increase in sound level, the following criteria are of relevance:

- **Δ ≤ 3 dBA:** An increase of 3 dBA or less will not cause any response from a community. It should be noted that for a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level would not be noticeable.
- **3 < Δ ≤ 5 dBA:** An increase of between 3 dBA and 5 dBA will elicit 'little' community response with 'sporadic complaints'. People will just be able to notice a change in the sound character in the area.
- **5 < Δ ≤ 15 dBA:** An increase of between 5 dBA and 15 dBA will elicit a 'medium' community response with 'widespread complaints'. In addition, an increase of 10 dBA is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dBA the community reaction will be 'strong' with 'threats of community action'.

Note that an increase of more than 7 dBA is defined as a disturbing noise and prohibited (National and Provincial Noise Control Regulations).

**Table 5-1: Acceptable Zone Sound Levels for noise in districts (SANS 10103:2008)**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Type of district | Equivalent continuous rating level ($L_{Req.T}$) for noise dBA | | | | | |
| | Outdoors | | | Indoors, with open windows | | |
| | Day/night $L_{R,dn}$ [a] | Daytime $L_{Req,d}$ [b] | Night-time $L_{Req,n}$ [b] | Day/night $L_{R,dn}$ [a] | Daytime $L_{Req,d}$ [b] | Night-time $L_{Req,n}$ [b] |
| a) Rural districts | 45 | 45 | 35 | 35 | 35 | 25 |
| b) Suburban districts with little road traffic | 50 | 50 | 40 | 40 | 40 | 30 |
| c) Urban districts | 55 | 55 | 45 | 45 | 45 | 35 |
| d) Urban districts with one or more of the following: workshops; business premises; and main roads | 60 | 60 | 50 | 50 | 50 | 40 |
| e) Central business districts | 65 | 65 | 55 | 55 | 55 | 45 |
| f) Industrial districts | 70 | 70 | 60 | 60 | 60 | 50 |

### 5.3.3 Other noise sources of significance

In addition, other noise sources that may be present should also be considered. During the day, people are generally bombarded with the sounds from numerous sources considered "normal", such as animal sounds, conversation, amenities and appliances (TV/Radio/CD playing in background, computer(s), freezers/fridges, etc). This excludes activities that may generate additional noise associated with normal work.

At night, sounds that are present are natural sounds from animals, wind as well as other sounds we consider "normal", such as the hum from a variety of appliances (magnetostriction) drawing standby power, freezers and fridges.

**Figure 5-3** illustrates the sound levels associated with some equipment or in certain rooms. This is however more for illustrative purposes, as there are many manufacturers with different equipment, each with a different noise emission character.

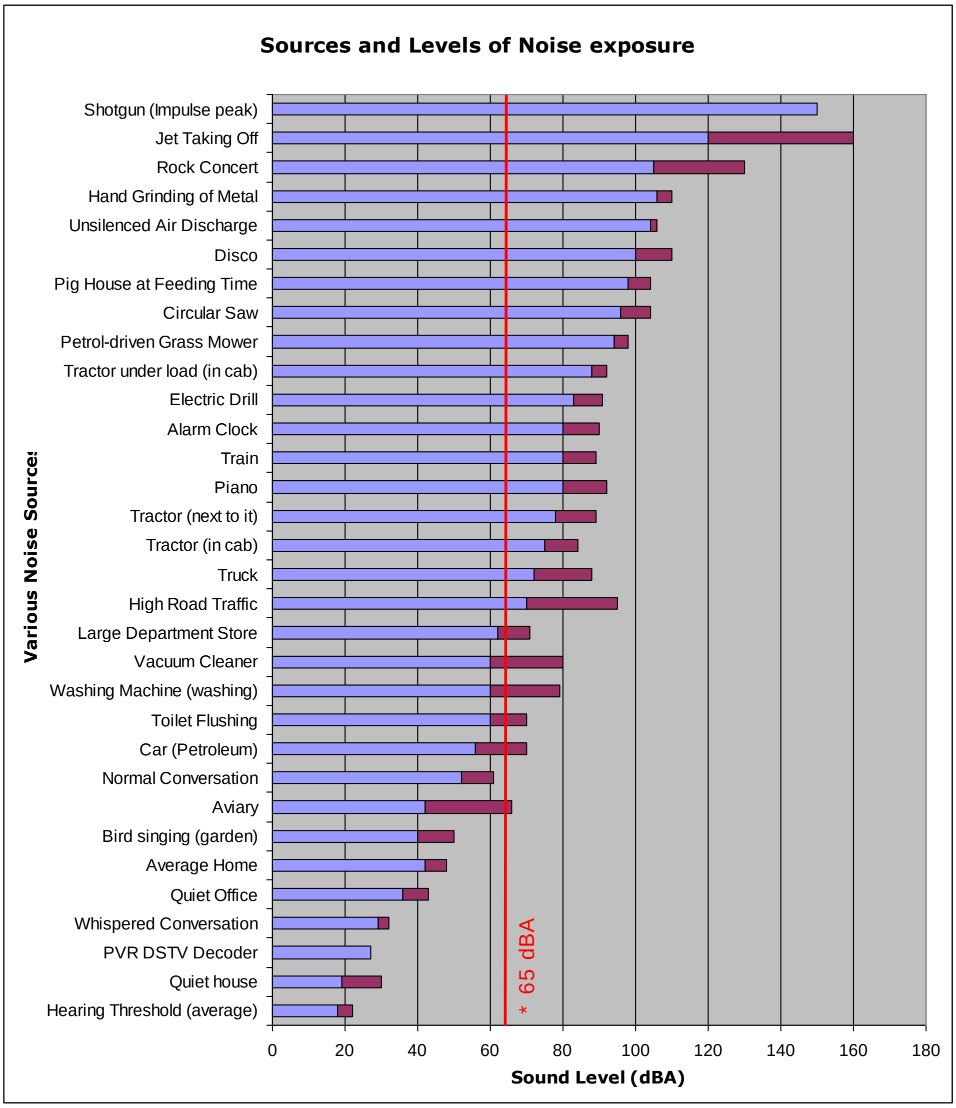


**Figure 5-3: Typical Noise Sources and associated Sound Pressure Level**

### 5.3.4 Determining the Significance of the Noise Impact

The level of detail as depicted in the EIA regulations was fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria. For such purposes each aspect was assigned a value as defined in the third column in the tables below.

The impact consequence is determined by the summing the scores of Magnitude **Table 5-2**), Duration (**Table 5-3**) and Spatial Extent (**Table 5-4**). The impact significance (see **Sections 5.3.5** and **Section 5.3.6**) is determined by multiplying the Consequence result with the Probability score (**Table 5-5**).

An explanation of the impact assessment criteria is defined in the following tables.

**Table 5-2: Impact Assessment Criteria - Magnitude**

| This defines the impact as experienced by any receptor. In this report the receptor is defined as any resident in the area, but excludes faunal species. | | |
|---|---|---|
| **Rating** | **Description** | **Score** |
| *Low* | Increase in average sound pressure levels between 0 and 3 dB from the expected ambient sound levels.<br>Total projected noise level is less than the Zone Sound Level and/or Equator Principle in wind-still conditions. | 2 |
| *Low Medium* | Increase in average sound pressure levels between 3 and 5 dB from the expected ambient sound levels.<br>Total projected noise levels between 3 and 5 above the Zone Sound Level and/or Equator Principle (wind-less conditions). | 4 |
| *Medium* | Increase in average sound pressure levels between 5 and 7 dB from the ambient sound levels.<br>Increase in sound pressure levels between 5 and 7 above the Zone Sound Level and/or Equator Principle (wind less conditions).<br>Sporadic complaints expected. | 6 |
| *High* | Increase in average sound pressure levels between 7 and 10 from the ambient sound level.<br>Total projected noise levels between 7 and 10 dBA above the Zone Sound Level and/or Equator Principle (wind-less condition).<br>Medium to widespread complaints expected. | 8 |
| *Very High* | Increase in average ambient sound pressure levels higher than 10 dBA.<br>Total projected noise levels higher than 10 dB above the Zone Sound Level and/or Equator Principle (wind less-conditions).<br>Change of 10 dBA is perceived as 'twice as loud', leading to widespread complaints and even threats of community or group action.<br>Any point where instantaneous noise levels exceed 65 dBA at any receptor. | 10 |

**Table 5-3: Impact Assessment Criteria - Duration**

| The lifetime of the impact that is measured in relation to the lifetime of the proposed development (construction, operational and closure phases). Will the receptors be subjected to increased noise levels for the lifetime duration of the project, or only infrequently. | | |
|---|---|---|
| **Rating** | **Description** | **Score** |
| *Temporary* | Impacts are predicted to be of short duration (portion of construction period) and intermittent/occasional. | 1 |
| *Short term* | Impacts that are predicted to last only for the duration of the construction period. | 2 |
| *Long term* | Impacts that will continue for the life of the Project, but ceases when the Project stops operating. | 4 |
| *Permanent* | Impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime. | 5 |

**Table 5-4: Impact Assessment Criteria – Spatial extent**

| Classification of the physical and spatial scale of the impact | | |
|---|---|---|
| **Rating** | **Description** | **Score** |
| *Site* | The impacted area extends only as far as the activity, such as footprint occurring within the total site area. | 1 |
| *Local* | The impact could affect the local area (within 1,000 m from site). | 2 |
| *Regional* | The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns. | 3 |
| *National* | The impact could have an effect that expands throughout the country (South Africa). | 4 |
| *International* | Where the impact has international ramifications that extend beyond the boundaries of South Africa. | 5 |

**Table 5-5: Impact Assessment Criteria - Probability**

| This describes the likelihood of the impacts actually occurring, and whether it will impact on an identified receptor. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows: | | |
|---|---|---|
| **Rating** | **Description** | **Score** |
| *Improbable* | The possibility of the impact occurring is none, due either to the circumstances, design or experience. The chance of this impact occurring is zero (0 %). | 1 |
| *Possible* | The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chances of this impact occurring is defined to be up to 25 %. | 2 |
| *Likely* | There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chances of this impact occurring is defined to be between 25% and 50 %. | 3 |
| *Highly Likely* | It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chances of this impact occurring is defined between 50 % to 75 %. | 4 |
| *Definite* | The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined to be between 75% and 100 %. | 5 |

In order to assess each of these factors for each impact, the following ranking scales as contained in **Table 5-6** will be used.

**Table 5-6: Assessment Criteria: Ranking Scales**

| **PROBABILITY** | | **MAGNITUDE** | |
|---|---|---|---|
| **Description / Meaning** | **Score** | **Description / Meaning** | **Score** |
| Definite/don't know | 5 | Very high/don't know | 10 |
| Highly likely | 4 | High | 8 |
| Likely | 3 | Medium | 6 |
| Possible | 2 | Low Medium | 4 |
| Improbable | 1 | Low | 2 |
| **DURATION** | | **SPATIAL SCALE** | |
| **Description / Meaning** | **Score** | **Description / Meaning** | **Score** |
| | | International | 5 |
| Permanent | 5 | National | 4 |
| Long Term | 4 | Regional | 3 |
| Short term | 2 | Local | 2 |
| Temporary | 1 | Footprint | 1 |

### 5.3.5 Identifying the Potential Impacts without Mitigation Measures (WOM)

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

Significance without mitigation is rated on the following scale:

| | | |
|---|---|---|
| **SR**<30 | Low (L) | Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative mitigation. No mitigation is required. |

| | | |
|---|---|---|
| 30<**SR** <60 | Medium (M) | Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged. |
| **SR**>60 | High (H) | Impact is significant, mitigation is critical to reduce impact or risk. Resulting impact could influence the decision depending on the possible mitigation. Animpact which could influence the decision about whether or not to proceed with the project. |

### 5.3.6 Identifying the Potential Impacts with Mitigation Measures (WM)

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact. Significance with mitigation is rated on the following scale:

| | | |
|---|---|---|
| **SR**<30 | Low (L) | The impact is mitigated to the point where it is of limited importance. |
| 30<**SR** <60 | Medium (M) | Notwithstanding the successful implementation of the mitigation measures, to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw. |
| **SR**>60 | High (H) | The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded of high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable. |

## 5.4 REPRESENTATION OF NOISE LEVELS

Noise rating levels will be calculated in this report using the appropriate sound propagation models as defined. It is therefore important to understand the difference between sound or noise level as well as the noise rating level (also see Glossary of Terms, Appendix A).

Sound or noise levels generally refers to a level as measured using an instrument, whereas the noise rating level refers to a calculated sound exposure level to which various corrections and adjustments was added. These noise rating levels are further processed into a 3D map illustrating noise contours of isopleths. In this project it illustrate the potential extent of the calculated noises of the complete project and not noise levels at a specific moment in time.

# 6 METHODS: CALCULATION OF NOISE CLIMATE

## 6.1 NOISE CLIMATE ON THE SURROUNDING ENVIRONMENT

### 6.1.1 Point Sources –Infrastructure

The noise emissions from various sources, as defined by the project, were calculated in detail for the operation of the construction and operational activities by using the sound propagation models described by SANS 10357 and checked with the ISO 9613-2 model.

The following were considered:

- The octave band sound pressure emission levels of processes and equipment;
- The distance of the receivers from the noise sources;
- The impact of atmospheric absorption;
- The meteorological conditions in terms of Pasquill stability;
- The operational details of the proposed project, such as projected areas where activities will be taking place;
- A barrier where berms, highwalls, spoil or discard dumps are expected around open cast or stockpile areas;
- Topographical layout; and
- Acoustical characteristics of the ground. 50% soft ground conditions were modelled, as the area where the mining activity would be taking place is well vegetated and sufficiently uneven to allow the consideration of soft ground conditions. This is because the use of hard ground conditions could represent a too precautionary situation.

### 6.1.2 Linear Sources – Road Traffic

The noise emission into the environment due to road traffic will be calculated using the sound propagation model described in SANS 10210. Calculated corrections such as the following will be considered:

- Distance of receptor from the road;
- Road construction material;
- Average speeds of travel;
- Types of vehicles used;
- Road gradient; and
- Ground acoustical conditions.

### 6.1.3 Linear Sources – Railway traffic

There is no standard or guideline in South Africa stipulating the requirements to calculate or model the potential noise impacts from a railway operation. Various International propagation models do exist, including the German Schall 03, Dutch SRM II, Nordic

TemaNor:1996 and NMPB-FER French acoustical models. The European Transportation Research Laboratory (TRL[31]) has recommended the British model "Calculation of Railway Noise, 1995" as the most technical sound of the available models.

For this purpose it was selected to make use of the United Kingdom Department of Transport document, "Calculation of Railway Noise, 1995". The methodology proposed in this document is illustrated in **Figure 6-1**.

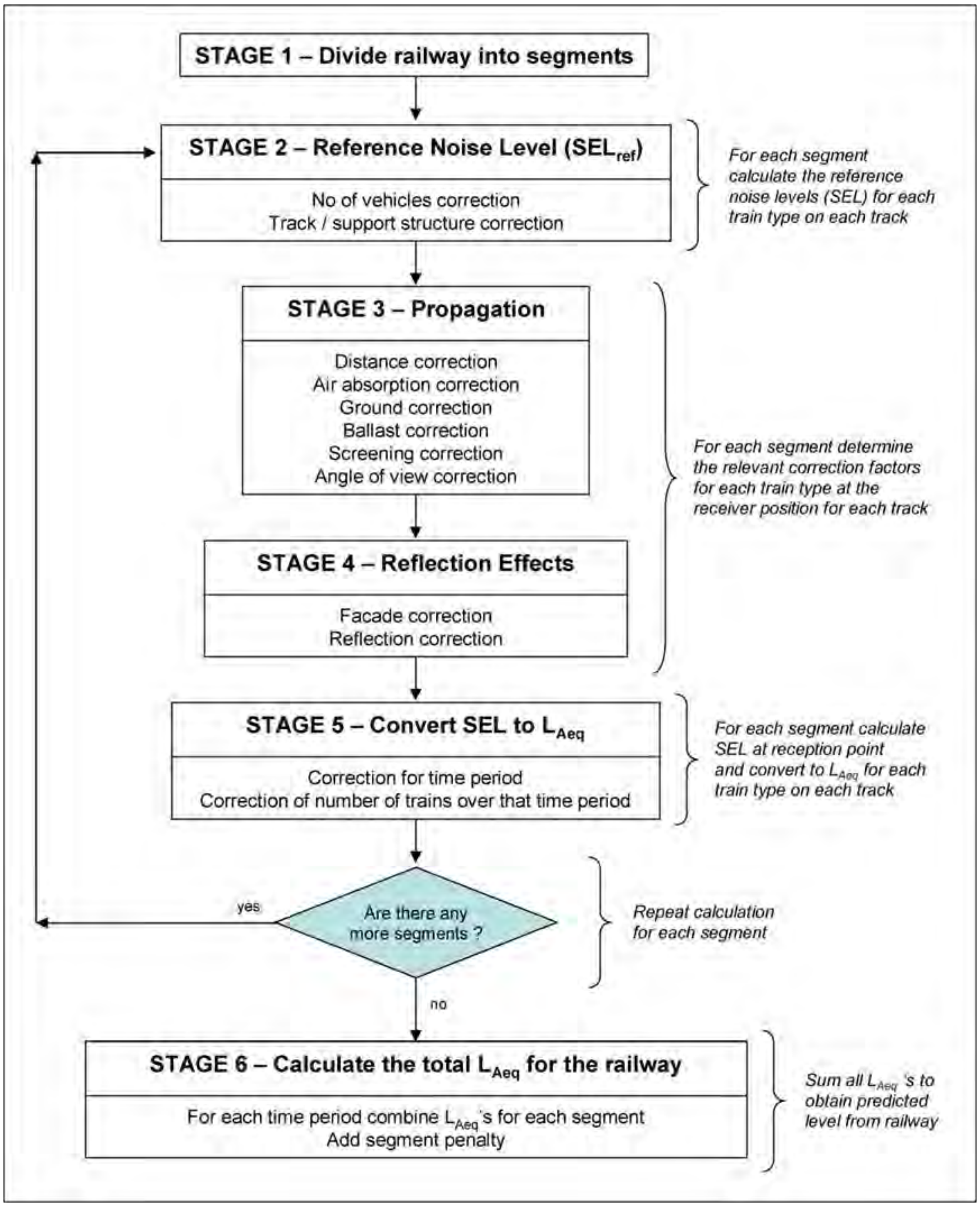


**Figure 6-1: Flow diagram illustrating the methodology to calculate the noise from railways**

[31] http://www.ectri.org.

## 6.2 SOUND PROPAGATION - CALCULATION LIMITATIONS

Limitations due to the calculations of the noise emissions into the environment include the following:

- Many sound propagation models do not consider sound characteristics as calculations are based on an equivalent level. These include intrusive sounds or amplitude modulation;
- Many sound propagation models do not calculate the increase of the ambient soundscape due to wind shear (masking noise);
- Most sound propagation models do not consider refraction through the various temperature layers (specifically relevant during the night-times);
- Most sound propagation models do not consider the low frequency range (third octave 16 – 31.5 Hz). This would be relevant to facilities with a potentially low frequency issues;
- Many environmental models consider sound to propagate in hemi-spherical way. Certain noise sources (e.g. a speakers, exhausts, fans) emit sound power levels in a directional manner;
- It is assumed that the octave sound power levels selected for processes and equipment accurately represents the sound character and power levels of processes/equipment. The determination of these levels in itself is subject to errors, limitations and assumptions with any potential errors carried over to any model making use of these results;
- Sound power emission levels from processes and equipment change depending on the load the process and equipment is subject too. While the octave sound power level is the average (equivalent) result of a number of measurements, these measurements relates to a period that the process or equipment was subject to a certain load. Normally these measurements are collected when the process or equipment is under high load. The result is that measurements generally represent a worse-case scenario;
- As it is unknown which processes and equipment will be operational, modelling considers a scenario where all processes and equipment are under full load 100% of the time. The result is that projected noise levels would likely over-estimate sound levels;
- The impact of atmospheric absorption is simplified and very uniform meteorological conditions are considered. This is an over-simplification and the effect of this in terms of sound propagation modelling is difficult to quantify; and
- Acoustical characteristics of the ground are over-simplified with ground conditions accepted as uniform. Ground conditions will be considered in this assessment.

As such, sound propagation modelling does not aim to calculate the sound level at a receptors, but rather aim to estimate a noise level (referred to as the rating level) that considers factors and corrections such as source characteristics, tones, impulsiveness, time-of-day corrections, etc. The calculated noise level therefore is referred to as the noise rating level in this report.

## 6.3 Investigated Construction Scenario

This section investigates the construction phase of the Chapudi, Chapudi West and Wildebeesthoek sections in terms of acoustics. Daytime (06:00 – 22:00) and night-time (22:00 – 06:00) operations will be assessed. Most critical investigational times would be the night-time hours when a quiet environment is desired (at night for sleeping, weekends etc.).

Only open cast and stockpile construction is assessed as other construction processes (road and plant infrastructure development) is relatively short-term in comparison to the lengthy open cast site clearance and boxcut development phase. As it is unsure if the developer intends on constructing the facility during the night-time hours, it is assumed that open cast site clearances will take place over the 24 hour day and night periods.

Calculations are based on a worst-case scenario and will not be relevant for all times during the construction phase and may only be relevant when construction activities occur near a receptor. Stockpiles, berms and barriers will be constructed during this phase. This material will be re-used to close the open pits for rehabilitation purpose after mining.

### 6.3.1 Investigated Worst-Case Construction Scenarios - Day and Night-times

#### *6.3.1.1 Road Traffic*

Traffic on the haul roads from open cast pits calculated as – 10 vehicles p/h on a single continuous non-paved road, heavy vehicles was calculated as 50 % of vehicles. Traffic calculated at constant speed of 60 km/h.

#### *6.3.1.2 Construction of Open Cast/Stockpile Areas*

Construction processes assessed included:

- A worst-case scenario was assessed whereby the most significant noisy equipment during construction takes place as feasibly close as possible to receptors, while still remaining on the project footprint; and
- Site preparations and other construction processes at pits and stockpiles are defined in **Section 4.2**, with construction localities illustrated in **Figure 6-2**.

#### *6.3.1.3 Existing Ambient Contributors and Acoustical Factors*

The following ambient soundscape factors were considered:

- Distance from receiver to noise source considered. Receptors are regarded at a 2 meters height in relation to the ground surface;
- The existing ambient soundscape as defined in **Section 3.6**;
- Intervening ground conditions of a medium ground nature, i.e. some flora etc. (50% hard ground conditions); and
- Activities functioning during wind-still conditions, in good sound propagation conditions (20ºC and 80% humidity).

## 6.4 INVESTIGATED OPERATIONAL SCENARIO

This section investigates the operational phase of the Chapudi, Chapudi West and Wildebeesthoek sections in terms of acoustics. Daytime (06:00 – 22:00) and night-time (22:00 – 06:00) operations will be assessed. Most critical investigational times would be the night-time hours when a quiet environment is desired (at night for sleeping, weekends etc.).

Calculations in this section are based on a worst-case scenario and will not be relevant for all times of the operation phase (not a moment in time, but the potential extent of noise rating levels during the operational phase). No screening corrections were considered (such as the cladding or enclosing of crushers and screens). Open cast pit operations took into consideration a conceptual 10 m berm/barrier around it.

### 6.4.1 Investigated Worst-Case Operational scenarios - Day and Night-times

#### *6.4.1.1 Haul Road Traffic*

Traffic on the haul roads calculated as – 174 vehicles p/h (delivering to stockpiles and dumps) travelling on a single non-paved continuous road, all heavy vehicles. Traffic calculated at constant speed of 60 km/h. The Articulated Dump Trucks (ADT) volumes used on haul roads was calculated from available information sourced in **Section 1.4**.

#### *6.4.1.2 Colliery infrastructure*

Colliery infrastructure and *modus operandi* is defined in **Section 4.3.1**, with assessed scenario localities illustrated in **Figure 6-3**.

#### *6.4.1.3 Open Cast "truck and shovel" Method and Stockpile Management*

It is expected that berms and barriers will be implemented during the construction phase from spoils, discards, hards, softs etc. Operations of the Open cast and stockpile areas took the following into account:

- A worst-case scenario was assessed whereby the most significant noisy equipment during operational phase takes place as close as feasibly possible to receptors, while still remaining on the project footprint;
- A conceptual 10 m barrier/berm constructed during the construction phase from overburden, interburden (hards, softs etc.) was considered as a screen completely enclosing open cast pits and stockpile areas;
- Drilling, excavating, trucks, overburden removal, truck and shovel coal mining, stockpile management and other operational processes are defined in **Section 4.3**, with assessed scenarios illustrated **Figure 6-3**.

#### *6.4.1.4 Railway traffic*

Based on available information (**Section 1.4**) the operations will be assessed taking into account the following acoustical corrections:

- Train lines were split into sections for various corrections. The daytime and night operations of 2 x Class 43 electric locomotives and 100 CCL 8 x 4-axle tread braked wagons per train with 1 (1 delivery, no return)  trains a day and night, traveling at 40 km/h;
- Ballast correction (acoustics attenuation due to ballast effect) was considered;
- Intervening ground conditions of a medium ground nature, i.e. (50% hard ground conditions);
- Continuous welded rail (CWR) corrections were considered; and
- Assessment does not consider façade corrections or the row of houses acting as a screen when obstructing a direct line of sight to the railway line. Assessed calculations better illustrate potential noise rating levels at houses directly adjacent or with a direct line of sight to railway lines.

#### *6.4.1.5 Existing Ambient Contributors and Acoustical Factors*

The following ambient soundscape factors were considered:

- Distance from receiver to noise source considered. Receptors are regarded at a 2 meters height in relation to the surrounding environment;
- Existing ambient soundscape contributors as defined in **Section 3.6**;
- Intervening ground conditions of a medium ground nature, i.e. some flora etc. (50% hard ground conditions); and
- Activities functioning during wind-still conditions, in good sound propagation conditions (20°C and 80% humidity).

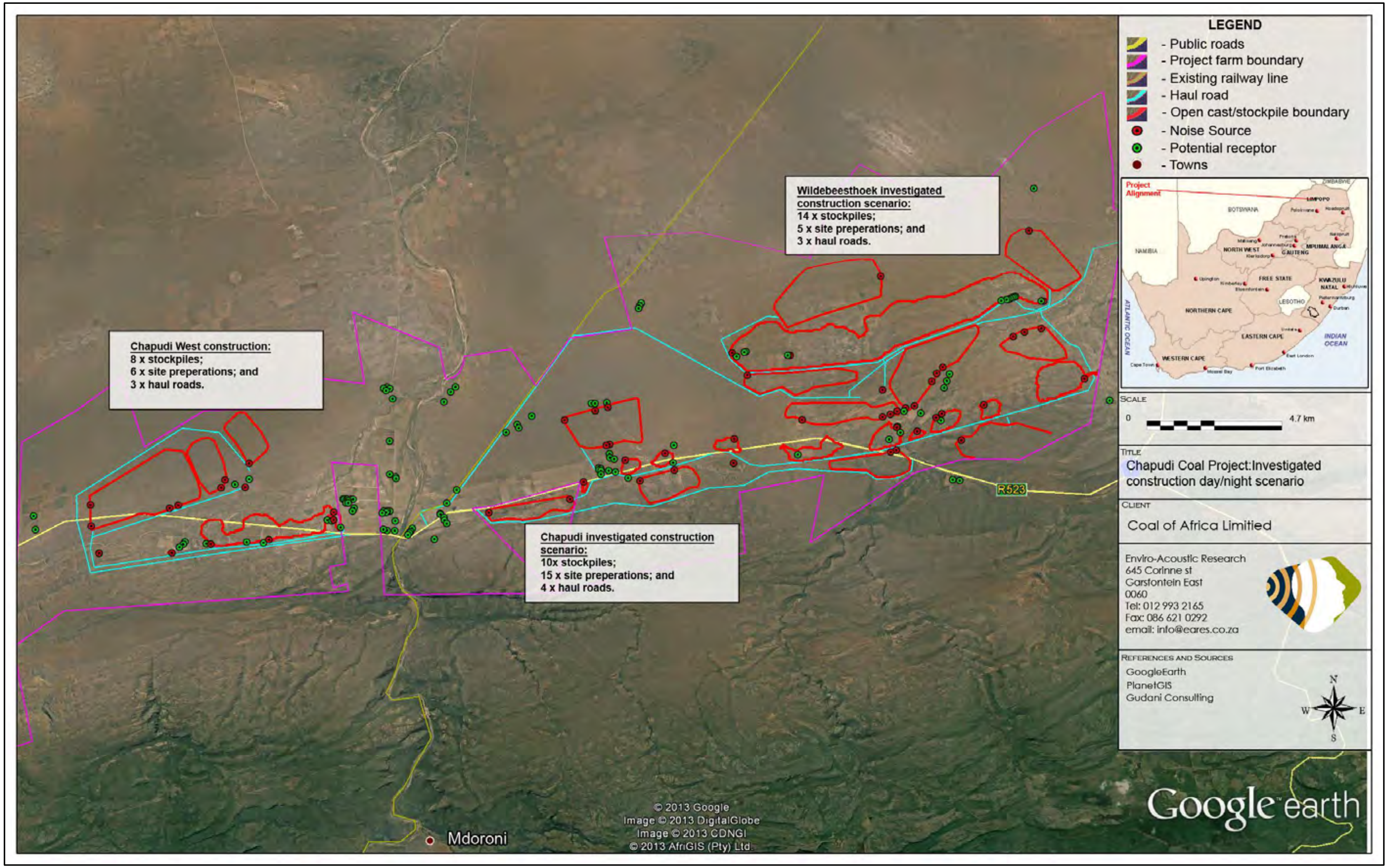


**Figure 6-2: Investigated construction scenario as modelled for the day/night time period – worst case**

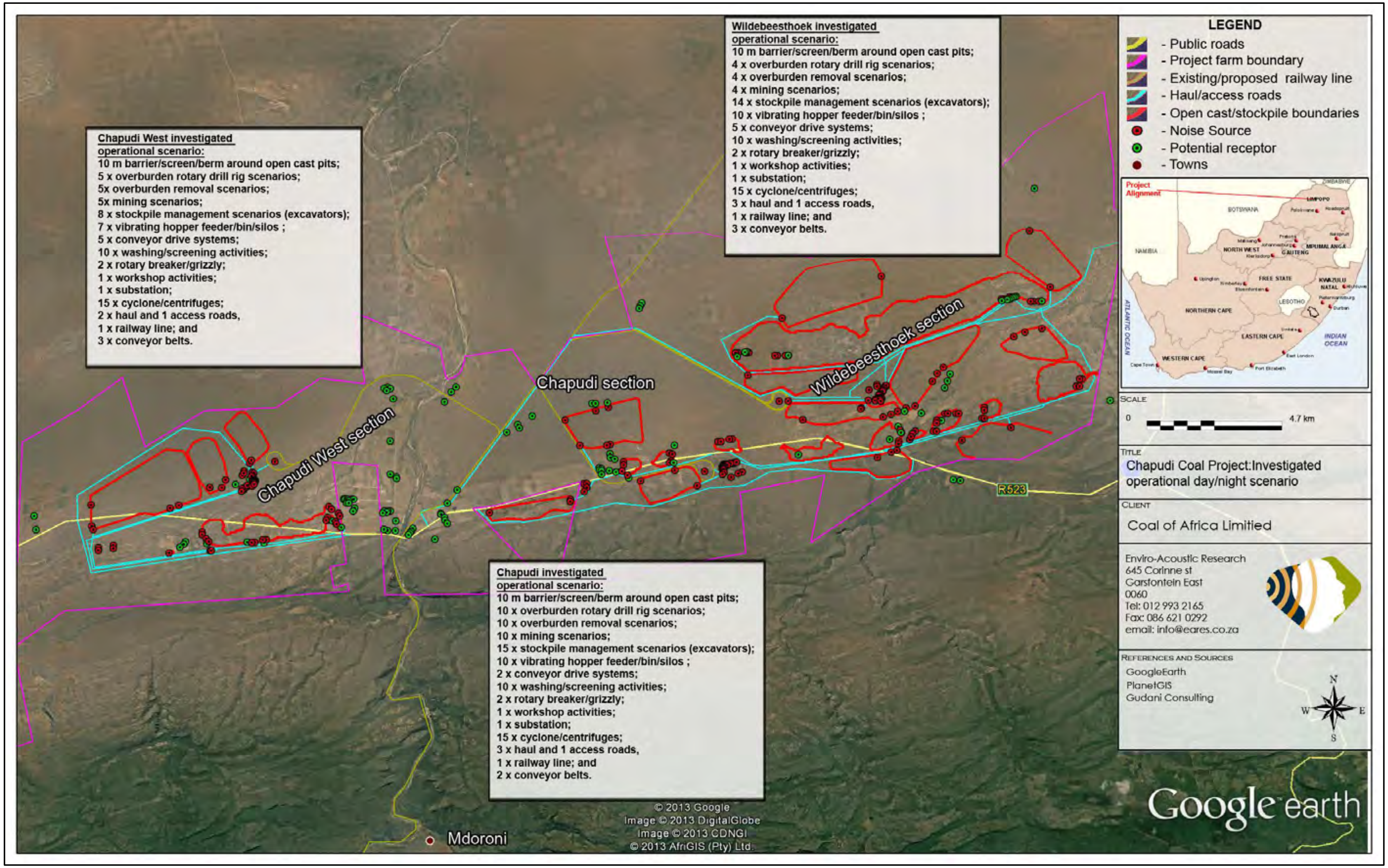


**Figure 6-3: Investigated operational scenario as modelled for the day/night time period – worst case**

# 7 MODELLING RESULTS AND IMPACT ASSESSMENT

## 7.1 CONSTRUCTION SCENARIO – WORST CASE: PEAK NOISE CLIMATE

This impact assessment is quite precautious and a worst-case scenario represents the potential maximum equivalent (average) noise climate ($L_{Req,1\ h}$) the receptors could be exposed to during peak construction hours. The potential day and night-time construction noise climate at receptors are presented in **Appendix D 1** and **Appendix D 2**.

Both day and night-times will be assessed as open cast pits (removal of overburden) and stockpile areas may be operated 24 hours. Receptors based on open cast pits, stockpiles areas as well as colliery infrastructure were considered to be relocated and the noise impact on them was not assessed. This would be relevant to receptors such as NSD02, 03, 04, 10, 11, 47, 62, 67 and 89 to 100. Refer to **Figure 1-5** indicating receptors numbering.

**Figure 7-1** illustrates the resulting conceptual night-time worst-case peak noise climate around the proposed development. These figure contours are illustrated from 40 dBA upwards (SANS 10103:2008 Rating level referencing), with contours illustrated in 5 dBA intervals. These figures indicate a $L_{Req,1\ h}$ value with no tone or impulse corrections. Only a night-time map is displayed.

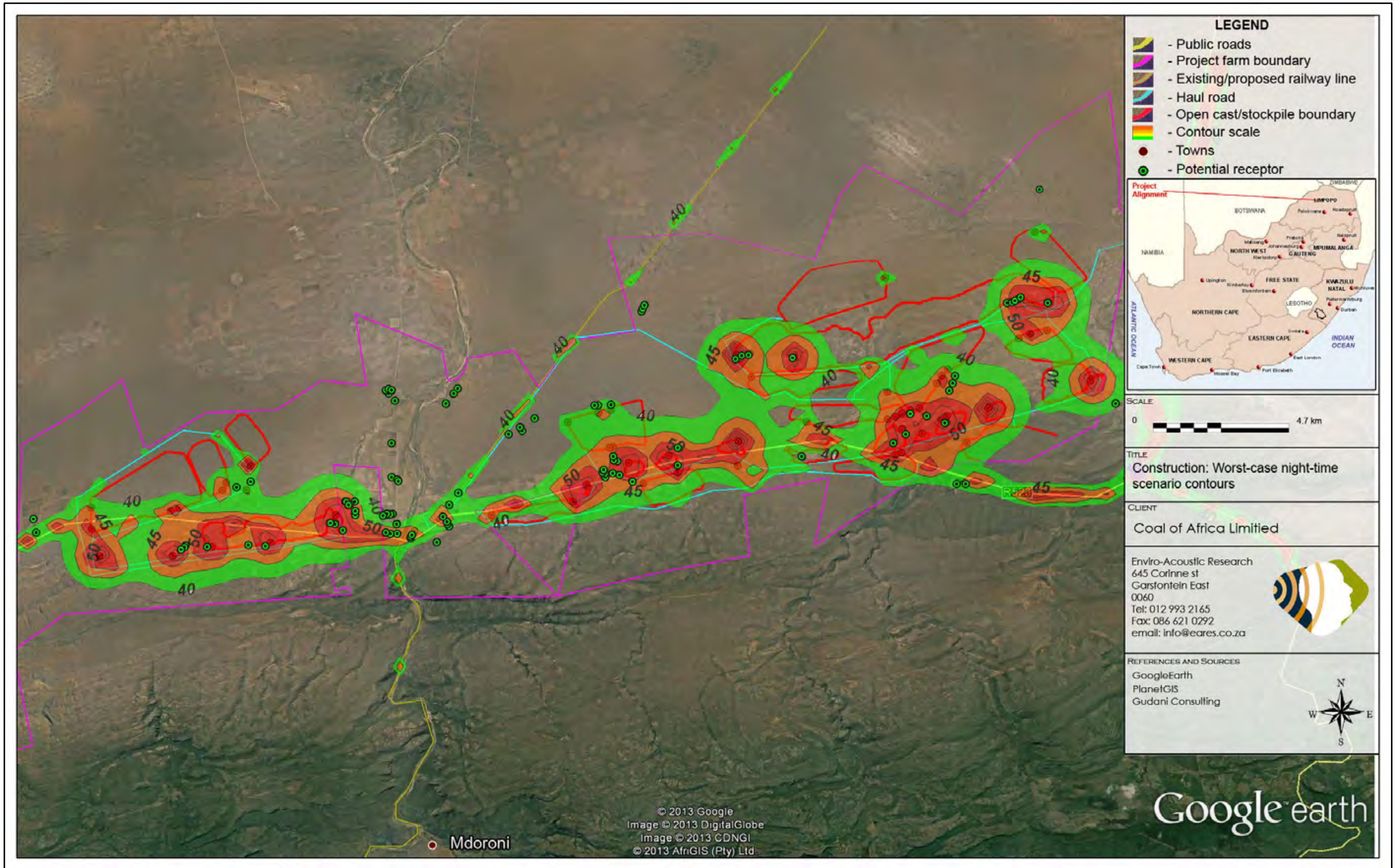


**Figure 7-1: Projected Construction Noise Rating Levels in contours of equal sound levels**

## 7.2 IMPACT ASSESSMENT – CONSTRUCTION PHASE

The impact significance as assessed for potential receptors when the open cast pits and stockpiles are constructed is presented in **Table 7-1** and **Table 7-2** below. Note that the potential acoustical impact on wildlife is not part of these documents terms of reference and will not be considered in this assessment.

**Table 7-1: Impact Assessment: Daytime scenarios – peak hours**

| | |
|---|---|
| ***Nature:*** | *Construction takes place during the daytime* hours of (22:00 – 06:00). |
| ***Acceptable Rating Level*** | Daytime Rating Level of 50 dBA – Suburban Rating.<br>Use of $L_{Req,D}$ of 50 dBA; and<br><br>IFC (Equator Principle) Residential; institutional and educational.<br>Use of $L_{Req,D}$ of 55 dBA. |
| ***Extent*** | **Local (2)** – The impact could affect the local area (within 1,000 m from site). |
| ***Duration*** | **Short term (2)** – Impacts that are predicted to last only for the duration of the construction period. |
| ***Magnitude ($L_{Req,D}$ < 55 dBA or Noise level > x dBA above ambient*** | Equivalent noise levels will exceed the the Equator Principle IFC guideline, SANS10103:2008 Rating or ambient soundscape during daytime hours. **Very High (10)**. |
| ***Probability*** | **Likely (3)**<br>• Calculated levels will exceed the Equator Principle IFC guideline, SANS10103:2008 Rating or ambient soundscape by a measurable value and during daytime hours;<br>• Engagements at a receptors dwelling as well noise sources of significance (N1 and R523 road traffic) may screen noise levels during the daytimes;<br>• Construction processes are normally short to medium term in operational period;<br>• The potential operations near buildings and facilities where a natural or quiet period is required. E.g. religious, educational and health care and hospitality facilities (game lodges) needs to be considered;<br>• Project likely economically positive for the surrounding communities (employment opportunities) that could result in a positive attitude towards the noises. |
| ***Significance*** | **42 (medium)** – for NSD59, 60, 61 and 106. Also refer to **Appendix D 1**. |
| ***Status*** | Negative. |
| ***Reversibility*** | High. |
| ***Comments*** | Mitigation recommended. |
| ***Can impacts be mitigated?*** | Possible. |

Based on the preceding data it is obvious that the risk of a noise impact developing during the daytime construction hours is of a medium significance. This is mostly due to the proximity of receptors to open cast boundaries. Mitigation is supplied in **Section 8** for the developer to consider.

**Table 7-2: Impact Assessment: Night-time scenarios – peak hours**

| | |
|---|---|
| ***Nature:*** | *Construction takes place during the night-time* hours of (*22:00 – 06:00*). |
| ***Acceptable Rating Level*** | Night-time Rating Level of 40 dBA – Suburban Rating.<br>Use of $L_{Req,D}$ of 40 dBA; and<br><br>IFC (Equator Principle) Residential; institutional and educational.<br>Use of $L_{Req,D}$ of 45 dBA. |

| | |
|---|---|
| ***Extent*** | **Local (2)** – The impact could affect the local area (within 1,000 m from site). |
| ***Duration*** | **Short term (2)** – Impacts that are predicted to last only for the duration of the construction period. |
| ***Magnitude ($L_{Req,D}$ < 55 dBA or Noise level > x dBA above ambient*** | Equivalent noise levels will exceed the the Equator Principle IFC guideline, SANS10103:2008 Rating or ambient soundscape during daytime hours. **Very High (10)**. |
| ***Probability*** | **Highly Likely (4)**<br>• Calculated levels will exceed the Equator Principle IFC guideline, SANS10103:2008 Rating or ambient soundscape by a measurable value and during a period when a receptor may require rest (night-times);<br>• Noises at a receptors dwelling as well noise sources of significance (N1 and R523 road traffic) may screen noise levels during the night-times;<br>• Construction processes are normally short to medium term in operational period. |
| ***Significance*** | **36 to 56 (medium)** – for NSD05, 06, 12 to 23, 48 to 66, 82, 85 and 106. Refer to **Appendix D 2**. |
| ***Status*** | Negative. |
| ***Reversibility*** | High. |
| ***Comments*** | Mitigation recommended. |
| ***Can impacts be mitigated?*** | Possible. |

Based on the preceding data it is obvious that the risk of a noise impact developing during the night-time hours is of a medium significance. This is mostly due to the proximity of receptors to open cast boundaries. Mitigation is supplied in **Section 8** for the developer to consider.

## 7.3 OPERATIONAL SCENARIO – WORST CASE: PEAK NOISE CLIMATE

This impact assessment is quite precautious and a worst-case scenario represents the maximum equivalent (average) noise climate ($L_{Req,1\,h}$) the receptors could be exposed to during peak operational hours. The potential day and night-time operational noise rating climate are presented in **Appendix D 3** and **Appendix D 4**.

Both day and night-times will be assessed in this section. Receptors based on open cast pits, stockpiles areas as well as colliery infrastructure were considered to be relocated and not assessed. This would be relevant to receptors NSD02, 03, 04, 10, 11, 47, 62, 67 and 89 to 100. Refer to **Figure 1-5** indicating receptors numbering.

**Figure 7-2** illustrates the resulting conceptual night-time worst-case peak noise climates for the Chapudi West section, while **Figure 7-3** illustrates the Chapudi and Wildebeesthoek sections. These noise rating contours are illustrated from 40 dBA upwards (SANS 10103:2008 night-time Zone Sound Level for a suburban area), with contours illustrated in 5 dBA intervals. These figures indicate a $L_{Req,1\,h}$

value with no tone or impulse corrections. Only night-time maps are displayed as daytime projections would not be easily presented.

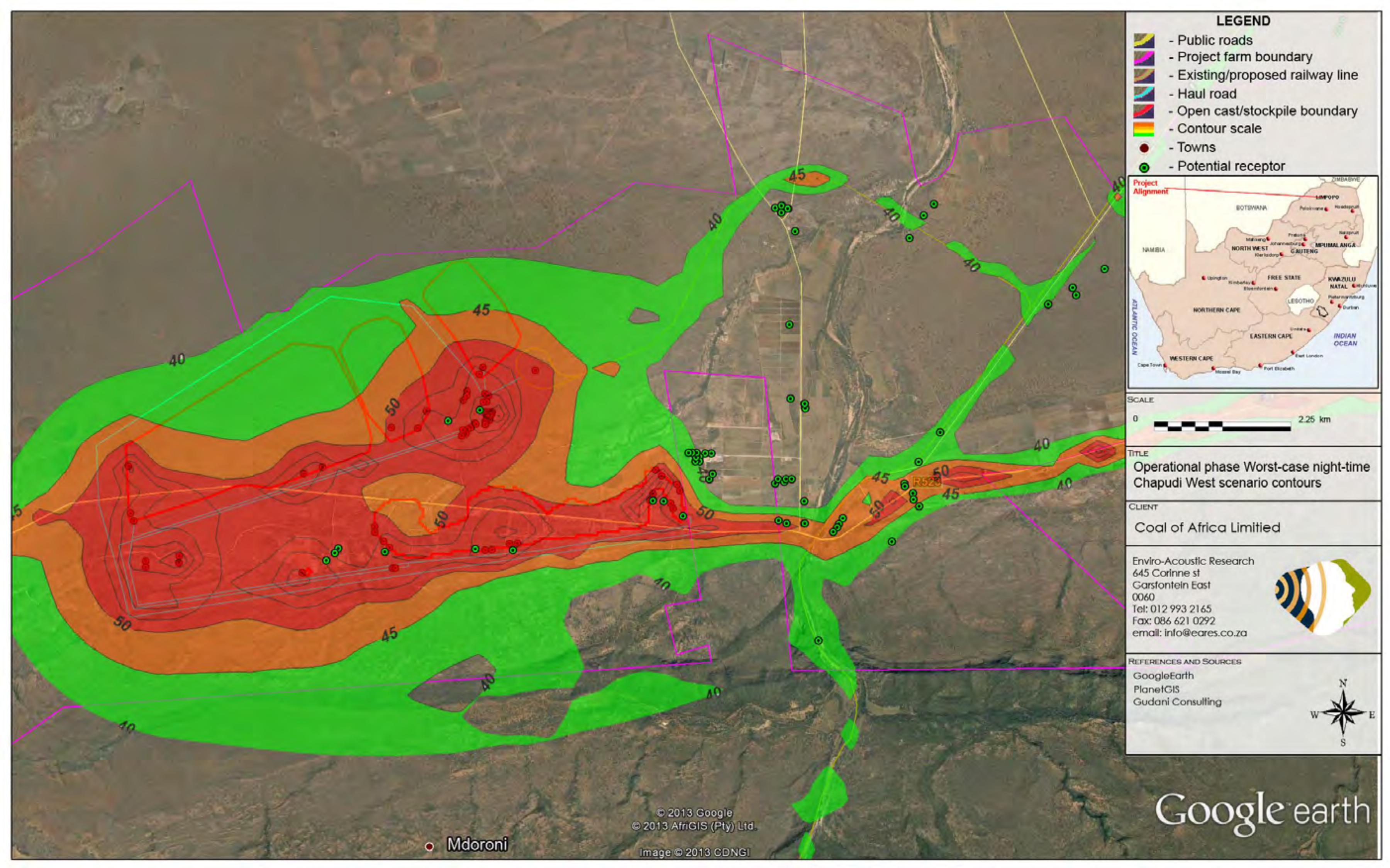


**Figure 7-2: Night-time operations: Projected noise contours – Chapudi West**

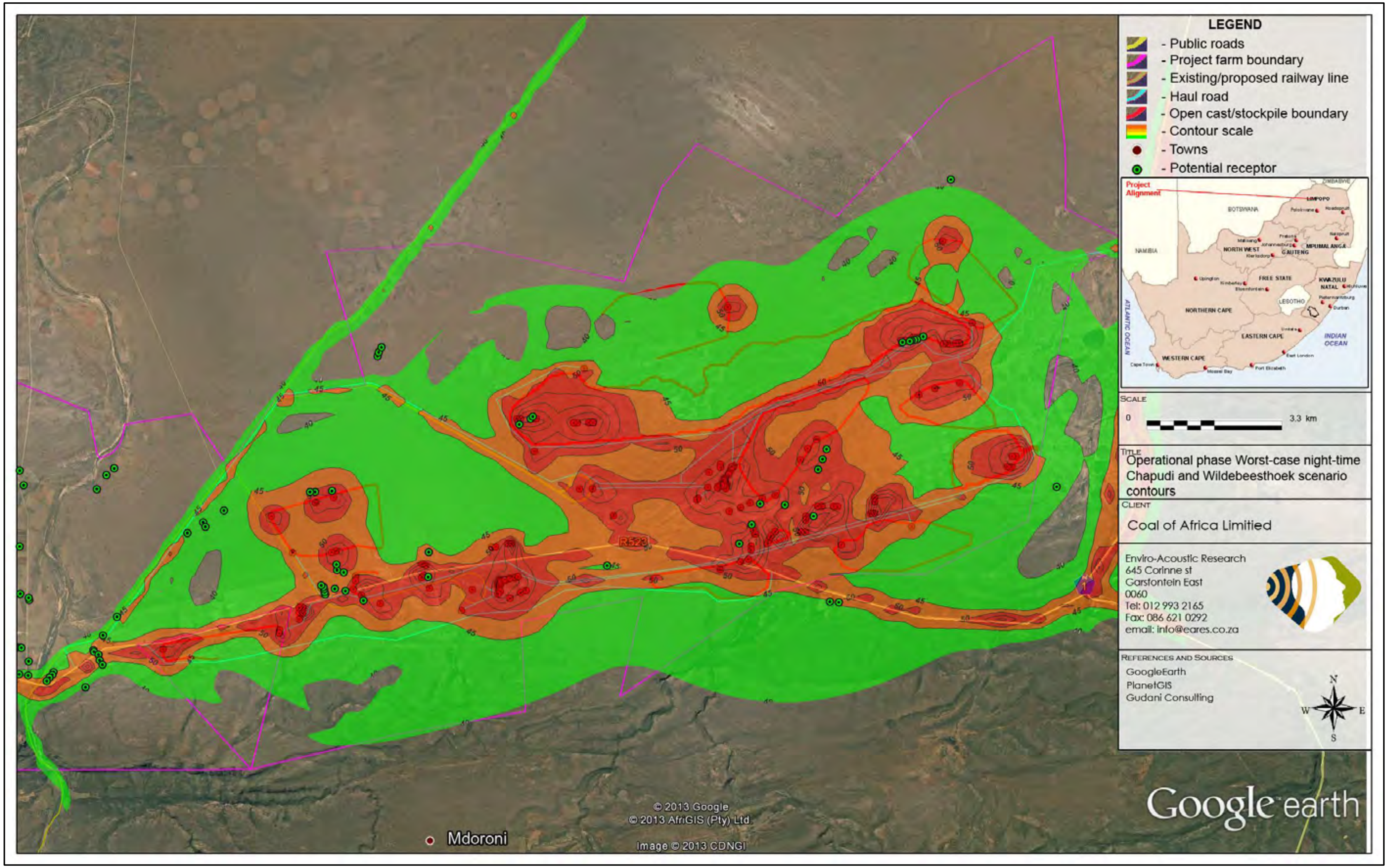


**Figure 7-3: Night-time operations: Projected noise contours – Wildebeesthoek and Chapudi**

## 7.4 IMPACT ASSESSMENT – OPERATIONAL PHASE

The impact significance as assessment for potential receptors when the project operates is presented in **Table 7-1** and **Table 7-2** below.

**Table 7-3: Impact Assessment: Daytime scenarios – peak hours**

| | |
|---|---|
| ***Nature:*** | *Operations take place during the daytime* hours of (22:00 – 06:00). |
| ***Acceptable Rating Level*** | Daytime Rating Level of 50 dBA – Suburban Rating.<br>Use of $L_{Req,D}$ of 50 dBA; and<br><br>IFC (Equator Principle) Residential; institutional and educational.<br>Use of $L_{Req,D}$ of 55 dBA. |
| ***Extent*** | **Local (2)** – The impact could affect the local area (within 1,000 m from site). |
| ***Duration*** | **Long term (4)** – Impacts that will continue for the life of the Project, but ceases when the Project stops operating. |
| ***Magnitude (L<sub>Req,D</sub> < 55 dBA or Noise level > x dBA above ambient*** | Equivalent noise levels will exceed the the Equator Principle IFC guideline, SANS10103:2008 Rating or ambient soundscape during daytime hours. **Very High (10)**. |
| ***Probability*** | **Likely (3)**<br>• The implementation of a berm/barrier during the construction phase and around the boundary of open cast pits will assist to screen noise levels;<br>• Calculated levels will exceed the Equator Principle IFC guideline, SANS10103:2008 Rating or ambient soundscape by a measurable value and during daytime hours;<br>• Engagements at a receptors dwelling as well noise sources of significance (N1 and R523 road traffic) may screen noise levels during the daytimes;<br>• Tonality from brake squeal may become an annoyance at new rail sections where momentum needs to be reduced or trains make periodic stops (rail loops etc.)**;**<br>• The potential operation near buildings and facilities where a natural or quiet period is required. E.g. religious, educational and health care and hospitality facilities (game lodges). |
| ***Significance*** | **32** to **48 (medium)** – for NSD05 to 06, 18, 50, 52 to 66 and 82. Refer to **Appendix D 3.** |
| ***Status*** | Negative. |
| ***Reversibility*** | High. |
| ***Comments*** | Mitigation recommended. |
| ***Can impacts be mitigated?*** | Possible. |

Based on the preceding data it is obvious that the risk of a noise impact developing during the daytime operational hours is of a medium significance. This is mostly due to the proximity of receptors to open cast boundaries. Mitigation is supplied in **Section 8** for the developer to consider. Note that if train operations such as shunting are proposed near a receptor the potential noise impact will increase.

**Table 7-4: Impact Assessment: Night-time scenarios – peak hours**

| | |
|---|---|
| ***Nature:*** | *Operations take place during the night-time* hours of (*22:00 – 06:00*). |
| ***Acceptable Rating Level*** | Night-time Rating Level of 40 dBA – Suburban Rating.<br>Use of $L_{Req,D}$ of 40 dBA; and<br><br>IFC (Equator Principle) Residential; institutional and educational.<br>Use of $L_{Req,D}$ of 45 dBA. |

| | |
|---|---|
| ***Extent*** | **Long term (4)** – Impacts that will continue for the life of the Project, but ceases when the Project stops operating. |
| ***Duration*** | **Short term (2)** – Impacts that are predicted to last only for the duration of the construction period. |
| ***Magnitude (L$_{Req,D}$ < 55 dBA or Noise level > x dBA above ambient*** | Equivalent noise levels will exceed the the Equator Principle IFC guideline, SANS10103:2008 Rating or ambient soundscape during daytime hours. **Very High (10)**. |
| ***Probability*** | **Highly Likely (4)**<br>• The implementation of a berm/barrier during the construction phase and around the boundary of open cast pits will assist to screen noise levels;<br>• Calculated levels will exceed the Equator Principle IFC guideline, SANS10103:2008 Rating or ambient soundscape by a measurable value and during a period when a receptor may require rest (night-times);<br>• Noise events (**L$_{Amax}$**) of train pass-by if railway line is adjacent to a receptor. It is not just the amount of **L$_{Amax}$** events, but also the magnitude (above 80 dB) of the **L$_{Amax}$.** Refer to **Section 4.3.4** motivating the chosen 80 dB for **L$_{Amax}$** values;<br>• Tonality from brake squeal may become an annoyance at sections of the railway where momentum needs to be reduced or trains make periodic stops (rail loops etc.);<br>• Train hooters will cause noise annoyance during night-times even though it is except from legislation as indicated in **Section 2.2.1**;<br>• The potential operation near buildings and facilities where a natural or quiet period is required. E.g. health care and hospitality facilities (game lodges). |
| ***Significance*** | **64 (High)** – for NSD05, 06, 12, 13, 18, 59 to 61, 66 and 106. Refer to **Appendix D 4**. |
| ***Status*** | Positive. |
| ***Reversibility*** | High. |
| ***Comments*** | Mitigation recommended. |
| ***Can impacts be mitigated?*** | Possible. |

Based on the preceding data it is obvious that the risk of a noise impact developing during the night-time hours is of a high significance. This is mostly due to the proximity of receptors to open cast boundaries. Mitigation is supplied in **Section 8** for the developer to consider. The need for shunting activities near a receptor will impact on the noise levels.

# 8 MITIGATION OPTIONS

## 8.1 CONSTRUCTION PHASE

It will be assumed that all receptors located on proposed open cast pits, stockpiles and colliery boundaries will be relocated. This would be relevant to receptors NSD02, 03, 04, 10, 11, 47, 62, 67 and 89 to 100. While not considered in this report, it is likely that other receptors as far as 500 m from the mining activities may be relocated.

The projected noise impact from the construction processes would be limited to the site and surrounding area. Due to the proximity of receptors to the proposed activities it is highly likely (daytime and night-times) that potential noise-sensitive development will experience a noise impact with a magnitude higher than the Sub-urban Rating Level and Equator Principal IFC guidelines. This is only relevant when heavy equipment operate within a distance of 500 meters from receptors.

### 8.1.1 Mitigation Options: Mitigation of noise source

Mitigation options included both management measures as well as technical changes. Management options to reduce the noise impact during the construction phase include:

- Berms with a potential to act as a noise barrier should be constructed as soon as possible around open cast pits and other mining activities. These construction processes should preferably only take place during the daytime period up to the point where these berms or stockpiles can act as a noise barrier for potential night-time activities. The following factors should be implemented to ensure an effective noise barrier/berm:
    - It is recommended that the barrier be built as close as possible to the operations or at receptors as is feasible as possible. The barrier design needs to consider diffraction, and should have no aperture or gaps facing receptors;
    - It is recommended that the height of the berms/barriers be at least 2 m higher than the line of sight to the highest noise source from open cast pits and stockpile areas, although the higher the berm/barrier the better acoustical screen it will be. Certain heavy vehicles have their exhaust ports above the cabin of the vehicle and needs to be considered as the noise source point. Barriers must also be sufficiently dense (at least 20 kilograms/square meter surface density) and sufficient in thickness. A brick wall provides a surface density of 244

kilograms/square m at thickness of 150 mm[32] and is considered as a typically good acoustical barrier. Certain metrological conditions (particularly during night-times) can see refraction of noise over the barriers due to the various temperature inversion layers. This means that noise levels from a mine may propagate back down to the ground at a receptors dwelling due to the curvature of sound in the warmer upper night-time atmosphere. Barrier height cannot effect this propagation;
    - The barrier should be sufficiently long to block the line of sight from receptors to the sides of the mining operations;
- Minimize any work that needs to take place at night. Night-time construction work should be limited to localities that are further than:
    - 2 000 meters from a noise-sensitive community when there is a direct line of sight (no barrier between the activity and receptor);
    - 1 000 meters from a noise-sensitive community when there exists a barrier between the activity and receptor;
- Using the smallest/quietest equipment when operating near receptors;
- Ensuring that equipment is well maintained and fitted with the correct and appropriate noise abatement measures. Acoustical mufflers (or silencers) should be considered on equipment exhausts on open cast pits and stockpile areas; and
- The developer should investigate the use of white-noise generators instead of reverse alarms on heavy vehicles operating on roads, in mine pits and at stockpile areas[33].

### 8.1.2 Mitigation Options: Mitigation at Receptors

The following optional possibility can be considered by the developer:

- When noisy processes are to take place very close to potentially sensitive receptors (development of access routes, security fencing or other infrastructure closer than 500 meters from a receptor), co-ordinate the working time with periods when the receptors are likely not at home. An example would be to work within the 8 am to 2 pm time-slot to minimise the significance of the impact because:
    - Potentially receptors are most likely at school or at work, minimizing the probability of an impact happening.

[32] Environmental Protection Department; Government of the Hong Kong SAR Second Issue, January 2003.
[33] White Noise Reverse Alarms: http://www.brigade-electronics.com/products.

    - Normal daily activities will generate other noises that would most likely mask construction noises, minimizing the probability of an impact happening.
- Ensure a good working relationship between the mining management and all potentially sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close to them. Information that should be provided to the potentially sensitive receptor(s) include:
    - Proposed working times;
    - How long the activity is anticipated to take place,
    - What is being done, or why the activity is taking place;
    - Contact details of a responsible person where any complaints can be lodged should there be an issue of concern;
- An option for the developer to consider is relocating receptors directly adjacent, bordering or within 100 m of open cast pits and stockpile areas; and
- An option for the developer to consider is to implement a buffer zone of 100 m whereby no open cast pit, stockpile or colliery infrastructure is designed next to a receptors dwelling.

## 8.2 OPERATIONAL PHASE

It will be assumed that all receptors based on open cast pits, stockpiles areas as well as colliery infrastructure will be relocated. This would include receptors NSD02, 03, 04, 10, 11, 47, 62, 67 and 89 to 100. While not considered in this report, it is likely that other receptors as far as 500 m from the mining activities may be relocated.

Due to the proximity of receptors to the proposed activities it is highly likely (daytime) to definite (night-time) that potential noise-sensitive developments will experience a noise impact with a magnitude higher than the Sub-urban Rating Level and Equator Principal IFC guidelines. This is only relevant when operational processes take place within a distance of 500 meters from receptors. The layout as evaluated (also considering the locations of the various stockpiles) would allow some mitigation of noises from the development. The implementation of the mitigation measures as proposed for the construction phase would further assist in reducing noise levels (berms and barriers).

### 8.2.1 Mitigation Options: Mitigation of noise source

#### *8.2.1.1 Mine Infrastructure, open cast pits and stockpiles*

Mitigation options included both management measures as well as technical changes. Management options to reduce the noise impact during the operational phase include:

- Mitigation measures as identified for construction phase still valid (berms barriers around open cast/stockpile boundaries);
- Environmental awareness training should include a noise component, allowing employees and contractors to realize the potential noise risks that activities (especially night-time activities) pose to the surrounding environment. All employees and contractors should receive this training;
- The developer should investigate the use of white-noise generators instead of reverse alarms on heavy vehicles operating on roads, in mine pits and at stockpile areas[34];
- Minimize equipment or processes at high levels, such as the development of the material tip being significantly higher than the surrounding landscape. It limits the mitigation of this noise using berms or barriers. The developer may consider keeping the material tip at ground height or even slightly below ground level;
- Ensuring that equipment is well maintained and fitted with the correct and appropriate noise abatement measures. Acoustical mufflers (or silencers) should be considered on equipment exhausts on open cast pits, stockpile areas as well as on exhausts from colliery equipment facing receptors within 800 m. If technically feasible colliery equipment exhaust ports should not face directly towards a receptor or upwards (due to diffraction in night-time atmosphere) but away from a receptor; and
- All equipment (especially crushers, conveyor transfer points, conveyor drive systems and washers and screeners) should be enclosed where practically possible.

#### *8.2.1.2 Facility haul roads*

To limit the maximum speed on the haul roads to less than 60 km/h.

#### *8.2.1.3 Railway lines*

Possibly the best mitigation options when considering acoustics is the design and specifications of railway lines and operations. These include:

[34] White Noise Reverse Alarms: http://www.brigade-electronics.com/products.

- Minimise train operations such as shunting during the night-times (22:00 – 06:00, SANS 10103:2008). The potential important times for a noise annoyance to occur would be during the night-time hours when a quiet environment is desired (at night for sleeping etc.);
- Continuous welded rails and ballast is recommended for newly constructed railway tracks and will result in a noise reduction factor. Cracked, corrugated or damaged rails should be mended or replace immediately to reduce noise and vibrations. The developer can considered a float slab track system at areas where no ballast may be used, generally slab tracks can be +5 dB louder than ballasted tracks[35];
- The developer can consider the implementation of composite material with added rubber (or similar) brake shoes for trains ("K or LL Blocks") as cast-iron brakes cause wheel roughness (and more friction and noise). These wheel dampers will produce the lowest peak noise levels, but may not prevent tyre squeal fully[36]. The LL brake block system has the potential to reduce rolling and braking noise the most over cast iron brakes as well as K blocks. LL block systems does not require the adaption of cast-iron brake systems and also damage the train wheels far less than a conventional cast-iron brake[37]. The developer should consider ensuring that rail head grinding and rail head maintenance is conducted regularly to ensure that the correct rail head profile is maintained and the elimination of corrugated rails. Defect or wheels with flat spots must be mended or replace to minimise vibrations. The developer could consider rail dampers on the rail line or wheels and at sections of rail near receptors dwellings. Sharp curves could be lubricated to reduce break squeal;
- Minimize train speeds ;
- The developer can consider berms and barriers between the railway line and close receptors.

### 8.2.2 Mitigation Options: General

Additionally the developer must note the following:

- Good public relations are essential, and at all stages surrounding receptors should be educated with respect to the potential sounds that could be generated by the mining activity. The information presented to stakeholders

[35] Georgios Michas, KTH Architecture and Built Environment. Slab Track Systems for High-Speed Railways. 2012
[36] E.H.W Jansen, M.G Ditrrich and E.L Sima. TNO Science and Industry, Brake noise measurements on mixed freight trains with composite brakes, 2008
[37] UIC SET 01, Usage guidelines for composite (LL) brake blocks, 10th edition, 2013.

should be factual and should not set unrealistic expectations. It is counterproductive to suggest that the mining operation will be inaudible, or to use vague terms like "quiet". Mining activities have the potential to generate significant noise that could be heard at some distance from the operation, especially at night when a quiet environment is more desirable and sought after. The magnitude (or intensity) of the sound will depend on a multitude of variables and will vary from day to day and from place to place with environmental and operational conditions. Audibility is distinct from the sound level, since it depends on the relationship between the sound character and level from the various processes and the ambient sound character and level.

- Community involvement needs to continue throughout the project. Annoyance is a complicated psychological phenomenon; as with many industrial operations, expressed annoyance with sound can reflect an overall annoyance with the project, rather than a rational reaction to the sound itself. Mining could offer a benefit to the community and local economy. A positive community attitude throughout the greater area should be fostered, particularly with those residents near the mining operation, to ensure they do not feel taken advantage of.
- The developer must implement a line of communication where complaints could be lodged/registered. All potentially sensitive receptors should be made aware of this line of communication. The mining operation should maintain a commitment to the local community and respond to concerns in an expedient fashion. Sporadic and legitimate noise complaints could develop. For example, sudden and sharp increases in sound levels could result from mechanical malfunctions, changes in operators, equipment and even operating protocols. Problems of this nature can be corrected quickly, and it may be in the mine's interest to do so.

# 9 ENVIRONMENTAL MANAGEMENT PLAN

## 9.1 CONSTRUCTION PHASE

Various construction activities would be taking place during the development of the mine and may pose a noise risk to the surrounding environment and potential noise-sensitive developments.

Projected noise levels during construction of the mining operation were modelled using the methodology as proposed by SANS 10357:2004. The resulting future noise projections indicated that the construction activities as modelled for the worst case scenario may not comply with both the Noise Control Regulations (GN R154) and with the SANS 10103:2004 guidelines for all NSD.

However, as with all modelling exercises it is impossible to evaluate all potential activities that could result in a noise impact. These activities could include temporary or short-term activities, such as small equipment used (such as the digging of trenches to lay underground power-lines) in the establishments of security fences, access routes or generated by the construction traffic itself.

As such certain objectives are recommended to define the performance of the developer in mitigating any projected noise impacts and reducing the significance of any noise impact.

| **OBJECTIVE** | **Control noise pollution stemming from construction activities** |
|---|---|
| Project Component(s) | Construction of infrastructure, including site establishment, the digging of foundations, erection of structures and fencing, development of access roads, etc. |
| Potential Impact | • Increased noise levels at potentially noise-sensitive developments/receptors<br>• Increasing the ambient sound levels in the area.<br>• Potentially changing the acceptable land use capability. |
| Activity/Risk source | • Any daytime construction activities taking place within 500 meters from any potentially noise-sensitive developments (NSDs).<br>• Any night-time construction activities taking place within 1,200 meters from any potentially noise-sensitive developments (NSDs). |
| Mitigation Target/Objective (IFC Recommended values for residential areas used in this section). | • Ensure equivalent A-weighted noise levels below 55 dBA at potentially noise-sensitive receptors (daytime).<br>• Ensure equivalent A-weighted noise levels below 45 dBA at potentially noise-sensitive receptors (night-time).<br>• Define the noisy areas with a set boundary ensuring that equivalent A-weighted noise levels at the mining boundary does not exceed 65 dBA (if measured over 24 hours this should be 61 dBA);<br>• Ensure that maximum noise levels (due to the mining activities) at potentially noise-sensitive receptors are less than 65 dBA;<br>• Ensuring compliance with the National Noise Control Regulations. |

| Mitigation: Action/Control | Responsibility | Timeframe |
|---|---|---|
| Design a noise monitoring programme (after the details of all mitigation measures to be implemented are known). | - Acoustical Consultant | Before operational phase commence |
| Implement a noise monitoring programme. Note: If there are no noise-sensitive receptors within 2 000 from any mining activities no routine noise monitoring will be required. | - Acoustical Consultant / Environmental Control Officer | Quarterly monitoring |
| Establish a line of communication and notify all stakeholders and NSDs of the means of registering any issues, complaints or comments. | - Environmental Control Officer | All phases of project |
| Notify potentially sensitive receptors about work to take place at least 2 days before the activity in the vicinity (within 500 meters) of the NSD is to start. Following information to be presented in writing:<br>- Description of Activity to take place;<br>- Estimated duration of activity;<br>- Working hours;<br>- Contact details of responsible party. | - Contractor<br>- Environmental Control Officer | At least 2 days, but not more than 5 days before activity is to commence |
| Ensure that all equipment is maintained and fitted with the required noise abatement equipment. | - Workshop Supervisor | During normal preventative maintenance |
| When any noise complaints are received, noise monitoring should be conducted at the complainant, followed by feedback regarding noise levels measured. | - Acoustical Consultant / Approved Noise Inspection Authority | Within 7 days after complaint was registered |
| The construction employees/contractors must abide by the local by-laws regarding noise | - Contractor<br>- Environmental Control Officer | Duration of construction phase |
| Where possible construction work should be undertaken during normal working hours (06H00 – 18H00), from Monday to Saturday; If agreements can be reached (in writing) with the all the surrounding (within a 1,1000 distance) potentially sensitive receptors, these working hours can be extended. | - Contractor | As required |
| Establish a line of communication and notify all stakeholders and NSDs of the means of registering any issues, complaints or comments. | - Environmental Control Officer | All phases of project |

| Performance indicator | • **No noise complaints are registered** |
|---|---|
| Monitoring | Quarterly noise measurements to be conducted at selected community members in the vicinity of the development during the construction period over a period of 24 hours in 10-minute bins, similar to the methodology employed in this report.<br><br>Noise monitoring to take place every time that a relevant noise complaint is registered. |

## 9.2 OPERATIONAL PHASE

Noise modelling conducted highlighted that the operation of the mine may not comply with the Noise Control Regulations (GN R154) or with the fixed SANS 10103:2008 guidelines during both the day and night-time. Noise levels could also exceed the guideline levels as set by the International Finance Corporation (closest receptors).

Mitigation measures were recommended that will reduce the noise levels (as experienced by the community). The following objectives and targets are recommended to define the performance of the mine in mitigating the projected noise impacts and reducing the significance of any noise impacts.

| **OBJECTIVE** | **Control noise pollution stemming from operation of Mine** |
|---|---|
| Project Component(s) | Operational Phase |
| Potential Impact | • Increased noise levels at potentially sensitive receptors;<br>• Changing ambient sound levels could change the acceptable land use capability;<br>• Changing ambient sound levels could increase annoyance and potential complaints;<br>• Disturbing character of sound. |
| Activity/Risk source | Numerous simultaneous operational activities |
| Mitigation Target/Objective (IFC Recommended values for residential areas used in this section). | • Ensure equivalent A-weighted noise levels below 55 dBA at potentially noise-sensitive receptors (daytime).<br>• Ensure equivalent A-weighted noise levels below 45 dBA at potentially noise-sensitive receptors (night-time).<br>• Define the noisy areas with a set boundary ensuring that equivalent A-weighted noise levels at this boundary does not exceed 65 dBA (if measured over 24 hours this should be 61 dBA);<br>• Ensure that maximum noise levels at potentially noise-sensitive receptors are less than 65 dBA;<br>• Ensure that the change in ambient sound levels as experienced by Potentially Sensitive Receptors is less than 7 dBA;<br>• Ensuring compliance with the National Noise Control Regulations. |

| **Mitigation: Action/Control** | **Responsibility** | **Timeframe** |
|---|---|---|
| Add additional noise measurement points at any complainants that registered a valid noise complaint. | - Acoustical Consultant | With quarterly monitoring |
| If similar noise complaints continue, or is frequently raised the complaint should be investigated further with feedback to the surrounding stakeholders / complainant. | - Acoustical Consultant | If required |

| **Performance indicator** | • **No noise complaints are registered**<br>• **Compliance with National Noise Control Regulations**<br>• **Compliance with IFC noise guideline levels for residential areas** |
|---|---|
| Monitoring | Quarterly noise monitoring by an Acoustic Consultant as well as when noise complaints are registered. If no noise complaints or issues are registered or noise monitoring registers compliance with the National Noise Control Regulations the frequency of the noise monitoring can be reduced. |

# 10 CONCLUSIONS AND RECOMMENDATIONS

With the input data as used, this assessment indicated that there is a potential noise impact of moderate significance during the construction phase. The layout as evaluated will provide a number of berms and stockpiles that will assist in the attenuation of noises from the mining activities and during the operational phase. Subsequently, the potential noise impact would be of a moderate to high significance during the night-time periods and during the operational phase.

It must be noted that commercial railway line functions are exempted from certain requirements of Government Notice R154 of 1992 (Noise Control Regulations) – Regulation 2.(c) - *"Provided that the provisions of this paragraph* (in reference to noise emanating from a development) *shall not apply in respect of a disturbing noise or noise nuisance caused by rail vehicles or aircraft which are not used as recreational vehicles"*. Furthermore the use of locomotive horns is exempt from the Government Notice R154 of 1992 (Noise Control Regulations) – Clause 7.(1) – *"the emission of sound is for the purposes of warning people of a dangerous situation".*

Mitigation measures are proposed that could reduce the noise levels as experienced by the closest noise-sensitive developments (the magnitude of the reduction depending on the selection of the mitigation measures).

Since there exist a risk of a noise impact, noise monitoring is recommended. As there exists scope for further mitigation measures such a noise monitoring program can only be designed after all mitigation measures are designed and known. Once designed it should be implemented on a quarterly basis for a period of one year before the construction processes start to define pre-mining ambient sound levels.

Quarterly noise monitoring is also recommended to be conducted during the first year of operation, and, depending on the findings of the monitoring report, to be extended, reduced or stopped. Noise measurements should be conducted over a period of 24 hours as per the methodology employed in this report.

Measurements should be collected in 10-minute bins over the measurement period. Variables recommended to be analysed include $\mathbf{L_{AMin}}$, $\mathbf{L_{AIeq}}$, $\mathbf{L_{Aeq,f}}$, $\mathbf{L_{Aeq}}$, $\mathbf{L_{Ceq}}$, $\mathbf{L_{AMax}}$, $\mathbf{L_{A10}}$, $\mathbf{L_{A90}}$ and spectral analysis. If all potential noise-sensitive receptors living within the 40 dBA contour are relocated before the mining project starts noise measurements can be dispensed with.

Additional measurements should be collected at the location of any receptors that have complained to the mine regarding noise originating from the operation. Feedback regarding noise measurements should be presented to all stakeholders and other interested and affected parties in the area.

This report should also be made available to all potentially sensitive receptors in the area, or the contents explained to them to ensure that they understand all the potential noise risks that the mining operation may have on them and their families.

Due to economic advantages, coal mining does provide valuable employment, local taxes and foreign currency. It must be noted when mining projects are near to potential noise-sensitive receptors, consideration must be given to ensuring a compatible co-existence. The potential sensitive receptors should not be adversely affected and yet, at the same time mining need to reach an optimal scale in terms of layout and production.

It should be noted that this does not suggest that the sound from the mining activities should not be audible under all circumstances - this is an unrealistic expectation that is not required or expected from any other agricultural, commercial, industrial or transportation related noise source – but rather that the sound due to the mining activities should be at a reasonable level in relation to the ambient sound levels.

If the layout changes significantly from the layout (and assumptions) used in this report, that this Environmental Noise Impact Assessment be reviewed, with the appropriate information supplied by the mine, including:

- Locality of the noise source;
- Operational time of the noise source; and
- If possible specifications regarding the noise source.

# 11 THE AUTHOR

The author of this report, M. de Jager (B. Ing (Chem), UP) graduated in 1998 from the University of Pretoria. He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker enclosure design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control. As from 2007 he has been involved with the following projects:

- Full Noise Impact Studies for a number of Wind Energy Facilities, including: Cookhouse, Amakhala Emoyeni, Dassiesfontein/Klipheuwel, Rheboksfontein, AB, Dorper, Suurplaat, Gouda, Riverbank, Deep River, West Coast, Happy Valley, Canyon Springs, Tsitsikamma WEF, West Coast One, Karoo, Velddrift and Saldanha.
- Full Noise Impact Studies for a number of mining projects, including: Skychrome (Pty) Ltd (A Ferro-chrome mine),Mooinooi Chrome Mine (WCM), Buffelsfontein East and West (WCM),Elandsdrift (Sylvania),Jagdlust Chrome Mine (ECM),Apollo Brick (Pty) Ltd (Clay mine and brick manufacturer), Arthur Taylor Expansion project (X-Strata Coal SA), Klipfontein Colliery (Coal mine), Landau Expansion project (Coal mine), Modelling for Tweefontein Colliery Expansion.

The author is an independent consultant to the project, Gudani Consulting and Coal of Africa. He,

- does not and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations;
- have and will not have no vested interest in the proposed activity proceeding;
- have no and will not engage in conflicting interests in the undertaking of the activity;
- undertake to disclose all material information collected, calculated and/or findings, whether favourable to the development or not; and
- will ensure that all information containing all relevant facts be included in this report.

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# APPENDIX A

## Glossary of Acoustic Terms, Definitions and General Information

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|---|---|
| *1/3-Octave Band* | A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the centre frequency of the band. See also definition of octave band. |
| *A – Weighting* | An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound. |
| *Air Absorption* | The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules. |
| *Alternatives* | A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are not limited hereto: alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called "no go" alternative refers to the option of not allowing the development and may also require investigation in certain circumstances. |
| *Ambient* | The conditions surrounding an organism or area. |
| *Ambient Noise* | The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation. |
| *Ambient Sound* | The all-encompassing sound at a point being composite of sounds from near and far. |
| *Ambient Sound Level* | Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this report the term Background Ambient Sound Level will be used. |
| *Amplitude Modulated Sound* | A sound that noticeably fluctuates in loudness over time. |
| *Anthropogenic* | Human impact on the environment or anthropogenic impact on the environment includes impacts on biophysical environments, biodiversity and other resources |
| *Applicant* | Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation. |
| *Assessment* | The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision. |
| *Attenuation* | Term used to indicate reduction of noise or vibration, by whatever method necessary, usually expressed in decibels. |
| *Audible frequency Range* | Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound. |
| *Ambient Sound Level* | The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations. |
| *Axle* | Shaft connecting two wheels on either side of the vehicle. The wheels are forced to rotate at the same speed. Vehicles with independent wheels have 'stub axles' that do not connect the two wheels on either side of the vehicle. |
| *Ballast* | A layer of coarse stones supporting the sleepers. |
| *Baseplate* | A track component designed to hold the rail in place, usually with resilience to provide improved vibration isolation. |
| *Broadband Noise* | Spectrum consisting of a large number of frequency components, none of which is individually dominant. |
| *C-Weighting* | This is an international standard filter, which can be applied to a pressure signal or to a *SPL* or *PWL* spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less |

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| | adjustment than the A-scale filter for frequencies less than 1000 Hz. |
| *dB(A)* | Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear. |
| *Decibel (db)* | A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 μ Pa. |
| *Diffraction* | The process whereby an acoustic wave is disturbed and its energy redistributed in space as a result of an obstacle in its path, Reflection and refraction are special cases of diffraction. |
| *Direction of Propagation* | The direction of flow of energy associated with a wave. |
| *Disturbing noise* | Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level at the same measuring point by 7 dBA or more. |
| *Echolocation* | Echo locating animals emit calls out to the environment and listen to the echoes of those calls that return from various objects near them. They use these echoes to locate and identify the objects. Echolocation is used for navigation and for foraging (or hunting) in various environments. |
| *Environment* | The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects. |
| *Environmental Control Officer* | Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise. |
| *Environmental impact* | A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them. |
| *Environmental Impact Assessment* | An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures. |
| *Environmental issue* | A concern felt by one or more parties about some existing, potential or perceived environmental impact. |
| *Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)* | The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time. |
| *Equivalent continuous A-weighted rating level ($L_{Req,T}$)* | The Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$) to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours). It is a calculated value. |
| *F (fast) time weighting* | (1) Averaging detection time used in sound level meters.<br>(2) Fast setting has a time constant of 125 milliseconds and provides a fast reacting display response allowing the user to follow and measure not too rapidly fluctuating sound. |
| *Footprint area* | Area to be used for the construction of the proposed development, which does not include the total study area. |
| *Free Field Condition* | An environment where there is no reflective surfaces. |
| *Frequency* | The rate of oscillation of a sound, measured in units of Hertz (Hz) or kiloHertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound |

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| | (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate. |
| *Green field* | A parcel of land not previously developed beyond that of agriculture or forestry use; virgin land. The opposite of Greenfield is Brownfield, which is a site previously developed and used by an enterprise, especially for a manufacturing or processing operation. The term Brownfield suggests that an investigation should be made to determine if environmental damage exists. |
| *Grinding* | A process for removing a thin layer of metal from the top of the rail head in order to remove roughness and/or to restore the correct profile. Special grinding trains are used for this. |
| *G-Weighting* | An International Standard filter used to represent the infrasonic components of a sound spectrum. |
| *Harmonics* | Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone. |
| *I (impulse) time weighting* | (1) Averaging detection time used in sound level meters as per South African standards and Regulations.<br>(2) Impulse setting has a time constant of 35 milliseconds when the signal is increasing (sound pressure level rising) and a time constant of 1,500 milliseconds while the signal is decreasing. |
| *Impulsive sound* | A sound characterized by brief excursions of sound pressure (transient signal) that significantly exceed the ambient sound level. |
| *Infrasound* | Sound with a frequency content below the threshold of hearing, generally held to be about 20 Hz. Infrasonic sound with sufficiently large amplitude can be perceived, and is both heard and felt as vibration. Natural sources of infrasound are waves, thunder and wind. |
| *Integrated Development Plan* | A participatory planning process aimed at developing a strategic development plan to guide and inform all planning, budgeting, management and decision-making in a Local Authority, in terms of the requirements of Chapter 5 of the Municipal Systems Act, 2000 (Act 32 of 2000). |
| *Integrated Environmental Management* | IEM provides an integrated approach for environmental assessment, management, and decision-making and to promote sustainable development and the equitable use of resources. Principles underlying IEM provide for a democratic, participatory, holistic, sustainable, equitable and accountable approach. |
| *Interested and affected parties* | Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups and the general public. |
| *Interburden* | Material of any nature that lies between two or more bedded ore zones or coal seams. Term is primarily used in surface mining |
| *Joint rail* | A connection between two lengths of rail, often held together by an arrangement of bolts and fishplates. |
| *Key issue* | An issue raised during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved. |
| *Listed activities* | Development actions that is likely to result in significant environmental impacts as identified by the delegated authority (formerly the Minister of Environmental Affairs and Tourism) in terms of Section 21 of the Environment Conservation Act. |
| *Locomotive* | A powered vehicle used to draw or propel a train of carriages or wagons (as opposed to a multiple unit). |
| $L_{AMin}$ *and* $L_{AMax}$ | Is the RMS (root mean squared) minimum or maximum level of a noise source. |
| *Loudness* | The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility. |
| *Magnitude of impact* | Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring. |
| *Masking* | The raising of a listener's threshold of hearing for a given sound due to the presence of another sound. |

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| *Mitigation* | To cause to become less harsh or hostile. |
| *Natural Sounds* | Are sounds produced by natural sources in their normal soundscape. |
| *Negative impact* | A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by damaging health, or by causing nuisance). |
| *Noise* | a. Sound that a listener does not wish to hear (unwanted sounds).<br>b. Sound from sources other than the one emitting the sound it is desired to receive, measure or record.<br>c. A class of sound of an erratic, intermittent or statistically random nature. |
| *Noise Level* | The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances. |
| *Noise-sensitive development* | developments that could be influenced by noise such as:<br>a) districts (see table 2 of SANS 10103:2008)<br>1. rural districts,<br>2. suburban districts with little road traffic,<br>3. urban districts,<br>4. urban districts with some workshops, with business premises, and with main roads,<br>5. central business districts, and<br>6. industrial districts;<br>b) educational, residential, office and health care buildings and their surroundings;<br>c) churches and their surroundings;<br>d) auditoriums and concert halls and their surroundings;<br>e) recreational areas; and<br>f) nature reserves.<br>In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor |
| *Octave Band* | A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency. |
| Overburden | In mining and in archaeology, overburden (also called waste or spoil) is the material that lies above an area of economic or scientific interest. In mining, it is most commonly the rock, soil, and ecosystem that lies above a coal seam or ore body |
| *Positive impact* | A change that improves the quality of life of affected people or the quality of the environment. |
| *Property* | Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon |
| *Public Participation Process* | A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development |
| *Reflection* | Redirection of sound waves. |
| *Refraction* | Change in direction of sound waves caused by changes in the sound wave velocity, typically when sound wave propagates in a medium of different density. |
| *Reverberant Sound* | The sound in an enclosure which results from repeated reflections from the boundaries. |
| *Reverberation* | The persistence, after emission of a sound has stopped, of a sound field within an enclosure. |
| *Rail head* | The bulbous part at the top of the rail. |
| *Rolling Stock* | Rolling stock comprises all the vehicles that move on a railway. It usually includes both powered and unpowered vehicles, for example locomotives, railroad cars, coaches, and wagons. |
| *ROM* | The coal delivered from the mine that reports to the coal preparation plant is called run-of-mine, or ROM, coal. This is the raw material for the CPP, and consists of coal, rocks, middlings, minerals and contamination |

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| *Shunting* | Shunting, in railway operations, is the process of sorting items of rolling stock into complete train sets. |
| *Railway Sidings* | A siding, in rail terminology, is a low-speed track section distinct from a running line or through route such as a main line or branch line or spur. It may connect to through track or to other sidings at either end. |
| *Significant Impact* | An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account. |
| *S (slow) time weighting* | (1) Averaging times used in sound level meters.<br>(2) Time constant of one [1] second that gives a slower response which helps average out the display fluctuations. |
| *Sound Level* | The level of the frequency and time weighted sound pressure as determined by a sound level meter, i.e. A-weighted sound level. |
| *Sound Power* | Of a source, the total sound energy radiated per unit time. |
| *Sound Pressure Level (SPL)* | Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as $L_p$ in dB (not weighted) or in various other weightings. |
| *Soundscape* | Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution. |
| *Study area* | Refers to the entire study area encompassing all the alternative routes as indicated on the study area map. |
| *Sustainable Development* | Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987). |
| *Tread braked* | The traditional form of wheel brake consisting of a block of friction material (which could be cast iron, wood or nowadays a composition material) hung from a lever and being pressed against the wheel tread by air pressure (in the air brake) or atmospheric pressure in the case of the vacuum brake. |
| *Tone* | Noise can be described as tonal if it contains a noticeable or discrete, continuous note. This includes noises such as hums, hisses, screeches, drones, etc. and any such subjective description is open to discussion and contradiction when reported. |
| *Wagon* | A freight-carrying vehicle. |
| *Zone of Potential Influence* | The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant. |
| *Zone Sound Level* | Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS 10103:2008. |

# APPENDIX B

## Site Investigation – Photos of monitoring locations

**Photo B.1: Measurement location CBN01**

**Photo B.2: Measurement location CBN02**

**Photo B.3: Measurement location CBN03**

**Photo B.4: Measurement location CBN04**

**Photo B.5: Measurement location CBN05**

**Photo B.6: Measurement location CBN06**

**Photo B.7: Measurement location CBN07**

**Photo B.8: Measurement location CBN08**

**Photo B.9: Measurement location CBN09**

# APPENDIX C

Potential Noise-Sensitive Developments

**Table D 1: Locations of identified noise-sensitive receptors (Datum type: WGS84, decimal degrees)**

| Noise-sensitive development | Status | Location X Co-ordinate | Location Y Co-ordinate |
|---|---|---|---|
| 1 | Receptor | -22.86301 | 29.86696 |
| 2 | Receptor | -22.87371 | 29.79154 |
| 3 | Receptor | -22.87167 | 29.79053 |
| 4 | Receptor | -22.87595 | 29.78746 |
| 5 | Receptor | -22.86664 | 29.79289 |
| 6 | Receptor | -22.86726 | 29.79893 |
| 7 | Receptor | -22.85884 | 29.80742 |
| 8 | Receptor | -22.85659 | 29.80843 |
| 9 | Receptor | -22.85425 | 29.80942 |
| 10 | Receptor | -22.8697 | 29.80615 |
| 11 | Receptor | -22.88101 | 29.75466 |
| 12 | Receptor | -22.8837 | 29.70996 |
| 13 | Receptor | -22.88876 | 29.69383 |
| 14 | Receptor | -22.88675 | 29.68927 |
| 15 | Receptor | -22.88251 | 29.6888 |
| 16 | Receptor | -22.88073 | 29.68707 |
| 17 | Receptor | -22.88631 | 29.68684 |
| 18 | Receptor | -22.88201 | 29.68723 |
| 19 | Receptor | -22.88755 | 29.68405 |
| 20 | Receptor | -22.88633 | 29.68405 |
| 21 | Receptor | -22.88568 | 29.68401 |
| 22 | Receptor | -22.88542 | 29.68322 |
| 23 | Receptor | -22.8861 | 29.68332 |
| 24 | Receptor | -22.90889 | 29.62442 |
| 25 | Receptor | -22.90374 | 29.62881 |
| 26 | Receptor | -22.90267 | 29.628 |
| 27 | Receptor | -22.90174 | 29.62783 |
| 28 | Receptor | -22.90074 | 29.62651 |
| 29 | Receptor | -22.90039 | 29.62642 |
| 30 | Receptor | -22.89705 | 29.62875 |
| 31 | Receptor | -22.90537 | 29.61639 |
| 32 | Receptor | -22.90641 | 29.61578 |
| 33 | Receptor | -22.90685 | 29.61539 |
| 34 | Receptor | -22.90747 | 29.61486 |
| 35 | Receptor | -22.90616 | 29.61015 |
| 36 | Receptor | -22.9029 | 29.6103 |
| 37 | Receptor | -22.90607 | 29.60737 |
| 38 | Receptor | -22.90568 | 29.60607 |
| 39 | Receptor | -22.89963 | 29.6083 |
| 40 | Receptor | -22.90002 | 29.60704 |
| 41 | Receptor | -22.90028 | 29.60559 |
| 42 | Receptor | -22.89961 | 29.60614 |
| 43 | Receptor | -22.89961 | 29.60743 |
| 44 | Receptor | -22.88889 | 29.61043 |
| 45 | Receptor | -22.88834 | 29.6103 |
| 46 | Receptor | -22.88748 | 29.60816 |
| 47 | Receptor | -22.90501 | 29.59077 |
| 48 | Receptor | -22.89964 | 29.59497 |
| 49 | Receptor | -22.89867 | 29.59549 |
| 50 | Receptor | -22.89698 | 29.59259 |
| 51 | Receptor | -22.89697 | 29.59335 |

| | | | |
|---|---|---|---|
| 52 | Receptor | -22.89624 | 29.59335 |
| 53 | Receptor | -22.89619 | 29.59271 |
| 54 | Receptor | -22.89568 | 29.59149 |
| 55 | Receptor | -22.89564 | 29.592 |
| 56 | Receptor | -22.89561 | 29.59287 |
| 57 | Receptor | -22.8957 | 29.59439 |
| 58 | Receptor | -22.8957 | 29.59511 |
| 59 | Receptor | -22.90284 | 29.58752 |
| 60 | Receptor | -22.90258 | 29.58591 |
| 61 | Receptor | -22.91007 | 29.56317 |
| 62 | Receptor | -22.90983 | 29.55712 |
| 63 | Receptor | -22.91149 | 29.533 |
| 64 | Receptor | -22.9105 | 29.53436 |
| 65 | Receptor | -22.9097 | 29.53497 |
| 66 | Receptor | -22.89083 | 29.55268 |
| 67 | Receptor | -22.88908 | 29.55774 |
| 68 | Receptor | -22.87649 | 29.60802 |
| 69 | Receptor | -22.89269 | 29.63227 |
| 70 | Receptor | -22.86351 | 29.62746 |
| 71 | Receptor | -22.86022 | 29.62985 |
| 72 | Receptor | -22.85855 | 29.63158 |
| 73 | Receptor | -22.85899 | 29.60574 |
| 74 | Receptor | -22.85859 | 29.60691 |
| 75 | Receptor | -22.85912 | 29.60794 |
| 76 | Receptor | -22.85975 | 29.60662 |
| 77 | Receptor | -22.86248 | 29.60899 |
| 78 | Receptor | -22.87364 | 29.64991 |
| 79 | Receptor | -22.87217 | 29.65445 |
| 80 | Receptor | -22.87108 | 29.65385 |
| 81 | Receptor | -22.86824 | 29.6591 |
| 82 | Receptor | -22.86383 | 29.68609 |
| 83 | Receptor | -22.86409 | 29.68183 |
| 84 | Receptor | -22.86403 | 29.68056 |
| 85 | Receptor | -22.87793 | 29.71021 |
| 86 | Receptor | -22.83247 | 29.69747 |
| 87 | Receptor | -22.83166 | 29.69783 |
| 88 | Receptor | -22.83067 | 29.69842 |
| 89 | Receptor | -22.84689 | 29.73618 |
| 90 | Receptor | -22.84706 | 29.73554 |
| 91 | Receptor | -22.84853 | 29.73273 |
| 92 | Receptor | -22.84813 | 29.75117 |
| 93 | Receptor | -22.82976 | 29.82823 |
| 94 | Receptor | -22.82942 | 29.83024 |
| 95 | Receptor | -22.82934 | 29.83091 |
| 96 | Receptor | -22.82903 | 29.83158 |
| 97 | Receptor | -22.82873 | 29.8323 |
| 98 | Receptor | -22.82852 | 29.83295 |
| 99 | Receptor | -22.82836 | 29.8335 |
| 100 | Receptor | -22.82985 | 29.8428 |
| 101 | Receptor | -22.79213 | 29.84044 |
| 102 | Receptor | -22.88928 | 29.8101 |
| 103 | Receptor | -22.88955 | 29.81261 |
| 104 | Receptor | -22.90562 | 29.48164 |
| 105 | Receptor | -22.90109 | 29.4809 |

| | | | |
|---|---|---|---|
| 106 | Receptor | -22.9103 | 29.5426 |

# APPENDIX D

Impact Assessment

## Table D 1: Modelling results and assessment - day construction – peak hours

| Noise-sensitive development | Est. Ambient Sound Level ($L_{Aeq}$) | Calculated Noise Level (LReq,1 h) | Change from Ambient Sound Level (dBA) | Above Equator Principle IFC guideline | Above SANS 10103 Rating Level – 50 dBA |
|---|---|---|---|---|---|
| 1 | 29.2 | 40.7 | 11.6 | 0 | 0 |
| 2 | On open cast/stockpile/colliery boundary | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | 24.4 | 54.1 | 29.6 | 0 | 4.1 |
| 6 | 24.2 | 53.0 | 28.8 | 0 | 3.0 |
| 7 | 20.6 | 46.9 | 26.3 | 0 | 0 |
| 8 | 20.3 | 45.5 | 25.2 | 0 | 0 |
| 9 | 20.1 | 45.0 | 24.9 | 0 | 0 |
| 10 | On open cast/stockpile/colliery boundary | | | | |
| 11 | | | | | |
| 12 | 49.1 | 54.1 | 5.0 | 0 | 4.1 |
| 13 | 43.8 | 50.5 | 6.7 | 0 | 0.5 |
| 14 | 55.0 | 56.3 | 1.2 | 1.3 | 6.3 |
| 15 | 38.3 | 53.4 | 15.1 | 0 | 3.4 |
| 16 | 33.9 | 49.9 | 16.0 | 0 | 0 |
| 17 | 47.5 | 50.9 | 3.4 | 0 | 0.9 |
| 18 | 36.1 | 50.2 | 14.1 | 0 | 0.2 |
| 19 | 50.5 | 52.6 | 2.2 | 0 | 2.6 |
| 20 | 44.7 | 49.6 | 4.9 | 0 | 0 |
| 21 | 42.6 | 48.8 | 6.3 | 0 | 0 |
| 22 | 41.3 | 48.7 | 7.4 | 0 | 0 |
| 23 | 43.3 | 49.5 | 6.2 | 0 | 0 |
| 24 | 38.2 | 39.2 | 1.0 | 0 | 0 |
| 25 | 42.7 | 43.1 | 0.4 | 0 | 0 |
| 26 | 47.7 | 47.8 | 0.1 | 0 | 0 |
| 27 | 53.0 | 53.1 | 0.0 | 0 | 3.1 |
| 28 | 52.7 | 52.8 | 0.1 | 0 | 2.8 |
| 29 | 51.2 | 51.3 | 0.1 | 0 | 1.3 |
| 30 | 46.0 | 46.8 | 0.8 | 0 | 0 |
| 31 | 45.7 | 46.0 | 0.3 | 0 | 0 |
| 32 | 47.8 | 48.0 | 0.2 | 0 | 0 |
| 33 | 49.1 | 49.2 | 0.1 | 0 | 0 |
| 34 | 51.6 | 51.6 | 0.1 | 0 | 1.6 |
| 35 | 47.5 | 47.8 | 0.3 | 0 | 0 |
| 36 | 39.1 | 40.8 | 1.7 | 0 | 0 |
| 37 | 49.3 | 49.6 | 0.3 | 0 | 0 |
| 38 | 47.2 | 47.7 | 0.5 | 0 | 0 |
| 39 | 31.9 | 38.1 | 6.2 | 0 | 0 |
| 40 | 32.6 | 38.8 | 6.2 | 0 | 0 |
| 41 | 33.1 | 39.7 | 6.5 | 0 | 0 |
| 42 | 32.0 | 39.1 | 7.1 | 0 | 0 |
| 43 | 31.9 | 38.5 | 6.5 | 0 | 0 |
| 44 | 22.0 | 34.5 | 12.5 | 0 | 0 |
| 45 | 21.8 | 34.4 | 12.6 | 0 | 0 |
| 46 | 21.4 | 34.8 | 13.4 | 0 | 0 |
| 47 | On open cast/stockpile/colliery boundary | | | | |
| 48 | 33.0 | 49.6 | 16.5 | 0 | 0 |
| 49 | 31.6 | 48.3 | 16.8 | 0 | 0 |
| 50 | 29.3 | 51.1 | 21.8 | 0 | 1.1 |
| 51 | 29.6 | 50.0 | 20.4 | 0 | 0 |
| 52 | 28.4 | 49.2 | 20.8 | 0 | 0 |
| 53 | 28.4 | 49.9 | 21.5 | 0 | 0 |
| 54 | 27.8 | 50.5 | 22.6 | 0 | 0.5 |
| 55 | 27.7 | 49.9 | 22.1 | 0 | 0 |
| 56 | 27.7 | 48.9 | 21.2 | 0 | 0 |
| 57 | 28.1 | 47.4 | 19.3 | 0 | 0 |
| 58 | 28.0 | 46.6 | 18.6 | 0 | 0 |
| 59 | 39.9 | 71.0 | 31.0 | 16.0 | 21.0 |
| 60 | 39.7 | 60.2 | 20.5 | 5.2 | 10.2 |
| 61 | 36.0 | 59.1 | 23.0 | 4.1 | 9.1 |
| 62 | On open cast/stockpile/colliery boundary | | | | |
| 63 | 29.8 | 55.6 | 25.8 | 0.6 | 5.6 |
| 64 | 31.3 | 51.2 | 20.0 | 0 | 1.2 |
| 65 | 32.5 | 49.6 | 17.2 | 0 | 0 |
| 66 | 26.7 | 43.6 | 16.9 | 0 | 0 |
| 67 | On open cast/stockpile/colliery boundary | | | | |
| 68 | 20.2 | 32.4 | 12.3 | 0 | 0 |
| 69 | 49.4 | 49.7 | 0.3 | 0 | 0 |
| 70 | 20.1 | 30.6 | 10.5 | 0 | 0 |
| 71 | 20.1 | 30.5 | 10.4 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| 72 | 20.0 | 30.5 | 10.4 | 0 | 0 |
| 73 | 20.0 | 30.7 | 10.7 | 0 | 0 |
| 74 | 20.0 | 30.7 | 10.6 | 0 | 0 |
| 75 | 20.0 | 30.7 | 10.6 | 0 | 0 |
| 76 | 20.0 | 30.7 | 10.7 | 0 | 0 |
| 77 | 20.0 | 30.8 | 10.8 | 0 | 0 |
| 78 | 36.3 | 39.1 | 2.8 | 0 | 0 |
| 79 | 29.3 | 34.7 | 5.3 | 0 | 0 |
| 80 | 31.7 | 35.7 | 4.0 | 0 | 0 |
| 81 | 27.7 | 34.6 | 6.9 | 0 | 0 |
| 82 | 20.8 | 48.2 | 27.4 | 0 | 0 |
| 83 | 20.7 | 44.3 | 23.6 | 0 | 0 |
| 84 | 20.7 | 42.9 | 22.2 | 0 | 0 |
| 85 | 38.9 | 52.7 | 13.7 | 0 | 0 |
| 86 | 20.0 | 31.7 | 11.7 | 0 | 0 |
| 87 | 20.0 | 31.6 | 11.6 | 0 | 0 |
| 88 | 20.0 | 31.5 | 11.5 | 0 | 0 |
| 89 | **On open cast/stockpile/colliery boundary** | | | | |
| 90 | | | | | |
| 91 | | | | | |
| 92 | | | | | |
| 93 | | | | | |
| 94 | | | | | |
| 95 | | | | | |
| 96 | | | | | |
| 97 | | | | | |
| 98 | | | | | |
| 99 | | | | | |
| 100 | | | | | |
| 101 | 20.0 | 31.7 | 11.7 | 0 | 0 |
| 102 | 45.3 | 46.1 | 0.8 | 0 | 0 |
| 103 | 46.8 | 47.3 | 0.5 | 0 | 0 |
| 104 | 45.8 | 46.0 | 0.2 | 0 | 0 |
| 105 | 35.2 | 37.1 | 1.9 | 0 | 0 |
| 106 | 32.6 | 61.8 | 29.3 | 6.8 | 0 |

**Defining Significance of Noise Impact (See Section 5)**

| Noise-sensitive development | Magnitude | Duration | Scale | Probability | Significance |
|---|---|---|---|---|---|
| 1 | 10 | 2 | 2 | 1 | 14 |
| 2 | **On open cast/stockpile/colliery boundary** | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | 10 | 2 | 2 | 2 | 28 |
| 6 | 10 | 2 | 2 | 2 | 28 |
| 7 | 10 | 2 | 2 | 1 | 14 |
| 8 | 10 | 2 | 2 | 1 | 14 |
| 9 | 10 | 2 | 2 | 1 | 14 |
| 10 | **On open cast/stockpile/colliery boundary** | | | | |
| 11 | | | | | |
| 12 | 4 | 2 | 2 | 2 | 16 |
| 13 | 6 | 2 | 2 | 2 | 20 |
| 14 | 6 | 2 | 2 | 1 | 10 |
| 15 | 10 | 2 | 2 | 2 | 28 |
| 16 | 10 | 2 | 2 | 1 | 14 |
| 17 | 4 | 2 | 2 | 1 | 8 |
| 18 | 10 | 2 | 2 | 1 | 14 |
| 19 | 2 | 2 | 2 | 1 | 6 |
| 20 | 4 | 2 | 2 | 1 | 8 |
| 21 | 6 | 2 | 2 | 1 | 10 |
| 22 | 8 | 2 | 2 | 2 | 24 |
| 23 | 6 | 2 | 2 | 1 | 10 |
| 24 | 2 | 2 | 2 | 1 | 6 |
| 25 | 2 | 2 | 2 | 1 | 6 |
| 26 | 2 | 2 | 2 | 1 | 6 |
| 27 | 4 | 2 | 2 | 1 | 8 |
| 28 | 2 | 2 | 2 | 1 | 6 |
| 29 | 2 | 2 | 2 | 1 | 6 |
| 30 | 2 | 2 | 2 | 1 | 6 |
| 31 | 2 | 2 | 2 | 1 | 6 |
| 32 | 2 | 2 | 2 | 1 | 6 |
| 33 | 2 | 2 | 2 | 1 | 6 |
| 34 | 2 | 2 | 2 | 1 | 6 |
| 35 | 2 | 2 | 2 | 1 | 6 |
| 36 | 2 | 2 | 2 | 1 | 6 |

| | | | | | |
|---|---|---|---|---|---|
| 37 | 2 | 2 | 2 | 1 | 6 |
| 38 | 2 | 2 | 2 | 1 | 6 |
| 39 | 6 | 2 | 2 | 1 | 10 |
| 40 | 6 | 2 | 2 | 1 | 10 |
| 41 | 6 | 2 | 2 | 1 | 10 |
| 42 | 8 | 2 | 2 | 1 | 12 |
| 43 | 6 | 2 | 2 | 1 | 10 |
| 44 | 10 | 2 | 2 | 1 | 14 |
| 45 | 10 | 2 | 2 | 1 | 14 |
| 46 | 10 | 2 | 2 | 1 | 14 |
| 47 | **On open cast/stockpile/colliery boundary** | | | | |
| 48 | 10 | 2 | 2 | 1 | 14 |
| 49 | 10 | 2 | 2 | 1 | 14 |
| 50 | 10 | 2 | 2 | 1 | 14 |
| 51 | 10 | 2 | 2 | 1 | 14 |
| 52 | 10 | 2 | 2 | 1 | 14 |
| 53 | 10 | 2 | 2 | 1 | 14 |
| 54 | 10 | 2 | 2 | 1 | 14 |
| 55 | 10 | 2 | 2 | 1 | 14 |
| 56 | 10 | 2 | 2 | 1 | 14 |
| 57 | 10 | 2 | 2 | 1 | 14 |
| 58 | 10 | 2 | 2 | 1 | 14 |
| 59 | 10 | 2 | 2 | 3 | 42 |
| 60 | 10 | 2 | 2 | 3 | 42 |
| 61 | 10 | 2 | 2 | 3 | 42 |
| 62 | **On open cast/stockpile/colliery boundary** | | | | |
| 63 | 10 | 2 | 2 | 2 | 28 |
| 64 | 10 | 2 | 2 | 1 | 14 |
| 65 | 10 | 2 | 2 | 1 | 14 |
| 66 | 10 | 2 | 2 | 2 | 28 |
| 67 | **On open cast/stockpile/colliery boundary** | | | | |
| 68 | 10 | 2 | 2 | 1 | 14 |
| 69 | 2 | 2 | 2 | 1 | 6 |
| 70 | 10 | 2 | 2 | 1 | 14 |
| 71 | 10 | 2 | 2 | 1 | 14 |
| 72 | 10 | 2 | 2 | 1 | 14 |
| 73 | 10 | 2 | 2 | 1 | 14 |
| 74 | 10 | 2 | 2 | 1 | 14 |
| 75 | 10 | 2 | 2 | 1 | 14 |
| 76 | 10 | 2 | 2 | 1 | 14 |
| 77 | 10 | 2 | 2 | 1 | 14 |
| 78 | 2 | 2 | 2 | 1 | 6 |
| 79 | 6 | 2 | 2 | 1 | 10 |
| 80 | 4 | 2 | 2 | 1 | 8 |
| 81 | 6 | 2 | 2 | 1 | 10 |
| 82 | 10 | 2 | 2 | 1 | 14 |
| 83 | 10 | 2 | 2 | 1 | 14 |
| 84 | 10 | 2 | 2 | 1 | 14 |
| 85 | 10 | 2 | 2 | 2 | 28 |
| 86 | 10 | 2 | 2 | 1 | 14 |
| 87 | 10 | 2 | 2 | 1 | 14 |
| 88 | 10 | 2 | 2 | 1 | 14 |
| 89 | **On open cast/stockpile/colliery boundary** | | | | |
| 90 | | | | | |
| 91 | | | | | |
| 92 | | | | | |
| 93 | | | | | |
| 94 | | | | | |
| 95 | | | | | |
| 96 | | | | | |
| 97 | | | | | |
| 98 | | | | | |
| 99 | | | | | |
| 100 | | | | | |
| 101 | 10 | 2 | 2 | 1 | 14 |
| 102 | 2 | 2 | 2 | 1 | 6 |
| 103 | 2 | 2 | 2 | 1 | 6 |
| 104 | 2 | 2 | 2 | 1 | 6 |
| 105 | 2 | 2 | 2 | 1 | 6 |
| 106 | 10 | 2 | 2 | 3 | 42 |

## Table D 2: Modelling results - night construction – peak hours

| Noise-sensitive development | Est. Ambient Sound Level ($L_{Aeq}$) | Calculated Noise Level (LReq,1 h) | Change from Ambient Sound Level (dBA) | Above Equator Principle IFC guideline | Above SANS 10103 Rating Level – 40 dBA |
|---|---|---|---|---|---|
| 1 | 26.2 | 40.6 | 14.4 | 0 | 0.6 |
| 2 | On open cast/stockpile/colliery boundary | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | 22.5 | 54.1 | 31.6 | 9.1 | 14.1 |
| 6 | 22.3 | 53.0 | 30.7 | 8.0 | 13.0 |
| 7 | 20.3 | 46.9 | 26.7 | 1.9 | 6.9 |
| 8 | 20.1 | 45.5 | 25.4 | 0.5 | 5.5 |
| 9 | 20.0 | 45.0 | 24.9 | 0 | 5.0 |
| 10 | On open cast/stockpile/colliery boundary | | | | |
| 11 | | | | | |
| 12 | 45.5 | 53.2 | 7.8 | 8.2 | 13.2 |
| 13 | 40.1 | 49.9 | 9.8 | 4.9 | 9.9 |
| 14 | 51.4 | 53.9 | 2.5 | 8.9 | 13.9 |
| 15 | 34.8 | 53.4 | 18.6 | 8.4 | 13.4 |
| 16 | 30.4 | 49.8 | 19.4 | 4.8 | 9.8 |
| 17 | 43.8 | 49.6 | 5.8 | 4.6 | 9.6 |
| 18 | 32.6 | 50.1 | 17.5 | 5.1 | 10.1 |
| 19 | 46.8 | 50.8 | 4.0 | 5.8 | 10.8 |
| 20 | 41.0 | 48.8 | 7.7 | 3.8 | 8.8 |
| 21 | 38.9 | 48.2 | 9.3 | 3.2 | 8.2 |
| 22 | 37.7 | 48.3 | 10.6 | 3.3 | 8.3 |
| 23 | 39.7 | 48.8 | 9.2 | 3.8 | 8.8 |
| 24 | 34.6 | 36.6 | 2.0 | 0 | 0 |
| 25 | 39.1 | 39.9 | 0.8 | 0 | 0 |
| 26 | 44.1 | 44.3 | 0.3 | 0 | 4.3 |
| 27 | 49.4 | 49.5 | 0.1 | 4.5 | 9.5 |
| 28 | 49.1 | 49.2 | 0.1 | 4.2 | 9.2 |
| 29 | 47.7 | 47.8 | 0.2 | 2.8 | 7.8 |
| 30 | 45.0 | 46.0 | 1.0 | 1.0 | 6.0 |
| 31 | 42.9 | 43.4 | 0.5 | 0 | 3.4 |
| 32 | 44.6 | 44.9 | 0.3 | 0 | 4.9 |
| 33 | 45.8 | 46.0 | 0.3 | 1.0 | 6.0 |
| 34 | 48.1 | 48.3 | 0.2 | 3.3 | 8.3 |
| 35 | 44.1 | 44.7 | 0.6 | 0 | 4.7 |
| 36 | 36.6 | 39.3 | 2.7 | 0 | 0 |
| 37 | 45.7 | 46.2 | 0.6 | 1.2 | 6.2 |
| 38 | 43.6 | 44.6 | 1.1 | 0 | 4.6 |
| 39 | 28.6 | 37.5 | 8.9 | 0 | 0 |
| 40 | 29.3 | 38.2 | 9.0 | 0 | 0 |
| 41 | 29.7 | 39.1 | 9.4 | 0 | 0 |
| 42 | 28.7 | 38.6 | 9.9 | 0 | 0 |
| 43 | 28.6 | 37.9 | 9.3 | 0 | 0 |
| 44 | 21.0 | 34.5 | 13.5 | 0 | 0 |
| 45 | 20.9 | 34.4 | 13.5 | 0 | 0 |
| 46 | 20.7 | 34.8 | 14.1 | 0 | 0 |
| 47 | On open cast/stockpile/colliery boundary | | | | |
| 48 | 29.6 | 49.5 | 19.9 | 4.5 | 9.5 |
| 49 | 28.3 | 48.3 | 20.0 | 3.3 | 8.3 |
| 50 | 26.3 | 51.1 | 24.8 | 6.1 | 11.1 |
| 51 | 26.5 | 50.0 | 23.5 | 5.0 | 10.0 |
| 52 | 25.5 | 49.1 | 23.7 | 4.1 | 9.1 |
| 53 | 25.5 | 49.9 | 24.4 | 4.9 | 9.9 |
| 54 | 25.0 | 50.5 | 25.4 | 5.5 | 10.5 |
| 55 | 25.0 | 49.9 | 24.9 | 4.9 | 9.9 |
| 56 | 24.9 | 48.9 | 24.0 | 3.9 | 8.9 |
| 57 | 25.2 | 47.3 | 22.1 | 2.3 | 7.3 |
| 58 | 25.2 | 46.6 | 21.4 | 1.6 | 6.6 |
| 59 | 36.3 | 71.0 | 34.6 | 26.0 | 31.0 |
| 60 | 36.1 | 60.2 | 24.1 | 15.2 | 20.2 |
| 61 | 32.5 | 59.0 | 26.5 | 14.0 | 19.0 |
| 62 | On open cast/stockpile/colliery boundary | | | | |
| 63 | 26.7 | 55.6 | 28.9 | 10.6 | 15.6 |
| 64 | 28.0 | 51.2 | 23.2 | 6.2 | 11.2 |
| 65 | 29.1 | 49.6 | 20.5 | 4.6 | 9.6 |
| 66 | 24.1 | 43.5 | 19.4 | 0 | 3.5 |
| 67 | On open cast/stockpile/colliery boundary | | | | |
| 68 | 20.1 | 32.4 | 12.3 | 0 | 0 |
| 69 | 49.4 | 49.7 | 0.3 | 4.7 | 9.7 |
| 70 | 20.0 | 30.6 | 10.5 | 0 | 0 |
| 71 | 20.0 | 30.5 | 10.5 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| 72 | 20.0 | 30.5 | 10.4 | 0 | 0 |
| 73 | 20.0 | 30.7 | 10.7 | 0 | 0 |
| 74 | 20.0 | 30.7 | 10.6 | 0 | 0 |
| 75 | 20.0 | 30.7 | 10.6 | 0 | 0 |
| 76 | 20.0 | 30.7 | 10.7 | 0 | 0 |
| 77 | 20.0 | 30.8 | 10.8 | 0 | 0 |
| 78 | 36.3 | 39.1 | 2.8 | 0 | 0 |
| 79 | 29.3 | 34.6 | 5.4 | 0 | 0 |
| 80 | 31.6 | 35.7 | 4.1 | 0 | 0 |
| 81 | 27.6 | 34.5 | 6.9 | 0 | 0 |
| 82 | 20.4 | 48.2 | 27.9 | 3.2 | 8.2 |
| 83 | 20.3 | 44.3 | 24.0 | 0 | 4.3 |
| 84 | 20.3 | 42.9 | 22.5 | 0 | 2.9 |
| 85 | 35.3 | 52.6 | 17.2 | 7.6 | 12.6 |
| 86 | 20.0 | 31.7 | 11.7 | 0 | 0 |
| 87 | 20.0 | 31.6 | 11.6 | 0 | 0 |
| 88 | 20.0 | 31.5 | 11.5 | 0 | 0 |
| 89 | **On open cast/stockpile/colliery boundary** | | | | |
| 90 | | | | | |
| 91 | | | | | |
| 92 | | | | | |
| 93 | | | | | |
| 94 | | | | | |
| 95 | | | | | |
| 96 | | | | | |
| 97 | | | | | |
| 98 | | | | | |
| 99 | | | | | |
| 100 | | | | | |
| 101 | 20.0 | 31.7 | 11.7 | 0 | 0 |
| 102 | 41.7 | 46.1 | 4.4 | 1.1 | 6.1 |
| 103 | 43.2 | 47.3 | 4.1 | 2.3 | 7.3 |
| 104 | 42.1 | 46.0 | 3.9 | 1.0 | 6.0 |
| 105 | 31.7 | 37.1 | 5.4 | 0 | 0 |
| 106 | 29.2 | 61.8 | 32.6 | 16.8 | 21.8 |
| **Defining Significance of Noise Impact (See Section 5)** | | | | | |
| **Noise-sensitive development** | **Magnitude** | **Duration** | **Scale** | **Probability** | **Significance** |
| 1 | 10 | 2 | 2 | 2 | **28** |
| 2 | **On open cast/stockpile/colliery boundary** | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | 10 | 2 | 2 | 3 | **42** |
| 6 | 10 | 2 | 2 | 3 | **42** |
| 7 | 10 | 2 | 2 | 2 | **28** |
| 8 | 10 | 2 | 2 | 2 | **28** |
| 9 | 10 | 2 | 2 | 2 | **28** |
| 10 | **On open cast/stockpile/colliery boundary** | | | | |
| 11 | | | | | |
| 12 | 10 | 2 | 2 | 3 | **42** |
| 13 | 8 | 2 | 2 | 3 | **36** |
| 14 | 10 | 2 | 2 | 3 | **42** |
| 15 | 10 | 2 | 2 | 3 | **42** |
| 16 | 10 | 2 | 2 | 3 | **42** |
| 17 | 8 | 2 | 2 | 3 | **36** |
| 18 | 10 | 2 | 2 | 3 | **42** |
| 19 | 10 | 2 | 2 | 3 | **42** |
| 20 | 8 | 2 | 2 | 3 | **36** |
| 21 | 8 | 2 | 2 | 3 | **36** |
| 22 | 10 | 2 | 2 | 3 | **42** |
| 23 | 8 | 2 | 2 | 3 | **36** |
| 24 | 2 | 2 | 2 | 1 | **6** |
| 25 | 2 | 2 | 2 | 1 | **6** |
| 26 | 2 | 2 | 2 | 1 | **6** |
| 27 | 8 | 2 | 2 | 1 | **12** |
| 28 | 8 | 2 | 2 | 1 | **12** |
| 29 | 8 | 2 | 2 | 1 | **12** |
| 30 | 6 | 2 | 2 | 1 | **10** |
| 31 | 4 | 2 | 2 | 1 | **8** |
| 32 | 4 | 2 | 2 | 1 | **8** |
| 33 | 6 | 2 | 2 | 1 | **10** |
| 34 | 8 | 2 | 2 | 1 | **12** |
| 35 | 4 | 2 | 2 | 1 | **8** |
| 36 | 2 | 2 | 2 | 1 | **6** |

| | | | | | |
|---|---|---|---|---|---|
| 37 | 6 | 2 | 2 | 1 | **10** |
| 38 | 4 | 2 | 2 | 1 | **8** |
| 39 | 8 | 2 | 2 | 1 | **12** |
| 40 | 8 | 2 | 2 | 1 | **12** |
| 41 | 8 | 2 | 2 | 1 | **12** |
| 42 | 8 | 2 | 2 | 1 | **12** |
| 43 | 8 | 2 | 2 | 1 | **12** |
| 44 | 10 | 2 | 2 | 1 | **14** |
| 45 | 10 | 2 | 2 | 1 | **14** |
| 46 | 10 | 2 | 2 | 1 | **14** |
| 47 | **On open cast/stockpile/colliery boundary** | | | | |
| 48 | 10 | 2 | 2 | 3 | **42** |
| 49 | 10 | 2 | 2 | 3 | **42** |
| 50 | 10 | 2 | 2 | 3 | **42** |
| 51 | 10 | 2 | 2 | 3 | **42** |
| 52 | 10 | 2 | 2 | 3 | **42** |
| 53 | 10 | 2 | 2 | 3 | **42** |
| 54 | 10 | 2 | 2 | 3 | **42** |
| 55 | 10 | 2 | 2 | 3 | **42** |
| 56 | 10 | 2 | 2 | 3 | **42** |
| 57 | 10 | 2 | 2 | 3 | **42** |
| 58 | 10 | 2 | 2 | 3 | **42** |
| 59 | 10 | 2 | 2 | 4 | **56** |
| 60 | 10 | 2 | 2 | 4 | **56** |
| 61 | 10 | 2 | 2 | 4 | **56** |
| 62 | **On open cast/stockpile/colliery boundary** | | | | |
| 63 | 10 | 2 | 2 | 3 | **42** |
| 64 | 10 | 2 | 2 | 3 | **42** |
| 65 | 10 | 2 | 2 | 3 | **42** |
| 66 | 10 | 2 | 2 | 3 | **42** |
| 67 | **On open cast/stockpile/colliery boundary** | | | | |
| 68 | 10 | 2 | 2 | 1 | **14** |
| 69 | 8 | 2 | 2 | 1 | **12** |
| 70 | 10 | 2 | 2 | 1 | **14** |
| 71 | 10 | 2 | 2 | 1 | **14** |
| 72 | 10 | 2 | 2 | 1 | **14** |
| 73 | 10 | 2 | 2 | 1 | **14** |
| 74 | 10 | 2 | 2 | 1 | **14** |
| 75 | 10 | 2 | 2 | 1 | **14** |
| 76 | 10 | 2 | 2 | 1 | **14** |
| 77 | 10 | 2 | 2 | 1 | **14** |
| 78 | 2 | 2 | 2 | 1 | **6** |
| 79 | 6 | 2 | 2 | 1 | **10** |
| 80 | 4 | 2 | 2 | 1 | **8** |
| 81 | 6 | 2 | 2 | 1 | **10** |
| 82 | 10 | 2 | 2 | 3 | **42** |
| 83 | 10 | 2 | 2 | 2 | **28** |
| 84 | 10 | 2 | 2 | 2 | **28** |
| 85 | 10 | 2 | 2 | 3 | **42** |
| 86 | 10 | 2 | 2 | 1 | **14** |
| 87 | 10 | 2 | 2 | 1 | **14** |
| 88 | 10 | 2 | 2 | 1 | **14** |
| 89 | **On open cast/stockpile/colliery boundary** | | | | |
| 90 | | | | | |
| 91 | | | | | |
| 92 | | | | | |
| 93 | | | | | |
| 94 | | | | | |
| 95 | | | | | |
| 96 | | | | | |
| 97 | | | | | |
| 98 | | | | | |
| 99 | | | | | |
| 100 | | | | | |
| 101 | 10 | 2 | 2 | 1 | **14** |
| 102 | 6 | 2 | 2 | 2 | **20** |
| 103 | 8 | 2 | 2 | 2 | **24** |
| 104 | 6 | 2 | 2 | 2 | **20** |
| 105 | 6 | 2 | 2 | 1 | **10** |
| 106 | 10 | 2 | 2 | 4 | **56** |

## Table D 3: Modelling results - day operational – peak hours

| Noise-sensitive development | Est. Ambient Sound Level ($L_{Aeq}$) | Calculated Noise Level (LReq,1 h) | Change from Ambient Sound Level (dBA) | Above Equator Principle IFC guideline | Above SANS 10103 Rating Level – 50 dBA |
|---|---|---|---|---|---|
| 1 | 29.2 | 40.8 | 11.6 | 0 | 0 |
| 2 | On open cast/stockpile/colliery boundary | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | 24.4 | 61.7 | 37.3 | 6.7 | 11.7 |
| 6 | 24.2 | 52.5 | 28.3 | 0 | 2.5 |
| 7 | 20.6 | 51.9 | 31.3 | 0 | 1.9 |
| 8 | 20.3 | 52.0 | 31.8 | 0 | 2.0 |
| 9 | 20.1 | 52.8 | 32.7 | 0 | 2.8 |
| 10 | On open cast/stockpile/colliery boundary | | | | |
| 11 | | | | | |
| 12 | 49.1 | 56.7 | 7.5 | 1.7 | 6.7 |
| 13 | 43.8 | 53.9 | 10.1 | 0 | 3.9 |
| 14 | 55.0 | 56.9 | 1.8 | 1.9 | 6.9 |
| 15 | 38.3 | 48.6 | 10.3 | 0 | 0 |
| 16 | 33.9 | 53.4 | 19.6 | 0 | 3.4 |
| 17 | 47.5 | 50.2 | 2.8 | 0 | 0.2 |
| 18 | 36.1 | 50.0 | 13.9 | 0 | 0.0 |
| 19 | 50.5 | 52.6 | 2.1 | 0 | 2.6 |
| 20 | 44.7 | 48.3 | 3.6 | 0 | 0 |
| 21 | 42.6 | 47.4 | 4.8 | 0 | 0 |
| 22 | 41.3 | 47.1 | 5.8 | 0 | 0 |
| 23 | 43.3 | 47.6 | 4.3 | 0 | 0 |
| 24 | 38.2 | 42.39 | 4.2 | 0 | 0 |
| 25 | 42.7 | 45.1 | 2.4 | 0 | 0 |
| 26 | 47.7 | 49.48 | 1.8 | 0 | 0 |
| 27 | 53.0 | 54.7 | 1.6 | 0 | 4.7 |
| 28 | 52.7 | 54.4 | 1.6 | 0 | 4.4 |
| 29 | 51.2 | 52.9 | 1.7 | 0 | 2.9 |
| 30 | 46.0 | 47.7 | 1.7 | 0 | 0 |
| 31 | 45.7 | 47.3 | 1.7 | 0 | 0 |
| 32 | 47.8 | 49.5 | 1.6 | 0 | 0 |
| 33 | 49.1 | 50.83 | 1.7 | 0 | 0.8 |
| 34 | 51.6 | 53.2 | 1.6 | 0 | 3.2 |
| 35 | 47.5 | 49.2 | 1.7 | 0 | 0 |
| 36 | 39.1 | 41.7 | 2.5 | 0 | 0 |
| 37 | 49.3 | 51.0 | 1.7 | 0 | 1.0 |
| 38 | 47.2 | 48.9 | 1.7 | 0 | 0 |
| 39 | 31.9 | 37.6 | 5.7 | 0 | 0 |
| 40 | 32.6 | 37.9 | 5.3 | 0 | 0 |
| 41 | 33.1 | 38.1 | 4.9 | 0 | 0 |
| 42 | 32.0 | 37.6 | 5.6 | 0 | 0 |
| 43 | 31.9 | 37.6 | 5.7 | 0 | 0 |
| 44 | 22.0 | 35.9 | 13.8 | 0 | 0 |
| 45 | 21.8 | 35.8 | 14.0 | 0 | 0 |
| 46 | 21.4 | 35.7 | 14.3 | 0 | 0 |
| 47 | On open cast/stockpile/colliery boundary | | | | |
| 48 | 33.0 | 39.7 | 6.6 | 0 | 0 |
| 49 | 31.6 | 39.0 | 7.4 | 0 | 0 |
| 50 | 29.3 | 41.8 | 12.5 | 0 | 0 |
| 51 | 29.6 | 39.0 | 9.5 | 0 | 0 |
| 52 | 28.4 | 40.6 | 12.2 | 0 | 0 |
| 53 | 28.4 | 40.8 | 12.4 | 0 | 0 |
| 54 | 27.8 | 40.8 | 13.0 | 0 | 0 |
| 55 | 27.7 | 40.5 | 12.8 | 0 | 0 |
| 56 | 27.7 | 40.2 | 12.5 | 0 | 0 |
| 57 | 28.1 | 38.2 | 10.1 | 0 | 0 |
| 58 | 28.0 | 38.0 | 10.0 | 0 | 0 |
| 59 | 39.9 | 53.9 | 13.9 | 0 | 3.9 |
| 60 | 39.7 | 58.3 | 18.5 | 3.3 | 8.3 |
| 61 | 36.0 | 55.3 | 19.3 | 0.3 | 5.3 |
| 62 | On open cast/stockpile/colliery boundary | | | | |
| 63 | 29.8 | 58.1 | 28.3 | 3.1 | 8.1 |
| 64 | 31.3 | 54.7 | 23.5 | 0 | 4.7 |
| 65 | 32.5 | 53.3 | 20.8 | 0 | 3.3 |
| 66 | 26.7 | 58.7 | 32.0 | 3.7 | 8.7 |
| 67 | On open cast/stockpile/colliery boundary | | | | |
| 68 | 20.2 | 39.5 | 19.3 | 0 | 0 |
| 69 | 49.4 | 50.0 | 0.6 | 0 | 0.0 |
| 70 | 20.1 | 37.5 | 17.4 | 0 | 0 |
| 71 | 20.1 | 37.3 | 17.2 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| 72 | 20.0 | 36.5 | 16.4 | 0 | 0 |
| 73 | 20.0 | 35.9 | 15.9 | 0 | 0 |
| 74 | 20.0 | 35.9 | 15.9 | 0 | 0 |
| 75 | 20.0 | 35.9 | 15.9 | 0 | 0 |
| 76 | 20.0 | 35.9 | 15.9 | 0 | 0 |
| 77 | 20.0 | 35.7 | 15.6 | 0 | 0 |
| 78 | 36.3 | 42.0 | 5.6 | 0 | 0 |
| 79 | 29.3 | 41.1 | 11.7 | 0 | 0 |
| 80 | 31.7 | 41.1 | 9.4 | 0 | 0 |
| 81 | 27.7 | 41.9 | 14.2 | 0 | 0 |
| 82 | 20.8 | 57.5 | 36.7 | 2.5 | 7.5 |
| 83 | 20.7 | 53.7 | 33.0 | 0 | 3.7 |
| 84 | 20.7 | 52.2 | 31.5 | 0 | 2.2 |
| 85 | 38.9 | 49.0 | 10.1 | 0 | 0 |
| 86 | 20.0 | 38.8 | 18.8 | 0 | 0 |
| 87 | 20.0 | 38.7 | 18.7 | 0 | 0 |
| 88 | 20.0 | 38.7 | 18.6 | 0 | 0 |
| 89 | **On open cast/stockpile/colliery boundary** | | | | |
| 90 | | | | | |
| 91 | | | | | |
| 92 | | | | | |
| 93 | | | | | |
| 94 | | | | | |
| 95 | | | | | |
| 96 | | | | | |
| 97 | | | | | |
| 98 | | | | | |
| 99 | | | | | |
| 100 | | | | | |
| 101 | 20.0 | 39.3 | 19.2 | 0 | 0 |
| 102 | 45.3 | 47.8 | 2.5 | 0 | 0 |
| 103 | 46.8 | 49.1 | 2.2 | 0 | 0 |
| 104 | 45.8 | 48.2 | 2.4 | 0 | 0 |
| 105 | 35.2 | 39.0 | 3.8 | 0 | 0 |
| 106 | 32.6 | 56.8 | 24.2 | 1.8 | 6.8 |

**Defining Significance of Noise Impact**
**(See Section 5)**

| Noise-sensitive development | Magnitude | Duration | Scale | Probability | Significance |
|---|---|---|---|---|---|
| 1 | 10 | 4 | 2 | 1 | **16** |
| 2 | **On open cast/stockpile/colliery boundary** | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | 10 | 4 | 2 | 3 | **48** |
| 6 | 10 | 4 | 2 | 2 | **32** |
| 7 | 10 | 4 | 2 | 2 | **32** |
| 8 | 10 | 4 | 2 | 2 | **32** |
| 9 | 10 | 4 | 2 | 2 | **32** |
| 10 | **On open cast/stockpile/colliery boundary** | | | | |
| 11 | | | | | |
| 12 | 8 | 4 | 2 | 3 | **42** |
| 13 | 10 | 4 | 2 | 2 | **32** |
| 14 | 6 | 4 | 2 | 3 | **36** |
| 15 | 10 | 4 | 2 | 2 | **32** |
| 16 | 10 | 4 | 2 | 2 | **32** |
| 17 | 2 | 4 | 2 | 1 | **8** |
| 18 | 10 | 4 | 2 | 2 | **32** |
| 19 | 2 | 4 | 2 | 1 | **8** |
| 20 | 4 | 4 | 2 | 1 | **10** |
| 21 | 4 | 4 | 2 | 1 | **10** |
| 22 | 6 | 4 | 2 | 1 | **12** |
| 23 | 4 | 4 | 2 | 1 | **10** |
| 24 | 4 | 4 | 2 | 1 | **10** |
| 25 | 2 | 4 | 2 | 1 | **8** |
| 26 | 2 | 4 | 2 | 1 | **8** |
| 27 | 4 | 4 | 2 | 1 | **10** |
| 28 | 4 | 4 | 2 | 1 | **10** |
| 29 | 2 | 4 | 2 | 1 | **8** |
| 30 | 2 | 4 | 2 | 1 | **8** |
| 31 | 2 | 4 | 2 | 1 | **8** |
| 32 | 2 | 4 | 2 | 1 | **8** |
| 33 | 2 | 4 | 2 | 1 | **8** |
| 34 | 4 | 4 | 2 | 1 | **10** |
| 35 | 2 | 4 | 2 | 1 | **8** |
| 36 | 2 | 4 | 2 | 1 | **8** |

| | | | | | |
|---|---|---|---|---|---|
| 37 | 2 | 4 | 2 | 1 | **8** |
| 38 | 2 | 4 | 2 | 1 | **8** |
| 39 | 6 | 4 | 2 | 1 | **12** |
| 40 | 6 | 4 | 2 | 1 | **12** |
| 41 | 4 | 4 | 2 | 1 | **10** |
| 42 | 4 | 4 | 2 | 1 | **10** |
| 43 | 4 | 4 | 2 | 1 | **10** |
| 44 | 10 | 4 | 2 | 1 | **16** |
| 45 | 10 | 4 | 2 | 1 | **16** |
| 46 | 10 | 4 | 2 | 1 | **16** |
| 47 | **On open cast/stockpile/colliery boundary** | | | | |
| 48 | 6 | 4 | 2 | 1 | **12** |
| 49 | 8 | 4 | 2 | 1 | **14** |
| 50 | 10 | 4 | 2 | 2 | **32** |
| 51 | 8 | 4 | 2 | 2 | **28** |
| 52 | 10 | 4 | 2 | 2 | **32** |
| 53 | 10 | 4 | 2 | 2 | **32** |
| 54 | 10 | 4 | 2 | 2 | **32** |
| 55 | 10 | 4 | 2 | 2 | **32** |
| 56 | 10 | 4 | 2 | 2 | **32** |
| 57 | 10 | 4 | 2 | 2 | **32** |
| 58 | 10 | 4 | 2 | 2 | **32** |
| 59 | 10 | 4 | 2 | 2 | **32** |
| 60 | 10 | 4 | 2 | 3 | **48** |
| 61 | 10 | 4 | 2 | 2 | **32** |
| 62 | **On open cast/stockpile/colliery boundary** | | | | |
| 63 | 10 | 4 | 2 | 3 | **48** |
| 64 | 10 | 4 | 2 | 2 | **32** |
| 65 | 10 | 4 | 2 | 2 | **32** |
| 66 | 10 | 4 | 2 | 3 | **48** |
| 67 | **On open cast/stockpile/colliery boundary** | | | | |
| 68 | 10 | 4 | 2 | 1 | **16** |
| 69 | 2 | 4 | 2 | 1 | **8** |
| 70 | 10 | 4 | 2 | 1 | **16** |
| 71 | 10 | 4 | 2 | 1 | **16** |
| 72 | 10 | 4 | 2 | 1 | **16** |
| 73 | 10 | 4 | 2 | 1 | **16** |
| 74 | 10 | 4 | 2 | 1 | **16** |
| 75 | 10 | 4 | 2 | 1 | **16** |
| 76 | 10 | 4 | 2 | 1 | **16** |
| 77 | 10 | 4 | 2 | 1 | **16** |
| 78 | 6 | 4 | 2 | 1 | **12** |
| 79 | 2 | 4 | 2 | 1 | **8** |
| 80 | 8 | 4 | 2 | 1 | **14** |
| 81 | 10 | 4 | 2 | 1 | **16** |
| 82 | 10 | 4 | 2 | 2 | **32** |
| 83 | 10 | 4 | 2 | 1 | **16** |
| 84 | 10 | 4 | 2 | 1 | **16** |
| 85 | 10 | 4 | 2 | 1 | **16** |
| 86 | 10 | 4 | 2 | 1 | **16** |
| 87 | 10 | 4 | 2 | 1 | **16** |
| 88 | 10 | 4 | 2 | 1 | **16** |
| 89 | **On open cast/stockpile/colliery boundary** | | | | |
| 90 | | | | | |
| 91 | | | | | |
| 92 | | | | | |
| 93 | | | | | |
| 94 | | | | | |
| 95 | | | | | |
| 96 | | | | | |
| 97 | | | | | |
| 98 | | | | | |
| 99 | | | | | |
| 100 | | | | | |
| 101 | 10 | 4 | 2 | 1 | **16** |
| 102 | 2 | 4 | 2 | 1 | **8** |
| 103 | 2 | 4 | 2 | 1 | **8** |
| 104 | 2 | 4 | 2 | 1 | **8** |
| 105 | 4 | 4 | 2 | 1 | **10** |
| 106 | 10 | 4 | 2 | 2 | **32** |

## Table D 4: Modelling results - night operational – peak hours

| Noise-sensitive development | Est. Ambient Sound Level ($L_{Aeq}$) | Calculated Noise Level (LReq,1 h) | Change from Ambient Sound Level (dBA) | Above Equator Principle IFC guideline | Above SANS 10103 Rating Level |
|---|---|---|---|---|---|
| 1 | 26.2 | 40.7 | 14.5 | 0 | 26.2 |
| 2 | On open cast/stockpile/colliery boundary | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | 22.5 | 61.7 | 39.2 | 16.7 | 21.7 |
| 6 | 22.3 | 52.5 | 30.1 | 7.5 | 12.5 |
| 7 | 20.3 | 51.9 | 31.6 | 6.9 | 11.9 |
| 8 | 20.1 | 52.0 | 31.9 | 7.0 | 12.0 |
| 9 | 20.0 | 52.8 | 32.8 | 7.8 | 12.8 |
| 10 | On open cast/stockpile/colliery boundary | | | | |
| 11 | | | | | |
| 12 | 45.5 | 56.2 | 10.7 | 11.2 | 16.2 |
| 13 | 40.1 | 53.7 | 13.5 | 8.7 | 13.7 |
| 14 | 51.4 | 54.8 | 3.5 | 9.8 | 14.8 |
| 15 | 34.8 | 48.4 | 13.6 | 3.4 | 8.4 |
| 16 | 30.4 | 53.4 | 23.0 | 8.4 | 13.4 |
| 17 | 43.8 | 48.7 | 4.9 | 3.7 | 8.7 |
| 18 | 32.6 | 49.9 | 17.4 | 4.9 | 9.9 |
| 19 | 46.8 | 50.7 | 3.9 | 5.7 | 10.7 |
| 20 | 41.0 | 47.1 | 6.1 | 2.1 | 7.1 |
| 21 | 38.9 | 46.4 | 7.5 | 1.4 | 6.4 |
| 22 | 37.7 | 46.4 | 8.7 | 1.4 | 6.4 |
| 23 | 39.7 | 46.5 | 6.9 | 1.5 | 6.5 |
| 24 | 34.6 | 41.4 | 6.7 | 0 | 1.4 |
| 25 | 39.1 | 43.4 | 4.3 | 0 | 3.4 |
| 26 | 44.1 | 47.5 | 3.4 | 2.5 | 7.5 |
| 27 | 49.4 | 52.5 | 3.1 | 7.5 | 12.5 |
| 28 | 49.1 | 52.2 | 3.1 | 7.2 | 12.2 |
| 29 | 47.7 | 50.8 | 3.1 | 5.8 | 10.8 |
| 30 | 45.0 | 47.0 | 2.0 | 2.0 | 7.0 |
| 31 | 42.9 | 45.9 | 3.0 | 0.9 | 5.9 |
| 32 | 44.6 | 47.7 | 3.1 | 2.7 | 7.7 |
| 33 | 45.8 | 48.9 | 3.1 | 3.9 | 8.9 |
| 34 | 48.1 | 51.2 | 3.1 | 6.2 | 11.2 |
| 35 | 44.1 | 47.2 | 3.2 | 2.2 | 7.2 |
| 36 | 36.6 | 40.4 | 3.8 | 0 | 0.4 |
| 37 | 45.7 | 48.8 | 3.2 | 3.8 | 8.8 |
| 38 | 43.6 | 46.9 | 3.3 | 1.9 | 6.9 |
| 39 | 28.6 | 37.0 | 8.3 | 0 | 0 |
| 40 | 29.3 | 37.1 | 7.9 | 0 | 0 |
| 41 | 29.7 | 37.2 | 7.5 | 0 | 0 |
| 42 | 28.7 | 36.9 | 8.2 | 0 | 0 |
| 43 | 28.6 | 36.9 | 8.3 | 0 | 0 |
| 44 | 21.0 | 35.8 | 14.8 | 0 | 0 |
| 45 | 20.9 | 36.7 | 15.8 | 0 | 0 |
| 46 | 20.7 | 35.7 | 15.0 | 0 | 0 |
| 47 | On open cast/stockpile/colliery boundary | | | | |
| 48 | 29.6 | 39.1 | 9.5 | 0 | 0 |
| 49 | 28.3 | 38.5 | 10.2 | 0 | 0 |
| 50 | 26.3 | 41.6 | 15.4 | 0 | 1.6 |
| 51 | 26.5 | 38.8 | 12.3 | 0 | |
| 52 | 25.5 | 40.4 | 15.0 | 0 | 0.4 |
| 53 | 25.5 | 40.7 | 15.2 | 0 | 0.7 |
| 54 | 25.0 | 40.7 | 15.7 | 0 | 0.7 |
| 55 | 25.0 | 40.4 | 15.5 | 0 | 0.4 |
| 56 | 24.9 | 40.1 | 15.2 | 0 | 0.1 |
| 57 | 25.2 | 38.0 | 12.8 | 0 | 0 |
| 58 | 25.2 | 37.8 | 12.6 | 0 | 0 |
| 59 | 36.3 | 53.8 | 17.5 | 8.8 | 13.8 |
| 60 | 36.1 | 58.2 | 22.1 | 13.2 | 18.2 |
| 61 | 32.5 | 55.3 | 22.8 | 10.3 | 15.3 |
| 62 | On open cast/stockpile/colliery boundary | | | | |
| 63 | 26.7 | 58.1 | 31.4 | 13.1 | 18.1 |
| 64 | 28.0 | 54.7 | 26.7 | 9.7 | 14.7 |
| 65 | 29.1 | 53.3 | 24.1 | 8.3 | 13.3 |
| 66 | 24.1 | 58.7 | 34.6 | 13.7 | 18.7 |
| 67 | On open cast/stockpile/colliery boundary | | | | |
| 68 | 20.1 | 39.5 | 19.4 | 0 | 0 |
| 69 | 49.4 | 49.9 | 0.6 | 4.9 | 9.9 |
| 70 | 20.0 | 37.5 | 17.5 | 0 | 0 |
| 71 | 20.0 | 37.3 | 17.2 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| 72 | 20.0 | 36.5 | 16.4 | 0 | 0 |
| 73 | 20.0 | 35.9 | 15.9 | 0 | 0 |
| 74 | 20.0 | 35.9 | 15.9 | 0 | 0 |
| 75 | 20.0 | 35.9 | 15.9 | 0 | 0 |
| 76 | 20.0 | 35.9 | 15.9 | 0 | 0 |
| 77 | 20.0 | 35.7 | 15.6 | 0 | 0 |
| 78 | 36.3 | 42.0 | 5.7 | 0 | 2.0 |
| 79 | 29.3 | 41.1 | 11.8 | 0 | 1.1 |
| 80 | 31.6 | 41.1 | 9.4 | 0 | 1.1 |
| 81 | 27.6 | 41.9 | 14.3 | 0 | 1.9 |
| 82 | 20.4 | 57.5 | 37.1 | 12.5 | 17.5 |
| 83 | 20.3 | 53.7 | 33.4 | 8.7 | 13.7 |
| 84 | 20.3 | 52.2 | 31.9 | 7.2 | 12.2 |
| 85 | 35.3 | 48.7 | 13.4 | 3.7 | 8.7 |
| 86 | 20.0 | 38.8 | 18.8 | 0 | 0 |
| 87 | 20.0 | 38.7 | 18.7 | 0 | 0 |
| 88 | 20.0 | 38.7 | 18.6 | 0 | 0 |
| 89 | **On open cast/stockpile/colliery boundary** | | | | |
| 90 | | | | | |
| 91 | | | | | |
| 92 | | | | | |
| 93 | | | | | |
| 94 | | | | | |
| 95 | | | | | |
| 96 | | | | | |
| 97 | | | | | |
| 98 | | | | | |
| 99 | | | | | |
| 100 | | | | | |
| 101 | 20.0 | 31.7 | 11.7 | 0 | 0 |
| 102 | 41.7 | 43.3 | 1.6 | 0 | 3.3 |
| 103 | 43.2 | 44.2 | 1.1 | 0 | 4.2 |
| 104 | 42.1 | 42.6 | 0.5 | 0 | 2.6 |
| 105 | 31.7 | 35.2 | 3.5 | 0 | 0 |
| 106 | 29.2 | 61.8 | 32.6 | 16.8 | 21.8 |

| **Defining Significance of Noise Impact (See Section 5)** | | | | | |
|---|---|---|---|---|---|
| **Noise-sensitive development** | **Magnitude** | **Duration** | **Scale** | **Probability** | **Significance** |
| 1 | 10 | 4 | 2 | 1 | **16** |
| 2 | **On open cast/stockpile/colliery boundary** | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | 10 | 4 | 2 | 4 | **64** |
| 6 | 10 | 4 | 2 | 4 | **64** |
| 7 | 10 | 4 | 2 | 3 | **48** |
| 8 | 10 | 4 | 2 | 2 | **32** |
| 9 | 10 | 4 | 2 | 2 | **32** |
| 10 | **On open cast/stockpile/colliery boundary** | | | | |
| 11 | | | | | |
| 12 | 10 | 4 | 2 | 4 | **64** |
| 13 | 10 | 4 | 2 | 4 | **64** |
| 14 | 10 | 4 | 2 | 3 | **48** |
| 15 | 10 | 4 | 2 | 3 | **48** |
| 16 | 10 | 4 | 2 | 3 | **48** |
| 17 | 8 | 4 | 2 | 3 | **42** |
| 18 | 10 | 4 | 2 | 4 | **64** |
| 19 | 10 | 4 | 2 | 2 | **32** |
| 20 | 8 | 4 | 2 | 3 | **42** |
| 21 | 8 | 4 | 2 | 3 | **42** |
| 22 | 8 | 4 | 2 | 3 | **42** |
| 23 | 6 | 4 | 2 | 3 | **36** |
| 24 | 6 | 4 | 2 | 2 | **24** |
| 25 | 4 | 4 | 2 | 1 | **10** |
| 26 | 8 | 4 | 2 | 1 | **14** |
| 27 | 10 | 4 | 2 | 1 | **16** |
| 28 | 10 | 4 | 2 | 1 | **16** |
| 29 | 10 | 4 | 2 | 1 | **16** |
| 30 | 8 | 4 | 2 | 1 | **14** |
| 31 | 6 | 4 | 2 | 1 | **12** |
| 32 | 8 | 4 | 2 | 1 | **14** |
| 33 | 8 | 4 | 2 | 1 | **14** |
| 34 | 10 | 4 | 2 | 1 | **16** |
| 35 | 8 | 4 | 2 | 1 | **14** |
| 36 | 4 | 4 | 2 | 1 | **10** |

| | | | | | |
|---|---|---|---|---|---|
| 37 | 8 | 4 | 2 | 1 | **14** |
| 38 | 6 | 4 | 2 | 1 | **12** |
| 39 | 8 | 4 | 2 | 1 | **14** |
| 40 | 8 | 4 | 2 | 1 | **14** |
| 41 | 8 | 4 | 2 | 1 | **14** |
| 42 | 8 | 4 | 2 | 1 | **14** |
| 43 | 8 | 4 | 2 | 1 | **14** |
| 44 | 10 | 4 | 2 | 1 | **16** |
| 45 | 10 | 4 | 2 | 1 | **16** |
| 46 | 10 | 4 | 2 | 1 | **16** |
| 47 | **On open cast/stockpile/colliery boundary** | | | | |
| 48 | 8 | 4 | 2 | 3 | **42** |
| 49 | 10 | 4 | 2 | 3 | **48** |
| 50 | 10 | 4 | 2 | 3 | **48** |
| 51 | 10 | 4 | 2 | 3 | **48** |
| 52 | 10 | 4 | 2 | 3 | **48** |
| 53 | 10 | 4 | 2 | 3 | **48** |
| 54 | 10 | 4 | 2 | 3 | **48** |
| 55 | 10 | 4 | 2 | 3 | **48** |
| 56 | 10 | 4 | 2 | 3 | **48** |
| 57 | 10 | 4 | 2 | 3 | **48** |
| 58 | 10 | 4 | 2 | 3 | **48** |
| 59 | 10 | 4 | 2 | 4 | **64** |
| 60 | 10 | 4 | 2 | 4 | **64** |
| 61 | 10 | 4 | 2 | 4 | **64** |
| 62 | **On open cast/stockpile/colliery boundary** | | | | |
| 63 | 10 | 4 | 2 | 3 | **48** |
| 64 | 10 | 4 | 2 | 3 | **48** |
| 65 | 10 | 4 | 2 | 3 | **48** |
| 66 | 10 | 4 | 2 | 4 | **64** |
| 67 | **On open cast/stockpile/colliery boundary** | | | | |
| 68 | 10 | 4 | 2 | 1 | **16** |
| 69 | 8 | 4 | 2 | 1 | **14** |
| 70 | 10 | 4 | 2 | 2 | **32** |
| 71 | 10 | 4 | 2 | 2 | **32** |
| 72 | 10 | 4 | 2 | 2 | **32** |
| 73 | 10 | 4 | 2 | 2 | **32** |
| 74 | 10 | 4 | 2 | 2 | **32** |
| 75 | 10 | 4 | 2 | 2 | **32** |
| 76 | 10 | 4 | 2 | 2 | **32** |
| 77 | 10 | 4 | 2 | 2 | **32** |
| 78 | 6 | 4 | 2 | 1 | **12** |
| 79 | 10 | 4 | 2 | 1 | **16** |
| 80 | 8 | 4 | 2 | 1 | **14** |
| 81 | 10 | 4 | 2 | 1 | **16** |
| 82 | 10 | 4 | 2 | 3 | **48** |
| 83 | 10 | 4 | 2 | 3 | **48** |
| 84 | 10 | 4 | 2 | 3 | **48** |
| 85 | 10 | 4 | 2 | 3 | **48** |
| 86 | 10 | 4 | 2 | 1 | **16** |
| 87 | 10 | 4 | 2 | 1 | **16** |
| 88 | 10 | 4 | 2 | 1 | **16** |
| 89 | | | | | |
| 90 | | | | | |
| 91 | | | | | |
| 92 | | | | | |
| 93 | | | | | |
| 94 | **On open cast/stockpile/colliery boundary** | | | | |
| 95 | | | | | |
| 96 | | | | | |
| 97 | | | | | |
| 98 | | | | | |
| 99 | | | | | |
| 100 | | | | | |
| 101 | 10 | 4 | 2 | 1 | **16** |
| 102 | 4 | 4 | 2 | 1 | **10** |
| 103 | 4 | 4 | 2 | 1 | **10** |
| 104 | 2 | 4 | 2 | 1 | **8** |
| 105 | 4 | 4 | 2 | 1 | **10** |
| 106 | 10 | 4 | 2 | 4 | **64** |

**End of Report**