ATB Environmental Consulting

PROJECT

Quantitative Noise Impact Assessment for the Proposed Development of the Vlermuislaagte Loops and Sishen Erts Yard Loop, Northern Cape

Transnet SOC Ltd

Submitted to:

Transnet SOC Limited - Transnet Freight Rail (The Applicant)

Submitted by:

ATB Environmental Consulting

Adam Bennett
adam@atbphotography.co.za

Project Number: Trans_TFR_NIA

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TRANSNET

freight rail

EXECUTIVE SUMMARY

Project overview

The Applicant, Transnet Freight Rail (TFR), under Transnet SOC Limited (Transnet) propose to develop of the Vlermuislaagte Loops and Sishen Erts Yard loops as part of the Manganese expansion program with respect to exporting manganese on the Saldanha corridor in the Northern Cape.

This report provides a professional qualitative noise impact assessment compiled by ATB Environmental Consulting *(A member of the ATB Group Pty Limited)* who was appointed on behalf of Transnet SOC Limited by Remofilwe 2010 Trading (Pty) Ltd, as an independent specialist consultancy.

Location

The proposed Vlermuislaagte Loop is located approximately 20 km west-north of the town of Kathu, 9 km south-south-west of the South32 Mamantwan mine and 9 km north-east of the town of Deben (GPS Location: 27°30’28.09”S 22°56’58.64”E). The proposed Sishen Erts Yard loop is located adjacent, east of the Sishen Iron Ore mining pit, approximately 7 km South of the Kathu Central Business District (GPS Location: 27°46'55.02"S 23° 2'37.83"E). The Vlermuislaagte Loops and Sishen Erts Yard loops are separated by approximately 26 km.

Proposed project infrastructure

The proposed Sishen expansion includes, but not limited to the following:

- Relocation of Eskom pylons;
- Bridge alterations to ensure space/clearances underneath;
- Lines to be electrified to 50 kV AC;
- Relocation of the following:
    - Relocation of power line (132kV)
    - Relocation of power line (11 kV / 6.6 kV);
    - Service roads (4 m wide);
    - Overheard aerial feeder and return conductors; and
    - Optic fibre cables if on the impacted structures.
- Culverts extensions;
- Demolish and relocate retaining wall running parallel to the rail track;
- Drainage for additional lines;
- Two (2) lines to be added on the eastern side of the yard as per considered Option 4, which will accommodate three (3) rakes of 116 CR13/14 wagon for iron ore trains and three (2) rakes of 125 CR17 wagon for Manganese trains. These rakes will be pulled by a combination of 15E and 43D locomotives (total length of 5 km); and
- One (1) line to be added on the locomotive staging area.

The proposed Vlermuislaagte expansion (total length of 8km) includes, but not limited to the following:

- Two (2) arrival lines/crossing loops for 125 wagon trains (approximately 1500 m long) to accommodate manganese traffic;
- Two (2) additional loops for staging trains;
- Shunting neck to accommodate 125 wagons;

- Track slab or inspection slab;
- Five (5) non-electrified “Not to Go” shunting spurs to accommodate six (6) wagons. Shunting spurs will be used to uncouple overloaded wagons for load weight rectification onsite;
- Additional inspection road;
- One (1) covered parking with four (4) vehicle parking bays;
- Hot box detector and vehicle identification system (i.e. signalling);
- One (1) level crossing will be relocated and another level crossing will be upgraded at Vlermuislaagte;
- All level crossings will include cattle grids;
- The site will have a 6 m wide surfaced road along its length on the east of the yard and access is proposed from either the Mamathwane Yard or from the R380. The servitude will be increased by approximately 80 m;
- Lines to be electrified to 3 kV DC;
- Relay rooms will be constructed for signalling works. Colour signals to be integrated with the Central Traffic Control CS90 train authorization system;
- The turnouts shall be 1:20 or 1:12;
- Catch points will be added to the first loop to protect the mainline; and
- 1:12 Runaway sets to be installed to protect loop 1 and 2.

A combination of locomotives will be used to haul the wagons. It is proposed that a combination of 15E and 43D locomotives will be used. The 50 kV AC 50 Hz Class 15E are a heavy-duty electric locomotive and the Class 43D are a heavy-duty diesel-electric locomotive. Hauling will be predominantly undertaken with the locomotives configured to the available electrical power supply however, during load shedding, the 43D locomotives will be the primary “workhorse” locomotive. The 43D diesel-electric locomotives are anticipated to be a considerable noise source, with significant engine exhaust noise being emitted at an approximate hight of four (4) metres above the rail which makes noise mitigation difficult. The 15E electric locomotives are quieter as they produce less mechanical noise and require no exhaust.

Note: *For further detail on the proposed infrastructure, please refer to the detailed project description contained in the Environmental Basic Assessment Report*.

Train frequency

It is understood that the train frequency on the current line is approximately 22 trains per day operating over a 24-hour period. Under the proposed project, the frequency of the trains will be reduced to approximately 11 trains per day operating over a 24-hour period however, the train waggon length will be approximately doubled. The noise impact at nearby sensitive receptors will be experienced less frequency but for a slightly longer duration as each train passes.

Summary impact opinion

Based on the assessment of the anticipated noise impacts of the construction, operation and decommissioning phases:

- There is no substantive reason why the development of the Sishen Erts Yard Loop cannot be authorised as no noise impacts serve as project fatal flaws for this proposed project site;
- There is no substantive reason why the development of the Vlermuislaagte Loops cannot be authorised as no noise impacts serve as project fatal flaws for this proposed project site; and

- No cumulative noise impacts were identified which would serve as a fatal flaw to the proposed project.

It must also be noted that it is unreasonable to expect the noises generated by this proposed project to be inaudible at the sensitive receptors under all circumstances, even mitigated noise. This would be an unrealistic expectation which is not required or expected from any other noise source (i.e. agricultural, transportation related, commercial, or industrial noise sources etc). Care must be taken to ensure that the sound produced by the proposed development is at a reasonable level in relation to the existing ambient sound levels considering that the proposed project is not increasing the capacity of the railway lines but allows for the frequency of trains to be increased for ease of operations and increased hauling of manganese aligned to the aims of the expansion project.

It is also recommended that mitigation and best practice measures be implemented as recommended in Section 11 to mitigate any impacts. These recommendations should be included in the Environmental Management Programme (EMP) for the project.

Acronym List

Acronyms	
AC	Alternating current
ATB	ATB Environmental Consulting (Member of ATB Group Pty Ltd.)
dB	Decibel
dB(A)	Decibel average weighted
DC	Direct current
EHS	Environmental, Health, and Safety
EIA	Environmental impact assessment
EMP	Environmental Management Plan
GPS	Global positioning system
Hz	Hertz
IFC	International Finance Corporation
km	Kilometre
km/h	Kilometre per hour
kV	Kilovolt
L_{Aeq}	A-weighted, equivalent continuous sound level
L_{AMax}	A-weighted, maximum sound level
m	Meter
m/s	Meters per second
NEM: AQA	National Environmental Management Act: Air Quality Act (Act No. 39 of 2004)
NIHLR	Noise-induced hearing loss regulations
OECD	Organization for Economic Co-ordination and Development
OHSAct	Occupational Health and Safety Act (Act No. 85 of 1993)
SANS	South African National Standard
SR	Sensitive receptor
TFR	Transnet Freight Rail
WHO	World health organisation

Table of Contents

TABLES

FIGURES

1. INTRODUCTION

The Applicant, Transnet Freight Rail (TFR), under Transnet SOC Limited (Transnet) propose to develop of the Vlermuislaagte Loops and Sishen Erts Yard Loop as part of the Manganese expansion program with respect to exporting manganese on the Saldanha corridor in the Northern Cape.

This report provides a professional qualitative noise impact assessment compiled by ATB Environmental Consulting *(A member of the ATB Group Pty Limited)* who was appointed on behalf of Transnet SOC Limited by Remofilwe 2010 Trading (Pty) Ltd, as an independent specialist consultancy.

The main focus of this assessment was to establish the potential degree of change in the noise climate within the projects area of influence as the railway line is an existing operational railway line on which, freight and ore is transported daily.

2. PROJECT BACKGROUND

2.1 Location of the proposed project

The proposed Vlermuislaagte Loops is located approximately 20 km west-north of the town of Kathu, 9 km south-south-west of the South32 Mamantwan mine and 9 km north-east of the town of Deben (GPS Location: 27°30'28.09"S 22°56'58.64"E) (Figure 1).

The proposed Sishen Erts Yard Loop is located adjacent, east of the Sishen Iron Ore mining pit, approximately 7 km South of the Kathu Central Business District (GPS Location: 27°46'55.02"S 23° 2'37.83"E) (Figure 1).

The Vlermuislaagte Loops and Sishen Erts Yard Loop are separated by approximately 26 km (Figure 1).

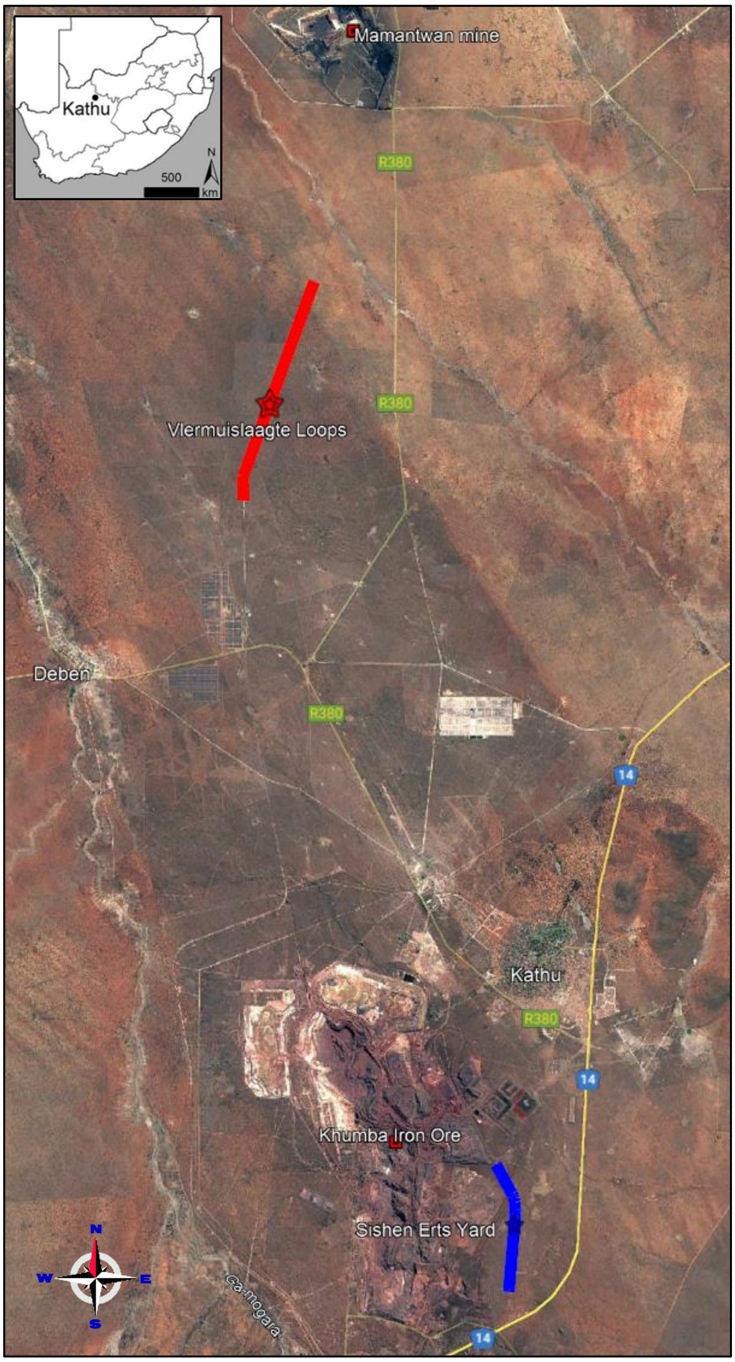

Figure 1: Location of the proposed project (Map sources: Google Earth, 17 January 2023)

2.2 Land use cover

The land use cover within an approximate 10 km radius or the proposed project includes (Figure 1):

- Formal and informal residential areas of Kathu and Deben;
- Individual farm residences and/or small holdings;

- Mining, quarrying and aggregate extraction (i.e. Khumba Iron Ore Sishen mine, Mamatwan mine etc.)
- Commercial and retail activities within the towns of Kathu and Deben;
- Private renewable power generation facilities and associated power distribution infrastructure;
- National power distribution infrastructure;
- Commercial agriculture (Cattle, sheep, goats; game);
- Recreational activities (i.e. Shooting range; Sishen golf & country club; off road driving; hunting; horse riding; game reserves etc.)
- Regional airport;
- National rail infrastructure and mining associated rail infrastructure;
- Industrial activities within the Kathu industrial area;
- Open vacant land;
- Sewerage and waste water treatment works;
- Municipal waste disposal (i.e. Kathu & Deben landfills);
- National, Regional and District road infrastructure (e.g. N14, R380, D3333, T25 and other unnamed "regional" gravel roads); and
- An extensive network of gravel access roads.

2.3 Proposed project infrastructure and locomotives

2.3.1 Sishen expansion

The proposed Sishen expansion (total length of 5 km) includes, but not limited to the following:

- Relocation of Eskom pylons;
- Bridge alterations to ensure space/clearances underneath;
- Lines to be electrified to 50 kV AC;
- Relocation of the following:
    - Relocation of power line (132kV)
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- One (1) line to be added on the locomotive staging area.

2.3.2 Vlermuislaagte expansion

The proposed Vlermuislaagte expansion (total length of 8 km) includes, but not limited to the following:

- Two (2) arrival lines/crossing loops for 125 wagon trains (approximately 1500 m long) to accommodate manganese traffic;
- Two (2) additional loops for staging trains;
- Shunting neck to accommodate 125 wagons;
- Track slab or inspection slab;
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- Additional inspection road;
- One (1) covered parking with four (4) vehicle parking bays;
- Hot box detector and vehicle identification system (i.e. signalling);
- One (1) level crossing will be relocated and another level crossing will be upgraded at Vlermuislaagte;
- All level crossings will include cattle grids;
- The site will have a 6 m wide surfaced road along its length on the east of the yard and access is proposed from either the Mamathwane Yard or from the R380. The servitude will be increased by approximately 80 m;
- Lines to be electrified to 3 kV DC;
- Relay rooms will be constructed for signalling works. Colour signals to be integrated with the Central Traffic Control CS90 train authorization system;
- The turnouts shall be 1:20 or 1:12;
- Catch points will be added to the first loop to protect the mainline; and
- 1:12 Runaway sets to be installed to protect loop 1 and 2.

2.3.3 Train types

A combination of locomotives will be used to haul the wagons. It is proposed that a combination of 15E and 43D locomotives will be used. The 50 kV AC 50 Hz Class 15E are a heavy-duty electric locomotive and the Class 43D are a heavy-duty diesel-electric locomotive. Hauling will be predominantly undertaken with the locomotives configured to the available electrical power supply however, during load shedding, the 43D locomotives will be the primary "workhorse" locomotive. The 43D diesel-electric locomotives are anticipated to be a considerable noise source, with significant engine exhaust noise being emitted at an approximate hight of four (4) metres above the rail which makes noise mitigation difficult. The 15E electric locomotives are quieter as they produce less mechanical noise and require no exhaust.

Note: *For further detail on the proposed infrastructure, please refer to the detailed project description contained in the Environmental Impact Report*.

2.3.4 Train frequency

It is understood that the train frequency on the current line is approximately 22 trains per day operating over a 24-hour period. Under the proposed project, the frequency of the trains will be reduced to approximately 11 trains per day operating over a 24-hour period however, the train waggon length will be approximately doubled.

The noise impact at nearby sensitive receptors will be experienced less frequency but for a slightly longer duration as each train passes.

3. STUDY APPROACH AND METHODOLOGY

3.1 Background literature review

A background literature review was conducted to gain an understanding of the proposed project, the typical ambient baseline noise levels experienced within the surrounding region, and the anticipated noise emissions from the proposed project. Documentation reviewed included the following:

- Sishen and Vlermuislaagte expansion engineering diagrams;
- Fay, RR.: Hearing in Vertebrates: A Psychophysics Databook. Hill-Fay Associates, 1988;
- Warfield, D.: The study of hearing in animals. In: W Gay, ed., Methods of Animal Experimentation, IV. Academic Press,1973;
- SANS 10103, 2008: The measurement and rating of environmental noise with respect to annoyance and to speech communication;
- SANS 10328, 2008: The SANS Method for environmental noise impact assessment;
- Provision for the control of noise is made under the National Environmental Management Act: Air Quality Act (Act No. 39 of 2004) (NEM:AQA);
- British Standard Institute, 2014: BS 5228-1:2009+A1:2014, Code of practice for noise and vibration Control on construction and open sites, Part 1: Noise, 2014;
- International Finance Corporation (IFC), 2007: IFC Environmental, Health, and Safety (EHS) Guidelines for noise management;
- Typical noise levels generated by construction equipment, www.fhwa.dot.gov;
- World Health Organization (WHO), 1999: Guidelines for Community Noise;
- South32: Hotazel Manganese Mines (Pty) Limited: Atmospheric Emissions Impact Report for Mamatwan Sinter Plant Application for Postponement of Compliance timeframes, Golder Associates Africa (Pty) Ltd, 2019; and
- Noise scoping assessment, Sishen Iron Ore Mine, Infrastructure relocation project. Rough Estimate of train noise levels as a function of distance, Acusolv, 2009

3.2 Baseline assessment

The assessment of ambient noise levels in the near vicinity of the proposed project included:

- A review of applicable noise policy, legislation and standards;
- Identification of sensitive receptors within a 5 km radius of the project boundary;
- Identification of local noise emission sources; and
- The identification and discussion of the potential health effects associated with applicable noise emissions from the proposed project.

3.3 Impact assessment

The impact assessment was undertaken based on the findings of the baseline noise assessment and ATB Environmental Consulting's professional opinion (i.e. qualitative opinion) of the anticipated noise impacts associated with the proposed project.

The main focus of the assessment for the operational phase of the project was to establish the potential degree of change in the noise climate within the projects area of influence as the railway line is existing operational railway line on which, freight and ore is transported daily.

3.3.1 Impact assessment and rating of impacts

The significance of the identified impacts will be determined using two (2) aspects for assessing the potential significance, namely *Occurrence* and *Severity*, which are further sub-divided as indicated in Table 1. The impact ranking will be described for the construction, operation and decommissioning phases both pre and post implementation of practical noise mitigation/management control measures.

Table 1: Impact classification for the impact assessment

Occurrence	Severity	Environmental Consequence
• Direction • Probability • Duration	• Magnitude • Scale/Geographic extent • Reversibility • Frequency	

- ***Direction*** of a noise impact may be negative, neutral or positive with respect to the particular impact (e.g. a reduction in the ambient noise levels would be considered positive, no change as neutral, and an increase in the ambient noise levels would be considered negative);
- ***Probability*** of occurrence is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur);
- ***Duration*** refers to the length of time over which an environmental impact may occur: transient (<1 year), short-term (0 to 5 years [i.e. construction]), medium term (5 to 15 years [i.e. operational]), long-term (>15 years [i.e. operational] with impact ceasing after closure) or permanent;
- ***Magnitude*** is a measure of the degree of change that may occur: negligible: predicted noise levels are below the respective guidelines (i.e. WHO Guidelines for ambient sound levels, Ambient Noise Guidelines, and/or South African National Standard typical rating levels for ambient noise) and will not affect baseline noise levels at the sensitive receptors; low: predicted cumulative noise levels (i.e. baseline and project contributions) within the guidelines and ΔLReq,T leading to no/little community response (i.e. ΔLReq,T <5 dB(A)); moderate: predicted cumulative noise levels may slightly exceed the respective guidelines and ΔLReq,T leading to medium community response (i.e. ΔLReq,T >5 &<10 dB(A)); high: guidelines exceeded and ΔLReq,T leading to strong/very strong community response (i.e. ΔLReq,T >10dB(A));
- ***Scale/Geographic extent*** refers to the area that could be affected by the impact and is classified as site: effects within the site boundary; local: effect restricted to within 1 – 10 km of the site boundary; regional: effect extends >10 km's; and national: effect extend beyond provincial boundaries and/or the RSA border;
- ***Reversibility*** allows for the impact to be described as reversible or irreversible;
- ***Frequency*** may be low: infrequent; medium: intermittent/transient; or high: very frequent/continuously; and
- ***Environmental Consequence***: The overall residual consequence for each effect will be classified as one of: negligible, low, moderate or high by evaluation of the rankings for magnitude, geographic extent and duration (Table 2).

Environmental impact assessment (EIA) involves prediction bases on sets of environmental criteria and thus uncertainty associated with the process and predictions is an integral part of the process. The certainty with which an impact analysis can be undertaken depends on a number of factors including an understanding of:

- The natural and ecological processes at work now and in the future;

- The socio-economic processes at work now and in the future; and
- Understanding of present and future properties of the affected resources.

If the factors above are considered questionable during the impact assessment, the level of prediction confidence for an impact analysis will be discussed. In cases where the level of confidence makes a prediction of the impact problematic, a subjective assessment is made based on the available information, the applicability of information and on professional opinion. If the level of prediction confidence is sufficiently low in some cases that an estimate of environmental consequence cannot be made with a sufficient degree of confidence, an undetermined rating is allocated and recommendations to address the gaps and/or monitoring recommendations are provided to provide more data in the future.

Table 2: Categories describing Environmental Consequence

Category	Description
High	Noise impact is of a high order and is expected to have a significant impact on the sensitive receptors. Mitigation is not possible to offset the impact, and/or mitigation is difficult. Guidelines exceeded and $\Delta L_{Req,T}$ leading to a strong/very strong community response (i.e. SANS 10103 Categories of community or group response $\Delta L_{Req,T} > 10$ dB(A))
Moderate	Noise impact will occur, but is unlikely to be substantial in relation to other environmental impacts that could occur. Mitigation measures are required, mitigation is feasible and relatively easy to achieve. May exceed guidelines slightly and $\Delta L_{Req,T}$ and leading to medium community response (i.e. SANS 10103 Categories of community or group response $\Delta L_{Req,T} > 5$ & < 10 dB(A))
Low	Noise impact is of a low order and is expected to have little real effect on the sensitive receptors. Nominal mitigation measures are required, mitigation is easily achievable, and/or both. Within guidelines and $\Delta L_{Req,T}$ and leading to no/little community response (i.e. SANS 10103 Categories of community or group response $\Delta L_{Req,T} < 5$ dB(A))
No Impact	No envisaged impact.

3.3.2 Estimation of project associated noise levels

There is no existing "official" train noise prediction model in South Africa and thus appropriate calculation method must be sourced from overseas in alignment with international best practice. The UK Department of Transport's prediction model, *Calculation of Railway Noise* (1995), uses basic train-type data to estimate noise levels that could potentially be generated by a train in the area of influence, namely the propagation and attenuation *(Note: this model is reported to be the most comprehensive model regarding train noise generation)*. Much of the required train-type data in relation to this project is not currently available as the project is still in the preliminary design phases and thus application of this model is not applicable.

In the absence of such train-type data, use of formal models is not possible as the model would be almost entirely based on assumptions and thus outputs could be highly questionable. The envisaged noise levels were thus estimated by basic depreciation calculations considering the use of the 43D diesel-electric locomotives as the worst-case scenario. The results of the basic depreciation calculations should also be viewed with some caution as they are considered a first order estimate of the envisaged noise levels and not a definitive noise level.

3.4 Mitigation and monitoring

Recommendations for control and/or mitigation measures were made in response to the identified noise impacts.

3.5 Assumptions and Limitations

3.5.1 Assumptions

The following assumptions are applicable:

- The project will enforce the following design specification limitations:
  - All infrastructure will be within a 100 m corridor, located to the east of the existing railway lines; and
  - The typical operational phase noise levels from the Vlermuislaagte Loops and Sishen Erts Yard loops are anticipated to typically range from 55 dB(A) to 110 dB(A) with an average operational noise level across the sites estimated at approximately 75 dB(A) depending on the activities and implemented noise mitigation measures. Considering this, the cumulative noise generation levels of the trains on the railway line must not exceed an L_{AMax} dB(A) of 85 dB(A) at the development corridor boundary and L_{Aeq} of 75 bB(A) within 30 m of the development corridor boundary. The 85 $dB(A)_{Max}$ limit at the boundary *(Note: Assumes noise sources are at least 10 m from boundary)* is viewed as the worst-case scenario and thus the most conservative approach. The 85 $dB(A)_{Max}$ limit has therefore been assumed as the uniform boundary noise level for the purpose of this assessment.
- The two L_{AMax} and L_{Aeq} design specifications limitation are viewed as the worst-case scenario and thus the most conservative approach. The L_{AMax} of 85 dB(A) has therefore been assumed as the uniform project boundary noise level for the purpose of this assessment;
- No recent baseline noise monitoring data (i.e. <3 years old) was available at the time of drafting this impact assessment. In the absence of such data, the typical ambient day/night noise rating levels for various districts as per the SANS 10103 Code of Practice was adopted and is assumed to be representative of current noise environment onsite;
- It is understood that the train frequency on the current line is approximately 22 trains per day operating over a 24-hour period. Under the proposed project, the frequency of the trains will be reduced to approximately 11 trains per day operating over a 24-hour period however, the train waggon length will be approximately doubled for ease of operations and increased ore hauling aligned to the aims of the expansion project. The noise impact at nearby sensitive receptors will be experienced less frequency but for a slightly longer duration as each train passes; and
- The edge of the 100 m corridor is selected as the effective boundary of the project for noise assessment purposes.

Table 3: Typical noise levels in railroad yards (Urman, 1978)

Noise-Producing Operation	*[dB(a)]*
Switcher engine movement	
Steady pull through yard	76-80
Classification start-stop cycle	80
Idling locomotive	
Road	71
Switcher	65
Car impacts	
Coupling	91
Chain reaction	91
Car retarders	
Master	110
Group or individual track	110
Inert or pull-out	95
Other	
Loudspeakers and PA systems	90-95
Engine load tests	92

Note: *Averaged railroad yard noise level yields a value of 89dB(A)*

3.5.2 Limitations

The following assumptions are applicable:

- Much of the required train-type data in relation to this project is not currently available as the project is still in the preliminary design phases. The envisaged noise levels were therefore estimated by basic depreciation calculations from the railway line corridor considering the noise levels of diesel-electric locomotives and typical train yard noise levels based on available literature. The results of the basic depreciation calculations should be viewed with some caution as they are considered a first order estimate of the envisaged noise levels and not a definitive noise level;
- Sporadic train horn blasts may reach 120 dB(A) on occasion although they are anticipated to be infrequent and have therefore been excluded from the assessment;
- The specialist assessment excluded quantitative modelling of the noise impacts and no baseline noise monitoring was undertaken to verify the assumed baseline noise levels; and
- The assessment of low frequency noise and ground-based vibration is excluded as:
  - Vibration decibel international criterion regarding nuisance impacts is generally based on railways used for commuting purposes in urban areas and not for as in this case, the almost exclusive use of hauling of ore and mine related freight; and
  - There isn't a standardised test, nor assessment procedure available low frequency sounds assessment. There is also no accepted methodology on how low frequency sounds can be modelled and/or predicted as low frequency sound can travel great distances, and is present all around us, with a significant component being generated naturally by the surrounding nature environment.

4. NOISE TERMINOLOGY AND EFFECTS

4.1 Noise terminology

Note: The following text has been extracted from multiple literature sources and modified to form ATB Environmental Consulting's definition of noise terminology.

Noise is typically defined as any unwanted acoustic sound deemed as disruptive to hearing and/or communication, is loud and unpleasant, and thus poses a nuisance. The accepted range of human audible sound is typically from 0 dB to 140 dB and the frequency response of the ear is generally accepted as ranging of 20 Hz to 20000 Hz. The human ear does not respond equal across all frequencies. It is more sensitive in the mid-frequency range than in the low and high frequencies. To account for this variation in sensitivity, a weighting filter is applied during noise monitoring. The filter commonly applied is the 'A weighting' filter as this filter is an internationally accepted standard for noise measurements representing a human's subjective response to sound.

Regarding noise levels, a change in the noise level (i.e. increase and/or decrease) of approximately 1 dB(A) is not normally perceptible to most people (Note: may be under controlled laboratory conditions). An increase/decrease of approximately 3 dB(A) is normally just perceptible. The 'loudness' of a noise is a purely subjective parameter, but it is generally accepted that an increase/decrease of approximately 10 dB(A) which corresponds to a doubling/halving in the perceived loudness.

Noise levels typically fluctuate according to the surrounding activities and are rarely steady. The relevant noise parameter to this assessment is the L_{Aeq}. The L_{Aeq} level is the equivalent continuous A-weighted sound pressure level, expressed in decibels. The L_{Aeq} level is a unit commonly used to describe noise and is the most suitable unit for the description of many forms of environmental noise.

4.2 Effects of noise

Activity generated noise during the construction, operation and decommissioning phases of the project will result in a change and increase in ambient noise levels within the local area. The impacts of the increase in noise will depend on the level of increase. Typical sound levels ((dB(A)) are shown in Figure 2 for reference.

4.2.1 Impacts on humans

An increase in ambient noise levels of over 3 dB(A) will be noticeable to most people, although such an increase is unlikely to cause disturbance to leisure activities or sleep. An increase of 10 dB(A), however, is likely to cause disturbance or require people to modify their behaviour to avoid that disturbance, depending on the absolute level of noise.

The following health impacts are typically associated with noise impacts:

- Permanent noise induced hearing loss;
- Tinnitus, which is an auditory disorder characterised by the perception of a sound (i.e. ringing, chirping, and/or buzzing) in the ear in the absence of an external sound source;
- Physiological responses such as: increase in blood pressure and hypertension, increase in frequency of headaches, increase the risk of myocardial infarction due to chronically elevating cortisol stress hormone production, effects on nervous system, liver, and other organs;
- Acute and chronic fatigue due to sleep disturbance;
- Reduction in cognitive processes associated with fatigue; and
- Psychological effects such as annoyance, increase in stress and psychiatric disorders, and general effects on psychosocial well-being leading to the reduction in the quality of life.

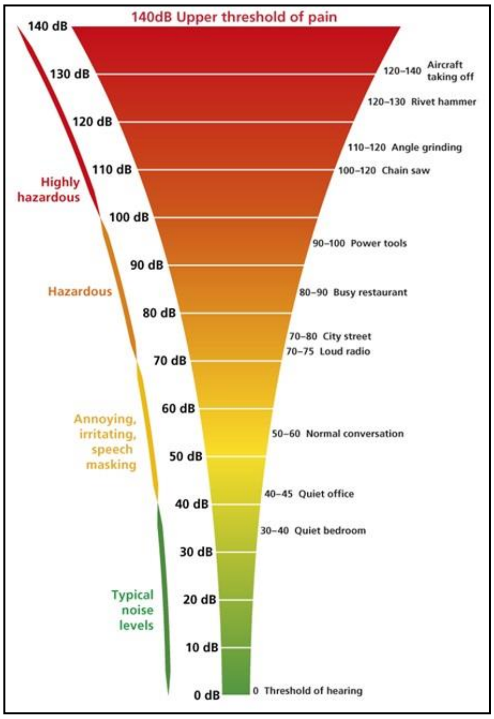


Figure 2: Typical sound levels (source: https://boomspeaker.com/noise-level-chart-db-level-chart, October 2020)

4.2.1 Impacts on animals

The accepted range of animal audible sound is far greater than that audible to humans. Data from Fay (1988) and Warfield (1973) provide animal hearing ranges from the infrasound range (i.e. less than 20 Hz) to the ultrasound range (i.e. greater 200 000 Hz) (Table 4).

Table 4: Approximate hearing range of various animals (after Fay,1988 and Warfield, 1973, https://www.lsu.edu/deafness/HearingRange.html, 9 October 2020)

Species	Approximate Range (Hz)	Species	Approximate Range (Hz)
Dog	67 - 45 000	Bat	2 000 - 110 000
Cat	45 - 64 000	Whales	1 000 - 123 000
Cattle	23 - 35 000	Elephant	16 - 12 000
Horse	55 - 33 500	Dolphin/porpoise	75 - 150 000
Sheep	100 - 30 000	Goldfish	20 - 3 000
Rabbit/hare	360 - 42 000	Catfish	50 - 4 000
Rat	200 - 76 000	Tuna	50 - 1 100

Mouse	1 000 - 91 000	Bullfrog	100 - 3 000
Gerbil	100 - 60 000	Tree frog	50 - 4 000
Hedgehog	250 - 45 000	Birds *(species dependent)*	125 - 12 000
Chicken	125 - 2 000		

The following impacts are typically associated with noise impacts on animals:

- Permanent noise induced hearing loss;
- Physiological responses such as: Stress induced urination; defecating; panting; drooling; trembling; cardiovascular impacts; increased stress hormone production; effects on nervous system, liver, and another organs;
- Acute and chronic fatigue due to sleep disturbance;
- Reduction in cognitive processes associates with fatigue which main include increased frequency of commands being disregarded by trained animals;
- Psychological effects such as annoyance, increase in stress and psychiatric disorders, and general effects on well-being leading to the reduction in the quality of life, increased aggression levels;
- Reduced physical endurance;
- Interference with breeding cycles;
- Changes in population densities and distributions as some animals may flee and migrate away from the noise source; and
- Eco-locating marine animal and bat communication can become disrupted.

5. LEGISLATION, STANDARDS AND GUIDELINES

5.1 The National Environmental Management Air Quality Act (Act no. 39 of 2004) (NEM:AQA)

Provision for the control of noise is made under the NEM:AQA. The act states:

(1) ‘The Minister may prescribe essential national standards -

a. For the control of noise, either in general or my specified machinery or activities or in specified places or areas; or
b. For determining:
   i. A definition of noise; and
   ii. The maximum levels of noise.

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

Currently, noise standards under NEM:AQA have not been published however the South African National Standard (SANS) 10103 Code of Practice provides typical ambient noise rating levels (LReq,T) in various districts and SANS 10103:2008 provided the measurement and rating of environmental noise with respect to annoyance and to speech communication.

5.2 International Standards and guidelines

The World Health Organization (WHO) in collaboration with the Organization for Economic Co-ordination and Development (OECD) developed ambient sound level guidelines based on the effects of exposure to environmental noise. The WHO recommends a standard guideline values for average outdoor noise levels of 55 dB(A) during the daytime and 45 dB(A) during the night-time in order to prevent significant interference with local communities’ normal activities. The WHO further recommends that, during the night-time, the maximum level of any single event should not exceed 60 dB(A) in order to avoid sleep disruption. Specific ambient guidelines are also set for dwellings, bedrooms and school (Table 5).

The WHO also specifies that an environmental noise impact assessment must be undertaken prior to implementing any project that would significantly increase the level of environmental noise in a community by more than 5 dB(A) (WHO, 1999).

The World Bank Group developed a program in pollution management so as to ensure that the projects they finance in developing countries are environmentally sound. This programme specifies that noise levels measured at the sensitive receptors located outside the project's boundary should not be 3 dB(A) greater than the background noise levels, or exceed the noise levels depicted in Table 6.

The International Finance Corporation (IFC) Environmental, Health, and Safety (EHS) Guidelines for noise management (IFC, 2007) adopt the WHO Guidelines for Community Noise (WHO, 1999) presented in Table 6. Noise impacts should not exceed these levels or result in a maximum increase in background levels of 3 dB(A) at the nearest sensitive receptor located off-site.

5.3 South African National Standard (SANS)

SANS 10328:2008 provides a standardised method for evaluating environmental noise impacts associated with a proposed development/project. SANS 10328:2008 makes references to SANS 10103:2008: Code of Practice regarding the measurement and rating of environmental noise with respect to annoyance and to speech communication. SANS 10103 provides typical outdoor ambient and indoor noise rating levels ($L_{Req,T}$) for various districts (Table 7).

Under SANS, noise is considered a nuisance and/or intrusive at nearby sensitive receptors if the rating level of the ambient noise under investigation exceeds the applicable rating level of the residual noise (determined in the absence of the specific noise under investigation), or the typical rating level for the ambient noise for the applicable environment given in Table 7 (i.e. Table 2 of SANS 10103).

Table 5: WHO Guidelines for ambient sound levels

Environment	Ambient sound level L_{Aeq} (dB(A))			
	Daytime		Night-time	
	Indoor	Outdoor	Indoor	Outdoor
Dwellings	50	50	-	-
Bedrooms	-	-	30	45
Schools	35	55	-	-
Average outdoor	-	55	-	45
Maximum single event	-	-	60	-

Table 6: IFC Ambient Noise Guidelines

Receptor	Maximum allowable ambient noise levels (1-hour L_{Aeq} dB(A))	
	Daytime (07:00 – 22:00)	Night-time (22:00 – 07:00)
Residential/institutional/educational	55	45
Industrial/commercial	70	70

Note: *L_{Aeq} values are not specified for rural areas*

Table 7: Typical Rating Levels for Ambient Noise

Type of district	Equivalent continuous rating level ($L_{Req,T}$) for noise (dB(A))					
	Outdoors			Indoors, with open windows		
	Day night $L_{R,dn}$	Daytime $L_{Req,d}$	Nigh-time $L_{Req,n}$	Day night $L_{R,dn}$	Daytime $L_{Req,d}$	Night-time $L_{Req,n}$
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with 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

Notes:

1) *If the measurement or calculation time interval is considerably shorter than the reference time intervals, significant deviations from the values given in the table might result;*

2) *If the spectrum of the sound contains significant low frequency components, or when an unbalanced spectrum towards the low frequencies is suspected, special precautions should be taken, and specialist advice should be obtained. In this case the indoor sound levels might significantly differ from the values given in Column 5 to 7;*

3) *In districts where outdoor $L_{R,dn}$ exceeds 55 dB, residential buildings (e.g. dormitories, hotel accommodation and residences) should preferably be treated acoustically to obtain indoor $L_{Req,T}$ values;*

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

5) *The values given in columns 2 and 5 in this table are equivalent continuous rating levels and include corrections for tonal character, impulsiveness of the noise and the time of day;*

6) *The values given in columns 3, 4, 6 and 7 in this table are equivalent continuous rating levels and include corrections for tonal character and impulsiveness of the noise; and*

7) *The noise from individual noise sources produced, or caused to be produced, by humans within natural quiet spaces such as national parks, wilderness areas and bird sanctuaries should not exceed a maximum A-weighted sound pressure level of 50 dB(A) at a distance of 15 m from each individual source.*

SANS 10103 provides criteria, for the evaluation of the community and/or group response to a noise source (Table 8).

Table 8: SANS 10103 Categories of community or group response

Excess, $\Delta L_{Req,T}$ dB(A)	Category	Description
0 to 10	Little	Sporadic complaints
5 to 15	Medium	Widespread complaints
10 to 20	Strong	Threats of community or group action
>15	Very Strong	Vigorous community or group action

SANS 10103 provides three methods for determining the excess level ($\Delta L_{Req,T}$) of a proposed development:

- $\Delta L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation minus $L_{Req,T}$ of the residual noise (determined in the absence of the rated noise, i.e. the specific noise under investigation);
- $\Delta L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation minus the typical rating level for the applicable district as determined from Table 7of SANS 10103:2008; or
- $\Delta L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in an area because of a proposed development under investigation.

5.4 Local Noise By-laws

The proposed project will also be required to comply with local municipal noise management by-laws which include the prevention of noise nuisances by all persons.

5.5 Railway noise guidelines

No guidelines for the assessment of railway noise is offered in either the South African noise regulations and or SANS 10103. National standards in other countries differ widely in respect of ratings and limits applied to railway noise (Table 9). On examining the table, it is noted that not only do the limits for $L_{Aeq.T}$ vary quite considerably between countries and are in most cases higher than the corresponding limits considered acceptable for general noise in Rural, Sub-urban and Urban Districts according to SANS 10103. This approach reflects a tendency to regard train noise, which is of a transient nature and of a relatively short duration, as being less disturbing compared to general noise at a given L_{Aeq} level. Countries like Germany, Austria and Switzerland, express this leniency towards railway noise by way of applying a 5 dB leniency which, is subtracted from the measured or predicted train noise value.

Table 9: Land-use noise impact limits employed in various countries for urban districts (Van Zyl, 2009).

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

Note: *Equivalent continuous sound pressure level LAeq.T dB(A) Integrated (averaged) over a period T as indicated and Maximum sound pressure level LAMa, dB(A). Registered during or predicted for the period as indicated*

Some countries, in addition to the average level $L_{Aeq,T}$, also set maximum level for train noise $L_{AMax,}$ dB(A) recorded during a reference period (Table 9). This limit is primarily aimed at urban railway lines located in close proximity to residential and office buildings. The L_{Amax} is meant to account for the startling effect and additional annoyance caused by the sudden burst of noise created when a train passes at high speed close to the building. Further away from a railway line, the noise burst stretches out, eventually changing into a gradual rise and fall in the noise level. In such cases, it is not necessary to apply the L_{Amax} level criterion.

The differences between the $L_{Aeq,T}$ and $L_{AMax,}$ limits account for the fact that the maximum level $L_{AMax,}$ of the railway noise is typically 25 - 30 dB higher than the longer term average level L_{Aeq}. Finally, when considering railway noise limits for use in noise studies, it should be noted that Table 9 doesn't differentiate between various types of districts, as is standard practice for general noise. The levels in Table 9 are thus appropriate for use in urban districts, as defined in SANS 10103 only.

5.6 Proposed standards for use in this survey

The project could be benchmarked against either the IFC/WHO requirements and/or SANS. As the project is within South Africa and international benchmarking is not critical for this project, it is proposed that the SANS standards are selected for compliance evaluation (Table 10). The Vlermuislaagte Loops site is located approximately 20km north-north-west outside of the Kathu urban area and is anticipated to be impacted by road traffic from the Regional Road 380 (i.e. R380) thus the Suburban districts with little road traffic ambient noise level has been selected as the proposed standard for the assessment of the Vlermuislaagte Loops. The Sishen Erts Yard Loop site is located approximately 7km south-south-west of the Kathu urban area and is anticipated to be significantly impacted by road traffic noise from the National Road 14 (i.e. N14) and the Sishen Iron Ore mining operations to the west of the yard thus the Urban districts with main roads, has been selected as the proposed standard for the assessment of the Sishen Erts Yard Loop. Furthermore, as railway noise is transient nature, and of a relatively short duration, we have applied a 5 dB(A) leniency which, is subtracted from the predicted train noise value.

Table 10: Proposed allowable ambient noise levels, after SANS 10103 with 5dB(A) leniency

Site	Environment	Day night ($L_{R,dn}$)	Daytime ($L_{Req,d}$)	Night-time ($L_{Req,n}$)
Construction phase				
Vlermuislaagte Loops and Sishen Erts Yard Loop	Rural districts	45	45	35
	Sub-urban districts with little road traffic	50	50	40
Operational phase				
Vlermuislaagte Loops and Sishen Erts Yard Loop	Rural districts with little road traffic, including 5 dB(A) leniency for transient railway noise	50	50	40
	Sub-urban districts with little road traffic, including 5 dB(A) leniency for transient railway noise	55	55	45

6. BASELINE NOISE ASSESSMENT

Noise impacts are typically experienced at relatively close proximity to the emitting source. The noise sensitive receptors are considered by SANS 10328:2008 to include residential dwellings, institutional and culturally important sites, such as schools, hospitals and places of worship.

6.1 Existing noise sources

6.1.1 Roads

The main roads influencing the local noise baseline in close proximity (i.e. within 10 km) of the proposed project include (Figure 1):

- Sishen Erts Yard Loop site:

- National Road 14 (N14): Aligned north to south and south-west to north-east direction approximately 2 km from the site;
- Regional route 380 (R380): Aligned south-east to north-west approximately 5.5 km north of the site, just outside of Kathu; and
- An extensive network of secondary unnamed roads and/or gravel access roads to the individual farms within the surrounding areas.

- Vlermuislaagte Loops site:
  - Regional route 380 (R380): Aligned north-south south-east to north-west approximately 4.4 km east the site and east-west approximately 5.5 km south of the site (section of R380 to Deben); and
  - An extensive network of secondary unnamed roads and/or gravel access roads to the individual farms within the surrounding areas.

6.1.2 Rail infrastructure

The existing local railway infrastructure including:

- The Lyleyveld turnout just east of the Khumba Iron Ore Sishen mine pits *(Note: The Sishen Erts Yard Loop expansion is on this line)*; and
- The relocated Postmusburg-Hotazel to the line west of Diggle and parallel to the Ga-mogara river *(Note: The Vlermuislaagte Loops expansion is on this line)*.

Note: Further information on the sources of railway noise is provided in Section 9.2.1.1.

6.1.3 Mining activities

The Khumba Iron Ore Sishen mine is situated directly west of the Sishen Erts Yard Loop site. The Mamantwan Mine is located approximately 9.5 km north of the Vlermuislaagte Loops site (Figure 1). Noise generated by the mining operations and particularly with blasting activities will influence the local noise baseline within the local area.

6.1.4 Industrial activities

The main industrial activities influencing the local noise baseline in close proximity (i.e. within 10 km) of the proposed project sites include the Kathu industrial area approximately 5.5 km north of the Sishen Erts Yard Loop site on the outskirts of Kathu (Figure 1).

6.1.5 Aerodromes

The Kathu airport located midway between the Sishen Erts Yard Loop and Vlermuislaagte Loops site, just east of the R380. Noise generated along the approach and departure flight corridors and from aircraft taxiing, landing and taking off will influence the local noise baseline within the local area (Figure 1).

6.1.6 Commercial activities

Commercial activities within the towns of Kathu and Deben will influence the local noise baseline within the local area (Figure 1).

6.1.7 Residential areas

Residential areas within a 10 km radius of the proposed project boundary include the Kathu and Deben residential areas (Figure 1). These residential areas are anticipated to be the main contributors to residential generated noise, however, there are also various scattered farmsteads throughout the region which are anticipated to contribute to the local noise baseline in close proximity to the proposed project.

6.1.8 Agricultural activities

Within the wider project area small scale crop agriculture is encountered around Deben along the Ga-mogara river (Figure 1). Low density cattle, goat farming and game farming is also common through the wider area. Noise associates with these agricultural activities will contribute to the baseline noise levels locally.

6.1.9 Eco-Tourism

Within the wider Kathu area, there are several eco-tourism lodges/bed and breakfasts scattered throughout the region, a private golf courses, and private game farms (Figure 1). These land uses and associated activities are anticipated to contribute to the local noise baseline in close proximity to the proposed project but contributions are anticipated to be minimal.

6.1.10 Power generation

There are several renewable energy generation facilities and sub-stations including (Figure 1):

- The solar plant approximately 2.8 km south-south-west of the Vlermuislaagte Loops site;
- The solar plant approximately 6.3 km south-south-west of the Vlermuislaagte Loops site; and
- The Kathu solar park approximately 10 km south-east south-south-west of the Vlermuislaagte Loops site.

These facilities will contribute to the baseline noise levels however their contributions are not anticipated to be significant.

6.1.11 Natural environmental noise

Natural environmental noise is also identified as a contribution source to the baseline noise levels including the following:

- Noise generated by local flora during the day and night-time (i.e. bird calls and other animal communications); and
- Wind whistling through the grass and/or rustling of tree and shrub leaves.

6.2 Local aspects of acoustical significance

6.2.1 Terrain

The proposed Sishen Erts Yard Loop and Vlermuislaagte Loops are located in close proximity to the town of Kathu and falls within the semi-arid Southern Kalahari Geomorphic Province (Partridge et al. 2010). The topography in the two project areas is relatively flat-lying around 1120m to 1220m above mean sea level (Figure 3). The Sishen Erts Yard Loop site lies in the valley between the Kuruman Hills to the east and Langberge to the west of the project. The Vlermuislaagte Loops lies in the valley between the Kuruman Hills to the east and Korannaberg to the west.

6.2.2 Meteorological Aspects

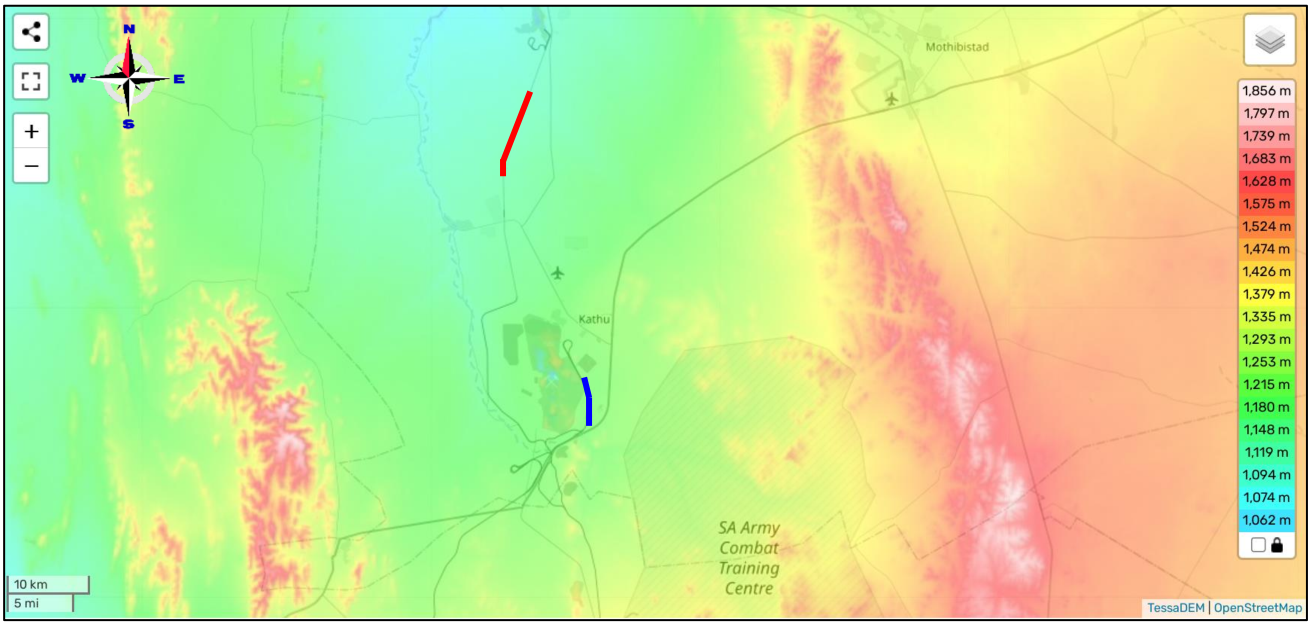
The main meteorological aspect that will affect the transmission (propagation) of the noise is wind and atmospheric temperature. Wind can either result in the periodic enhancement of noise levels at downwind sensitive receptors or a reduction at upwind sensitive receptors in relation to the noise source locations. No meteorological monitoring is undertaken within the project site currently. Reliance was thus placed on publicly available meteorological data.

As the local topography is relatively similar and considering that the project sites are less than 10-20 km's from the Mamantwan mine, the Mamantwan meteorological data is assumed to be representative of that which would be anticipated onsite.

6.2.2.1 Wind roses

As the local topography is relatively similar and considering that the project sites are less than 10-20 km's from the Mamantwan mine, the Mamantwan meteorological data for the 2013 to 2017 period is assumed to be representative of that which would be anticipated onsite.

Winds are expected to originate predominantly from the north easterly and southerly sectors (Figure 4). Wind speeds are moderate, averaging 3.2 m/s with a low percentage (9%) of calm conditions (<1 m/s). A significant diurnal variation in wind is observed during the monitoring period (Figure 5). A significant seasonal variation in wind is observed during the monitoring period (Figure 6).



Note: *Red indicates the Vlermuislaagte Loops site and blue the Sishen Erts Yard Loop site*

Figure 3: Topography of the Kathu region in relation to the project site (https://en-za.topographic-map.com/map-kgmcz/Kathu/?center=-27.68555%2C23.12325&zoom=10, 25 January 2023).

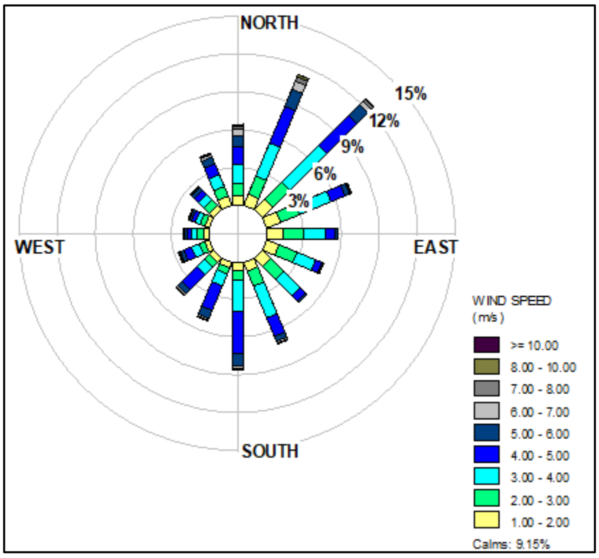


Figure 4: Modelled annual wind rose for the Mamantwan mine 10 km north of the Vlermuislaagte Loops for the period 2013 to 2017 (Golder, 2019)

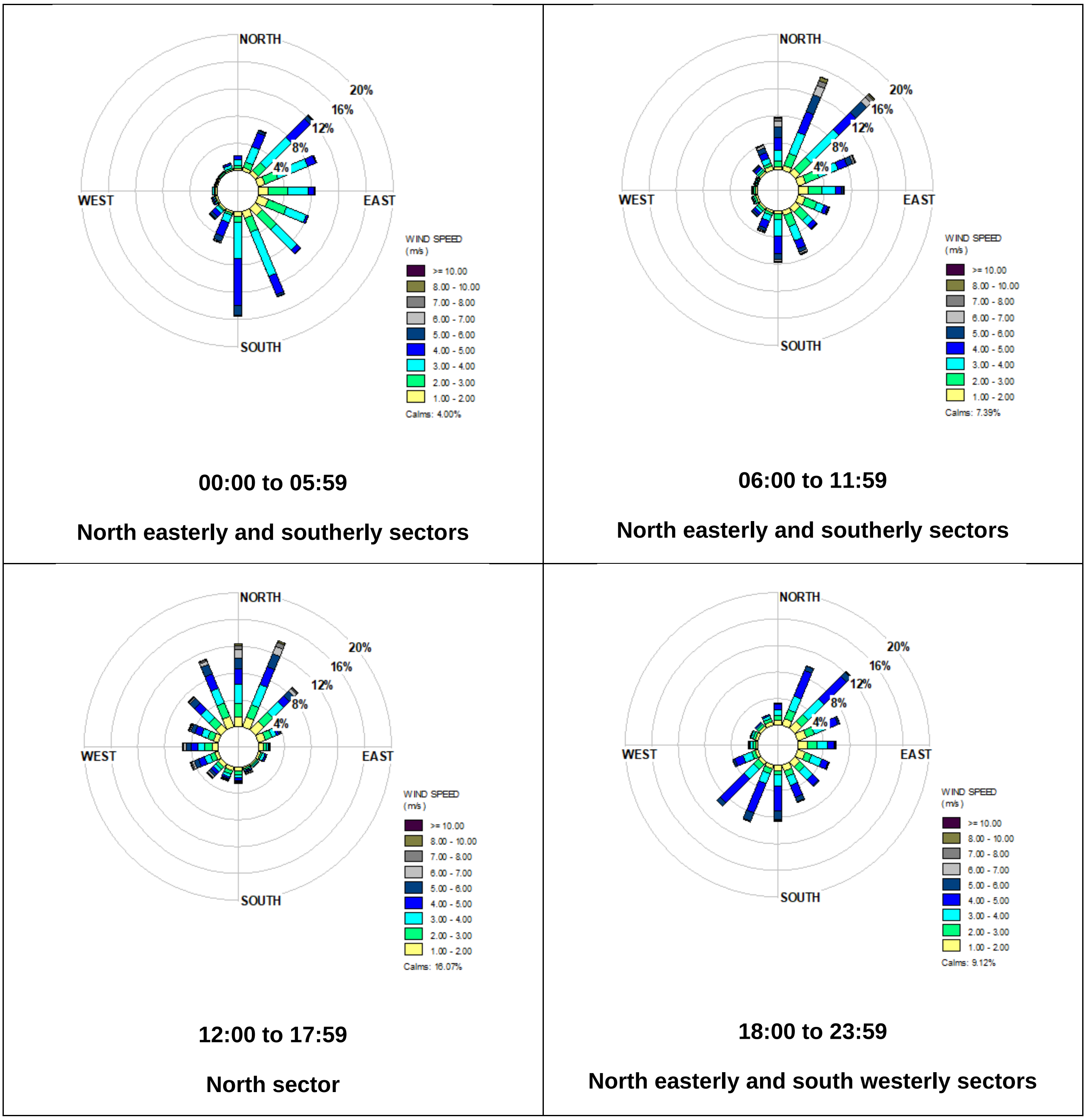


Figure 5: Modelled diurnal wind roses for Mamatwan with predominant wind directions for 2013-2017 (Golder, 2019).

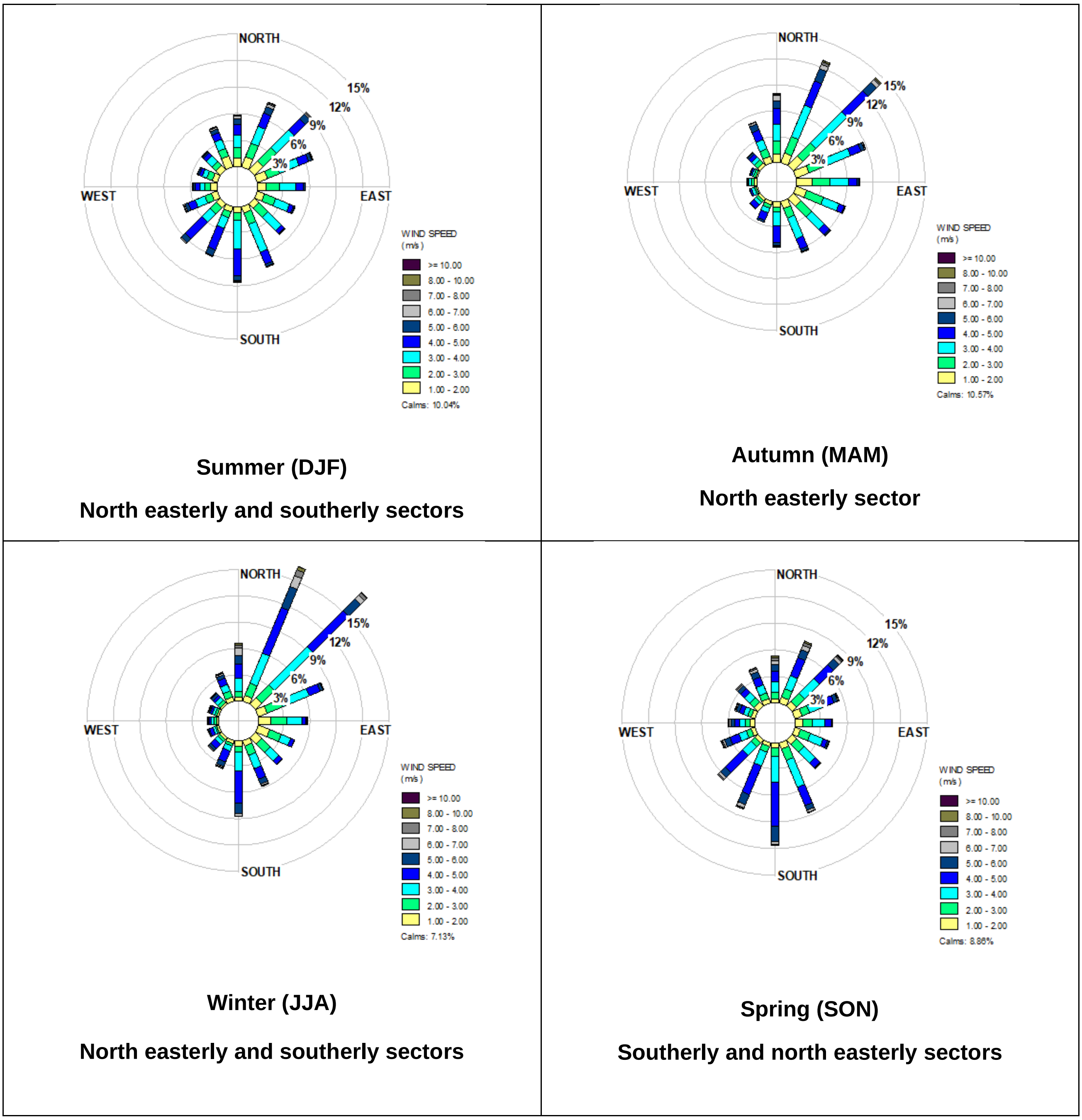


Figure 6: Modelled seasonal wind roses for Mamatwan with predominant wind directions for 2013-2017 (Golder, 2019).

6.2.2.2. Atmospheric temperature

Atmospheric temperature has a significant effect on the propagation character of an area. The propagation of a sound wave is faster in warm air than in cold air and thus when a sound wave propagates in air whose temperature varies with altitude, refraction occurs. Sound waves refract towards areas of lower temperature. At night, the air near the surface is cooler and sound waves are refracted towards the ground with the sinking air mass. During the day, the sun radiation heats the surface of the ground which heats the air in contact with the surface. The air near the surface is heated more than the air above which results in the sound waves being refracted upwards along with the rising air mass. For this reason, colder atmospheric temperatures typically increase noise levels at a distance from a source hence why noise carries further at night than compared to the day. Thermal inversions typically increase noise levels at a distance from the source as the noise reflects off the inversion layer and is directed back towards the ground with little to no attenuation.

No meteorological monitoring is undertaken within the project site currently. Reliance was thus placed on publicly available historic temperature data from www.meteoblue.com for Sishen. The data is presented for reference purposes only as formal verification is not possible as the full data source and data recovery levels are unknown.

Average temperatures within Sishen typically range between 33°C during the summer months to 2°C during the winter months and are anticipated to be relatively representative of temperatures experienced within the project footprint (Figure 7).

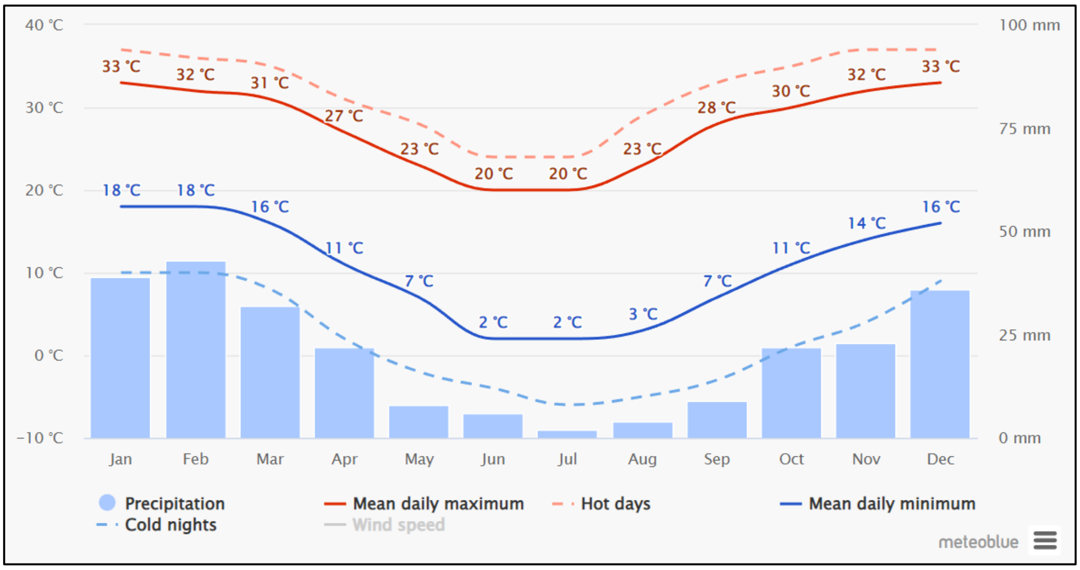


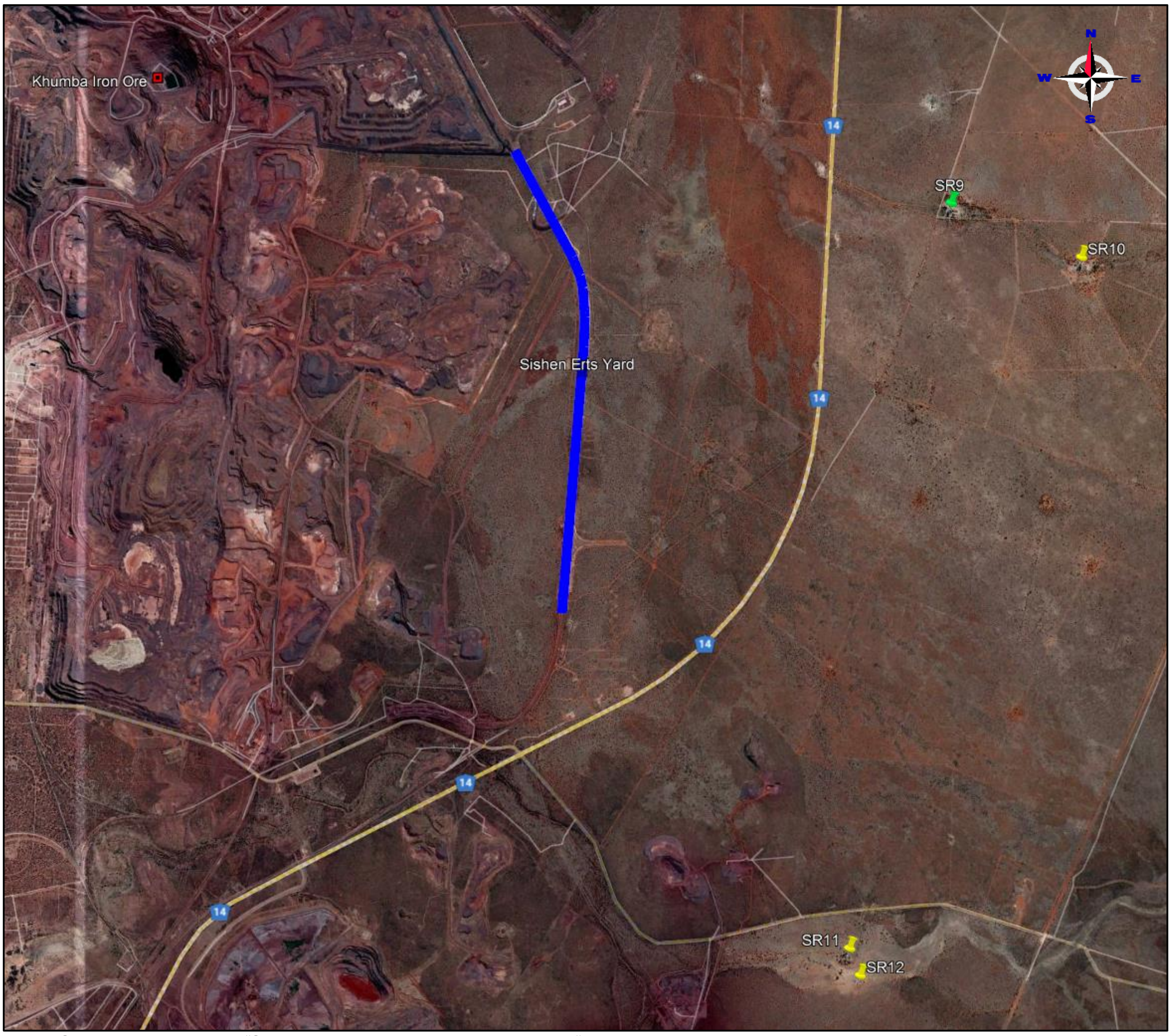
Figure 7: Average temperatures in Sishen based on historical data records (www.meteoblue.com, 25 January 2023)

7 SENSITIVE RECEPTORS

A total of fifteen (15) residential sensitive receptors (SR) within a 5 km radius of the proposed Sishen Erts Yard Loop site and Vlermuislaagte Loops site were identified (Table 11, Figure 8, and Figure 9).

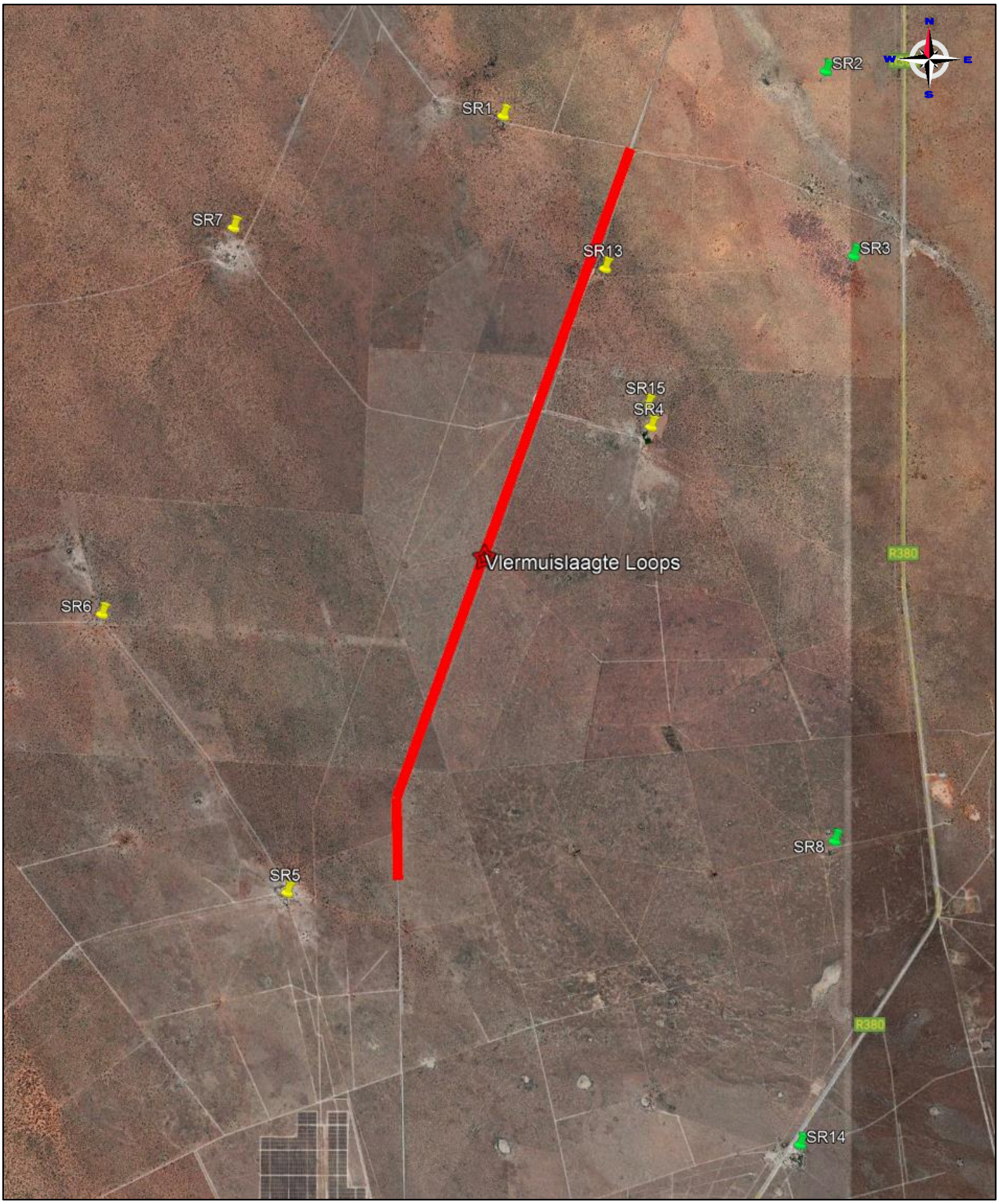
Table 11: Sensitive receptors (SR) around the proposed project (5 km radius)

Vlermuislaagte Loops site				Sishen Erts Yard Loop site			
Name	SANS 10103 District classification	South	East	Name	SANS 10103 District classification	South	East
SR1	Rural	27°27'49.35"S	22°57'3.20"E	SR9	Sub-urban	27°46'7.86"S	23° 4'50.83"E
SR2	Sub-urban	27°27'33.03"S	22°59'16.20"E	SR10	Rural	27°46'25.89"S	23° 5'39.50"E
SR3	Rural	27°28'40.67"S	27°28'40.67"S	SR11	Rural	27°50'14.32"S	23° 4'12.40"E
SR4	Rural	27°29'43.14"S	22°58'3.98"E	SR12	Rural	27°50'23.25"S	23° 4'16.35"E
SR5	Rural	27°32'33.46"S	22°55'34.06"E				
SR6	Rural	27°30'51.58"S	22°54'17.74"E				
SR7	Rural	27°28'30.17"S	22°55'12.05"E				
SR8	Sub-urban	27°32'14.48"S	22°59'19.59"E				
SR13	Rural	27°28'45.24"S	22°57'45.20"E				
SR14	Sub-urban	27°34'5.39"S	22°59'5.32"E				
SR15	Rural	27°29'35.43"S	22°58'2.66"E				



Note: *Green pins represent "Sub-urban" receptors and yellow pins "Rural" receptors*

Figure 8: Sensitive receptors (SR) around the proposed Sishen Erts Yard Loop site (Map sources: Google earth, 25 January 2023)



Note: *Green pins represent "Sub-urban" receptors and yellow pins "Rural" receptors*

Figure 9: Sensitive receptors (SR) around the proposed Vlermuislaagte Loops site (Map sources: Google earth, 25 January 2023)

8 BASELINE NOISE MONITORING

8.1 Site specific monitoring

No current (i.e. <3 years old) baseline noise monitoring date is available for the project area. Based on ATB Environmental Consulting's noise monitoring and assessment project experience, the baseline noise levels within the project area are anticipated to vary quite substantially based on the distribution of local key noise sources. Noise levels in the vicinity of the “rural” located farms and homesteads (i.e. yellow pointers) are anticipated to be within 45 dB(A) during the day and 35 dB(A) at night (i.e. considered “Rural district” under SANS 10103). These SANS 10103 assumed baseline noise levels will be used for further assessment purposes.

9 IMPACT ASSESSMENT – QUALITATIVE OPINION

9.1 Construction noise

The full details of the construction plans for the proposed Sishen Erts Yard Loop and Vlermuislaagte Loops have yet to been finalised. In order to provide a sound basis for the analysis of anticipated noise impacts, data related to typical construction activities has been sourced from various consultants and contractors, British Standard BS 5228 and the experience that ATB Environmental Consulting has working on similar projects.

Daily construction related traffic will vary over the duration of the construction period. The main percentage of the trips will be concentrated in the morning and late afternoon peak periods when deliveries are made. Construction activities will be undertaken during daytime hours only (i.e. 06:00 to 18:00). It is estimated that the construction durations will be 12 to 24-months.

9.1.1 Sources of construction noise

The following are anticipated to be the key noise sources related to the construction activities which may impact on nearby sensitive receptors:

- Construction camp establishment;
- Earthworks to remove topsoil and preparation of the Sishen Erts Yard and Vlermuislaagte Loops footprints;
- Erection of shuttering for concrete works;
- Fixing of steel reinforcing;
- Placing and vibration of concrete (i.e. with poker vibrators);
- Stripping of shuttering after concrete pouring;
- Erection of structural steelwork;
- Finishing operations on buildings including cladding, services installation, etc.;
- Tipping of railroad aggregate for railway line footprint preparation *(Note: Aggregate will be imported to site)*;
- Laying of sleepers and tracks including: cutting, welding, grinding and profiling of the track;
- Installation of all railroad and yard infrastructure;
- Erection of train overhead power line infrastructure;
- Crane lifting operations;
- General movement of heavy vehicles on site;
- Construction equipment including scrapers, dozers, compactors, water tankers etc.;
- Construction site fabrication workshops and plant maintenance workshops;
- Concrete batching plant;
- Construction of temporary construction access roads;
- Construction of railway line maintenance access road; and
- Construction material and equipment delivery vehicles.

The level and character of construction noise experienced at the nearby sensitive receptors will be highly variable as different activities with different plant/equipment will take place at different times, over different periods, in different combinations, in different sequences on the construction site. Typical noise levels generated by various types of construction equipment at difference distances is provided in Table 12 for reference purposes *(**Note:** These noise levels assume that the equipment is maintained in good order).*

Table 12: Typical noise levels generated by construction equipment (www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm)

Equipment description	Max. sound power levels - dB(A)	Construction noise level at a 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) - dB(A)											
		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	120	95	89	83	75	69	65	63	59	55	51	49	43
Backhoe	115	90	84	78	70	64	60	58	54	50	46	44	38
Chain Saw	120	95	89	83	75	69	65	63	59	55	51	49	43
Compactor (ground)	115	90	84	78	70	64	60	58	54	50	46	44	38
Compressor (air)	115	90	84	78	70	64	60	58	54	50	46	44	38
Concrete Batch Plant	118	93	87	81	73	67	63	61	57	53	49	47	41
Concrete Mixer Truck	120	95	89	83	75	69	65	63	59	55	51	49	43
Concrete Pump Truck	117	92	86	80	72	66	62	60	56	52	48	46	40
Concrete Saw	125	100	94	88	80	74	70	68	64	60	56	54	48
Crane	120	95	89	83	75	69	65	63	59	55	51	49	43
Dozer	120	95	89	83	75	69	65	63	59	55	51	49	43
Drill rig truck	119	94	88	82	74	68	64	62	58	54	50	48	42
Drum Mixer	115	90	84	78	70	64	60	58	54	50	46	44	38
Dump Truck	119	94	88	82	74	68	64	62	58	54	50	48	42
Excavator	120	95	89	83	75	69	65	63	59	55	51	49	43
Flat Bed Truck	119	94	88	82	74	68	64	62	58	54	50	48	42
Front end loader	115	90	84	78	70	64	60	58	54	50	46	44	38
Generator	117	92	86	80	72	66	62	60	56	52	48	46	40
Generator (<25KVA)	105	80	74	68	60	54	50	48	44	40	36	34	28
Grader	120	95	89	83	75	69	65	63	59	55	51	49	43
Impact Pile Driver	130	105	99	93	85	79	75	73	69	65	61	59	53
Jackhammer	120	95	89	83	75	69	65	63	59	55	51	49	43
Man Lift	120	95	89	83	75	69	65	63	59	55	51	49	43
Mounted Impact Hammer	125	100	94	88	80	74	70	68	64	60	56	54	48
Paver	120	95	89	83	75	69	65	63	59	55	51	49	43
Pickup Truck	90	65	59	53	45	39	35	33	29	25	21	19	13
Pumps	111. 7	87	81	75	67	61	57	55	51	47	43	41	35
Rivet Buster/ Chipping Gun	120	95	89	83	75	69	65	63	59	55	51	49	43
Rock Drill	120	95	89	83	75	69	65	63	59	55	51	49	43
Roller	120	95	89	83	75	69	65	63	59	55	51	49	43
Sand Blasting (single nozzle)	120	95	89	83	75	69	65	63	59	55	51	49	43
Scraper	120	95	89	83	75	69	65	63	59	55	51	49	43
Sheers (on backhoe)	120	95	89	83	75	69	65	63	59	55	51	49	43
Slurry Plant	113	88	82	76	68	62	58	56	52	48	44	42	36
Slurry Trenching Machine	117	92	86	80	72	66	62	60	56	52	48	46	40
Soil Mix Drill Rig	115	90	84	78	70	64	60	58	54	50	46	44	38
Tractor	119	94	88	82	74	68	64	62	58	54	50	48	42
Vacuum excavator (Vac - Truck)	120	95	89	83	75	69	65	63	59	55	51	49	43
Vacuum Street Sweeper	115	90	84	78	70	64	60	58	54	50	46	44	38
Ventilation Fan	120	95	89	83	75	69	65	63	59	55	51	49	43
Vibrating Hopper	120	95	89	83	75	69	65	63	59	55	51	49	43
Vibratory Concrete Mixer	115	90	84	78	70	64	60	58	54	50	46	44	38
Vibratory Pile Driver	130	105	99	93	85	79	75	73	69	65	61	59	53
Warning Horn	120	95	89	83	75	69	65	63	59	55	51	49	43
Welder/Torch	108	83	77	71	63	57	53	51	47	43	39	37	31
Average		***93***	***87***	***80***	***73***	***67***	***63***	***60***	***57***	***53***	***49***	***47***	***40***

9.1.2 Construction noise impacts

Based on the typical noise levels generated by construction machinery and ATB Environmental Consulting's experience, a one-hour equivalent noise level of between 70 bB(A) to 110 bB(A) may be anticipated within the construction areas adjacent to the specific noise sources. The one-hour equivalent noise level across the construction sites are anticipated to be in the order of approximately 75 dB(A).

By comparing an average of the constructions equipment's typical construction noise levels at a given offset (Table 12) with the expected baseline noise levels at the sensitive receptors, and against the SANS 10103 criteria for evaluating the community or group response to a noise source (Table 8), the noise impacts can be qualitatively assessed at a high level regarding nuisance effects and thus used to infer the anticipated level of impact at the sensitive receptors. To refine the impact assessment further, one must consider the locations of the nearby sensitive receptors in relation to the power plant footprint and transmission line corridors.

This assessment has taken a conservative approach and assumed the construction noise emissions will not exceed 85 $dB(A)_{Max}$ at the boundaries of the Sishen Erts Yard Loop and Vlermuislaagte Loops construction areas.

9.1.2.1 Sishen Erts Yard Loop construction noise impacts

The daytime Sishen Erts Yard Loop construction noise nuisance impacts are anticipated to be limited to within an approximate 1250 m radius of the construction activities (Table 13). No daytime construction noise impacts are therefore anticipated at any of the "Rural" and or "Sub-urban" receptors in the vicinity of the proposed development as the nearest sensitive receptor, SR 9, a "Sub-urban" receptor, is located approximately 3.8 km east of the site (Note: Green pins represent "Sub-urban" receptors and yellow pins "Rural" receptors

Figure *8*).

The noise nuisance impacts of the construction phase are anticipated to be of a Negligible environmental significance (Table 14). The implementation of typical construction noise mitigation measures will further reduce the risks of any noise nuisance impacts which will remain with a Negligible environmental significance (Table 14).

9.1.2.2 Vlermuislaagte Loops construction noise impacts

The daytime Vlermuislaagte Loops construction noise nuisance impacts are anticipated to be limited to within an approximate 1250 m radius of the construction activities (Table 15). The following "Rural" receptors were identified as possibly being impacted by the daytime construction noise impacts (Table 15 and Figure 9):

- SR 13, farm residences, located ± 80 m east of the proposed development corridor and may trigger a very strong community response;
- SR 4, a farm residence located ± 1 km east of the proposed development corridor and may trigger a little community response;
- SR 5, a farm residence located ±1.2km east of the proposed development corridor and may trigger a little community response; and
- SR 15, informal farm residences, located ±1.25km east of the proposed development corridor and may trigger a little community response.

The noise nuisance impacts at SR 13 are anticipated to be of a High environmental significance without mitigation and low with mitigation (Table 16). We recommend that should SR13 lodge noise complaints, a detailed environmental noise monitoring survey must be undertaken to identify the potential offending noise sources and a noise management plan must be compiled and implemented to mitigate the construction phase noise impacts.

The noise nuisance impacts at SR 4, SR 5, and SR 15 are anticipated to be of a Low environmental significance without mitigation (Table 16). With the implementation of typical construction noise mitigation measures, these impacts may be reduced however are likely to remain with a Low environmental significance.

9.1.2.3 Cumulative construction impacts

The presence of several significant noise sources within a 10 km radius of the proposed site of the including: national and regional road infrastructure; the existing rail infrastructure; mining activities; industrial activities; Sishen airport; commercial activities; and power generation have likely significantly impacted the baseline noise levels within the wider project area. The noise contributions by the proposed project's construction phase may serve to nominally increase the baseline levels although most of the noise nuisance is anticipated to be absorbed by the existing noise climate of the local area.

Table 13: Assessment of the Sishen Erts Yard Loop construction noise nuisance level during the day - Rural and Sub-urban receptors

Plant/Equipment	Typical Noise Level at Given Offset (dBA) during the day									
	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	1500 m	2000 m	2500 m
Averaged construction noise	67	63	60	57	53	49	47	44	40	39
Baseline noise levels at the "Rural" receptors (day)	45	45	45	45	45	45	45	45	45	45
Standard value	45	45	45	45	45	45	45	45	45	45
Excess, ΔLReq,T dB(A)	22	18	15	12	8	4	2	-1	-5	-6
Community response	Very strong	Very strong	Strong	Strong	Medium	Little	Little	Unlikely	Unlikely	Unlikely
Plant/Equipment	**Typical Noise Level at Given Offset (dBA) during the day**									
	100 m	**150 m**	**200 m**	**300 m**	**500 m**	**750 m**	**1000 m**	**1500 m**	**2000 m**	**2500 m**
Averaged construction noise	67	63	60	57	53	49	47	44	40	39
Baseline noise levels at the "Sub-urban" receptors (day)	45	45	45	45	45	45	45	45	45	45
Standard value	50	50	50	50	50	50	50	50	50	50
Excess, ΔLReq,T dB(A)	17	13	10	7	3	-1	-3	-6	-10	-11
Community response	Very strong	Strong	Medium	Medium	Little	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

Table 14: Construction noise impact assessment for the Sishen Erts Yard Loop during the day - Rural and Sub-urban receptors

Activity	Impact summary	Occurrence			Severity				Environmental Consequence	Environmental Consequence
		Direction	Probability	Duration	Magnitude	Geographic Extent	Reversibility	Frequency	(Before Mitigation)	(After Mitigation)
Sishen Erts Yard Loop daytime construction noise impacts	Noise nuisance experienced at all "Rural" and "Sub-urban" receptors	Neutral	Improbable	Short-term	Negligible	Local	Reversible	Low	No Impact	No Impact

Table 15: Assessment of the Vlermuislaagte Loops construction noise nuisance level during the day - Rural and Sub-urban receptors

Plant/Equipment	Typical Noise Level at Given Offset (dBA) during the day									
	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	1500 m	2000 m	2500 m
Averaged construction noise	67	63	60	57	53	49	47	44	40	39
Baseline noise levels at the "Rural" receptors (day)	45	45	45	45	45	45	45	45	45	45
Standard value	45	45	45	45	45	45	45	45	45	45
Excess, ΔLReq,T dB(A)	22	18	15	12	8	4	2	-1	-5	-6
Community response	Very strong	Very strong	Strong	Strong	Medium	Little	Little	Unlikely	Unlikely	Unlikely
Plant/Equipment	**Typical Noise Level at Given Offset (dBA) during the day**									
	100 m	**150 m**	**200 m**	**300 m**	**500 m**	**750 m**	**1000 m**	**1500 m**	**2000 m**	**2500 m**
Averaged construction noise	67	63	60	57	53	49	47	44	40	39
Baseline noise levels at the "Sub-urban" receptors (day)	45	45	45	45	45	45	45	45	45	45
Standard value	50	50	50	50	50	50	50	50	50	50
Excess, ΔLReq,T dB(A)	17	13	10	7	3	-1	-3	-6	-10	-11
Community response	Very strong	Strong	Medium	Medium	Little	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

Table 16: Construction noise impact assessment for the Vlermuislaagte Loops during the day - Rural and Sub-urban receptors

Activity	Impact summary	Occurrence			Severity				Environmental Consequence	Environmental Consequence
		Direction	Probability	Duration	Magnitude	Geographic Extent	Reversibility	Frequency	(Before Mitigation)	(After Mitigation)
Vlermuislaagte Loops daytime construction noise impacts	Noise nuisance experienced at "Rural" receptor SR 13	Negative	High	Short-term	High	Local	Reversible	High	High*	Low*
	Noise nuisance experienced "Rural" receptors SR 4, SR 5, & SR15	Negative	Low	Short-term	Low	Local	Reversible	Medium	Low	Low
	Noise nuisance experienced at all other "Rural" and "Sub-urban" receptors	Neutral	Improbable	Short-term	Negligible	Local	Reversible	Low	No Impact	No Impact

Note: **The construction phase impacts experienced at SR 13 may be High but will be very limited in duration (i.e. construction phase only) and thus the environmental consequence after mitigation is considered Low and does not serve as a project fatal flaw.*

9.2 Operational noise

The full details of the operational phase for the proposed Sishen Erts Yard Loop and Vlermuislaagte Loops have yet to been finalised. In order to provide a sound basis for the analysis of anticipated noise impacts, data related to typical operational activities has been sourced from various consultants and contractors, and the experience that ATB Environmental Consulting has working on a variety of noise impact assessment projects.

By comparing the calculated average operational noise levels at given offsets with the expected baseline noise levels at the sensitive receptors and against the SANS 10103 criteria for evaluating the community or group response to a noise source (Table 8), the noise impacts can be qualitatively assessed at a high level regarding nuisance effects and thus used to infer the anticipated level of impact at the sensitive receptors. To refine the impact assessment further, one must consider the locations of the nearby sensitive receptors in relation to the proposed infrastructure and development corridor boundary.

9.2.1 Operational noise impacts

It is understood that the train frequency on the current line is approximately 22 trains per day operating over a 24-hour period. Under the proposed project, the frequency of the trains will be reduced to approximately 11 trains per day operating over a 24-hour period however, the train waggon length will be approximately doubled. The noise impact at nearby sensitive receptors will be experienced less frequency but for a slightly longer duration as each train passes. Cumulatively, the noise impacts associated with the changes in train frequency and length are thus anticipated to remain neutral (i.e. relatively unchanged).

The typical operational phase noise levels from the Vlermuislaagte Loops and Sishen Erts Yard Loop are anticipated to typically range from 55 dB(A) to 110 dB(A) with an average operational noise level across the sites estimated at approximately 75 dB(A) depending on the activities and implemented noise mitigation measures.

The project will however enforce design specification limitations that the cumulative noise generation levels must not exceed an L_{AMax} dB(A) of 85 dB(A) at the development corridor boundary and an L_{Aeq} of 75 bB(A) within 30 m of the development corridor boundary. The 85 $dB(A)_{Max}$ limit at the development corridor boundary is viewed as the worst-case scenario and thus the most conservative approach Based on the proposed project plot plans, the infrastructure will extend approximately 40 m to the east of the mainline within the 100 m development corridor to allow for the new servitude. This assessment thus assumes that the noise sources are at least 60 m from the boundary. The 85 $dB(A)_{Max}$ limit has therefore been assumed as the uniform boundary noise level for the purpose of this assessment.

9.2.1.1 Sources of operational noise

Disturbance from trains can be divided into two key impacts:

- Airborne noise from the operation of a surface rail line that is heard at the sensitive receptors; and
- Ground-borne noise and vibration generated inside a building by ground-borne vibration generated from the pass-by of a vehicle on rail *(Note: Assessment of these aspects is excluded from this assessment as discussed in the limitation section).*

Noise disturbance associated with trains and train yards is dependent upon the following aspects:

- Physical characteristics of the train;
- Train propulsion system (i.e. electric, diesel, diesel-electric);
- Breaking technology employed on wagons and locomotives;
- Number of locomotives, wagons and overall train length;
- Operating speed;
- State of acceleration and or deceleration;
- Number of axels per train;
- Total weight and length of the train;
- Contour/alignment of the railway line and associated curve squeal and brake squeal;
- Noise radiated from vibrating structures;
- Locomotive hooters;
- Implemented noise mitigation measures;
- Auxiliary equipment noise;
- Railway maintenance operations;

- Interaction of wheels and rails based on the condition of the wheels and rails
- Workshops and other equipment maintenance activities; and
- Ground geology.

Key “loud” train noise sources include: Train hooters; curve squeal; and brake squeal:

- Train hooters are activated prior to train pull off and at level crossings. The hooters are sounded in short bursts of a very high-level pure tone noise which is audible over large distances. Railway safety specifications require that train hooter must produce a minimum level of 120 dB(A) at 5 m. Train hooter noise impacts are however significantly reduced by the very short duration. The equivalent L_{Aeq} which determines the noise impact, depends on the duration and number of blasts. Assuming, two (2) hooter blasts with a five (5) second duration each, averaged over a 1-hour period yields an L_{Aeq} of 40 dB(A) at approximately 650m from the source. Based on the prevailing meteorological conditions at the time of the hooter blasts, the noise impact may extend to approximately 1km down-wind; and
- Noise levels associated with curve and break squeal as trains approach a sharp curved railway alignment and/or under heavy breaking could range between the 90 dB(A) to more than 105 dBA (peak) at source and can be audible for more than 2 km.

9.2.1.2 Sishen Erts Yard Loop operational noise impacts

The daytime Sishen Erts Yard Loop operational noise nuisance impacts are anticipated to be limited to within an approximate 650 m radius of the development corridor boundary (Table 17 & Table 18). During the night-time, the radius of impact is anticipated to expand to approximately 1.75 km (Table 17 & Table 18). No daytime and/or night time operational noise impacts are therefore anticipated at any of the “Rural” and or “Sub-urban” receptors in the vicinity of the proposed development as the nearest sensitive receptor, SR 9, a “Sub-urban” receptor, is located approximately 3.8 km east of the site (Table 17, Table 18, and Note: Green pins represent “Sub-urban” receptors and yellow pins “Rural” receptors

Figure *8*). The occasional operational loud noises such as train horns may be audible on occasion at the nearby sensitive receptors however these are not anticipated to cause any significant noise nuisance as will be absorbed into the existing local noise baseline and will be very transient in nature.

The daytime and night-time noise nuisance impacts of the operational phase are anticipated to be of a Negligible environmental significance (Table 19). The implementation of typical operational phase noise mitigation measures will further reduce the risks of any noise nuisance impacts which will remain with a Negligible environmental significance (Table 19).

The occasional operational loud noises such as train horns may be audible on occasion at the nearby sensitive receptors however these are not anticipated to cause any significant noise nuisance as will be absorbed into the existing local noise baseline and will be highly transient in nature.

9.2.1.3 Vlermuislaagte Loops operational noise impacts

The daytime Vlermuislaagte Loops operational noise nuisance impacts are anticipated to be limited to within an approximate 650 m radius of the development corridor boundary (Table 20 & Table 21). During the night-time, the radius of impact is anticipated to expand to approximately 1.75 km (Table 20 & Table 21).

The following “Rural” receptors were identified as possibly being impacted by the daytime operational noise impacts (Table 20 and Figure 9):

- SR 13, farm residences, located ± 80 m east of the proposed development corridor and may trigger a very strong community response *(Note: Mainly a function of the current existing operations)*.

Considering that the cumulative noise impacts associated with the changes in train frequency and length are anticipated to “Neutral”, the daytime noise nuisance impacts at SR 13 are anticipated to be of a Medium environmental significance without mitigation (Table 22). With the implementation of typical operational noise mitigation measures, these impacts may be reduced to a Low environmental significance (Table 22). We recommend that should SR13 lodge noise complaints, a detailed environmental noise monitoring survey must be undertaken to identify the potential offending noise sources and a noise management plan must be compiled and implemented to mitigate the operational phase noise impacts.

The following “Rural” receptors were identified as possibly being impacted by the night-time operational noise impacts (Table 20 and Figure 9):

- SR 13, farm residences, located ± 80 m east of the proposed development corridor and may trigger a very strong community response *(Note: Mainly a function of the current existing operations)*;
- SR 4, a farm residence located ± 1 km east of the proposed development corridor and may trigger a little community response;
- SR 5, a farm residence located ±1.2 km east of the proposed development corridor and may trigger a little community response;
- SR 15, informal farm residences, located ±1.25 km east of the proposed development corridor and may trigger a little community response; and
- SR 1 a farm residence located ±1.5 km north-west of the proposed development corridor and may trigger a little community response.

Considering that the cumulative noise impacts associated with the changes in train frequency and length are anticipated to “Neutral”, the night-time noise nuisance impacts at SR 13 are anticipated to be of a Medium environmental significance without mitigation (Table 22). With the implementation of typical operational noise mitigation measures, these impacts may be reduced to a Low environmental significance (Table 22).

The night-time noise nuisance impacts at SR 4, SR 5, SR 15, and SR 1 are anticipated to be of a Low environmental significance without mitigation (Table 22). With the implementation of typical operational noise mitigation measures, these impacts may be reduced however are likely to remain with a Low environmental significance (Table 22).

No daytime and/or night time operational noise impacts are anticipated at any of the “Sub-urban” receptors in the vicinity of the proposed development as the nearest sensitive receptor, SR 2, a “Sub-urban” receptor, is located approximately 2.3 km north-east of the site (Table 21, Table 22 and Figure 9).

The occasional operational loud noises such as train horns may be audible on occasion at the nearby sensitive receptors however these are not anticipated to cause any significant noise nuisance as will be absorbed into the existing local noise baseline and will be highly transient in nature.

9.2.1.4 Cumulative operational noise impacts

The presence of several significant noise sources within a 10 km radius of the proposed site of the including: national and regional road infrastructure; the existing rail infrastructure; mining activities; industrial activities; Sishen airport; commercial activities; and power generation have likely significantly impacted the baseline noise levels within the wider project area. The noise contributions by the proposed project’s operational phase may serve to nominally increase the baseline levels although most of the noise nuisance is anticipated to be absorbed by the existing noise climate of the local area.

Table 17: Assessment of the Sishen Erts Yard Loop operational noise levels during the day and night - Rural receptors

Plant/Equipment	Typical Noise Level at Given Offset (dBA) during the day										
	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	1500 m	2000 m	2500 m	3000 m
Averaged operational noise	65	62	59	56	51	48	45	42	39	37	36
Baseline noise levels at the "Rural" receptors (day)	45	45	45	45	45	45	45	45	45	45	45
Standard value	50	50	50	50	50	50	50	50	50	50	50
Excess, ΔLReq,T dB(A)	15	12	9	6	1	-3	-5	-9	-11	-13	-15
Community response	Strong	Strong	Medium	Medium	Little	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Plant/Equipment	**Typical Noise Level at Given Offset (dBA) during the night**										
	100 m	**150 m**	**200 m**	**300 m**	**500 m**	**750 m**	**1000 m**	**1500 m**	**2000 m**	**2500 m**	**3000 m**
Averaged operational noise	65	62	59	56	51	48	45	42	39	37	36
Baseline noise levels at the "Rural" receptors (night)	35	35	35	35	35	35	35	35	35	35	35
Standard value	40	40	40	40	40	40	40	40	40	40	40
Excess, ΔLReq,T dB(A)	25	22	19	16	11	8	5	2	-1	-3	-5
Community response	Very strong	Very strong	Very strong	Very strong	Strong	Medium	Little	Little	Unlikely	Unlikely	Unlikely

Table 18: Assessment of the Sishen Erts Yard Loop line operational noise levels during the day and night – Sub-urban receptors

Plant/Equipment	Typical Noise Level at Given Offset (dBA) during the day								
	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	1500 m	2000 m
Averaged operational noise	65	62	59	56	51	48	45	42	39
Baseline noise levels at the "Sub-urban" receptors (day)	50	50	50	50	50	50	50	50	50
Standard value	55	55	55	55	55	55	55	55	55
Excess, ΔLReq,T dB(A)	10	7	4	1	-4	-8	-10	-14	-16
Community response	Medium	Medium	Little	Little	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Plant/Equipment	**Typical Noise Level at Given Offset (dBA) during the night**								
	100 m	**150 m**	**200 m**	**300 m**	**500 m**	**750 m**	**1000 m**	**1500 m**	**2000 m**
Averaged operational noise	65	62	59	56	51	48	45	42	39
Baseline noise levels at the "Sub-urban" receptors (night)	40	40	40	40	40	40	40	40	40
Standard value	45	45	45	45	45	45	45	45	45
Excess, ΔLReq,T dB(A)	20	17	14	11	6	3	0	-4	-6
Community response	Very strong	Very strong	Strong	Strong	Medium	Little	Little	Unlikely	Unlikely

Table 19: Operational noise impact assessment for the Sishen Erts Yard Loop during the day and night-time - Rural and Sub-urban receptors

Activity	Impact summary	Occurrence			Severity				Environmental Consequence	Environmental Consequence
		Direction	Probability	Duration	Magnitude	Geographic Extent	Reversibility	Frequency	(Before Mitigation)	(After Mitigation)
Sishen Erts Yard daytime operational noise impacts	Noise nuisance experienced at all "Rural" and "Sub-urban" receptors	Neutral	Improbable	Long-term	Negligible	Local	Reversible	Low	**No Impact**	**No Impact**
Sishen Erts Yard night-time operational noise impacts	Noise nuisance experienced at all "Rural" and "Sub-urban" receptors	Neutral	Improbable	Long-term	Negligible	Local	Reversible	Low	**No Impact**	**No Impact**

Table 20: Assessment of the Vlermuislaagte Loops operational noise nuisance levels - Rural receptors

Plant/Equipment	Typical Noise Level at Given Offset (dBA) during the day										
	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	1500 m	2000 m	2500 m	3000 m
Averaged operational noise	65	62	59	56	51	48	45	42	39	37	36
Baseline noise levels at the "Rural" receptors (day)	45	45	45	45	45	45	45	45	45	45	45
Standard value	50	50	50	50	50	50	50	50	50	50	50
Excess, ΔLReq,T dB(A)	15	12	9	6	1	-3	-5	-9	-11	-13	-15
Community response	Strong	Strong	Medium	Medium	Little	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Plant/Equipment	**Typical Noise Level at Given Offset (dBA) during the night**										
	100 m	**150 m**	**200 m**	**300 m**	**500 m**	**750 m**	**1000 m**	**1500 m**	**2000 m**	**2500 m**	**3000 m**
Averaged operational noise	65	62	59	56	51	48	45	42	39	37	36
Baseline noise levels at the "Rural" receptors (night)	35	35	35	35	35	35	35	35	35	35	35
Standard value	40	40	40	40	40	40	40	40	40	40	40
Excess, ΔLReq,T dB(A)	25	22	19	16	11	8	5	2	-1	-3	-5
Community response	Very strong	Very strong	Very strong	Very strong	Strong	Medium	Little	Little	Unlikely	Unlikely	Unlikely

Table 21: Assessment of the Vlermuislaagte Loops operational noise nuisance levels - Sub-urban receptors

Plant/Equipment	Typical Noise Level at Given Offset (dBA) during the day								
	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	1500 m	2000 m
Averaged operational noise	65	62	59	56	51	48	45	42	39
Baseline noise levels at the "Sub-urban" receptors (day)	50	50	50	50	50	50	50	50	50
Standard value	55	55	55	55	55	55	55	55	55
Excess, ΔLReq,T dB(A)	10	7	4	1	-4	-8	-10	-14	-16
Community response	Medium	Medium	Little	Little	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Plant/Equipment	**Typical Noise Level at Given Offset (dBA) during the night**								
	100 m	**150 m**	**200 m**	**300 m**	**500 m**	**750 m**	**1000 m**	**1500 m**	**2000 m**
Averaged operational noise	65	62	59	56	51	48	45	42	39
Baseline noise levels at the "Sub-urban" receptors (night)	40	40	40	40	40	40	40	40	40
Standard value	45	45	45	45	45	45	45	45	45
Excess, ΔLReq,T dB(A)	20	17	14	11	6	3	0	-4	-6
Community response	Very strong	Very strong	Strong	Strong	Medium	Little	Little	Unlikely	Unlikely

Table 22: Operational noise impact assessment for the Vlermuislaagte Loops during the day and night-time - Rural and Sub-urban receptors

Activity	Impact summary	Occurrence			Severity				Environmental Consequence (Before Mitigation)	Environmental Consequence (After Mitigation)
		Direction	Probability	Duration	Magnitude	Geographic Extent	Reversibility	Frequency		
Vlermuislaagte Loops daytime operational noise impacts	Noise nuisance experienced at "Rural" receptor SR 13	Negative	Medium	Long-term	Medium	Local	Reversible	Medium	**Moderate**	**Low**
	Noise nuisance experienced at all other "Rural" and "Sub-urban" receptors	Neutral	Improbable	Long-term	Negligible	Local	Reversible	Low	**No Impact**	**No Impact**
Vlermuislaagte Loops night-time operational noise impacts	Noise nuisance experienced at "Rural" receptor SR 13	Negative	Medium	Long-term	Medium	Local	Reversible	Medium	**Moderate**	**Low**
	Noise nuisance experienced "Rural" receptors SR 4, SR 5, SR15	Negative	Low	Long-term	Low	Local	Reversible	Medium	**Low**	**Low**
	Noise nuisance experienced at all other "Rural" and "Sub-urban" receptors	Neutral	Improbable	Long-term	Negligible	Local	Reversible	Low	**No Impact**	**No Impact**

9.3 Decommissioning phase

Decommissioning and the anticipated noise impacts have not been specifically assessed as it is anticipated that the decommissioning process will be undertaken via a decommissioning Environmental process which will specifically address these issues. Nevertheless, decommissioning impacts are anticipated to be similar to those experienced during the construction phase.

10 SUMMARY OPINION

Based on the assessment of the anticipated noise impacts of the construction, operation and decommissioning phases:

- There is no substantive reason why the development of the Sishen Erts Yard Loop cannot be authorised as no noise impacts serve as project fatal flaws for this proposed project site;
- There is no substantive reason why the development of the Vlermuislaagte Loops cannot be authorised as no noise impacts serve as project fatal flaws for this proposed project site; and
- No cumulative noise impacts were identified which would serve as a fatal flaw to the proposed project.

It must also be noted that it is unreasonable to expect the noises generated by this proposed project to be inaudible at the sensitive receptors under all circumstances, even mitigated noise. This would be an unrealistic expectation which is not required or expected from any other noise source (i.e. agricultural, transportation related, commercial, or industrial noise sources etc). Care must be taken to ensure that the sound produced by the proposed development is at a reasonable level in relation to the existing ambient sound levels considering that the proposed project is not increasing he capacity of the railway lines but allows for the frequency of trains to be increased for ease of operations and increased ore hauling aligned to the aims of the expansion project; and

It is also recommended that mitigation and best practice measures be implemented as recommended in Section 11 to mitigate any impacts. These recommendations should be included in the Environmental Management Programme (EMP) for the project.

11 RECOMMENDED MITIGATION AND BEST PRACTICE MEASURES

11.1 Design phase

The following design phase recommended mitigation measures should be implemented:

- Design specifications for the Engineering, Procurement and Construction (EPC) contractor and/or Project developer must include the requirement that the cumulative noise generation levels of the trains on the railway line must not exceed an L_{AMax} dB(A) of 85 dB at the development corridor boundary and L_{Aeq} of 75 bB(A) within 30 m of the development corridor boundary. All project designs must incorporate this aspect to ensure compliance once built;
- Continuous welded rails and ballast should be used to the noise generation factor. is indicated to be implemented by the developer which will result in a noise reduction factor. The developer can consider a float slab track system at areas where no ballast may be used, generally slab tracks can be +5 dB louder than ballasted tracks (Michas, 2012);
- Implement track vibration isolation techniques; and
- Programmes to manage rail and wheels ground and air-borne vibration should be considered. The developer can consider the implementation of composite material with added rubber (or similar) brake shoes ("K or LL Blocks") as cast-iron brakes cause wheel roughness, more friction and noise. These wheel dampers will produce the lowest peak noise levels, but may not prevent wheel squeal fully (Jansen *Et. Al.*, 2008). The LL brake block system has the potential to reduce rolling and braking noise in favour of cast iron brakes and K blocks. LL block systems does not require the adaption of cast iron brake systems and reduces wheel ware compared to conventional cast-iron brakes.

11.2 Construction phase

The following construction recommended mitigation measures must be implemented:

- Construction noise emissions must be mitigated such that they do not exceed an L_{AMax} of 85 dB at the development corridor boundary and a 1-hour L_{Aeq} of 75 bB(A) within 30 m of the development corridor boundary;
- Construction camp, mobile equipment and other noisy fixed facilities should be located as far away from the development corridor boundary and sensitive receptors as possible to allow for some degree of natural noise attenuation between the noise source and nearest sensitive receptors;
- All construction vehicles and equipment are to be kept in good repair to reduce operational noise levels;
- Where possible, stationary noisy equipment (for example compressors, pumps, pneumatic breakers,) should be encapsulated in acoustic covers, screens or sheds. Proper sound insulation can reduce noise by up to 20 dB(A);
- Construction activities are only to be undertaken during the daytime (i.e. 06:00 to 18:00);
- With regard to unavoidable very noisy construction activities in the vicinity of noise sensitive areas, the Applicants should liaise with local residents on how best to minimise the impact;
- Machines in intermittent use should be shut down in the intervening periods between work or throttled down to a minimum;
- Vehicles should not be allowed to idle for more than 5-minutes when not in use;
- All equipment is to be well maintained and fitted with appropriate noise abatement measures;
- Under the Occupational Health and Safety Act (Act No. 85 of 1993) (OHSAct) Noise-induced hearing loss regulations (NIHLR) section 10, an employer shall ensure the exposure to noise above the 85 dB(A) noise rating level is controlled to below that level via implementing engineering control measures or administration control measures or by enforcing the wearing of hearing protection by people exposed to above noise limit levels. Section 8 requires that an employer shall establish and maintain a system of medical surveillance for all employees exposed to noise at or above the noise-rating limit. Medical surveillance is typically undertaken annually. Section 9 requires the demarcation of noise zones and the wearing of hearing protection equipment on entering such noise zones and Section 10 on the control of noise exposures by the employer. The above requirements under OHSAct are to be met onsite during the construction phase;
- Rigorous speed control to reduce the noise from vehicle traffic onsite must be implemented. It is recommended maximum speed of 30 km/h to be set on all construction roads. If significant noise is noted and/or noise complaints are received, the noise levels must be investigated, and suitable mitigation measures are to be implemented;
- If noise levels associated with construction material handling activities are deemed as too high, mechanisms to reduce noise levels must be investigated;
- A materials handling drop height policy should be maintained onsite. All equipment operators should be trained in the policy such that drop height reduction is implemented to reduce noise generation during construction operations;
- Encouraging the receipt of materials during non-peak traffic hours to avoid traffic build-up and associated noise; and
- The above recommendations are to be included in each of the Environmental Management Programmes (EMPs) for each Portion as applicable.

11.3 Operational phase

The following operational phase recommended mitigation measures must be implemented:

- Consideration of a 40 km/h train speeds limit between the Sishen Erts Yard and Vlermuislaagte Loops should be considered to reduce train noise at the sensitive receptors;
- 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 to eliminate corrugated rails;

- Cracked, corrugated or damaged rails should be mended or replace immediately to reduce noise and vibrations;
- Locomotive and/or wagon wheels with defects and/or flat spots must be repaired or replace to minimise vibrations;
- Operational mitigation measures implemented must be sufficient such that the operational noise levels do not exceed an L_{AMax} of 85 dB at the development corridor boundary and a 1-hour L_{Aeq} of 75 bB(A) within 30 m of the development corridor boundary;
- Vehicles should not be allowed to idle for more than 5-minutes when not in use;
- Locomotives should not be allowed to idle for more than 10-minutes when not in use;
- Noisy operational phase maintenance activities, are to be confined to reasonable hours during the day. No noisy maintenance activities are to be undertaken at night;
- Rigorous speed control to reduce the noise from onsite vehicle traffic must be maintained. It is recommended maximum speed of 30 km/h to be set onsite. If significant noise is noted and/or noise complaints are received, the noise levels must be investigated, and suitable mitigation measures are to be implemented;
- Shunting operations should be limited to daytime operating periods (where possible) to limit the night-time impacts;
- Compliance is to be achieved with Sections 8, 9, 10 of the OHSAct NIHLR during the operational phase;
- Establish a noise and vibration complaint logging system with established lines of communication (e.g. a help line where complaints could be lodged). All potential sensitive receptors should be made aware the complaints system and how to raise a complaint (i.e. contact numbers, email etc). Legitimate noise and vibration complaints could arise during the project. For example, a sudden increase in noise levels could result from a section of poorly maintained track needing maintenance or rolling stock. The logged complaints could be provided to the railway maintenance teams to further investigate (i.e. rail roughness, corrugated rail head, profile etc.);
- A noise propagation model must be developed to illustrate the potential extent of the noise impact from the railway. This may enable the developer to identify and potential problems relating to noise and vibration from the development during the operational phase; and
- The above recommendations are to be included in each of the Environmental Management Programmes (EMPs) for each Portion as applicable.

11.3 Monitoring requirements

The following monitoring measures must be implemented:

- Monthly construction phase daytime noise monitoring must be undertaken to confirm if the construction noise is leading to exceedances of the respective guidelines at the nearby sensitive receptors if complaints are received;
- Bi-annual (i.e. Twice a year or more frequently) daytime and night-time noise monitoring surveys must be undertaken to confirm if operational phase noise is leading to exceedances of the respective guidelines at the nearby sensitive receptors (if any noise complaints are recorded);
- A vibration monitoring programme should be implemented to monitor ground-based vibration and possible nuisance impacts (if complaints are received);
- Should SR13 lodge noise complaints (in relation to the Vlermuislaagte Loops), a detailed environmental noise monitoring survey must be undertaken to identify the potential offending noise sources and a noise management plan must be compiled and implemented to mitigate the operational phase noise impacts;
- All noise and vibration monitoring surveys and reporting is to be undertaken by an independent noise specialist;
- Under the OHSAct NIHLR section 8, the developer/site operator shall establish and maintain a system of medical surveillance for all employees exposed to noise at or above 85 dB(A); and
- The above recommendations are to be included in each the Environmental Management Plan (EMP) for the project.

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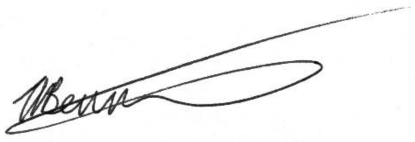

Adam Bennett

MD & Senior Environmental Specialist
ATB Environmental Consulting
ATB Group (Pty) Limited
SACNASP (400142/08) Environmental Science
Cell: +27 (0)83 538 9424
Email: adam@atbphotography.co.za

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Environmental
Consulting

APPENDIX 1: DOCUMENT LIMITATIONS

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- If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by us;
- Conditions may exist at the project site were retained to undertake. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the document. Accordingly, additional studies and actions may be required;
- Our opinions are based upon information that existed at the time of the production of the document. It is understood that the services provided allowed us to form no more than an opinion of the actual conditions of the site at the time. Site visits and site visit observations cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations;
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- Where data is supplied by the Client or other external sources have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by us for incomplete and/or inaccurate data supplied by others;
- The Client acknowledges that ATB Environmental Consulting may have retained sub-consultants to provide services for the benefit of ATB Environmental Consulting. We will be fully responsible to the Client for the services and work done by all our sub-consultants and subcontractors. The Client agrees that it will only assert claims against and seek to recover losses, damages or other liabilities from ATB Environmental Consulting and not ATB Environmental Consulting's affiliated companies. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any legal recourse, and waives any expense, loss, claim, demand, or cause of action, against ATB Environmental Consulting's affiliated companies, and their employees, officers and directors; and
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APPENDIX 2: DETAILS OF SPECIALIST, DECLARATION OF INTEREST

Details of Specialist	
Environmental Specialist	Adam Bennett
Contact Person	Adam Bennett
Postal address	21 Impala Street, Randpark Ridge, Ext 34, Johannesburg, South Africa
Post code	2169
Cell	+27 (0) 83 538 9424
E-mail	adam@atbphotography.co.za
Professional affiliations	SACNASP (Member # 400142/08) EAPASA Environmental Assessment Practitioner (#2021/3860)

The Environmental Specialist

I, **Adam Bennett** declare that:

General declaration:

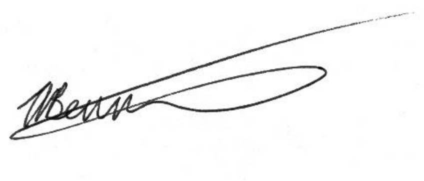
- I act as the independent environmental specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental impact assessments, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in regulation 8 of the Regulations when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of this report are made available to the projects EAP for distribution to the interested and affected parties as part of the projects stakeholder engagement process as required under the Regulations. The public and interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on the report which is produced to support the EA application;
- I will ensure that the comments of all interested and affected parties provided to me by the EAP and/or directly by the interested and affected parties are considered in this report and assessment of the impacts. The EAP will be responsible for recording the comments in a report that is to be submitted to the competent authority in respect of the application;

- Iwillprovidethecompetentauthoritywithaccesstoallinformationatmydisposal regarding the report, whether such information is favourable to the applicant or not; all the particulars furnished by me in this form are true and correct; will perform all other obligations as expected from an environmental assessment practitioner in terms of the Regulations; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;

I do not have a vested interest in the proposed activity proceeding:



Signature of the specialist:

ATB Environmental Consulting

Name of company:

22 February 2023

Date: