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Environmental Noise Report

Kusile Power Station Railway Siding

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EXECUTIVE SUMMARY

Zitholele Consulting is in the process of undertaking an Environmental Impact Assessment (EIA) for the proposed construction of a railway line (and associated infrastructure) from the existing Pretoria – Witbank railway line, two kilometers north of the N4 highway, to the Kusile Power Station, near Witbank. As part of the Impact Assessment Phase of the EIA, Zitholele Consulting contracted JH Consulting to undertake a Noise specialist study to assess the potential noise impacts associated with the construction and operation of the proposed railway.

It is proposed that one train, carrying 50 trucks of sorbent, will enter and exit the siding per day for use in the Flue Gas Desulphurisation [FGD] process at the Kusile Power Station (currently under construction).

The study area for the proposed project is located in a rural area with all three railway alternatives crossing the R104 and N4 Highway approximately 15km east of Bronkhorstspruit, in an area with the generally low ambient noise levels typical of rural environments, but significantly affected by these two roads.

The purpose of the investigation was to assess the potential noise impact of the proposed siding and the rail on the existing ambient noise climate in the surrounding areas, which are predominantly rural. This was achieved by measuring the existing ambient noise levels at the site as well as predicting the noise generated by the train and offloading operation. Measurements of the existing noise climate in the study area were made at three defined positions in and around the proposed route alignments as described in section 3.

All measurements were carried out in accordance with the relevant SABS with Code of practice, and as required by the regulations of the Department of Environmental Affairs. It is assumed that operations will take place during periods defined as daytime and nighttime in these publications.

All comparisons were carried out with the recommended zone levels in accordance with the relevant SANS 10103:2008 Code of practice, and as required by the regulations of the DEA. It is assumed that a two-shift system is to be used which means that operations will take place during periods defined as daytime (06:00 to 22:00) and at least partially in the night-time period 22:00 to 06:00) in these publications.

The expected response from the local community to the noise impact, i.e. any increase of predicted operational noise over the original ambient or recommended zone noise levels, is primarily based on the relevant document, SANS 10103:2008, and expressed in terms of the effects of impact, on a scale of ‘NONE’ to ‘VERY HIGH’.

This report is an overall assessment designed to predict the collective response of a noise-exposed population and therefore the impact the operation is likely to have on them, and is based on measured and predicted equivalent continuous noise levels according to the relevant SANS code of practice.

The noise impact is generally rated as NONE or VERY LOW at areas beyond 120m from the centreline of the alignment. The impact at some of the surrounding dwellings and other buildings, in the worst case of the alignment being at its closest to those dwellings, may rise to LOW at night.

1 PURPOSE OF THE INVESTIGATION AND TERMS OF REFERENCE

Zitholele Consulting is in the process of undertaking an Environmental Impact Assessment (EIA) for the proposed construction of a railway line (and associated infrastructure) from the existing Pretoria – Witbank railway line, two kilometers north of the N4 highway, to the Kusile Power Station, near Witbank. As part of the Impact Assessment Phase of the EIA, Zitholele Consulting contracted JH Consulting to undertake a Noise specialist study to assess the potential noise impacts associated with the construction and operation of the proposed railway.

It is proposed that one train, carrying 50 trucks of sorbent, will enter and exit the siding per day for use in the Flue Gas Desulphurisation [FGD] process at the Kusile Power Station (currently under construction).

The study area for the proposed project is located in a rural area with all three railway alternatives crossing the R104 and N4 Highway approximately 15km east of Bronkhorstspruit, in an area with the generally low ambient noise levels typical of rural environments, but significantly affected by these two roads.

The purpose of the investigation was to assess the potential noise impact of the proposed siding on the existing ambient noise climate in the surrounding areas, which are predominantly rural. This was achieved by comparing the predicted noise generated by the train and offloading operation with the recommended zone levels of SANS 10103:2008, backed up by confirmatory noise measurements at site. It is assumed that operations may take place during periods defined as daytime and night-time in these publications.

1.1 Construction phase

Construction activities associated with the new infrastructure are unlikely to increase the noise level by more than that experienced for the operational phase. This is in any case likely to span a relatively short time period.

1.2 Operational phase

This Operational noise impact is the primary purpose of this report. The rail alignment and the discharge process are considered. Formal complaints regarding noise disturbance should be responded to using an agreed protocol.

1.3 Decommissioning and closure phase

No significant noise impacts are expected during the decommissioning phase of the project. This impact is in any case likely to be of a short duration.

1.4 Possible residual and latent impacts

Residual noise is the noise remaining after the operation is decommissioned and the infrastructure removed. Latent refers to noise which is dormant but may develop after decommissioning. No residual or latent impacts are expected.

2 INVESTIGATIVE METHODOLOGY

2.1 Introduction

The proposed siding is situated in a rural environment, with typically low levels of noise, dominated by the natural sounds of rustling vegetation, wildlife (primarily birdsong), and man-influenced sounds such as livestock, farming activities, domestic activity and very occasional road and air traffic. Therefore it is to be expected that the noise from the suggested operation could potentially have an impact on the surrounding area. In order to be able to assess both the quantitative and geographical extent of the potential impact, it is necessary to predict the noise levels generated by the operation of the siding and compare these with the zone noise level for the type of district backed up by confirmatory noise measurements on site. The extent of community response can then be assessed according to national and international standards which take into account sociological factors as well as the estimated change in noise climate.

2.2 Ambient Noise Measurements in the Study Area

Confirmatory site measurements were carried out on Wednesday 2 and Sunday 6 September 2009. These are reported and discussed in section 3.5 below.

2.3 Prediction of Noise Emitted by Railway and Discharging Operations

The approach used in this assessment is to identify all the characteristic noise-generating operations and make predictions of each. This approach has the advantage that realistic noise values representing actual equipment maintenance condition and actual operating conditions and durations are used in the later predictions.

2.4 Prediction of Noise Levels in the Study Area

The values measured at the operating sites formed the basis of calculations to predict the noise levels at specific locations of interest at the boundaries of the proposed rail siding and associated infrastructure including discharging. Using the point source and attenuation-by-distance model, the following assumptions were made:

1. Acoustically hard ground conditions. This assumes that no attenuation due to absorption at the ground surface takes place. The effects of frequency-dependent atmospheric absorption were also ignored. Both assumptions represent a pessimistic evaluation of the potential noise impact, that is, a worst case scenario approach.

2. Meteorological conditions. Neutral weather conditions, i.e. windless and inversionless, and standard conditions of temperature and humidity (20°C and 50%RH) were assumed, representing a neutral evaluation of the noise impact.

3. Noise measurements were representative of normal operation. Equivalent continuous A-weighted noise levels, $L_{Aeq,I}$, measured for each type of operation correctly represent the noise from that operation. Impossible-to-predict (random) single noise events louder than the continuous noise level are not taken into account, although short events which are part of the process, such as the impact noise from material

transport, and beepers indicating reversing vehicles, for example, are fully represented in the measurements, representing a neutral to mildly optimistic evaluation of the noise impact.

4. Ambient noise levels. Measured levels are assumed typical of the environment, representing a neutral evaluation of the noise impact.

5. Normal traffic noise. This has been ignored in favour of comparison with untrafficked background noise which pertains at most remote locations, but not near most settlements. This represents a pessimistic evaluation of the potential noise impact on the settlements.

6. Current noise control technology is assumed. No allowance is made in the noise level predictions for improvements in noise control techniques or mitigation measures which may be incorporated into the proposed project, representing a pessimistic evaluation of the potential noise impact.

7. Worst case operational noise level assumption. The highest noise level of operation noise as measured or predicted at an operating site was used as the criterion value for the noise predictions for the proposed project, representing a pessimistic evaluation of the potential noise impact.

2.5 Quantifying the Noise Impact

The noise impact is quantified as the predicted increase in ambient noise level, in decibels, which can be attributed to the operation of the proposed siding appropriate to the proposed operating times. The siding is expected to accommodate one train discharging 50 wagons per day.

Existing noise sources include:

1. Natural sounds of the bush;

2. Livestock and agricultural activity on surrounding land;

3. Local community and domestic noise; and
4. Remote vehicles and other transport serving the local community.

Table 1: Typical noise level and human perception of common noise sources.

Noise level (dBA)	Source	Subjective description
160-170	Turbo-jet engine	Unbearable
130	Pneumatic chipping and riveting (operator's position)	Unbearable
120	Large diesel power generator	Unbearable
110	Circular saw Blaring radio	Very noisy
90 - 100	Vehicle on highway	Very noisy
80 - 90	Corner of a busy street Voice - shouting	Noisy
70	Voice - conversational level	Quiet
40 - 50	Average home - suburban areas	Quiet
30	Average home - rural areas Voice - soft whisper	Quiet
0	Threshold of normal hearing	Very quiet

The recommended noise levels in various types of district area are described in Table 2 and Table 5 of SANS 10103 (ref. 1). These are presented in Table 1 and Table below.

Table 1: Acceptable rating levels for noise in districts (Ref.1.)

Type of district						
	Day-night $L_{R,dn}$ [1)]	**Day-time** $L_{Req,d}$ [2)]	**Night-time** $L_{Req,n}$ [2)]	**Day-night** $L_{R,dn}$ [1)]	**Day-time** $L_{Req,d}$ [2)]	**Night-time** $L_{Req,n}$ [2)]
a) Rural districts	**45**	**45**	**35**	**35**	**35**	**25**
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

NB: DAY-TIME : 06:00 TO 22:00, NIGHT-TIME : 22:00 TO 06:00

The appropriate criteria for this assessment are in **bold script** in Table 1 above.

Table 1: SANS 10103-2008 Table 5 – Categories of Community/Group Response

1	2	3
Excess $\Delta L_{Req,T}$ [a] dBA	**Estimated community/group response**	
	Category	**Description**
0 – 10	Little	Sporadic complaints
5 – 15	Medium	Widespread complaints
10 – 20	Strong	Threats of community/group action

>15	Very strong	Vigorous community/group action

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

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

2) $)L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the maximum rating level for the ambient noise given in table 1.

3) $)L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the acceptable rating level for the applicable district as determined from table 2.

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

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

2.6 Assessing the Noise Impact

The expected response from the local community to the noise impact, i.e. the increase of noise over the original ambient, is primarily based on Table 5 of SANS 10103 (ref. 1) (Table 3 of this document), but expressed in terms of the effects of impact, on a scale of 'none' to 'very high' (**Error! Reference source not found.**).

Table 4: Response intensity and noise impact for various increases over the ambient noise.

INCREASE dB	**RESPONSE INTENSITY**	**REMARKS**	**NOISE IMPACT**
0	None	Change not discernible to a person	None
3	None to little	Change just discernible	Very low
3 ≤ 5	Little	Change easily discernible	Low

5 ≤ 7	Little	Sporadic complaints	Moderate
7	Little	Defined by National Noise Regulations as being 'disturbing'	Moderate
7 ≤ 10	Little to medium	Sporadic complaints	High
10 ≤ 15	Medium	Change of 10dB perceived as 'twice as loud' leading to widespread complaints	Very high
15 ≤ 20	Strong	Threats of community/group action	Very high

3 AMBIENT NOISE MEASUREMENTS IN THE STUDY AREA

3.1 Introduction

Ambient noise measurements were carried out according to SANS Code of Practice 10103:2008 (Ref. 1) at six points on or near the property boundary on Wednesday and Sunday September 2 and 6, 2009. These points are defined and the measurements reported in Section 1.5.

3.2 Equipment Used:

01dB Type SdB01+ Precision Integrating Sound Level Meter, serial number 10167, fitted with 01dB Microphone Type MCE210, serial number 001194, and windscreen. Field calibration using and Bruel & Kjaer Type 4230 Sound Level Calibrator, serial number 1314348.

3.3 Calibration Certificates:

All equipment used have valid calibration certificates, from the testing laboratories of De Beer Calibration Services. The calibration certificates are available for viewing if required.

3.4 Procedures Used:

Measurements were carried out strictly in accordance with SOUTH AFRICAN NATIONAL STANDARD - Code of practice, SANS 10103:2008, *The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication* and as required by the regulations of the DEA. NO. R. 154. *Noise Control Regulations in Terms of Section 25 of the Environmental Conservation Act, 1989 (Act No. 73 of 1989).* Govt. Gaz. No. 13717, 10 January 1992, i.e. Gauteng province, Department of Agriculture and Rural Development (GDARD – Previously referred to as the Gauteng Department of Agricultural, Conservation and Environment – GDACE) (, Notice 5479 of 1999. *Noise control regulations, 1999,* Provincial gazette extraordinary, 20 august 1999.

3.5 Measurements along the Proposed Routes:

Measurements were carried out at six positions on or near the boundaries of the study area, and as described under each noise measurement position reported below. These positions were chosen for one or more of the following reasons:

1) Easily definable and with easy future access in case of need for comparison measurements after completion of the project;

2) Most likely to continue to exist after development;

3) Representative of the important background noise regime; and

4) Near sensitive receptors likely to be affected by future noise.

Note 1: All noise levels in this report are A-weighted noise levels expressed in dB(A).

Note 2: $\mathbf{L_{Aeq,I}}$ is the A-weighted equivalent sound level using the 'I' (Impulse) dynamic response characteristic as recommended in SANS 10103:2008 (ref. 1)

Note 3: The noise level exceeded for 90% of the time (L_{90}) is taken as an expression of the background noise in the absence of intrusive noisy events, primarily road traffic and random noise events such as pedestrians, animals, birds, and local road or air traffic.

Note 4: In the Comments column of the noise tables, C - Car, Minibus or LDV, HGV – Heavy Goods Vehicle or Bus, A/c – Commercial airliner, La/c – light aircraft, H – Helicopter, cN - noise level calculated from traffic count, for the measurement period, usually (but at least) 10 Minutes.

Measurement Position 1

On the dirt road near the entrance to the farm Bossemanskraal as shown in the Figure 1 below.

GPS co-ordinates – S25° 53.718′, E28° 50.708′. Height 1428m (±3.8m)

Figure 1: (1) View southeast towards the proposed Kusile railway routes (2) View to Bossemanskraal Farms

Table 5: Measurement Table – Postion 1

Day/Date	Time	T °C	RH %	Wind m/s	L_{eq}	L_{90}	Comments
Sun 06/09/09	09:55-10:05	22.5	25	<0.5	43.5	26	La/c=1
Sun 06/09/09	10:06-10:16	22.5	25	<0.5	43.2	22	La/c=1

Wed 02/09/09	12:02-12:12	30	10	4.2	45.5	33	
Wed 02/09/09	12:14-12:24	30	10	4.2	43.2	33	
Wed 02/09/09	14:26-14:36	30	10	4.0	43.4	33	
Wed 02/09/09	14:38-14:48	30	10	4.0	39.6	33	

OBSERVATIONS: The area is natural grassland with some arable farming and extensive pig farms. The primary noise sources in the area are natural birdlife and farm stock as well as sparse and unpredictable local traffic on the dirt roads and overflying aircrafts**.**

Measurement Position 2

15m from the centreline of the R104 on the southern road reserve fence as shown in **Error! Reference source not found.** below.

GPS co-ordinates – S25° 50.778′, E28° 52.562′. Height 1395m (±4.6m)

Figure 2 : (1) View east towards proposed rail crossing, (2) View west away from proposed rail crossing.


Figure 3 (1) View south over R104 towards N4 (2) View north over R104 towards rail junction

Table 6 Measurement Table – Position 2

Day/Date	**Time**	**T °C**	**3.**	**Wind m/s**	**L_{eq}**	**L_{90}**	**Comments**
Sun 06/09/09	10:45-10:55	26	16	1.1	58.9	30	C=9, HGV=0, La/c=1
Sun 06/09/09	10:56-11:06	26	16	1.1	57.6	27	C=6, HGV=0, La/c=1
Sun 06/09/09	12:23-12:33	28	13	1.6	54.8	25	C=6, HGV=0
Sun 06/09/09	12:35-12:45	28	13	1.6	50.4	24	C=4, HGV=0
Wed 02/09/09	13:05-13:15	30	10	4.0	58.5	35	C=7, HGV=2
Wed 02/09/09	13:16-13:26	30	10	4.0	58.4	34	C=6, HGV=1
Wed 02/09/09	15:53-16:03	28	12	2.0	59.7	36	C=8, HGV=3
Wed 02/09/09	16:04-16:14	28	12	2.0	58.1	34	C=8, HGV=2. La/c=1

OBSERVATIONS: The noise climate in the study area along the R104 corridor is dominated by traffic noise up to 300m from the road. The measured values tabulated above are also in good agreement with calculations using the traffic counts according to the SABS recommended method, see Ref. 4, below.

It should be noted that the **L_{90}**, the noise level exceeded for 90% of the time, and taken as an expression of the background noise in the absence of intrusive noisy events, varies widely between 25 and 35 dB(A), primarily due to traffic from the N4 which effectively forms the background noise here, the noise from individual heavy vehicles on the N4 falling within the range 35-40 dB(A).

Measurement Position 3

Near the entrance to the farm Onverwacht at the entrance gate as shown in the following Figure 2 below.

GPS co-ordinates – S25° 51.541′, E28° 51.389′. Height 1428m (±4.1m)

Figure 3: (1) View to site over Onverwacht farm to MP3 in relation to (2) Onverwacht farm entrance N4, R104 and the proposed rail branch.

Figure 2: View along the dirt access road towards intersection with the N4.

Table 7: Measurement Table – Position 3.

Day/Date	**Time**	**T °C**	R H %	**Wind m/s**	**L_{eq}**	**L_{90}**	**Comments**
Sun 06/09/09	09:20-09:30	22.5	25	Still	39.0	29	
Sun 06/09/09	09:32-09:42	22.5	25	Still	32.5	28	
Sun 06/09/09	10:17-10:27	26	16	Still	38.1	28	
Sun 06/09/09	10:17-10:27	26	16	Still	31.9	23	
Sun 06/09/09	11:20-11:30	28	13	2.1	39.6	29	
Sun 06/09/09	11:32-11:42	28	13	2.1	36.0	26	
Wed 02/09/09	12:38-12:48	30	10	2.5	38.1	31	
Wed 02/09/09	13:50-14:00	30	10	2.2	36.8	29	

Wed 02/09/09	15:08-15:18	30	10	2.0	39.6	30	

OBSERVATIONS: This is a typical of a rural area with little or no man-made noise, primarily natural noise from birds and domestic animals. Noise is sometimes audible from the N4 and may be as high as 35 dB(A) but is not high enough to affect the noise climate at this position.

4 IMPACT ASSESSMENT

4.1 General

Two noise generating mechanisms have been identified and their levels predicted:

1. Noise from the train (during the operational phase); and

2. Noise from the discharging operation.

Assumptions

1. Two train pass-bys per day, at any time of the day;

2. Train of 50 trucks;

3. Train speed - 70 km/hr;

4. Train pass-by duration - 2mins;

5. Maximum pass-by noise at 15m – 82 dB(A);

6. Daily $\mathbf{L_{eq}}$ value (night-time, worst case scenario) – 58 dB(A) at 15m;

7. Discharging operations are assumed to generate less noise than the railway itself and are expected to be within the Eskom site and therefore remote from the site boundaries.

4.2 Continuous Noise Levels and Individual Noise Events - START

This report is an overall assessment designed to predict the collective response of a noise-exposed population and therefore the impact the operation is likely to have on them, and is based on measured and predicted equivalent continuous noise levels according to SANS 10103:2008. It will be possible to detect and distinguish individual noise events, even if the noise impact is assessed as NONE, or VERY LOW, i.e. where a person with normal hearing will not be able to detect the predicted increase in ambient noise level attributable to operation of the railway, but where an individual noise-generating operation may nevertheless be audible to that person.

4.3 Existing Ambient Noise Levels along the alignments

The ambient noise in such rural communities is generally similar to and sometimes lower than the suggested values for rural districts according to the relevant section (Table 1) of the recommendations of SANS 10103:2008 as follows:

Table 8: Part of Table 2 of SANS 10103:2008

Type of District	**Daytime**	**Nighttime**
Suburban	50	40
Rural	45	35

The confirmatory measurements made on site agree very well with the recommendations of SANS 10103:2008, so for the purpose of this assessment the above stricter zone levels for a rural area have been used in the subsequent assessments:

4.4 Predicted Impact of General Site Operation Noise

The investigation shows that because of its remoteness from occupied dwellings, the discharging operation is unlikely to have a significant impact on the ambient noise of the

area. After development there are not expected to be occupied dwellings within 100m of the railway alignment for any of the proposed alignments.

Table 9: Distances from the rail alignment for a certain response intensity and noise impact for various increases over the ambient daytime and night-time noise

Exceedance dB	**Noise Impact**	**Distance - day**	**Distance – night**
0	None	57m	120m
3	Very low	27m	85m
3 ≤ 5	Low	21m	67m
5 ≤ 7	Moderate	17m	53m
7 ≤ 10	High	12m	38m
10 ≤ 15	Very high	7m	21m

These values represent the change of community response as described in Table, and Table reflects the distance from the alignment at which these responses can be expected to occur. The values represent the worst case, which is the nighttime case.

Table 1: Summary of impacts of noise, vibration and shock

Phase	**Impact: Noise**						
	Nature	**Extent**	**Duration**	**Intensity**	**Probability**	**Significance**	
						M	**No M**
Construction	Noise	Local to site	Short term	Low, Negative	Probable	NONE	Very Low

Phase	Impact: Noise						
	Nature	**Extent**	**Duration**	**Intensity**	**Probability**	**Significance**	
						M	**No M**
Operation	Noise	Local to site	Long term	Moderate, Negative	Probable	Very Low	LOW
Decommissioning	Noise	Local to site	Short term	Low, Negative	Probable	NONE	NONE
Residual	None	n/a	n/a	n/a	n/a	n/a	n/a
Latent	None	n/a	n/a	n/a	n/a	n/a	n/a

Note: M = With mitigation measures

No M = Without mitigation measures

5 CONCLUSION AND RECOMMENDATIONS

The findings from the noise assessment were as follows:

1. The study area is situated in a rural environment, with typically low levels of noise, dominated by the natural sounds of rustling vegetation, wildlife (primarily birdsong), and man-influenced sounds such as livestock, farming activities, domestic activity and very occasional road and air traffic. Therefore it is to be expected that the noise from the suggested operation of the railway could potentially have an impact on the surrounding area;

2. There is an existing noise impact along the R104, and especially the N4 corridor, which dominates the background noise and has a significant effect on the noise climate of the northern section of the proposed alignment from the turn-off from main railway line to approximately 500m south of the N4. Up to this distance, the N4 has a greater impact than the proposed alignment.

3. The ambient noise levels in the study area currently fall significantly below the recommended noise levels for suburban residential areas (as per the SANS 10103 acceptable rating levels);

4. The major noise impacts associated with the proposed railway are:

    a. Noise during the construction phase due to heavy vehicles;

    b. Noise from the train during operation; and

    c. Noise at the offloading facility during discharge.

5. Of these impacts, none are deemed to be problematic and it is in the specialists professional opinion that the railway project should not have a significant detrimental noise impact;

6. The noise impact is a factor of distance from the receptor. The further the receptor (dwellings) is form the source of the noise the lower the noise impact is.

7. During the screening phase of the EIA being undertaken by Zitholele Consulting the stakeholder sensitivities and the number of dwellings in close proximity to the proposed railway alternatives were assessed. The findings are summarised in Table 11 below:

Table 11: Stakeholder noise sensitivities determined by number of dwellings in close proximity.

	Alternative 1	**Alternative 2**	**Alternative 3**
Stakeholder sensitivities and proximity to proposed railway	Not as long as alternative two but comes in close proximity to more dwellings then	Longest alternative, therefore more stakeholders affected and in close proximity to the	Preferred alternative in terms of stakeholder proximity. This alternative deviates

	alternative 3	proposed railway. Additionally this railway affects the Topigs pig farm. This pig farm is highly sensitive to noise.	from alternative one by avoiding certain dwellings.
Sensitivity Ranking	**2**	**3**	**1**

Impact	Lowest impact	Moderate impact	Highest impact

8. The preferred alternative from a noise impact perspective is Alternative 3, followed by Alternative 1 and the least preferable alternative is alternative 2.

5.1 Recommended Mitigation Measures

The proposed noise mitigation measures that should be implemented in the construction and operation phases are as follows:

1. During Construction

    a. All noise generating activities should be undertaken during the day between 7h00 and 17h00 including the transportation of structures / equipment to site with the aid of heavy duty vehicles.

    b. All heavy duty vehicles should be fitted with effective exhaust silencers;

    c. All diesel powered earth moving and construction equipment must be of high quality and well maintained

d. Regular scheduled maintenance must include the checking and replacement, if necessary, of intake and exhaust silencers

e. Any change in the noise characteristics of a particular equipment piece should serve as an indicator of potential mechanical failure and immediately be investigated.

2. During Operations

a. The limitation of rail transportation to daytime operations should be seriously considered.

6 REFERENCES

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