APPENDIX H: NOISE STUDY

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Tharisa Mine	Report G991-R1
EMP Amendment	
Noise Study	
For: Tharisa Minerals	Revised: 14-Sep-2012

Declaration of independence

I am an independent acoustic consulting engineer with no commercial interest in Tharisa Minerals, or the above-mentioned project. A personal curriculum vitae in support of my qualifications, expertise and experience to undertake studies of this nature, is attached in Appendix B.

Executive Summary

Scope

Acusolv was appointed to undertake a noise study required in terms of the current Tharisa Mine EMP amendment process. The objective of the study was to assess the noise implications of changes proposed in terms of the EIA amendment. To put the impact of the mine into perspective, it was necessary to develop a noise model simulating not only the additional noise expected from the changes, but the noise of current EIA-approved operations (the reference condition) as well. Noise surveys were conducted to assess the impact of the mine in its current state of operation, which is an intermediate state where not all EIA-approved components have been constructed yet, whilst at the same time, some of the proposed EIA Amendment changes have already been constructed.

Findings

The measurement surveys show that a significant impact is currently taking place in the area south of the N4, particularly as a result of night-time TSF construction activities. This is a temporary problem, but can be prevented by restricting TSF construction activities to daytime hours (06:00 to 22:00).

Based on noise modelling, the predictive noise study finds that, without mitigation, EIA-approved operations will have a significant impact on communities remaining inside the mining rights boundary, as well as occasional significant impacts outside the boundary on the nearest residences to the south.

Changes made in terms of the proposed EIA Amendment, including the addition of the Chrome Sand Drying Plant, will not change the noise footprint of the mine and will not result in a noticeable increase in the noise impact on noise-sensitive receptors in the study area. The incremental impact of these changes is expected to be negligible.

The character of audible or disturbing noises will vary, depending on the location of the receptor relative to the various mining components and activities. The dominant source of audible noise in the relocated residential area (Silver Town), as well as Lapologong Village, the entire area around West Mine and the area to the north of the mine, will be diesel engine, dumping and scraping noises coming from the various waste rock dumps. In most of these areas truck movement on the haul road will also be audible. Except for periods when operations are taking place at surface level, opencast operations will be screened off by the pit walls and will not be audible above surface activity noises.

In the area south of the mine, N4 traffic noise will normally dominate and mask noise from the mine. On occasions when mining noise is intensified by unfavourable atmospheric conditions, the mine will sound louder and stand out above traffic noise during quiet periods at night. Under such conditions the plant is expected to constitute the dominant source of audible mining noise with the crushers and mills being the most noticeable. Noise from the tailings facilities, despite their large footprints, will be negligible. The TSF motor-pump units will not be audible anywhere in the external surroundings.

Mitigation

Recommendations of various measures and procedures to mitigate the noise impact of the mine are made in the report. Noise impacts on residents destined to remain inside the mining rights boundaries can be mitigated to some extent by construction of berms along haul roads and by design of waste rock dumps with an outer shell to screen off the noise of trucks, dumping and dozing activities at a lower work level. By far the most effective and sure way of mitigating the noise impacts inside the mining rights boundaries, however, is to restrict noise generating activities west of the D1325 to daytime hours (06:00 to 22:00).

The main area of concern outside the mining rights boundaries, once the 300 kT plant starts operating, are the residences south of the N4. The existing topsoil berm already provides a degree of noise screening in the area, but will have to be extended in length as well as height, raising the height by at least another 15 m. The effectiveness of the berm to screen off noise can be improved quite significantly by moving it closer to the plant.

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1 Introduction

1.1 Project and study area

Tharisa Minerals (Pty) Ltd (Tharisa) produces chrome and platinum group metals (PGM) concentrate at Tharisa Mine near Marikana town in the Rustenburg and Madibeng Local Municipalities and Bojanala Platinum District Municipality in the North West Province. The Mine is located near Buffelspoort, approximately 30km east of Rustenburg, as shown on the map in Figure 1.1.

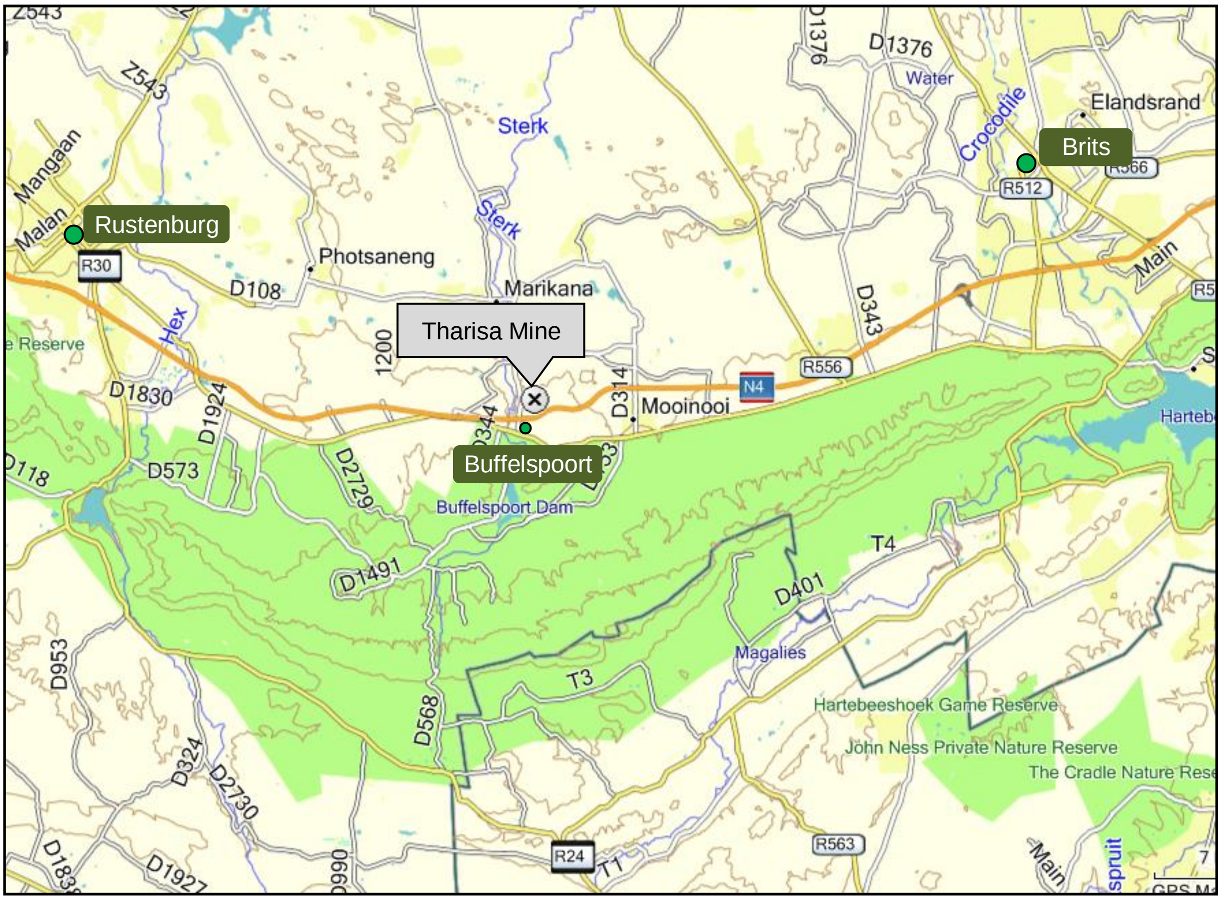


Figure 1.1

Location Map
Tharisa Mine

Tharisa proposes the following developments at Tharisa Mine:

- Construct and operate a chrome sand drying plant;
- Changes to the tailings dam design; and
- Changes to the general surface infrastructure layout and operations

Tharisa has removed the on-site smelter from the project as initially proposed. Furthermore, since the approved run of mine (ROM) pads as per the approved EIA/EMP report will be sufficient for operations at the mine, the proposed ROM pads have been removed from this EIA process. Tharisa has also increased the size of the proposed chrome sand drying plant.

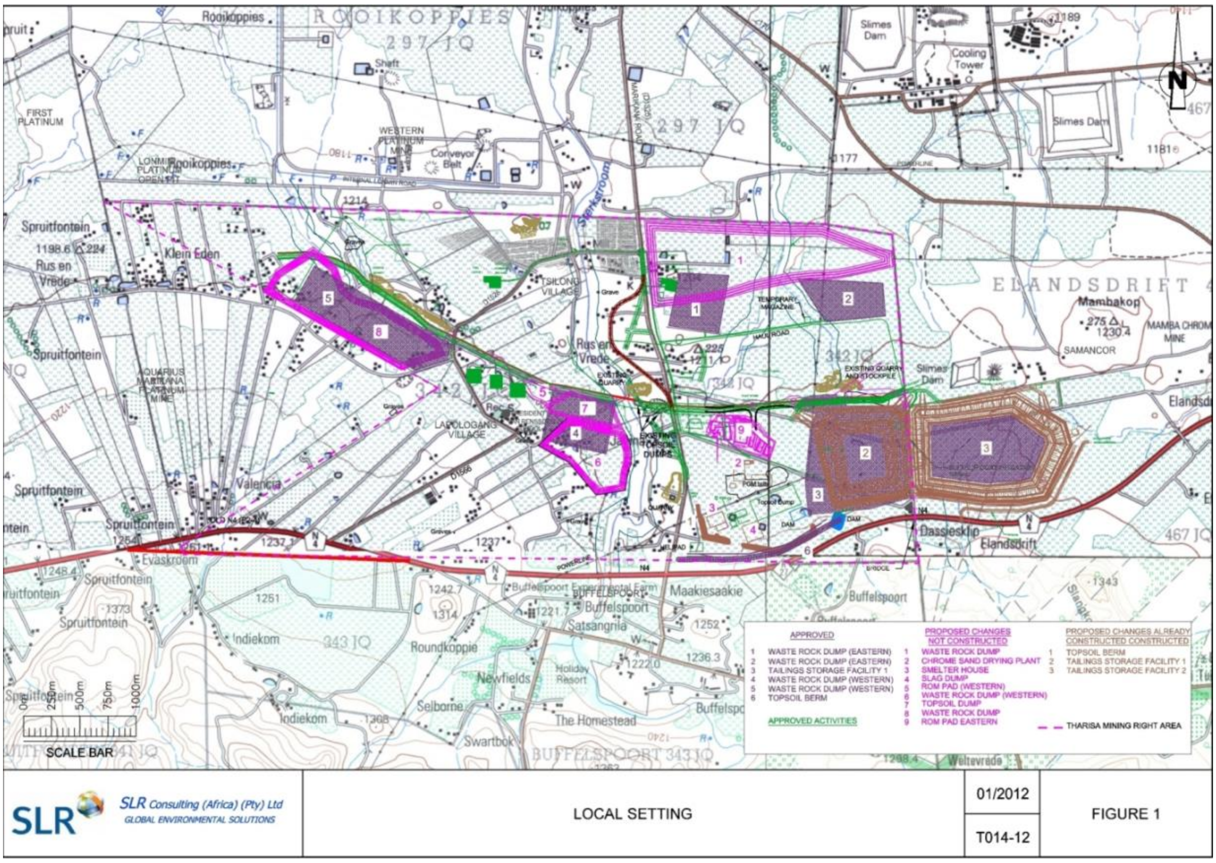


Figure 1.2

Tharisa local setting and layout of proposed changes

1.2 Terms of reference and scope of work

In compliance with EMPR requirements, Tharisa has been conducting annual noise surveys since commencement of mining activities. Acusolv was tasked to carry two such surveys, the first completed in 2009 (Report G754-R1) and the second in 2010 (Report G823-R1).

Acusolv has now been appointed to undertake a noise study required in terms of the current Tharisa Mine EMP amendment process. The scope of work includes the following:

Scoping and baseline study

Carry out a physical scoping survey to assess the nature of the existing noise environment as well as the locations of Tharisa Mine's existing infrastructure, the locations of EIA-approved infrastructure not yet completed and of proposed new mining infrastructure in terms of the EIA Amendment. Conduct noise surveys at selected locations to determine typical existing ambient sound levels.

Predictive noise impact study

Carry out a study to assess the noise impact implications of previously approved operations and infrastructure, as well as that of the amendment currently applied for.

This report presents the results and findings of the ambient survey and the predictive noise study.

2 Methodology

2.1 General considerations

The Tharisa noise study was carried out in accordance with SANS 10328 [2], a South African Standard presenting guidelines on procedures to conduct noise assessments.

2.2 Ambient noise survey and assessment

2.2.1 Principles and methodology

Selection of noise monitoring locations

Criteria applied and practical considerations taken into account in the selection of suitable locations for noise monitoring, include the following:

- **Community concerns:** In selecting locations for noise monitoring, concerns raised by interested and affected parties should be taken into account.
- **Worst-case impact:** Focus on areas where maximum noise impact is expected.
- **Suitability for future surveys:** As far possible, select locations likely to be accessible in future surveys.
- **Avoid interference:** As far as practically possible, stay clear of and avoid interference by localised noise sources which may distort the data. Examples are power distribution boxes, barking dogs, speech interference by curious visitors and insects.
- **Equipment safety:** Measurement procedure, integration periods and sample size depend on the availability of facilities for safeguarding equipment. Long duration samples are only possible at locations where facilities are available to lock away recording equipment connected via a cable to a microphone positioned outdoors at a point clear of vertical reflecting surfaces and protected from the elements.

Meteorological considerations

Outdoor noise measurement is not permitted under certain weather conditions. Rain, drizzle or fog affects the conductivity of measurement microphones, resulting in faulty readings. It may also damage the microphone and measuring equipment. Secondly, although measurement often has to be performed in the presence of wind, care should be taken to verify that wind turbulence noise on the microphone capsule is negligible compared to the sound level of interest. There is no fixed upper limit for permissible wind speed - it all depends on the level being measured. Another weather phenomenon which may cause interference and spoil measurement data is lightning and thunder.

Meteorological conditions also affect the acoustic environment and the actual sound levels without causing interference or measurement error. Normal fluctuations in atmospheric conditions may cause large variations in noise level which cannot and should not be avoided in the planning and execution of noise monitoring surveys. These variations constitute the natural variance in both background and intrusive noise levels. Noise levels at a distance from large sources are highly dependent on meteorological conditions. In fact, the difference in characteristic day and night meteorological patterns is one reason why 24-hour mining or industrial operations always have a much greater noise impacts at night[1].

It should be noted that, for the reasons explained above, the monitoring of meteorological conditions, such as temperature, wind and humidity on the ground can at best only serve to avoid errors and distortion of measurement data. Knowledge of cloud cover, temperature, humidity and wind which prevailed during the course of a noise survey has little if any value in the post-processing and interpretation of data.

Sampling considerations

To be of any use as an environmental management tool, noise monitoring has to produce accurate and relevant data. As a minimum requirement measurements should be performed using equipment with the necessary precision and accuracy as laid down in SANS 10103 [3]. Just as important, no matter how accurate the measurements, the data is only as good as the sample. What complicates noise sampling is that ambient noise is all but constant. As a rule, it is the net result of contributions from various constant, cyclic and randomly fluctuating sources.

To account for the intrinsic 24-hour cyclic variation, measurements should be taken within the relevant period of interest, e.g. daytime, night-time or a 24-hour cycle. Noise regulations require that the noise investigated must be measured (averaged) over a period of at least 10 minutes; i.e. 10 minutes or longer. Occasionally, in the investigation of noise complaints, a 10 minute sample may be sufficient to obtain the data needed to make a finding. For purposes of predictive noise studies and monitoring surveys, however, longer averaging periods are required to determine baseline or operational noise levels. Noise levels have to be averaged over intervals long enough to ensure that the sample is representative of conditions which prevailed during the period of investigation.

Where this is possible, in addition to measuring the average over the day or night-time period of interest, equipment may be programmed to simultaneously determine averages in a contiguous series of short sub-intervals of say 10-minute, 30-minute, or 1 hour duration, covering the main survey period. In this way, a picture can be obtained of the noise pattern over that period. For practical reasons, it is often not possible to attend measurements for the full duration of such long recordings.

2.2.2 Surveys conducted in the Tharisa EIA amendment study

Protocols and procedure

It was an explicit requirement that permission for access to property be arranged through the mine. Suitable locations for noise monitoring were identified and selected by the noise specialist in consultation with the mine. Property owners were informed by the mine of the intention and reason to conduct noise surveys and the noise specialist was introduced to the owners by the mine.

The main ambient noise assessment was based on a comprehensive survey comprising a series of noise monitoring recordings made at representative locations. This survey was conducted with the mine fully operational in its current state of completion and was completed

1 *The other main reason is the increased community sensitivity at night due to a natural decline in road traffic and human activity noise.*

in July 2012. An opportunity to conduct measurements during a plant shut-down arose at a later stage after completion of the basic noise impact assessment as initially planned. Hence a second supplementary survey was carried out to augment the data obtained in the first survey and to improve the calibration of the noise model used in the predictive assessment.

Noise survey 1 (Basic survey)

A scoping assessment and noise monitoring tests in the main survey were carried out during the period 26 to 27-Jul-2012. Ambient noise was monitored at four locations representative of areas closest to the mine where maximum impact is likely to occur.

Noise survey 2 (Supplementary survey)

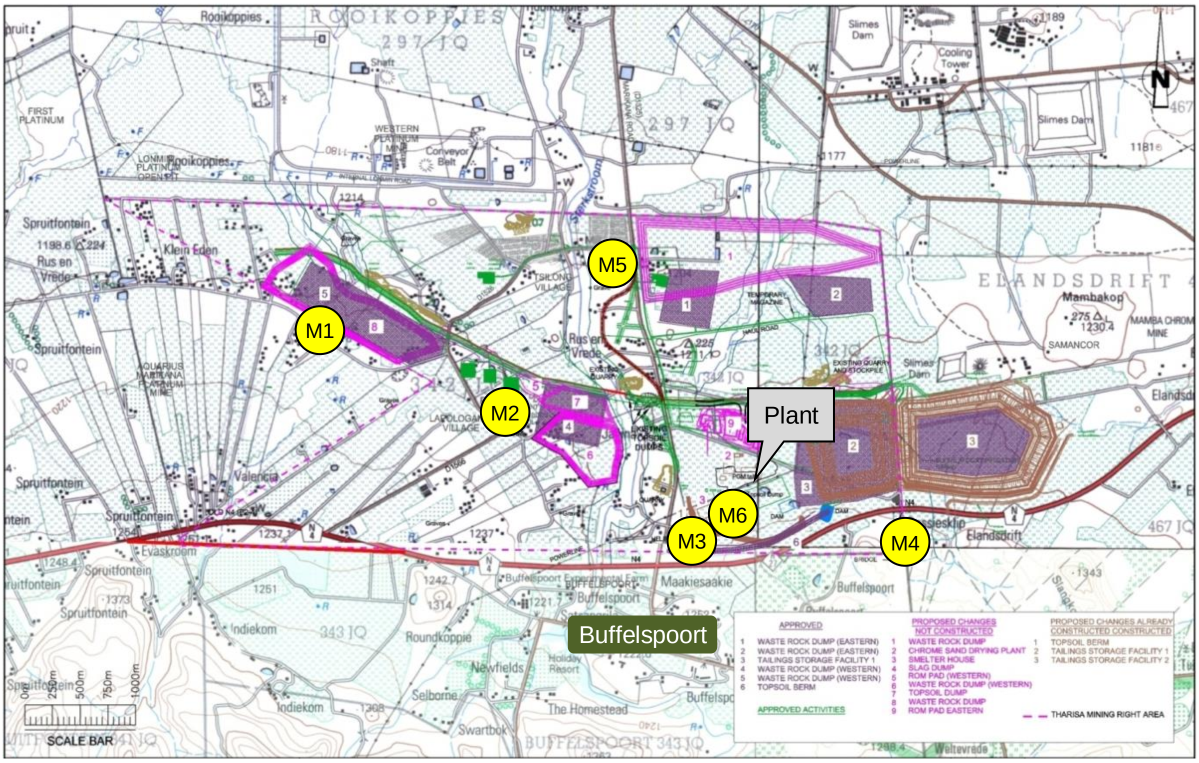
Noise monitoring tests in this supplementary survey were carried out during the period 05 to 06-Sep-2012. The decision to undertake this survey was taken when Tharisa Mine indicated that the 100 k Tone Plant would be shut down during the night of 05-Sep-2012 and that the mine would attempt to start up the plant again during the same night. This afforded a rare opportunity to determine the actual increase in night-time ambient level purely as a result of plant noise (the rest of the mine would operate as per normal night-time schedules).

In the supplementary survey, test stations were set up and ambient noise was monitored at four locations, some of which had also been covered in the main survey. This was the maximum number of points that could be set up and managed within time constraints. Unfortunately, the shutdown-startup schedule did not materialize as planned. Although the plant was shut down during the day, it could not be started up again during the night. This was due primarily to a sudden change in weather conditions, resulting in thunderstorms with heavy rainfalls during the course of the night.

Notwithstanding the setback, the recordings made during the course of the night still contained very useful data, because the plant was off all the time. This allowed the ambient noise to be captured at a set of reference points in the absence of Tharisa plant noise. This was achieved by listening to the recordings, filtering out bad data and analyzing useful data retrieved from periods during which there was no rain, wind or thunder. The supplementary data obtained in this way was used to recalibrate and improve the accuracy of the predictive noise model used in the noise impact assessment.

Ambient noise recordings in the two surveys were made over periods of approximately 24 hours, each covering one full night-time period, as follows (see Figure 2.1):

Monitoring Survey 1:	Location M1	Residence Potgieter H
	Location M2	Proximity of Spruitfontein School
	Location M3	Residence Potgieter M
	Location M4	Residence Potgieter D
Monitoring Survey 2:	Location M5	Silver Town village boundary nearest to mine
	Location M2	Proximity of Spruitfontein School
	Location M3	Residence Potgieter M
	Location M6	500 m south of plant, 100 north of berm



Point	Location	Represented area
M1	S25 43 49.2 E27 27 40.7	West pit immediate surroundings
M2	S25 44 18.6 E27 28 39.7	Spruitfontein school surroundings
M3	S25 45 00.7 E27 29 35.2	Plant surroundings - Nearest residence
M4	S25 44 56.8 E27 30 45.7	Area east and south-east of mine
M5	S25 43.717 E27 29.314	Silver Town village boundary nearest to the mine
M6	S25 44.863 E27 29.797	500 m south of plant, 100 north of berm

Figure 2.1

Noise monitoring locations

Noise recording equipment was programmed to measure averages in sequences of 10-minute intervals for a total duration of 24 hours or longer. In all recordings, A-weighted, equivalent continuous sound pressure levels L_{Aeq} (dBA) were measured, using an integrating sound analyser. For purposes of identifying sources of noise, third-octave spectra were examined during attended sessions, as well as in post-processing of data. At the same time, for purposes of identifying sources of noise, audio recordings synchronised with the data recordings were made at each monitoring point.

Assessment

Although measurements covered daytime periods as well, when considering noise impact, it is for all practical purposes only the night-time results that matter. Night-time, when people are normally sleeping, is when the environment is by far the most sensitive to intrusive noise and when maximum impact is experienced. Hence, in the assessment of noise, the focus is on night-time conditions.

Measurement data was processed to obtain a time history of ambient noise levels. Using the audio recordings, it was possible to listen to the actual noises which occurred at any time, to identify sources of noise and to correlate audible noise events with data.

2.2.3 Test equipment

Noise level measurements

Field measurements were carried out using the following equipment:

(a) Brüel & Kjaer Type 2260 Modular Precision Sound Analyser (Ser no. 1875497)

(b) Brüel & Kjaer Type 4231 Sound Calibrator (Ser no. 2606011)

Equipment conformed to IEC 61672-1 Electro-Acoustics – Sound Level Meters – Part 1: Specifications.

Calibration:

- M& N Calibration Services Certificates No's 2010-1164 & 2010-1165
- National Metrology Institute of SA Certificate No AV/AS-4016-R
- National Metrology Institute of SA Certificate No AV/AS-4021-R

Audio recording equipment

(a) MS1 Acoustic Data Logger (Ser no. 200109647)

(b) MS2 Acoustic Data Logger (Ser no. 200114547)

(c) MS3 Acoustic Data Logger (Ser no. 200108967)

(d) MS4 Acoustic Data Logger (Ser no. 200108968)

(e) MS5 Acoustic Data Logger (Ser no. 200108928)

2.3 Predictive noise impact study

2.3.1 Principle

Estimates of future noise levels to be generated by the development in the study area were derived with the aid of a model simulating noise emission from all major noise-generating components and activities of the development. To this end, it was required to quantify the acoustic emission (sound power) levels, as well as the frequency and directional characteristics of individual or groups of sources. This data was available from measurement data obtained in previous noise studies and from in-house noise data archives.

Calculation of geometric dispersion and atmospheric propagation of noise is broadly based on the principles of the Concawe method SANS ARP 014 [3], extended to deal with more complex source configurations, as well as to simulate the effect of wind.

2.3.2 Tests to determine the noise emission characteristics of mining components

In addition to the field surveys, tests were also conducted on the mining site to determine noise emission (sound power) levels of individual components and of the entire plant when fully operational in its current state of completion.

2.4 Acoustic modelling - Sources of noise in the Tharisa mining operation

2.4.1 Mining activities

Open pit mining

Topsoil, overburden and excess rock will be removed and stockpiled adjacent to the pit. Ore will be blasted, transported by trucks or conveyor and stockpiled. The open pit will be backfilled and rehabilitated by replacing the rock, followed by the subsoil, followed by topsoil. Approximately 32 million tonnes of waste rock /overburden will be moved per year. The open pit operation will extend along approximately 5km of the strike and 180m in depth.

Waste rock disposal

Some waste rock from the open pit will be used for backfilling and rehabilitating the open pit. The remaining waste rock will be stockpiled on site and used for construction and/or the rehabilitation of areas such as screening berms, the slag dump, roads and the tailings dam. Some waste rock will be stockpiled in waste rock dumps, but the option remains for these dumps to be processed and removed for building aggregate purposes.

Removal of topsoil

All topsoil will be dozed into stockpiles along the low wall sides of the open pits. On completion of the operation, topsoil will be replaced in reverse sequence, thus ensuring that the vegetated layer is on the surface. Noise-generating equipment and operations are:

- 2 x 120 ton Excavators operating 20 h/day
- 10 x 100 ton Rigid Dump Trucks operating 20 h/day

Drilling and blasting

Once the topsoil has been removed, the area will be drilled as per the drill design. Charges will be designed to prevent excessive ground vibration and fly rock. The remaining overburden and the ore will be drilled and blasted together. The main noise-generating equipment and operations are:

- 8 x Drill rigs operating 20 h/day
- 2 x Explosives trucks operating 20 h/day
- Removal of overburden

Removal of overburden above the ore body will be executed as a bulk operation by load and haul with large equipment. Material will be placed on the pit extremities so that final voids can be rehabilitated. Noise generating equipment and activities:

- 3 x 120 ton Excavators
- 15 x 100 ton Articulated and Rigid Dump Trucks
- Removal of ore

Prior to ore removal, the top of the reef horizon will be cleaned. The footwall will then be swept to ensure that all the fines are recovered. Noise generating equipment and activities:

- 7 x 65 ton Excavators
- 12 x 50 ton Articulated and Rigid Dump Trucks

2.4.2 Concentrator plant and mineral processing

Four main chrome seams will be mined, namely MG1, MG2, MG3 and MG4. Due to lower platinum concentrations and higher chrome levels within the MG1 and MG4 (A) seams, these seams will be treated in a separate concentrator plant referred to as the chrome plant. The other plant that will treat the MG2, MG3 and MG4 is referred to as the PGM plant.

2.4.2.1 Materials handling and storage

Handling and storage of materials at the concentrator plant will include:

Ore stockpiles

ROM will be stockpiled according to ROM type - 1 x 120 ton Excavator - 20 h/day.

Intermediary process materials

As part of the concentrating process, materials will be transported via conveyors and pipelines and where required, stored in storage silos and/or on stockpiles. Dust suppression will be used for air quality control as required.

2.4.2.2 Crushing and screening

Chrome plant

Run of mine material will be tipped into a receiving bin for crushing by a primary jaw crusher. The – 275 mm crushed material is then conveyed to a 10 000 ton stockpile for controlled feed to the secondary jaw crusher circuit. Oversized material from the secondary circuit is returned to the crusher feed conveyor for reprocessing. A double deck screen will separate the expected 214 tph ore from the secondary crusher circuit into three fractions namely:

An undersized of – 8 mm.
Chips of – 20 mm + 8 mm.
Lumpy of – 90 mm + 20 mm.

The lumpy and chips will report to separate bins for treatment in the DMS section, while the undersize will report to a 4 000 ton mill feed stockpile for milling prior to spiral plant treatment

PGM plant

The MG2-4 plant crushing facility will consist of a primary gyratory crusher and a secondary cone crusher. Material (600 x 600 x 600 mm max) is discharged directly into the primary gyratory crusher to be crushed to an expected –275 mm. Following primary crushing the material will be stored in a 15 000 ton stockpile. Ore will be extracted from the stockpile by feeders onto a conveyor for transport to a sizing screen. The crushed material is screened with the oversize + 75 mm material reporting to the secondary crusher for further crushing (closed circuit). Undersize from the screen will report to a 12 000 ton silo for storage prior to milling. Expected average feed rate to the plant will be approximately 450 tph. The crushing and screening plants will be equipped with dust suppression equipment comprising water sprays. Dust suppression will be used for air quality control as required.

Dense Media Separation (DMS) section – Chrome plant only

The lumpy material (- 90mm + 20 mm) will be treated in a DMS drum plant, while the chip fraction will be treated in a cyclone plant. The DMS plants will have a magnetic drum for recovery of FeSi, a float screen for DMS rejects, a sinks screen for recovered product, densifiers for maintaining correct media density, a FeSi make-up circuit (shared between cyclone and drum plant).

The recovered lump and chip material will be conveyed to separate 8 000 ton (each) stockpiles, while the discard (float) material is transported to a discard bin for removal to the waste rock stockpile.

2.4.2.3 Milling

Chrome plant

The – 6mm will be fed at a controlled rate to a ball mill for grinding to 100 % passing 1 mm. Product from the ball mill will be screened with oversize (+ 0.8 mm) returning to the grinding circuit and undersize reporting to the spirals plant via a pump box.

PGM plant

Ore from the silo will be fed onto the mill feed conveyor by three variable speed feeders. The primary ball mill will receive both feed material (– 75 mm), as well as mill water for flushing the ore into the mill. Material from the mill discharges onto a screen where the oversize will be collected in a bin and the undersize pumped through a cyclone. The cyclone overflow will be filtered with the oversize material being recycled and the undersize material reporting to a screen together with the cyclone sinks. Undersize material from the screen (- 0.2 mm) will report to the agitated rougher flotation feed tank, while the oversize material reports to the secondary mill feed.

2.4.2.4 Flotation – PGM plant only

The flotation plant will consist of a rougher, cleaner, re-cleaner and scavenger section.

2.4.2.5 Spiral plant

PGM plant

Underflow material from the floatation section is pumped to cyclones with the underflow gravitating into the spirals and the overflow reporting to the tailings thickener. Two streams will leave the spirals plant; a product stream and tailings. The product stream will be dewatered and stockpiled (8 000 ton). Approximately 40 000 tonnes of PGM concentrate will be produced per year.

Chrome plant

Material from the grinding section will be pumped to cyclones with the underflow gravitating into the spirals and the overflow reporting to the tailings thickener. Two streams will leave the spirals plant; a product stream (Met and Chem grade chromite) and tailings. The product stream will be pumped to four cyclones to produce two fine material stockpiles. Drainage from these stockpiles will be returned to the MG1 plant for water and product recovery. Tailings will be dewatered in the tailings thickener, while the underflow is pumped to the tailings dam. Approximately 1.5 million tonnes of chrome concentrate will be produced per year.

2.4.2.6 Tailings

Slurry from the secondary rougher flotation process will be discarded as tailings. It will be thickened and pumped to a tailings facility for deposition by means of conventional spigotting. Tailings production will be approximately 4 million tonnes per year. Process water from the tailings dam will be recycled to the plant for use in the process. After the underground mine is operational the new arisings are planned to be backfilled underground.

2.5 EIA Amendment Project description – Proposed changes

2.5.1 The proposed Chrome Sand Drying Plant

The capacity of the proposed chrome sand drying plant is approximately 25 000 tons per month of chrome concentrate. It is proposed that the wet chrome concentrate will be fed by front-end loader to a conveyor feeding the drier feed bin. This wet chrome will then be fed into the static fluid bed drier where it will be dried by a stream of hot gas blowing through a perforated plate. The hot burner gas will be mixed with air to achieve the correct drier gas temperature. The moisture-laden exhaust gas will be drawn off from the top of the drier chamber and ducted to gas cleaning cyclones and a bag filter to remove particulates before discharge to the atmosphere. The dried chrome will be discharged from the drier and fed to a similar static fluid bed cooling unit. The dried and cooled product will be discharged via a conveyor to a storage bin, from where it will be packaged in 1 ton bags, stored in a covered store and loaded by forklift onto trucks for dispatch.

The proposed plant will make use of approximately 640 kg/h of diesel or fuel oil. The exhaust gas volume will be approximately 64 000 m^3/h at 110 C°. There will be trace amounts of SO_2 in the off gas due to the combustion process which uses diesel and other products of combustion such as CO_2 will be present as well. There will be no solid or liquid effluent or wastes generated by the drier plant. The proposed plant will be located within the existing concentrator plant area and will be operated continuously (24 hours per day). Approximately 460 tons of diesel or HFO will be stored in the concentrator plant area.

2.5.2 Proposed increase of the high wall from 120 m to 180 m

The open pit mining operations at Tharisa Mine are divided into two sections: the western and eastern pits on each side of the mine. The two sections are separated by the D1325 (Marikana) road. Tharisa proposes to increase the approved depth of the pits from 120 m to 180 m. This change will result in an increase in the life of the mine from 12 years as approved (EIA/EMP report 2008) to 18 years. The TSF and rock waste dumps have also incorporated the related increase in the tailings and waste rock tonnages.

2.5.3 Proposed realignment and reshaping of waste rock dumps

It is proposed that there will be three rock waste dumps: two on the western side of the mine and one on the eastern side of the mine. The related volumes are outlined in Table 2.1.

Table 2.1

Approved and proposed waste rock dump (WRD) dimensions

Approved Waste Rock Dumps				
Dimensions	**Eastern WRD** (1)	**Eastern WRD** (2)	**Western WRD** (4)	**Western WRD** (5)
Footprint	22 ha	22 ha	22 ha	49 ha
Volume	5 890 000 m^3	5 890 000 m^3	5 890 000 m^3	13 330 000 m^3

Proposed Waste Rock Dumps			
Dimensions	**Eastern WRD** (1)	**Western WRD** (6)	**Western WRD** (8)
Footprint	116 ha	34 ha	65 ha
Volume	41 342 832 m^3	18 663 400 m^3	35 852 500 m^3

2.5.4 Proposed change to the design of the tailings storage facility

Due to the proposed increase of the open pit high wall and space related constraints at the mine, the designs and sizes of the tailings storage facility (TSFs) have changed as follows:

Table 2.2

Proposed changes to Tailings Storage Facility dimensions

Tailings Facilities				
Facility	**Status**	**Footprint** [Ha]	**Max height** m	**Volume** Mm^3
TSF 1	Approved	52	33	5,4
	Proposed	70	40	8,1
TSF 2	Approved	100	31	12,8
	Proposed	135	40	24

The black turf clays underneath the containment walls that were included in the approved designs have not been incorporated in the new designs as well as a low permeability liner along the inside of the face of the TSF. The clay cut-off keys have also not been incorporated in the new designs. Instead, toe drains have been incorporated on the inside toe of the TSF containment walls to draw down the phreatic surface of the tailings dam thus making it more stable. A seepage collector trench to intercept seepage in the weathered norite will also be constructed. The side outer slopes of the TSF have been constructed at 1V:2.5H instead of 1V:3H as per the approved EIA/EMP report. It is understood that the outer slopes will ultimately be constructed at 1V:3H.

2.5.5 Proposed change to the general infrastructure layout at tharisa mine

Tharisa proposes various other changes to the mine's general surface layout.

2.5.5.1 Proposed construction of a truck parking area

Tharisa proposes to construct a truck parking area near to the mine entrance. The parking area will comprise a one-way gravel road, 700 m long x 8 m wide for queuing/parking trucks that wait to enter the plant as well as the main gravel parking area of approximately 200 x 50 m. The total parking area will be 15 600 m^2 and will operate for 24 hours per day. Trucks that be will be parked will be double-trailer 'interlink' type, 22 m long. There will be space for 28 trucks to be parked in the queuing road and 50 trucks in the main parking area. The trucks will access the plant from the truck park by crossing the Marikana road (D1325) public road at a 4-way stop to be constructed at the plant truck entrance. Ten trucks will travel from the truck parking area to the plant per hour.

2.5.5.2 Change to the location and height of the topsoil berms

The approved eastern topsoil berm walls have been shifted towards the concentrator plant which is currently under construction. Tharisa also propose to increase the height of the berm walls from 10 m to 30 m. The related purpose is to minimise negative visual and noise impacts.

2.5.5.3 Proposed construction of one topsoil facility on the western side of the mine

It is proposed that an additional topsoil storage facility will be developed on the western side of the mine. This facility will be 30m high, volume of 5, 047,770m3 and cover an area of approximately123, 417m2.

2.6 Environmental noise assessment criteria

2.6.1 South African noise regulations

In 1994, with the devolution of regulatory power from governmental to provincial level, the authority to promulgate noise regulations was ceded to provinces. Each province could henceforth decide whether to develop their own regulations, or to adopt and adapt existing regulations. As yet, however, only three provinces (Gauteng, Free State and Western Cape) have promulgated such regulations. Elsewhere, including North West Province, no provincial noise regulations have been put in place.

Consequently, in noise studies undertaken in provinces lacking official noise regulations, specialists usually consider the old national noise regulations to apply by default. For further guidance, it is noted that noise criteria in all previous national and current provincial regulations, as well as current metropolitan noise policies, are all derived from SANS 10103. SANS 10103 defines the relevant acoustic parameters that should be measured, gives guidelines with respect to acceptable levels and assessment criteria and specifies test methods and equipment requirements. In this noise monitoring survey, the provisions of the old national noise regulations [2] are taken into account, but noise assessment is based by and large on the principles, guidelines and criteria of SANS 10103.

2.6.2 Prohibitions

Prohibition of disturbing noise

Noise regulations prohibit any changes to existing facilities, or uses of land, or buildings or the erection of new buildings, if it will house activities that will cause a disturbing noise, unless precautionary measures to prevent disturbing noises have been taken to the satisfaction of the local authority. Noise is deemed to be disturbing, if it exceeds certain limits. Depending on what data is available, SANS 10103 allows for different formulations of the excess.

- **If the real residual ambient level is known:** The excess is taken to be the difference between the noise under investigation and the residual noise measured in the absence of the specific noise under investigation. This definition finds application in both predictive and noise monitoring assessments, if baseline noise data is available.

- **If the real residual ambient level is unknown:** Alternatively, the excess may also be defined as the difference between the ambient noise under investigation and the acceptable ambient rating for the type of district under consideration in accordance with SANS 10103. This means that a nominal table value is used as reference. This definition is employed in predictive noise studies and in noise monitoring assessments, when no baseline is data available or if the noise source cannot be switched off for purposes of measuring the residual background level.

In terms of the old national noise regulations, a disturbing noise means a noise that causes the ambient sound level to increase by 7 dB or more above the designated zone level, or if no zone level has been designated, the ambient sound level measured at the same point. Noise regulations also require that the measurement and assessment of ambient noise comply with the guidelines of SANS 10103.

It should be cautioned, however, that the legal limit of 7 dB should not be construed as the upper limit of acceptability. SANS 10103 (See Table 2.4 in this report) warns that an increase of 5 dB is already significant and that an increase of 7 dB can be expected to evoke widespread complaints from the community. Hence, although the applicant would be within legal limits if the noise impact is prevented from exceeding 7 dB, that would not prevent noise disturbance and noise complaints. In the EIA phase, i.e. in the design and planning stage of a new development, it is advised the design target be set at 3 dB, while 5 dB is considered a significant impact. The margin so provided is required as a matter of good planning and to maintain good relations with neighbors. It also brings the assessment in line with World Bank guidelines. Once in operation, an appropriate limit in EMP noise monitoring of the actual levels would be an excess of 5 dB, which is still 2 dB below the legal limit.

Prohibition of a noise nuisance

Noise regulations also prohibit the creation of a noise nuisance, defined as any sound which disturbs, or impairs the convenience or peace of any person. The intent of this clause is to make provision for the control of types of noise not satisfactorily covered by measurement and assessment criteria applicable to disturbing noises. These are noises which are either difficult to capture[2], or noises for which the readings registered on a sound level meter do not correlate satisfactorily with the annoyance it causes, when assessed against standard criteria. Noise regulations list specific activities which are prohibited if exercised in a manner to cause a noise nuisance, such as[3]:

- The playing of musical instruments and amplified music;
- Allowing an animal to cause a noise nuisance.
- Discharging fireworks;
- Discharge of explosive devices, firearms or similar devices which emit impulsive sound, except with the prior consent in writing of the local authority concerned and subject to conditions as the local authority may deem necessary;
- Load, unload, open, shut or in any other way handle a crate, box, container, building material, rubbish container or any other article, or allow it to be loaded, unloaded, opened, shut or handled, (if this may cause a noise nuisance).
- Drive a vehicle on a public road in such a manner that it may cause a noise nuisance.
- Use any power tool or power equipment used for construction work, drilling or demolition work in or near a residential area, (if this may cause a noise nuisance).

And:

- Except in an emergency, emit a sound, or allow a sound to be emitted, by means of a bell, carillon, siren, hooter, static alarm, whistle, loudspeaker or similar device (if it may cause a noise nuisance).

One or more of these activities may occur on industrial sites and in mining operations. A common cause of noise nuisance are reverse hooters, the last item listed above.

2 *For example, barking dogs. Not only is the occurrence unpredictable and erratic, but the presence of a person investigating the problem with a noise meter is likely to attract attention and falsely trigger incessant barking.*

3 *See Noise Regulations for the full list of prohibited activities.*

The essential difference between a disturbing noise and a noise nuisance is as follows:

Noise disturbance – Is quantifiable and its assessment is based on estimated or measured sound levels, expressed in decibel (dBA). Investigation and assessment of existing noise disturbance problems involve the measurement of ambient levels in the presence a specific source under investigation and comparison of this level with either the level measured in the absence of the source, or a table value deemed to be an acceptable level for the type of district under consideration.

Noise nuisance – Is difficult to quantify and is not confirmed or assessed by measurement. Judging whether a noise qualifies as a nuisance is based purely on its character and audibility, in conjunction with subjective considerations such as the perceived intent of the noise maker and connotations attributable to the source of noise. Where measurement is possible, measured data may serve as supplementary information.

SANS 10103

As mentioned before, noise regulations require that the measurement and assessment of noise comply with the guidelines of in SANS 10103. The concept of noise nuisance, however, only features in the regulations. SANS 10103 only deals with quantifiable noise (noise disturbance), without any guidelines for, or reference to noise nuisance whatsoever.

It is normally expected of an EIA noise study to make findings based on noise modelling and quantitative assessment of predicted noise levels, i.e. based on noise disturbance considerations. The same applies to noise monitoring conducted in terms of an EMP, where the report is expected to make findings based on concrete measured data, assessed in terms of noise disturbance criteria as well. But once an industrial site or mine starts operating, predictable as well as unexpected sources of noise nuisance may emerge. If present, they often constitute a major cause of complaints. It is therefore imperative that, in addition to quantitative predictions and measurements, noise studies also identify potential sources and monitoring surveys actual sources of noise nuisance.

2.6.3 SANS 10103 - Acceptable ambient levels

Noise regulations require that the rating level of the ambient noise be compared with the rating level of the residual noise (where this can be measured), or alternatively (where the noise source cannot be switched off or interrupted), with the appropriate rating level given in Table 2 of SANS 10103. Neither the noise regulations, nor SANS 10103 define or refer to the term noise impact. It is however generally understood and defined for purposes of this study, as the amount in dB by which the total noise level exceeds the nominal or the measured ambient level rating, whichever is applicable, for the area under consideration.

Table 2.3 in this report summarises SANS 10103 criteria for acceptable ambient levels in various districts. Note that ratings increase in steps of 5 dB from one to the next higher category and that in general, regardless of the type of district, ambient noise levels tend to decline by typically 10 dB from daytime to night-time. It follows that, for the same level of intrusive noise, the noise impact would typically increase by 10 dB from daytime to night-time.

Table 2.3

Typical outdoor ambient noise levels in various districts (SANS 10103)

Type of district	Day-Night	Day-time	Night-time
(a) Rural	45	45	35
(b) Suburban – With little road traffic	50	50	40
(c) Urban	55	55	45
(d) Urban - With some workshops, business premises & main roads	60	60	50
(e) Central business districts	65	65	55
(f) Industrial districts	70	70	60

A 24 hour cycle is divided into the following periods:

Day-time (06:00 – 22:00)

Night-time (22:00 – 06:00)

Day-Night (24-hour day-night period)

The day-night level L_{dn} represents a 24-hour average of the ambient noise level, with a weighting of +10 dB applied to night-time levels, yielding approximately equal values for daytime and day-night levels.

SANS 10103 also gives guidelines in respect of expected community response to different levels of noise impact (increase in noise level), as summarized in Table 2.4.

Table 2.4

Expected community response to an increase in ambient noise level
(SANS 10103)

Increase in ambient level [dB]	Expected community reaction
0 - 10	Sporadic complaints
5 - 15	Widespread complaints
10 - 20	Threats of community action
More than 15	Vigorous community action

3 Results and findings – Existing conditions

3.1 Ambient noise prior to proposed amendment changes

Perspective

The results of the surveys conducted in this noise study serve as a sample of existing ambient noise conditions in the external surroundings of Tharisa Mine, with the mine operating in its current state of completion. It should be cautioned that these are not the same conditions that would prevail once all EIA-approved project components have been constructed (see discussion in Section 4.1).

3.2 Present state of the environment – Findings of the current survey

General

Tharisa Mine is located in a district where the character of ambient noise is already affected by industrialisation and economic activity, which over time, has resulted in an increase in road traffic noise and noise generated by intensive mining activities. Road traffic noise emanates from the N4 and secondary roads, such as the D1325 between Buffelspoort and Marikana. The N4 has a wide noise footprint. It has a significant impact on people living within a zone of approximately 1,2 km either side of the road and is clearly audible in most of the study area. In addition, mining activity noise affects communities in the immediate surroundings of mines.

The area surrounding Tharisa Mine cannot be considered a typical rural environment any more. In terms of SANS 10103 guidelines (See Table 2.3) it falls in the category between Rural and Urban Districts, described as “Suburban – With little road traffic”. As such, one would expect typical ambient levels in most of the area to be in the order of 50 dBA (daytime) and 40 dBA night-time, respectively. The results of the noise surveys conducted in this study serve to verify the current status and to establish the extent to which ambient levels are currently affected by abovementioned activities.

Conditions at M1 (Representative of immediate surroundings of Tharisa West Pit operations)

Monitoring station M1 was located at a house on a property (Residence H Potgieter) close to Tharisa West Pit opencast operations. Noise levels at this location should not be interpreted as indicative of the mine’s impact on any specific noise-sensitive recipients in the area. The property where the noise was recorded is earmarked for acquisition by the mine and is located in close proximity, less than 400 m away from opencast mining operations currently taking place at Tharisa West Pit. Noise levels recorded at this location provide useful data for verification of predictions made by noise modeling in this study. Average daytime and night-time levels recorded at M1 were:

Daytime average 57 dBA

Night-time average 52 dBA

Mining noise elevates the night-time ambient level by about 12 dB above the characteristic level of 40 dBA in this district. The main sources of audible noise that could be discerned from recordings made during the night were:

- Diesel engine noise of trucks and bulldozers

- Occasional reverse alarm noise
- Occasional livestock noises (pigs and poultry, cocks crowing) and barking on farmhouse premises
- Traffic noise from the N4 approximately 2,3 km away was barely audible above local mining activity noise.

Conditions at M2 (Representative of conditions in proximity of the Spruitfontein school)

Monitoring station M2 was located at a house on property bordering the Spruitfontein School premises. Based on the levels recorded during the course of this survey, current ambient noise levels near the Spruitfontein School are still in line with typical background levels expected in a district of this nature. In Survey 1, with Tharisa Plant and East Mine opencast operations running, daytime and night-time levels recorded at M2 were:

Daytime average 47 dBA

Night-time average 40 dBA

These levels are to be expected in an area interspersed with mining activities and main roads. Since Tharisa Mine is currently restricting operations at West Mine to daytime hours, the mine does not have a significant influence on night-time ambient levels in this area. Noise levels measured in Survey 2 during the Tharisa plant shutdown were in fact 3 dB higher than the levels measured in Survey 1 with the plant running. Considering that the two surveys were conducted on different nights, this difference is ascribed to the inherent variance and fluctuating nature of ambient noise in general.

The main sources of audible noise that could be discerned from recordings made during the night were:

- Distant truck movements and diesel engine noise
- Livestock and barking noises
- Traffic noise from the N4 approximately 1,4 km away was barely audible above general mining and local noises.

Conditions at M3 (Representative of conditions at nearest houses south of the plant)

Monitoring station M3 was located on the premises of a smallholding (Residence M Potgieter) situated about 900 m south-west of the Tharisa Plant and 200 m north of the N4. The D1325 provincial road passes at a distance of 150 m to the west.

Despite the relatively short distance to the plant, Tharisa Plant noise was barely audible at this location. The reason is two-fold:

(a) Due to its proximity to the N4, this area is exposed to very high levels of traffic noise dominating and largely masking all other sources of noise.

(b) Tharisa Plant noise levels reaching this location are reduced quite substantially by the topsoil dumps acting (as intended) as noise screens. The positioning of the dumps relative to both the plant and the smallholdings result in effective noise screening at this location (The closer a noise screen is positioned to either the source or the receiver, the higher the degree of noise reduction achieved).

Despite the screening of plant noise by the berm, Tharisa Mine does still affects ambient noise conditions in this area by its contribution to (truck) traffic noise on the D1325. Average daytime and night-time levels recorded at M3 in Survey 1 with the plant running were:

Daytime average 56 dBA

Night-time average 53 dBA

With the plant shut down, levels measured during daytime in Survey 2 were identical to those measured with the plant running in Survey 1. Night-time levels were 3 dB lower during shutdown. This seems to indicate that the Tharisa plant is elevating the night-time ambient level by an insignificant 3 dB, which is within the natural variance in ambient levels in general.

N4 traffic noise in conjunction with trucks on the D1325 elevates the night-time ambient level by about 13 dB above the characteristic level of 40 dBA otherwise expected for the larger part of this district. The main sources of audible noise that could be discerned from recordings made during the night were:

- N4 traffic noise was the dominating source of noise throughout the night.
- Truck noise on the D1325.
- Plant and opencast mining noises were barely noticeable in the background
- Occasional livestock noises and barking

Conditions at M4 (Representative of conditions in the area south of the N4)

Monitoring station M4 was located at a farmhouse (Residence D Potgieter) situated about 1,5 km south-east of Tharisa Plant and 250 m south of the N4. Due to construction activities which were taking place throughout the night at and around the tailings facilities, diesel engine noise of trucks and what sounded like dozers, predominated and masked N4 traffic noise. Traffic noise was seldom audible above continuous bulldozer engine and dozing noise on the night-time audio recordings made at this location.

Average daytime and night-time levels recorded at M4 were:

Daytime average 58 dBA

Night-time average 53 dBA

Under these conditions traffic noise from the N4 and mining-related activities collectively elevate the background night-time ambient level by about 13 dB above the characteristic level of 40 dBA.

Conditions at M5 (Representative of conditions in Silver Town village)

Monitoring station M5 was located on the premises of a church near the southern boundary of Silver Town village where noise from Tharisa Plant and East Mine operations are expected to have maximum impact. The D1325 provincial road passes at a distance of 50 m to the west. The dominant contribution to ambient noise in this area comes from trucks and other traffic on the D1325. Thereafter, at a lower level, is noise from West Mine opencast operations. Plant noise is not expected to contribute significantly to the ambient level in this area. As a preventative control measure to minimise noise disturbance to residents in this area, Tharisa Mine is restricting dump and haul road activities around West Mine to daytime hours.

During plant shutdown but with opencast operations in progress, average ambient levels recorded at M5 in Survey 2 were:

Daytime average 52 dBA

Night-time average 42 dBA

Except for the plant that was not running, these levels are representative of conditions with the mine operating in its current state of completion. The results confirm that ambient noise in Silver Town village are still at acceptable levels, well in line with levels (50 dBA daytime, 40 dBA night-time) expected in small villages in terms of SANS 10103 guidelines (Suburban Districts with little road traffic – see Table 2.3).

Conditions at M6 (Plant noise reference point)

Monitoring station M6 was located 500 m south of the plant, 100 m north of the berm. This location was selected, not to monitor ambient levels at any noise-sensitive receptors, but as a reference point for monitoring plant noise levels and for calibration of the predictive noise model. The plant unfortunately did not start up during Survey 2 as planned. Notwithstanding, the data obtained is useful as it serves as a sample of background ambient levels near the D1325 road, but screened off by the berm from traffic noise on the N4. The difference between the level at this location (exposed predominantly to D1325 traffic noise) and the level measured at M3 (exposed to both N4 and D1325 traffic noise) gives an indication of the influence of N4 traffic noise on ambient levels in that area.

During Tharisa plant shutdown, average ambient levels recorded at M6 and at M3 in Survey 2 were as follows:

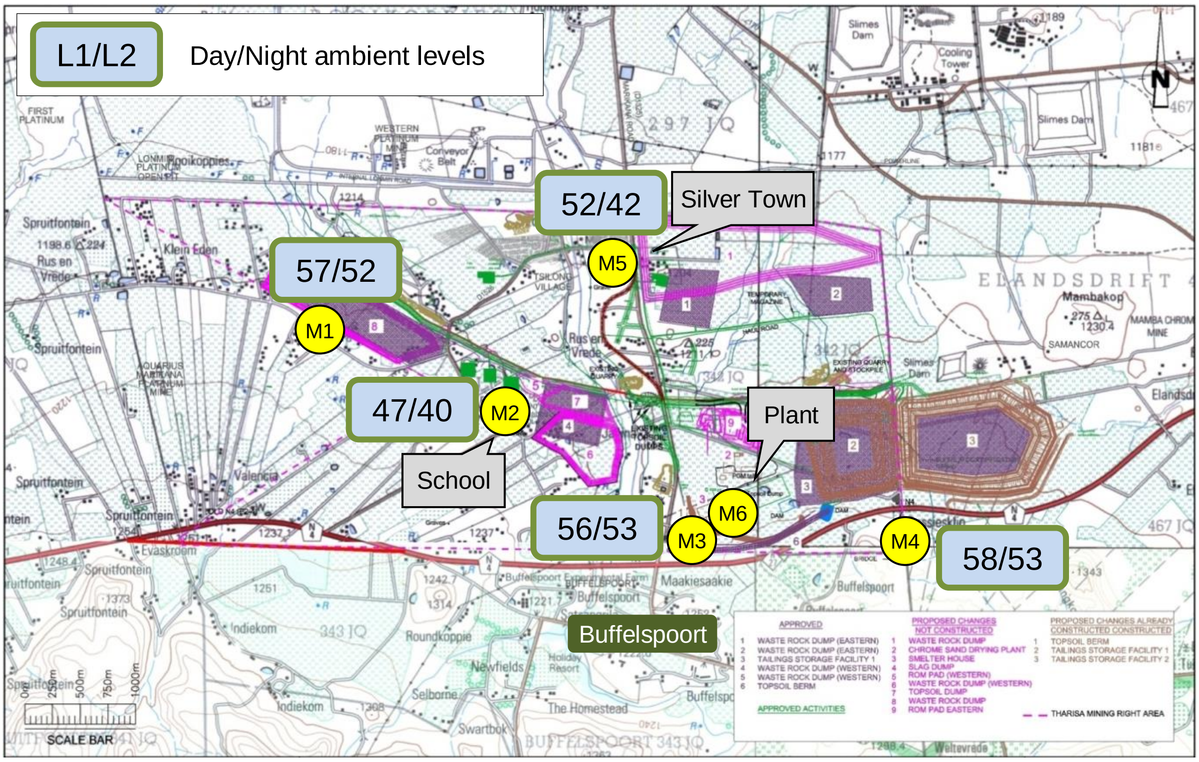
Daytime average at M6 north of the berm (Predominantly D1325 traffic noise):	52 dBA
Daytime average at M3 south of the berm (D1325 + N4 traffic noise):	56 dBA
Difference in level north and south of the berm	4 dBA

Night-time average at M6 north of the berm (Predominantly D1325 traffic noise):	46 dBA
Night-time average at M3 south of the berm (D1325 + N4 traffic noise):	53 dBA
Difference in level north and south of the berm	7 dBA

These results should be interpreted with caution, bearing in mind that there are variables other than the berm at play. For example, M3 is about 400 m closer than M6 to the N4. All the relevant factors are however taken into account in using these results in the noise model.

Summary

The surveys confirm that the ambient climate in the larger surroundings of Tharisa mine are as expected in a district interspersed with mining activities and main roads. It also shows that noise from Tharisa mining activities in particular have a significant impact in certain areas south of the mine. Due to the operational schedules currently implemented by Tharisa in terms of which noisy activities around West Mine are restricted to daytime hours, the impacts on Silver Town village and the school surroundings are contained to acceptable levels. The results of the survey are summarised on the map in Figure 3.1. Daytime and night-time periods are as defined in SANS 10103 (See Section 2.6.3). Detailed results of the recordings made in 10-minute intervals at all monitoring locations are presented in Appendix A.



Point	Location	Represented area
M1	S25 43 49.2 E27 27 40.7	West pit immediate surroundings
M2	S25 44 18.6 E27 28 39.7	Spruitfontein school surroundings
M3	S25 45 00.7 E27 29 35.2	Plant surroundings - Nearest residence
M4	S25 44 56.8 E27 30 45.7	Area east and south-east of mine
M5	S25 43.717 E27 29.314	Silver Town village boundary nearest to the mine
M6	S25 44.863 E27 29.797	500 m south of plant, 100 north of berm

Figure 3.1

Existing ambient noise levels in the area surrounding Tharisa Mine

4 Results and findings – Predictive noise study

4.1 Perspective

Since the subject of this noise study is the proposed EIA Amendment, the objective in the first instance is to assess the noise consequences of changes implemented in terms of the amendment. The study therefore sets out to quantify and assess the expected increase in ambient noise levels (i.e. the impact) resulting from the amendment, relative to noise levels produced by Tharisa EIA-approved operations (the reference condition).

What complicates the matter is that the reference condition referred to above does not exist and cannot be measured at this stage. This is because (a) some of the EIA-approved components are still under construction and (b) some of the proposed amendment components have already been partially or fully constructed. This means the mine will never be in the above-mentioned reference state of operation (after full implementation of EIA-approved operations, yet before implementation of any EIA-Amendment changes). Although essential for assessing existing conditions, ambient noise levels determined from the surveys conducted in this noise study represent the state of the environment with the mine operating in an intermediate hybrid, rather than post-EIA or pre-EIA Amendment states.

Against this background, best estimates of EIA-approved as well as EIA Amendment impacts were obtained by means of noise modelling, with the model calibrated against actual levels measured with the mine operating in the present hybrid state of completion, as well as levels measured at reference points during plant shutdown.

4.2 Noise impact – Construction phase

Construction of the new tailings facilities (already in process) generates the following types of noises:

- Continuous diesel engine noise from trucks and dozers
- Dumping and earth-moving activity noises
- Reverse alarm noise

This particular construction activity is currently causing a significant impact on residents in the immediate vicinity of the tailings facilities. In the area south of the N4 it stood out above N4 traffic noise and was responsible for the high night-time levels (53 dBA) measured at noise monitoring location M4 (Figure 3.1). This however is a temporary state which will come to an end once TSF construction is complete. After that, the night-time ambient noise level in this area will drop to an estimated 47 dBA, the average night-time level produced by N4 traffic. This is still 7 dB above the residual level in the larger surroundings away from main roads, but the contribution of Tharisa mining noise in the proximity of the TSFs will be negligible.

Otherwise, construction activities ensuing from the proposed EIA amendment changes are not expected to produce noise that will be audible above Tharisa Mine’s operational noise.

4.3 Noise impact – Operational phase

4.3.1 Worst-case assumptions

Depending on the time of day or night and on meteorological conditions in particular, noise levels produced by industrial sources over long distances vary by a considerable margin. Noise contours were derived from calculations intended to investigate probable worst-case conditions (Night-time levels and Concawe model Meteorological Category 6). On average, typical levels are expected to be lower. “Probable worst-case” in the context of this study refers to levels that are higher than typical levels. Although less probable than typical levels, they are expected to occur from time to time during the course of the year, sometimes possibly for several days on end. Occurrence of worst-case conditions is not simplistically related to weather conditions and not limited to any particular season of the year.

It should be cautioned that predicted noise levels and contours are not to be taken as absolute. Noise maps must be interpreted with caution. Predicted levels are valid for the assumptions made in respect of meteorological and other conditions. Since meteorological conditions in particular are highly variable, levels produced at a distance by a source at a constant acoustic output will vary considerably, even during the course of a single day-time or night-time period. Variance in noise level due to changes in atmospheric conditions increases with distance from the source. It should also be borne in mind that noise propagation is not only affected by distance and wind, but by temperature gradients in the atmosphere as well. The contours represent best estimates of continuous project activity noise levels averaged over a relatively long duration, in this case the nominal night-time period of 8 hours.

4.3.2 Presentation of results

The unmitigated operational noise footprints of the Tharisa operations are presented with the aid of noise contour maps. Noise contours delineate the 3 dB and 5 dB noise impact footprints of the project calculated for night-time conditions. These footprints delineate the distances at which the relevant components of mining noise elevate the ambient level by 3 dB (insignificant impact; recommended upper limit) and 5 dB (significant impact), respectively.

If the specific level of mining noise at an observation point rises to the point where it equals the background level, the ambient level will rise by 3 dB above its initial level. This represents a noise impact of 3 dB, which is still acceptable in terms of noise regulations and SANS 10103 criteria. A significant impact is deemed to occur (See SANS 10103 criteria in Table 2.4) if the ambient level is exceeded by 5 dB or more.

4.3.3 Findings - Unmitigated operational noise

In order to make it as clear as possible, the results of the noise study are presented by means of three noise maps in logical order as follows:

Noise Map 4.1 – Impact of EIA-approved operations

This map shows the estimated unmitigated impact footprint of Tharisa Mine in the EIA-approved state of operation. It is assumed that all EIA-approved components are constructed and operational, prior to implementation of any of the proposed EIA Amendment changes. Topsoil berm height is assumed to be 10 m with all gaps closed and with the berm wide enough to break the line-of-sight between the plant and the residences south of the N4. As explained in Section 4.1, this a hypothetical state simulated by means of noise modeling. The impact here is defined as the increase in level caused by the mine relative to the background ambient level (the reference level). The reference level in this case is the net result of natural sounds, domestic and farming activity, of mining activity (other than Tharisa) and of traffic noise on the general road network, the N4 in particular. Using N4 traffic flow data from traffic studies conducted by traffic specialists in other projects and N4 traffic noise measurements previously conducted by Acusolv, a good estimate of the N4 noise footprint could be obtained by means of the noise model developed for the Tharisa noise study. The validity of the traffic noise model could be verified with data obtained in the latest ambient surveys. The model also accounts for traffic noise from the D1325. In most of the study area traffic on the N4 is one of the main sources of noise.

Noise Map 4.2 – Impact of EIA-approved operations plus EIA Amendment changes

Noise Map 4.2 shows the estimated noise impact footprint of Tharisa Mine in the future state assuming all EIA-approved components are in operation and that all EIA-approved changes have been implemented. This is the unmitigated impact for a 24 hour operation: it does not take any time management control measures, such as restriction of operations to daytime hours, into account. The reference condition is the same as in the previous case. The map shows the extent to which Tharisa Mine is expected to change the environment after implementation of the proposed EIA amendment changes.

Noise Map 4.3 – Incremental impact of EIA Amendment changes

Noise Map 4.3 shows the estimated incremental impact of the proposed EIA Amendment changes, relative to the EIA-approved state of operation.

Inspection of the three noise maps lead to the following conclusions:

A Impact of Tharisa EIA-approved operations

- Due to the physical extent of EIA-approved operations Tharisa Mine has a large noise footprint. The significant impact denoted by the 5 dB contour on Noise Map 4.1 extends over an area of roughly 4 km (north-south) by 8 km (east-west). The most important parts of the footprint however, are those areas where it overlaps the Tharisa mining rights boundary. The overlap comprises a complex pattern which can only be assessed by inspection of the maps. Note that the footprint in a southerly direction from the mine is pinched off by the effect of N4 traffic noise. In the proximity of the N4 where traffic noise predominates, the increase caused by mining noise is negligible. For most of the time, Tharisa mining noise cannot be heard above traffic noise.

  Another factor which helps to reduce the footprint to the south of the mine is the screening of plant noise by the topsoil berm constructed south of the mine. It should be noted that it was assumed in the calculations that the current gaps in the berm have been closed and that the berm is wide enough, as a minimum, to break the line-of-sight between the plant and residences south of the N4. Also note that the noise reduction achieved with a berm (or with any noise screen) declines with distance (it becomes less effective).

- The maximum advantage of the berm's screening effect in this case occurs at M3 (Residence M Potgieter) 500 m south-west of the plant. Despite its proximity to the plant, the screening provided by the berm as well as the high levels of traffic noise from the N4 and D1325 results in a negligible incremental impact by the mine (the mine cannot be heard above the other background noises).

- A significant impact is expected on Lapologong Village bordering on the mining rights boundary.

- The map shows that, although not significant in impact, mining noise can be expected to be audible at houses such as the Geldenhuys residence in an area south of the N4 (3 dB contour). Because of variances in atmospheric conditions, however, this noise will at times grow louder and be experienced as disturbing during night-time. Also bear in mind that the prediction was made for a continuous 10 m high berm of sufficient length.

- As already explained, the high noise levels measured at the Potgieter residence south of the N4 (Figure 3.1) were as a result of temporary TSF construction activities. As predicted, the noise maps show that once TSF construction is completed and the TSFs are operational, the incremental impact of the mine should be negligible in this area.

- Inside the Tharisa mining rights boundary, the Spruitfontein School and the relocated residential area to the north (Silver Town) fall inside the 5 dB night-time impact footprint. As already mentioned, the noise maps were calculated for 24-hour operation of all mining components. Restriction of mining activities at and around West Mine would significantly reduce the impact on residences located in the area west of the D1325.

- The impact on the Spruitfontein School should not be assessed by means of the noise contour maps. The contours were calculated for night-time conditions, as applicable to residential areas, whereas the school operates during daytime, with much higher levels of acceptable background noise. The acceptable daytime background reference for the school would be 55 dBA as in Urban Residential areas, 15 dB higher than the night-time reference rating used in the assessment of night-time residential noise in this study. The noise impact of Tharisa Mine on the school (calculated separately) turns out to be only 2 dB, which is negligible.

- Night-time conditions are of course relevant in respect of residences at and near the school. The noise maps were calculated for the worst case where all EIA-approved components are operational. Should the mine adhere to the practice of restricting operations in the West Mine surroundings to daytime hours, the night-time ambient level will be in the order of 39 to 43 dBA, as measured in the current surveys. Under such conditions the noise impact would be negligible.

B Impact of EIA-approved plus amendment changes

- Examination of Noise Maps 4.1 and 4.2 reveals that there is virtually no difference in the noise footprints before and after implementation of the proposed amendment changes. The small effect of the changes is further illustrated by the incremental noise footprint shown on Noise Map 4.3.

- It is clear that the changes made in terms of the proposed EIA Amendment, including the addition of the Chrome Sand Drying Plant, will not change the noise footprint of the mine and will not result in a noticeable increase of the noise impact on noise-sensitive receptors in the study area. The incremental impact of the EIA Amendment changes will be negligible. In fact, the impact will be even smaller if the height of the topsoil berm is increased to 30 m as proposed and if operations at and around West Mine are restricted to daytime hours.

It must be noted that the estimated noise footprints are based on averages, 8-hour night-time average levels in particular. In reality, with ever-changing atmospheric conditions, especially during quiet traffic intervals at night, the mine will at times be clearly audible in areas outside the estimated noise footprints as shown on the maps.

A summary of the noise implications for some specific locations is given in Table 4.1. It shows the estimated impact of the mine (increase in night-time ambient levels) before and after implementation of the proposed EIA amendment changes. Levels are rounded off to the nearest integer dB value. The table confirms that, with all EIA-approved operations completed, the mine will have a significant impact on the relocated residents north of the mine and on Lapologong Village. The locations listed in the table are examples of locations known to the specialist. It does not take into account any negotiations that may be taking place between property owners and the mine. The noise maps need to be examined carefully to identify other noise-sensitive receptors in areas that fall inside the significant noise impact footprints. The table also shows that implementation of the proposed EIA amendments is not expected to result in any discernible incremental changes in the noise impact.

Table 4.1

Noise implications of Tharisa EIA operations and amendment changes
Examples of increase in ambient level expected at specific locations
Rounded to nearest dB integer value

Location	**Tharisa noise impact**	
	Before amendment changes	After amendment changes
Relocated houses	8	8
Lapologong Village	16	16
Residence Geldenhuys	3	3
Residence Potgieter M	3	3
Residence Potgieter D	2	2
Spruitfontein School (Daytime)	2	3

The character of audible or disturbing noise will vary, depending on the location of the receptor relative to the various mining components and activities. Without time restriction control measures, the dominant source of audible noise in the Silver Town residential area, as well as Lapologong Village and the entire area around West Mine and the area to the north of the mine, will be diesel engine, dumping and scraping noises coming from the various waste rock dumps. In most of these areas truck movement on the haul road will also be audible. Except for periods when operations are taking place at surface level, pit operations will be screened off by the pit walls and will not be heard above aforementioned sources of noise.

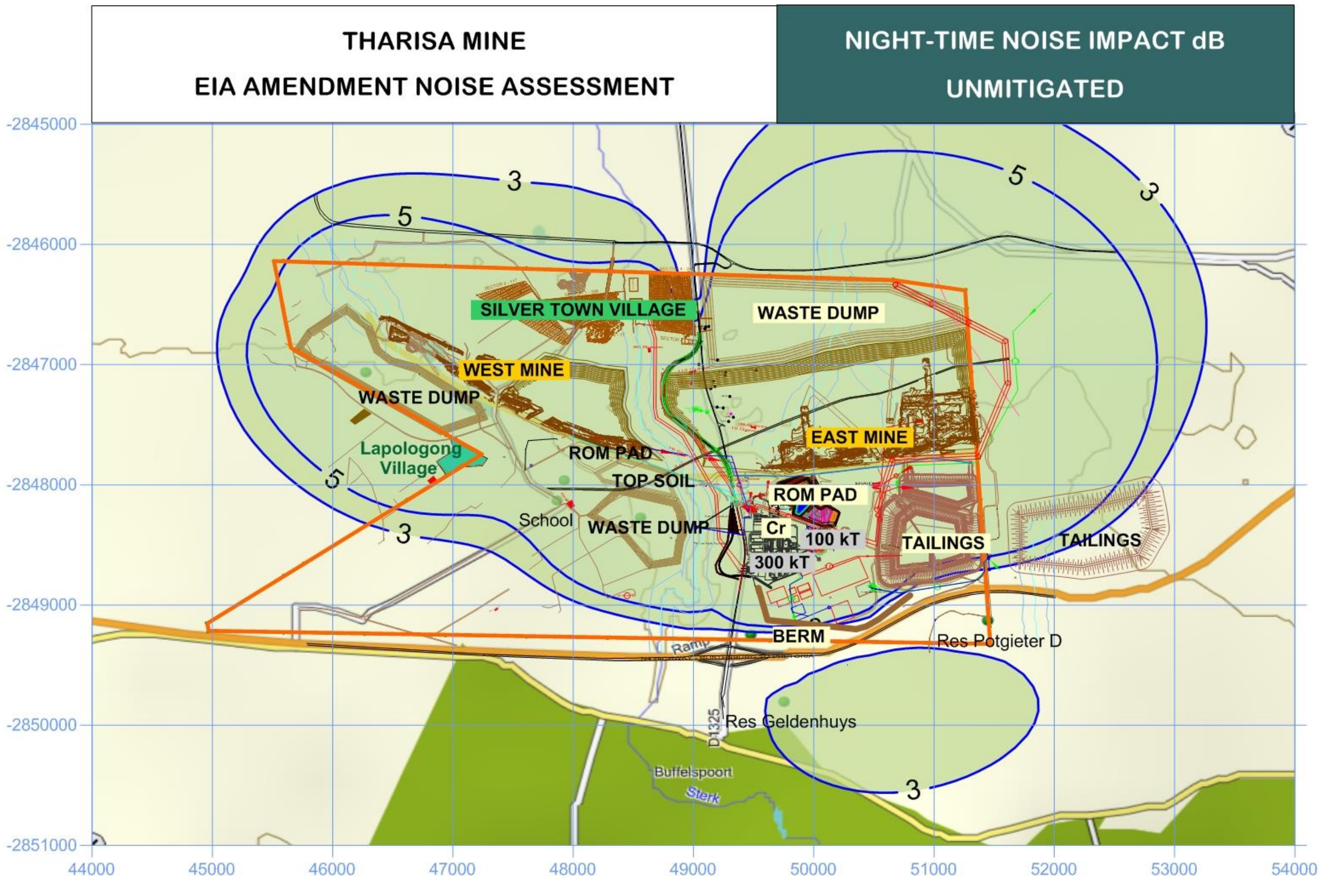
In the area south of the mine, N4 traffic noise will normally dominate and mask noise from the mine. On occasions when mining noise is amplified by unfavourable atmospheric conditions mining noise may grow louder and emerge above traffic noise during quiet periods at night. Under such conditions the plant is expected to constitute the dominant source of audible noise with the crushers and mills being the most noticeable. Note that the tailings facilities, despite their large footprints, constitute negligible sources of noise. The TSF motor-pump units will not be audible anywhere in the external surroundings.

Sirens, reverse alarms and truck hooters are often the cause of noise nuisance experienced by residents in the external surroundings of a mine. The most common occurrence is as a result of waste rock dump operations. The nuisance impact is ascribed to the musical tone characteristics of sirens and reverse alarms. A musical tone, also referred to as pure-tone noise, becomes audible to the human ear even before it starts raising the overall ambient level. It can be clearly audible and annoying, without a noticeable effect in the dBA reading registered on a sound level meter. It is for this reason that noise regulations distinguish between disturbing noises which are quantifiable by measurement and a noise nuisance, which is confirmed without measurement, if reported to disturb, or impair the convenience or peace of any person.

4.4 Noise impact – Decommissioning and closure phases

The contribution of amendment components to the total noise during decommissioning and closure will be negligible.

Noise Maps



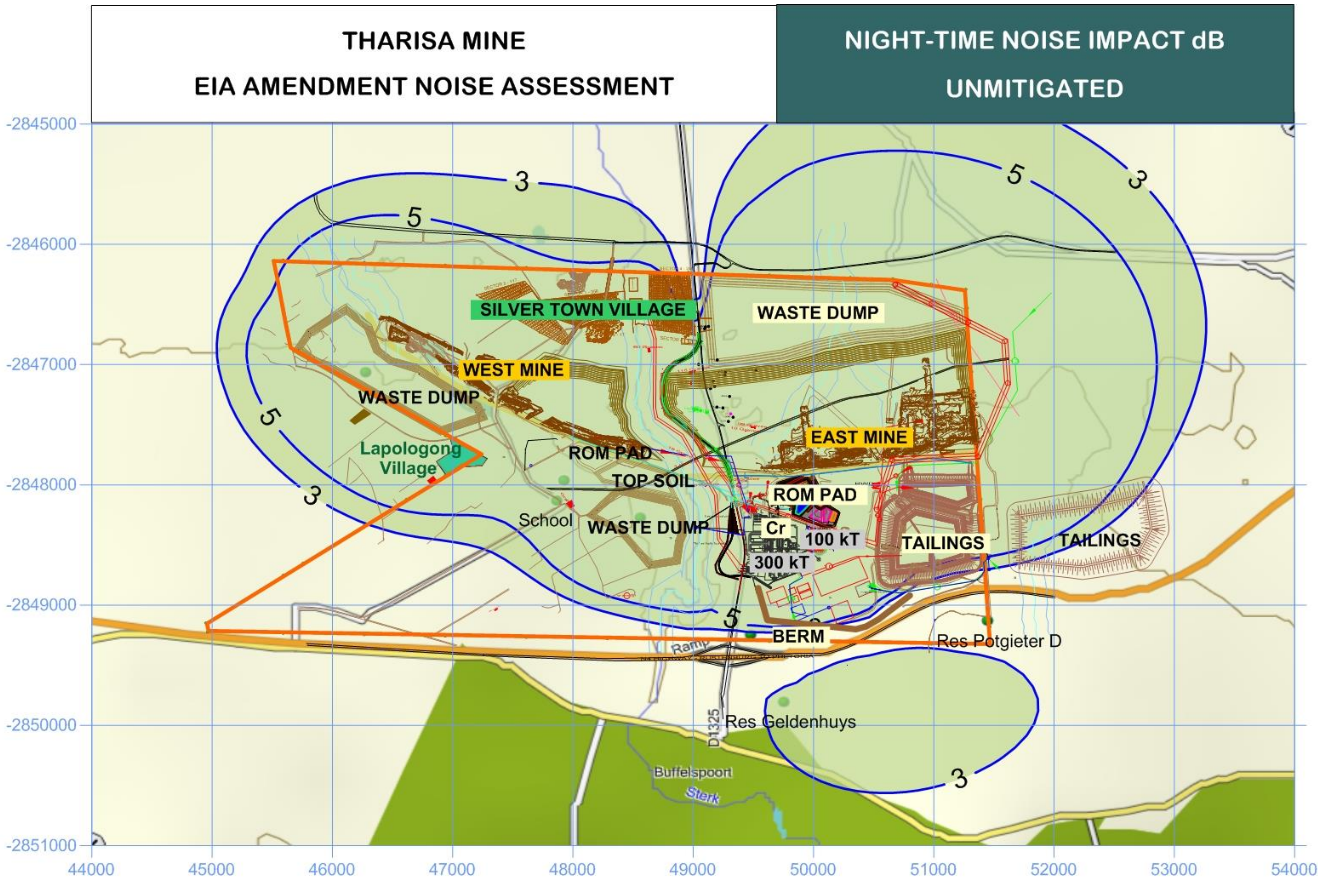
Noise Map 4.1

Tharisa mining noise

Impact of EIA-Approved operations
Prior to implementation of any proposed EIA Amendment changes
Berm height = 10 m

Estimated increase in night-time ambient level dB

Significant impact occurs inside the 5 dB contour
Impact insignificant outside the 3 dB contour



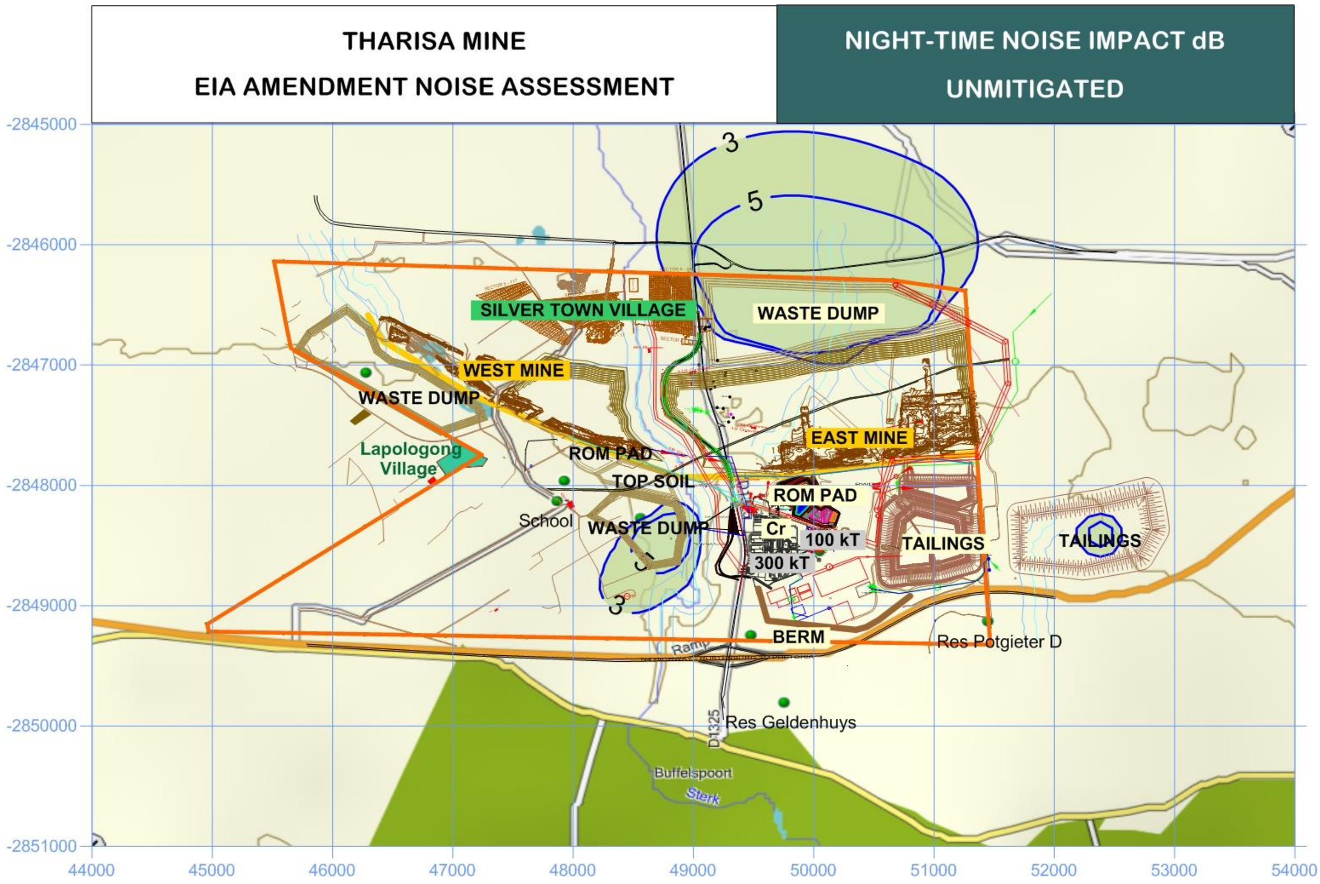
Noise Map 4.2

Tharisa mining noise

Impact of EIA-Approved operations plus proposed Amendment changes
Berm height = 10 m

Estimated increase in night-time ambient level dB

Significant impact occurs inside the 5 dB contour
Impact insignificant outside the 3 dB contour



Noise Map 4.3

Tharisa mining noise

Incremental impact of proposed EIA Amendment changes
Berm height = 12 m

Estimated increase in night-time ambient level dB

Significant impact occurs inside the 5 dB contour
Impact insignificant outside the 3 dB contour

5 Mitigation

5.1 TSF Construction noise

Night-time TSF construction activities are currently causing a noise disturbance at the nearest houses south of the N4. Although this is a temporary problem, it should be considered to restrict these activities to daytime hours (06:00 to 22:00).

5.2 Noise screening by means of berms

Plant noise

The topsoil berm south of the plant already acts as a noise screen providing a degree of noise reduction and protection to residents south of the mine. It will however not be enough to prevent occasional noise disturbance and consequent complaints under certain atmospheric conditions. It is recommended that, in addition to closing the existing gaps in the berm, the height be further increased by at least another 15 m. It should be borne in mind that the berm only commences to act as a noise screen if the height is increased beyond the point where it starts cutting off the line-of-sight between the top of the plant and the noise receptor. Obviously the same requirement applies to the width of the berm: it should be wide enough to ensure that the line-of-sight is also obstructed in the horizontal plane.

The berm is currently located about 600 m south of the plant. It may be too late to change at this stage, but a fact that should be borne in mind, is that for a given height, the efficiency of the berm to act as a noise screen would be greatly enhanced if it was moved closer to the plant.

The snag with a berm is that for the duration its construction, the actual source of noise (trucks and dozers) is positioned right on top of the berm where it is most audible and causes the maximum noise impact in the external surroundings. This is a common problem at opencast mines and lasts for as long as night-time construction of the berm, or dumping on top of the berm for that matter, takes place.

Notwithstanding, bearing in mind that maximum noise impact occurs at night, this measure could still be effective during the construction period if berm construction is restricted to daytime hours. Once the berm (with sufficient height) is in place, the noise impact of the plant and other operations will be reduced quite substantially at locations from where the sources of noise are obscured by the berm.

Haul road noise

The placement of berms to screen off haul road and other noises affecting the relocated community to the north should also be considered. As in the case of the plant, a berm only starts acting as a noise screen if it is high enough as well as wide enough to cut off the line-of-sight between the top of the noise source and the noise receptor.

5.3 Waste dump noise control

A major contributor to the noise impact of the mine in all directions will be the waste dump operations. There are two methods or practices (successfully employed at some other mines) that may be considered by Tharisa Mine for mitigating waste dump activity noise.

Construction of berms with an outer shell

The first is to construct and maintain an outer shell always acting as a noise screen to on-going day and night dumping operations at a lower working level. For this to work, construction (i.e. truck movements, dumping and dozing) of the outer shell must be restricted to daytime hours. Otherwise the noise created by night-time activities on top of the outer shell will defeat the object of the exercise.

Restriction of operating hours

Alternatively, the only other effective option is to restrict all waste dump operations to daytime hours (06:00 to 22:00).

5.4 Sirens, hooters and reverse alarms

This noise study report cannot be prescriptive about specific measures to be implemented in respect of reverse alarms, considering that it may have operational and safety implications.

- The mine is advised to instruct drivers and fleet owners of trucks to use hooters in a disciplined manner for purposes of safety only, not for signalling or any other purpose. The mine should be very strict on enforcing this rule and should verify compliance.
- If not already implemented at Tharisa Mine, it should be considered to replace conventional beeping type reverse alarms (which produce a whistle) with buzzer types (producing a hissing sound) on vehicles operating on waste rock dumps or anywhere on the mine. This measure will only be successful if implemented on all vehicles and if adherence by contractors is strictly enforced and monitored on a continual basis.

Before implementation, the mine should ensure that any modification or replacement will still comply with legal and in-house occupational safety requirements.

5.5 Blasting

One of the most effective ways to reduce blast noise levels, is to adhere to a standard practice of carrying out blasting later in the afternoon, rather than during morning hours. On average, airborne blast levels generated at large distances are considerably lower when blasting takes place in the afternoon, rather than in the morning.

6 Summary of noise impact implications

To the best of the information available and the accuracy of noise prediction methods, the noise impact implications of Tharisa mining operations are as summarised in Table 6.1 (for noise receptors inside the mining rights boundary) and in Table 6.2 (for noise receptors outside the mining rights boundary). The ratings are equally valid for conditions before and after implementation of the proposed amendment changes.

Table 6.1

Noise impact implications of Tharisa mining operations before and after proposed EIA amendment changes
For receptors residing inside Tharisa mining rights boundary and inside the 5 dB impact footprint

Operations & Activities	Before Mitigation						After Mitigation					
	Severity	**Duration**	**Spatial Scale**	**Consequence**	**Probability**	**Significance**	**Severity**	**Duration**	**Spatial Scale**	**Consequence**	**Probability**	**Significance**
Construction phase – Before Mitigation							***Construction phase – After Mitigation***					
Topsoil remove & Dumps Construction	M	L	L	L	M	L	L	L	L	L	L	L
Operational Phase – Before Mitigation							***Operational Phase – After Mitigation***					
Plant Pit works Waste Dumps Haul Road	H Regular disturbance	M For duration of project	M Inside mining rights boundary but onto residential	H High	H Definite	H High	M Occasional disturbance	M For duration of project	M Inside mining rights boundary but onto residential	M Low	M Possible But Occasional	M Medium
Decommissioning Phase – Before Mitigation							***Decommissioning Phase – After Mitigation***					
Dismantling	L	L	L	L	L	L	No mitigation required					
Closure Phase – Before Mitigation							***Closure Phase – After Mitigation***					
No residual noise	L	L	L	L	L	L	No mitigation required					

Table 6.2

Noise impact implications of Tharisa mining operations before and after proposed EIA amendment changes
For receptors outside Tharisa mining rights boundary and inside the 5 dB impact footprint

Operations & Activities	Before Mitigation						After Mitigation					
	Severity	Duration	Spatial Scale	Consequence	Probability	Significance	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Construction phase – Before Mitigation							***Construction phase – After Mitigation***					
TSF Construction	M	L	M	M	M	M	L	L	L	L	L	L
Operational Phase – Before Mitigation							***Operational Phase – After Mitigation***					
Plant Pit works Waste Dumps Haul Road	M Occasional disturbance	M For duration of project	M Beyond mining rights boundary	M Medium	M Frequent	M Medium	L Levels will seldom be exceeded	M For duration of project	M Beyond mining rights boundary	L Low	L Unlikely Seldom	L Low
Decommissioning Phase – Before Mitigation							***Decommissioning Phase – After Mitigation***					
Dismantling	L	L	L	L	L	L	No mitigation required					
Closure Phase – Before Mitigation							***Closure Phase – After Mitigation***					
No residual noise	L	L	L	L	L	L	No mitigation required					

7 Monitoring programme

Annual noise surveys should be continued in accordance with Tharisa Mine's EMP.

(a) Using previous reference points shown on the map in Figure 7.1 as guideline, revise the list of most relevant locations to be used for noise monitoring, taking into account the state of completion of EIA-approved components and the complaints history, if any at the time when the survey is conducted.

(b) Measure noise levels at the selected reference points.

(c) If possible, conduct measurements during normal operation as well as during a shut-down period. Ideally, such measurements should be conducted on a night during which the mine is temporarily shut down completely for a period of two hours.

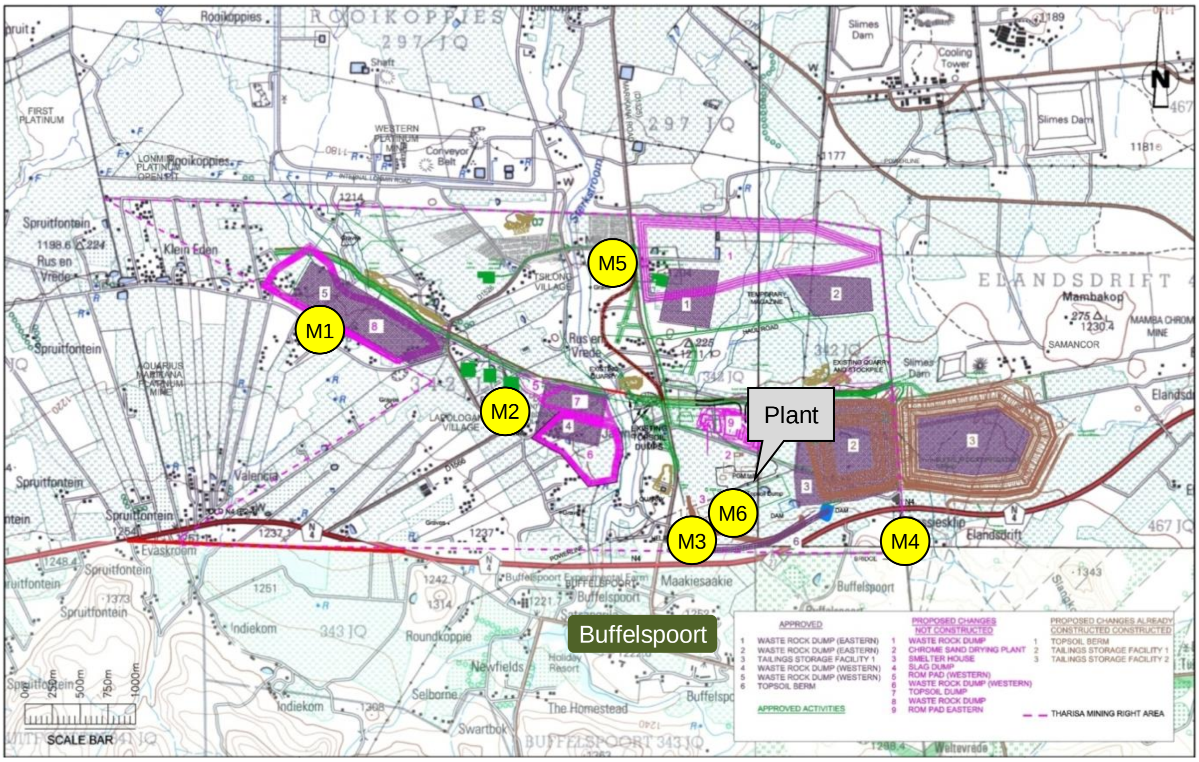
(d) Measure the A-weighted equivalent continuous noise level in a sequence of 10-minute intervals covering a period of preferably 24 hours, but at least the night-time period from 22:00 to 06:00.

(e) Process the data and determine the increase in ambient level caused by Tharisa mining operations.

(f) Assess the noise impact of the mine and present the findings in a report. If applicable, make recommendations for steps required to mitigate excessive noise.

(g) Monitoring locations and procedures for annual surveys must be revised prior to each survey and taking the findings of previous surveys into account.

(h) Equipment, calibration and measurement procedures must comply with the requirements laid down in SANS 10103.



Point	Location	Represented area
M1	S25 43 49.2 E27 27 40.7	West pit immediate surroundings
M2	S25 44 18.6 E27 28 39.7	Spruitfontein school surroundings
M3	S25 45 00.7 E27 29 35.2	Plant surroundings - Nearest residence
M4	S25 44 56.8 E27 30 45.7	Area east and south-east of mine
M5	S25 43.717 E27 29.314	Silver Town village boundary nearest to the mine
M6	S25 44.863 E27 29.797	500 m south of plant, 100 north of berm

Figure 7.1

Recommended EMP Monitoring points
To be revised and updated annually

8 References

[1] Van Zyl B G: *Tharisa Mine Noise monitoring survey,* 22-May-2009.

[2] SANS 10328: *Methods for environmental noise impact assessments.*

[3] SANS 10103: *The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication.*

[4] Department of environment affairs: *Noise control regulations under the environment conservation act***,** (Act No. 73 of 1989), Government Gazette No. 15423, 14 January 1994.

Ben van Zyl PhD MSc Eng
Acoustical Engineer

Appendix A

Noise survey complete data sets

Figure A.1	Survey 1	26 to 27 Jul-2012	Monitoring Point	M1	Residence Potgieter H

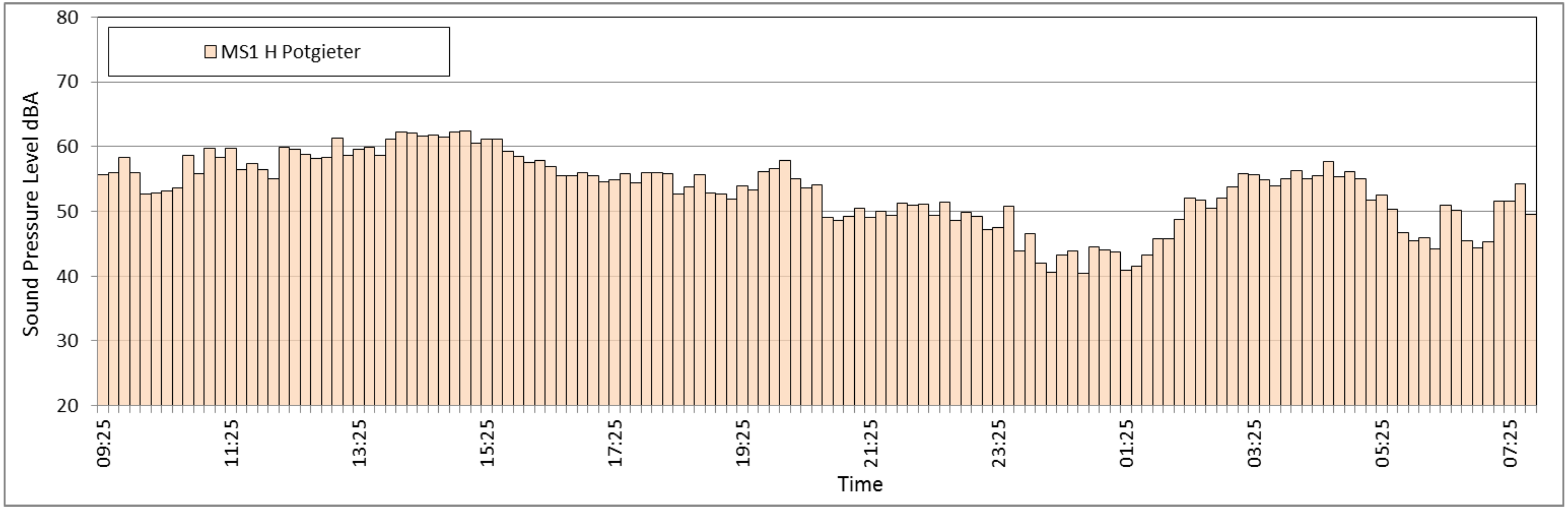


Figure A.2	Survey 1	26 to 27 Jul-2012	Monitoring Point M2 Spruitfontein School

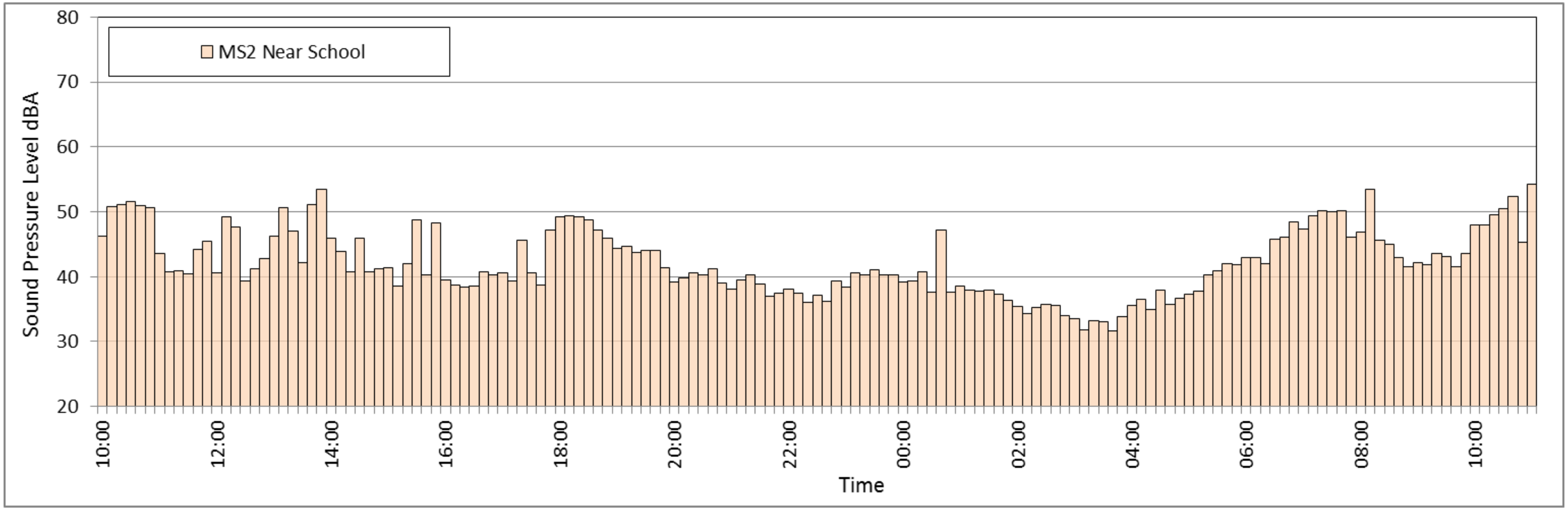


Figure A.3	Survey 1	26 to 27 Jul-2012	Monitoring Point	M3	Residence Potgieter M

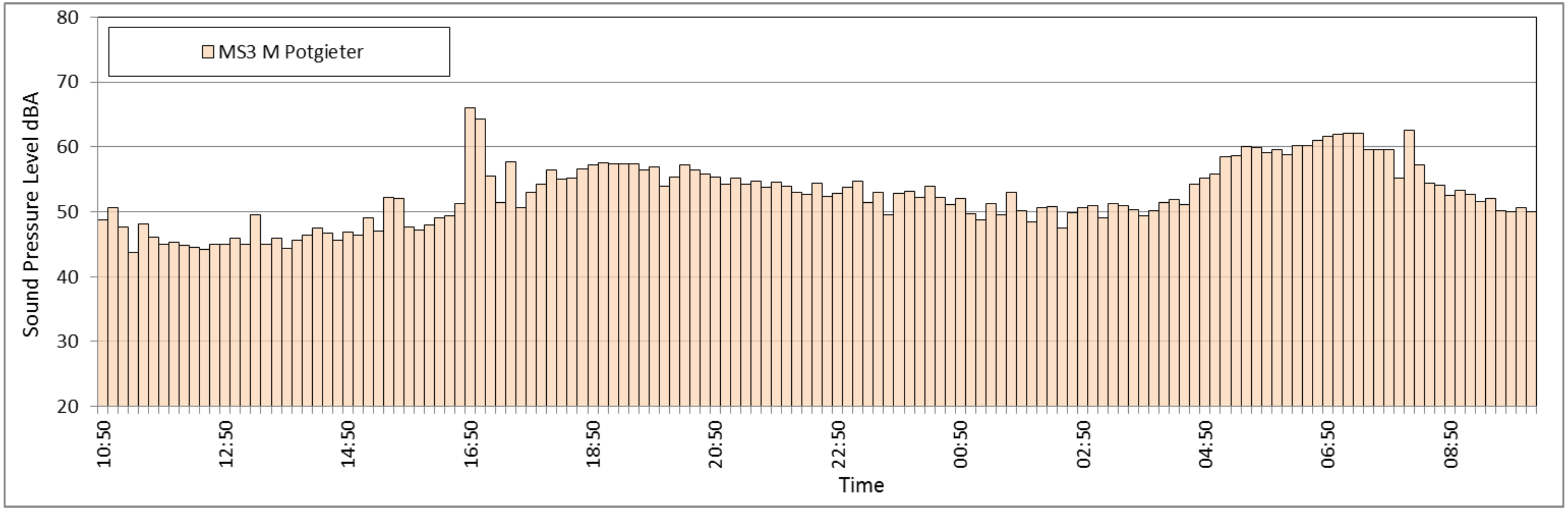


Figure A.4	Survey 1	26 to 27 Jul-2012	Monitoring Point	M4	Residence Potgieter D

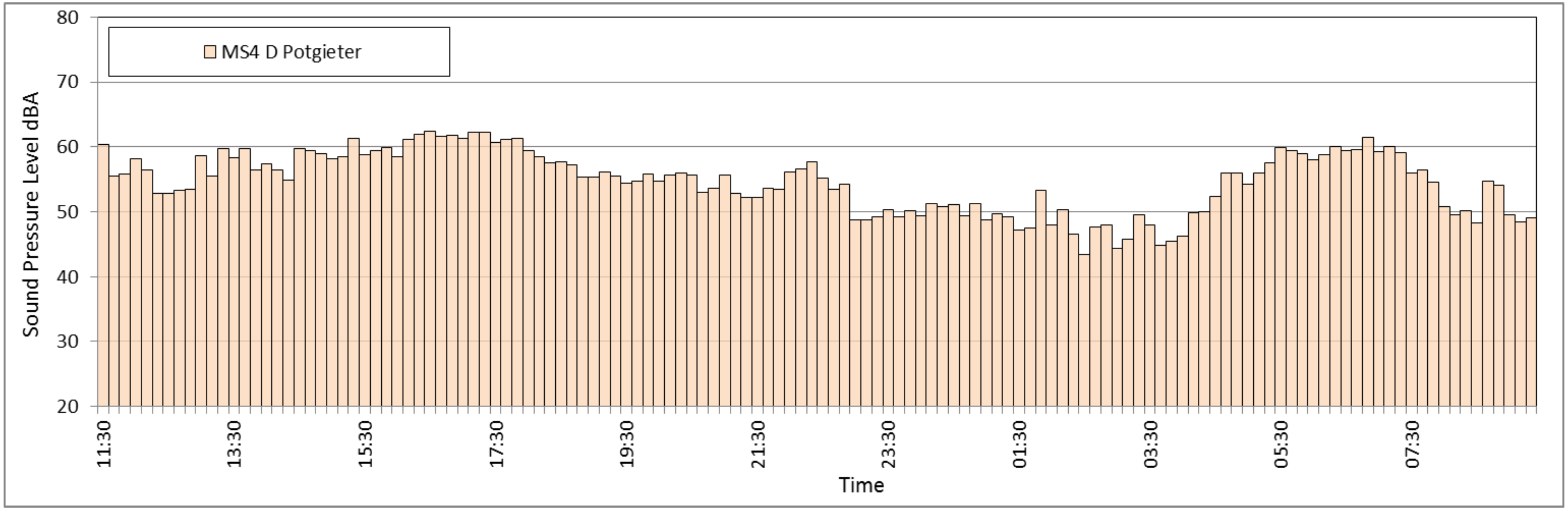


Figure A.5	Survey 2	05 to 06 Sep-2012	Monitoring Point	M5	Silver Town Village

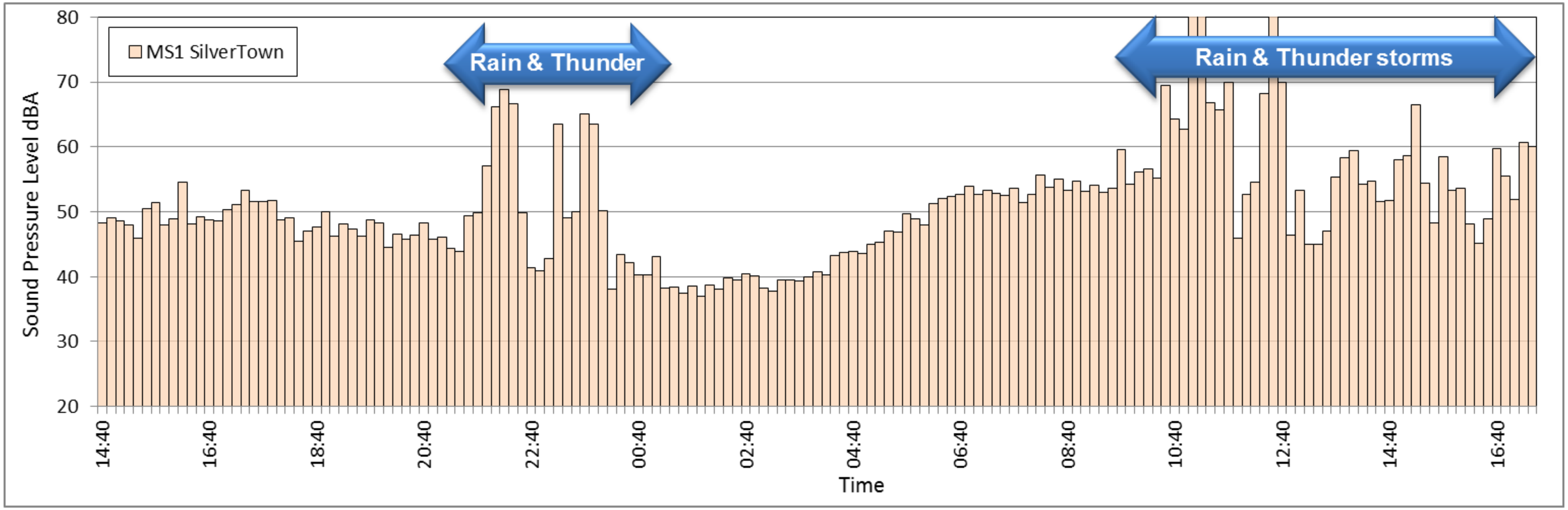


Figure A.6	Survey 2	05 to 06 Sep-2012	Monitoring Point	M6	Spruitfontein School

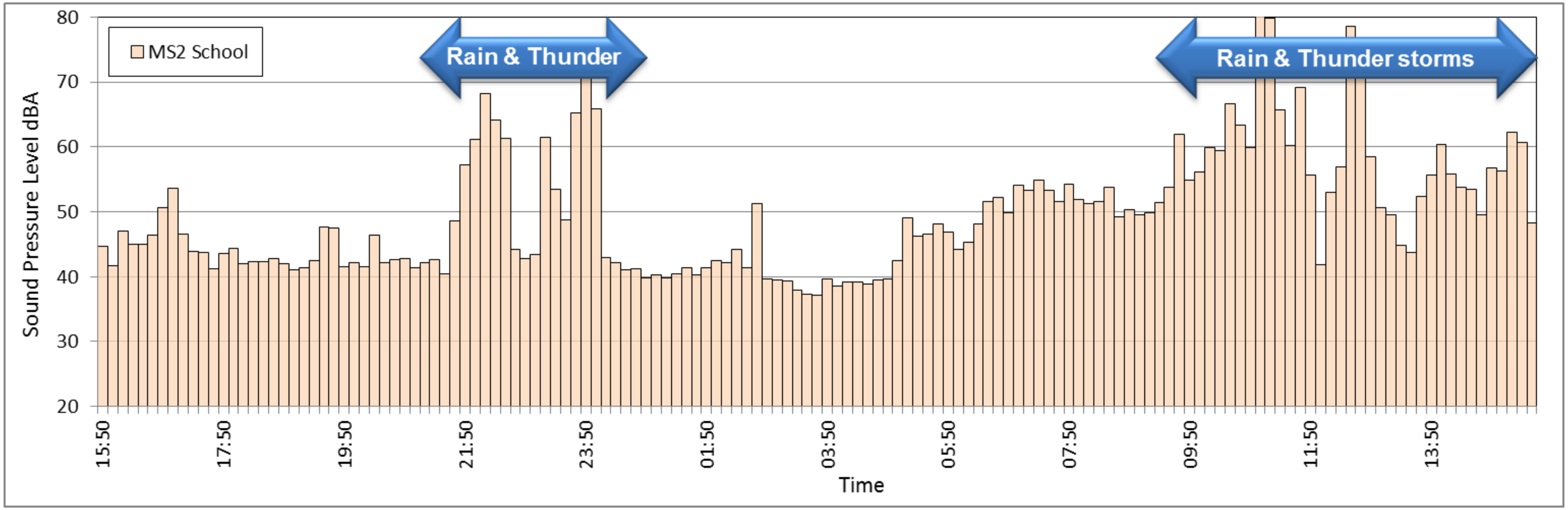


Figure A.7	Survey 2	05 to 06 Sep-2012	Monitoring Point	M7	Residence Potgieter M

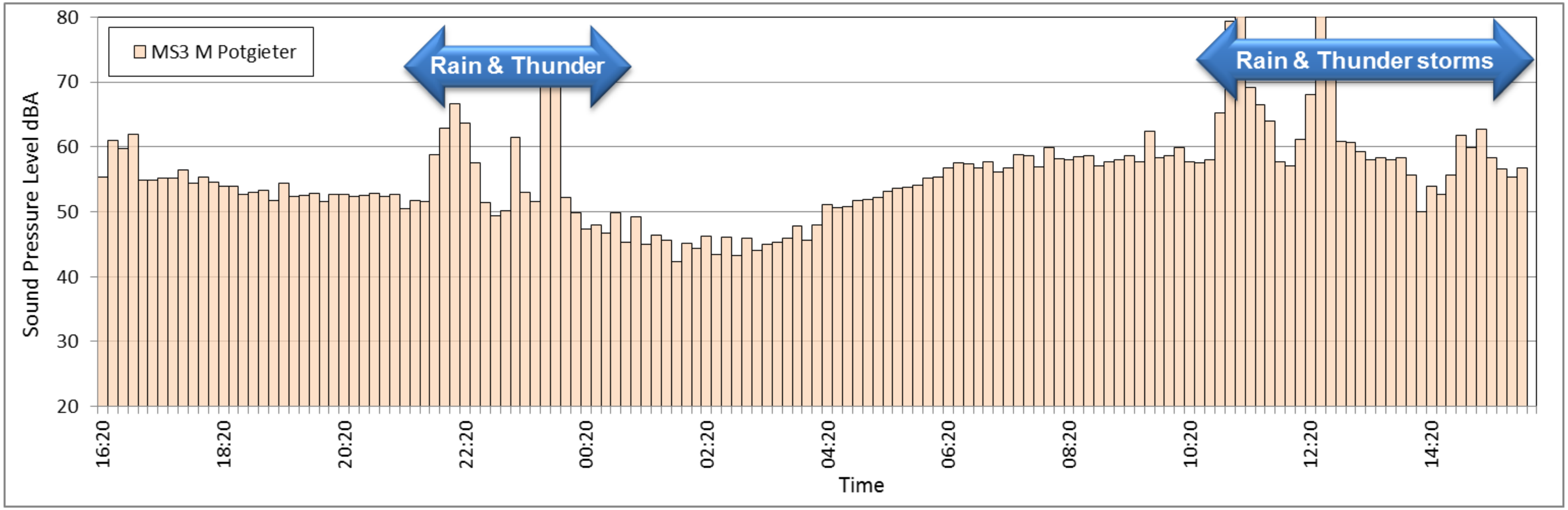
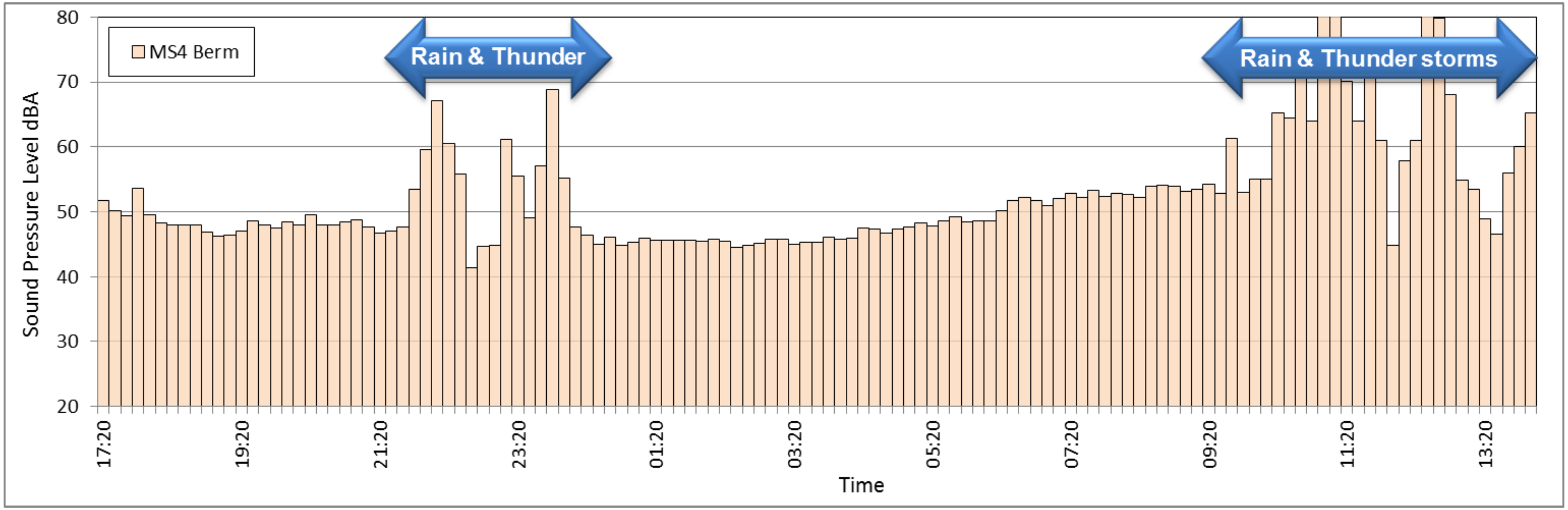


Figure A.8	Survey 2	05 to 06 Sep-2012	Monitoring Point	M8	400 m South of Tharisa Plant



Appendix B

Curriculum Vitae

Barend Gideon van Zyl - ID No 4605105089082
P O Box 70 596, Die Wilgers, 0041; 542 Verkenner Ave, Die Wilgers, Pretoria

Qualifications		Institution	Year Completed
(1)	BSc (Eng) Elec	University of Pretoria	1970
(2)	BSc (Eng) Hon Elec	University of Pretoria	1972
(3)	MSc (Eng) (Cum Laude)	University of Pretoria	1974
(4)	PhD	University of Natal	1986

MSc thesis: Sound intensity vector measurement
PhD thesis: Sound transmission analysis by measurement of sound intensity vector

Professional registration and membership

- Southern African Acoustics Institute Fellow (President 1994) Member since 1974

Career

CSIR
1971 – 1989

Join the Acoustics Division of the Council for Scientific and Industrial Research (CSIR) in 1971; Chief Specialist Research Engineer 1981 - 1989.

- Undertake basic and applied acoustic research & development projects;
- Pioneer technique and instrumentation for measurement of sound intensity vector, leading to sponsored research & consulting work in the Netherlands (TNO 1978) and Denmark (Brüel & Kjaer 1981).
- Acoustic consulting engineering services rendered in the fields of building acoustics, industrial noise control, acoustic materials development & environmental acoustics.

Advena
1989 – 1990

- SA Space Programme: Manager Systems Integration & Environmental Test Laboratories;
- Design and commissioning of ultra-high noise level simulation facilities for endurance testing of rocket launch vehicles, spacecraft, satellites, instrumentation and payload.

SABS
1991 – 1994

- Acoustic consulting engineering services rendered to industry
- Building acoustics, industrial noise control and environmental acoustics.

Acusolv
Private Practice
Since 1995

Private practice - Sole proprietor - Acoustic consulting engineering

- Noise studies; Environmental noise surveys; Blast noise measurement & assessment
- Design & problem solving: Building acoustics, Industrial & machinery noise reduction, Vehicle noise reduction (road, rail & air)
- Specialised services: Theoretical analysis & design of multi-layered acoustic panels.
- SABS Laboratory & field testing: Building systems and materials, Equipment & machinery noise

Papers and publications

- Several papers presented at international congresses and symposia.
- Several papers published in international acoustic journals, such as

Journal of the Acoustical Society of America; Applied Acoustics; Noise Control Engineering Journal.

- Several papers published in Southern African journals.

Other

- Part-time lecturer: Architectural acoustics, Department of Architecture, University of Pretoria;
- Associate of and specialist advisor to SABS Laboratory for Sound and Vibration

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Practice Profile

Sole Proprietor: Dr Ben van Zyl

Practicing since 1995.

Based in Pretoria South Africa, Ben van Zyl T/A Acusolv is an independent sole proprietor acoustic consulting engineering practice with in-house expertise and experience in various acoustic disciplines, including building acoustics, noise impact studies, industrial noise control, test and evaluation and acoustic materials development.

This practice is equipped with state-of-the-art acoustic measuring instruments employed in noise monitoring surveys, measurement of blast noise, laboratory and field testing of systems and materials and as an aid in the investigation and solving of noise problems.

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Examples of projects

Acoustic Field: Noise studies

Project	For	Aspects
• Gauteng Waste Plant	S E Solutions	Impact study: New waste plant
• Swartland	Centurus	Residential and commercial development - traffic
• Mapoch II	Marlin Granite	Quarry Impact study: Blasting, open cast mining
• Delmas Extension: mining dev	Ingwe Coal Corp	Noise study – Plant, conveyors, trains, roads
• Twistdraai new access roads	Sasol Coal	Noise study – Roads, conveyors
• Bosjesspruit shaft ventilation fans	Sasol Coal	Noise study; shaft & ventilation fan noise rural area
• Hillendale new mining development	Iscor Heavy Minerals	Noise study – Plant, road transport
• Empangeni Central Processing Plant	Iscor Heavy Minerals	Noise study – Large processing plant
• Rooiwater mining development	Iscor Mining	Noise study – Plants, road & rail transport
• Sigma overland conveyor	Sasol Mining	Conveyors: Analyse sources of conveyor noise
• Sigma overland conveyor	Sasol Mining	Noise study – Conveyors measurement survey
• Maputo steel project	Gibb Africa	Noise study peer review: trains, slurry pipe
• Pump station noise	Transvaal Suiker Bpk	Noise study & Design for noise reduction
• GPMC Environmental Resources Plan	GPMC	Noise policy & resources plan
• Damelin College Randburg	Titan Construction	Assess impact of traffic noise on college + design
• Atterbury Value Mart	Parkdev	Land use planning - City Council requirements noise
• Holmes Place HAC London	V Z de Villiers	Land use planning - City Council requirements noise
• Elmar College Pretoria	Iscor Pension Fund	Assess impact of traffic noise on college + design
• Sanae 4 Base Antarctica	Dept Public Works	Noise impact design for control - Plant rooms
• New truck fuel & service station	Bulktrans	Noise study & Design for noise control
• Country Lane	Country Lane Dev	Land use planning – Road traffic noise impact
• Randburg Water Front	Randburg City	Advisor & specialist court witness
• Syferfontein overland conveyor	Sasol Coal	Noise impact as function of idler properties
• Twistdraai East mining noise	Sasol Coal	Mitigation of noise impact on neighbouring farm
• Little Loftus – The Rest Nelspruit	TAP de Beer	Sports bar - Impact study
• Blast noise	Somchem	Blast noise impact assess & design noise control
• Syferfontein overland conveyor	Sasol Coal	Noise impact as function of conveyor design
• Leeuwpan Mine Delmas district	Iscor/Ticor	Noise study – Plant noise, loading
• Fairbreeze open cast mine KwaZulu	Iscor/Ticor	Noise study – Open cast mining; plant, transport
• Brandspruit mine	Sasol	Noise study - Ventilation fan noise rural area
• Irene Ext 47	Irene Land Dev Corp	Noise study - Mixed development; road traffic noise
• Irene Ext 55	Irene Land Dev Corp	Noise study - Residential; road traffic noise
• Lynnwood filling station & car wash	Town Planning Hub	Noise study: Filling station & car wash in residential
• Lyttleton 190	Ferero	Noise study: Residential next to N1 highway
• Twistdraai N-East Mine shaft	Sasol Mining	Noise study; shaft & ventilation fan noise rural area

Acoustic Field: Noise studies (Continued)

Project	For	Aspects
• Wesput open cast mine	Petmin	Noise study: Blasting, excavation & transport
• Gedex open cast mine	Petmin	Noise study: Open cast excavation & transport
• Kensington college	Centurus	Noise study: Sport grounds, roads
• Spandow mine shaft	Sasol Mining	Noise study; shaft & ventilation fan noise rural area
• Twistdraai Central Mine Shaft	Sasol Mining	Noise study; shaft & ventilation fan noise rural area
• Addington Hospital	Delen Oudkerk	Equipment outdoor noise impact & mitigation
• Fourways Gardens Country Club	Fourways Gardens	Music noise impact assess & design for mitigation
• Irene Ext 29	Irene Land Dev Corp	Noise study: New township & highway noise
• Pick ‘n Pay Warehouse Meadowbrook	Pick ‘n Pay	Truck movement & loading: Assessment
• Irene Sports Academy	Centurus	Impact assessment: Sports grounds & road traffic
• Jameson substation transformer	EThekwini Municipal	Transformer noise: Assess & design mitigation
• Eugene Marais Hospital	Eugene Marais Hosp	Plantroom & outdoor equipment impact & mitigate
• Klipspruit mine wash plant	Billiton & DRA	Coal wash plant infra-sound: design for mitigation
• Eagle Quarry	Mapochs Action	Quarry new application: peer review
• Blast Test Facility Somchem	Denel	Blast noise impact: assess & design for mitigation
• Virgin Active Sandton Gym	Virgin Active	Aerobics, squash & equipment: assess & mitigate
• Conveyor noise study	Bateman	Overland conveyor noise: Causes & parameters
• Zuid Afrikaans Hospital	Z A Hospital	Chiller outdoor noise: design for mitigation
• K54 Road	Tshwane	Noise Study: Future road through residential
• PWV6 Road	Gautrans	Noise Study: Future highway noise contours
• Zandfontein mine shaft	Sasol Mining	Noise Study: Mine shaft & fan noise outdoor impact
• Pierre van Ryneveld Ext 24	Van Vuuren Dev	Noise study: New township & highway noise
• PFG Glass new float plant	PFG Glass	Noise study: Future plant noise in residential area
• Sterkfontein residential development	M&T	Noise study: Road noise impact mitigation
• Sasol future Irenedale mine	Sasol	Noise study: Prediction of shaft & conveyor noise
• Ammunition demolition	SA Army	Noise study: Long distance noise impact assess
• Rietvlei Ridge residential development	M&T	Noise study: Road noise impact mitigation
• Mooiplaats / Hoekplaats	Chieftain	Noise study: Road noise impact mitigation
• Sasol Syferfontein conveyor	Bateman	Noise study: Noise complaints from farmers
• Madagascar Toliara Sands	Exxaro	Noise study: Future mining, plant, transport
• Rooipoort Mine	Sasol Mining	Noise study: Mining and conveyor noise
• Vlakplaats	Quantum	Noise study: Residential development
• Polokwane 2010 Soccer stadium	Africon	Noise study: Stadium noise in residential area
• New Clydesdale colliery	Exxaro	Noise study: Open cast mining, blasting and plant
• Grootfontein ventilation shaft	Sasol Mining	Noise study: Ventilation shaft & surface fan
• Cicada Pycna mating call study	Anglo Platinum	Cicada mating call – Mining noise interference
• Weltevreden ventilation shaft	Sasol Mining	Noise study: Ventilation shaft & surface fan
• Leandra North new colliery	Ingwe	Noise study: Mining development
• PTM new platinum mine	PTM Platinum	Noise study: Mining development
• Lyttleton X191	Pro-Direct	Noise study, new residential development
• Barking noise nuisance	Vd Merwe	Barking noise measurements, specialist report

Acoustic Field: Noise studies (Continued)

Project	For	Aspects
• Vanggatfontein	Exxaro/Metago	Noise study: Open-cast mine
• Forfar clay mining extension	Forfar/Zimbiwe	Noise study: Open-cast clay mining operations
• Luhfereng Doringkop development	Bigen	Noise study: Mixed development, train noise
• K113 Road noise study	Heartland/Bokamoso	Noise study: Road, mixed development
• Eland Mine	Exstrata/Metago	Noise study: New access road for product transport
• Sheraton Hotel	Pan Pacific Property	Noise study: Hotel impact on residential area
• Sishen Infrastructure Relocation	Kumba/Synergistics	Noise study: Railway route options evaluation
• Tharisa Mine noise monitoring	Tharisa/Metago	Baseline noise monitoring surveys
• Sishen Mine baseline monitoring	Kumba/Synergistics	Baseline noise monitoring surveys
• Sishen Mine Protea discard dump	Kumba/Synergistics	Discard dump location - Noise screening assess
• Eastplats	Barplats/Metago	Noise study: New vertical shaft
• Inyanda Mine noise disturbance	Exxaro	Noise surveys: Noise complaints investigation
• Irenedale Mine commissioning	Sasol Mining	Noise Monitoring: New shaft operational phase
• Honey Ridge indoor shooting range	Insul-Coustic	Design for noise reduction
• Sishen Mine expansion project 2	Kumba/Synergistics	Noise study: New processing plant Sishen mine
• Sishen Mine noise monitoring	Kumba Iron Ore	Peer review: Baseline survey
• Sishen Mine new 10 MTon plant	Kumba/AGES	Noise study: New 10 MTon processing plant
• Khameni Kalkfontein/Tamboti Mine	Khameni/Metago	Noise study: New opencast mine and plant
• Exxaro Kalbasfontein rail load-out	Exxaro	Noise survey: Assess impact of railway loud-out
• Sishen Mine Lylyveld development	Kumba/EGES	Noise study: New opencast mine & transport
• Haasfontein new opencast mine	Exxaro/Synergistics	Noise study: New underground mine + conveyor
• Westlake mixed development	Heartland/SEF	Noise study: New urban mixed development
• Marlboro road M60	Heartland/SEF	Noise study: New road traffic noise modelling
• Driefontein Mine	Goldfields	Noise scoping assessment and recommendations
• Bokfontein Chrome Mine	Hernic/Metago	Noise study: New furnaces and beneficiation plant
• Eland opencast mine extensions	Exstrata/Metago	Noise study: Opencast mine extensions
• Tharisa Mine EMP noise monitoring	Tharisa/Metago	EMP noise monitoring survey 1
• Dragline noise reduction Kriel	Anglo Coal	Dragline noise – Design for noise reduction
• Ivory Coast noise studies	Metago	Peer review
• Eskom Grootvlei Power Station	Insul-Coustic	Design for noise reduction - internal
• Inyanda Mine	Exxaro	Design for plant noise reduction - enviromental
• Swakkop Uranium Husab Project	Swakkop Uranium	Noise study: New open-cast operation & plant
• Sasol Shondoni Shaft	Sasol Mining	Noise study: New shaft and overland conveyor
• Vanggatfontein EMP	Keaton	EMP annual noise surveys
• Doornpoort Plaza Service Station	Petroland	Noise study: New service station on N4 highway
• Hawerklip railway load facility	Exxaro	Noise study: New railway coal loading facility
• Lusthof Coal Mine	Black Gold	Noise study: New open-cast coal mine
• Conveyor noise parameters	Melco	Research investigation: Conveyor noise
• Sishen discard dumps	Kumba	Noise study: New discard dumps at Sishen
• Impala Shafts 18 & 19	Impala Platinum	Noise study: New shafts & infrastructure
• Tharisa noise complaint investigation	Tharisa Minerals	Noise complaint investigation, survey & assessment
• Moonlight Iron Ore Project	Turquoise Moon	Noise study: New Open-cast mine and plant
• New Largo	Anglo Coal	Noise study: New Open-cast mine

Acoustic Field: Noise studies (Continued)

Project	For	Aspects
• Phola-Kusile conveyor	Anglo Coal	Noise study: New conveyor to Kusile Power Station
• Leeuw Colliery	Leeuw Mine	Noise study: Leeuw Utrecht Colliery
• Letaba Crushers	F Kruger	Noise complaint investigation, survey & assessment

Acoustic Field: Industrial, machinery & equipment noise control

Project	For	Aspects
• Iscor New Compressor House	Voest Alpine	Design for noise reduction, inspection & testing
• Botswana TV centre Air-con system	Atlantic Tech	Design for control of plantroom & ducted noise
• Granulation plant	DOW Plastics	Design for noise reduction, inspection & testing
• CS2 Xantate plant	DOW Chemicals	Design for noise reduction, inspection & testing
• Alkylate chemical plant	DOW Chemicals	Design for noise reduction, inspection & testing
• SAP 4 Acid plant	Sasol Agri Palaborwa	Design for noise reduction, inspection & testing
• Motor pump enclosures	Sulzer	Design of noise hoods for large motor-pump units
• Rite Value Refrigeration Plant	Rite Value	Problem solving & design for noise reduction
• Sugar mills pump station	TSB	Design for noise reduction – noise impact control
• Pferd factory noise reduction	Pferd SA	Problem solving & design factory noise reduction
• Alusaf Bayside compressor plant	Alusaf	Problem solving & design for noise reduction
• Alusaf Bayside blower plant	Alusaf	Problem solving & design for noise reduction
• Alusaf Bayside cold rolling mill	Alusaf	Problem solving & design for noise reduction
• Sinter plant Van der Bijl Park	Iscor	Noise reduction strategy & requirements
• Blast furnace fan noise	Universal Fans	Design for fan noise reduction
• Aircraft Engine test facility	Kentron	Design for noise control – environmental impact
• Sulphuric acid plant noise	Fedmis	Design for noise reduction, inspection & testing
• Automotive assembly line	Nissan	Design & commissioning noise reduction canopies
• Scrubber fan noise	RBM	Design for noise reduction
• Ship unloader machine room noise	Algroup Alusuisse	Design for noise reduction
• Paint plant noise	Daimler Chrysler	Design for noise reduction on skid cleaner
• Mail sorting centre plantroom noise	Telkom Sapos	Design for plantroom noise control
• Scrubber system and fan noise	Aquachlor	Design for noise reduction
• Power station turbine hall noise	Eskom	Design for noise reduction
• Mill noise	PPC	Design for noise reduction in control rooms & offices
• Plantroom noise	Vodacom	Design for noise control in offices
• G6 armoured veh power plant noise	SME	Design enclosure for noise control
• Carltonville hospital boiler plant noise	Gauteng Health Dept	Design for noise reduction
• Refinery noise	Rand Refineries	Diagnostic investigation & strategy for noise reduct
• Engine test facility ultra-high noise	Sasol	Design for sound proofing engine test facility
• Chiller plant noise	Dep Public Works	Design for noise reduction
• New Chipper Plant	Sappi Tugela	Plant building design for external noise control
• Transformers	Hawker Siddeley	Acoustic test and evaluation
• Sappi Enstra Paper Mill	Sappi SA	Noise reduction programme and design
• Blast noise	Somchem	Blast noise eval; test facility design for noise control
• Mill noise	Anglo Platinum	Bond mill & sieve shaker design for noise reduction
• Vibration screen infra-sound problem	Billiton	Problem analysis and design for infra-sound control
• Bucket repair workshop	S A Coal Estates	Design enclosures & screens for noise reduction
• LoadHallDump vehicle noise reduction	Anglo-Coal	Design ventilated hood for noise reduction
• PMR Precious metal refinery	Anglo Platinum	Excessive ventilation noise: design to reduce
• Pebble bed ball impact test facility	Necsa	Noise control booth design

Acoustic Field: Industrial, machinery & equipment noise control (Continued)

Project	For	Aspects
• Sasol Syferfontein conveyor	Sasol Mining	Design: Overland conveyor noise reduction
• SARS Alberton new building	SARS	Plantroom design for noise impact control
• Sulzer large flow bend	Insul-Coustic	Design bend treatment for flow noise control
• BMW wax & seal test facility	Insul-Coustic	Test facility soundproofing design - Metal cutting
• Kumba induction panel test facility	Kumba	Test facility soundproofing
• KZN P Maritz B new legislative offices	KZN Dept P Works	Plantrooms and machinery design for noise control
• Alstom 32 MVA Power transformer	Alstom	Power transformer noise output tests
• Waterfall Boven	Nkalanga Municipal	New water purification design for noise control
• Conveyor noise study	Bateman	Overland conveyor noise: Causes & parameters
• Harvest House Pretoria	Desmo Eng	Chiller & cooler plant design noise screening meas
• Ventilation fan noise problem	Anglo Coal	Surface ventilation fan - Design noise reduction
• Sasol Syferfontein conveyor	Sasol Mining	Diagnostic analysis: noise generating mechanisms
• Sasol Syferfontein conveyor	Sasol Mining	Design: Overland conveyor noise reduction
• Metal press noise	TRW	Design enclosures & screens for noise reduction
• Stone Duster Vehicle	Bird Machines	New vehicle – Design & achieve noise spec
• Gautrain	Insul-Coustic	Construction sites – Design noise enclosures
• Exxaro High-frequency generator	Insul-Coustic	Noise enclosure and soundproofing design
• Unisa new registration building	Unisa	Plantroom noise predictions and design inputs
• Columbus Steel	Insul-Coustic	Control room and pulpit soundproofing design
• Sesane TV studios	Insul-Coustic	Plantroom and machinery noise reduction design
• Safour air plant noise reduction	Insul-Coustic	Compressor enclosure and soundproofing design
• Rustenburg Mine Laboratories	Rustenburg Mine	Design for machine noise reduction
• Anglo Research Lab Mills	Anglo American	Research lab mills, design for noise reduction
• Safripol Blowers	Safripol	Blower noise, design for noise reduction

Acoustic Field: Specialised services

Project	**For**	**Aspects**
• Specialist advisor to SABS LVA	SABS	Specialist advisor for SABS Acoustics Laboratory
• Pakistan Airforce: Missile assessment	Dep Trade & Industry	Assessments non-proliferation treaty
• Taiwan push-pull loco bullet train	Union Carriage	Driver's cabin speech intelligibility & noise control
• NRZ rail coaches	Union Carriage	Acoustic design for noise reduction
• Locomotive Class 9E Electrical Sishen	Alstom	Design upgrade - Noise reduction for hearing safety
• Theoretical analysis sound insulation	CSIR & several other	Predict/analyse acoustical properties of materials
• Overland coal conveyor noise	Sasol	Diagnostic analysis: noise generating mechanisms
• G6 artillery vehicle – Gun shot noise	LIW	Acoustic measurements & assessment hearing risk
• Locomotive Class 11E Electrical	Spoornet	Design upgrade - Noise reduction for hearing safety
• Dakota aircraft upgrade	Aerosud	Design for noise reduction
• Hearing damage gunshot noise	SA Police	Hearing conservation programme
• New drywall product development	BPB Gypsum	Theoretical analysis of acoustical properties
• Power generators outside broadcast	Ontrack	Noise reduction and field tests
• Ermelo – Richards Bay Locomotive	Transwerk	Design upgrade speech intelligibility & noise control
• Indoor artillery test facility	Somchem	Design for environmental noise control
• MUF building systems	Chipboard Industries	System acoustic evaluation and development
• Locomotive Class 34GM Diesel-elec	Spoornet	Design upgrade - Noise reduction for hearing safety
• Locomotive Class 35GM Diesel-elec	Spoornet	Design upgrade - Noise reduction for hearing safety
• Locomotive Class 36GM Diesel-elec	Spoornet	Design upgrade - Noise reduction for hearing safety
• Locomotive Class 37GM Diesel-elec	Spoornet	Design upgrade - Noise reduction for hearing safety
• Locomotive Class 34GE Diesel-elec	Spoornet	Design upgrade - Noise reduction for hearing safety
• Locomotive Class 35GE Diesel-elec	Spoornet	Design upgrade - Noise reduction for hearing safety
• Locomotive Class 36GE Diesel-elec	Spoornet	Design upgrade - Noise reduction for hearing safety
• SABS acoustic test lab validation	SABS	Assess & validate SABS test laboratory & method
• Mobile partitioning system	L J Doors	Design input to improve insulation performance
• Locomotive Class 7E Elec	Spoornet	Design upgrade - Noise reduction for hearing safety
• Weapons and ammunition demolition	SA Navy	Measurement of hi-explosives detonation noise
• Locomotive Class 19E Elec	UCW	New Coal-link locomotive – Low noise design
• Locomotive Class 15E Elec	UCW	New Sishen iron ore loco - Low noise design
• Soshalowa power car	Transnet	Train set power car sound-proofing design
• Locomotive hooters	Transnet	Study hooter audibility at level crossings
• Aluglass building systems	Aluglass	Acoustic panel theoretical evaluation