NOISE STUDY FOR
ENVIRONMENTAL IMPACT ASSESSMENT
Development of the Swaziland Rail Link – Work Package 2:
Davel Railway Yard and Connections -Mpumalanga
EXECUTIVE SUMMARY

Enviro-Acoustic Research (EARES) was contracted by Aurecon South Africa (Pty) Ltd to conduct an Environmental Noise Impact Assessment for Transnet’s proposed Swaziland Rail Link project. This project involves the development of a multinational strategic rail corridor stretching from Davel in Mpumalanga to Richards Bay in KwaZulu Natal via Sidvokodvo in Swaziland. The project is divided into 6 work packages with this report focusing on work package 2, the proposed Davel Railway Yard.

This report describes the noise rating levels and potential noise impact that the operation of the development may have on the surrounding sound environment, highlighting the methods used, potential issues identified, findings and recommendations. This report briefly discussed low frequency and vibrations. It investigated only the most critical operational phase in terms of acoustics.

Assessments done in this document is as recommended by the United Kingdom Department of Transport - Calculation of Railway Noise (CRN), SANS 10328 and SANS 10103 guidelines.

Measurements and site investigation were conducted from the 10th September till the 13th September 2013. Potentially sensitive receptors, also known as noise-sensitive developments (NSDs) were identified up to 200 m from the railway line. Receptors were identified using tools such as Google Earth® and other available internet resources and information. The Davel and Kwadela communities were surveyed as part of the measurement procedure. Besides the Davel and Kwadela communities other potential receptors around the development were classified between NSD01 to NSD03. The following rating levels are proposed for receptors in the study area:

- “Suburban districts with little road traffic” (50 and 40 dBA day/night-time Rating);
- and
- The Equator Principles was considered with a 55 and 45 dBA day/night time rating level for residential areas and dwellings.

Site investigation, available internet resources and information indicated the main existing ambient noise contributors to be the N17 National Highway at 1 000 m from the railway yard. The existing Davel railway infrastructure was not operational during site investigational dates.

Four operational scenarios were assessed when the project functions, namely:
• The projected daytime initial peak hour assessment (worst case) when the facility initially starts operations;
• The projected night-time initial peak hour assessment (worst case) when the facility initially starts operations;
• The projected daytime future peak hour assessment (worst case) when the facility operates at maximum capacity; and
• The projected night-time future peak hour assessment (worst case) when the facility operates at maximum capacity.

There is no standard or guideline in South Africa stipulating the requirements to calculate or model the potential noise impacts from a railway operation although various International propagation models do exist. The European Transportation Research Laboratory (TRL) has recommended the British model "Calculation of Railway Noise, 1995" as the most technical sound of the available models. For this reason assessment calculations were done in accordance with the sound propagation model described by British CRN (Railway Noise) model. Road traffic calculations were conducted using the SANS 10210:2004 model.

Assessment indicate a potential sound environment where rating levels would exceed the initial and future night-time zone sound levels during peak traffic periods at houses directly adjacent to the train line in the Davel and Kwadela communities. This is mostly due to the 12 dBA impulse correction implemented (shunting activities at Davel Yard) for calculated values as recommended in SANS 10103:2008.

Commercial railway line activities are exempted from certain requirements of Government Notice R154 of 1992 (Noise Control Regulations) – Regulation 2.(c) - “Provided that the provisions of this paragraph (in reference to noise emanating from a development) shall not apply in respect of a disturbing noise or noise nuisance caused by rail vehicles or aircraft which are not used as recreational vehicles”.

Furthermore the locomotive horns is exempted from the Government Notice R154 of 1992 (Noise Control Regulations) – Clause 7.(1) – “the emission of sound is for the purposes of warning people of a dangerous situation”.

With a risk of a noise impact developing during the night-time hours being of a potential high significance, mitigation options could be considered by the developer. The mitigation of noise from railway lines is difficult and potentially expensive to implement. Mitigation discussed below is optional and not mandatory for the developer due to the exemptions
mentioned above. Mitigation options would be most relevant to the houses directly adjacent to the railway line in the Davel and Kwadela communities.

The most important mitigation options to consider include:

**Mitigation of Noise Source – Railway Line:**

1. *Minimise train and shunting operations during the night-times (22:00 – 06:00, SANS 10103:2008)* - The potential important times for a noise annoyance to occur would be during the night-time hours when a quiet environment is desired (at night for sleeping etc.). It is highly likely that maximum noise levels due to single noise events outdoor at houses (directly adjacent to the train line in the Davel and Kwadela communities) could exceed 80 dBA. This would be also relevant during religious worship, at educational and health care facilities (e.g. pray times at the Mosque or Sunday church services);

2. *Railway line specifications* – Continuous welded rails and ballast is indicated to be implemented by the developer which will result in a noise reduction factor. Cracked, corrugated or damaged rails should be mended or replace immediately to reduce noise and vibrations. The developer can considered a float slab track system at areas where no ballast may be used, generally slab tracks can be +5 dB louder than ballasted tracks;

3. *Programmes to manage rail and wheel roughness* – The developer can consider the implementation of composite material (or similar) brake shoes (“K or LL Blocks”) as cast-iron brakes cause wheel roughness (and more friction and noise). These wheel dampers will produce the lowest peak noise levels, but may not prevent tyre squeal fully. The LL brake block system has the potential to reduce rolling and braking noises over cast iron brakes as well as K blocks. LL block systems does not require the adaption of cast-iron brake systems and also damage the train wheels far less than a conventional cast-iron brake. The developer should consider ensuring that rail head grinding and rail head maintenance is conducted regularly to ensure that the correct rail head profile is maintained and the elimination of corrugated rails. The developer could consider rail dampers on the rail line or wheels and at sections of rail near receptors dwellings. Sharp curves could be lubricated to reduce break squeal; and

4. *Screen the line of sight from receptors to the Davel Yard and railway line* – The developer can consider berms, barriers and design of the train yard (placement of buildings, lines where wagons are left and shunting line) in order to screen the railway line operations maximally to receptors dwellings. From a technical perspective it would seem easiest to consider a berm or single/double brick wall. The
developer can also consider the layout of building infrastructure at the yard whereby the development buildings (e.g. office block) is used to obscure the line of sight to surrounding receptors from the train yard. A less feasible option (from a technical perspective) is to design the railway yard and line to be at a lower elevation than the receptors dwelling (sufficient height difference to obscure line of sight). Advancement in barriers designed specifically for sound insulation has improved drastically over the years. Although a more expensive option than single/double brick/concrete wall or an aggregate berm, acoustic barriers are specifically designed as a buffer for noises. Such barriers could be implemented along the railway line where there is a potential for a high noise impact or at dwellings directly adjacent to the Davel and Kwadela communities. If the developer decides to implement a double brick wall or berm, the following factors should be implemented to ensure an effective noise boundary wall/barrier:

- It is recommended that the barrier be built as close as possible to the footprint of the railway line (noise source) or residents (receptor) as is feasible as possible. The barrier design needs to consider diffraction, and should have no aperture or gaps;
- It is recommended that the height of the berms/barriers be at least 1 m higher than the line of sight to the highest noise source from the road to a receptors dwelling. Barriers must also be sufficiently dense (at least 20 kilograms/square meter surface density) and sufficient in thickness. A brick wall provides a surface density of 244 kilograms/square m at thickness of 150 mm and is considered as a typically good acoustical barrier. Certain metrological conditions (particularly during night-times) can see refraction of noise over the barrier due to the various temperature inversion layers. This means that noise levels from a road vehicle may propagate back down to the ground at a receptors dwelling due to the curvature of sound in the warmer upper night-time atmosphere. Barrier height cannot effect this propagation; and
- The barrier should be sufficiently long.

Management mitigation options

1. **Public participation** – A developer representative could discuss the calculated noise levels in this document with receptors. The developer representative should indicate other positive aspects of the project (job and infrastructure enhancement in the area); and

2. **Help line and noise and vibration complaint logging** - The developer could consider a line of communication (e.g. a help line where complaints could be lodged). All potential sensitive receptors should be made aware of these contact numbers.
Sporadic and legitimate noise and vibration complaints could develop. For example, sudden and sharp increases in sound levels could result from poorly maintained tracks or rolling stock. Noise and vibration complaints can be logged and supplied to railway maintenance staff to further investigate (rail roughness, corrugated rail head etc.);

3. *Environmental Acoustical and Vibration Measurement Programme* – The developer could implement a noise and vibration measurements programme and reporting conducted on an annual basis. The noise measurements should preferably be linked to a noise propagation model 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 at that stage of the project operations;

4. *Religious, health, educational buildings, nature reserves and hospitality facilities* – The developer could consider identifying these facilities near the railway line and co-ordinating any operational times that may be sensitive to these receptors.

As it is unsure of which (if any) mitigation options the developer may implement, identifying the potential impacts with mitigation options implemented cannot be assessed.

The findings of this report should be made available to all identified potentially noise-sensitive developments in the area with the contents explained to them to ensure that they understand all the potential risks that the development may have on them and their families.

It must also be noted that it is unfair to expect the noises from the development to be inaudible under all circumstances (even mitigated noise) as this is an unrealistic expectation that is not required or expected from any other agricultural, commercial, industrial or transportation related noise source. 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.
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GLOSSARY OF ABBREVIATIONS

AZSL  Acceptable Zone Sound Level (Rating Level)
CWR   Continuous Welded Rail
DEADP Department of Environmental Affairs and Development Planning
DEDEA Department of Economic Development and Environmental Affairs
dB    Decibel
DEA   Department of Environmental Affairs
EARES Enviro-Acoustic Research cc
EAP   Environmental Assessment Practitioner
ECA   Environment Conservation Act (Act 78 of 1989)
ECO   Environmental Control Officer
EIA   Environmental Impact Assessment
EMP   Environmental Management Plan
EMS   Environmental Management System
FEL   Front End Loader
IAPs  Interested and Affected Parties
i.e.  that is
IEM   Integrated Environmental Management
km    kilometres
LHD   Load haul dumper
m     Meters (measurement of distance)
\(m^2\)  Square meter
\(m^3\)  Cubic meter
mamsl Meters above mean sea level
NCR   Noise Control Regulations (under Section 25 of the ECA)
NGO   Non-government Organisation
PPE   Personal Protective Equipment
PPP   Public Participation Process
SABS  South African Bureau of Standards
SANS  South African National Standards
SHEQ  Safety Health Environment and Quality
TLB   Tip Load Bucket
UTM   Universal Transverse Mercator
VdB   Vibration decibels
WHO   World Health Organisation
1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE
Enviro-Acoustic Research (EARES) was contracted by Aurecon South Africa (Pty) Ltd (the main consultant) to conduct an Environmental Noise Impact Assessment (ENIA) for Transnet’s proposed Swaziland Rail Link project. This project involves the development of a multinational strategic rail corridor stretching from Davel in Mpumalanga to Richards Bay in KwaZulu Natal via Sidvokodvo in Swaziland. The project is divided into 6 work packages with this report focusing on work package 2, the proposed Davel Railway Yard.

This report describes the noise levels and potential noise impact that the operation of the development may have on the surrounding sound environment, highlighting the methods used, potential issues identified, findings and recommendations. This report briefly discussed low frequency and vibrations. It investigated only the most critical operational phase in terms of acoustics.

1.2 BRIEF PROJECT DESCRIPTION
Transnet SOC Limited is proposing the development of a robust rail connection between Lothair and the Komatipoort-Richards Bay route (refer to Figure 1-1). This will provide a viable General Freight diversionary route to remove this traffic from the Mpumalanga Coal Line, freeing up slots for Coal Traffic. Further projects requirements include:

• Providing a rail connection from Davel to Maputo via the Swaziland Railway Network.
• Enhancing capacity for the Komatipoort – Richards Bay railway corridor; accommodating traffic identified within the Transnet Long Term Planning Framework and the prospective GFB traffic from the Coal Line.
• Providing viable connections for rail freight from Western Swaziland to markets in South Africa, Mozambique, and overseas.
• Providing viable connections for rail freight from South Africa to markets in Swaziland, Mozambique, and overseas via Maputo.

The project is divided into 6 Work Packages (WP) for project implementation purposes, namely:

• WP1: The construction of a new rail link between Lothair (Mpumalanga) to Sidvokodvo (Swaziland). Being a multinational project the work package is subdivided into two sub-sections, namely Lothair to Nerston (RSA) and Nerston to Sidvokodvo (Swaziland).
• WP2: The construction of a new terminal and network links at Davel – known as Davel Yard and Connections.

• WP3: The upgrade of the existing line between the proposed Davel Yard and Lothair.

• WP4: The upgrade of the existing line between Sidvokodvo (Swaziland) and Phuzumoya (Swaziland). This also includes the construction of a new line in certain sections.

• WP5: The upgrade of the existing line between Phuzumoya (Swaziland) and Golela (Swaziland – RSA border). This also includes the construction of a new line in certain sections.

• WP6: The upgrade of the existing line between Golela (Swaziland – RSA border) and Nsese near Richards Bay. This also includes the construction of a new line in certain sections.

This Noise report specifically focuses on the proposed Davel Yard and Connections (refer to Figure 1-2). This new transport node created at Davel is of great significance in both the infrastructure layout as well as operational context of the project. The yard forms a unique nexus between the Coal Line (Webbsrus - Hamelfontein), the Eastern Mainline (Machadodorp - Breyten) as well as the Central Basin (Trichardt).

The Transnet operating ideal envisages consolidation of loads into the maximum length consist allowable as close as possible to the source siding(s). Currently loads can vary in length from 40 wagon block loads, through 50 and 60 up to 75/80 and 100 wagon general freight trains.

Until such time as this operating concept is realised, Davel is designed to fulfil the role of consolidating traffic into optimised lengths suitable for the new Swaziland Rail Link system, i.e. from 75/80 to 150/160 and 200 wagon trains. The reverse (de-consolidation) has been planned for traffic returning from the export ports.

The yard will include the following infrastructure capabilities:

• Traction change capability - 3 kV DC electric to Diesel;

• 200 wagon yard. The most relevant infrastructure at the yard (in terms of acoustics) besides train operations and shunting are:

1. Locomotive inspection and workshop;

2. Locomotive re-fuelling station;

3. Substation with generator back-up; and

• DP network and track layout.
1.3 STUDY AREA
The development is proposed on existing rail infrastructure near the town of Davel in the Gert Sibande District and Msukaligwa Local municipalities, Mpumalanga Province. A site locality map is presented in Figure 1-1 with the layout of the proposed railway line illustrated as a red line. The study area is further described in terms of environmental components that may contribute or change the sound character in the area.

1.3.1 Topography
The study area is generally relatively flat plains. There are little natural topographical features that limit the propagation of noise. Man-made structures do feature in a heterogeneous scattered fashion around the study area.

1.3.2 Surrounding Land Use
The study area borders the communities of Davel and KwaDela, approximately 1 000 m north of the N17 National Highway. Two existing railway routes do traverse the study area (including the Davel line as illustrated by a red line in Figure 1-2). A railway siding for numerous AFGRI (agricultural) silos run perpendicular to the existing Davel line (refer to Appendix C indicating railway line layout).

The area in the vicinity of the proposed development is currently classified as “Forest plantations”, “Cultivated: commercial dryland” or “Urban / built-up land: residential” according to the Environmental potential atlas for South Africa (ENPAT1). Mpumalanga Department of Public Works, Roads and Transport (information during 2013)2 classifies the surrounding land use as either “cultivated land” or “mining” (areas away from Davel and Kwadela communities). The department also indicates The Laerskool Davel and Davel Combined School within the mentioned communities.

1.3.3 Roads and Railway lines
The most important public roads from an acoustic perspective are the N17 National Highway that is illustrated as a yellow line in Figure 1-2. This paved N17 route runs parallel to the communities of Davel and Kwadela (at approximately 1 000 m from the Davel railway alignment). The N17 is used as a provincial coal haul route in the Mpumalanga Province.

Smaller less significant roads (in terms of acoustics) do feature in the area. These include the paved provincial D480_060 to D480_100 roads (based along the same stretch of road) and borders the Davel and Kwadela communities. The Mpumalanga Department of Public

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Works, Roads and Transport’s Annual Average Daily Traffic (ADDT) for these roads indicates a low magnitude in traffic volumes when considering acoustics (less than 500 cars p/d).

The existing Davel railway line is illustrated as a red line in Figure 1-2 while the proposed Davel Yard is indicated as magenta lines. An additional train line runs perpendicular to the Davel line and passes the community of Kwadela (train line not illustrated in this document).

1.3.4 Residential areas
There exist two communities identified for acoustical investigations due to the proposed Davel yard namely the communities of Davel and Kwadela (green areas in Figure 1-2). Numerous assumed households (GoogleEarth®, imagery date 2013) were identified via a desktop study and are illustrated as green dots in the mentioned figure.

1.3.5 Ground conditions and vegetation
The surrounding area consists of the Grassland biome, with the vegetation type being themeda veld (turf Highveld, pure grassveld type). At areas away from the suburb infrastructure the ground is covered with mostly low growing grasses and some scattered shrubs and trees. Taking into consideration available information the ground conditions could be classified as medium in terms of acoustics (acoustically medium ground absorbency).

The mean annual evaporation in the area is classified under the 1 800 to 2 000 m range, while the mean annual rainfall is between 737 to 823 mm per year. Taking into consideration available information the ground conditions could be classified as medium-hard in terms of acoustics (acoustically medium-little ground absorbency).

This will influences the propagation of the sound from noise sources in the area as the fraction of sound that is reflected from the ground would be influenced as certain frequencies would be absorbed by the ground surface.

1.4 Potential Sensitive Receptors (Noise Sensitive Developments)
Potentially sensitive receptors, also known as noise-sensitive developments (NSDs) were identified up to 200 m from the railway line. Receptors were identified using tools such as

Google Earth® and other available internet resources and information. The Davel and Kwadela communities were surveyed on the 10th September 2013 as part of the measurement procedure. These communities are illustrated as green areas in Figure 1-2 and with the closest houses to the railway line in from the communities presented as NSA in Table 1-1 below.

Besides the Davel and Kwadela communities, other potential receptors around the development were classified between NSD01 to NSD03 and are presented in Figure 1-2 (as green dots), with their localities defined in Table 1-1 below. These potential receptors were identified by a desktop study making use of available internet resources and information.

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

<table>
<thead>
<tr>
<th>Noise-sensitive development</th>
<th>Status</th>
<th>Location X Co-ordinate</th>
<th>Location Y Co-ordinate</th>
<th>Location Z Co-ordinate (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSD01</td>
<td>Status unconfirmed</td>
<td>-26.431508°</td>
<td>29.676683°</td>
<td>1720</td>
</tr>
<tr>
<td>NSD02</td>
<td>Status unconfirmed</td>
<td>-26.414975°</td>
<td>29.668605°</td>
<td>1716</td>
</tr>
<tr>
<td>NSD03</td>
<td>Status unconfirmed</td>
<td>-26.415560°</td>
<td>29.666263°</td>
<td>1707</td>
</tr>
<tr>
<td>NSA</td>
<td>Davel Community</td>
<td>-26.447373°</td>
<td>29.665690°</td>
<td>N/A</td>
</tr>
<tr>
<td>NSA</td>
<td>Kwadela Community</td>
<td>-26.460480°</td>
<td>29.667897°</td>
<td>N/A</td>
</tr>
</tbody>
</table>

The following should be noted:
- The Laerskool Davel and Davel Combined School are situated within the NSA communities.
Figure 1-1: Map illustrating proposed alignment of the Swazi Rail Link
Figure 1-2: Site map indicating the proposed Davel Yard and Connections
1.5 Terms of Reference
SANS 10328:2008 (Edition 3) specifies the methods to be used in order to assess the noise impacts on the environment as result of a proposed or existing activity. The standard also stipulates the minimum requirements to be assessed for an EIA. These minimum requirements are:

1. the purpose of the investigation;
2. a brief description of the planned or existing development or the changes that are being considered;
3. a brief description of the existing environment including, where relevant, the topography, surface conditions and meteorological conditions during measurements;
4. the identified noise sources together with their respective sound pressure levels or sound power levels (or both) and, where applicable, the operating cycles, the nature of sound emission, the spectral composition and the directional characteristics;
5. the identified noise sources that were not taken into account and the reasons as to why they were not assessed;
6. the identified noise-sensitive developments and the noise impact on them;
7. where applicable, any assumptions, with references, made with regard to any calculations or determination of source and propagation characteristics;
8. an explanation, either by a brief description or by reference, of all measuring and calculation procedures that were followed, as well as any possible adjustments to existing measuring methods that had to be made, together with the results of calculations;
9. an explanation, either by description or by reference, of all measuring or calculation methods (or both) that were used to determine existing and predicted rating levels, as well as other relevant information, including a statement of how the data were obtained and applied to determine the rating level for the area in question;
10. the location of measuring or calculating points in a sketch or on a map;
11. quantification of the noise impact with, where relevant, reference to the literature consulted and the assumptions made;
12. alternatives that were considered and the results of those that were assessed;
13. a list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation;
14. a detailed summary of all the comments received from interested or affected parties as well as the procedures and discussions followed to deal with them;
15. conclusions that were reached;
16. proposed recommendations;
17. if remedial measures will provide an acceptable solution which would prevent a significant impact, these remedial measures should be outlined in detail and included
in the final record of decision if the approval is obtained from the relevant authority. If the remedial measures deteriorate after time and a follow-up auditing or maintenance programme (or both) is instituted, this programme should be included in the final recommendations and accepted in the record of decision if the approval is obtained from the relevant authority; and

18. any follow-up investigation which should be conducted at completion of the project as well as at regular intervals after the commissioning of the project so as to ensure that the recommendations of this report will be maintained in the future.
2 LEGAL CONTEXT, POLICIES AND GUIDELINES

2.1 The Republic of South Africa Constitution Act ("the Constitution")
The environmental rights contained in section 24 of the Constitution provide that everyone is entitled to an environment that is not harmful to his or her well-being. In the context of noise, this requires a determination of what level of noise is harmful to well-being. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate in the particular circumstances. The subjectivity of this approach can be problematic which has led to the development of noise standards (see Section 2.5).

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

2.2 The Environment Conservation Act (Act 73 of 1989)
The Environment Conservation Act ("ECA") allows the Minister of Environmental Affairs and Tourism ("now the Ministry of Water and Environmental Affairs") to make regulations regarding noise, among other concerns. See also Section 2.2.1.

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

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

The National Noise Control Regulations (GN R154 1992) defines:
"controlled area" as:
a piece of land designated by a local authority where, in the case of--
c) industrial noise in the vicinity of an industry-
i. the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or

ii. the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 meters, but not more than 1,4 meters, above the ground for a period of 24 hours, exceeds 61 dBA;

"disturbing noise" as:
noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more.

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

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

In terms of Regulation 3 (a):
"No person shall –
establish a new township unless the lay-out plan concerned, if required by a local authority, indicates in accordance with the specifications of the local authority, the existing and future sources of noise, with concomitant dBA values which are foreseen in the township for a period of 15 years following the date on which the erection of the buildings in and around the township commences”;

In terms of Regulation 4 of the Noise Control Regulations:
"No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof”.

It should be noted that the emission of a sound (such as the locomotive horn) for the purpose of warning people of a dangerous situation is exempted in terms of Regulation 7(1).

2.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT 107 OF 1998)
The National Environmental Management Act ("NEMA") defines “pollution” to include any change in the environment, including noise. A duty therefore arises under section 28 of NEMA to take reasonable measures while establishing and operating any facility to prevent noise pollution occurring. NEMA sets out measures which may be regarded as reasonable.

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

2.4 NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT ("AQA" – ACT 39 OF 2004)
Section 34 of the National Environmental Management: Air Quality Act (Act 39 of 2004) makes provision for:

(1) the Minister to prescribe essential national noise standards -
    (a) for the control of noise, either in general or by specified machinery or activities or in specified places or areas; or
(b) for determining –
  (i) a definition of noise
  (ii) the maximum levels of noise

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

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

An atmospheric emission licence issued in terms of section 22 may contain conditions in respect of noise. This however is unlikely to be relevant to the project, as no atmospheric emissions licence is required.

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

Model Air Quality Management By-Laws for adoption and adaptation by municipalities was published by the Department of Water and Environmental Affairs in the Government Gazette of 2 July 2010 as Government Notice 579 of 2010.

The main aim of the model air quality management by-law is to assist municipalities in the development of their air quality management by-law within their jurisdictions. It is also the aim of the model by-law to ensure uniformity across the country when dealing with air quality management challenges. Therefore, the model by-law is developed to be generic in order to deal with most of the air quality management challenges. With Noise Control being covered under the Air Quality Act (Act 39 of 2004), noise is also managed in a separate section under this Government Notice.

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

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

2.5 Noise Standards

Four South African Bureau of Standards (SABS) scientific standards are considered relevant to noise from the roads. They are:
• SANS 10103:2008. ‘The measurement and rating of environmental noise with respect to annoyance and to speech communication’.
• SANS 10210:2004. ‘Calculating and predicting road traffic noise’.
• SANS 10357:2004. ‘The calculation of sound propagation by the Concave method’.

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

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

2.6.1 Guidelines for Community Noise (WHO, 1999)
The World Health Organization’s (WHO) document on the Guidelines for Community Noise is the outcome of the WHO- expert task force meeting held in London, United Kingdom, in April 1999. It is based on the document entitled “Community Noise” that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute.

The scope of WHO’s effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments. It discusses the specific effects of noise on communities including:
• Interference with communication;
• Noise-induced hearing impairment;
• Sleep disturbance effects;
• Cardiovascular and psychophysiological effect;
• Mental health effects;
• Effects on performance;
• Annoyance responses; and
• Effects on social behavior.
It further discusses how noise can impact (and propose guideline noise levels) on specific environments such as:

- Residential dwellings;
- Schools and preschools;
- Hospitals;
- Ceremonies, festivals and entertainment events;
- Sounds through headphones;
- Impulsive sounds from toys, fireworks and firearms; and
- Parklands and conservation areas.

To protect the majority of people from being affected by noise during the daytime, it propose that sound levels at outdoor living areas should not exceed 55 dB $L_{Aeq}$ for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB $L_{Aeq}$. At night, equivalent sound levels at the outside façades of the living spaces should not exceed 45 dBA and 60 dBA $L_{Amax}$ so that people may sleep with bedroom windows open. Singular events ($L_{Amax}$) due to train pass-bys recommend by International railway lines do vary depending on the country. The $L_{Amax}$ for railway lines are generally much higher as the WHO recommendation is based on indoor (interior, $L_{Amax,inside}$) values. Refer to Section 2.7 for International $L_{Amax}$ railway values.

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

2.6.2 Night Noise Guidelines for Europe (WHO, 2009)

Refining previous Community Noise Guidelines issued in 1999, and incorporating more recent research, the World Health Organization has released a comprehensive report on the health effects of night time noise, along with new (non-mandatory) guidelines for use in Europe. Rather than a maximum of 30 dB inside at night (which equals 45-50 dB max outside), the WHO now recommends a maximum year-round outside night-time noise average of 40 db to avoid sleep disturbance and its related health effects. The report notes that only below 30 dB (outside annual average) are “no significant biological effects observed,” and that between 30 and 40 dB, several effects are observed, with the chronically ill and children being more susceptible; however, “even in the worst cases the effects seem modest.” Elsewhere, the report states more definitively, “There is no sufficient evidence that the biological effects observed at the level below 40 dB (night, outside) are harmful to health.” At levels over 40 dB, “Adverse health effects are observed” and “many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected.”
The 184-page report offers a comprehensive overview of research into the various effects of noise on sleep quality and health (including the health effects of non-waking sleep arousal), and is recommended reading for anyone working with noise issues. The use of an outdoor noise standard is in part designed to acknowledge that people do like to leave windows open when sleeping, though the year-long average may be difficult to obtain (it would require longer-term sound monitoring than is usually budgeted for by either industry or neighbourhood groups).

The document also makes recommendations on the singular maximum noise vents. At night, instant noise events indoors (interior, $L_{A,\text{max},\text{inside}}$) should not exceed 42 dBA.

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

2.6.3 Equator Principles

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

The Equator Principles were developed by private sector banks and were launched in June 2003. The banks chose to model the Equator Principles on the environmental standards of the World Bank and the social policies of the International Finance Corporation (IFC). 67 financial institutions (October 2009) have adopted the Equator Principles, which have become the de facto standard for banks and investors on how to assess major development projects around the world. The environmental standards of the World Bank have been integrated into the social policies of the IFC since April 2007 as the International Finance Corporation Environmental, Health and Safety (EHS) Guidelines.

2.6.4 IFC: General EHS Guidelines – Environmental Noise Management

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

It states that noise prevention and mitigation measures should be applied where predicted or measured noise impacts from a project facility or operations exceed the applicable noise level guideline at the most sensitive point of reception. The preferred method for
controlling noise from stationary sources is to implement noise control measures at source. It goes as far as to proposed methods for the prevention and control of noise emissions, including:

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment casing radiating noise;
- Improving the acoustic performance of constructed buildings, apply sound insulation;
- Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m² in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective;
- Installing vibration isolation for mechanical equipment;
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas;
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding;
- Placement of permanent facilities away from community areas if possible;
- Taking advantage of the natural topography as a noise buffer during facility design;
- Reducing project traffic routing through community areas wherever possible;
- Planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas; and
- Developing a mechanism to record and respond to complaints.

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

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

<table>
<thead>
<tr>
<th>Receptor type</th>
<th>One hour $L_{Aeq}$ (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daytime</td>
</tr>
<tr>
<td></td>
<td>07:00 - 22:00</td>
</tr>
<tr>
<td>Residential; institutional; educational</td>
<td>55</td>
</tr>
<tr>
<td>Industrial; commercial</td>
<td>70</td>
</tr>
</tbody>
</table>
The document uses the $L_{Aeq,1 \text{ hr}}$ noise descriptors to define noise levels. It does not determine the detection period, but refers to the IEC standards, which requires the fast detector setting on the Sound Level Meter during measurements in Europe.

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

The green paper highlights the need for mitigation measures to be implemented in the European Union regarding air pollution and includes – “More attention needs to be paid to rail noise where some Member States are planning national legislation and where there is considerable opposition to the expansion of rail capacity due to excessive noise$^5$.

### 2.7 INTERNATIONAL GUIDELINES – STANDARDS FOR NOISE FROM RAILWAYS

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

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**Figure 2-1: Residential Noise Limits for New and Upgraded Railway Lines$^6$**

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$^5$ European Commission Green Paper (Com (96) 540).

$^6$ European Commission, 2003
These limits are however not completely comparable, as they differ in terms of:

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

Furthermore the single noise events (L_{Amax}) magnitude and number of events have been investigated in various International documents including the World Health Organization, 2009: “Night Noise Guidelines for Europe” 7 briefly discussed in Section 2.6.2. International countries L_{Amax} outdoor values generally range between 73 to 88 dBA8.

Several railway activities, including train pass-bys, emit repetitive noises of a significant level for brief periods of time that can interfere with sleep, communications, and the wellbeing of the residents of neighbouring properties (WHO 1999). A brief overview of International Standards and guidelines relating to the magnitude of the L_{Amax} singular event (source "Environmental Impact Assessment: Proposed Gautrain Rapid Rail Link Volume 3: Socio-Economic Environment") is presented in Table 2-2.

8 Environmental Impact Assessment: Proposed Gautrain Rapid Rail Link Volume 3: Socio-Economic Environment
Table 2-2: International Railway (L_{Amax}) magnitude

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>PERIOD (T)</th>
<th>L_{Amin} (dBA)</th>
<th>L_{Amax} (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>0600-0800</td>
<td>55</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>0800-2200</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>2200-0600</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Denmark</td>
<td>0600-0600</td>
<td>88</td>
<td>60</td>
</tr>
<tr>
<td>France</td>
<td>0600-2200</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2200-0600</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td>Germany</td>
<td>0600-2200</td>
<td></td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>2200-0600</td>
<td></td>
<td>49</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>0700-2300</td>
<td>65-70</td>
<td>55-60</td>
</tr>
<tr>
<td></td>
<td>2300-0700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>0600-2200</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>2200-0600</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>Japan</td>
<td>0700-2200</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>2200-0700</td>
<td>70</td>
<td>55</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0700-1900</td>
<td>73</td>
<td>53 (avg)</td>
</tr>
<tr>
<td></td>
<td>1900-2300</td>
<td>73</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>2300-0700</td>
<td>73</td>
<td>45 (avg)</td>
</tr>
<tr>
<td>Norway</td>
<td>0600-0600</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>South Korea</td>
<td>0600-2200</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2200-0600</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>0600-0600</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0600-2200</td>
<td>55-60</td>
<td>45-50</td>
</tr>
<tr>
<td></td>
<td>2200-0600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>0600-2400</td>
<td>85</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>2400-0600</td>
<td>85</td>
<td>65</td>
</tr>
<tr>
<td>USA</td>
<td>0600-0600</td>
<td>67</td>
<td>55 (L_{eq})</td>
</tr>
</tbody>
</table>

2.7.1 National and International Guidelines - Appropriate limits for game parks and wilderness

2.7.1.1 United States National Park Services

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

Although game park visitors may not seek intrusive un-natural sounds, the operation of the game park itself is source of anthropogenic noise (vehicles, game park electrical and mechanical infrastructure etc.).

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

2.7.1.2 National and International Regulations and Guidelines

Very little guidelines are available regarding industrial noise sources near National Parks in Swaziland. Most guidelines available in Africa relate to visitors making noise in the parks.

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9 US National Park Service, 2000
such as the Nature Conservation Ordinance, 1975: Ordinance 4 (Namibia)\textsuperscript{10}.

Internationally there exists numerous International State and local laws to try and encourage industries near parks to keep within limits set out by the local authorities\textsuperscript{11}.

\textsuperscript{11} E.g. State of Oregon’s Environmental Standards for Wilderness Areas.
3 CURRENT ENVIRONMENTAL SOUND CHARACTER

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

- Type of equipment;
- Minimum duration of measurement;
- Microphone positions;
- Calibration procedures and instrument checks; and
- Weather conditions.

Refer to Appendix A for a glossary of acoustical as well as project terms.

3.2 LIMITATIONS - ACOUSTICAL MEASUREMENTS AND ASSESSMENTS
Limitations due to environmental acoustical measurements include the following:

- Ambient sound levels are the cumulative effects of innumerable sounds generated at various instances both far and near. High measurements may not necessarily mean that noise levels in the area are high. Similarly, a low sound level measurement will not necessarily mean that the area is always quiet, as sound levels will vary over seasons, time of the day, faunal characteristics, vegetation in the area and meteorological conditions (especially wind). This is excluding the potential effect of sounds from anthropogenic origin. It is impossible to quantify and identify the numerous sources that influenced one 10-minute measurement using the reading result at the end of the measurement;

- Defining ambient sound levels using the result of one 10-minute measurement will be very inaccurate (very low confidence level in the results) for the reasons mentioned above. The more measurements that can be collected at a location the higher the confidence levels in the ambient sound level determined (at that location). The more complex the sound environment, the longer the required measurement (especially when at a community or house);

- Determination of existing road traffic and other noise sources of significance are important (traffic counts etc);

- Measurements over wind speeds of 3 m/s will provide data influenced by wind-induced noises;
• Ambient sound levels recorded near rivers, streams, wetlands, trees and bushy areas can be high. This is due to faunal activity which can dominate the sound levels around the measurement point;
• Considering one sound descriptor is not sufficient for an acoustical assessment. Parameters such as $L_{A_{\text{Min}}}$, $L_{A_{\text{eq}}}$, $L_{C_{\text{eq}}}$, $L_{A_{\text{Max}}}$, $L_{A_{10}}$, $L_{A_{90}}$ and spectral analysis forms part of the many variables to be considered;
• It is technically difficult to correctly measure the spectral distribution of a large equipment in an industrial setting due to the other noise sources active in the area;
• Exact location of a sound level meter in an area in relation to structures, vegetation and external noise sources will impact on the measurements; and
• As a residential area develops the presence of people will result in increased sounds. These are generally a combination of traffic noise, voices, animals and equipment (incl. TV’s and Radios). The result is that ambient sound levels will increase as an area matures.

3.3 Existing Measured Soundscape

The location of the day/night ambient sound measurement locations are presented in Table 3-1 below and is also illustrated in Figure 3-1 as blue squares. Measurements were conducted from the 10th September till the 13th September 2013.

Sound level meter settings conform to specifications listed in SANS 10103:2008. Where possible International guidelines where referenced. Certain settings may differ between International and National guidelines. Internet resources (weather24.com) indicated there to be little or no rain during the measurement dates.

Appendix B presents photos taken of the measurement locations. The measurement location was classified as AR01 in this report.

Table 3-1: Day/night-time measurement locations (Datum type: WGS 84, lat./long.)

<table>
<thead>
<tr>
<th>Point name</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR01</td>
<td>-26.447843°</td>
<td>29.667336°</td>
</tr>
</tbody>
</table>
Figure 3-1: Locality of ambient sound measurement
3.3.1 Measurement Point AR01 - Davel, Mr. Marius Pienaar’s household

A number of 10 minute measurements were taken over a day/night period from the afternoon of the 10\textsuperscript{th} September till the morning of the 13\textsuperscript{th} September 2013. The sound level meters were referenced at 1,000 Hz directly before and after the measurements were taken. In all cases drift was less than 0.2 dBA. The equipment defined in Table 3-2 was used for gathering data. Measured data is presented in Figure 3-2.

Table 3-2: Equipment used to gather data

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Model</th>
<th>Serial no</th>
<th>Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLM</td>
<td>Svan 955</td>
<td>27637</td>
<td>25 April 2013</td>
</tr>
<tr>
<td>Microphone</td>
<td>ACO 7052E</td>
<td>49596</td>
<td>25 April 2013</td>
</tr>
<tr>
<td>Calibrator</td>
<td>Rion NC-74</td>
<td>34494286</td>
<td>23 January 2013</td>
</tr>
<tr>
<td>Weather Station</td>
<td>WH3081PC</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The measurement point was situated adjacent to the dwelling of Mr. Marius Pienaar and the Davel Police Station. It border and had a direct line of site to the existing and proposed railway line. The measurement location was chosen as it was a safe location for the equipment to be left overnight. One other feasible measurement location was identified but not used due to security concerns for the equipment. Refer to Appendix B for a photo of taken of this measurement point.

**Measured 10 minute $L_{Aeq}$ day/night-time data:** During the daytime $L_{Aeq}$ values ranged between 42.8 dBA to 64.6 dBA. The night-time $L_{Aeq}$ values ranged between 28.7 to 64.4 dBA. The average value of the 233 ten minute equivalent daytime measurements was calculated at 55.7 dBA, while the 146 night-time average was 47.3 dBA.

**Measured 10 min. $L_{A90}$ day/night-time data:** $L_{A90}$ daytime values ranged from 29.2 dBA to 59.6 dBA. The night-time $L_{A90}$ values ranged from 22.8 to 55.3 dBA. The average value of the 233 ten minute equivalent daytime measurements was calculated at 44.4 dBA, while the 146 night-time measurements was calculated at 33.4 dBA. Measured $L_{A90}$ data indicated that there are slight consistent ambient sounds in the study area (along with the impulsive noise events) during all hours at these receptors. The background noise levels ($L_{A90}$) became low at certain times of day and night.

**$L_{Aeq}$ - $L_{A90}$ average difference, day/night-time:** The average daytime difference between the $L_{Aeq}$ and $L_{A90}$ variables was calculated as 11.3 dBA while the difference at night was 13.9 dBA. This indicates potentially highly impulsive noise events during the day and night at the measurement location.
\( L_{A_{\text{max}}} - L_{A_{\text{min}}} \) day/night-time: The average difference between 34.0 indicating the average intensity of the noise events to be relatively high.

\( L_{A_{\text{max}}} (f) \) night-time occurrences (Figure 3-3): At least 33 instances (night 1), 41 instances (night 2) and 39 instances (night 3) were measured where \( L_{A_{\text{max}}} \) levels exceeded 55 dBA during the night-times where noise events may become an annoyance.\(^{12}\)

Daytime/night-time 8 and 16 hour \( L_{A_{\text{eq}}} \): Daytime \( L_{A_{\text{eq}}} \) values were calculated at 52.1 dBA (first day till 22:00), 57.4 dBA for the second day (06:00 - 22:00), 57.6 dBA for the third day (06:00 - 22:00) and 58.4 dBA for the fourth day (06:00 - 07:58). Night-times equivalent levels were calculated at 50.9 dBA (22:00 – 06:00) for the first night, 55.6 dBA (22:00 – 06:00) for the second night and 52.1 dBA (22:00 – 06:00) for the third night.

Figure 3-2: Ambient Sound Levels at AR01 – Impulse Setting (South Africa)

Figure 3-3: Ambient Sound Levels at AR01 – Fast Setting (International)

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

Table 3-3: Noises/sounds heard during measurement date at receptor

<table>
<thead>
<tr>
<th>Ambient Sound Character -Sounds of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faunal and Natural</td>
</tr>
<tr>
<td>Wind shear and fauna (bird) communication (song).</td>
</tr>
<tr>
<td>Residential and other Anthropogenic</td>
</tr>
<tr>
<td>Pedestrian communication on local roads and local road traffic</td>
</tr>
<tr>
<td>Industries, Commercial and Road Traffic</td>
</tr>
<tr>
<td>N/a</td>
</tr>
</tbody>
</table>

Third octave spectral analysis (Figure 3-4, Figure 3-5, Figure 3-6, Figure 3-6, Figure 3-8 and Figure 3-9):

Lower frequency (20 – 250 Hz): Day and night measurements reflected some energy peaks in this range and particularly in the 63 And 80 Hz range. Noise sources of significance (industrial or transport) can contribute towards these levels as lower frequencies may travel further through the atmosphere than higher frequencies (due to
atmospheric conditions). Motor vehicle engine revs per minute (rpm) convert to this range of frequency (not considering other motor car acoustical sources e.g. tyre to road interaction pumping and “horn effect”)\(^\text{13}\). Low frequency noise sources completely dominated these measurements.

**Third octave surrounding 1000 Hz:** Day and night measurements reflected energy around the 800 or 1000 Hz range although not many spikes (or peaks) were measured. This range contains energy mostly associated with human speech (mostly 350 Hz – 2,000 Hz, could be between 20 – 16,000 Hz), dwelling related sounds and road to tyre interaction from road traffic. Tyre road impacts and shocks as well as tyre to road pumping (during standard rolling conditions, pumping is the compression of air under tyre tread) can contribute mainly below and above 1000 Hz respectively (up to 2,000 Hz for pumping). The horn effect created by the geometry of the tyre and road surface can amplify at frequencies up to 10,000 Hz\(^\text{14}\).

**Higher frequency (2,000 Hz upwards):** Many peaks during the day and night were measured at 3,150, 4,000, 12,500, 16,000 and 20,000 Hz. Smaller faunal species such as birds, crickets and cicada would use this range to communicate and hunt etc.\(^\text{15, 16, 17}\)

**Octave data analysis:** The lower frequencies would most likely indicate motor engine revolutions from vehicle related noises during both day and night-times. This was further verified by spikes measured at the 800 and 1,000 Hz range (road tyre interaction). Data indicated that vehicles were travelling at low speeds as is limited to in a typical suburban setting (60 to 80 km/h speed limits). This measurement data indicated potential much faunal communication during both day and night-times. Data varies indicating various different sound and noise sources.

\(^{12}\) Dr. K. Clark Midkiff. Mechanical engineering Conversion Factors.
\(^{14}\) SILVIA. Guidance Manual for the Implementation of Low Noise Road Surface 2nd ed. FEHRL Report
\(^{17}\) H.C Bennet-Clark. The Scaling of Song Frequency in Cicadas. The Company of Biologist Limited, 1994
Figure 3-4: Daytime spectral frequency distribution as measured at AR01, day 1

Figure 3-5: Daytime spectral frequency distribution as measured at AR01, day 2
Figure 3-6: Daytime spectral frequency distribution as measured at AR01, day 3

Figure 3-7: Night-time spectral frequency distribution as measured at AR01, night 1
Figure 3-8: Night-time spectral frequency distribution as measured at AR01, night 2

Figure 3-9: Night-time spectral frequency distribution as measured at AR01, night 3
SANS 10103 Rating Level: Considering the $L_{Aeq,1}$ measured data, ambient sound levels conform to a noise rating level for an "Urban districts" (55 and 45 dBA day/night-time Rating). Night-time sound levels were impacted by a number of loud single events that ultimately impacted on the “average” night-time sound level. Considering the $L_{Aeq,f}$ and $L_{A90,f}$ measurements as well as the developmental character of the area, it is the opinion of the author that the noise rating level should conform to an "Suburban district" (50 and 40 dBA day/night-time Rating)".

3.4 Existing Ambient Soundscape

3.4.1 Daytime Ambient Soundscape for Assessment Purpose

Data used in this section is based on available information (Section 1.3.3) as well information gathered during the site investigation dates.

The most distinguishable noise contributor to the daytime ambient soundscape is the existing N17 road traffic. Daytime calculated major ambient sound contributors include:

- An existing ambient sound level of 23.1 dBA. This value is based on the lowest $L_{A90}$ values measured during site investigation dates (refer to Section 3);
- No other existing railway line/ associated infrastructure operations were considered;
- Façade corrections were not taken into account; and
- Existing N17 National highway (yellow line in Figure 1-2) calculated as – 62.5 vehicles p/h on a single paved road (non-porous i.e. semi dense air void of 9 – 14 %), heavy vehicles was calculated as 20 % vehicles p/h. Traffic calculated at constant speed of 120 km/h. Refer to Section 1.3.3 indicating criteria and specifications used for the N17 road calculations.

Daytime ambient soundscape is not illustrated in this section but considered in the impacts assessment in this document. Potential increase in the future daytime traffic volumes for the N17 National Highway were not considered.

3.4.2 Night-time Ambient Soundscape for Assessment Purpose

As limited road traffic volumes was available for this report it is chosen to assess a scenario whereby the N17 does not contribute significant background noises to the area. No other existing railway line/ associated infrastructure operations were considered.

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At over 1,000 m from the closest portion of the railway line the N17 highway contribution does not influence the study area much in terms of this acoustic assessment at receptors.
4 INVESTIGATED DEVELOPMENT NOISE SOURCES

4.1 LINEAR SOURCES - ROAD TRAFFIC
Noise propagation due to increase road traffic around the Davel community depends on various acoustical factors. The most important are briefly discussed below.

4.1.1 Road tyre interaction and other vehicle noise sources
The most significant noise contributor above 60 km p/h is the tyre interaction with the road surface. Tyre road impacts and shocks as well as tyre to road pumping (during standard rolling conditions, pumping is the compression of air under tyre tread) can contribute mainly below and above 1000 Hz respectively (up to 2000 Hz for pumping). The horn effect created by the geometry of the tyre and road surface can amplify at frequencies up to 10 000 Hz\textsuperscript{20}.

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

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

4.1.4 Road traffic volume
Road traffic with the volume and type of traffic generated may vary from day to day. Only noise levels due to traffic volumes from the existing roads will be estimated using the Calculation of Road Traffic Noise (CRTN; Department of Transport, 1988) prediction method.

4.1.5 Other road noise contributors
Other noise sources associated with motor vehicles include the exhaust outlet, engine motor and associated engine components (mostly audible below 60 km p/h) as well as the

\textsuperscript{20} FEHRL Report 2006/02, Guidance manual for the implementation of low-noise road surfaces
general maintenance condition of the vehicles. Many motor engine revs per minute (rpm) convert to a low range of frequency below the 100 Hz range. Wind shear can contribute to this range but at much faster speeds.

### 4.2 Point and Linear Sources - Railway Traffic and Infrastructure

Disturbance from trains can be divided into two impacts, namely:
- Airborne noise from the operation of a surface rail line that is heard at and within noise-sensitive developments;
- Ground-borne noise and vibration generated inside a building by ground-borne vibration generated from the pass-by of a vehicle on rail.

#### 4.2.1 Vibrations

South African Standards available are limited to the SABS ISO 4866:1990 and SABS ISO 2631-1 1991. These documents are based on human and building infrastructure that is exposed to vibrations. It is a trend in African countries to refer to International Standards and guidelines in terms of vibration criteria.

Infrastructure vibrations predominately occur below 300 Hz, with many International guidelines highlighting the need to consider the measurement frequency weighting when assessing vibrations. These include the international $W_m/KB$ and British $W_b/W_d$ standards, vibration decibel (VdB) measurements as well as the correlation between $L_{Aeq}$ and $L_{Ceq}$ for assessment of lower frequencies \(^{21}\) (refer to Section 2.5 for SANS methodology).

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

This report will only investigate airborne noise disturbances motivated by the following reasons:
- Vibration decibel’s international criterion for annoyance includes the amount of trains per day and is generally based on railways used for commuting purposes (Figure 4-3). International countries where railways are used for commuting purposes is a far busier and more complex system than what is required from this proposed industrial route;
- International documents based on commuter trains do focus a fair amount on built-up dense urban environments whereby potential vibration annoyance may increase. This

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\(^{21}\) RIVAS. Review of existing standards, regulations and guidelines, as well as laboratory and field studies concerning human exposure to vibration. 2011.
proposed railway route assessment is in a fairly rural area when considering the
surrounding land use;

- International guidelines also take into account high speed commuter trains, with
  commuter trains that can reach a velocity of a maximum of 200 km/h\(^{22}\). This
  proposed industrial route will have trains operating at 40 km/h near sensitive areas.
  The levels of ground-borne vibration and noise vary approximately 20 times the
  logarithm of speed. This means that doubling train speed will increase the vibration
  levels approximately 6 decibels and halving train speed will reduce the levels by 6
  decibels. Due to the directly proportional relationship between vibration and noise,
  the lower the rolling stock speeds the less likely there will be for a vibration
  annoyance\(^{23}\);

- Ground-borne noise mainly applies at receiver locations above rail operations in
  tunnels where ground-borne noise levels from rail transport are likely to be greater
  than airborne noise levels (and at speed). This is particularly relevant internationally
  for commuter underground subway systems. Air-borne noise generally is far more
  annoying to a receptor than ground-borne vibrations;

- Only limited research into the impacts of ground-borne noise is available, and
  information and modelling on practices applied overseas is scarce\(^{24}\). There is currently
  no accepted model available to allow the extent of vibration and ground-born noise
  from railway vehicles. Such efforts as the CATdBTren\(^{25}\) and ENVIB\(^{26}\) projects
  whereby empirical calculations are proposed for the prediction of the complex ground-
  borne vibration;

- A ground-borne vibration is proportional of the distance from noise source to the
  receiver. Refer to **Figure 4-1** for such an example (based on an underground subway
  system, example only). In this instance, not all receptors in the study area are
  adjacent to the proposed railway line;

- Many proposed mitigation measures for consideration in this document due to air-
  borne noise will similarly influence ground vibrations\(^{27}\). Refer to **Table 4-1** indicating
  the likely corrections that can be achieved to reduce both air and ground-borne
  vibrations simultaneously, and was considered for the air-borne acoustical mitigation
  section of this document\(^{28}\). Continuous welded rails and wheel maintenance is
  important for both air and ground-borne vibration reductions. Wheel flat spots can be
  generated when trains slide over the tracks. The wheel flat spots will similarly

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\(^{24}\) M.J Griffin. The Handbook of Human Vibration. 1996


\(^{26}\) Mehdi Bahrekazemi. Train-Induce Ground Vibration and its Prediction. 2004

\(^{27}\) High-Speed Ground Transportation Noise and Vibration Impact Assessment. 1998.

influence the increase in audible acoustics as well as ground-borne vibrations due to the clunking effect of the lack of symmetry of wheel radii. The maintenance of the wheel will thus benefit both air and ground-borne acoustics; and

• There are many factors involved in the sophisticated estimation of vibration and ground-borne vibration, including\textsuperscript{29}:
  1. The medium - The surrounding geological strata, bedrock depth, soil type, bedrock contours, soil layering, depth of the water table etc.;
  2. The source - Condition of the track, design of the track, speed of the locomotive and carriage, track support, suspension, track alignment, weight of cargo, condition of the rail track and wheel, wheel axles etc.; and
  3. The receiver - Receptor's foundation design, building construction, interior acoustical absorption and location of building etc.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{train_speed_vdb.png}
\caption{Trains speed vs. VdB (underground subway system)}\textsuperscript{30}
\end{figure}

\textsuperscript{29} David A. Towers, P.E. Rail Transit Noise and Vibration; Sinan Al Suhairy. Prediction of Ground Vibration from Railways.2000
\textsuperscript{30} High-Speed Ground Transportation Noise and Vibration Impact Assessment.1998.
<table>
<thead>
<tr>
<th>Source Factor</th>
<th>Adjustment to Propagation Curve</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle Speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60 mph</td>
<td>+1.6 dB</td>
<td>Vibration level is approximately proportional to 20*log(speed/speed&lt;sub&gt;ref&lt;/sub&gt;). Sometimes the variation with speed has been observed to be as low as 10 to 15 log(speed/speed&lt;sub&gt;ref&lt;/sub&gt;).</td>
</tr>
<tr>
<td>50 mph</td>
<td>+4.4 dB</td>
<td></td>
</tr>
<tr>
<td>40 mph</td>
<td>-1.9 dB</td>
<td></td>
</tr>
<tr>
<td>30 mph</td>
<td>-4.4 dB</td>
<td></td>
</tr>
<tr>
<td>20 mph</td>
<td>-8.0 dB</td>
<td></td>
</tr>
<tr>
<td>Vehicle Parameters (not additive, apply greatest value only)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle with stiff primary suspension</td>
<td>+8 dB</td>
<td>Transit vehicles with stiff primary suspensions have been shown to create high vibration levels. Include this adjustment when the primary suspension has a vertical resonance frequency greater than 15 Hz.</td>
</tr>
<tr>
<td>Resilient Wheels</td>
<td>0 dB</td>
<td>Resilient wheels do not generally affect ground-borne vibration except at frequencies greater than about 80 Hz.</td>
</tr>
<tr>
<td>Worn Wheels or Wheels with Flats</td>
<td>+10 dB</td>
<td>Wheel flats or wheels that are unevenly worn can cause high vibration levels. This can be prevented with wheel truing and slip-slip detectors to prevent the wheels from sliding on the track.</td>
</tr>
<tr>
<td><strong>Track Conditions (not additive, apply greatest value only)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worn or Corrugated Track</td>
<td>+10 dB</td>
<td>If both the wheels and the track are worn, only one adjustment should be used. Corrugated track is a common problem. Mild scale on new rail can cause higher vibration levels until the rail has been in use for some time.</td>
</tr>
<tr>
<td>Special Trackwork</td>
<td>+10 dB</td>
<td>Wheel impacts at special trackwork will significantly increase vibration levels. The increase will be less at greater distances from the track.</td>
</tr>
<tr>
<td>Jointed Track or Uneven Road Surfaces</td>
<td>+5 dB</td>
<td>Jointed track can cause higher vibration levels than welded track. Rough roads or expansion joints are sources of increased vibration for rubber-tire transit.</td>
</tr>
<tr>
<td><strong>Track Treatments (not additive, apply greatest value only)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floating Slab Trackbed</td>
<td>-15 dB</td>
<td>The reduction achieved with a floating slab trackbed is strongly dependent on the frequency characteristics of the vibration.</td>
</tr>
<tr>
<td>Ballast Mats</td>
<td>-10 dB</td>
<td>Actual reduction is strongly dependent on frequency of vibration.</td>
</tr>
<tr>
<td>High-Resilience Fasteners</td>
<td>-5 dB</td>
<td>Slab track with track fasteners that are very compliant in the vertical direction can reduce vibration at frequencies greater than 40 Hz.</td>
</tr>
<tr>
<td><strong>Factors Affecting Vibration Path</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resiliently Supported Ties</td>
<td>-10 dB</td>
<td>Resiliently supported tie systems have been found to provide very effective control of low-frequency vibration.</td>
</tr>
<tr>
<td><strong>Type of Transit Structure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative to grade tie &amp; ballast:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevated structure</td>
<td>-10 dB</td>
<td>The general rule is the heavier the structure, the lower the vibration levels. Putting the track in cut may reduce the vibration levels slightly. Rock-based subways generate higher-frequency vibration.</td>
</tr>
<tr>
<td>Open cut</td>
<td>0 dB</td>
<td></td>
</tr>
<tr>
<td>Relative to bored subway tunnel in soil:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station</td>
<td>-5 dB</td>
<td></td>
</tr>
<tr>
<td>Cut and cover</td>
<td>-3 dB</td>
<td></td>
</tr>
<tr>
<td>Rock-based</td>
<td>-15 dB</td>
<td></td>
</tr>
<tr>
<td><strong>Geologic conditions that promote efficient vibration propagation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficient propagation in soil</td>
<td>+10 dB</td>
<td>Refer to the text for guidance on identifying areas where efficient propagation is possible.</td>
</tr>
<tr>
<td>Propagation in rock layer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dist.</td>
<td>Adjust.</td>
<td></td>
</tr>
<tr>
<td>50 ft</td>
<td>+2 dB</td>
<td>The positive adjustment accounts for the lower attenuation of vibration in rock compared to soil. It is generally more difficult to excite vibrations in rock than in soil at the source.</td>
</tr>
<tr>
<td>100 ft</td>
<td>+4 dB</td>
<td></td>
</tr>
<tr>
<td>150 ft</td>
<td>+6 dB</td>
<td></td>
</tr>
<tr>
<td>200 ft</td>
<td>+9 dB</td>
<td></td>
</tr>
<tr>
<td><strong>Coupling to building foundation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood Frame Houses</td>
<td>-5 dB</td>
<td>The general rule is the heavier the building construction, the greater the coupling loss.</td>
</tr>
<tr>
<td>1-2 Story Masonry</td>
<td>-7 dB</td>
<td></td>
</tr>
<tr>
<td>3-4 Story Masonry</td>
<td>-10 dB</td>
<td></td>
</tr>
<tr>
<td>Large Masonry on Piles</td>
<td>-10 dB</td>
<td></td>
</tr>
<tr>
<td>Large Masonry on Spread Footings</td>
<td>-13 dB</td>
<td></td>
</tr>
<tr>
<td>Foundation in Rock</td>
<td>0 dB</td>
<td></td>
</tr>
<tr>
<td><strong>Factors Affecting Vibration Receiver</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor-to-floor attenuation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 to 5 floors above grade:</td>
<td>-2 dB/floor</td>
<td>This factor accounts for dispersion and attenuation of the vibration energy as it propagates through a building.</td>
</tr>
<tr>
<td>5 to 10 floors above grade:</td>
<td>-1 dB/floor</td>
<td></td>
</tr>
<tr>
<td>Amplification due to resonances of floors, walls, and ceilings</td>
<td>+6 dB</td>
<td>The actual amplification will vary greatly depending on the type of construction. The amplification is lower near the wall/floor and wall/ceiling intersections.</td>
</tr>
<tr>
<td><strong>Conversion to Ground-borne Noise</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise Level in dBA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak frequency of ground vibration:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low frequency (&lt;30 Hz):</td>
<td>-35 dB</td>
<td>Use these adjustments to estimate the A-weighted sound level given the average vibration velocity level of the room surfaces. See text for guidelines for selecting low, typical or high frequency characteristics. Use the high-frequency adjustment for subway tunnels in rock or if the dominant frequencies of the vibration spectrum are known to be 60 Hz or greater.</td>
</tr>
<tr>
<td>Typical (peak 30 to 60 Hz):</td>
<td>-35 dB</td>
<td></td>
</tr>
<tr>
<td>High frequency (&gt;60 Hz):</td>
<td>-20 dB</td>
<td></td>
</tr>
</tbody>
</table>
It must be noted that due to the high level of uncertainties of the geology in relation to the railway line, an individual's unique infrastructure and foundation specifications, it cannot be guaranteed that ground-borne vibrations will meet international criteria at all dwellings. An unlikely situation may arise whereby a receptors dwelling may be located in an ideal setting whereby vibrations may be easily transmitted to the surrounding environment.

4.2.1.1 Vibrations - International Regulations and Guidelines

International guidelines available for vibrations include the ISO 2631-1:1997, ISO8041:2005, Austrian ÖNORMS S 9012: 2010, German DIN4150-2:1999, American ANSI S3.29-1983 etc. These standards are measurement-based methodologies recommending units and weighting corrections that can be used in a measured scenario. The descriptor used for structural vibration damage is the Peak Particle Velocity unit (PPV. in/sec), while potential vibration annoyance is expressed in vibration decibels (VdB), a root mean square calculation.

Europe, Australia and other countries make use of railway lines for multiple purposes and not just industrial use, with commuting rail infrastructure far more advanced than what is available in South Africa. The magnitude of trains due to rail commuting in mentioned countries far exceeds the trip volume as proposed for this acoustical assessment. A staggering example is the 1.3 billion commuter journeys made by rails annually in the United Kingdom, with 575,000 trains alone from towns/cities traversing into London. In comparison a paltry 8 trains is envisaged operations on this assessed rail route (initial volume).

As such the VdB criterion is a correction based on the amount of train passages near a receptor as well as the magnitude of trains per day/night period. The magnitude of trains that pass-by is defined as either infrequent or frequent events. Infrequent events can be classed as “fewer than 70 vibrations a day”. This criterion is defined in Figure 4-2. Furthermore a correction based on the type noise receiver is implemented. The limits for the three land uses applicable for vibrational assessments are:

1. Buildings where a low ambient vibration is essential – Refer to Figure 4-3;
2. Residential dwellings where a peaceful environment is sought for rest; and
3. Institutional land use.

31 Networkrail.co.uk.
4.2.1.2 Secondary Vibrations – wind and air-borne infrastructure vibration

Buildings can be classified into two categories with regards to wind-induced vibration; vibration sensitive (flexible) and Vibration Insensitive (Rigid). The height of the building is directly proportional the vibration sensitivity of the building. As such, skyscrapers make use of large mass-tuned dampers to act as a ballast or counter-weight in relation to opposing wind shear.

Secondary vibrations can occur due to the propagation of acoustics in an air-borne manner, with the result manifesting as a secondary action, such as an audible rattle from a window pane.
4.2.2 Train movement

Rail traffic is considered as a line source of noise with a continuous area of impact both sides of and parallel to the railway line. Railway related noise is general acoustically characterised by high noise levels of relatively short duration. The wayside noise radiated into a community is the function of a number of different factors, namely:

- Interaction of wheels and rails. This includes the type of railway and wheel design, wheel diameter and “roughness”. The main cause of wheel roughness is due to the use of cast iron brakes. Most worldwide railway lines consist of flat-bottom steel rails supported on timber or pre-stressed concrete sleepers. These are usually laid on crushed stone ballast. Railway lines with heavy traffic use continuous welded rails (CWR) attached to sleepers via baseplates which spread the load. Certain railway lines make use of the jointed track, leaving (over time) small spacing between tracks;
- Amount of axels per carriage. The developer intends on running CCL/CCR wagon carriages on the line. These carriages consist of 4 axels per carriage. An example of a CCL – 8 carriages is illustrated in Figure 4-4.
- The vehicle or locomotive propulsion system. The developer proposes the use of between 4 and 6 class 43 diesel locomotives (example in Figure 4-5);
- Type of locomotive and wagons. Refer to points above for locomotive and wagon specifications;
- Amount of trains per day/night. The initial trains per day are indicated at 8 per day while future operations are indicated at 16 trains per day. It is assumed this does not include the trains returning and these figures will be doubled for returning freights. As SANS1010:2008 defines day and night as 16 and 8 hours (over 24 hours, refer to Appendix C) day and night operations will be split 66 % and 33 % i.e. constant homogenous operations;
- Braking technology employed on the wagons and locomotives. All trains will have to be fitted with electronic controlled pneumatic brakes (ENP). It is assumed that the brakes will be cast iron. Railway braking is also associated with brake squeal which may have an acoustical tonal element to it;
- Railway alignment, in particular the design radius of curves and turns. The minimum railway curve radius has an important bearing on construction costs and operating costs;
- Auxiliary equipment;
- Noise radiated from vibrating structures;
- Train speed. The developer intends on running trains in yards at 15 km/h, and 40 km/h in environmental sensitive areas. Maximum line speeds will be 80 km/h;

---

• Train length. The envisage maximum length of carriages is intended to be 200. Train lengths can vary from 160 to 200 (Appendix C);
• Aerodynamics (for higher speed operations above 200 km/h); and
• Locomotive warning devices or horn noise.

Figure 4-4: CCL – 8 Wagon

Figure 4-5: Class 43 diesel locomotives

Train speed is a major influence parameter for noise emission. The noise due to traction and auxiliary systems (diesel units, electrically driven powertrains, cooling equipment, compressors), if present, tends to be predominant at low speeds, up to around 60 km/h. The relationship with speed is illustrated in Figure 4-6.

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

**Figure 4-6: Railway exterior sound sources and typical dependence on train speed**

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

### 4.2.3 Switching Yard operations

There are two main types of noises in a shunting yards, namely a highly impulsive sound as the wagons slam into each other during coupling as well as the movement of the shunting locomotives as they power up to move the wagons around.

Other significant sources of noise include:

- Noise generated during the start-up of the diesel engines (propulsion system, auxiliary equipment);  
- As movement of the diesel locomotives (without load);  
- The sound from the shunting locomotives as it powers up to move the wagons around or onto the hump (high load); and

---

33 Auxiliary equipment: compressors, motor generators, brakes, ventilation systems and any other locomotive-mounted equipment.
• Sound from the trains as it enters and leaves the yard at low speed (brake squeal from train, auxiliary equipment, propulsion system).

Noise levels due to brake squeal as trains approach the rail loop could range between the 90 to more than 105 dBA (peak). It can be audible for more than 2,000 meters. The character of this noise can be considered tonal and could also increase annoyance levels with receptors. Although not significantly and generally far less than sources of noise mentioned above, other sources noises include:

• Ancillary equipment in the yard (substations, compressors, refuelling, etc.);
• Railway maintenance operations;
• Workshops and other equipment maintenance; and
• Induced noises due to the vibration of the railway line components during a train pass-by.

4.2.4 Single maximum noise events - magnitude and occurrences ($L_{A_{max}}$)

Several railway activities, including train pass-by’s, emit repetitive noises of a significant level for brief periods of time that can interfere with sleep, communications, and the wellbeing of the residents of neighbouring properties (WHO 1999). International Standards relating to $L_{A_{max}}$ singular maximum events is briefly discussed in Section 2.7.

4.2.5 Acoustical tone – locomotive and carriage brake and curve squeal

Curve squeal and brake squeal are common noise sources for railways in urban areas and light rail networks. Both are considered highly annoying due to the high levels and the tonal content. Tonal noise includes sounds such as hums, hisses, screeches, drones\textsuperscript{34} etc. Curve squeal is known as the tonal noise that occurs during curving either at curves or in points.\textsuperscript{35}

4.2.6 Low Frequency Noise\textsuperscript{36}

4.2.6.1 Background and Information

Low frequency sound is the term used to describe sound energy in the region below ~200Hz. The rumble of thunder and the throb of a diesel engine are both examples of sounds with most of their energy in this low frequency range. Infrasound is often used to describe sound energy in the region below 20Hz.

Almost all noise in the environment has components in this region although they are of such a low level that they are not significant (wind, ocean, thunder). See also Figure 4-7,

\textsuperscript{34} Bruel & Kjaer. Investigation of Tonal Noise. 2007.
\textsuperscript{35} Micheal Dittrich and Erwin Jansen. Virtual certification of acoustic performance for freight and passenger trains, 11/04/2013
\textsuperscript{36} Renewable Energy Research Laboratory, 2006; DELTA, 2008; DEFRA, 2003; HGC Engineering, 2006; Whitford, Jacques, 2008;
Noise-con, 2008; Minnesota DoH, 2009; Kamperman, 2008, Van den Berg, 2004
which indicates the sound power levels in the different octave bands from measurements taken at different wind speeds with no other audible noise sources. Sound that has most of its energy in the 'infrasound' range is only significant if it is at a very high level, far above normal environmental levels.

4.2.6.2 The generation of Low Frequency Sounds

Low frequency oscillation may occur in the lower frequency of railway grids. Internet resources are abundant regarding low frequency

![Image: Acoustic Energy associated with wind](image)

**Figure 4-7: Third octave band sound power levels at various wind speeds**

4.2.6.3 Measurement, Isolation and Assessment of Low Frequency Sounds

There isn’t a standardised test, nor an assessment procedure available for the assessment of low frequency sounds, neither is there an accepted methodology on how low frequency sounds can be modelled or predicted. This is because low frequency sound can travel large distances, and are present all around us, with a significant component generated by nature itself (ocean, wind, etc.).

SANS 10103 proposes a method to identify whether low frequency noise could be an issue. It proposes that if the difference between the A-frequency weighted and the C-frequency weighted equivalent continuous ($L_{Aeq} >> L_{Ceq}$) sound pressure levels is greater than 10 dB, a predominant low frequency component may be present.
5 METHODS: NOISE IMPACT ASSESSMENT

5.1 POTENTIAL NOISE IMPACT ON ANIMALS\(^{37}\)

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

Overall, the research suggests that species differ in their response to:
- Various types of noise;
- Durations of noise;
- Magnitude of the noise;
- Characteristic of the noise; and
- Sources of noise.

A general animal behavioural reaction to aircraft noise is the startle response. However, the strength and length of the startle response appears to be dependent on:
- Which species is exposed;
- Whether there is one animal or a group; and
- Whether there have been some previous exposures.

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

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

\(^{37}\)Report to Congressional Requesters, 2005; USEPA, 1971; Autumn, 2007; Noise quest, 2010
5.1.1 Wildlife

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

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

5.2 Why noise concerns communities

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

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

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

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

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

Severity of the annoyance depends on factors such as:

---

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

5.2.1 Annoyance associated with Industrial Activities

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

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

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

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

5.3 IMPACT ASSESSMENT CRITERIA

5.3.1 Overview - The common characteristics

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

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

Of the four common characteristics of sound, intensity is the only one which is not subjective and can be quantified. Loudness is a subjective measure of the effect sound has on the human ear. As a quantity it is therefore complicated, but has been defined by experimentation on subjects known to have normal hearing.
The annoyance and offensive characteristics of noise are also subjective. Whether or not a noise causes annoyance mostly depends upon its reception by an individual, the environment in which it is heard, the type of activity and mood of the person and how acclimatised or familiar that person is to the sound.

### 5.3.2 Noise criteria of concern

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

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

- **Increase in noise levels**: People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations (promulgated in terms of the ECA), an increase of more than 7 dBA is considered a disturbing noise. See also Figure 5-2.

- **Zone Sound Levels**: Previously referred to as the acceptable rating levels, it sets acceptable noise levels for various areas. See also Table 5-1.

- **Absolute or total noise levels**: Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA. Anything above this level will be considered unacceptable.

![Figure 5-2: Criteria to assess the significance of impacts stemming from noise](image-url)

Figure 5-2: Criteria to assess the significance of impacts stemming from noise
In South Africa, the document that addresses the issues concerning environmental noise is SANS 10103:2008 (See also Table 5-1). It provides the equivalent ambient noise levels (referred to as Rating Levels), $L_{\text{req,D}}$ and $L_{\text{req,N}}$, during the day and night respectively to which different types of developments may be exposed. The following rating levels are recommended:

- “Suburban districts with little road traffic” (50 and 40 dBA day/night-time Rating).

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

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

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

**Table 5-1: Acceptable Zone Sound Levels for noise in districts (SANS 10103:2008)**
5.3.3 Other noise sources of significance

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

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

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

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

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

An explanation of the impact assessment criteria is defined in the following tables.
Table 5-2: Impact Assessment Criteria - Magnitude

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Increase in average sound pressure levels between 0 and 3 dB from the expected ambient sound levels. Total projected noise level is less than the Zone Sound Level and/or Equator Principles in wind-still conditions.</td>
<td>2</td>
</tr>
<tr>
<td>Low Medium</td>
<td>Increase in average sound pressure levels between 3 and 5 dB from the expected ambient sound levels. Increase in sound pressure levels between 3 and 5 above the Zone Sound Level and/or Equator Principles (wind-less conditions).</td>
<td>4</td>
</tr>
<tr>
<td>Medium</td>
<td>Increase in average sound pressure levels between 5 and 7 dB from the ambient sound levels. Increase in sound pressure levels between 5 and 7 above the Zone Sound Level and/or Equator Principles (wind less conditions). Sporadic complaints expected.</td>
<td>6</td>
</tr>
<tr>
<td>High</td>
<td>Increase in average sound pressure levels between 7 and 10 from the ambient sound level. Increase in sound pressure levels between 7 and 10 dBA above the Zone Sound Level and/or Equator Principles (wind-less condition). Medium to widespread complaints expected.</td>
<td>8</td>
</tr>
<tr>
<td>Very High</td>
<td>Increase in average sound pressure levels higher than 10 dBA. Increases in sound pressure levels higher than 10 dB above the Zone Sound Level and/or Equator Principles (wind less-conditions). Change of 10 dBA is perceived as 'twice as loud', leading to widespread complaints and even threats of community or group action. Any point where instantaneous noise levels exceed 65 dBA at any receptor.</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 5-3: Impact Assessment Criteria - Duration

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary</td>
<td>Impacts are predicted to be of short duration (portion of construction period) and intermittent/occasional.</td>
<td>1</td>
</tr>
<tr>
<td>Short term</td>
<td>Impacts that are predicted to last only for the duration of the construction period.</td>
<td>2</td>
</tr>
<tr>
<td>Long term</td>
<td>Impacts that will continue for the life of the Project, but ceases when the Project stops operating.</td>
<td>4</td>
</tr>
<tr>
<td>Permanent</td>
<td>Impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 5-4: Impact Assessment Criteria – Spatial extent

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>The impacted area extends only as far as the activity, such as footprint occurring within the total site area.</td>
<td>1</td>
</tr>
<tr>
<td>Local</td>
<td>The impact could affect the local area (within 1,000 m from site).</td>
<td>2</td>
</tr>
<tr>
<td>Regional</td>
<td>The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.</td>
<td>3</td>
</tr>
<tr>
<td>National</td>
<td>The impact could have an effect that expands throughout the country (South Africa).</td>
<td>4</td>
</tr>
</tbody>
</table>
Where the impact has international ramifications that extend beyond the boundaries of South Africa.

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

This describes the likelihood of the impacts actually occurring, and whether it will impact on an identified receptor. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improbable</td>
<td>The possibility of the impact occurring is none, due either to the circumstances, design or experience. The chance of this impact occurring is zero (0 %).</td>
<td>1</td>
</tr>
<tr>
<td>Possible</td>
<td>The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chances of this impact occurring is defined to be up to 25%.</td>
<td>2</td>
</tr>
<tr>
<td>Likely</td>
<td>There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chances of this impact occurring is defined to be between 25% and 50%.</td>
<td>3</td>
</tr>
<tr>
<td>Highly Likely</td>
<td>It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chances of this impact occurring is defined between 50% to 75%.</td>
<td>4</td>
</tr>
<tr>
<td>Definite</td>
<td>The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined to be between 75% and 100%.</td>
<td>5</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>PROBABILITY</th>
<th>MAGNITUDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description / Meaning</td>
<td>Score</td>
</tr>
<tr>
<td>Definite/don’t know</td>
<td>5</td>
</tr>
<tr>
<td>Highly likely</td>
<td>4</td>
</tr>
<tr>
<td>Likely</td>
<td>3</td>
</tr>
<tr>
<td>Possible</td>
<td>2</td>
</tr>
<tr>
<td>Improbable</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DURATION</th>
<th>SPATIAL SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description / Meaning</td>
<td>Score</td>
</tr>
<tr>
<td>Permanent</td>
<td>5</td>
</tr>
<tr>
<td>Long Term</td>
<td>4</td>
</tr>
<tr>
<td>Short term</td>
<td>2</td>
</tr>
<tr>
<td>Temporary</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned probabilities, resulting in a Significance Rating (SR) value for each impact (prior to the implementation of mitigation measures).
Significance without mitigation is rated on the following scale:

| SR <30 | Low (L) | Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative mitigation. No mitigation is required. |
| 30<SR <60 | Medium (M) | Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged. |
| SR >60 | High (H) | Impact is significant, mitigation is critical to reduce impact or risk. Resulting impact could influence the decision depending on the possible mitigation. An impact which could influence the decision about whether or not to proceed with the project. |

5.3.6 Identifying the Potential Impacts with Mitigation Measures (WM)

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

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

6.1 NOISE CLIMATE ON THE SURROUNDING ENVIRONMENT

6.1.1 Point Sources – Railway Infrastructure

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

The following were considered:

- The octave band sound pressure emission levels of processes and equipment;
- The distance of the receiver from the noise sources;
- The impact of atmospheric absorption;
- The meteorological conditions in terms of Pasquill stability;
- The operational details of the proposed project.
- Topographical layout; and
- Acoustical characteristics of the ground.

6.1.2 Linear Sources – Roads Traffic

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

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

6.1.3 Linear Sources – Railway traffic

There is no standard or guideline in South Africa stipulating the requirements to calculate or model the potential noise impacts from a railway operation. Various International propagation models do exist. These include the German Schall 03, Dutch SRM II, Nordic TemaNor:1996 and NMPB-FER French acoustical models. The European Transportation Research Laboratory (TRL) has recommended the British model “Calculation of Railway Noise, 1995” as the most technical sound of the available models.

For this purpose it was selected to make use of the United Kingdom Department of Transport document, “Calculation of Railway Noise, 1995”. The methodology proposed in this document is illustrated in Figure 6-1.
Figure 6-1: Flow diagram illustrating the methodology to calculate the noise from railways

6.2 SOUND PROPAGATION - CALCULATION LIMITATIONS
Limitations due to the calculations of the noise emissions into the environment include the following:

- Many sound propagation models do not consider sound characteristics as calculations are based on an equivalent level. These include intrusive sounds or amplitude modulation;
- Many sound propagation models do not calculate the increase of the ambient soundscape due to wind shear (masking noise);
Most sound propagation models do not consider refraction through the various temperature layers (specifically relevant during the night-times);

Most sound propagation models do not consider the low frequency range (third octave 16 – 31.5 Hz). This would be relevant to facilities with a potentially low frequency issues;

Many environmental models consider sound to propagate in hemi-spherical way. Certain noise sources (e.g. a speakers, exhausts, fans) emit sound power levels in a directional manner;

The octave sound power levels selected for processes and equipment accurately represents the sound character and power levels of processes/equipment. The determination of these levels in itself is subject to errors, limitations and assumptions with any potential errors carried over to any model making use of these results;

Sound power emission levels from processes and equipment change depending on the load the process and equipment is subject too. While the octave sound power level is the average (equivalent) result of a number of measurements, this measurement relates to a period that the process or equipment was subject to a certain load. Normally these measurements are collected when the process or equipment is under high load. The result is that measurements generally represent a worse-case scenario;

As it is unknown which processes and equipment will be operational, modelling considers a scenario where all processes and equipment are under full load 100% of the time. The result is that projected noise levels would likely over-estimate sound levels;

The impact of atmospheric absorption is simplified and very uniform meteorological conditions are considered. This is an over-simplification and the effect of this in terms of sound propagation modelling is difficult to quantify;

Many environmental models are not highly suited for close proximity calculations; and

Acoustical characteristics of the ground are over-simplified with ground conditions accepted as uniform. Ground conditions will not be considered in this assessment.

Due to these assumptions modelling generally could be out with as much as +10 dBA although realistic values ranging from 3 ≤ 5 dBA is more common in practice.

6.3 Investigated Scenarios

Initial daytime (06:00 – 22:00) and night-time (22:00 – 06:00) operations will be assessed in this section. Most critical investigational times would be the night-time hours when a quiet environment is desired (at night for sleeping, weekends etc.).
At future dates (taken as 15 years in this document) the capacity of train trips, carriages and locomotives will increase. Assessment for future daytime (06:00 – 22:00) and night-time (22:00 – 06:00) operations will also be addressed.

Calculations in this section are based on a worst-case scenario and will not be relevant for all times of the development operations. It is based on peak hours (over a 1 hour equivalent period). Assessed initial and future operations are illustrated in Figure 6-2.

6.3.1 Investigated Worst-Case Scenarios - Initial Day and Night-time

6.3.1.1 Road Traffic

It is likely that the road traffic volumes around the proposed Davel yard will increase during the operational phase but this increase is unlikely to impact on the total noise levels. It will not be considered in scenario.

6.3.1.2 Railway traffic

Based on available information (Section 4) the initial operations will be assessed taking into account the following:

- The railway line was split into sections for various corrections. The daytime rail yard and mainline operations of 4 x Class 43 electric locomotives and 140 x 4-axle tread braked wagons per train with 10 trains passing through the station per day at 15 km/h. 15 km/h is below the calculation speed of the CRN model and as per the model method specifications 20 km/h was assessed for speeds below 20 km/h\(^{40}\). Train speeds outside rail yard are calculated at 40 km/h near potential environmentally sensitive sections, and 80 km/h at maximum speed where allowable;
- The night-time rail yard and mainline operations of 4 x Class 43 electric locomotives and 140 x 4-axle tread braked wagons per train with 6 trains passing through the station per night at 15 km/h;
- Shunting activities at railway sidings in the rail yard will consider a +12 dBA correction as per SANS 10103:2008 methodology\(^{41}\) due to the highly impulsive nature of shunting activities. The recommendation in this guideline indicates a +12 dBA correction for \(C_i\) in the calculation of the Rating level in \(L_{\text{req},T} = L_{\text{req},T} + C_i + C_t\). Note that the correction is only calculated in Table 7-1 and Table 7-2 and not illustrated in maps;
- Ballast correction (acoustics attenuation due to ballast effect) was not considered on the single rail (main line);
• Intervening ground conditions of a medium ground nature, i.e. (50% hard ground conditions); and
• Assessment does not consider façade corrections or the row of houses acting as a screen when obstructing a direct line of sight to the railway line. Assessed calculations better illustrate potential noise levels at houses directly adjacent or with a direct line of sight to railway lines.

6.3.1.3 Railway Infrastructure

• Railway infrastructure is defined in Section 4.2.3 and illustrated in Figure 6-2 as red dots. A worst-case scenario was assessed whereby the most significant noisy equipment functions simultaneously at full load. Substation operations was calculated the entire day period, while other infrastructure operations was calculated at 10% of the day night period. Railway workshop considered no apertures and a cladding correction for a 1.6 mm galvanized steel sheet (workshop structural cladding) was assumed.

6.3.1.4 Existing Ambient Contributors and Acoustical Factors

• Receptors are regarded at a 2 meter height in relation to the surrounding environment;
• Daytime soundscape contributors as defined in Section 3.4 considered;
• Intervening ground conditions of a medium ground nature, i.e. some flora etc. (50% hard ground conditions);
• No existing railway lines and infrastructure activities were considered; and
• Activities functioning during wind-still conditions, in good sound propagation conditions (20°C and 80% humidity).

6.3.2 Investigated Worst-Case Scenarios - Future Day and Night-time

6.3.2.1 Road Traffic

It is likely that the road traffic volumes around the proposed Davel yard will increase during future dates. As the railway line operations would dominate the ambient soundscape and the potential increase in noise levels due to additional road traffic was not considered.

6.3.2.2 Railway Traffic

Based on available information (Section 4) the initial operations will be assessed taking into account the following:

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Train lines were split into sections for various corrections. The daytime rail yard and mainline operations of 6 x Class 43 electric locomotives and 200 x 4-axle tread braked wagons per train with 22 trains passing through the station per day at 15 km/h. 15 km/h is below the calculation speed of the CRN model and as per the model method specifications 20 km/h was assessed for speeds below 20 km/h\(^\text{43}\). Train speeds outside rail yard are calculated at 40 km/h near potential environmentally sensitive sections, and 80 km/h at maximum speed where allowable;

- The night-time rail yard and mainline operations of 6 x Class 43 electric locomotives and 200 x 4-axle tread braked wagons per train with 10 trains passing through the station per night at 15 km/h;

- Shunting activities at railway sidings in the rail yard will consider a +12 dBA correction as per SANS 10103:2008 methodology\(^\text{44}\). The recommendation in this guideline indicates a +12 dBA correction for \(C_i\) in the calculation of the Rating level in \(L_{\text{Req,T}} = L_{\text{Aeq,T}} + C_i + C_t\). Note that the correction is only calculated in Table 7-1 and Table 7-2 and not illustrated in maps;

- Ballast correction (acoustics attenuation screening of ballast effect) was not considered on single rail (main line); and

- Assessment does not consider façade corrections or the row of houses acting as a screen when obstructing a direct line of sight to the railway line. Assessed calculations better illustrate potential noise levels at houses directly adjacent or with a direct line of sight to railway lines.

### 6.3.2.3 Railway Infrastructure

- Railway infrastructure is defined in Section 4.2.3 and illustrated in Figure 6-2 as red dots. A worst-case scenario was assessed whereby the most significant noisy equipment functions simultaneously at full load. Substation operations was calculated the entire day period, while other infrastructure operations was calculated at 10% of the day night period.

### 6.3.2.4 Existing Ambient Contributors and Acoustical Factors

- Receptors are regarded at a height of 2 meters in relation to the surrounding environment;

- Daytime soundscape contributors as defined in Section 3.4 considered;

- Intervening ground conditions of a medium ground nature, i.e. some flora etc. (50% hard ground conditions);

\(^{43}\)United Kingdom Department of Transport, Calculation of Railway Noise, 1995 (CRN), pg. 13.

\(^{44}\)SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.

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• No existing railway lines and infrastructure activities were considered; and
• Activities functioning during wind-still conditions, in good sound propagation conditions (20°C and 80% humidity).
Figure 6-2: Future scenario as modelled for the day/night time period – Worst case
7 MODELLING RESULTS AND IMPACT ASSESSMENT

7.1 SCENARIO – WORST CASE: INITIAL NOISE LEVELS AS MODELLED – PEAK HOURS

This impact assessment is quite precautionary and a worst-case scenario represents maximum equivalent (average) noise climate ($L_{\text{req,1 h}}$) the area could be exposed to during peak traffic hours. The initial day and night-time operational noise levels are presented in Table 7-1.

In this table a 5 dBA correction is added to the $L_{\text{req,1 h}}$ which could indicate the likely rating when considering the train brake squeal at the train yard (Davel and Kwadela only). Column 5 indicates the likely rating when considering a 12 dBA highly impulsive correction when considering the shunting activities as the railway yard.

Table 7-1: Modelling results - Initial day/night-time operations – peak hours

<table>
<thead>
<tr>
<th>Receiver</th>
<th>Est. Day/Night Ambient Sound Level ($L_{\text{a,90}}$)</th>
<th>Calculated Noise Level ($L_{\text{req,1 h}}$)</th>
<th>Calculated Noise Level ($L_{\text{a}}$) 5 dBA Time Correction</th>
<th>Change from Ambient Sound Level (dBA)</th>
<th>Above Proposed SANS Rating Level (dBA)</th>
<th>Defining Significance of Noise Impact (see Section 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ambient sound level was obtained from lowest LA90 measured data.</td>
<td>Ambient noise level was calculated using the SANS methods discussed in this report.</td>
<td>12 dBA Impulse Correction from shunting yard – SANS10103:2008</td>
<td>Ambient noise level was calculated using the SANS methods discussed in this report.</td>
<td>12 dBA Impulse Correction from shunting yard – SANS10103:2008</td>
<td>Rating level obtained from on-site measurements.</td>
</tr>
<tr>
<td>NSD01</td>
<td>23.1 32.0 Na 46.0 8.9&lt;20.9 0 0 8 4 3 1 15</td>
<td>23.1 32.0 Na 46.0 8.9&lt;20.9 0 0 8 4 3 1 15</td>
<td>23.1 32.0 Na 46.0 8.9&lt;20.9 0 0 8 4 3 1 15</td>
<td>23.1 32.0 Na 46.0 8.9&lt;20.9 0 0 8 4 3 1 15</td>
<td>23.1 32.0 Na 46.0 8.9&lt;20.9 0 0 8 4 3 1 15</td>
<td>23.1 32.0 Na 46.0 8.9&lt;20.9 0 0 8 4 3 1 15</td>
</tr>
<tr>
<td>NSD02</td>
<td>23.1 32.9 Na 44.9 9.8&lt;21.8 0 0 8 4 3 1 15</td>
<td>23.1 32.9 Na 44.9 9.8&lt;21.8 0 0 8 4 3 1 15</td>
<td>23.1 32.9 Na 44.9 9.8&lt;21.8 0 0 8 4 3 1 15</td>
<td>23.1 32.9 Na 44.9 9.8&lt;21.8 0 0 8 4 3 1 15</td>
<td>23.1 32.9 Na 44.9 9.8&lt;21.8 0 0 8 4 3 1 15</td>
<td>23.1 32.9 Na 44.9 9.8&lt;21.8 0 0 8 4 3 1 15</td>
</tr>
<tr>
<td>NSD03</td>
<td>23.1 28.4 Na 40.4 5.3&lt;17.3 0 0 6 4 3 1 13</td>
<td>23.1 28.4 Na 40.4 5.3&lt;17.3 0 0 6 4 3 1 13</td>
<td>23.1 28.4 Na 40.4 5.3&lt;17.3 0 0 6 4 3 1 13</td>
<td>23.1 28.4 Na 40.4 5.3&lt;17.3 0 0 6 4 3 1 13</td>
<td>23.1 28.4 Na 40.4 5.3&lt;17.3 0 0 6 4 3 1 13</td>
<td>23.1 28.4 Na 40.4 5.3&lt;17.3 0 0 6 4 3 1 13</td>
</tr>
<tr>
<td>Davel</td>
<td>21.1 52.0 58.0 62.0 28.9&lt;40.9 0 0 2.0&lt;14.0 8 4 3 2 34</td>
<td>21.1 52.0 58.0 62.0 28.9&lt;40.9 0 0 2.0&lt;14.0 8 4 3 2 34</td>
<td>21.1 52.0 58.0 62.0 28.9&lt;40.9 0 0 2.0&lt;14.0 8 4 3 2 34</td>
<td>21.1 52.0 58.0 62.0 28.9&lt;40.9 0 0 2.0&lt;14.0 8 4 3 2 34</td>
<td>21.1 52.0 58.0 62.0 28.9&lt;40.9 0 0 2.0&lt;14.0 8 4 3 2 34</td>
<td>21.1 52.0 58.0 62.0 28.9&lt;40.9 0 0 2.0&lt;14.0 8 4 3 2 34</td>
</tr>
<tr>
<td>Kwadela</td>
<td>21.1 47.2 51.2 59.2 24.1&lt;36.1 0 0 2.0&lt;14.0 8 4 3 2 34</td>
<td>21.1 47.2 51.2 59.2 24.1&lt;36.1 0 0 2.0&lt;14.0 8 4 3 2 34</td>
<td>21.1 47.2 51.2 59.2 24.1&lt;36.1 0 0 2.0&lt;14.0 8 4 3 2 34</td>
<td>21.1 47.2 51.2 59.2 24.1&lt;36.1 0 0 2.0&lt;14.0 8 4 3 2 34</td>
<td>21.1 47.2 51.2 59.2 24.1&lt;36.1 0 0 2.0&lt;14.0 8 4 3 2 34</td>
<td>21.1 47.2 51.2 59.2 24.1&lt;36.1 0 0 2.0&lt;14.0 8 4 3 2 34</td>
</tr>
</tbody>
</table>

Another method of indicating the potential noise climate is in a linear fashion. For the purposes of this illustration method, three different train speeds are assessed in a linear fashion. This result is illustrated in Table 7-1. Figure 7-3 illustrates the conceptual daytime worst-case peak operational contours of noise levels while Figure 7-4 illustrates night-time scenario. Both day and night-times contours are illustrated from 40 dBA upwards (night-time rating level 40 dBA, daytime contours for better illustration). These figures indicate a $L_{\text{req,1 h}}$ value with no highly impulse or tone corrections.
7.2 SCENARIO – WORST CASE: FUTURE NOISE LEVELS AS MODELLED – PEAK HOURS

This impact assessment is quite precautious and a worst-case scenario represents maximum equivalent (average) noise climate ($L_{eq,1h}$) the area could be exposed to during peak traffic hours. The initial day and night-time operational noise levels are presented in Table 7-2.

In this table a 5 dBA correction is added to the $L_{eq,1h}$ which could indicate the likely rating when considering the train brake squeal at the train yard (Davel and Kwadela only). Column 5 indicates the likely rating when considering a 12 dBA highly impulsive correction when considering the shunting activities as the railway yard.
Table 7-2: Modelling results - Initial day/night-time operations – peak hours

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Est. Day/Night Ambient Sound Level (L_{A90})</th>
<th>Calculated Noise Level (L_{Aeq})</th>
<th>Calculated Noise Level (L_{Aeq}) 5 dBA Tone Correction</th>
<th>Change From Ambient Sound Level (dBA)</th>
<th>Above Equiv. Principles</th>
<th>Above Proposed SANS Rating Level (dBA)</th>
<th>Probability</th>
<th>Duration</th>
<th>Scale</th>
<th>Magnitude</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSD01</td>
<td>23.1</td>
<td>36.0</td>
<td>46.1</td>
<td>13.0 - 25.0</td>
<td>0</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>NSD02</td>
<td>23.1</td>
<td>37.4</td>
<td>49.4</td>
<td>14.5 - 26.3</td>
<td>0</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>NSD03</td>
<td>23.1</td>
<td>33.2</td>
<td>45.2</td>
<td>10.1 - 22.3</td>
<td>0</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Davel</td>
<td>23.1</td>
<td>57.2</td>
<td>59.2</td>
<td>34.1 - 46.1</td>
<td>7.2 - 0.2</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Kwadela</td>
<td>23.1</td>
<td>51.6</td>
<td>63.6</td>
<td>28.5 - 40.5</td>
<td>0 - 8.6</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSD01</td>
<td>22.8</td>
<td>37.2</td>
<td>49.2</td>
<td>14.4 - 26.4</td>
<td>0 - 8.2</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>NSD02</td>
<td>22.8</td>
<td>38.5</td>
<td>50.5</td>
<td>15.7 - 27.7</td>
<td>0 - 6.2</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>NSD03</td>
<td>22.8</td>
<td>34.3</td>
<td>N/a</td>
<td>N/a</td>
<td>N/a</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Davel</td>
<td>22.8</td>
<td>58.3</td>
<td>70.3</td>
<td>35.5 - 47.5</td>
<td>13.3 - 25.3</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Kwadela</td>
<td>22.8</td>
<td>52.7</td>
<td>64.7</td>
<td>29.9 - 41.9</td>
<td>7.7 - 19.7</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>68</td>
<td></td>
</tr>
</tbody>
</table>

Similar to the initial scenario, another method of indicating the potential noise climate is in a linear fashion. For the purposes of this illustration method, three different train speeds are assessed in a linear fashion. This result is illustrated in Figure 7-2.

**Figure 7-5** illustrates the conceptual daytime worst-case peak operational contours of noise levels while **Figure 7-6** illustrates night-time scenario. Both day and night-times contours are illustrated from 40 dBA upwards (night-time rating level 40 dBA, daytime contours for better illustration). These figures indicate a $L_{\text{Req,1h}}$ value with no highly impulse or tone corrections.
Figure 7-2: Basic linear calculations, noise climate vs. speed at distance from railway line
Figure 7-3: Projected initial scenario – Modelled worst-case daytime noise levels (no 12 dBA highly impulsive correction – shunting)
Figure 7-4: Projected initial scenario – Modelled worst-case night-time noise levels (no 12 dBA highly impulsive correction – shunting)
Figure 7-5: Projected future scenario – Modelled worst-case daytime noise levels (no 12 dBA highly impulsive correction – shunting)
Figure 7-6: Projected future scenario – Modelled worst-case night-time noise levels (no 12 dBA highly impulsive correction – shunting)
7.3 IMPACT ASSESSMENT – TRANSNET DAVEL TRAIN YARD

The impact significance as assessment for potential receptors when the project initially operates is presented in Table 7-3 and Table 7-4 below.

Table 7-3: Impact Assessment: Initial and night-time scenarios – Peak hours

<table>
<thead>
<tr>
<th>Nature:</th>
<th>Operations take place during the day (06:00 – 22:00) and night-time hours of (22:00 – 06:00).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptable Rating Level</td>
<td>Suburban districts with little road traffic. Use of L_{昼,D} of 50 dBA. Use of L_{昼,N} of 40 dBA.</td>
</tr>
<tr>
<td>Extent</td>
<td>Regional (3) – The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.</td>
</tr>
<tr>
<td>Duration</td>
<td>Long term (4) – Impacts that will continue for the life of the development</td>
</tr>
<tr>
<td>Magnitude</td>
<td>Equivalent noise levels will exceed the the Zone Sound Level and/or Equator Principles during day and night-time hours. Very High (10).</td>
</tr>
<tr>
<td>Probability</td>
<td>Highly Likely (4) • The first and second rows of houses adjacent to the railway line may act as “sound barriers” assisting in the reduction noise propagation; • Calculated levels will exceed the Zone Sound Level and/or Equator Principles by a significant value during a period when a receptor may require rest (night-times); • Modelling the result of cumulative effect of activities at shunting line (+12 dB penalty), the railway represents a potential worst-case scenario; • Highly impulsive noise events (L_{max}) of shunting during night-times may increase annoyance levels. It is not just the amount of L_{max} events, but also the magnitude (above 80 dB) of the L_{max}. Refer to Section 2.6 and Section 4.2.4 motivating the the chosen 80 dB for L_{max} values; • Project likely economically positive for the surrounding communities that could result in a positive attitude towards the noises.</td>
</tr>
<tr>
<td>Significance</td>
<td>68 (High) – for certain NSD’s during the night-time. Refer to Table 7-1 for NSD’s where this will be applicable.</td>
</tr>
<tr>
<td>Status</td>
<td>Positive.</td>
</tr>
<tr>
<td>Reversibility</td>
<td>Medium.</td>
</tr>
<tr>
<td>Comments</td>
<td>Mitigation recommended.</td>
</tr>
<tr>
<td>Can impacts be mitigated?</td>
<td>Possible.</td>
</tr>
</tbody>
</table>

Table 7-4: Impact Assessment: Future day and night-time scenarios – Peak hours

<table>
<thead>
<tr>
<th>Nature:</th>
<th>Operations take place during the day (06:00 – 22:00) and night-time hours of (22:00 – 06:00).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptable Rating Level</td>
<td>Suburban districts with little road traffic. Use of L_{昼,D} of 50 dBA. Use of L_{昼,N} of 40 dBA.</td>
</tr>
<tr>
<td>Extent</td>
<td>Regional (3) – The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.</td>
</tr>
<tr>
<td>Duration</td>
<td>Long term (4) – Impacts that will continue for the life of the development</td>
</tr>
<tr>
<td>Magnitude</td>
<td>Equivalent noise levels will exceed the the Zone Sound Level and/or Equator Principles during day and night-time hours. Very High (10).</td>
</tr>
<tr>
<td>Probability</td>
<td>Highly Likely (4) • The first and second rows of houses adjacent to the railway line may act as “sound barriers” assisting in the reduction noise propagation; • Calculated levels will exceed the Zone Sound Level and/or Equator Principles by a significant value during a period when a receptor may require rest (night-times); • Modelling the result of cumulative effect of activities at shunting line (+12 dB penalty), the railway represents a potential worst-case scenario; • Highly impulsive noise events (L_{max}) of shunting during night-times may increase annoyance levels. It is not just the amount of L_{max} events, but also the magnitude (above 80 dB) of the L_{max}. Refer to Section 2.6 and Section 4.2.4 motivating the the chosen 80 dB for L_{max} values; • Project likely economically positive for the surrounding communities that could result in a positive attitude towards the noises.</td>
</tr>
</tbody>
</table>
Highly Likely (4)
- The first and second rows of houses adjacent to the railway line may act as “sound barriers” assisting in the reduction noise propagation;
- Calculated levels will exceed the Zone Sound Level and/or Equator Principles by a significant value during a period when a receptor may require rest (night-times);
- Modelling the result of cumulative effect of activities at shunting line (+12 dB penalty), the railway represents a potential worst-case scenario;
- Highly impulsive noise events ($L_{A_{max}}$) of shunting during night-times may increase annoyance levels. It is not just the amount of $L_{A_{max}}$ events, but also the magnitude (above 80 dB) of the $L_{A_{max}}$. Refer to Section 2.6 and Section 4.2.4 motivating the the chosen 80 dB for $L_{A_{max}}$ values;
- Project likely economically positive for the surrounding communities that could result in a positive attitude towards the noises.

Significance
- 68 (High) – for certain NSD’s during the night-time. Refer to Table 7-2 for NSD’s where this will be applicable.

Status
- Positive.

Reversibility
- Medium.

Comments
- Mitigation recommended.

Can impacts be mitigated?
- Possible.

Based on the preceding data it is obvious that the risk of a noise impact developing during the night-time hours is of a high significance. Mitigation is supplied in Section 7.3 for the developer to consider.
8 MITIGATION OPTIONS

Assessment indicate a potential sound environment where rating levels would exceed the initial and future night-time zone sound levels during peak traffic periods at houses directly adjacent to the train line in the Davel and Kwadela communities. This is mostly due to the 12 dBA impulse correction implemented (shunting activities at Davel Yard) for calculated values as recommended in SANS10103:2008.

With a risk of a noise impact developing during the night-time hours of high significance, mitigation options are recommended to be evaluated by the developer. The mitigation of noise from existing roads and railway lines are difficult and potentially expensive to implement. Mitigation discussed below is optional and not mandatory for the developer due to the clauses mentioned above. Mitigation options would be most relevant to the houses directly adjacent to the railway line in the Davel and Kwadela communities.

8.1 MITIGATION OPTIONS: MITIGATION OF NOISE SOURCE – RAILWAY LINE

Commercial railway line activities are excluded from the requirements of the Government Notice R154 of 1992 (Noise Control Regulations) – Clause 2.(c) - “Provided that the provisions of this paragraph (in reference to noise emanating from a development) shall not apply in respect of a disturbing noise or noise nuisance caused by rail vehicles or aircraft which are not used as recreational vehicles”.

As such mitigation options are supplied for the developer’s consideration only, with no Environmental Management Programme supplied due to the clause above.

Furthermore the locomotive horns is exempted from the Government Notice R154 of 1992 (Noise Control Regulations) – Clause 7.(1) – “the emission of sound is for the purposes of warning people of a dangerous situation”.

The mitigation options below are highlighted for the developer to consider during the planning stage of the project. As mentioned mitigation options are optional and not mandatory:

1. Minimise train and shunting operations during the night-times (22:00 – 06:00, SANS 10103:2008) - The potential important times for a noise annoyance to occur would be during the night-time hours when a quiet environment is desired (at night for sleeping etc.). It is highly likely that maximum noise levels due to single noise events outdoor at houses (directly adjacent to the train line in the Davel and Kwadela communities) could exceed 80 dBA. This would be also relevant during...
religious worship, at educational and health care facilities (e.g. pray times at the Mosque or Sunday church services);

2. **Railway line specifications** – Continuous welded rails and ballast is indicated to be implemented by the developer which will result in a noise reduction factor. Cracked, corrugated or damaged rails should be mended or replace immediately to reduce noise and vibrations. The developer can considered a float slab track system at areas where no ballast may be used, generally slab tracks can be +5 dB louder than ballasted tracks.;

3. **Programmes to manage rail and wheels (ground and air-borne vibration)** – 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 (and more friction and noise). These wheel dampers will produce the lowest peak noise levels, but may not prevent tyre squeal fully. The LL brake block system has the potential to reduce rolling and braking noise the most over cast iron brakes as well as K blocks. LL block systems does not require the adoption of cast-iron brake systems and also damage the train wheels far less than a conventional cast-iron brake. The developer should consider ensuring that rail head grinding and rail head maintenance is conducted regularly to ensure that the correct rail head profile is maintained and the elimination of corrugated rails. Defect or wheels with flat spots must be mended or replace to minimise vibrations. The developer could consider rail dampers on the rail line or wheels and at sections of rail near receptors dwellings. An illustration of dampers is presented in Figure 8-1 below. Sharp curves could be lubricated to reduce break squeal.

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4. **Screen the line of sight from receptors to the Davel Yard and railway line** – The developer can consider berms, barriers and design of the train yard (placement of buildings, lines where wagons are left and shunting line) in order to screen the railway line operations maximally to receptors dwellings. From a technical perspective it would seem easiest to consider a berm or single/double brick wall. The developer can also consider the layout of building infrastructure at the yard whereby the development buildings (e.g. office block) is used to obscure the line of sight to surrounding receptors from the train yard. A less feasible option (from a technical perspective) is to design the railway yard and line to be at a lower elevation than the receptors dwelling (sufficient height difference to obscure line of sight).

Advancement in barriers designed specifically for sound insulation has improved drastically over the years. Although a more expensive option than single/double brick/concrete wall or an aggregate berm, acoustic barriers are specifically designed as a buffer for noises. Such barriers could be implemented along the railway line where there is a potential for a high noise impact or at dwellings directly adjacent to the Davel and Kwadela communities. Examples of barriers designed for acoustics is illustrated below in **Figure 8-2** with examples of national and international suppliers supplied in the footer and reference section of this document.  

If the developer decides to implement a double brick wall or berm, the following factors should be implemented to ensure an effective noise boundary wall/barrier:

- It is recommended that the barrier be built as close as possible to the footprint of the railway line (noise source) or residents (receptor) as is feasible as possible. The barrier design needs to consider diffraction, and should have no aperture or gaps;
- It is recommended that the height of the berms/barriers be at least 1 m higher than the line of sight to the highest noise source from the road to a receptors dwelling. Barriers must also be sufficiently dense (at least 20 kilograms/square meter surface density) and sufficient in thickness. A brick wall provides a surface density of 244 kilograms/square m at thickness of 150 mm and is considered as a typically good acoustical barrier. Certain metrological conditions (particularly during night-times) can see refraction of noise over the barrier due to the various temperature inversion layers. This means that noise levels from a road vehicle may propagate back down to the ground at a receptors dwelling due to the

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67 Environmental Protection Department, Government of the Hong Kong SAR Second Issue, January 2003.
curvature of sound in the warmer upper night-time atmosphere. Barrier height
cannot effect this propagation; and
• The barrier should be sufficiently long.

8.2 Mitigation Options: Management Mitigation
5. Public participation – A developer representative could discuss the calculated
noise levels in this document with receptors. The developer representative should
indicate other positive aspects of the project (job and infrastructure enhancement
in the area); and
6. Help line and noise and vibration complaint logging - The developer could consider
a line of communication (e.g. a help line where complaints could be lodged). All
potential sensitive receptors should be made aware of these contact numbers.
Sporadic and legitimate noise and vibration complaints could develop. For
example, sudden and sharp increases in sound levels could result from poorly
maintained tracks or rolling stock. Noise and vibration complaints can be logged
and supplied to railway maintenance staff to further investigate (rail roughness,
corrugated rail head etc.);
7. Environmental Acoustical and Vibration Measurement Programme – The developer
could implement a noise and vibration measurements programme and reporting
conducted on an annual basis. The noise measurements should preferably be
linked to a noise propagation model 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 at that stage of
the project operations;
8. Religious, health, educational buildings, nature reserves and hospitality facilities –
The developer could consider identifying these facilities near the railway line and
co-ordinating any operational times that may be sensitive to these receptors.
9 CONCLUSIONS

Assessments done in this document is as recommended by the United Kingdom Department of Transport - Calculation of Railway Noise (CRN), SANS 10328 and SANS 10103 guidelines. This assessment investigates the potential noise impact from the proposed Davel Railway Yard.

Measurements and site investigation were conducted from the 10th September till the 13th September 2013. Potentially sensitive receptors, also known as noise-sensitive developments (NSDs) were identified up to 200 m from the railway line. Receptor locations were identified using tools such as Google Earth® and other available internet resources and information. The Davel and Kwadela communities were surveyed as part of the measurement procedure. Besides the Davel and Kwadela communities other potential receptors around the development were classified between NSD01 to NSD03. The following rating levels are proposed for receptors in the study area:

- “Suburban districts with little road traffic” (50 and 40 dBA day/night-time Rating);
- The Equator Principles was considered with a 55 and 45 dBA day/night time rating level for receptors.

Site investigation, available internet resources and information indicated the main existing ambient noise contributors to be the N17 National Highway at 1 000 m from the railway yard. The existing Davel railway infrastructure was not operational during site investigational dates.

Four operational scenarios were assessed when the project functions, namely:

- The projected daytime initial peak hour assessment (worst case) when the facility initially starts operations;
- The projected night-time initial peak hour assessment (worst case) when the facility initially starts operations;
- The projected daytime future peak hour assessment (worst case) when the facility operates at maximum capacity; and
- The projected night-time future peak hour assessment (worst case) when the facility operates at maximum capacity.

Calculations were done in accordance with the sound propagation model described by British CRN (Railway Noise) model. Road traffic calculations were conducted using the SANS 10210:2004 model.
Assessment indicated a potential sound environment where rating levels would be exceeded by the initial and future *night-time* peak traffic periods at houses directly adjacent to the train line in the Davel and Kwadela communities. This is mostly due to the 12 dBA impulse correction implemented (shunting activities at Davel Yard) for calculated values as recommended in SANS10103:2008.

With a risk of a noise impact developing during the night-time hours being of a potential high significance, mitigation options could be considered by the developer (Section 8). As it is unsure of which (if any) mitigation options the developer may implement, identifying the potential impacts with mitigation options implemented cannot be assessed.

The findings of this report should be made available to all identified potentially noise-sensitive developments in the area with the contents explained to them to ensure that they understand all the potential risks that the development may have on them and their families.

It must also be noted that it is unfair to expect the noises from the development to be inaudible under all circumstances (even mitigated noise) as this is an unrealistic expectation that is not required or expected from any other agricultural, commercial, industrial or transportation related noise source. However 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.
10 THE AUTHOR

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

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

The author is an independent consultant to the project, Aurecon South Africa (Pty) Ltd and the client. He,

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

Signed:  
2013-12-10  
Date:
11 REFERENCES

In this report reference was made to the following documentation:

18. SANS 10103:2008. ‘The measurement and rating of environmental noise with respect to annoyance and to speech communication’.
22. USEPA, 1971: “*Effects of Noise on Wildlife and other animals*”.


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30. Dr. K. Clark Midkiff. Mechanical engineering Conversion Factors.


38. UIC SET 01, Usage guidelines for composite (LL) brake blocks, 10th edition, 2013.


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53. ÖNORMS S 9012.
55. Networkrail.co.uk.
57. SABS ISO 4866:1990.
63. RIVAS. Review of existing standards, regulations and guidelines, as well as laboratory and field studies concerning human exposure to vibration. 2011.
APPENDIX A

Glossary of Acoustic Terms, Definitions and General Information
### Appendix A: Glossary of Acoustical Terms, Definitions and General Information

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/3-Octave Band</td>
<td>A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the centre frequency of the band. See also definition of octave band.</td>
</tr>
<tr>
<td>A – Weighting</td>
<td>An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound.</td>
</tr>
<tr>
<td>Air Absorption</td>
<td>The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.</td>
</tr>
<tr>
<td>Alternatives</td>
<td>A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are not limited hereto: alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called “no go” alternative refers to the option of not allowing the development and may also require investigation in certain circumstances.</td>
</tr>
<tr>
<td>Ambient</td>
<td>The conditions surrounding an organism or area.</td>
</tr>
<tr>
<td>Ambient Noise</td>
<td>The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.</td>
</tr>
<tr>
<td>Ambient Sound</td>
<td>The all-encompassing sound at a point being composite of sounds from near and far.</td>
</tr>
<tr>
<td>Ambient Sound Level</td>
<td>Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this report the term Background Ambient Sound Level will be used.</td>
</tr>
<tr>
<td>Amplitude Modulated Sound</td>
<td>A sound that noticeably fluctuates in loudness over time.</td>
</tr>
<tr>
<td>Applicant</td>
<td>Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.</td>
</tr>
<tr>
<td>Assessment</td>
<td>The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.</td>
</tr>
<tr>
<td>Attenuation</td>
<td>Term used to indicate reduction of noise or vibration, by whatever method necessary, usually expressed in decibels.</td>
</tr>
<tr>
<td>Audible frequency Range</td>
<td>Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.</td>
</tr>
<tr>
<td>Ambient Sound Level</td>
<td>The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations.</td>
</tr>
<tr>
<td>Axle</td>
<td>Shaft connecting two wheels on either side of the vehicle. The wheels are forced to rotate at the same speed. Vehicles with independent wheels have 'stub axles' that do not connect the two wheels on either side of the vehicle.</td>
</tr>
<tr>
<td>Ballast</td>
<td>A layer of coarse stones supporting the sleepers.</td>
</tr>
<tr>
<td>Baseplate</td>
<td>A track component designed to hold the rail in place, usually with resilience to provide improved vibration isolation.</td>
</tr>
<tr>
<td>Broadband Noise</td>
<td>Spectrum consisting of a large number of frequency components, none of which is individually dominant.</td>
</tr>
<tr>
<td>C-Weighting</td>
<td>This is an international standard filter, which can be applied to a pressure signal or to a SPL or PWL spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less adjustment than the A-scale filter for frequencies less than 1000 Hz.</td>
</tr>
<tr>
<td>dB(A)</td>
<td>Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the frequency response of the human ear.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Decibel (db)</td>
<td>A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 µ Pa.</td>
</tr>
<tr>
<td>Diffraction</td>
<td>The process whereby an acoustic wave is disturbed and its energy redistributed in space as a result of an obstacle in its path. Reflection and refraction are special cases of diffraction.</td>
</tr>
<tr>
<td>Direction of Propagation</td>
<td>The direction of flow of energy associated with a wave.</td>
</tr>
<tr>
<td>Disturbing noise</td>
<td>Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level at the same measuring point by 7 dBA or more.</td>
</tr>
<tr>
<td>Environment</td>
<td>The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.</td>
</tr>
<tr>
<td>Environmental Control Officer</td>
<td>Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.</td>
</tr>
<tr>
<td>Environmental impact</td>
<td>A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them.</td>
</tr>
<tr>
<td>Environmental Impact Assessment</td>
<td>An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures.</td>
</tr>
<tr>
<td>Environmental issue</td>
<td>A concern felt by one or more parties about some existing, potential or perceived environmental impact.</td>
</tr>
<tr>
<td>Equivalent continuous A-weighted sound exposure level ($L_{eq,T}$)</td>
<td>The value of the average A-weighted sound pressure level measured continuously within a reference time interval $T$, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.</td>
</tr>
<tr>
<td>Equivalent continuous A-weighted rating level ($L_{eq,16}$)</td>
<td>The Equivalent continuous A-weighted sound exposure level ($L_{eq,T}$) to which various adjustments has been added. More commonly used as ($L_{eq,16}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{eq,8}$) over a time interval of 22:00 – 06:00 (T=8 hours). It is a calculated value.</td>
</tr>
<tr>
<td>F (fast) time weighting</td>
<td>(1) Averaging detection time used in sound level meters. (2) Fast setting has a time constant of 125 milliseconds and provides a fast reacting display response allowing the user to follow and measure not too rapidly fluctuating sound.</td>
</tr>
<tr>
<td>Footprint area</td>
<td>Area to be used for the construction of the proposed development, which does not include the total study area.</td>
</tr>
<tr>
<td>Free Field Condition</td>
<td>An environment where there is no reflective surfaces.</td>
</tr>
<tr>
<td>Frequency</td>
<td>The rate of oscillation of a sound, measured in units of Hertz (Hz) or kiloHertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate.</td>
</tr>
<tr>
<td>Green field</td>
<td>A parcel of land not previously developed beyond that of agriculture or forestry use; virgin land. The opposite of Greenfield is Brownfield, which is a site previously developed and used by an enterprise, especially for a manufacturing or processing operation. The term Brownfield suggests that an investigation</td>
</tr>
</tbody>
</table>
should be made to determine if environmental damage exists.

**Grinding**
A process for removing a thin layer of metal from the top of the rail head in order to remove roughness and/or to restore the correct profile. Special grinding trains are used for this.

**G-Weighting**
An International Standard filter used to represent the infrasonic components of a sound spectrum.

**Harmonics**
Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone.

**I (impulse) time weighting**
(1) Averaging detection time used in sound level meters as per South African standards and Regulations.
(2) Impulse setting has a time constant of 35 milliseconds when the signal is increasing (sound pressure level rising) and a time constant of 1,500 milliseconds while the signal is decreasing.

**Impulsive sound**
A sound characterized by brief excursions of sound pressure (transient signal) that significantly exceed the ambient sound level.

**Infrasound**
Sound with a frequency content below the threshold of hearing, generally held to be about 20 Hz. Infrasonic sound with sufficiently large amplitude can be perceived, and is both heard and felt as vibration. Natural sources of infrasound are waves, thunder and wind.

**Integrated Development Plan**
A participatory planning process aimed at developing a strategic development plan to guide and inform all planning, budgeting, management and decision-making in a Local Authority, in terms of the requirements of Chapter 5 of the Municipal Systems Act, 2000 (Act 32 of 2000).

**Integrated Environmental Management**
IEM provides an integrated approach for environmental assessment, management, and decision-making and to promote sustainable development and the equitable use of resources. Principles underlying IEM provide for a democratic, participatory, holistic, sustainable, equitable and accountable approach.

**Interested and affected parties**
Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups and the general public.

**Joint rail**
A connection between two lengths of rail, often held together by an arrangement of bolts and fishplates.

**Key issue**
An issue raised during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved.

**Listed activities**
Development actions that is likely to result in significant environmental impacts as identified by the delegated authority (formerly the Minister of Environmental Affairs and Tourism) in terms of Section 21 of the Environment Conservation Act.

**Locomotive**
A powered vehicle used to draw or propel a train of carriages or wagons (as opposed to a multiple unit).

**$L_{AMin}$ and $L_{AMax}$**
Is the RMS (root mean squared) minimum or maximum level of a noise source.

**Loudness**
The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.

**Magnitude of impact**
Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring.

**Masking**
The raising of a listener's threshold of hearing for a given sound due to the presence of another sound.

**Mitigation**
To cause to become less harsh or hostile.

**Negative impact**
A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by damaging health, or by causing nuisance).

**Noise**
a. Sound that a listener does not wish to hear (unwanted sounds).
b. Sound from sources other than the one emitting the sound it is desired to receive, measure or record.
c. A class of sound of an enatic, intermittent or statistically random nature.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Noise Level</strong></td>
<td>The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.</td>
</tr>
<tr>
<td><strong>Noise-sensitive development</strong></td>
<td>Developments that could be influenced by noise such as:</td>
</tr>
<tr>
<td></td>
<td>a) districts (see table 2 of SANS 10103:2008)</td>
</tr>
<tr>
<td></td>
<td>1. rural districts,</td>
</tr>
<tr>
<td></td>
<td>2. suburban districts with little road traffic,</td>
</tr>
<tr>
<td></td>
<td>3. urban districts,</td>
</tr>
<tr>
<td></td>
<td>4. urban districts with some workshops, with business premises, and with main roads,</td>
</tr>
<tr>
<td></td>
<td>5. central business districts, and</td>
</tr>
<tr>
<td></td>
<td>6. industrial districts;</td>
</tr>
<tr>
<td></td>
<td>b) educational, residential, office and health care buildings and their surroundings;</td>
</tr>
<tr>
<td></td>
<td>c) churches and their surroundings;</td>
</tr>
<tr>
<td></td>
<td>d) auditoriums and concert halls and their surroundings;</td>
</tr>
<tr>
<td></td>
<td>e) recreational areas; and</td>
</tr>
<tr>
<td></td>
<td>f) nature reserves.</td>
</tr>
<tr>
<td></td>
<td>In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor.</td>
</tr>
<tr>
<td><strong>Octave Band</strong></td>
<td>A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.</td>
</tr>
<tr>
<td><strong>Positive impact</strong></td>
<td>A change that improves the quality of life of affected people or the quality of the environment.</td>
</tr>
<tr>
<td><strong>Property</strong></td>
<td>Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon</td>
</tr>
<tr>
<td><strong>Public Participation Process</strong></td>
<td>A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development.</td>
</tr>
<tr>
<td><strong>Reflection</strong></td>
<td>Redirection of sound waves.</td>
</tr>
<tr>
<td><strong>Refraction</strong></td>
<td>Change in direction of sound waves caused by changes in the sound wave velocity, typically when sound wave propagates in a medium of different density.</td>
</tr>
<tr>
<td><strong>Reverberant Sound</strong></td>
<td>The sound in an enclosure which results from repeated reflections from the boundaries.</td>
</tr>
<tr>
<td><strong>Reverberation</strong></td>
<td>The persistence, after emission of a sound has stopped, of a sound field within an enclosure.</td>
</tr>
<tr>
<td><strong>Rail head</strong></td>
<td>The bulbous part at the top of the rail.</td>
</tr>
<tr>
<td><strong>Rolling Stock</strong></td>
<td>Rolling stock comprises all the vehicles that move on a railway. It usually includes both powered and unpowered vehicles, for example locomotives, railroad cars, coaches, and wagons.</td>
</tr>
<tr>
<td><strong>Shunting</strong></td>
<td>Shunting, in railway operations, is the process of sorting items of rolling stock into complete train sets.</td>
</tr>
<tr>
<td><strong>Railway Sidings</strong></td>
<td>A siding, in rail terminology, is a low-speed track section distinct from a running line or through route such as a main line or branch line or spur. It may connect to through track or to other sidings at either end.</td>
</tr>
<tr>
<td><strong>Significant Impact</strong></td>
<td>An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.</td>
</tr>
<tr>
<td><strong>S (slow) time weighting</strong></td>
<td>(1) Averaging times used in sound level meters. (2) Time constant of one [1] second that gives a slower response which helps average out the display fluctuations.</td>
</tr>
<tr>
<td><strong>Sound Level</strong></td>
<td>The level of the frequency and time weighted sound pressure as determined by a sound level meter, i.e. A-weighted sound level.</td>
</tr>
<tr>
<td><strong>Sound Power</strong></td>
<td>Of a source, the total sound energy radiated per unit time.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Sound Pressure Level (SPL)</td>
<td>Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as $L_p$ in dB (not weighted) or in various other weightings.</td>
</tr>
<tr>
<td>Soundscape</td>
<td>Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.</td>
</tr>
<tr>
<td>Study area</td>
<td>Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.</td>
</tr>
<tr>
<td>Sustainable Development</td>
<td>Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of &quot;needs&quot;, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).</td>
</tr>
<tr>
<td>Tread braked</td>
<td>The traditional form of wheel brake consisting of a block of friction material (which could be cast iron, wood or nowadays a composition material) hung from a lever and being pressed against the wheel tread by air pressure (in the air brake) or atmospheric pressure in the case of the vacuum brake.</td>
</tr>
<tr>
<td>Tone</td>
<td>Noise can be described as tonal if it contains a noticeable or discrete, continuous note. This includes noises such as hums, hisses, screeches, drones, etc. and any such subjective description is open to discussion and contradiction when reported.</td>
</tr>
<tr>
<td>Wagon</td>
<td>A freight-carrying vehicle.</td>
</tr>
<tr>
<td>Zone of Potential Influence</td>
<td>The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.</td>
</tr>
<tr>
<td>Zone Sound Level</td>
<td>Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS 10103:2008.</td>
</tr>
</tbody>
</table>
APPENDIX B

Site Investigation – Photos of continuous measurement locations
Photos B 1: AR01 measurement location
Annexure B: Site Investigation – Photos of continuous measurement locations
APPENDIX C

Project Layout and Capacity
Figure C 1: Project layout used for acoustical assessment (MMSA-303044-B-DR-DB-ZAR-0001-001 DAVEL BUILDINGS LAYOUT)

Annexure C: Project Layout and Capacity
### Table 20-11: Potential and Enabled capacity data - Work Packages and Sequencing

<table>
<thead>
<tr>
<th>Work Package Number</th>
<th>Project Capability Enabled</th>
<th>Towns to Phumzumoya</th>
<th>Phumzumoya to Nelspruit</th>
<th>Phumzumoya to Beluasane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daily Turn 2 Tend</td>
<td>Daily Turn 2 Tend</td>
<td>Daily Turn 2 Tend</td>
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<tr>
<td></td>
<td></td>
<td>Tonnage (Thousand)</td>
<td>Tonnage (Thousand)</td>
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<td>% Laid</td>
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<td>Daily Turn 2 Tend</td>
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<td></td>
<td></td>
<td>% Laid</td>
<td>% Placed</td>
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</tr>
</tbody>
</table>

**Figure C 2: Project capacity**