Environmental Noise Specialist Study for the Hi-Fos (Pty) Ltd Phosphoric Acid Plant Project, Standerton

Project done for **Terra Pacis Environmental (Pty) Ltd**

Report compiled by:
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NEMA Regulation (2014), Appendix 6

NEMA Regulations (2014) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report.	Report details (page i)
The expertise of that person to compile a specialist report including curriculum vitae.	Section 10: Annex C – Specialist Curriculum Vitae (page 54)
A declaration that the person is independent in a form as may be specified by the competent authority.	Report details (page i)
An indication of the scope of, and the purpose for which, the report was prepared.	Introduction and background (page ii)
The date and season of the site investigation and the relevance of the season to the outcome of the assessment.	Section 3.3: Baseline Noise Survey and Results (page 19)
A description of the methodology adopted in preparing the report or carrying out the specialised process.	Section 1.5: Approach and Methodology (page 6)
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.	Section 3.1: Noise Sensitive Receptors (page 15)
An identification of any areas to be avoided, including buffers.	Not applicable
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	Section 3.1: Noise Sensitive Receptors (page 15)
A description of any assumptions made and any uncertainties or gaps in knowledge.	Section 1.6: Limitations and Assumptions (page 12)
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment.	Section 4: Impact Assessment (page 30) Section 6: Impact Significance Rating (page 40)
Any mitigation measures for inclusion in the environmental management programme report	Section 5: Management Measures (page 38)
Any conditions for inclusion in the environmental authorisation	Section 5: Management Measures (page 38)
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A reasoned opinion as to whether the proposed activity or portions thereof should be authorised.	Section 6: Impact Significance Rating (page 40)
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the environmental management programme report, and where applicable, the closure plan.	Section 5: Management Measures (page 38)
A description of any consultation process that was undertaken during the course of carrying out the study.	Not applicable.
A summary and copies if any comments that were received during any consultation process.	No comments received.
Any other information requested by the competent authority.	Not applicable.

Glossary and Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
ASG	Atmospheric Studies Group
CNX	Calcium Ammonium Nitrite
dB	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure.
dBA	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure that has been A-weighted to simulate human hearing.
C_i	Correction for impulsiveness
Ct	Correction for tonality
EAP	Enviromental Assessment Practitioner
EC	European Commission
EHS	Environmental, Health, and Safety (IFC)
Hi-Fos	Hi-Fos (Pty) Ltd
Hz	Frequency in Hertz
IEC	International Electro Technical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
Kn	Noise propagation correction factor
K1	Noise propagation correction for geometrical divergence
K2	Noise propagation correction for atmospheric absorption
K3	Noise propagation correction for the effect of ground surface;
K4	Noise propagation correction for reflection from surfaces
K5	Noise propagation correction for screening by obstacles
kW	Power in kilowatt
LAN	Liquid ammonium nitrate
L_{Aeq} (T)	The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
L_{AIeq} (T)	The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
$L_{Req,d}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.
$L_{Req,n}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.
$L_{R,dn}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night.
L_{A90}	The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels (L_{A90}) (in dBA)

L_{AFmax}	The A-weighted maximum sound pressure level recorded during the measurement period
L_{AFmin}	The A-weighted minimum sound pressure level recorded during the measurement period
L_P	Sound pressure level (in dB)
L_{PA}	A-weighted sound pressure level (in dBA)
L_{PZ}	Un-weighted sound pressure level (in dB)
Ltd	Limited
L_W	Sound Power Level (in dB)
NEMAQA	National Environment Management Air Quality Act
MAP 33	Mono-ammonium phosphate
MAP 39	Pure mono-ammonium phosphate
m^2	Area in square meters
m/s	Speed in meters per second
NLG	Noise level guideline
NR	Noise receptor
p	Pressure in Pa
Pa	Pressure in Pascal
µPa	Pressure in micro-pascal
p_{ref}	Reference pressure, 20 µPa
Pty	Proprietary
rpm	Rotational speed in revolutions per minute
SABS	South African Bureau of Standards
SANS	South African National Standards
S&EIR	Scoping and Environmental Impact Reporting
SLM	Sound Level Meter
SoW	Scope of Work
STRM	Shuttle Radar Topography Mission
Terra Pacis	Terra Pacis Environmental (Pty) Ltd
USGS	United States Geological Survey
WG-AEN	Working Group – Assessment of Environmental Noise (EC)
WHO	World Health Organisation
%	Percentage

Executive Summary

Hi-Fos (Pty) Ltd (Hi-Fos) proposes to construct and operate a phosphoric acid plant, a calcium ammonium nitrate (CNX) plant, a pure mono ammonium phosphate (MAP 39) plant, a mono ammonium phosphate (MAP 33) plant, and chicken manure/gypsum granulation plant, on Portion 4 of the farm Holfontein 399 approximately 27 km from Standerton. They also intend to move the Granular Fertilizer Blending Plant from Sonskyn (Pty) Ltd in Standerton to the proposed site.

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Terra Pacis Enviromental (Pty) Ltd (Terra Pacis) to provide independent and competent services for the compilation of the environmental noise specialist study as part of the Scoping and Environmental Impact Reporting (S&EIR) process for the proposed facility, cumulatively referred to as the proposed Phosphoric Acid Plant. The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and noise receptors (NRs).

To meet the above objective, the following tasks were included in the Scope of Work (SoW):

1. A review of available technical project information.
2. A review of the legal requirements and applicable environmental noise guidelines.
3. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of NRs from available maps and field observations;
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from surveys conducted in March 2017.
4. An impact assessment, including:
    a. The establishment of a source inventory for proposed activities.
    b. Noise propagation simulations to determine environmental noise levels as a result of the proposed Phosphoric Acid Plant.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. Determining impact significance.
7. The preparation of a comprehensive specialist noise impact assessment report.

In the assessment of sampled and simulated noise levels, reference was made to the International Finance Corporation (IFC) noise level guidelines (NLGs) for residential, institutional and educational receptors (55 dBA during the day and 45 dBA during the night) since these are applicable to nearby NRs. The IFC's 3 dBA increase in noise level criterion was used to determine the potential for noise impact.

The baseline acoustic environment was described in terms of the location of NRs, the ability of the environment to attenuate noise over long distances, as well as existing background and baseline noise levels. The following was found:

- The closest NRs include a community approximately 450 m south of the proposed Phosphoric Acid Plant and farmsteads close to the proposed access road.
- Atmospheric conditions are more conducive to noise attenuation during the day.
- On average, noise impacts are expected to be more notable to the south-east and west during the day and to the west during the night.
- There are no natural terrain features that would provide acoustic shielding to the closets receptors.
- Farming activities, road and rail traffic, domesticated animals, birds and insects are the main contributors to the acoustic environment of the area.
- Representative background noise levels were determined as being 44.3 dBA during the day and 42.9 dBA during the night. These levels were applied in the estimation of the extent to which noise levels increase as a result of the base and project scenarios.

Sound power levels were determined from noise emission factors and area wide calculations. The source inventory, local meteorological conditions and information on local land use were used to populate the noise propagation model (CadnaA, ISO 9613, RSL-90). The propagation of noise was calculated over an area of 5 km east-west by 5 km north-south. The area was divided into a grid matrix with a 10 m resolution and NRs were included as discrete receptors.

It was found that the proposed Phosphoric Acid Plant's operations during the day (06:00 to 22:00) will result in levels below the guideline of 55 dBA for residential, institutional and educational receptors at all nearby NRs. During the day, noise generated by the proposed Phosphoric Acid Plant and traffic will be most notable at the community south of the site and farmsteads close to the access road. At the community, the increase in day-time noise levels of 8.1 dBA may lead to 'little' to 'medium' community reaction with sporadic complaints.

As a result of atmospheric conditions less conducive to noise attenuation and stricter guidelines, night-time noise impacts (22:00 to 06:00) will be more notable. Simulations showed that the night-time guideline of 45 dBA will likely be exceeded at the nearby community, and farmstead along the access road predominantly as a result of heavy vehicle traffic. The increase in night-time noise levels of 9.3 dBA and 5.3 dBA at these receptors, may lead to 'little' to 'medium' community reaction with sporadic complaints.

The significance of environmental noise impacts was determined using the methodology adopted by Terra Pacis for the S&EIR. The significance of the construction phase, assessed qualitatively, was found to be *low*. The significance of operational phase noise impacts, assessed quantitatively, was found to be *moderate.*

It is recommended that general good practice measures for mitigating and managing noise as set out in this report, be adopted. An environmental noise monitoring campaign should be conducted once during the pre-construction phase, once during construction and once during the operational phase, specifically at the nearby community and farmstead along the access road. Also, In the event that noise related complaints are received short term (24-hour) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

Based on the findings of the assessment and provided the measures planned and recommended are in place, it is the specialist opinion that the project may be authorised.

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1 Introduction

Hi-Fos (Pty) Ltd (Hi-Fos) proposes to construct and operate a phosphoric acid plant, a calcium ammonium nitrate (CNX) plant, a pure mono ammonium phosphate (MAP 39) plant, a mono ammonium phosphate (MAP 33) plant, and a chicken manure/gypsum granulation plant, on Portion 4 of the farm Holfontein 399 approximately 27 km from Standerton. They also intend to move the Granular Fertilizer Blending Plant from Sonskyn (Pty) Ltd in Standerton to the proposed site for the phosphoric acid, CNX, MAP 39, and MAP 33 plants.

In order to construct and operate the abovementioned facilities (collectively referred to as the proposed Phosphoric Acid Plant) Hi-Fos, is applying, by way of Scoping and Environmental Impact Reporting (S&EIR) process for an environmental authorisation, an atmospheric emission licence and a water use licence. Airshed Planning Professionals (Pty) Ltd (Airshed) was commissioned by Terra Pacis Environmental (Pty) Ltd (Terra Pacis), the Environmental Assessment Practitioner (EAP) to undertake an environmental noise specialist study for the proposed Phosphoric Acid Plant as part of the S&EIR process.

1.1 Study Objective

The main objective of the noise specialist study was to determine the potential impact on the acoustic environment and noise receptors (NRs) given activities proposed as part of the Phosphoric Acid Plant.

1.2 Scope of Work

To meet the above objective, the following tasks were included in the Scope of Work (SoW):

1. A review of available technical project information.
2. A review of the legal requirements and applicable environmental noise guidelines.
3. A study of the receiving (baseline) acoustic environment, including:
    a. The identification of NRs from available maps and field observations;
    b. A study of environmental noise attenuation potential by referring to available weather records, land use and topography data sources; and
    c. Determining representative baseline noise levels through the analysis of sampled environmental noise levels obtained from surveys conducted in March 2017.
4. An impact assessment, including:
    a. The establishment of a source inventory for proposed activities.
    b. Noise propagation simulations to determine environmental noise levels as a result of the proposed Phosphoric Acid Plant.
    c. The screening of simulated noise levels against environmental noise criteria.
5. The identification and recommendation of suitable mitigation measures and monitoring requirements.
6. Determining impact significance.
7. The preparation of a comprehensive specialist noise impact assessment report.

1.3 Description of Activities from a Noise Perspective

A technical description of the proposed Phosphoric Acid Plant, report reference SK/5/7-2016 Rev. 6 (Knights, 2017), was studied to identify likely sources of noise. Although a detailed plant design from which specific individual noise generating components could be identified was not yet available, it is likely that noise will be generated by large rotating machines, including compressors and turbines, pumps, electric motors, fans, air coolers, rotating drums, conveyors belts, cranes, fired heaters, driers and boilers.

In addition to these stationary type sources, noise will also be generated by mobile diesel equipment (such as front-end loaders), loading and unloading processes, as well as traffic associated with the transport of raw materials and products to- and from site. Vehicle reverse warning signals, announcement systems and plant information or warning signals will further contribute to the noise impact of the proposed Phosphoric Acid Plant.

1.4 Background to Environmental Noise and the Assessment Thereof

Before more details regarding the approach and methodology adopted in the assessment is given, the reader is provided with some background, definitions and conventions used in the measurement, calculation and assessment of environmental noise.

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable as it is subjective rather than objective.

A direct application of linear scales (in pascal (Pa)) to the measurement and calculation of sound pressure leads to large and unwieldy numbers. And, as the ear responds logarithmically rather than linearly to stimuli, it is more practical to express acoustic parameters as a logarithmic ratio of the measured value to a reference value. This logarithmic ratio is called a decibel or dB. The advantage of using dB can be clearly seen in Figure 1. Here, the linear scale with its large numbers is converted into a manageable scale from 0 dB at the threshold of hearing (20 micro-pascals (μPa)) to 130 dB at the threshold of pain (~100 Pa) (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

As explained, noise is reported in dB. "dB" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure. The relationship between sound pressure and sound pressure level is illustrated in this equation.

$$L_p = 20 \cdot \log_{10}\left(\frac{p}{p_{ref}}\right)$$

Where:

L_p *is the sound pressure level in dB;*

p *is the actual sound pressure in Pa; and*

p_{ref} *is the reference sound pressure (*p_{ref} *in air is 20 µPa).*

1.4.1 Perception of Sound

Sound has already been defined as any pressure variation that can be detected by the human ear. The number of pressure variations per second is referred to as the frequency of sound and is measured in hertz (Hz). The hearing frequency of a young, healthy person ranges between 20 Hz and 20 000 Hz.

In terms of L_P, audible sound ranges from the threshold of hearing at 0 dB to the pain threshold of 130 dB and above. Even though an increase in sound pressure level of 6 dB represents a doubling in sound pressure, an increase of 8 to 10 dB is required before the sound subjectively appears to be significantly louder. Similarly, the smallest perceptible change is about 1 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

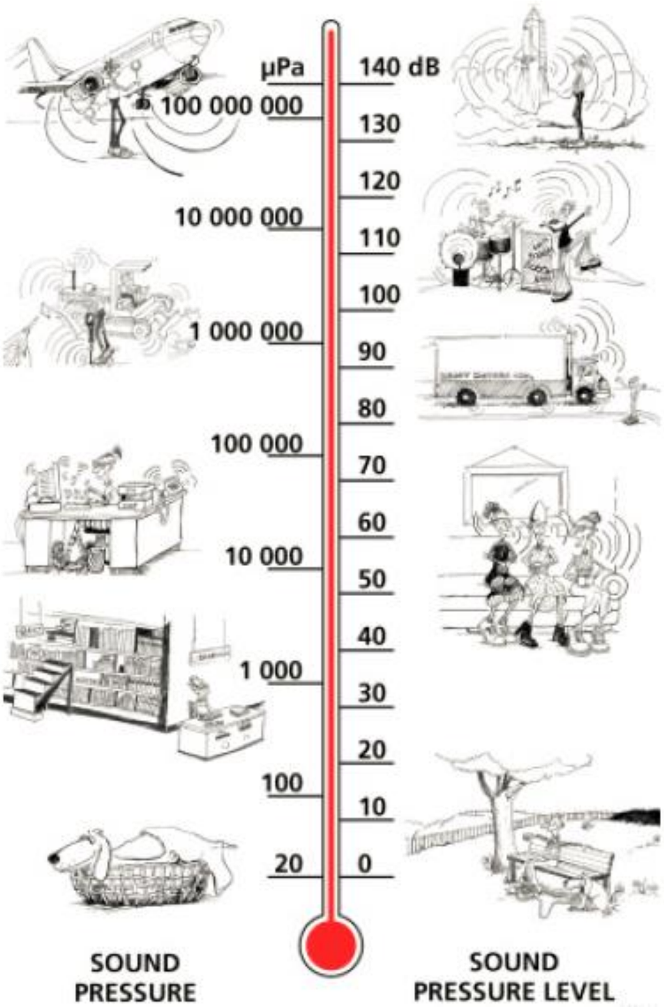


Figure 1: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

1.4.2 Frequency Weighting

Since human hearing is not equally sensitive to all frequencies, a 'filter' has been developed to simulate human hearing. The 'A-weighting' filter simulates the human hearing characteristic, which is less sensitive to sounds at low frequencies than at high frequencies (Figure 2). "dBA" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities, that have the same units (in this case sound pressure) that has been A-weighted.

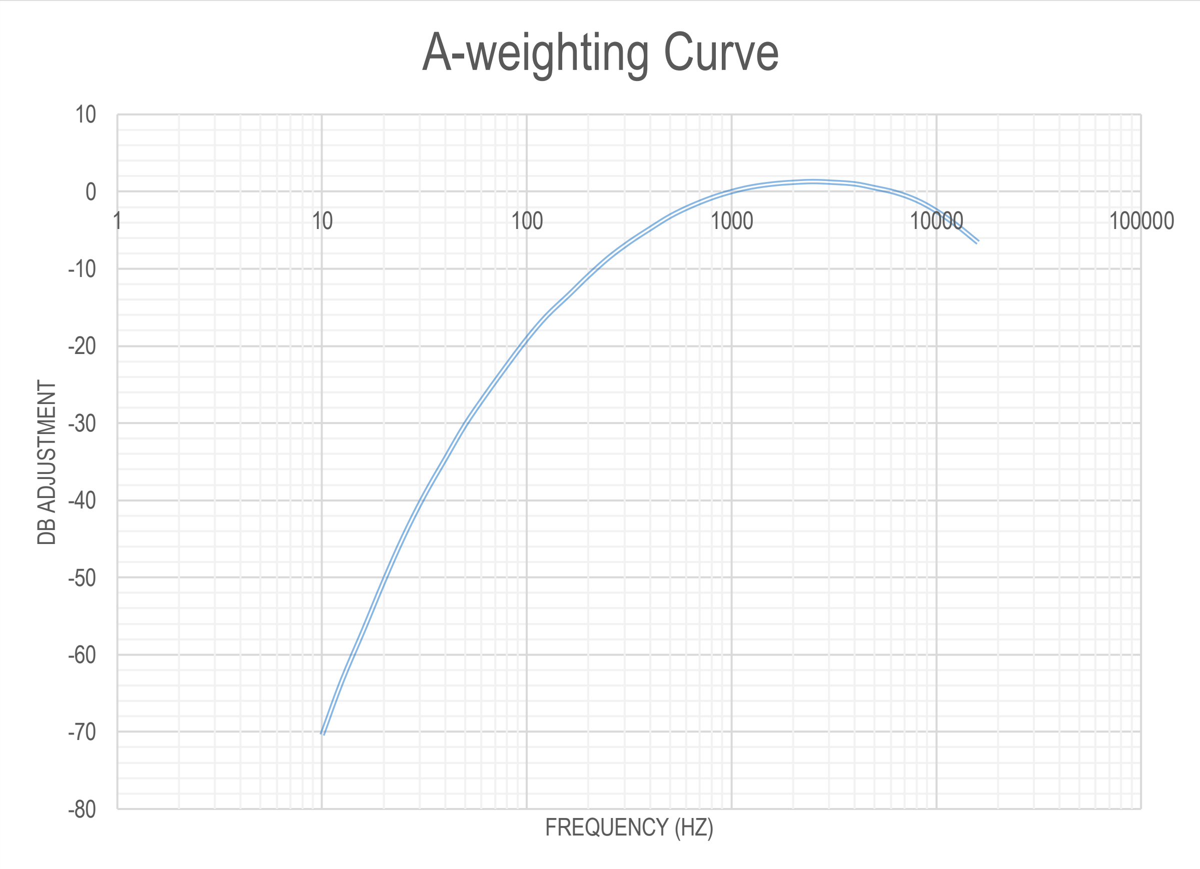


Figure 2: A-weighting curve

1.4.3 Adding Sound Pressure Levels

Since sound pressure levels are logarithmic values, the sound pressure levels as a result of two or more sources cannot just simply be added together. To obtain the combined sound pressure level of a combination of sources such as those at an industrial plant, individual sound pressure levels must be converted to their linear values and added using:

$$L_{p\_combined} = 10 \cdot \log\left(10^{\frac{L_{p1}}{10}} + 10^{\frac{L_{p2}}{10}} + 10^{\frac{L_{p3}}{10}} + \cdots 10^{\frac{L_{pi}}{10}}\right)$$

This implies that if the difference between the sound pressure levels of two sources is nil the combined sound pressure level is 3 dB more than the sound pressure level of one source alone. Similarly, if the difference between the sound pressure levels of two sources is more than 10 dB, the contribution of the quietest source can be disregarded (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.4.4 Environmental Noise Propagation

Many factors affect the propagation of noise from source to receiver. The most important of these are:

- The type of source and its sound power (L_W);
- The distance between the source and the receiver;
- Atmospheric conditions (wind speed and direction, temperature and temperature gradient, humidity etc.);
- Obstacles such as barriers or buildings between the source and receiver;
- Ground absorption; and
- Reflections.

To arrive at a representative result from either measurement or calculation, all these factors must be taken into account (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

1.4.5 Environmental Noise Indices

In assessing environmental noise either by measurement or calculation, reference is generally made to the following indices:

- **L_{Aeq} (T)** – The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured). The International Finance Corporation (IFC) provides guidance with respect to L_{Aeq} (1 hour), the A-weighted equivalent sound pressure level, averaged over 1 hour.
- **L_{AIeq} (T)** – The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured). In the South African Bureau of Standards' (SABS) South African National Standard (SANS) 10103 of 2008 for 'The measurement and rating of environmental noise with respect to annoyance and to speech communication' prescribes the sampling of L_{AIeq} (T).
- **$L_{Req,d}$** – The L_{Aeq} rated for impulsive sound (L_{AIeq}) and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.
- **$L_{Req,n}$** – The L_{Aeq} rated for impulsive sound (L_{AIeq}) and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.
- **$L_{R,dn}$** – The L_{Aeq} rated for impulsive sound (L_{AIeq}) and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10 dB in order to account for the additional disturbance caused by noise during the night.
- **L_{A90}** – The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels.
- **L_{AFmax}** – The maximum A-weighted noise level measured with the fast time weighting. It's the highest level of noise that occurred during a sampling period.
- **L_{AFmin}** – The minimum A-weighted noise level measured with the fast time weighting. It's the lowest level of noise that occurred during a sampling period.

1.5 Approach and Methodology

The assessment included a study of the legal requirements pertaining to environmental noise impacts, a study of the physical environment of the area surrounding the project and the analyses of existing noise levels in the area. The impact assessment focused on the estimation of sound power levels (L_W's) (noise 'emissions') and sound pressure levels (L_P's) (noise impacts) associated with the operational phase. The findings of the assessment components informed recommendations of management measures, including mitigation and monitoring. Individual aspects of the noise impact assessment methodology are discussed in more detail below.

1.5.1 Information Review

The following documents were included in the information review:

- *Hi-Fos (Pty) Ltd | Phosphoric Acid Plant Standerton | Technical Review | Final Draft* (Knights, 2017); and
- *Environmental, Health and Safety (EHS) Guidelines for Phosphate Fertilizer Manufacturing* (IFC, 2007).

1.5.2 Review of Assessment Criteria

In South Africa, provision is made for the regulation of noise under the National Environmental Management Air Quality Act (NEMAQA) (Act. 39 of 2004) but environmental noise limits have yet to be set. It is believed that when published, national criteria will make extensive reference to SANS 10103 of 2008 '*The measurement and rating of environmental noise with respect to annoyance and to speech communication*'. This standard has been widely applied in South Africa and is frequently used by local authorities when investigating noise complaints. These guidelines, which are in line with those published by the IFC in their *General EHS Guidelines* and World Health Organisation (WHO) *Guidelines for Community Noise*, were considered in the assessment.

1.5.3 Study of the Receiving Environment

NRs generally include private residences, community buildings such as schools, hospitals and any publicly accessible areas outside an industrial facility's property. Homesteads and residential areas which were included in the assessment as NRs were identified from available maps and satellite imagery.

The ability of the environment to attenuate noise as it travels through the air was studied by considering local meteorology, land use and terrain. Atmospheric attenuation potential was described based on data recorded at the Eskom owned and operated ambient air quality monitoring station at the Grootdraaidam for 2014 and 2016. The Grootdraaidam station is situated approximately 27 km east of the proposed site for the Phosphoric Acid Plant.

Readily available terrain data was obtained from the Atmospheric Studies Group (ASG) via the United States Geological Survey (USGS) web site. A study was made of Shuttle Radar Topography Mission (STRM) (90 m, 3 arc-sec) data.

1.5.4 Noise Survey

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in an area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area. The opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels. The data from a baseline noise survey conducted on 2 and 3 March 2017 was studied to determine current noise levels within the area.

The survey methodology, which closely followed guidance provided by the IFC (2007) and SANS 10103 (2008), is summarised below:

- The survey was designed and conducted by a trained specialist.
- Sampling was carried out using a Type 1 sound level meter (SLM) that meet all appropriate International Electrotechnical Commission (IEC) standards and is subject to calibration by an accredited laboratory (Annex A). Equipment details are included in Table 1.
- The acoustic sensitivity of the SLM was tested with a portable acoustic calibrator before and after each sampling session.
- Samples, 15 to 30 minutes in duration, representative and sufficient for statistical analysis were taken with the use of the portable SLM capable of logging data continuously over the sampling time period. Samples representative of the day- and night-time acoustic environment were taken. SANS 10103 defines day-time as between 06:00 and 22:00 and night-time between 22:00 and 06:00 (SANS 10103, 2008).
- L_{AIeq} (T), L_{Aeq} (T); L_{AFmax}; L_{AFmin}; L_{90} and 3rd octave frequency spectra were recorded.
- The SLM was located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- SANS 10103 states that one must ensure (as far as possible) that the measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer.
- A detailed electronic log and record was kept. Records included site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

Table 1: Sound level meter details

Equipment	Serial Number	Purpose	Last Calibration Date
Brüel & Kjær Type 2250 Lite SLM	S/N 2731851	Attended 15 to 30-minute sampling.	26 January 2016
Brüel & Kjær Type 4950 ½" Pre-polarized microphone	S/N 2709293	Attended 15 to 30-minute sampling.	26 January 2016
SVANTEK SV33 Class 1 Acoustic Calibrator	S/N 57649	Testing of the acoustic sensitivity before and after each daily sampling session.	14 June 2016

SANS 10103 (2008) prescribes the method for the calculation of the equivalent continuous rating level ($L_{Req,T}$) from measurement data. $L_{Req,T}$ is the equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$) during a specified time interval, plus specified adjustments for tonal character, impulsiveness of the sound and the time of day; and derived from the applicable equation:

$$L_{Req,T} = L_{Aeq,T} + C_i + C_t + K_n$$

Where

- $L_{Req,T}$ is the equivalent continuous rating level;
- $L_{Aeq,T}$ is the equivalent continuous A-weighted sound pressure level, in decibels;
- C_i is the impulse correction;
- C_t is the correction for tonal character; and
- K_n is the adjustment for the time of day (or night), 0 dB for daytime and +10 dB for night-time.

Instrumentation used in this survey are capable of integrating while using the I-time (impulse) weighting and $L_{AIeq,T}$ directly measured. When using $L_{AIeq,T}$, only the tonal character correction and time of day adjustment need to be applied to derive $L_{Req,T}$.

If audible tones such as whines, whistles, hums, and music, are present as determined by the procedure given hereafter (e.g. if the noise contains discernible pitch), then C_t = +5 dBA may be used. If audible tones are not present, then C_t = 0 should be used.

The presence of tones can be determined as follows (SANS 10103, 2008): Using a one-third octave band filter, which complies with the requirements of IEC 61260, the time average sound pressure level in the one-third octave band that contains the tone to be investigated as well as the time average one-third octave band sound pressure level in the adjacent bands to the one that contains the tone frequency should be measured. The difference between the time average sound pressure levels in the two adjacent one-third octave bands should be determined with the time average sound pressure level of the one-third octave band that contains the tone frequency. A level difference between the one-third octave band that contains the tone frequency and the two adjacent one-third octave bands should exceed the limits given in Table 2 to indicate the presence of a tonal component.

NOTE: the adjustment for tonality was only applied if the tone was clearly identifiable as being generated by human activities and not birds or insects.

Table 2: Level differences for the presence of a tonal component

Centre frequencies of 3rd octave bands (Hz)	Minimum 3rd octave band L_P difference (dB)
25 to 125	15
160 to 400	8
500 to 10 000	5

The equivalent continuous day/night rating level can be calculated using the following equation:

$$L_{R,dn} = \left[\left(\frac{d}{24}\right)10^{L_{Req,d}/10} + \left(\frac{24-d}{24}\right)10^{(L_{Req,n}+k_n)/10}\right]$$

Where

- $L_{R,dn}$ is the equivalent continuous day/night rating level;
- D is the duration of the day-time reference time period (06:00 to 22:00);
- $L_{Req,d}$ is the equivalent continuous rating level determined for the day-time reference time period (06:00 to 22:00);
- $L_{Req,n}$ is the equivalent continuous rating level determined for the night-time reference time period (22:00 to 06:00); and
- K_n is the adjustment 10 dB that should be added to the night-time equivalent continuous rating level.

1.5.5 Source Inventory

Since a detailed stationary and mobile equipment list will only be available once the proposed Phosphoric Acid Plant detailed design has been finalised, sound power levels could not be determined for individual noise generating components. Instead, use was made of the default noise "emission factors" for heavy industrial, light industrial and commercial areas as developed by the European Commission's (EC) Working Group for the Assessment of Exposure to Noise (WG-AEN) for their *Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure* (EC WG-AEN, 2006).

Estimates of road traffic were made given raw material consumption and production rates and assumed truck capacities, vehicle speeds and road conditions.

1.5.6 Noise Propagation Simulations

The propagation of noise from proposed activities was simulated with the DataKustic CadnaA software. Use was made of:

(a) The International Organisation for Standardization's (ISO) 9613 module for outdoor noise propagation from industrial noise sources; and

(b) The German "Richtlinien für den Lamschutz an Straben" or RLS90 traffic noise module.

1.5.6.1 ISO 9613

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favourable to propagation from sources of known sound emission. These conditions are for downwind propagation or, equivalently, propagation under a well-developed moderate ground based temperature inversion, such as commonly occurs at night.

The method also predicts an average A-weighted sound pressure level. The average A-weighted sound pressure level encompasses levels for a wide variety of meteorological conditions. The method specified in ISO 9613 consists specifically of octave-band algorithms (with nominal midband frequencies from 63 Hz to 8 kHz) for calculating the attenuation of sound which originates from a point sound source, or an assembly of point sources. The source (or sources) may be moving or stationary. Specific terms are provided in the algorithms for the following physical effects; geometrical divergence, atmospheric absorption, ground surface effects, reflection and obstacles. A basic representation of the model is given in the equation below:

$$L_P = L_W - \sum [K_1, K_2, K_3, K_4, K_5, K_6]$$

Where;

L_P *is the sound pressure level at the receiver;*

L_W *is the sound power level of the source;*

K_1 *is the correction for geometrical divergence;*

K_2 *is the correction for atmospheric absorption;*

K_3 *is the correction for the effect of ground surface;*

K_4 *is the correction for reflection from surfaces; and*

K_5 *is the correction for screening by obstacles.*

This method is applicable in practice to a great variety of noise sources and environments. It is applicable, directly or indirectly, to most situations concerning road or rail traffic, industrial noise sources, construction activities, and many other ground-based noise sources.

To apply the method of ISO 9613, several parameters need to be known with respect to the geometry of the source and of the environment, the ground surface characteristics, and the source strength in terms of octave-band sound power levels for directions relevant to the propagation.

1.5.6.2 RLS90

The RLS90 road traffic noise module included in CadnaA requires average hourly traffic flow, separated into heavy and light vehicles, the average speed for each group, the dimension, geometry and type of the road and of any natural and artificial obstacles. As with ISO 9613, the module also takes also into account the main features which influence the propagation of noise namely obstacles, vegetation, air absorption, reflections and diffraction.

1.5.6.3 Simulation Domain

If the dimensions of a noise source are small compared with the distance to the listener, it is called a point source. All sources were quantified as point sources or areas/lines represented by point sources. The sound energy from a point source spreads out spherically, so that the sound pressure level is the same for all points at the same distance from the source, and decreases by 6 dB per doubling of distance. This holds true until ground and air attenuation noticeably affect the level. The impact of an intruding industrial noise on the environment will therefore rarely extend over more than 5 km from the source and is therefore always considered “local” in extent.

The propagation of noise was calculated over an area of 5 km east-west by 5 km north-south. The area was divided into a grid matrix with a 10 m resolution. NRs and survey locations were included as discrete receptors. The model was set to calculate L_P's at each grid and discrete receptor point at a height of 1.5 m above ground level.

1.5.7 Presentation of Results

Noise impacts were calculated in terms of:

- The equivalent continuous day-time rating level ($L_{Req,d}$);
- The equivalent continuous night-time rating level ($L_{Req,n}$); and
- The equivalent day/night rating level ($L_{R,dn}$).

Results are presented in isopleth form. An isopleth is a line on a map connecting points at which a given variable (in this case sound pressure, L_P) has a specified constant value. This is analogous to contour lines on a map showing terrain elevation. In the assessment of environmental noise, isopleths present lines of constant noise level as a function of distance.

Simulated noise levels were assessed according to guidelines published in SANS 10103 and by the IFC. To assess annoyance at nearby places of residence, reference was made to guidelines published in SANS 10103.

1.5.8 Recommendations of Management and Mitigation

The findings of the noise specialist study informed the recommendation of suitable noise management and mitigation measures.

1.5.9 Impact Significance Assessment

The significance of environmental noise impacts was assessed according to the methodology adopted by Terra Pacis. The impact assessment methodology makes provision for the assessment of impacts against the following criteria:

- significance;
- spatial scale;
- temporal scale;
- probability; and
- degree of certainty.

For a detailed description of the methodology, the reader is referred to the *Final Scoping Report* (report ref. SON001-2.2015-Final Scoping Report-v1.pt.12Dec16) (Tolksdorff & Maraschin, 2016).

1.6 Limitations and Assumptions

The following limitations and assumptions should be noted:

- Since a detailed stationary and mobile equipment list will only be available once the proposed Phosphoric Acid Plant detailed design has been finalised, sound power levels could not be determined for individual noise generating components. Instead, use was made of the default noise “emission factors” for heavy industrial, light industrial and commercial areas as developed by the EC WG-AEN and published in their *Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure* (EC WG-AEN, 2006).
- Estimates of road traffic were made given raw material consumption and production rates and assumed truck capacities, vehicle speeds and road conditions. Trucks were assumed to have a payload of 30 t and to travel at 60 km/h.
- The mitigating effect of buildings, walls and infrastructure acting as acoustic barriers were conservatively not taken into account.
- The quantification of sources of noise was limited to the operational phase of the plant. Construction phase activities are expected to be similar or even less significant and its impacts only assessed qualitatively.
- Although other existing sources of noise within the area were identified, such sources were not quantified but were taken account during the survey.

2 Legal Requirements and Noise Level Guidelines

2.1 South African National Standards

SANS 10103 (2008) successfully addresses the manner in which environmental noise measurements are to be taken and assessed in South Africa, and is fully aligned with the WHO guidelines for Community Noise (WHO, 1999). It should be noted that the values given in Table 3 are typical rating levels that it is recommended should not be exceeded outdoors in the different districts specified. Outdoor ambient noise exceeding these levels will be annoying to the community.

Table 3: Typical rating levels for outdoor noise

Type of district	Equivalent Continuous Rating Level ($L_{Req,T}$) for Outdoor Noise		
	Day/night $L_{R,dn}$ (c) (dBA)	Day-time $L_{Req,d}$ (a) (dBA)	Night-time $L_{Req,n}$ (b) (dBA)
Rural districts	45	45	35
Suburban districts with little road traffic	50	50	40
Urban districts	55	55	45
Urban districts with one or more of the following; business premises; and main roads.	60	60	50
Central business districts	65	65	55
Industrial districts	70	70	60

Notes

(a) $L_{Req,d}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.

(b) $L_{Req,n}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.

(c) $L_{R,dn}$ =The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night.

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

- "$\Delta \leq 0$ dB: There will be no community reaction;
- 0 dB < $\Delta \leq 10$ dB: There will be 'little' reaction with 'sporadic complaints';
- 5 dB < $\Delta \leq 15$ dB: There will be a 'medium' reaction with 'widespread complaints'. $\Delta = 10$ dB is subjectively perceived as a doubling in the loudness of the noise;
- 10 dB < $\Delta \leq 20$ dB: There will be a 'strong' reaction with 'threats of community action'; and
- 15 dB < Δ: There will be a 'very strong' reaction with 'vigorous community action'.

The categories of community response overlap because the response of a community does not occur as a stepwise function, but rather as a gradual change.

2.2 International Finance Corporation Guidelines on Environmental Noise

The IFC General Environmental Health and Safety Guidelines on noise address impacts of noise beyond the property boundary of the facility under consideration and provides noise level guidelines.

The IFC states that noise impacts **should not exceed the levels presented in Table 4**, or result in a maximum **increase above background levels of 3 dBA** at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. Δ = 3 dBA is, therefore, a useful significance indicator for a noise impact.

It is further important to note that the IFC noise level guidelines for residential, institutional and educational receptors correspond with the SANS 10103 guidelines for urban districts.

Table 4: IFC noise level guidelines

Area	**One Hour L_{Aeq} (dBA) 07:00 to 22:00**	**One Hour L_{Aeq} (dBA) 22:00 to 07:00**
Industrial receptors	70	70
Residential, institutional and educational receptors	55	45

2.3 Criteria Applied in this Assessment

Reference is made to the IFC guidelines for residential, institutional and educational receptors (55 dBA during the day and 45 dBA during the night) since these (a) are applicable to nearby NRs (b) in-line with SANS 10103 guidelines for areas of residence.

3 Description of the Receiving Environment

This chapter provides details of the receiving acoustic environment which is described in terms of:

- Local NRs;
- The local environmental noise propagation and attenuation potential; and
- Current noise levels and the existing acoustic climate.

3.1 Noise Sensitive Receptors

NRs generally include places of residence and areas where members of the public may be affected by noise generated by industrial activities. There is a community settlement (NR1) approximately 350 m south of the proposed Phosphoric Acid Plant and adjacent to the site access road. All other identified NRs within the 5 km study area are farmsteads (Figure 3). The closest of these are NR2 and NR3, ~300 m and ~150 m north of the site respectively.

3.2 Environmental Noise Propagation and Attenuation potential

3.2.1 Atmospheric Absorption and Meteorology

Atmospheric absorption and meteorological conditions have already been mentioned with regards to their role in the propagation on noise from a source to receiver (Section 1.4.4). The main meteorological parameters affecting the propagation of noise include wind speed, wind direction and temperature. These along with other parameters such as relative humidity, air pressure, solar radiation and cloud cover affect the stability of the atmosphere and the ability of the atmosphere to absorb sound energy. Use is made of data recorded at the Eskom owned and operated ambient air quality monitoring station at the Grootdraaidam for 2014 and 2016.

Wind speed increases with altitude. This results in the ‘bending’ of the path of sound to ‘focus’ it on the downwind side and creating a ‘shadow’ on the upwind side of the source. Depending on the wind speed, the downwind level may increase by a few dB but the upwind level can drop by more than 20 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). It should be noted that at wind speeds of more than 5 m/s, ambient noise levels are mostly dominated by wind generated noise.

The on-site diurnal wind field is presented in Figure 4. Wind roses represent wind frequencies for the 16 cardinal wind directions. Frequencies are indicated by the length of the shaft when compared to the circles drawn to represent a frequency of occurrence. Wind speed classes are assigned to illustrate the frequencies with high and low winds occurring for each wind vector. The frequencies of calms, defined as periods for which wind speeds are below 1 m/s, are also indicated.

Average day and night-time wind speeds were 3.6 m/s and 2.7 m/s respectively. Calm conditions occurred 8.7% during the day and 13.5% during the night. On average, noise impacts are expected to be more notable to the south-east and west during the day and to the west during the night.

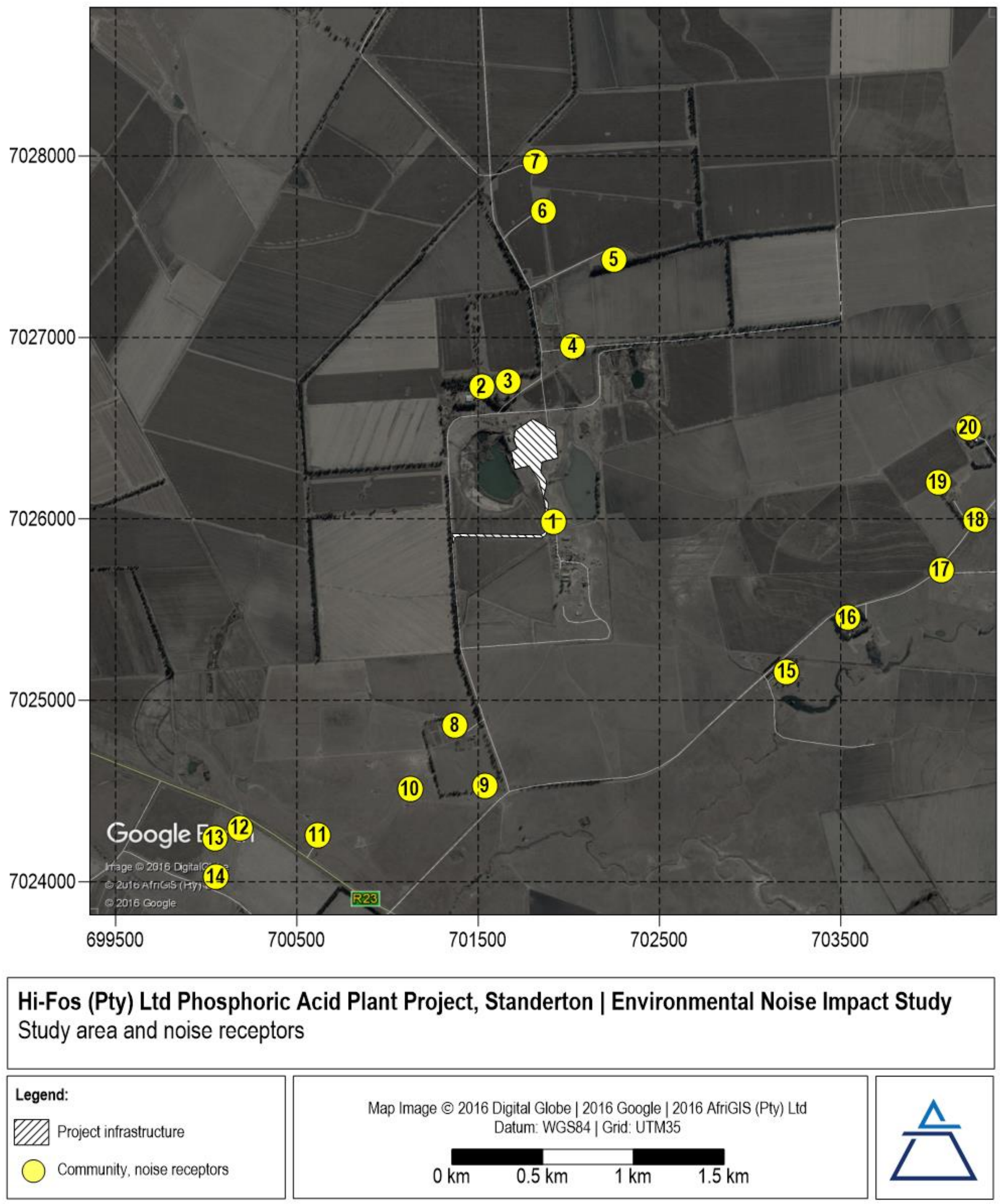


Figure 3: Location of noise receptors

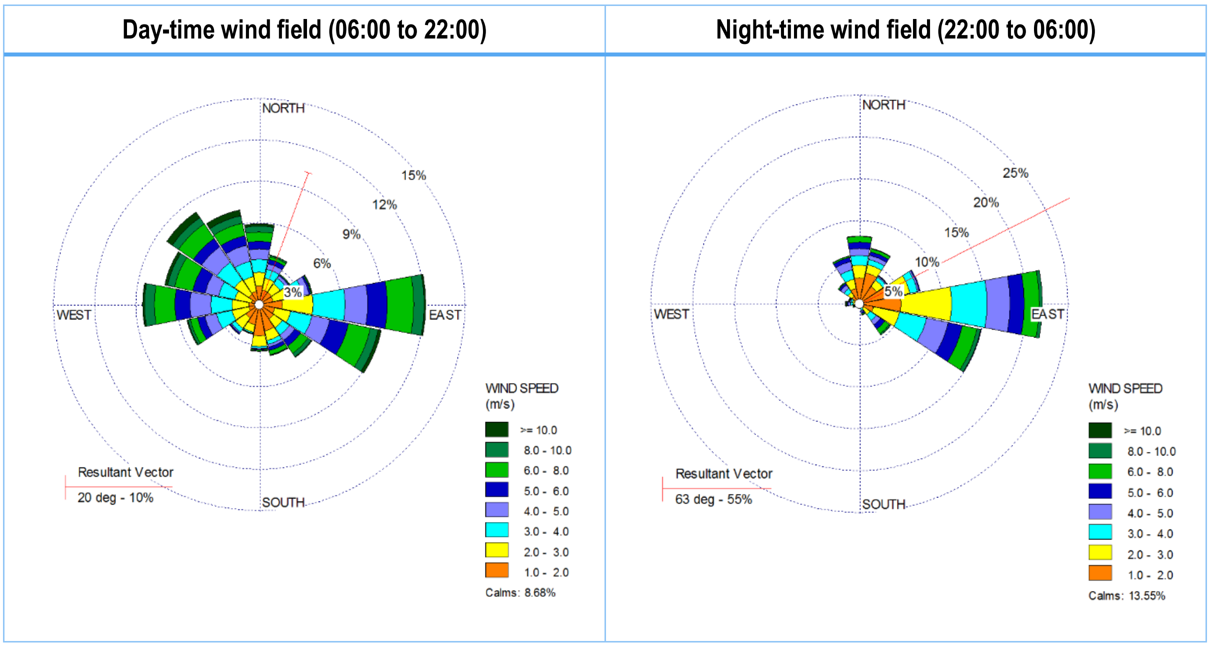


Figure 4: Day- and night-time wind field (Eskom Grootdraaidam data, 2014 to 2016)

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a 'shadowing' effect for sounds. On a clear night, temperatures may increase with altitude thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night. For day-time impacts an average temperature of 18°C and a humidity of 54% were applied in simulations. For night-time impacts an average temperature of 12°C and a humidity of 78% were used.

3.2.2 Terrain, Ground Absorption and Reflection

Noise reduction caused by a barrier (i.e. natural terrain, installed acoustic barrier, building) feature depends on two factors namely the path difference of a sound wave as it travels over the barrier compared with direct transmission to the receiver and the frequency content of the noise (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). The terrain of the study area is shown in Figure 5. There are no natural terrain features between sources of noise and the closest NRs that would provide acoustic shielding.

Sound reflected by the ground interferes with the directly propagated sound. The effect of the ground is different for acoustically hard (e.g., concrete or water), soft (e.g., grass, trees or vegetation) and mixed surfaces. Ground attenuation is often calculated in frequency bands to take into account the frequency content of the noise source and the type of ground between the source and the receiver (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). Based on observations made during the visit to site, ground cover was found to be acoustically mixed, that is, somewhat conducive to noise attenuation.

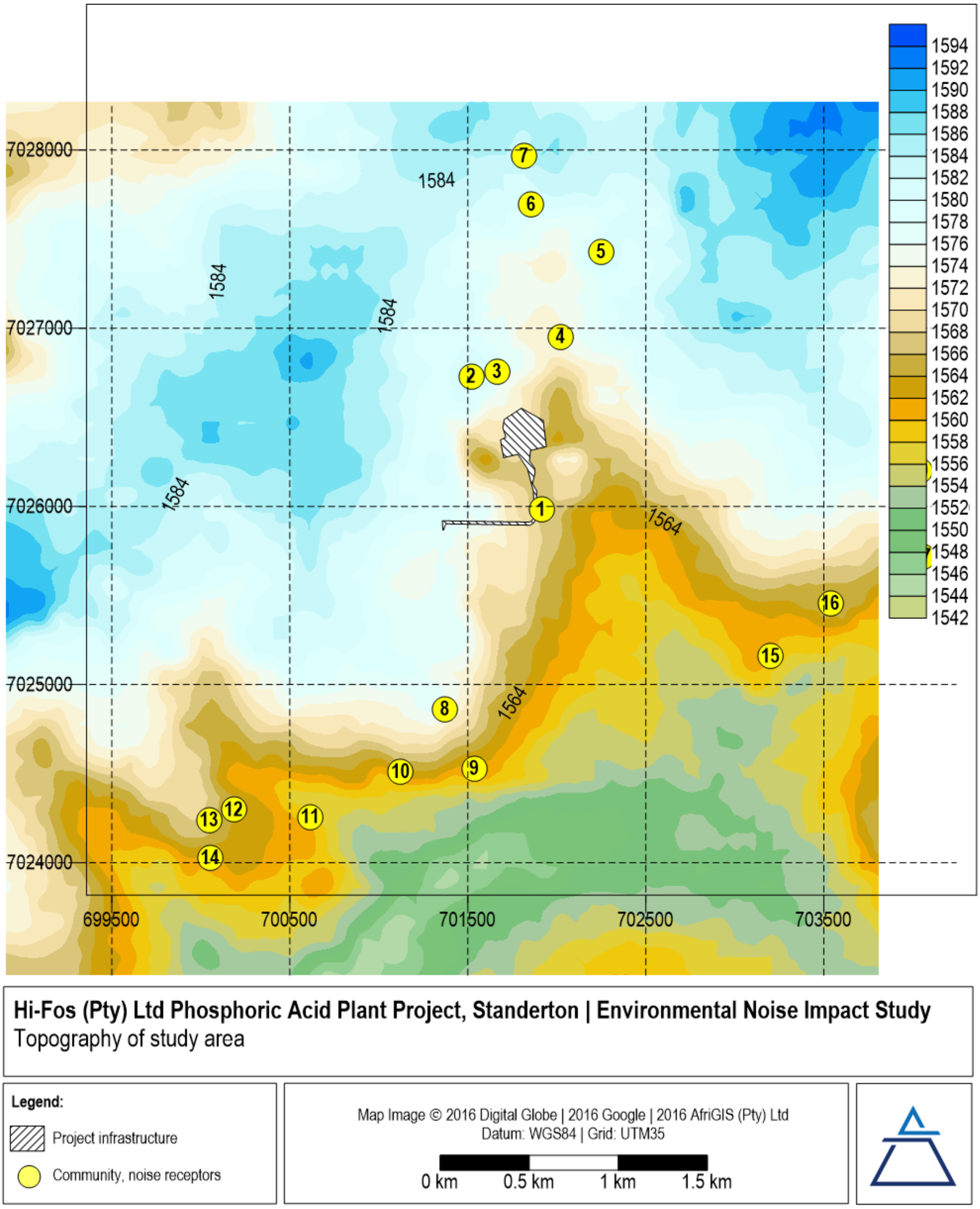


Figure 5: Topography of the study area

3.3 Baseline Noise Survey and Results

Day- and night-time noise measurements were conducted on 2 January and 3 March 2017 at the four locations shown in Figure 6. Survey sites were selected taking into consideration proposed activates, NRs, accessibility and safety. Photographs of the sampling sites and microphone placement are included in Figure 7 to Figure 10.

During the day, the temperatures were in the high twenties and low thirties and the sky was somewhat overcast. The wind was slight to moderate (1 to 3 m/s) and mostly from the north-east. During the night, temperatures ranged between 14°C and 16°C with almost no cloud cover. Wind speeds were lower than during the day and from the north-east.

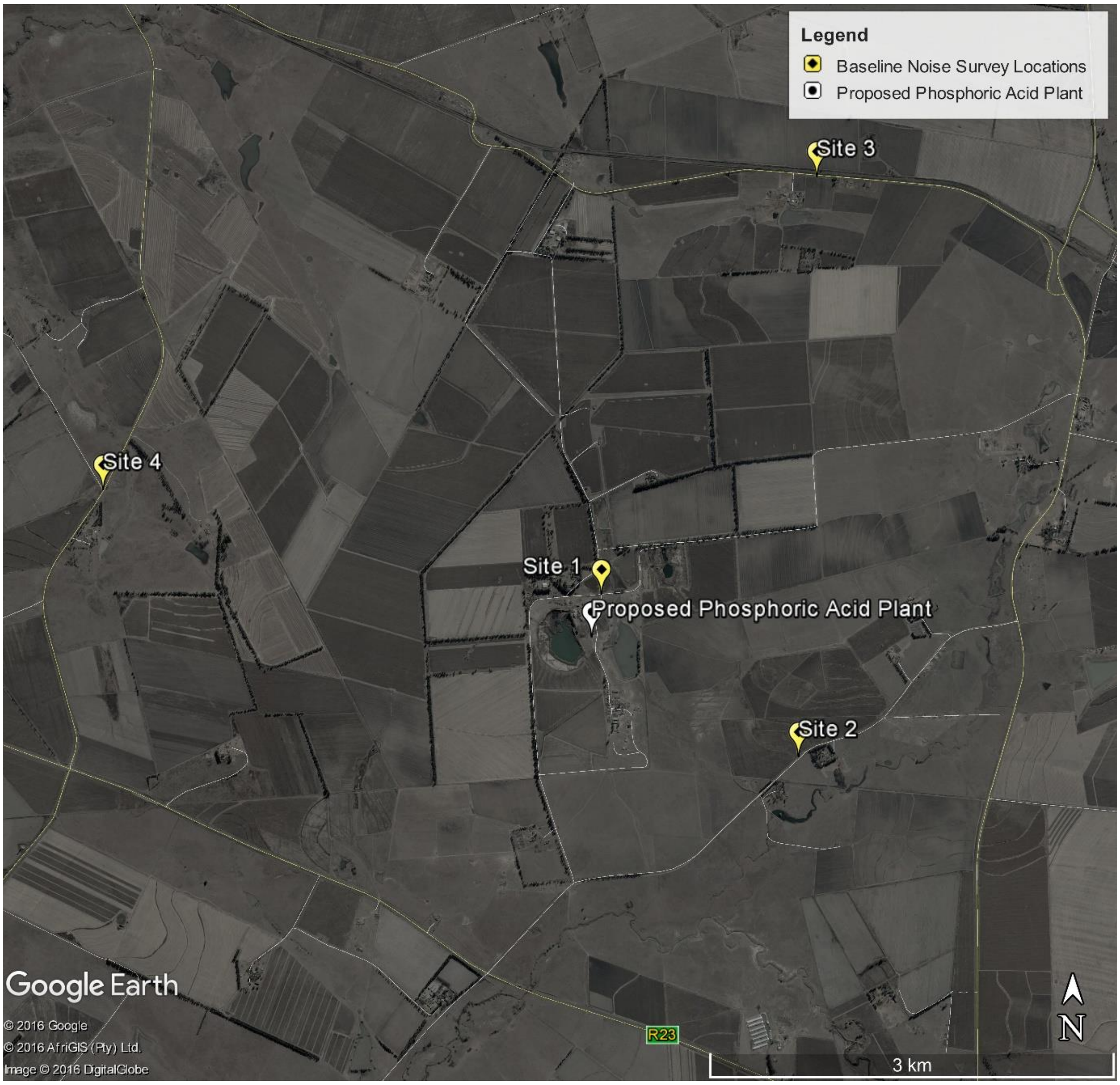


Figure 6: The location of noise survey points

Site 1, facing north

Site 1, facing east

Site 1, facing south

Site 1, facing west

Figure 7: Photographs taken at Site 1, on-site

Site 2, facing north

Site 2, facing east

Site 2, facing south

Site 2, facing west

Figure 8: Photographs taken at Site 2, near a farmstead to the south-east

Site 3, facing north

Site 3, facing east

Site 3, facing south

Site 3, facing west

Figure 9: Photographs taken at Site 3, near a farmstead to the north-northeast along D1585

Site 4, facing north

Site 44, facing east

Site 4, facing south

Site 4, facing west

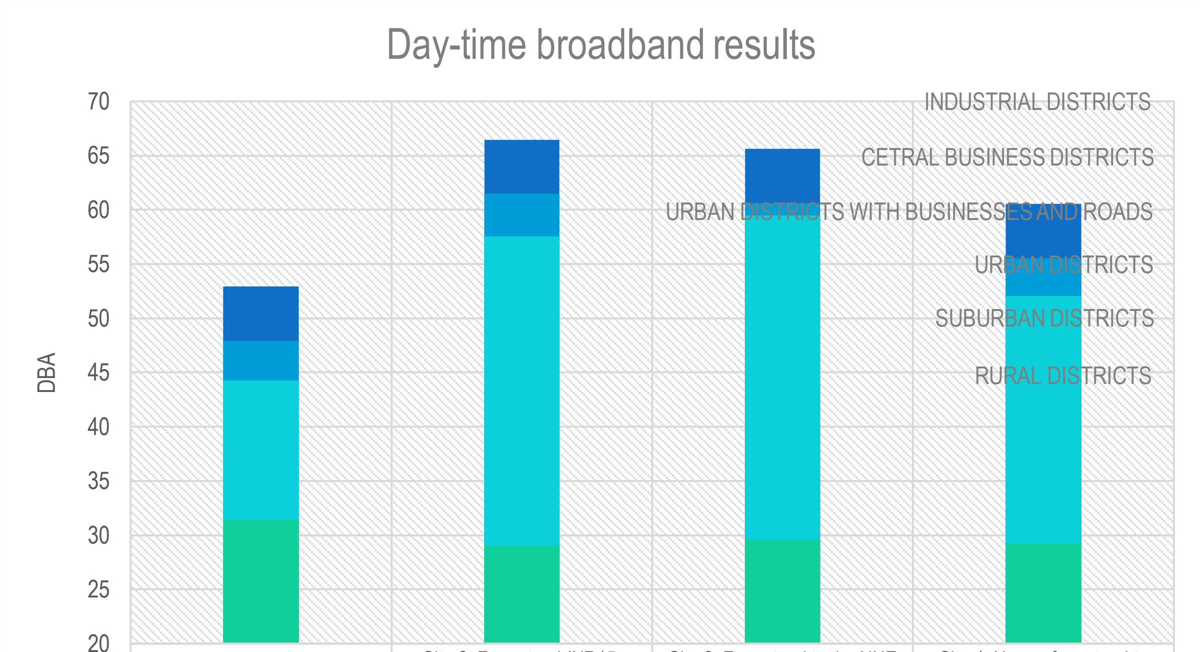
Figure 10: Photographs taken at Site 4, near a farmstead to the west along the D759

Recorded L_{A90}, L_{Aeq} and L_{AIeq} as well as calculated $L_{Req,T}$ during the day and night are presented in Figure 11 and Figure 12 respectively. Results are compared to noise levels typically found in rural, suburban, urban, commercial and industrial areas as per SANS 10103 (2008). Time series data, 3rd octave frequency spectra and statistical noise levels for each recording are included in Figure 13 to Figure 20 (page 26 to 29). All field survey log sheets are included in Annex B this report.

During the day, the acoustic environment at all sites were influenced by farming activities incl. mobile equipment and animals, road traffic, railway noise, birds and insects. At night, noise from the nearby railway siding at a silo complex, insects and frogs, contributed most notably to recorded noise levels. The notably large difference between sampled L_{A90} and L_{Aeq} is indicative of frequent noise incidents such as passing cars.

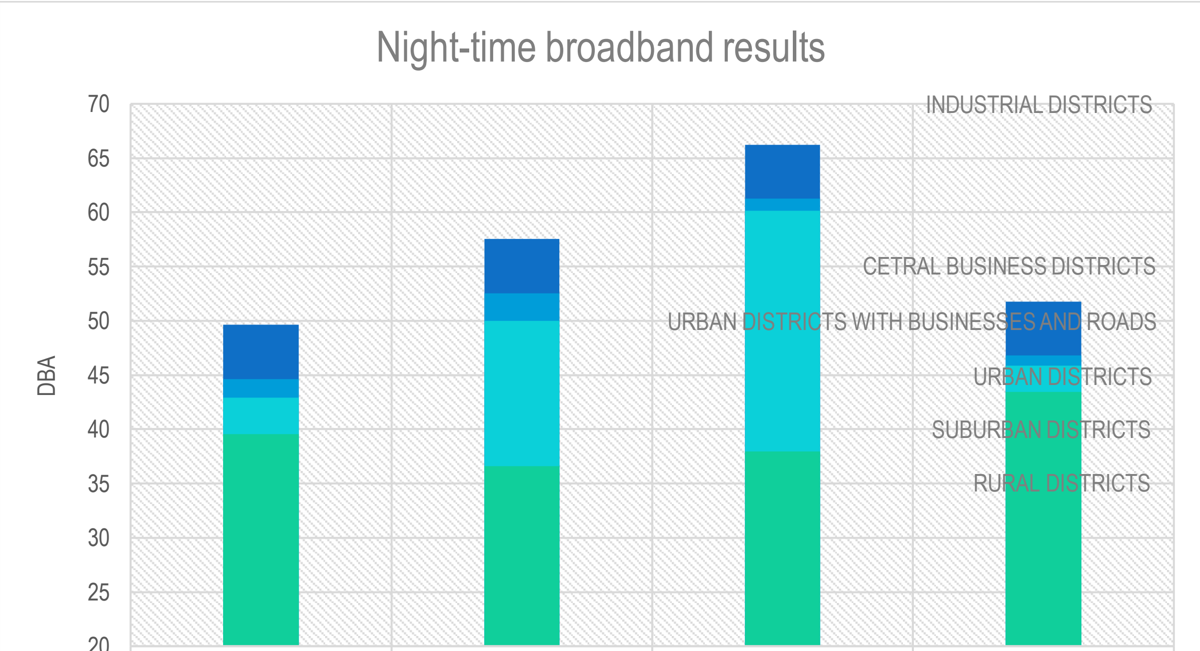
An analysis of frequency spectrum data, done in accordance with the procedure set out in SANS 10103 (2008), indicated tonality in noise levels at all sampling sites and both during the day and the night. Except for insects/frogs and the more distant rail related noise, no other sources of tonal noise could be identified.

For the purpose of this assessment, given the description of the baseline acoustic environment and survey results, it was decided that sampled on-site L_{Aeq} values would be more representative of prevailing baseline conditions and provide the specialist with a slightly more conservative estimate of the project's noise impact since on-site noise levels were lower that levels recorded near farmsteads and roads. Baseline noise levels applied in the impact assessment are 44.3 dBA during the day, and 42.9 dBA at night.



	Site 1, On-site	Site 2, Farmstead (NR15, NR16) to the SE	Site 3, Farmstead to the NNE along D1585	Site 4, Near a farmstead to the west along the D759
LReq,d	52.9	66.5	65.6	60.6
LAIeq	47.9	61.5	60.6	55.6
LAeq	44.3	57.5	59.5	52.1
LA90	31.4	29.0	29.6	29.2

Figure 11: Day-time survey broadband results and calculated equivalent continuous day-time rating levels



	Site 1, On-site	Site 2, Farmstead (NR15, NR16) to the SE	Site 3, Farmstead to the NNE along D1585	Site 4, Near a farmstead to the west along the D759
LReq,n	49.6	57.6	66.3	51.8
LAIeq	44.6	52.6	61.3	46.8
LAeq	42.9	50.0	60.1	45.9
LA90	39.5	36.6	38.0	43.5

Figure 12: Night-time survey broadband results and calculated equivalent continuous night-time rating levels

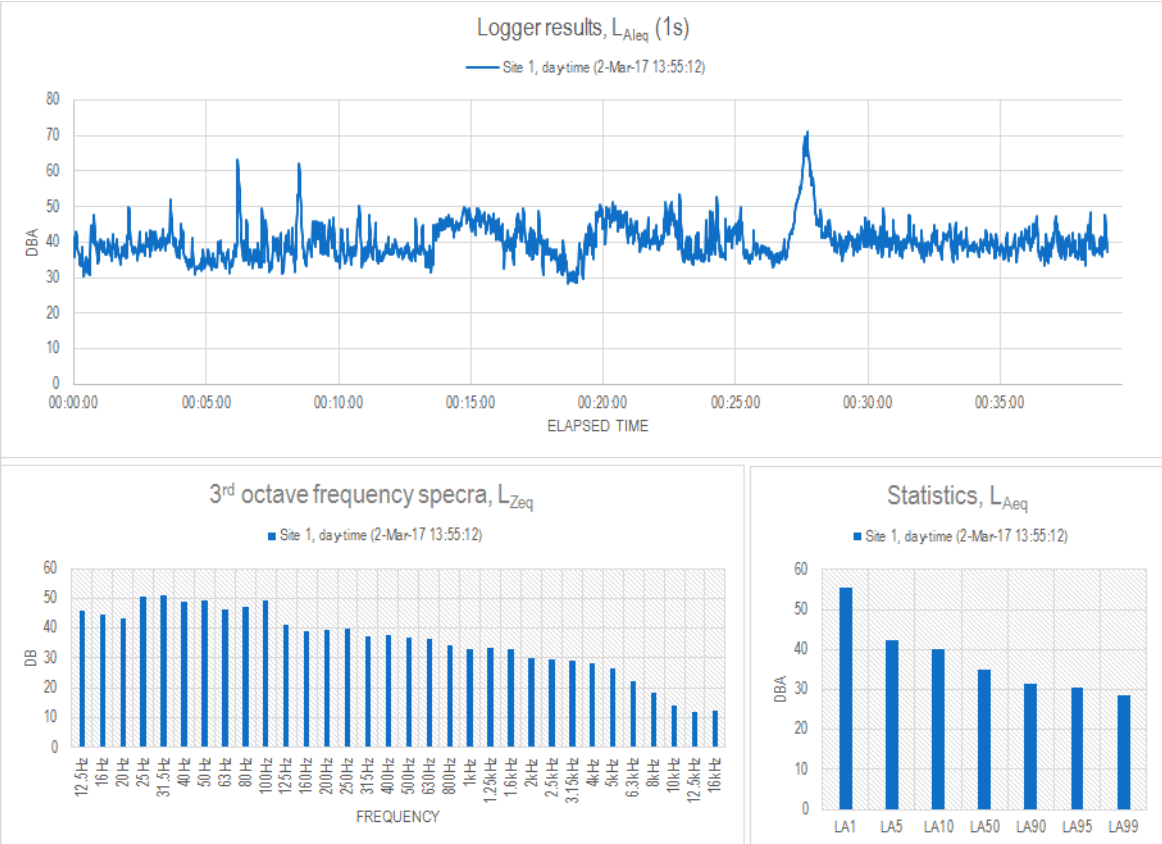


Figure 13: Detail survey results for Site 1, on-site, during the day

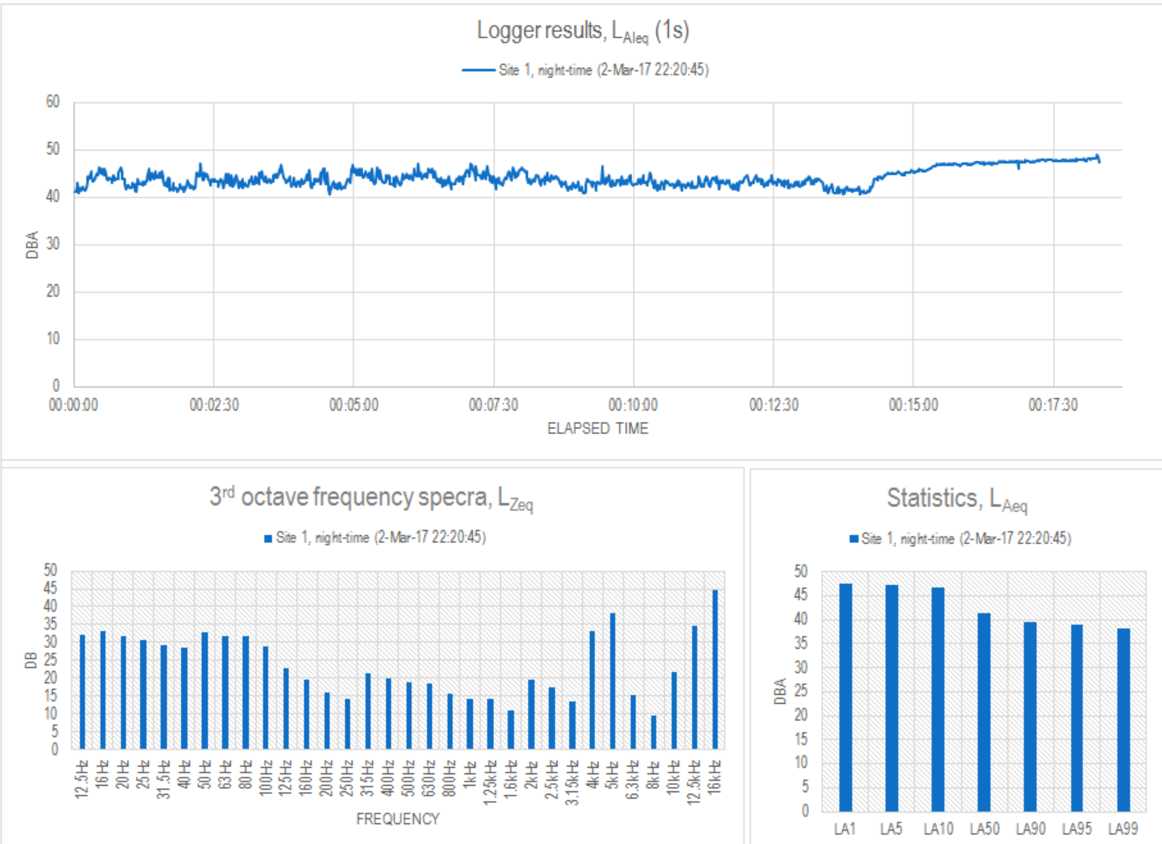


Figure 14: Detail survey results for Site 1, on-site, during the night

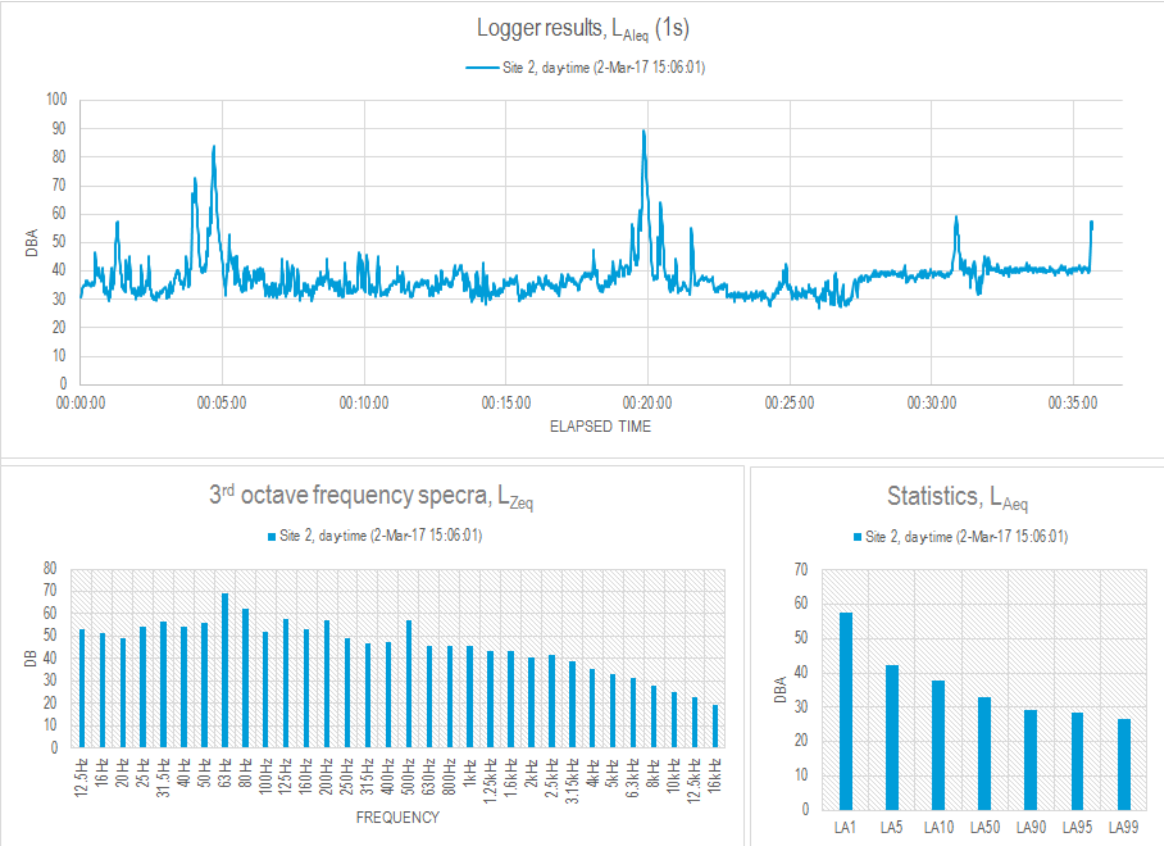


Figure 15: Detail survey results for Site 2, near a farmstead to the south-east, during the day

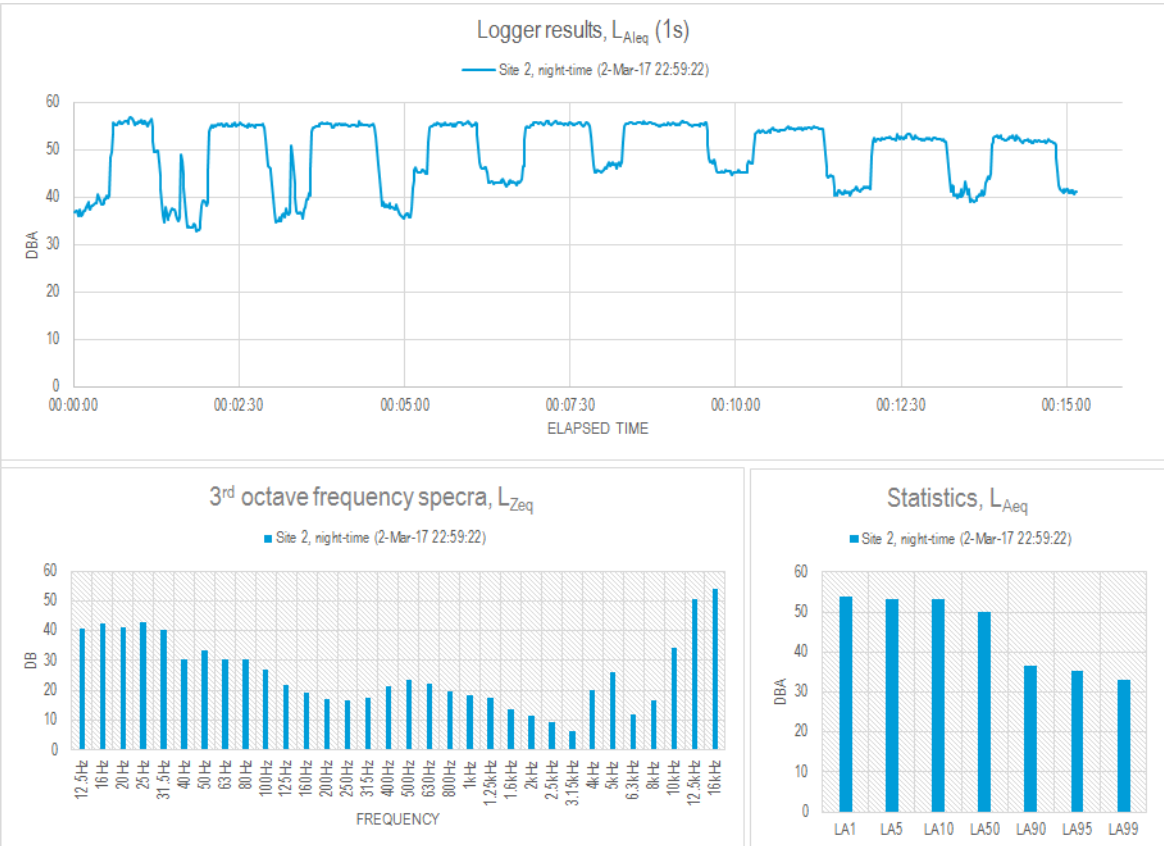


Figure 16: Detail survey results for Site 2, near a farmstead to the south-east, during the night

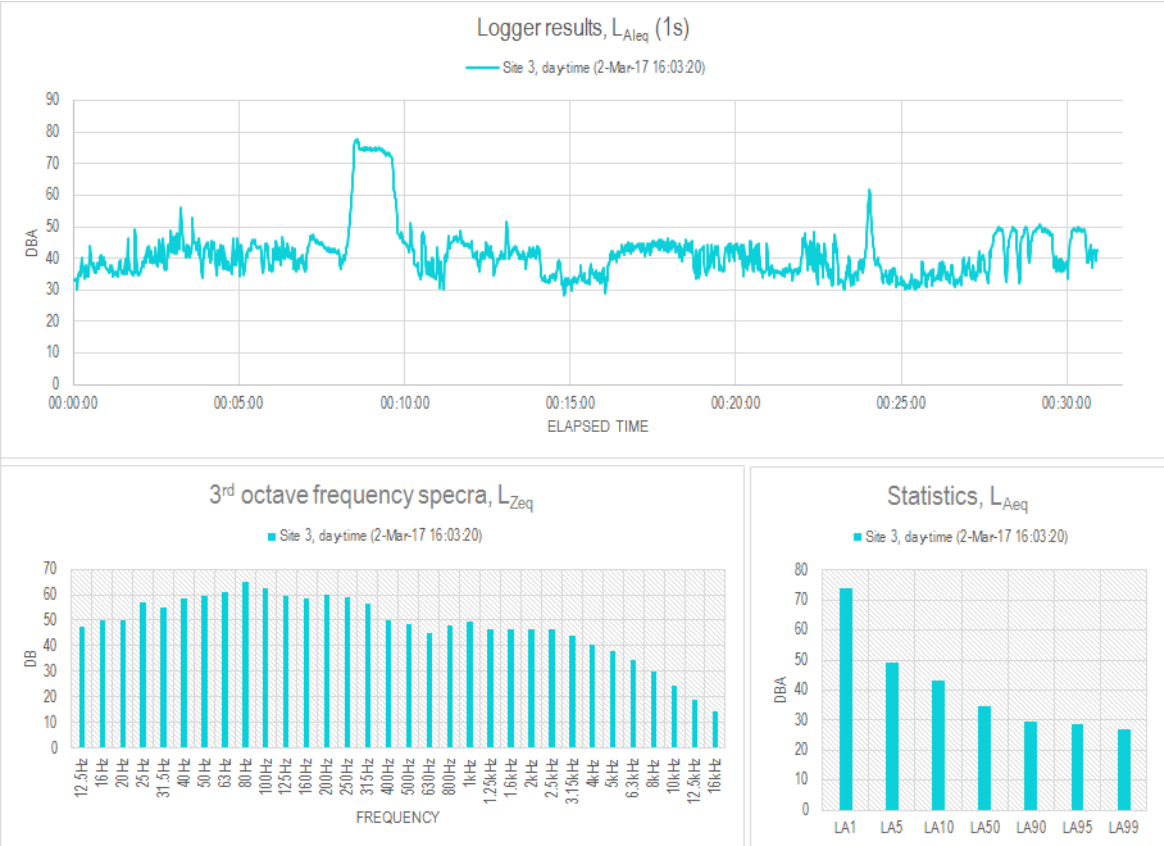


Figure 17: Detail survey results for Site 3, near a farmstead to the north-northeast along D1585, during the day

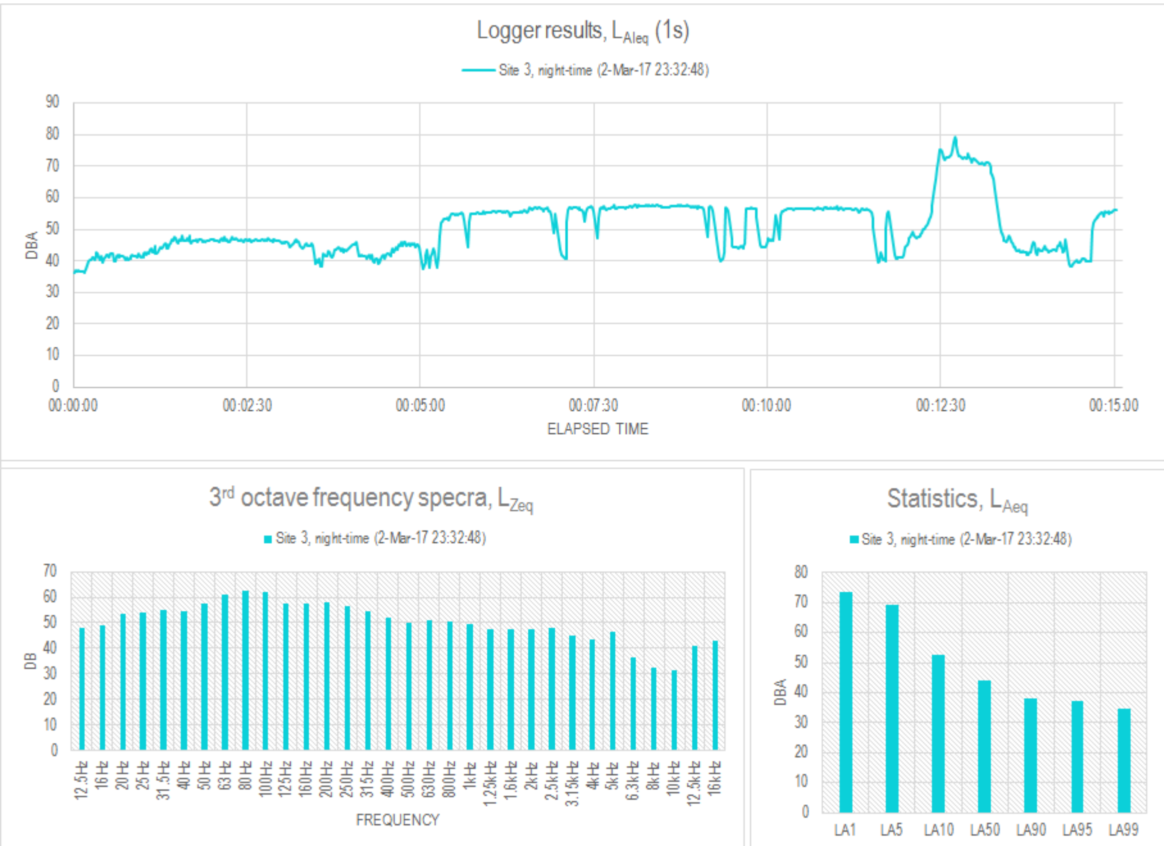


Figure 18: Detail survey results for Site 3, near a farmstead to the north-northeast along D1585, during the night

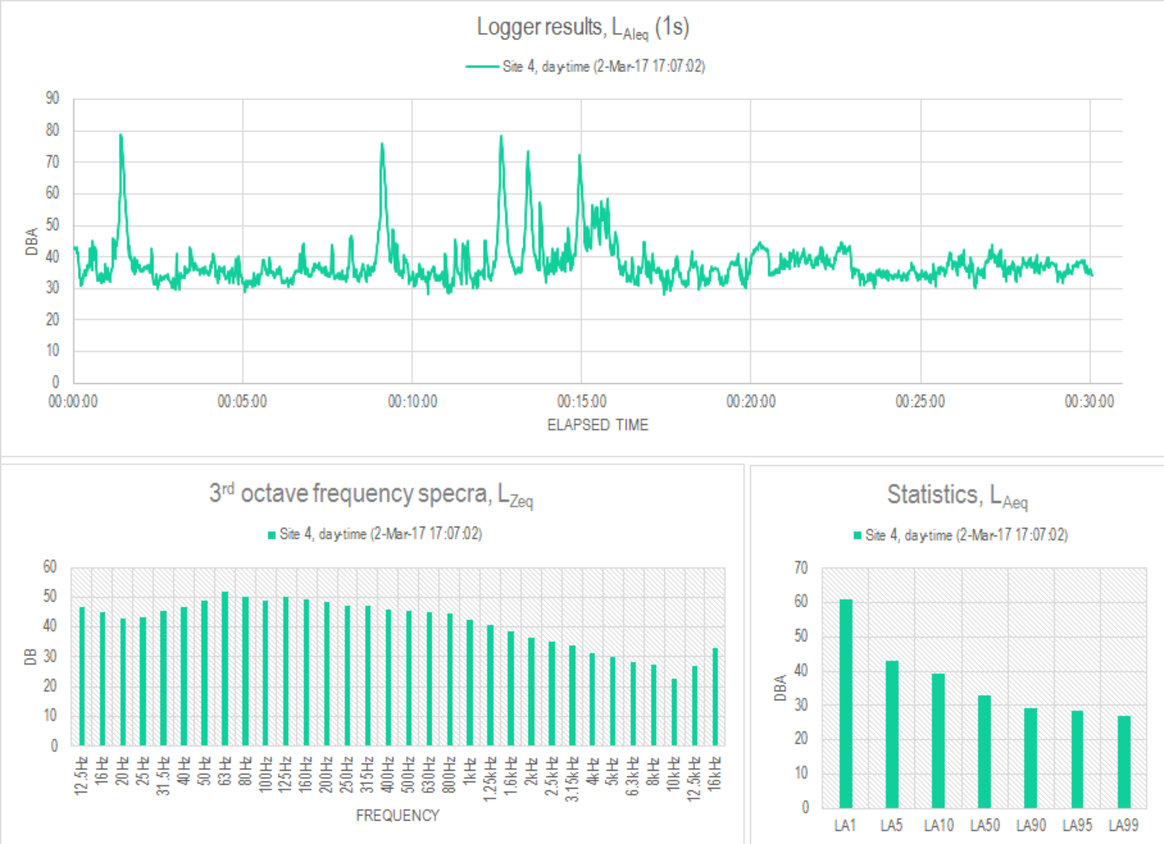


Figure 19: Detail survey results for Site 4, near a farmstead to the west along the D759, during the day

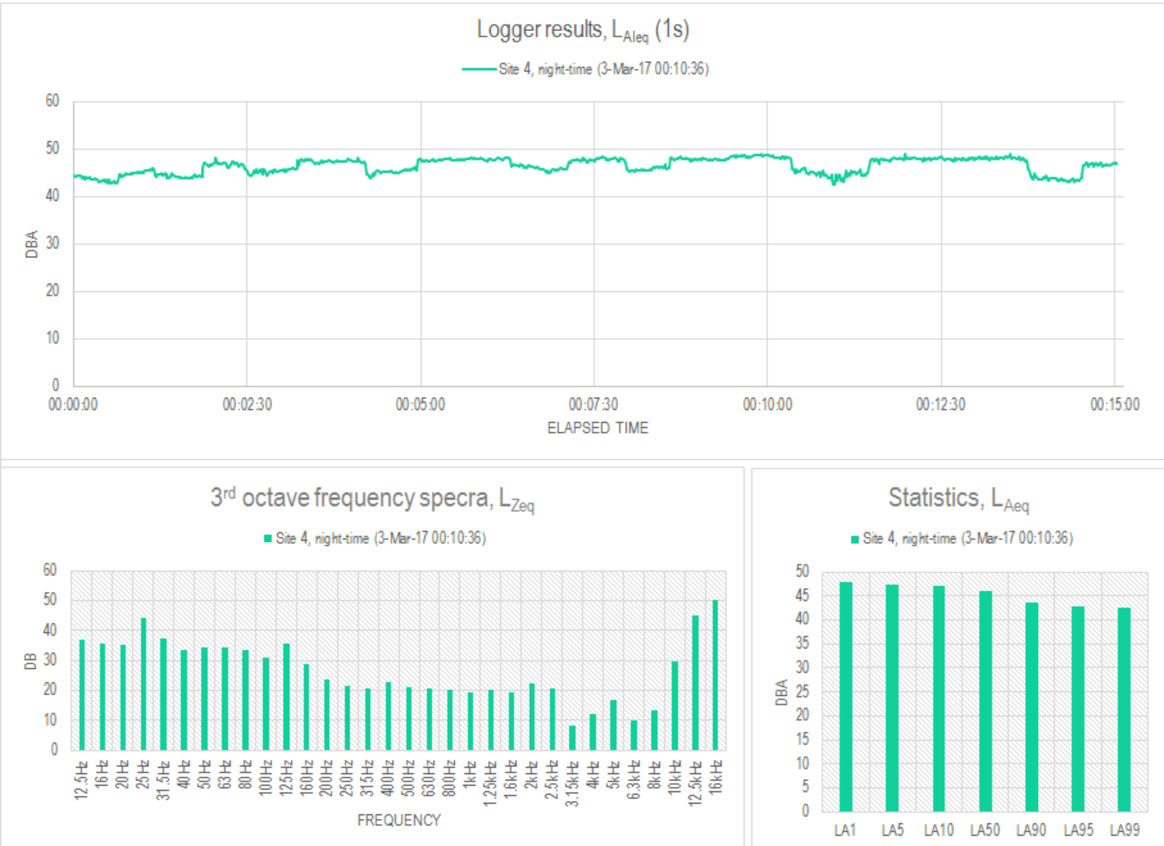


Figure 20: Detail survey results for Site 4, near a farmstead to the west along the D759, during the night

4 Impact Assessment

The noise source inventory, noise propagation modelling and results are discussed in Section 4.1 and Section 4.2 respectively.

4.1 Noise Sources and Sound Power Levels

Given the complexity of the proposed Phosphoric Acid Plant complex and number of noise generating components/activities and limited plant design information, an approach was adopted wherein emissions were included as area wide noise emissions.

The EC established a Working Group for the Assessment of Environmental to Noise (WG-AEN) who published a position paper in 2006. The WG-*AEN "Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure"*, provides default sound power levels, L_W's, for different types of industry, to be used when sufficient information for a detailed noise emissions inventory is not available. Default L_W's of 60 dBA/m^2 during the day and 45 dBA/m^2 during the night were applied to the ablutions. The default L_W of 60 dBA/m^2 for light industrial areas during both the day- and night was applied to all storage and bunker areas. The default L_W of 65 dBA/m^2 for heavy industries was applied to the CNX Plant, MAP 33 and MAP 39 Plant, Phosphoric Acid Plant, compressor and cooling area, boiler, etc. These factors were applied to take into account all materials handling, feeders, feed hoppers and conveyors, electrical motors, motor driven pumps and fans, pumping and compressed air noise, loading etc.

Traffic associated with the delivery of raw materials and transport of products were calculated as approximately 2.2 return trips per hour. It is the number of trips required to transport 18.4 tonnes of raw materials per hour, 0.5 tonnes of solid and liquid wastes, and 13.8 tonnes of product per hour. The calculation assumed an average truck capacity of 30 tonnes. It was further assumed that trucks will travel at a seed of 60 km/h.

The reader is reminded of the non-linearity in the addition of L_W's. If the difference between the sound power levels of two sources is nil the combined sound power level is 3 dB more than the sound pressure level of one source alone. Similarly, if the difference between the sound power levels of two sources is more than 10 dB, the contribution of the quietest source can be disregarded (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). Therefore, although some sources of noise could not be quantified, the incremental contributions of such sources are expected to be minimal given that the majority of sources are considered in the source inventory and noise emission factors.

The source inventory and estimated L_W's as established using the approach detailed in above is summarised in Table 5.

Table 5: Noise source inventory for the proposed Phosphoric Acid Plant

Source name	Source type	LWA (dBA)		LWA/m² (dBA/m²)		$L_{m,E}$, 25 from the road, 4 m above ground (dBA)	
		Day	Night	Day	Night	Day	Night
CNX Plant	Area (300 m²)	89.8	89.8	65	65		
MAP 33 and 39 Plant	Area (900 m²)	94.5	94.5	65	65		
Ammonium Nitrate (AN) and anhydrous ammonia (NH_3) Storage	Area (300 m²)	84.8	84.8	60	60		
Phosphoric Acid Plant	Area (1200 m²)	95.8	95.8	65	65		
Phosphate Rock Storage	Area (200 m²)	83	83	60	60		
Compressor and Cool Tower	Area (100 m²)	85	85	65	65		
Boiler	Area (100 m²)	85	85	65	65		
Coal Bunker	Area (100 m²)	80	80	60	60		
Water	Area (50 m²)	77	77	60	60		
Nitric Acid	Area (50 m²)	77	77	60	60		
Nitric Acid Off-loading	Area (300 m²)	84.8	84.8	60	60		
Nitric Acid Storage	Area (1 200 m²)	90.8	90.8	60	60		
Loading Bay	Area (400 m²)	86	86	60	60		
Storage 50 kg	Area (500 m²)	87	87	60	60		
Storage 500 kg	Area (900 m²)	89.5	89.5	60	60		
MAP	Area (200 m²)	88	88	65	65		
Limestone Ammonium Nitrate (LAN)	Area (200 m²)	88	88	65	65		
Storage	Area (200 m²)	88	88	65	65		
Granulation Blend Plant	Area (900 m²)	94.5	94.5	65	65		
Storage Final Product	Area (1 350 m²)	91.3	91.3	60	60		
Bagged Product Storage	Area (2 000 m²)	93	93	60	60		
Ablutions	Area (150 m²)	81.7	66.7	60	45		
Waste Store	Area (525 m²)	87.2	87.2	60	60		
Phosphate Rock Store	Area (485 m²)	86.8	86.8	60	60		
Substation	Area (275 m²)	84.4	84.4	60	60		
MAP Bulk	Area (1 442 m²)	91.6	91.6	60	60		
Pack Plant	Area (86 m²)	79.3	79.3	60	60		
Access Road	Road (3 810 m)					54.7	54.7

4.2 Noise Propagation and Simulated Noise Levels

The propagation of noise likely to be generated during the operational phase of the proposed Phosphoric Acid Plant was calculated with CadnaA in accordance with ISO 9613 and RLS-90. Meteorological and site specific acoustic parameters as discussed in Section 3.2.1 along with source data discussed in 4.1, were applied in the model. Results are presented in tabular form Table 6 and isopleth form (Figure 21 to Figure 24).

Simulations of the proposed Phosphoric Acid Plant's operations during the day (06:00 to 22:00), indicate levels within the guideline of 55 dBA for residential, institutional and educational receptors at all nearby NRs. During the day, noise generated by the proposed Phosphoric Acid Plant and traffic will be most notable at the community south of the site (NR01), and farmsteads NR02, NR03, NR08 and NR09. At NR01 the increase in day-time noise levels of 8.1 dBA may lead to 'little' to 'medium' community reaction with sporadic complaints.

As a result of atmospheric conditions less conducive to noise attenuation and stricter guidelines, night-time noise impacts (22:00 to 06:00) will be more notable. Simulations show that the night-time guideline of 45 dBA will likely be exceeded at the community (NR01), and farmstead NR09 predominantly as a result of heavy vehicle traffic. At NR01 and NR09 the increases in night-time noise levels of 9.3 dBA and 5.3 dBA respectively, may lead to 'little' to 'medium' community reaction with sporadic complaints.

Table 6: Simulation results at noise receptors

Receptor	Noise levels as a result of the proposed Phosphoric Acid Plant (dBA)		Increase in ambient noise levels above the baseline as a result of the proposed Phosphoric Acid Plant (dBA)	
	Day-time	Night-time	Day-time (Baseline 44.3 dBA)	Night-time (Baseline 42.9 dBA)
NR01	51.7	51.7[(a)]	8.1[(a)]	9.3[(a)]
NR09	46.7	46.7[(a)]	4.4[(a)]	5.3[(a)]
NR08	42.6	42.6	2.2	2.9
NR03	40.7	41.0	1.6	2.2
NR02	39.0	39.6	1.1	1.7
NR10	37.5	37.5	<1	<1
NR04	35.4	35.4	<1	<1
NR11	31.3	31.3	<1	<1
NR05	27.2	27.3	<1	<1
NR12	25.6	25.6	<1	<1
NR06	25.0	25.3	<1	<1
NR13	24.1	24.1	<1	<1
NR14	23.8	23.8	<1	<1
NR15	23.4	23.5	<1	<1
NR07	21.4	21.8	<1	<1

Receptor	Noise levels as a result of the proposed Phosphoric Acid Plant (dBA)		Increase in ambient noise levels above the baseline as a result of the proposed Phosphoric Acid Plant (dBA)	
	Day-time	Night-time	Day-time (Baseline 44.3 dBA)	Night-time (Baseline 42.9 dBA)
NR16	18.5	18.5	<1	<1
NR17	-80.2	-80.2	neg.	neg.
NR18	-80.2	-80.2	neg.	neg.
NR19	-80.2	-80.2	neg.	neg.
NR20	-80.2	-80.2	neg.	neg.

Notes:

(a) Exceeds NLG

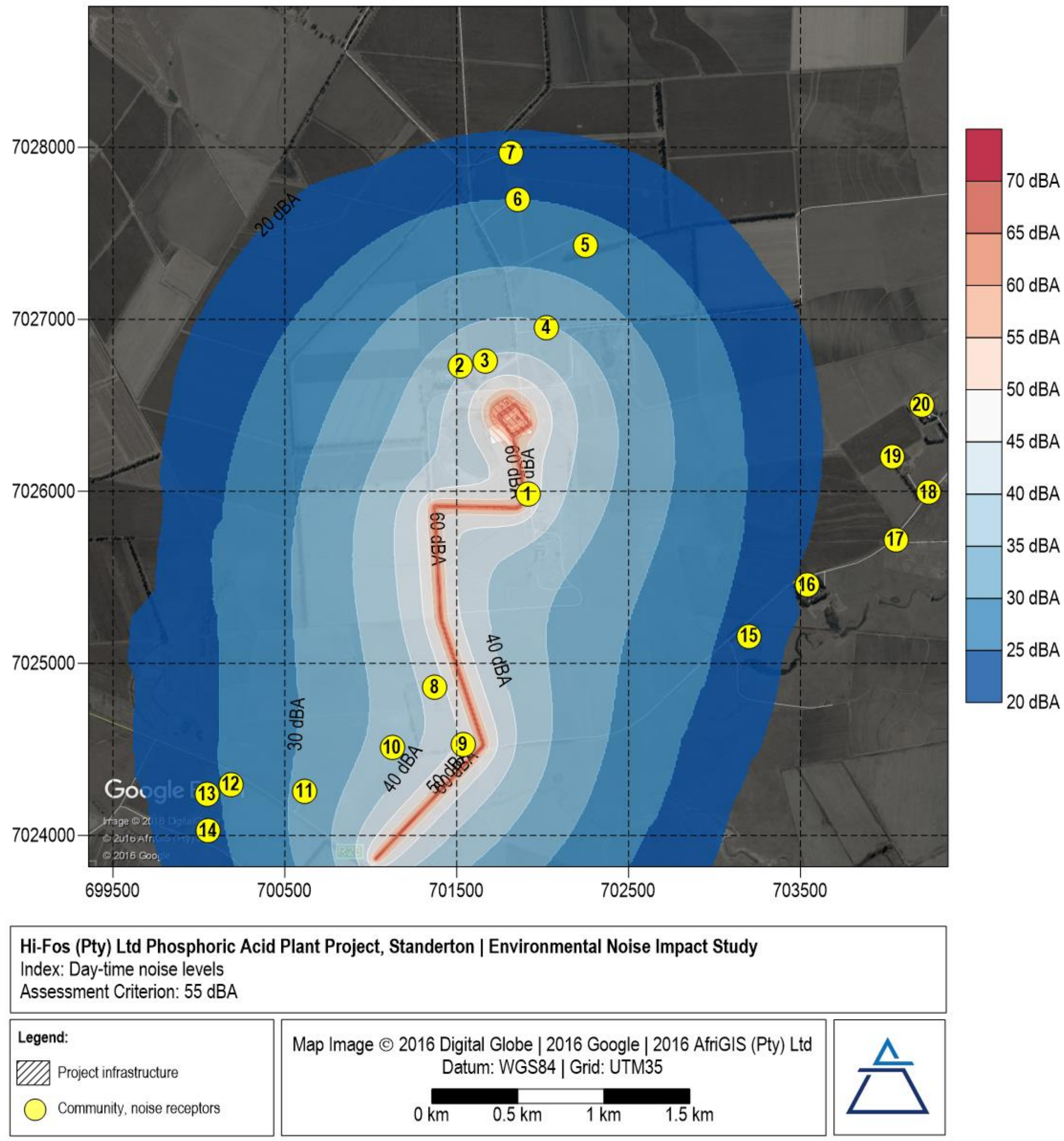


Figure 21: Simulated day-time noise levels

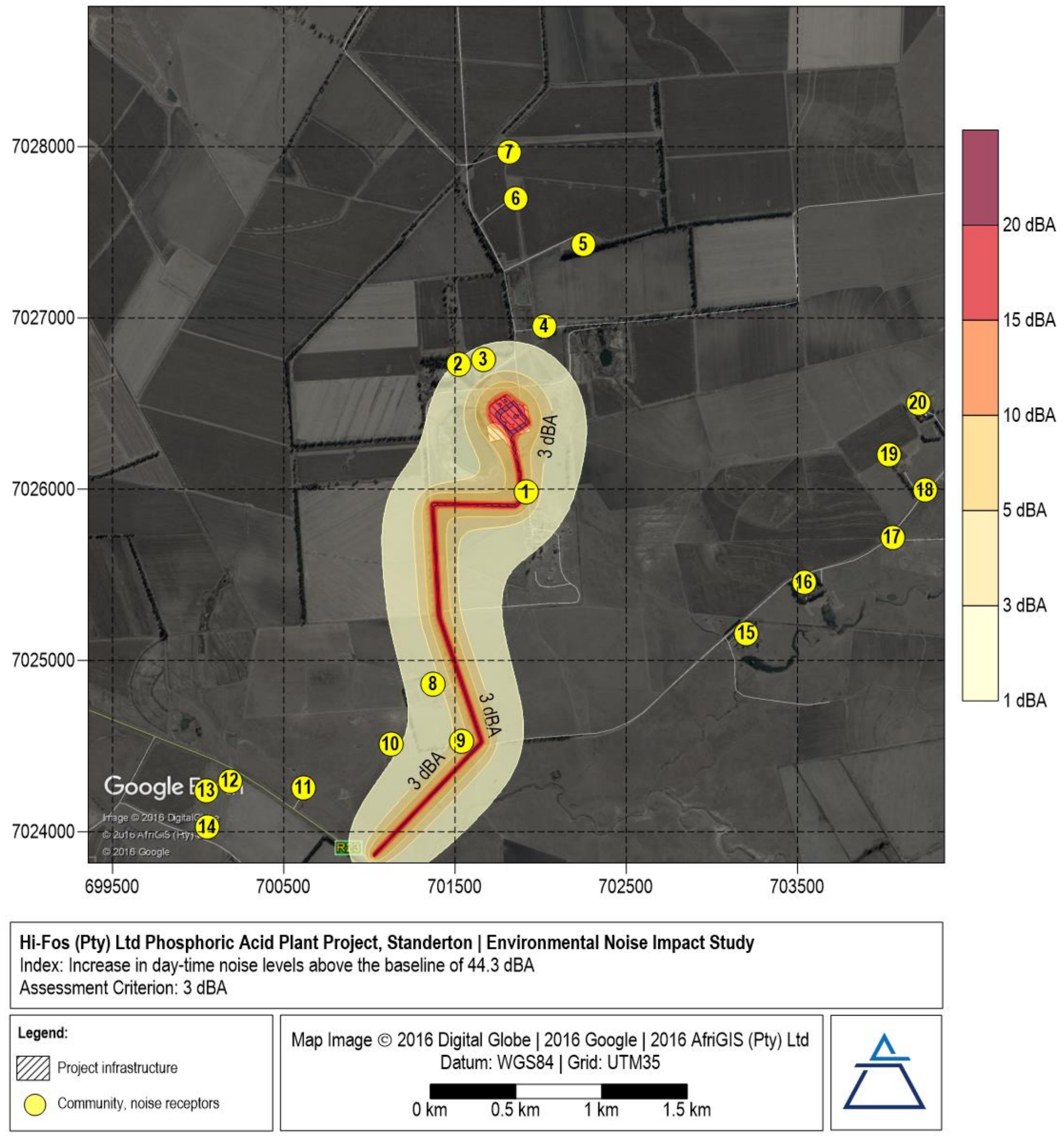


Figure 22: Simulated increase in day-time noise levels above the baseline of 44.3 dBA

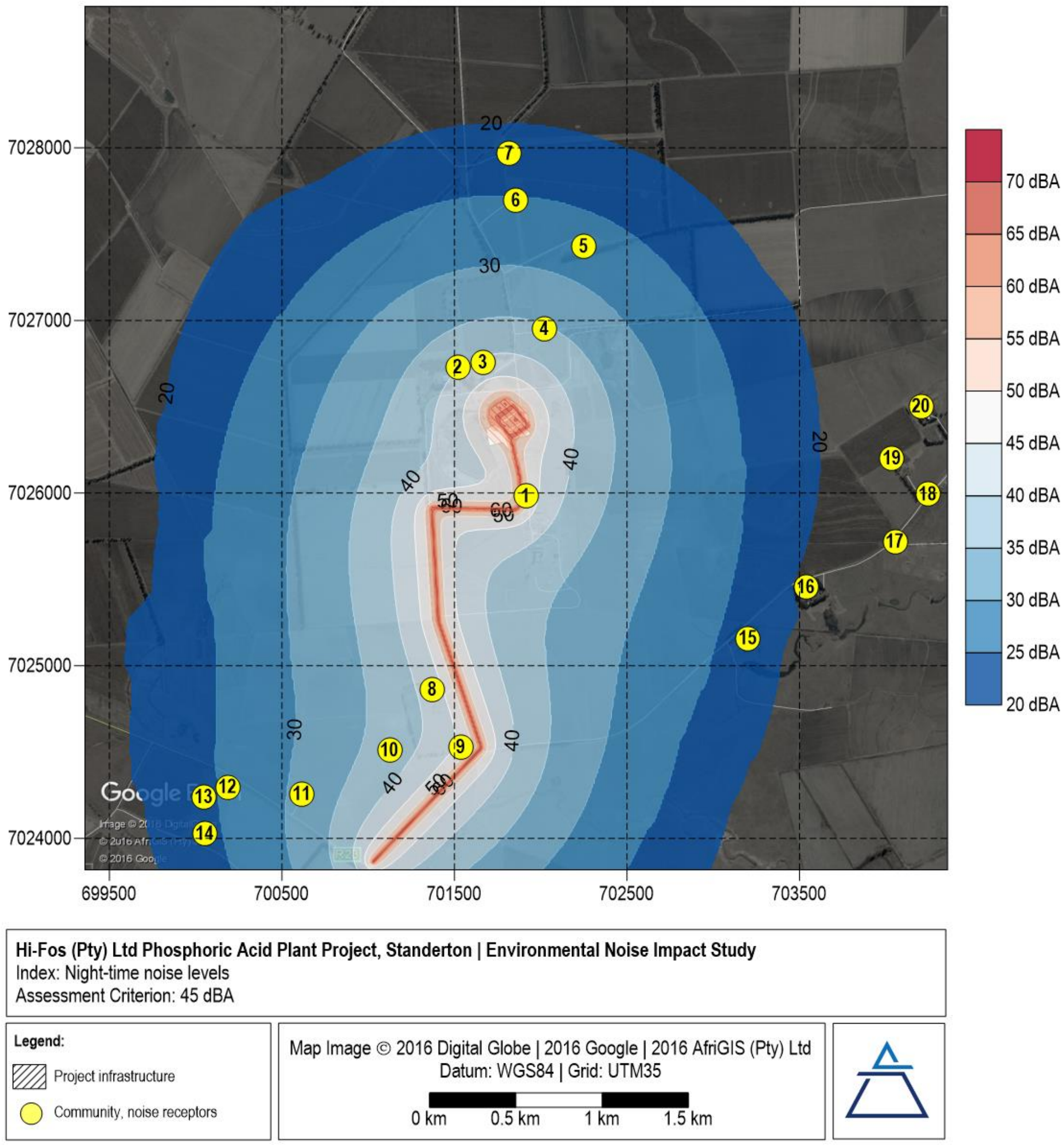


Figure 23: Simulated night-time noise levels

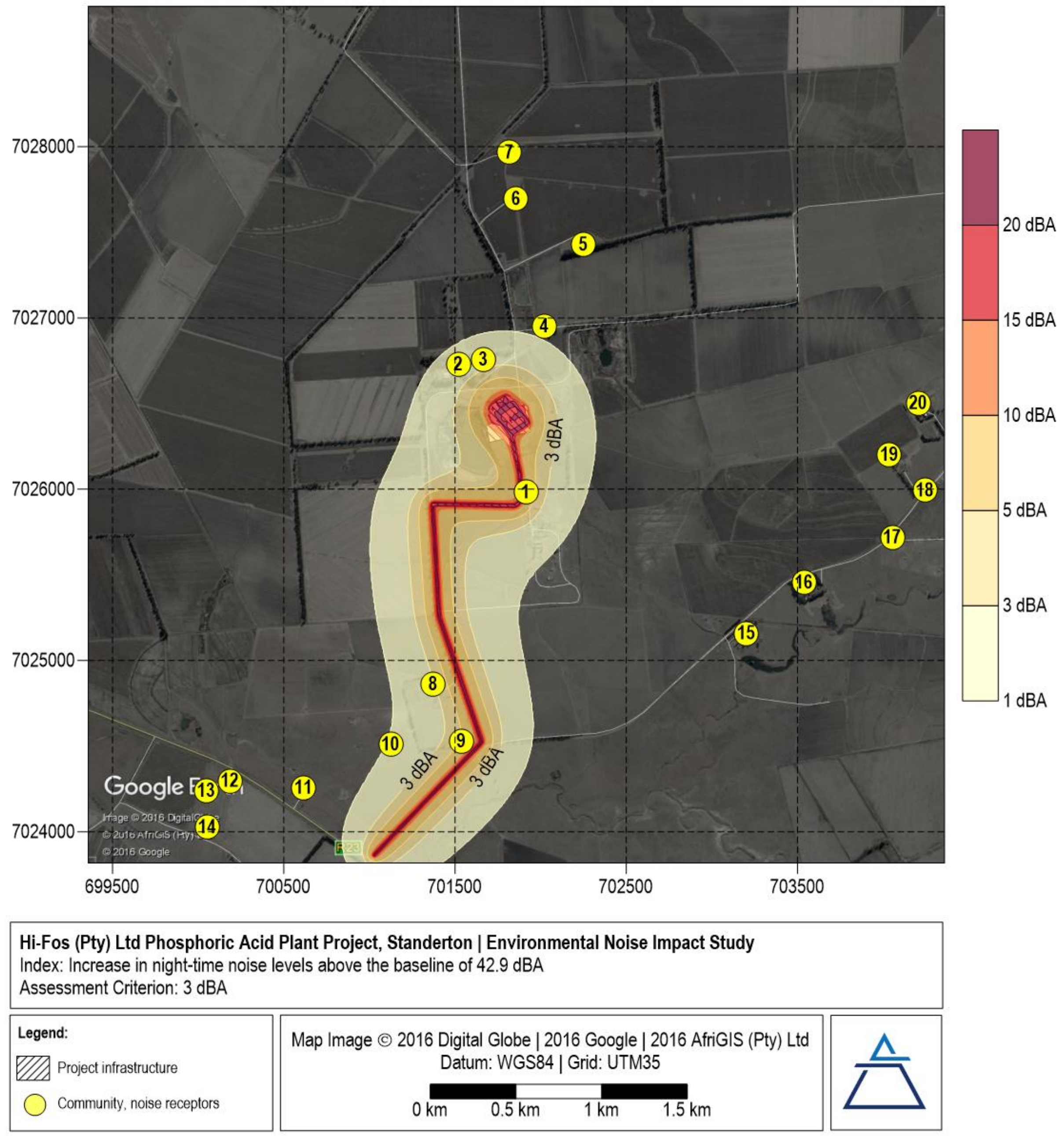


Figure 24: Simulated increase in night-time noise levels above the baseline of 42.9 dB

5 Management Measures

In the quantification of noise emissions and simulation of noise levels as a result of the proposed Phosphoric Acid Plant, it was calculated that ambient noise evaluation criteria for human receptors may be exceeded at the community south of the site and those in closest proximity to the access road. It was also found that night-time impacts will be most significant.

The proposed Phosphoric Acid Plant contribution to noise levels at most NRs, the exceptions being NR01 and NR09, will be less than 3 dBA which would not likely result in annoyance. Impacts at NR01 and NR09 need however be monitored and managed. The general good practice measures for mitigating and managing noise as set out below, are recommended.

5.1 Good Engineering and Operational Practices

For general activities, the following good engineering practice **should** be applied to **all project phases**:

- All diesel-powered equipment and plant vehicles should be kept at a high level of maintenance. This should particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment should serve as trigger for withdrawing it for maintenance.
- Equipment with lower sound power levels must be selected. Vendors should be required to guarantee optimised equipment design noise levels.
- In managing noise specifically related to truck and vehicle traffic, efforts **should** be directed at:
    - Minimising individual vehicle engine, transmission, and body noise/vibration. This is achieved through the implementation of an equipment maintenance program.
    - Maintain road surface regularly to avoid corrugations, potholes etc.
    - Avoid unnecessary idling times.
    - Minimising the need for trucks/equipment to reverse. This will reduce the frequency at which disturbing but necessary reverse warnings will occur. Alternatives to the traditional reverse 'beeper' alarm such as a 'self-adjusting' or 'smart' alarm could be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm is so that it is 5 to 10 dB above the noise level near the moving equipment. The promotional material for some smart alarms does state that the ability to adjust the level of the alarm is of advantage to those sites 'with low ambient noise level' (Burgess & McCarty, 2009).
    - Limiting traffic to hours between 06:00 and 18:00.
- Where possible, other non-routine noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.
- A noise complaints register must be kept.

5.2 Monitoring

An environmental noise monitoring campaign should be conducted once during the pre-construction phase, once during construction and once during the operational phase, specifically at NR01 and NR09.

Also, In the event that noise related complaints are received short term (24-hour) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

The following procedure should be adopted for all noise surveys:

- Any surveys should be designed and conducted by a trained specialist.
- Sampling should be carried out using a Type 1 SLM that meets all appropriate IEC standards and is subject to annual calibration by an accredited laboratory.
- The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session.
- Samples of at least 24 hours in duration and sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time acoustic environment should be taken.
- The following acoustic indices should be recoded and reported: L_{Aeq} (T), L_{AIeq} (T), statistical noise level L_{A90}, L_{AFmin} and L_{AFmax}, octave band or 3rd octave band frequency spectra.
- The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet.
- A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

The investigation of complaints, should include an investigation into equipment or machinery that likely result or resulted in noise levels annoying to the community. This could be achieved with source noise measurements.

6 Impact Significance Rating

The significance of environmental noise impacts was determined using the methodology adopted by Terra Pacis for the S&EIR. The significance of the construction phase, assessed qualitatively, was found to be *low*. The significance of operational phase noise impacts, assessed quantitatively, was found to be *moderate* (Table 7).

Based on the findings of the assessment and provided the measures planned and recommended are in place, it is the specialist opinion that the project may be authorised.

Table 7: Cumulative impact significance rating for environmental noise

	Significance	Spatial Scale	Temporal Scale	Probability	Rating	Degree of Certainty
Construction Phase	MODERATE	*Study Area*	Short-term	*Could happen*	**Low**	Probable
	3	2	2	3	**1.4**	
Operational Phase	MODERATE	*Study Area*	Medium-term	*Very likely*	**Moderate**	Possible
	3	2	3	4	**2.1**	

7 References

Brüel & Kjær Sound & Vibration Measurement A/S, 2000. *www.bksv.com.* [Online] Available at: http://www.bksv.com
[Accessed 14 October 2011].

Burgess, M. & McCarty, M., 2009. *Review of Alternatives to 'Beeper' Alarms for Construction Equipment,* Canberra: University of New South Wales.

EC WG-AEN, 2006. *Position Paper | Final Draft | Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure,* Brussels: European Commission.

IFC, 2007. *Environmental, Health and Safety Guidelines for Phosphate Ferilizer Manufacturing: IFC.* [Online] Available at: http://www.ifc.org/wps/wcm/connect/c24fb68048855759bc24fe6a6515bb18/Final%2B-%2BPhosphate%2BFertilizer%2BPlants.pdf?MOD=AJPERES&id=1323152989386
[Accessed 1 March 2017].

IFC, 2007. *General Environmental, Health and Safety Guidelines,* s.l.: s.n.

Knights, T., 2017. *Hi-Fos (Pty) Ltd | Phosphoric Acid Plant Standerton | Technical Review | Final Report,* Johannesburg: Knights Environmental.

SANS 10103, 2008. *The measurement and rating of environmental noise with respect to annoyance and to speech communication,* Pretoria: Standards South Africa.

Tolksdorff, P. & Maraschin, N., 2016. *Final Scoping Report for Hi-Fos (Pty) Ltd Proposed Phosphoric Acid Plant, Standerton, Mpumalanga,* Johannesburg: Terra Pacis Environmental (Pty) Ltd.

WHO, 1999. *Guidelines to Community Noise.* s.l.:s.n.

8 Annex A – Sound Level Meter Calibration Certificates

nmisa
National Metrology Institute of South Africa

Certificate of Conformance

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Calibration of:	SOUND LEVEL METER, OCTAVE BAND FILTER, THIRD OCTAVE BAND FILTER & MICROPHONE
Manufacturer:	BRÜEL & KJÆR
Model number:	2250, 4950
Serial number:	2731851, 2709293
Calibrated for:	AIRSHED PLANNING PROFESSIONALS (PTY) LTD Johannesburg
Calibration procedure:	AV\AS-0007 AV\AS-0010
Period of calibration:	26 – 27 January 2016

1 PROCEDURE

The sound level meter was electrically calibrated according to the relevant clauses of SANS 656 and 658 specifications. The microphone with the sound level meter was acoustically calibrated according to the relevant clauses of SANS 656 specifications. The instrument complete with filters was electrically calibrated according to IEC 61260 specification.

The results of the measurements are traceable to the national measurement standards.

The following equipment was used:

Brüel & Kjær 4226 Multi-function calibrator	(AS-131)
Inline Capacitor	(AS-98)
Brüel & Kjær 3630 Calibration platform	(AS-109)

Calibrated by	Checked by	For Chief Executive Officer
R Nel Metrologist (Technical Signatory)	ML Temba Metrologist	
Date of Issue 27 January 2016	Page 1 of 3	Certificate number AV\AS-4534

Your measure of excellence

2 RESULTS

2.1 The following parameters of the sound level meter were calibrated and conformed to the SANS 656 and SANS 658 specifications, type 1:

Indication under reference conditions (SANS 656 clause 11.2)			U = 0,20 dB
Electrical self generated noise			
	A-weighted	(12,4 dB)	U = 0,30 dB
	C-weighted	(13,2 dB)	U = 0,30 dB
	Linear	(18,9 dB)	U = 0,30 dB
Linearity range (SANS clause 9.9, table 11)			
	31,5 Hz		U = 0,12 dB
	1 kHz		U = 0,12 dB
	8 kHz		U = 0,12 dB
Frequency Weightings (SANS 656 clauses 8.1, 11.2, tables 4 & 5)			
	A-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
	C-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
	Linear	(25 Hz – 16 kHz)	U = 0,12 dB
Time weightings (SANS 656 clauses 9.2, 9.3, 9.5, 11.4, table 9, 7 & 10)			
	Slow and Fast		U = 0,11 dB
	Impulse		U = 0,11 dB
	Peak		U = 0,09 dB
Time averaging, L_{Aeq} (SANS 658 clause 11.3.3, table 4)			U = 0,12 dB
Impulse weighted time averaging, L_{AIeq} (SANS 658 Annex C, table C1)			U = 0,12 dB
Overload indication (SANS 656 clause 11.3)			U = 0,31 dB

2.2 The following parameter of the microphone with the sound level meter were calibrated and conformed to the SANS 656 specifications, type 1:

Frequency response (SANS 656 clauses 8.1, tables 4 & 5) 31,5 Hz – 12,5 kHz	U = 0,20 dB @ 1 kHz

Calibrated by R Nel Metrologist (Technical Signatory)	Checked by ML Temba Metrologist	For Chief Executive Officer
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2.3 The following parameter of the octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation — U = 0,12 dB @ f_m
(IEC 61260 clause 4.4, 5.3)
16 Hz - 8 kHz

2.4 The following parameter of the third octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation — U = 0,12 dB @ f_m
(IEC 61260 clause 4.4, 5.3)
12,5 Hz - 16 kHz

3 REMARKS

3.1 The reported uncertainties of measurement were calculated and expressed in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "A Guide to the Expression of Uncertainty in Measurement" (International Organisation for Standardisation, Geneva, Switzerland, 1993).

3.2 The reported expanded uncertainty of measurement, U, is stated as the standard uncertainty of measurement multiplied by a coverage factor of k = 2, which for a normal distribution approximates a level of confidence of 95,45 %. The reported expanded uncertainty of measurements is at the reference points.

3.3 Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

3.4 The calibrations were carried out at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 %RH ± 20 %RH.

3.5 Only parameters given in 2.1, 2.2, 2.3 and 2.4 were calibrated.

3.6 The above statement of conformance is based on the measurement value(s) obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limit(s).

3.7 The firmware version of the sound measuring device at the time of calibration was: 4.4.0.44; BZ7130 v4.4; BZ7131 v4.4; BZ7132 v4.4

------------------ *end of certificate* ------------------

Calibrated by **R Nel** **Metrologist (Technical Signatory)**	Checked by **ML Temba** **Metrologist**	For Chief Executive Officer
Date of Issue **27 January 2016**	**Page 3 of 3**	Certificate number **AV\AS-4534**

9 Annex B – Survey Log Sheets

SITE NUMBER:	1 DAY		SLM DATA RECORD:	170302 001
Longitude/Easting: 29 01.927 E		Latitude/Northing: 26° 52.056'		Elevation: 1560 m
Short Location Description & Notes: 2/03/2017				

SETUP	Start Date & Time: 13:55:16	End Date & Time: 14:34:15	Sensitivity Before: 113.85 dB	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	Light to medium	NE	–	–	10%	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☐ Dogs	☐ Music	☑ Community	☑ Air Traffic	☑ Road Traffic	☑ Constr.	☐ Other

Description: Construction, mostly from loading truck and backactor reverse alarm. Cars in background, ~~They have a~~ long grass Farm house ± 100 m NE. There are some background and construction noise I can't account for. Therefore I'm taking longer measurement. They have a crusher) Power line making funny noise (I think)

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
~~13:55~~							
14:01:22	That was me (sorry)						
14:15:68	Tractor pulling wagon (metal banging)						
14:22:10	Backactor passing						

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SITE NUMBER:	2 DAY			**SLM DATA RECORD:**	170302002	
Longitude/Easting:	29° 02.812'	**Latitude/Northing:**	26° 52.707'	**Elevation:**	1555	
Short Location Description & Notes:						

SETUP	**Start Date & Time:** 2/03/2017 15:06:02	**End Date & Time:**	**Sensitivity Before:**	**Sensitivity After:**

METEOROLOGY	**Wind Speed (m/s)**	**Wind Direction (°)**	**Temperature (°C)**	**Humidity (%)**	**Clouds (%)**	**Remarks:**
Start	Light - Medium	NE	25 - 26°C	–	20%	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☐ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other
Description: Next to road. Farm animals. Next to open field. some long grass									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
15:07:06	Car						
15:09:49	Bus						
25:04	Bus						
15:36:48	Car						

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SITE NUMBER: 3 DAY	SLM DATA RECORD: 170302 003

Longitude/Easting: 29°02,891'	Latitude/Northing: 26°50.390'	Elevation: 1586 m

Short Location Description & Notes:

SETUP	Start Date & Time: 02/03/17 16:03:21	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	Medium-Strong	NE	—	—	50%	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☑ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other

Description: ~~I~~ Next to field (~~corn~~ mielies) Next to railroad (Powerlines) ± 25m Close to ~~house~~ Home. Leafs in wind from mielies. Thunder in background.

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
16:10:19	TRAIN						
16:21:53	Thunder						
16:27:04	Car						

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SITE NUMBER: 4 DAY		**SLM DATA RECORD:** 17 0302 004	
Longitude/Easting: 28 59,694'	**Latitude/Northing:** 26° 51 638'		**Elevation:** 1553m
Short Location Description & Notes:			

SETUP	**Start Date & Time:** 17:07:15	**End Date & Time:**	**Sensitivity Before:**	**Sensitivity After:**

METEOROLOGY	**Wind Speed (m/s)**	**Wind Direction (°)**	**Temperature (°C)**	**Humidity (%)**	**Clouds (%)**	**Remarks:**
Start	Light to medium	NE	–	–	60%	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☑ Community	☑ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other
Description:									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
17:08:18	Car						
17:15:50	Car						
17:19:28	Car						
17:20:20	Car						
17:20:47	That was me (again)						
21:50	Car						
17:21:40	Footgoers						

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SITE NUMBER:	1 Night		**SLM DATA RECORD:**	170302005	
Longitude/Easting:	29 0.1,927 E	**Latitude/Northing:**	26° 52.056'	**Elevation:**	1560 m
Short Location Description & Notes:					

SETUP	**Start Date & Time:** 22:20:45	**End Date & Time:**	**Sensitivity Before:**	**Sensitivity After:**

METEOROLOGY	**Wind Speed (m/s)**	**Wind Direction (°)**	**Temperature (°C)**	**Humidity (%)**	**Clouds (%)**	**Remarks:**
Start	Light	NE	–	–	0	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☐ Community	☐ Air Traffic	☑ Road Traffic (very far away)	☐ Constr.	☐ Other

Description: same as before (with construction site noise)

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
22:34:55	I'm guessing a train, but its too faraway to be certain						

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SITE NUMBER:	2 Night	SLM DATA RECORD:	170302 006
Longitude/Easting: 29° 02,812'	Latitude/Northing: 26° 52.707'	Elevation:	1555m
Short Location Description & Notes:			

SETUP	Start Date & Time: 22:59:22	End Date & Time:	Sensitivity Before:	Sensitivity After:

METEOROLOGY	Wind Speed (m/s)	Wind Direction (°)	Temperature (°C)	Humidity (%)	Clouds (%)	Remarks:
Start	light	NE	–	–	0%	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☑ Community	☐ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other
Description:	Same as before, Traffic from R23								

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
22:59:57	~~[illegible]~~. Train						
23:00:34	Car slamed door						
23:02:06	Train (suspect) → keep pulsing like that						
02:39	Car ~~doo~~ door						

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SITE NUMBER: 3 Night		**SLM DATA RECORD:** ~~12~~. 170302 007	
Longitude/Easting: 29° 02,891'	**Latitude/Northing:** 26° 50,390'		**Elevation:** 1586 m
Short Location Description & Notes:			

SETUP	**Start Date & Time:** 23:32:49	**End Date & Time:**	**Sensitivity Before:**	**Sensitivity After:**

METEOROLOGY	**Wind Speed (m/s)**	**Wind Direction (°)**	**Temperature (°C)**	**Humidity (%)**	**Clouds (%)**	**Remarks:**
Start	Medium	NE	—	—	0%	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☐ Community	☐ Air Traffic	☑ Road Traffic	☐ Constr.	☐ Other
Description: Same as before									

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description
23:34:03	Wind picking up						
	(actually not sure)						
39:07	Suspect Wind						
	But could be						
	Train in the distance						
42:20	Definitely a train						
44:44	TRAINS x 2						
	At the same time						

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SITE NUMBER: 4 Night		**SLM DATA RECORD:** 17 08 18 170303 001	
Longitude/Easting: 28 59,694'	**Latitude/Northing:** 26° 51,638'		**Elevation:** 1553m
Short Location Description & Notes:			

SETUP	**Start Date & Time:** 00:10:43	**End Date & Time:**	**Sensitivity Before:**	**Sensitivity After:**

METEOROLOGY	**Wind Speed (m/s)**	**Wind Direction (°)**	**Temperature (°C)**	**Humidity (%)**	**Clouds (%)**	**Remarks:**
Start	light - medium	NE	—	—	—	
Middle						
End						

NOISE CLIMATE	☑ Birds	☑ Insects	☑ Dogs	☐ Music	☐ Community	☐ Air Traffic	☑ Road Traffic (R23)	☐ Constr.	☐ Other
Description:	TRAINS IN BACKGROUND ALSO COWS								

EVENTS

Time	Description	Time	Description	Time	Description	Time	Description

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10 Annex C – Specialist Curriculum Vitae

CURRICULUM VITAE

Name	Nicolette von Reiche (nee Krause)
Date of Birth	22 October 1982
Nationality	South African
Employer	Airshed Planning Professionals (Pty) Ltd
Position	Principal Consultant and Project Manager
Profession	Mechanical Engineer employed as an Air Quality and Environmental Noise Assessment Consultant
Years with Firm	10 Years

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- South African Acoustic Institute (SAAI), 2006 to present
- National Association for Clean Air (NACA), 2006 to present
- International Institute for Acoustics and Vibration (IIAV), 2014 to present

EXPERIENCE

Nicolette has ten years of experience in both air quality and noise impact assessment and management. She is an employee of Airshed Planning Professionals (Pty) Ltd and is involved in the compilation of emission inventories, atmospheric dispersion modelling, air pollution mitigation and management, and air pollution impact work. Airshed Planning Professionals is affiliated with Francois Malherbe Acoustic Consulting cc and in assisting with numerous projects she has gained experience in environmental noise measurement, modelling and assessment as well.

PROJECTS COMPETED IN VARIOUS SECTORS ARE LISTED BELOW:

Power Generation, Oil and Gas

eni East Africa S.p.A Rovuma Area 4 baseline for offshore gas (Mozambique), Staatsolie Power Company Suriname (Suriname), Benga Coal Fired Power Station (Mozambique), Zuma Energy Project (Nigeria), Anglo Coal Bed Methane Project, Eskom Ash Disposal Projects for Kusile Power Station, Camden Power Station and Kendal Power Station, Hwange Thermal Coal Fired Power Station Project (Zimbabwe), Eskom Ankerlig Gas Power Station.

Industrial Sector

Scantogo Cement Project (Togo), Boland Bricks, Brits Ferrochrome Smelter Project, Samancor Chrome's Ferrometals, Middelburg Ferrochrome and Tubatse Ferrochrome, BHP Billiton Metalloys Ferromanganese Projects and Mamatwan Sinter Plant Projects, Tharisa Minerals Concentrator Plant Project, Obuasi Gold Processing Plant (Ghana), Obuasi Gold Mine Pompora Treatment Plant Project (Ghana), Afrisam Saldanha Project, Scaw Metals Projects, including a Co-generation Plant and Steel Wire Rope Plant Project, Delta EMD Project, Dense Medium Separation (DMS) Powders Project, Transalloys Silica Manganese, Dundee Precious Metals Tsumeb (Namibia), Rössing Uranium Desalination Plant (Namibia), Otavi Steel Project (Namibia)

Air Quality and Environmental Noise Management

Saldanha Industrial Development Zone (IDZ) – Part of an integrated team of specialists that developed the proposed development and management strategies for the IDZ. Air quality guidelines were developed and a method of determining emissions for potential developers. The investigation included the establishment of the current air emissions and air quality impacts (baseline) with the objective to further development in the IDZ and to allow equal opportunity for development without exceeding unacceptable air pollution levels.

Gauteng Department of Transport air quality and noise management plan - The plan involved the identification of main traffic related sources of noise and air pollution, the identification of intervention strategies to reduce traffic related noise and emissions to air and the theoretical testing of intervention strategies through emission quantification and dispersion modelling of selected case studies.

Erongo Strategic Environmental Impact Assessment (Namibia) and Air Quality Management Plan

Mining Sector

- Coal mining: Elders Colliery, Grootgeluk Colliery, Inyanda Colliery, Boschmanspoort Colliery, Benga Mine (Mozambique), Vangatfontein Colliery Dust Monitoring, T-Project Underground Coal Mine, Lusthof Colliery
- Metalliferous mines: Samancor Chrome's Eastern and Western Chrome Mines, Kinsenda Copper Mine (DRC), Bannerman Uranium Mine (Namibia), Sadiola Gold Mine Deep Sulphides Project (Mali), Kolomela Iron Ore Mine Noise Monitoring, Mamatwan Manganese Mine, Ntsimbintle Manganese Mine, Tharisa Minerals Chrome and Platinum Group Metals Open-pit Mine Project, Obuasi Gold Mine (Ghana), Omitiomire Copper Mine (Namibia), Perkoa Zinc Project (Burkina Faso), Tschudi Copper Mine (Namibia), Rössing Uranium Mine (Namibia), WCL Iron Ore Mines (Liberia), Fekola Gold Project (Mali), Esaase Gold Project (Ghana), Xstrata Paardekop and Amersfoort Underground Coal Mines, Mampon Gold Mine (Ghana), Husab Uranium Mine (Namibia), Mkuju River Uranium Project (Tanzania), Impala Platinum Mine, Angola Exploration Mining Resources Project (Angola), Kanyika Niobium Mine (Malawi)
- Quarries: Scantogo Limestone Quarry, Lion Park Quarries Dustfall Monitoring

Waste Disposal and Treatment Sector

Aloes Hazardous Waste Disposal Site, Holfontein Hazardous Waste Disposal Site, Shongweni Hazardous Waste Disposal Site, Coega General and Hazardous Waste Disposal Site, Umdloti Waste Water Treatment Works, Waltloo Medical Waste Incinerator

Transport and Logistics Sector

Saldanha Iron Ore Port Projects and Railway Line, Gautrain Environmental Noise Monitoring Project, Guinea Port and Railway Project (Guinea), Kenneth Kaunda International Airport Expansion (Zambia), Zambia Dry Port Project in Walvis Bay (Namibia)

Ambient Air Quality and Noise Sampling

- Gravimetric Particulate Matter (PM) and dustfall sampling
- Passive diffusive gaseous pollutant sampling
- Environmental noise sampling
- Source noise measurements

SOFTWARE PROFICIENCY

- Atmospheric Dispersion Models: AERMOD, ISC, CALPUFF, ADMS (United Kingdom), CALINE, GASSIM, TANKS
- Noise Propagation Modeling: Integrated Noise Model (for airport noise), DataKustik CadnaA, CONCAWE, South African National Standards (SANS 10210) for Calculating and Predicting Road Traffic Noise
- Graphical Processing: Surfer, ArcGIS (basic proficiency)
- Other: MS Word, MS Excel, MS Outlook

EDUCATION

- BEng: (Mechanical Engineering), 2005, University of Pretoria
- BEng (Hons): (Mechanical Engineering) 2010, University of Pretoria; specializing in:
    - Advance Heat and Mass Transfer
    - Advanced Fluid Mechanics
    - Numerical Thermo-flow
    - Tribology

COURSES COMPLETED AND CONFERENCES ATTENDED

- Course: Air Quality Management. Presented by the University of Johannesburg (March 2006)
- Course: AERMET/AERMAP/AERMOD Dispersion Model. Presented by the University of Johannesburg (March 2010)
- Conference: NACA (October 2007), Attended and presented a paper
- Conference: NACA (October 2008), Attended and presented a paper
- Conference: NACA (October 2011), Attended and presented a poster
- Conference: NACA (October 2012), Attended and presented a paper
- Conference: IUAPPA (October 2013), Attended and presented a paper
- Conference: ICSV22 (July 2015), Attended
- Conference NACA (October 2015), Attended

COURSES PRESENTED

- Introduction to Air Dispersion Modelling
- Air Quality Legislation in South Africa
- Air Quality Management Planning

COUNTRIES OF WORK EXPERIENCE

South Africa, Mozambique, Zimbabwe, Zambia, Namibia, the Democratic Republic of the Congo, Botswana, Ghana, Liberia, Togo, Mali, Burkina Faso, Tanzania, Malawi, Angola, Nigeria and Suriname.

LANGUAGES

Language	Proficiency
English	Full professional proficiency
Afrikaans	Native language
French	Limited working proficiency

REFERENCES

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Dr. Gerrit Kornelius	Associate of Airshed Planning Professionals	+27 (82) 925 9569 gerrit@airshed.co.za
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CERTIFICATION

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications and my experience.

23/08/2016