NOISE STUDY FOR THE PROPOSED NEW ACCESS ROAD TO TREKKOPJE AT ARANDIS

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The shallow uranium deposits on the farms Trekkopje, Klein Trekkopje and Arandis have been extensively drilled and assessed for mining potential in the past. AREVA Resources Namibia (then UraMin Namibia) was awarded an exploration and prospecting license for these farms in 2006 and has conducted a drilling and sampling campaign on site in accordance with an approved environmental management programme (EMP). The requirement for a more efficient (economically, in terms of safety and in terms of resource consumption) road access route has been identified.

The principle justification is to optimise travelling time, carbon emission through fuel consumption and safety of employees and the general public. In this regard AREVA undertook a review of the access road alignment. Road accidents rates are directly proportional to distance travelled (i.e. longer roads are likely to result in greater numbers of accidents, all other parameters being equal). Consequently, a more direct route to the main mining area running directly from Arandis has been selected as the proposed alignment of the new access road. The route follows the existing temporary water pipeline that supplies the mine from the Rössing Terminal Reservoirs near Arandis.

To comply with Namibian legislation, international best practise, the requirements of the Equator Principles, an environmental impact assessment is required for the construction and operation of a new access road. The new access road will cause noise emissions into the environment and elevation of existing ambient noise levels, particularly at Arandis. The town is close to the route of the proposed access road and the present noise study addresses the noise issues of the project during construction and operation.

The purpose of this noise study is:

- *To identify the major existing noise sources and noise sensitive areas in the environment of the proposed development;*
- *To estimate the present ambient noise levels at Arandis;*
- *To estimate the future noise emissions during construction and operational traffic on the road;*
- *To determine and assess the impact that these noise emissions will have on existing ambient noise levels at Arandis; and*
- *To investigate and illustrate, if necessary, the effect of noise mitigation measures.*

Although legislation covering the health and safety aspects of noise exists, no environmental noise regulations have yet been published in Namibia. Therefore, the noise standards and guidelines of other countries and institutions will have to be applied.

In South Africa the document that addresses the issues concerning environmental noise is SANS 10103. It has recently been thoroughly revised and brought in line with the guidelines of the World Health Organisation (WHO). It provides the maximum average ambient noise levels during respectively the day and night to which different types of districts may be exposed. For rural residential areas these limits are:

- *Day (06:00 to 22:00):* *45 dBA*
- *Night (22:00 to 06:00):* *35 dBA*

Furthermore the expected community reactions to increases in ambient noise levels are provided. The document provides detailed procedures for the measurement of noise levels.

It is recommended that the measurement of noise levels and assessment of community reaction be conducted in terms of SANS 10103 and that the limits specified by the IFC apply to the Trekkopje access road project.

A site visit was conducted between 21 and 23 August 2009. The purpose of the visit was to familiarise the consultant with the environment of the proposed project and to conduct representative sampling measurements of the existing ambient noise levels in the area.

The proposed new road will start at the existing Arandis railway siding and then follow the alignment of the existing temporary water pipeline in a north-north-westerly direction in relative close proximity past the town. Thereafter it passes through a very remote region where no human habitation will be affected. Therefore, the study area for the present noise study is restricted to the immediate environment of Arandis.

In order to assess the future noise impact knowledge of the typical present ambient noise levels is essential. For practical reasons it is not possible to measure the ambient noise level at all the affected points in the study area. Consequently sampling measurements have to be undertaken at locations that are deemed to be representative of noise sensitive receptors inside the noise study area. Therefore, ambient noise levels were sampled at four representative locations at the edge of the town facing the proposed new road and the hospital.

The noise measurements were taken in accordance with the methods stipulated by the SANS 10103. These describe the practical aspects of choosing the measurement locations and the taking of precautionary steps during the measurement of noise levels. In this respect the methods are in line with internationally accepted good measurement practice as described, for instance, in the guidelines provided by the World Health Organisation (WHO) and the requirements of ISO 1966.

The noise emissions from the Trekkopje access road were calculated, using the typical sound power emission levels of equipment that are available on the consultant's database. The noise emissions were calculated for the following conditions:

- *Construction of the road. The construction activities take place at a location nearest to the town, i.e. directly opposite the Arandis hospital. The noise sources include a bulldozer, grader, roller and construction truck and activities are restricted to the day only; and*
- *Operation of the road. The noise emissions are caused by traffic on the road, consisting of heavy (e.g. transport trucks) and light (LDV's) vehicles. The former travel at a speed of 80 km/h and the latter at 100 km/h. The traffic flow consists of 10 and 20 passes of, respectively, heavy and light vehicles during both the day and night.*

The propagation of the noise emissions into the environment was calculated in accordance with the CONCAWE method, as specified in SANS 10357. The model took account of the following aspects:

- *The sound power emission levels of the major noise sources;*
- *The geometric spreading of noise energy over distance;*
- *The absorption of noise energy by the air;*
- *The typical meteorological conditions of the area, i.e. temperature, relative humidity, static air pressure, wind speed and direction;*
- *The atmospheric conditions that influence the propagation of sound, e.g. during the night conditions favour the propagation of sound; and*
- *The acoustic characteristics of the ground between noise source and receiver.*

The noise impact was expressed as the total resulting ambient noise level and the increase in ambient noise level caused by the noise emissions from the road during construction and operation. The results are presented as noise impact contours superimposed on a scaled sattelite image of Arandis and its environment.

The following conclusions are drawn from the results of the study:

- *The present ambient noise levels in Arandis are typical for a rural community and are determined by communal activities, local traffic and natural noise sources, such as the interaction of the wind with the foliage of trees.*
- *Ambient noise levels outside the town itself quickly drop to very low levels. This is also the case for the hospital, which is located a small distance out of town.*
- *During construction there will be no increase in ambient noise level in Arandis itself and the total resulting ambient noise levels during the day and night will effectively remain unchanged. As a result there will be no community response to the noise emissions from the construction activities.*
- *However, at the hospital the increase in ambient noise level will be between 3 dB and 5 dB, resulting in 'little' community response with 'sporadic complaints' (SANS 10103 1).*
- *During the construction period the intensity of the noise impact will be low to moderate and the significance rating Low with a score of 2.*
- *For the unmitigated operation of the access road during the day the noise impact is very much limited to the immediate vicinity of the road, and the resulting total ambient noise level at the nearest noise sensitive receiver, i.e. the hospital, will be well below 35 dBA.*
- *Although the extent of the noise impact is further than during the day, the remarks made under the previous bullet are also applicable during the night.*

- *Therefore, the effective operation of the hospital activities will not be compromised.*

- *During the day the increase in ambient noise level at the hospital will be 3 dB, which may be regarded as barely significant. During the night the increase will be between 3 dB and 5 dB, which does represent a significant noise impact.*

- *According to SANS 10103 1 the community response during both the day and night will be 'little' with 'sporadic complaints'.*

- *During the unmitigated operational period the intensity of the noise impact will be low to moderate and the significance rating Low with a score of 2.*

- *With the placement of a noise barrier with a minimum height of 2,5 m on the Arandis side of the road the extent of the noise impact at the hospital is significantly reduced. The increase in ambient noise level is now less than 3 dB and, therefore, insignificant.*

- *According to SANS 10103 1 the community response during both the day and night will be 'little' with 'sporadic complaints'.*

- *During the mitigated operational period the intensity of the noise impact will be low and the significance rating will remain Low with a score of 2.*

The following recommendations can be made:

- *All diesel powered equipment must be kept in a prime state of maintenance;*

- *Regular maintenance routines must include the checking and replacement of intake and exhaust silencers if necessary; and*

- *A change in the noise emission characteristics of a piece of equipment must serve as a trigger to withdraw it for maintenance purposes.*

- *A noise barrier may be considered, with a minimum height of 2,5 m above ground level stretching for a distance of approximately 640 m along the Arandis side of the road opposite the hospital.*

NOISE STUDY FOR THE PROPOSED NEW ACCESS ROAD TO TREKKOPJE AT ARANDIS

1. INTRODUCTION

The shallow uranium deposits on the farms Trekkopje, Klein Trekkopje and Arandis have been extensively drilled and assessed for mining potential in the past. AREVA Resources Namibia (then UraMin Namibia) was awarded an exploration and prospecting license for these farms in 2006 and has conducted a drilling and sampling campaign on site in accordance with an approved environmental management programme (EMP). The requirement for a more efficient (economically, in terms of safety and in terms of resource consumption) road access route has been identified.

The principle justification is to optimise travelling time, carbon emission through fuel consumption and safety of employees and the general public. In this regard AREVA undertook a review of the access road alignment. Road accidents rates are directly proportional to distance travelled (i.e. longer roads are likely to result in greater numbers of accidents, all other parameters being equal). Consequently, a more direct route to the main mining area running directly from Arandis has been selected as the proposed alignment of the new access road. The route follows the existing temporary water pipeline that supplies the mine from the Rössing Terminal Reservoirs near Arandis.

To comply with Namibian legislation, international best practise, the requirements of the Equator Principles, an environmental impact assessment is required for the construction and operation of a new access road. The new access road will cause noise emissions into the environment and elevation of existing ambient noise levels, particularly at Arandis. The town is close to the route of the proposed access road and the present noise study addresses the noise issues of the project during construction and operation.

2. PURPOSE OF THE NOISE STUDY

The purpose of this noise study is:

- To identify the major existing noise sources and noise sensitive areas in the environment of the proposed development;
- To estimate the present ambient noise levels at Arandis;
- To estimate the future noise emissions during construction and operational traffic on the road;
- To determine and assess the impact that these noise emissions will have on existing ambient noise levels at Arandis; and
- To investigate and illustrate, if necessary, the effect of noise mitigation measures.

3. REGULATORY FRAMEWORK, STANDARDS AND GUIDELINES

3.1 NOISE REGULATIONS IN NAMIBIA

Although legislation covering the health and safety aspects of noise exists, no environmental noise regulations have yet been published in Namibia. Therefore, the noise standards and guidelines of other countries and institutions will have to be applied.

3.2 SOUTH AFRICAN NATIONAL STANDARD 10103

In South Africa the document that addresses the issues concerning environmental noise is SANS 10103 [1]. It has recently been thoroughly revised and brought in line with the guidelines of the World Health Organisation (WHO) [2]. It provides the maximum average ambient noise levels during respectively the day and night to which different types of districts may be exposed. For rural residential areas these limits are:

- Day (06:00 to 22:00): 45 dBA
- Night (22:00 to 06:00): 35 dBA

Furthermore the expected community reactions to increases in ambient noise levels are provided. The document provides detailed procedures for the measurement of noise levels. Therefore, it is recommended that this standard is applied for the present noise study.

3.3 THE WORLD HEALTH ORGANISATION GUIDELINES

The guideline developed by the WHO [2] is a document that comprises chapters on noise sources and their measurement, the adverse health effects of noise, guideline values and noise management. It is an important document since it is firmly based on international research findings on the subject of noise, and serves as a base document for many other noise related publications.

In Chapter 4 of this document the guideline values for community noise in specific environments are tabulated. As far as residential areas are concerned, no distinction is made between different types of environments and the maximum ambient noise levels during the day (time base: 16 hours, e.g. 06:00 to 22:00) and night (time base: 8 hours, e.g. 22:00 to 06:00) are 55 dBA and 45 dBA, respectively.

3.4 THE WORLD BANK GUIDELINES

The World Bank issues only a very short paragraph [3] on the issue of ambient noise levels that should be maintained in residential and industrial areas. For residential areas these limits are in essence the same as those recommended by the WHO [2], i.e. 55 dBA and 45 dBA during the day (07:00 to 22:00) and night (22:00 to 07:00), respectively, determined for a period of one hour.

It further states that alternatively the ambient noise level should not be increased by more than 3 dB. It is interesting to note that an increase of less than 3 dB generally is not detectable by a person with average hearing acuity. The consultant is of the opinion that this '3 dB criterion was probably introduced to address situations where the pre-development ambient noise level is equal to or in excess of the specified limits. However, in situations where the pre-development ambient noise level is quite low, applying the '3 dB criterion' may lead to large areas being sterilised for further developments. For example, if the current ambient noise level is 35 dBA an increase of 3 dB will result in 38 dBA, which is still very low and well within the specified limits.

3.5 THE INTERNATIONAL FINANCE CORPORATION GUIDELINES

The International Finance Corporation (IFC) guidelines [4] for noise are also short, although with more detail than those of the World Bank [3]. They comprise paragraphs on prevention and control, noise level guidelines and monitoring. For the noise level guidelines the guidelines refer to those stipulated by the WHO [2], i.e. for residential areas 55 dBA and 45 dBA during the day (07:00 to 22:00) and night (22:00 to 07:00), respectively, determined for the period of one hour. For industrial and commercial areas the limit is 70 dBA for both the day and night.

The IFC guidelines [4] also specify the '3 dB criterion' discussed in the previous section.

3.6 GUIDELINES AND STANDARDS RECOMMENDED FOR THE ETANGO PROJECT

It is recommended that the measurement of noise levels and assessment of community reaction be conducted in terms of SANS 10103 [1] and that the limits specified by the IFC [4] apply to the Trekkopje access road project.

4. METHODOLOGY OF THE NOISE STUDY

4.1 SITE VISIT

A site visit was conducted between 21 and 23 August 2009. The purpose of the visit was to familiarise the consultant with the environment of the proposed project and to conduct representative sampling measurements of the existing ambient noise levels in the area.

4.2 DISCUSSION OF THE STUDY AREA

The proposed new road will start at the existing Arandis railway siding and then follow the alignment of the existing temporary water pipeline in a north-north-westerly direction in relative close proximity past the town. Thereafter it passes through a very remote region where no human habitation will be affected. Therefore, the study area for the present noise study is restricted to the immediate environment of Arandis.

4.3 NOISE MEASUREMENT LOCATIONS

As indicated in the previous section, the impact that the future noise emissions will have will be assessed in terms of the effect that they will have on humans. In order to assess the future noise impact knowledge of the typical present ambient noise levels is essential. For practical reasons it is not possible to measure the ambient noise level at all the affected points in the study area. Consequently sampling measurements have to be undertaken at locations that are deemed to be representative of noise sensitive receptors inside the noise study area. Therefore, ambient noise levels were sampled at the following four representative locations (see Figure 4.3.1):

Figure 4.3.1: Satellite image showing the locations of the measurement points.

- MP1: 33K 0497321E 7521687S (UTM WGS84). At the northern edge of the town, approximately 20 m from the nearest residential property.

- MP2: 33K 0497812E 7521439S (UTM WGS84). At the north-east facing wall of the Arandis Primary School.

- MP3: 33K 0498101E 7521820S (UTM WGS84). At the north-western corner of the Arandis Hospital.

- MP4: 33K 0498079E 7521020S (UTM WGS84). In the open area on the western edge of the town.

The reasons for choosing these measurement points are the following:

- MP1: This measurement point is representative of the residential properties that are located at the northern edge of the town.
- MP2: This measurement point is located at a noise sensitive receptor, i.e. the primary school.
- MP3: The hospital is the noise sensitive receptor nearest to the route of the proposed Trekkopje access road. The subjective impression was that the ambient noise level at this location is very low and similar to conditions away from the town and in the desert.
- MP4: This measurement point is representative of a mixed development, i.e. with residential properties, some commercial activities and local traffic.

4.4 METHODOLOGY OF THE MEASUREMENTS

The noise measurements were taken in accordance with the methods stipulated by the SANS 10103 [1]. These describe the practical aspects of choosing the measurement locations and the taking of precautionary steps during the measurement of noise levels. In this respect the methods are in line with internationally accepted good measurement practice as described, for instance, in the guidelines provided by the World Health Organisation (WHO) [2] and the requirements of ISO 1966 [5,6].

4.5 MEASUREMENT PARAMETERS

The ambient noise level at the measurement locations was quantified in terms of the following measurement parameters:

- The A-weighted equivalent sound pressure level, L_{Aeq}.
- The instantaneous A-weighted sound pressure level, L_{pA}.
- The A-weighted 90 – percentile level, L_{A90}. Although this parameter is not specifically required by SANS 10103 [1] or the IFC Performance Standards, it does provide useful additional information as it indicates what the L_{Aeq} could have been in the absence of noisy single events, such as the wind interfering with the measurement results.
- Although the IFC guidelines [4] also do not require the measurement of the L_{A90} and frequency spectra, they allow the noise expert leeway in choosing the monitoring indices required to describe the ambient noise.

4.6 MEASUREMENT INSTRUMENTATION

The measurement instrumentation used for this noise study conformed to the requirements of SANS 10103[1]. A list of the measurement instrumentation used is provided in Appendix A to this report.

4.7 NOISE EMISSIONS FROM THE PROPOSED ACCESS ROAD

The noise emissions from the Trekkopje access road were calculated, using the typical sound power emission levels of equipment that are available on the consultant's database. The noise emissions were calculated for the following conditions:

- Construction of the road. The construction activities take place at a location nearest to the town, i.e. directly opposite the Arandis hospital. The noise sources include a bulldozer, grader, roller and construction truck and activities are restricted to the day only; and

- Operation of the road. The noise emissions are caused by traffic on the road, consisting of heavy (e.g. transport trucks) and light (LDV's) vehicles. The former travel at a speed of 80 km/h and the latter at 100 km/h. The traffic flow consists of 10 and 20 passes of, respectively, heavy and light vehicles during both the day and night.

A list of the equipment octave band sound power levels used in the calculations is given in Appendix B to this report.

4.8 CALCULATION OF NOISE PROPAGATION

Since the World Bank[3] does not prescribe any specific calculation method, the propagation of the noise emissions into the environment was calculated in accordance with the CONCAWE method, as specified in SANS 10357[7]. The model took account of the following aspects:

- The sound power emission levels of the major noise sources;

- The geometric spreading of noise energy over distance;

- The absorption of noise energy by the air;

- The typical meteorological conditions of the area, i.e. temperature, relative humidity, static air pressure, wind speed and direction;

- The atmospheric conditions that influence the propagation of sound, e.g. during the night conditions favour the propagation of sound; and

- The acoustic characteristics of the ground between noise source and receiver.

The meteorological and ground conditions that were assumed for these calculations are summarised in Table 4.8.1.

TABLE 4.8.1
Summary of the assumptions made for the calculations.

Parameter	Assumed value
Temperature	28 °C max (day)
	21 °C min (night)
Wind	1,5 m/s
	NE
Relative Humidity (RHD)	14% RHD (during the day)
	22% RHD (at night)
Static air pressure	95 kPa
Acoustically soft ground conditions	30% Due to sandy soils

The data given in Table 4.8.1 were actually measured on site (apart from the soft ground conditions) during the taking of noise measurements, i.e. between 21 and 23 August 2009. Although the wind speed during gusts often was in excess of 1,5 m/s, the latter was typically measured during the quieter periods. Furthermore, it is understood that the direction of the wind at Arandis is most frequent from the west, i.e. blowing from the town towards the road. However, during the measurements it was found to be from the north-east, i.e. from the road towards the town. In terms of noise propagation this presents a more pessimistic condition than a westerly wind.

Furthermore, it was assumed that the terrain at Arandis and its environment is flat, i.e. that there will be no topographical screening against the propagation of noise. This assumption leads to a conservative estimate of the noise impacts.

4.9 EXPRESSION OF THE NOISE IMPACTS

The impact of noise emissions from the Trekkopje access road on existing ambient noise levels was expressed as contours of the resulting total ambient noise level, i.e.:

- 35 dBA or less
- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA
- 60 dBA or more

Table 5 of SANS 10103 [1] provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If ? is the increase in noise level, the following criteria are of relevance:

- **? = 0 dBA:** An increase of 0 dBA will not cause any response from a community.
- **0 < ? = 10 dBA:** According to Table 5 of SANS 10103 [1], an increase of between 0 dBA and 10 dBA an increase will elicit 'little' community response with 'sporadic complaints'. However, between 5 dBA and 15 dBA the strength of the response will gradually change to 'medium' with 'widespread complaints'. For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level will not be noticeable. The contour describing an increase of 3 dBA is, therefore, a very useful significance indicator.
- **5 dBA < ? = 15 dBA:** Between 5 dBA and 15 dBA an increase will elicit a 'medium' community response with 'widespread complaints'. In addition, an increase of 10 dBA is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dBA, the community reaction will be 'strong' with 'threats of community action'.
- **10 dBA < ? = 20 dBA:** for an increase of between 10 dBA and 20 dBA, the community response will gradually increase in strength to 'strong' with 'threats of community action'.

It will be noted that there are overlapping areas in the categories of responses to increases. The purpose is to underline the fact that there is no clear-cut transition from one community response to another. Instead, the transition is more gradual and may differ substantially from one scenario to another, depending on a large number of variables.

The guidelines provided by the World Bank [3] are in essence the same as those of the WHO [2]. However, they include an interesting criterion in that the noise emissions must not cause the ambient noise level in a residential area to rise by 3 dBA or more, determined during the noisiest hour of a 24-hour period. This is obviously based on the detectability of a general increase in ambient noise levels.

Therefore, in addition to the resulting total ambient noise levels the noise impact was also expressed in terms of the following increases in noise level:

- ? = 0 dBA
- ? = 3 dBA (Significance indicator)
- 0 dBA < ? = 5 dBA
- 5 dBA < ? = 10 dBA
- 10 dBA < ? = 15 dBA

- ? > 15 dBA

4.10 ASSESSMENT OF THE RESULTS

The results were primarily assessed in terms of the guidelines provided by SANS 10103 [1], WHO [2] and IFC [4]. The assessment results were then expressed in terms of the methodology supplied by Turgis.

5. RESULTS OF THE NOISE STUDY

5.1 AMBIENT NOISE MEASUREMENTS

The detailed measurement results are given in Appendix C to this report and are summarised in Table 5.1.1.

TABLE 5.1.1
Summary of the measurement results.

Point	Period	Time	L_{Aeq} (20 min) dBA	L_{A90} dBA	Comments
MP1	Day	10:22	49,2	30,1	Constant wind and warm. Noise in the foliage of trees. Vehicle passes now and then. Man working with wheelbarrow. Bird song. Droning sound from the direction of B2.
	Night	01:27	40,0	36,5	Light wind causes noise in foliage of trees. Very quiet. People talking and calling in the background. Noise with tonality audible on the other side of town.
MP2	Day	10:57	37,9	28,5	Wind as before. Traffic on B2 audible. People talking in the background. Bird song.
	Night	01:55	35,6	30,7	Weather as before. Community noise. People talk and shout. Barking dogs. Noise with tonality audible.
MP3	Day	11:23	25,5	20,2	Warm with little wind. Very quiet. Vehicle arrives at hospital now and then.
	Night	02:20	28,0	24,8	Very quiet, but community is audible. Noise with tonality audible. Traffic on the B2.
MP4	Day	11:52	43,7	29,2	Warm with little wind. Community noise. People talking. Traffic noise in background. Vehicle passes point. Bird song.
	Night	02:46	42,0	37,5	Noise caused by wind in the foliage of trees. Barking dogs. People calling now and then. Traffic on the B2.

The following remarks are of relevance to the results presented in Table 5.1.1:

- MP1: The relatively high L_{Aeq} (20 min) measured during the day was to a large degree caused by the wind in the foliage of trees. This is confirmed by the detailed results given in Figure C-1 (Appendix C), where the noise level is particularly high at the start of the measurement period. Thereafter the noise level tends to be considerably lower. Furthermore, the difference between the measured L_{Aeq} (20 min) and L_{A90} is quite large, which indicates that the former was caused by noisy single events such as caused by wind. During the night the measured L_{Aeq} (20 min) is somewhat lower and considerably more constant than during the day (see Figure C-2). This is confirmed by the small difference between the measured L_{Aeq} (20 min) and L_{A90}. Overall the measured noise levels seem slightly higher than would be expected for this specific environment at the edge of the town.

- MP2: The L_{Aeq} (20 min) measured both during the day and night are relatively low and very much comparable. However, during the day the difference between the L_{Aeq} (20 min) and the L_{A90} is relatively large. This indicates that noisy single events occurred during the measurement that influenced the measurement result. This is confirmed if the detailed measurement results given in Figures C-3 and C-4 (Appendix C) are compared.

- MP3: The measured L_{Aeq} (20 min) and L_{A90} are very low and close to the lowest noise levels measurable in a natural environment. The results give an indication what the ambient noise levels presently are at locations at distances removed from the town. Communal activities probably contributed to the measurement results during the night, since meteorological and other atmospheric conditions favour the propagation of noise during that period. The detailed results in Figure C-5 (Appendix C) show that the ambient noise level is indeed very low, interspersed with single events that were caused by the light wind and occasional arrivals and departures of vehicles at the hospital. The results in Figure C-6 indicate a more stable ambient noise level.

- MP4: The large difference between the L_{Aeq} (20 min) and L_{A90} measured during the day indicate that noisy single events contributed significantly to the former. This is confirmed by the detailed results in Figure C-7 (Appendix C), which show that the ambient noise level is low in between the noisy single events mainly caused by local traffic. Although barking dogs had a significant effect on the L_{Aeq} (20 min) measured during the night, the detailed results (see Figure C-8) also show a more constant ambient noise level once the barking stopped. This confirmed by the relatively smaller difference between the measured L_{Aeq} (20 min) and L_{A90}.

The arithmetic averages of the noise levels measured on the edge of the town, i.e. excluding the results obtained at the hospital, are 43,6 dBA and 39,2 dBA for the day and night, respectively. According to Table 2 of SANS 10103 [1] the corresponding typical ambient noise levels for a 'rural district' are 45 dBA and 35 dBA. It is recommended that these levels be accepted as representative for the ambient noise level in Arandis.

Outside the town, i.e. at the hospital, the measured L_{Aeq} (20 min) was 25,5 dBA and 28,0 dBA for the day and night, respectively. Therefore, it is proposed that 25 dBA and 28 dBA be used for the area that falls outside Arandis. It must be noted that this is a very conservative assumptions, since they will cause rather an over- than under-estimation of the noise impact.

5.2 THE NOISE IMPACT DURING THE CONSTRUCTION PERIOD

The following assumptions were made for the construction period:

- The construction activities take place at a location nearest to the town, i.e. directly opposite the Arandis hospital;
- The noise sources include a bulldozer, grader, roller and construction truck; and
- Construction activities are restricted to the day only.

The calculated noise impact contours are given in Figures 5.2.1 and 5.2.2.

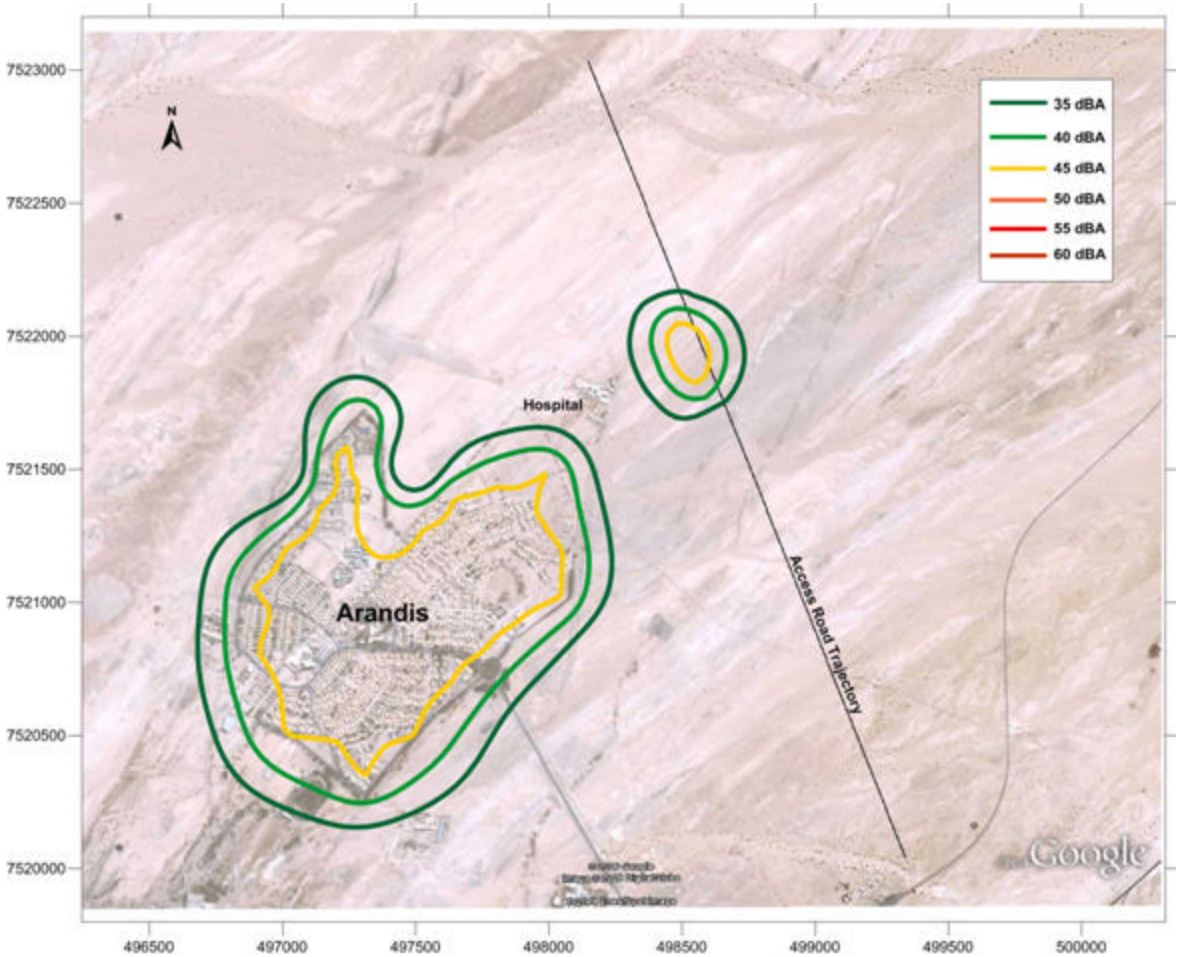

Figure 5.2.1: The noise impact during the construction period expressed as the total resulting ambient noise level.

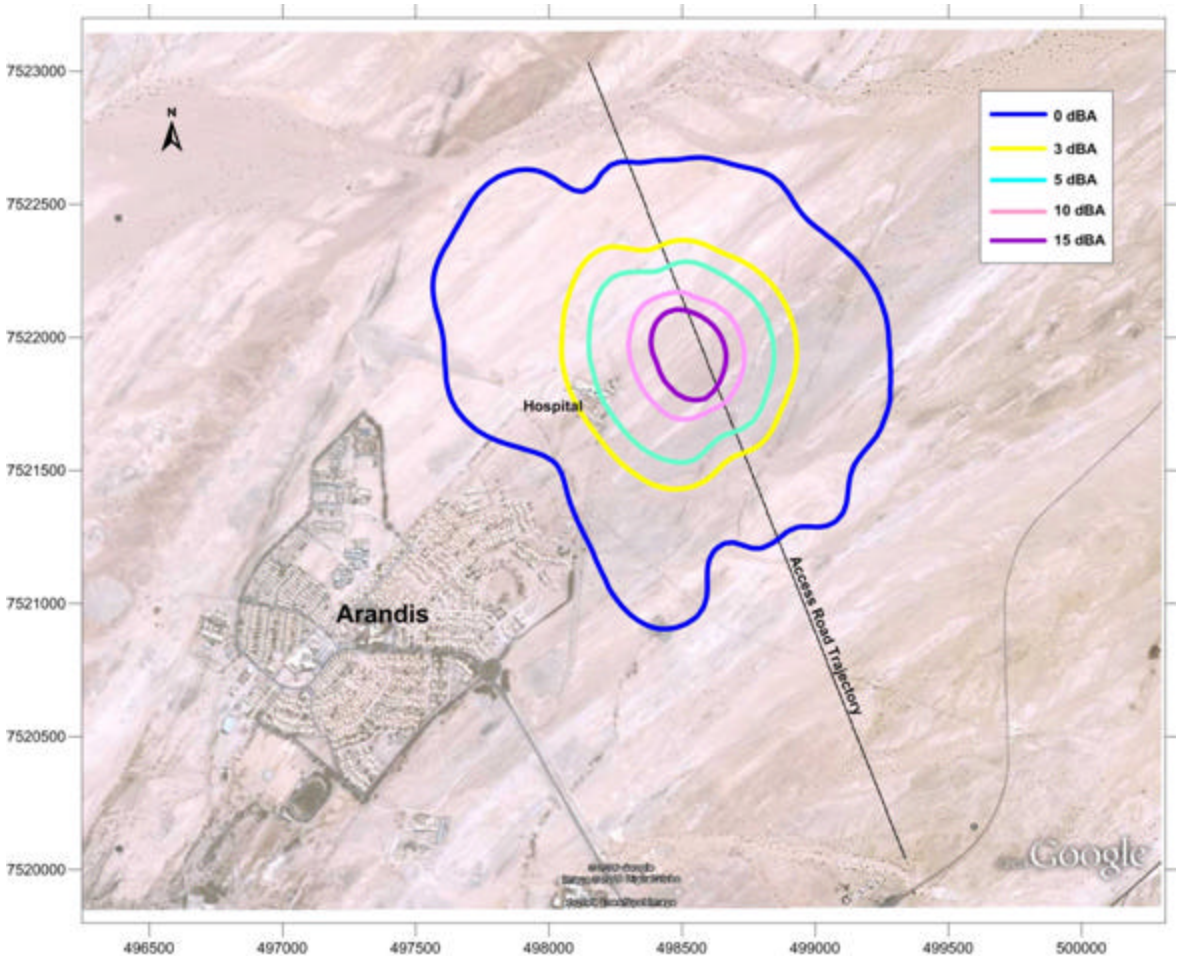

Figure 5.2 .2: The noise impact during the construction period expressed as the increase in ambient noise level.

The following remarks are applicable to the results presented in Figures 5.2.1 and 5.2.2:

- It is clear that during construction the total resulting ambient noise level (see Figure 5.2.1) in Arandis will be 45 dBA or less, whereas at the point nearest to the construction activities, i.e. the hospital, it will be well below 35 dBA. According to Table 1 of SANS 10103 [1] the ambient noise level inside a ward with one bed should optimally not exceed 30 dBA. If it is assumed that the insertion loss of the building façade is 10 dB, then this would imply an outdoor noise level of 40 dBA. Therefore, the calculated ambient noise level at the hospital is well below 40 dBA, and will not affect the effective functioning of the hospital.

- In terms of the results given in Figure 5.2.2 there will be no increase in ambient noise level in Arandis. At the hospital the increase will be between 3 dB and 5 dB. This level of increase is due to the presently very low ambient noise level at this location. According to Table 5 of SANS 10103 [1] there will be no community response in Arandis to this increase, whereas at the hospital it will be 'little' with 'sporadic complaints'.

The impact rating according to the methodology supplied by Turgis is summarised in Table 5.2.1.

TABLE 5.2.1
Summary of the impact rating during construction.

Impact rating criterion					Significance rating
Intensity	Extent	Mitigation	Duration	Probability	
Low to moderate	Site only	Moderate to high	Temporary	Highly probable	**Low**
2	1	2	1	4	24

Therefore the significance score is 2.

5.3 THE NOISE IMPACT DURING THE UNMITIGATED OPERATION OF THE ROAD

The following assumptions were made for the unmitigated operational phase of the road:

- The noise emissions are caused by traffic on the road, consisting of heavy (e.g. transport trucks) and light (LDV's) vehicles;
- The heavy vehicles travel at a speed of 80 km/h and the light vehicles at 100 km/h; and
- The traffic flow consists of 10 and 20 passes of, respectively, heavy and light vehicles during both the day and night.

The resulting noise impact contours are given in Figures 5.3.1 and 5.3.2 for the day and Figures 5.3.3 and 5.3.4 for the night.

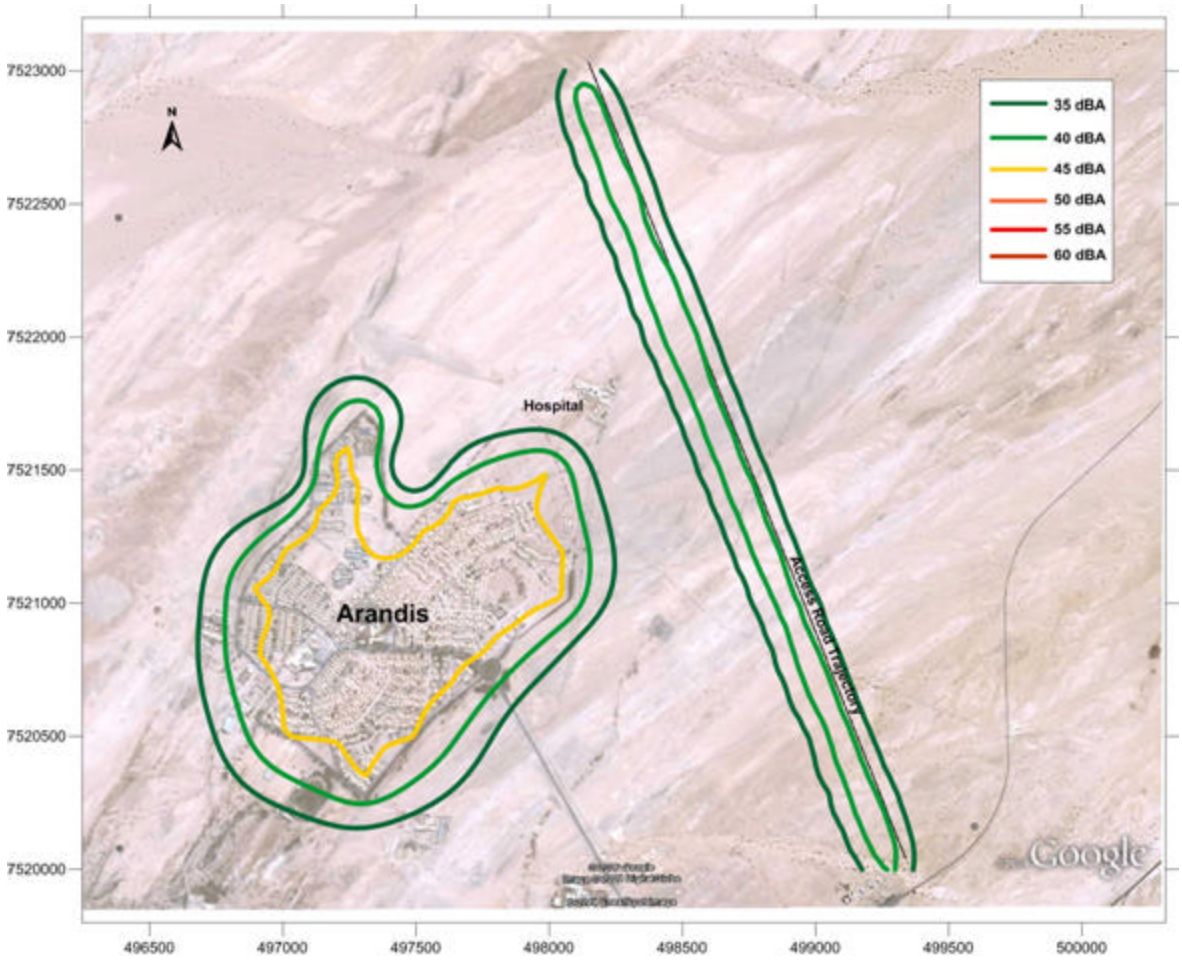

Figure 5.3.1: Contours of the noise impact during the unmitigated operation of the access road during the day, expressed as the total resulting ambient noise level.

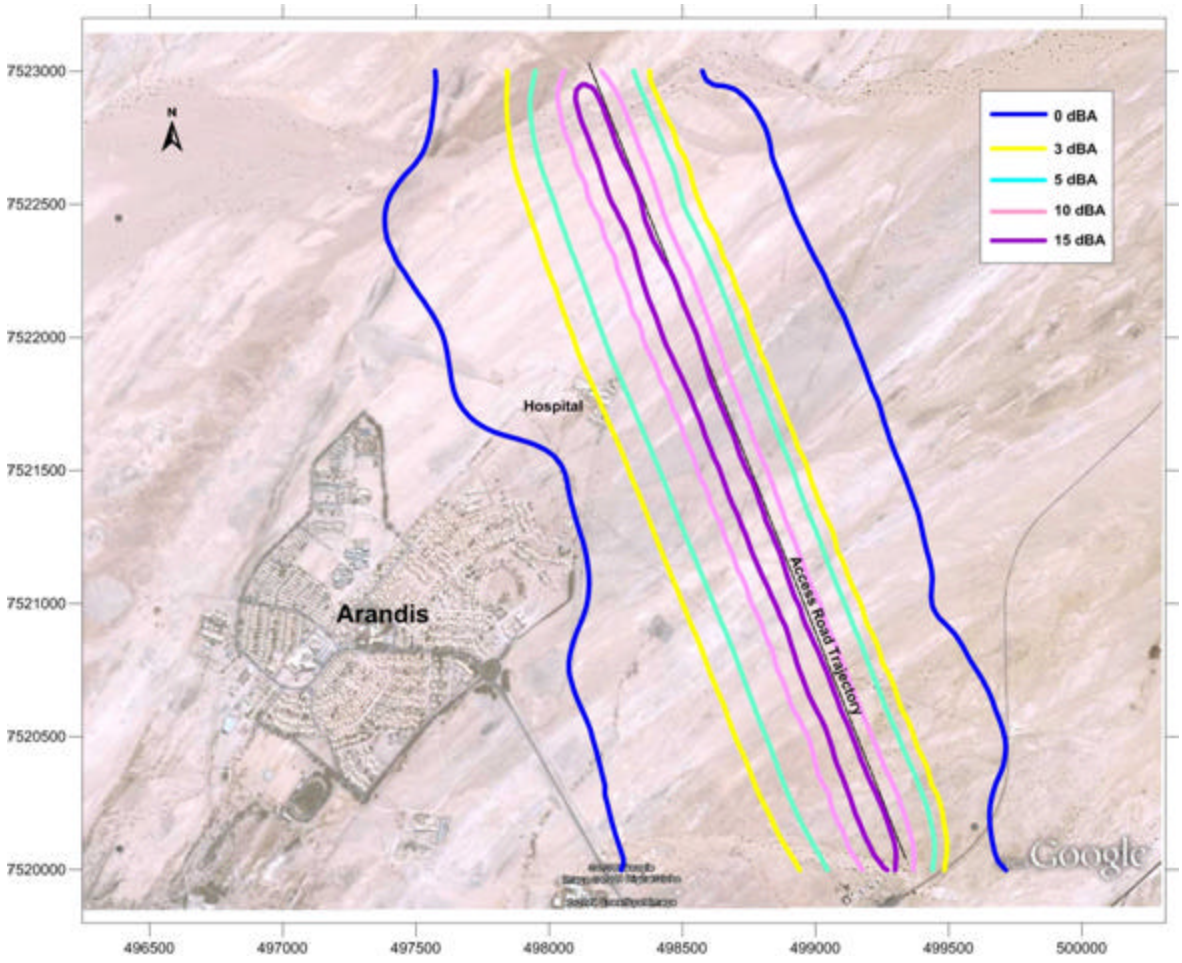

Figure 5.3.2: Contours of the noise impact during the unmitigated operation of the access road during the day, expressed as the increase in ambient noise level.

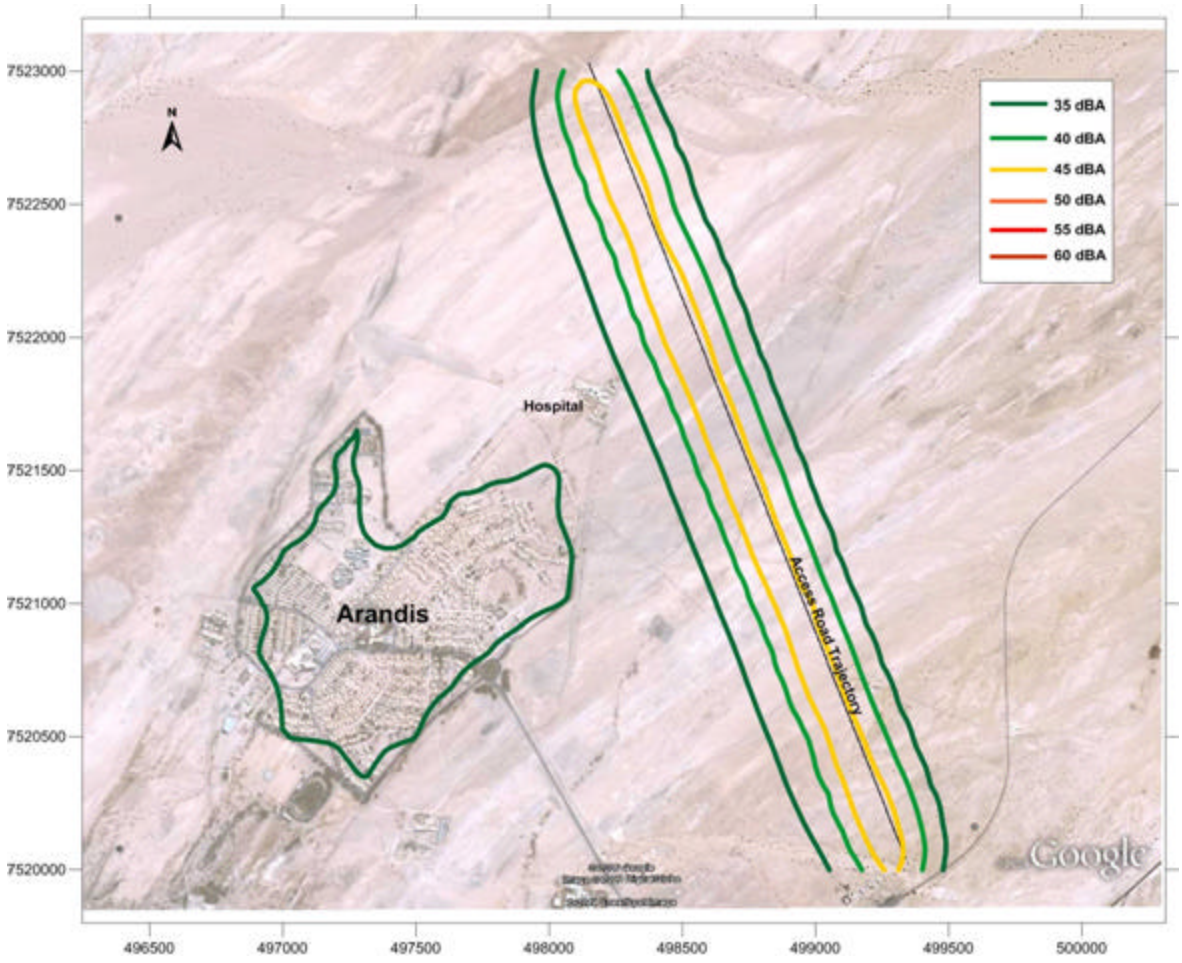

Figure 5.3.3: Contours of the noise impact during the unmitigated operation of the access road during the night, expressed as the total resulting ambient noise level.

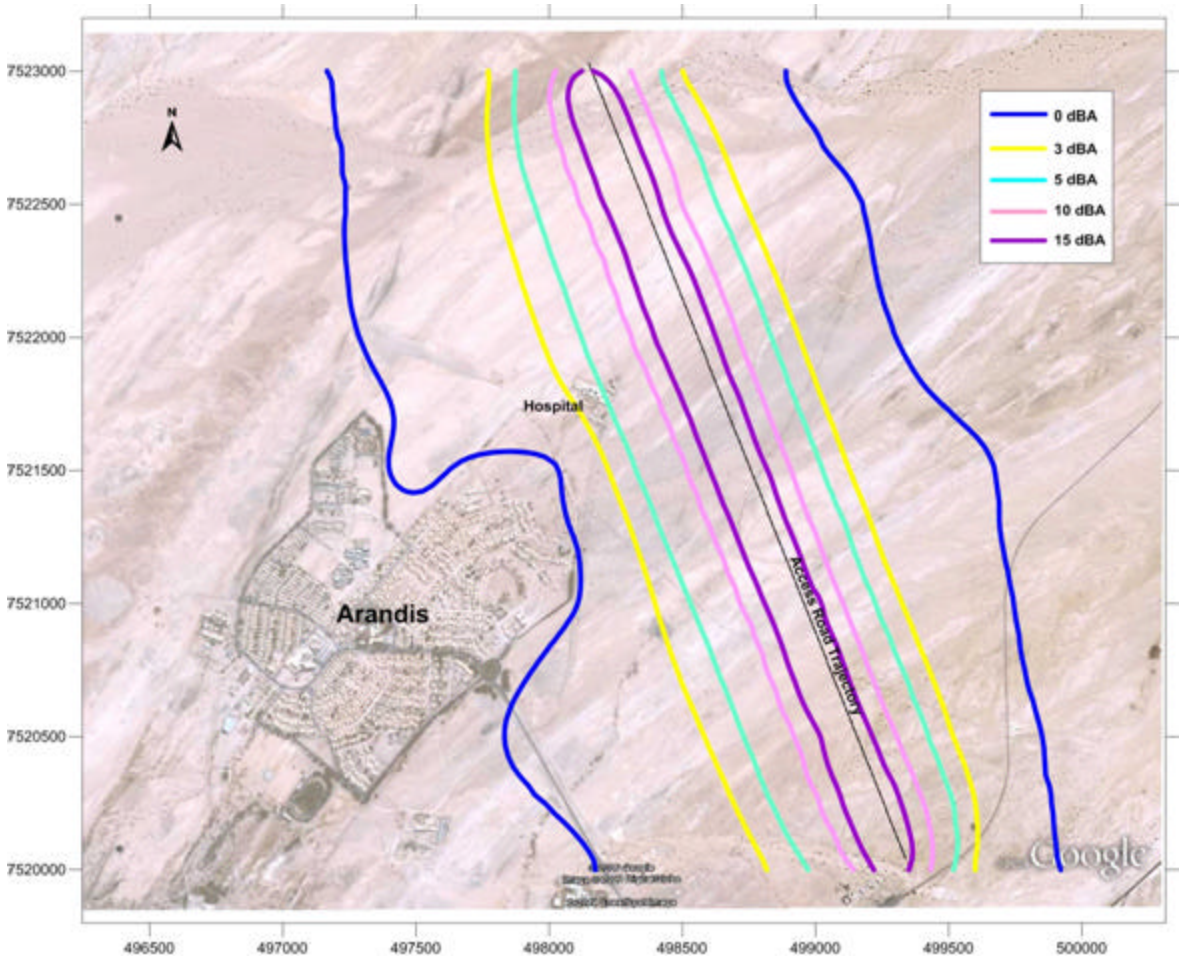

Figure 5.3.4: Contours of the noise impact during the unmitigated operation of the access road during the night, expressed as the increase in ambient noise level.

The following remarks are of relevance to the results presented in Figures 5.3.1 to 5.3.4:

- The offset of the noise impact contours towards the south-west is due to the assumed north-easterly wind, as explained in Section 4.8 of this report.

- During the day the contours of the total resulting ambient noise level (see Figure 5.3.1) are very much limited to the immediate vicinity of the access road. The ambient noise level at the nearest noise sensitive receptor, i.e. the hospital, is well below 35 dBA. Therefore, in terms of the total resulting ambient noise level the functioning of the hospital will not be affected.

- In terms of the increase in ambient noise level during the day (see Figure 5.3.2) it is clear that the town of Arandis will not experience an impact. At the hospital the increase in ambient noise level will be approximately 3 dB. This impact is, in terms of the assessment criteria explained in Section 4.9 of this report, just significant.

According to Table 5 of SANS 10103 [1] the community reaction at the hospital to this increase will be 'little' with 'sporadic complaints'.

- As may be expected the extent of the noise impact during the night is further than during the day. This is due to the fact that meteorological and other atmospheric conditions favour the propagation of sound during the night.

- However, the total resulting ambient noise level (see Figure 5.3.3) during the night will still be below 35 dBA. Therefore, in terms of this parameter the effective operation of the hospital during the night will not be affected.

- In terms of the increase in ambient noise level (see Figure 5.3.4) the hospital will experience a significant increase of between 3 dB and 5 dB. According to Table 5 of SANS 10103 [1] the community reaction at the hospital to this increase will be 'little' with 'sporadic complaints'.

The impact rating according to the methodology supplied by Turgis is summarised in Table 5.3.1.

TABLE 5.3.1
Summary of the impact rating during unmitigated operation.

Impact rating criterion					Significance rating
Intensity	Extent	Mitigation	Duration	Probability	
Low to moderate	Local	Moderate to high	Long term	Highly probable	**Low**
2	2	2	4	4	40

Therefore the significance score is 2.

5.4 MITIGATION OF THE NOISE IMPACT

Although the intensity of the noise impact for the unmitigated operational phase is only *low to moderate* the increase in ambient noise level at the hospital will be significant. Therefore, the application of noise mitigation may be recommended.

A combination of two noise mitigation measures can be considered:

- The use of a smooth road surface texture for the section of road that passes close to Arandis, specifically the hospital; and

- The placing of an effective noise barrier with a minimum height of 2,5 m above ground level on the Arandis side of the road.

For the noise barrier to be effective it must comply with the following requirements:

- It must be high enough to prevent line of sight from the receiver to the source line. The latter typically has a height of 0,5 m above the road surface for light vehicles and 1,5 m for heavy vehicles.

- The barrier must be long enough to cover a substantial angle of view from the receiver onto the source line.
- The barrier must be continuous, i.e. without any gaps over the entire length.
- The barrier must have a minimum mass of 40 kg/m^2.

The effect of such a noise barrier was calculated and the results are presented in Figures 5.4.1 and 5.4.2. Since the maximum noise impact occurs during the night, only the results for this time period are shown.

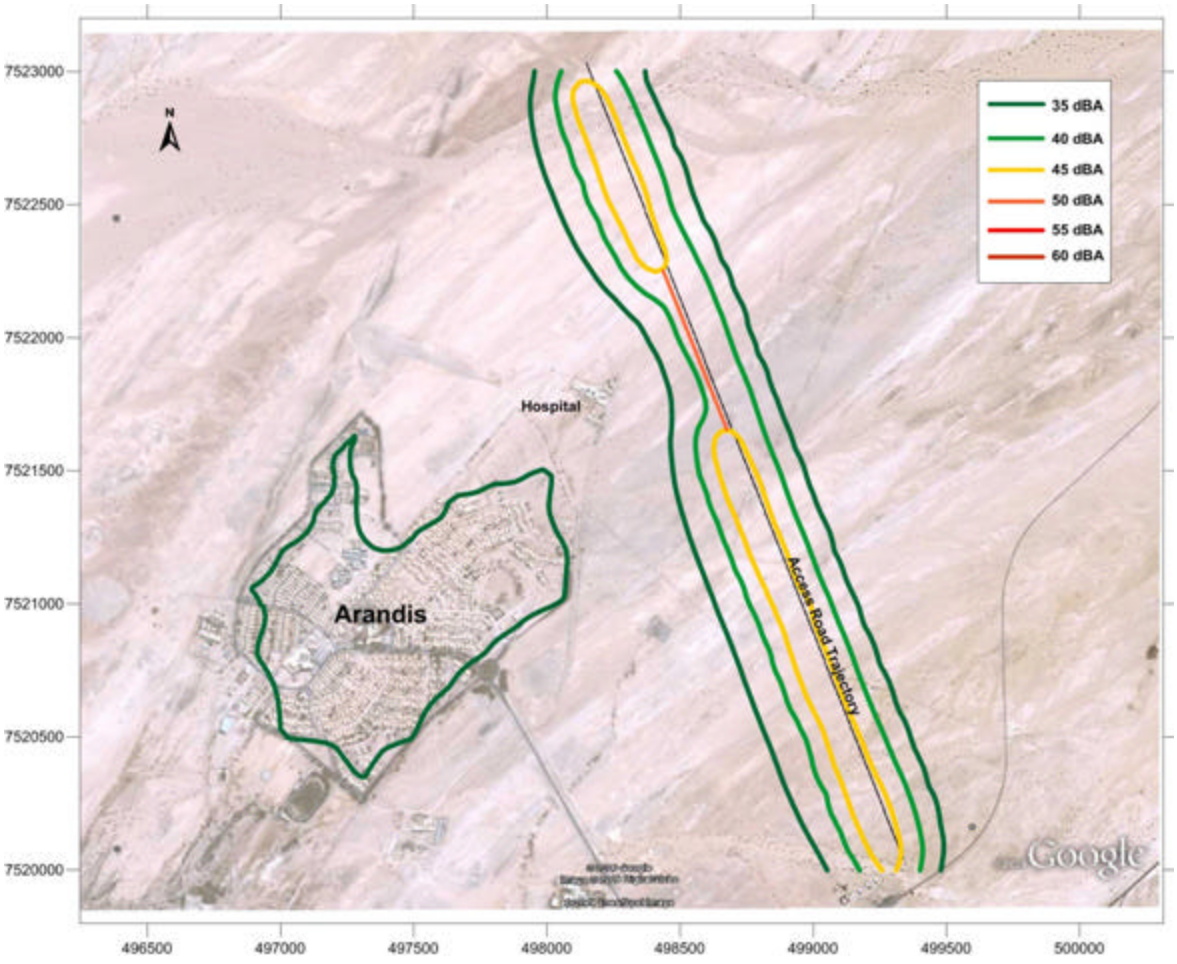

Figure 5.4.1: Contours of the noise impact during the mitigated operation of the access road during the night, expressed as the total resulting ambient noise level. The brown line represents the location of the noise barrier.

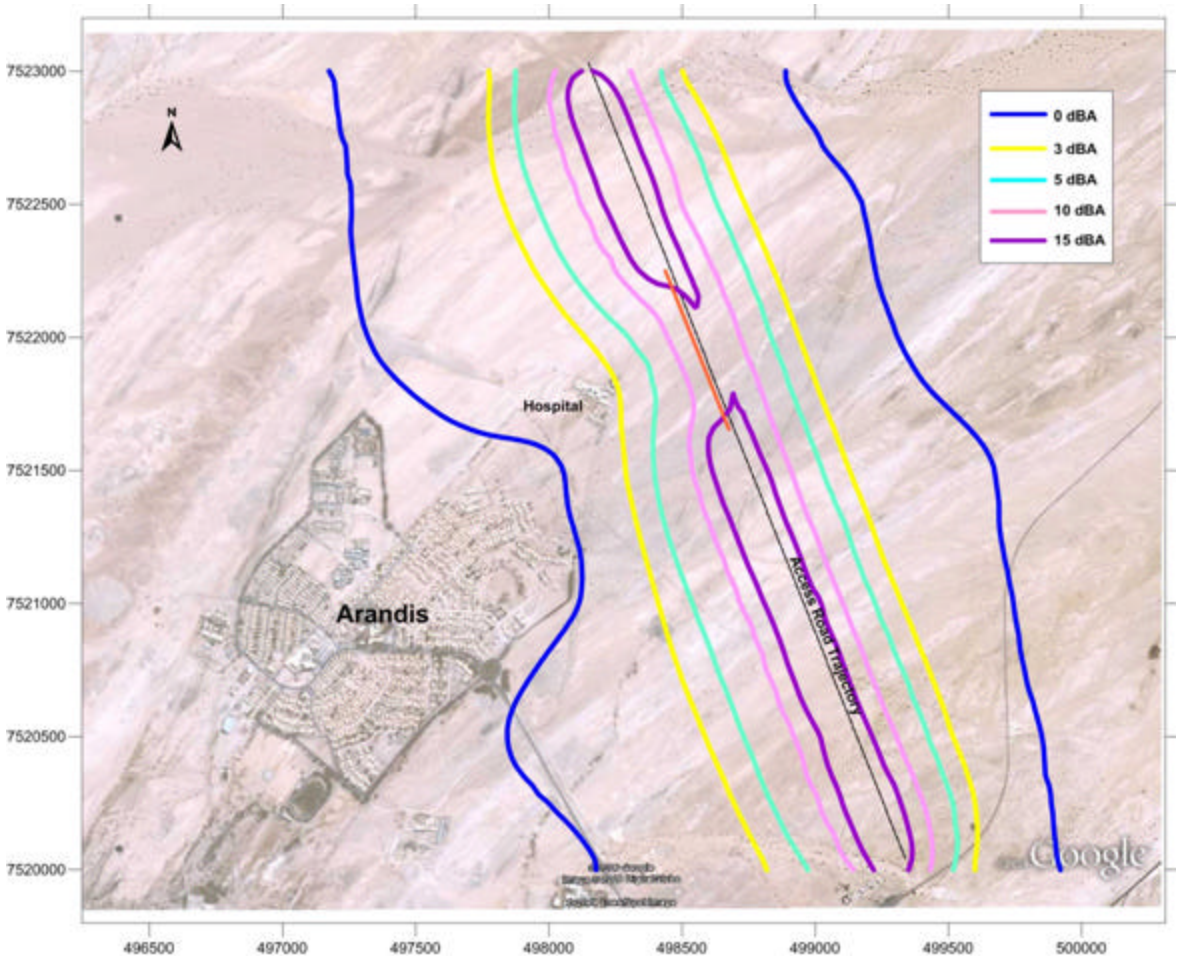

Figure 5.4.2: Contours of the noise impact during the mitigated operation of the access road during the night, expressed as the increase in ambient noise level. The brown line represents the location of the noise barrier.

The results presented in Figures 5.4.1 and 5.4.2 clearly indicate that the extent of the noise impact at the hospital has been significantly reduced. The increase in ambient noise level is now less than 3 dB and, therefore, insignificant.

The impact rating according to the methodology supplied by Turgis is summarised in Table 5.4.1.

TABLE 5.4.1
Summary of the impact rating during mitigated operation.

Impact rating criterion					Significance rating
Intensity	Extent	Mitigation	Duration	Probability	
Low	Local	High	Long term	Highly probable	**Low**
1	2	1	4	4	32

Therefore the significance score is 2.

6. CONCLUSIONS

The following conclusions may be drawn from the results of this noise study:

- The present ambient noise levels in Arandis are typical for a rural community and are determined by communal activities, local traffic and natural noise sources, such as the interaction of the wind with the foliage of trees.

- Ambient noise levels outside the town itself quickly drop to very low levels. This is also the case for the hospital, which is located a small distance out of town.

- During construction there will be no increase in ambient noise level in Arandis itself and the total resulting ambient noise levels during the day and night will effectively remain unchanged. As a result there will be no community response to the noise emissions from the construction activities.

- However, at the hospital the increase in ambient noise level will be between 3 dB and 5 dB, resulting in 'little' community response with 'sporadic complaints' (SANS 10103[1]).

- During the construction period the intensity of the noise impact will be low to moderate and the significance rating **Low** with a score of 2.

- For the unmitigated operation of the access road during the day the noise impact is very much limited to the immediate vicinity of the road, and the resulting total ambient noise level at the nearest noise sensitive receiver, i.e. the hospital, will be well below 35 dBA.

- Although the extent of the noise impact is further than during the day, the remarks made under the previous bullet are also applicable during the night.

- Therefore, the effective operation of the hospital activities will not be compromised.

- During the day the increase in ambient noise level at the hospital will be 3 dB, which may be regarded as barely significant. During the night the increase will be between 3 dB and 5 dB, which does represent a significant noise impact.

- According to SANS 10103[1] the community response during both the day and night will be 'little' with 'sporadic complaints'.

- During the unmitigated operational period the intensity of the noise impact will be low to moderate and the significance rating **Low** with a score of 2.

- With the placement of a noise barrier with a minimum height of 2,5 m on the Arandis side of the road the extent of the noise impact at the hospital is

significantly reduced. The increase in ambient noise level is now less than 3 dB and, therefore, insignificant.

- According to SANS 10103 [1] the community response during both the day and night will be 'little' with 'sporadic complaints'.

- During the mitigated operational period the intensity of the noise impact will be low and the significance rating will remain **Low** with a score of 2.

7. RECOMMENDATIONS

The following recommendations can be made:

- All diesel powered equipment must be kept in a prime state of maintenance;

- Regular maintenance routines must include the checking and replacement of intake and exhaust silencers if necessary; and

- A change in the noise emission characteristics of a piece of equipment must serve as a trigger to withdraw it for maintenance purposes.

- A noise barrier may be considered, with a minimum height of 2,5 m above ground level stretching for a distance of approximately 640 m along the Arandis side of the road opposite the hospital.

8. REFERENCES

In this report reference was made to the following documentation:

(1) SANS 10103:2008 'The measurement and rating of environmental noise with respect to annoyance and to speech communication', Edition 6.

(2) Guidelines for Community Noise, World Health Organisation, Geneva, 1999.

(3) Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production, Published March 1999 by World Bank ISBN: 0-8213-3638-X.

(4) International Finance Corporation, General EHS Guidelines: Environmental, 30 April 2007.

(5) ISO 1996-1, Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment.

(6) ISO 1996-2, Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels.

(7) SANS 10357:2004 'The calculation of sound propagation by the Concawe method'. Edition 1.2.

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APPENDIX A

Measurement instrumentation

9. APPENDIX A: MEASUREMENT INSTRUMENTATION

The measurement instrumentation complies with the accuracy requirements specified for a type 1 instrument in IEC 651 'Sound level meters', IEC 804 'Integrating-averaging sound level meters' and IEC 942 'Sound calibrators'.

TABLE A-1
Measurement instrumentation

Instrument	Type	Serial Number	Date calibrated	Calibration Certificate
Sound Analyser	Svan912AE	2935	2008/03/25	2008-359
Microphone	GRAS 40AN	1687513	2008/03/25	2008-359
Sound level calibrator	Rion NC-73	10486628	2007/11/06	2332.AV1350-1

The calibration status of the instrumentation was checked before and after each set of measurements against a calibrated signal with a level of 94,0 dB at 1 kHz. In each case the instrument displayed a reading of within 1 dB of the calibrated value. A windshield supplied by the manufacturer of the instrument was used during all the measurements.

APPENDIX B

Sound power emission levels of equipment

10. APPENDIX B: SOUND POWER EMISSION LEVELS OF EQUIPMENT

The sound power emission levels that were used in the calculations are summarised in Table B-1.

TABLE B-1
Sound power emission levels of equipment.

Equipment	Sound power emission level, dB re 1 pW, in octave frequency band, Hz						
	63	125	250	500	1000	2000	4000
Heavy vehicle	90.0	101.0	102.0	105.0	105.0	104.0	99.0
Light vehicle	74.2	86.0	84.0	85.4	90.0	84.8	77.8
Bulldozer, D9	100.0	118.0	111.0	109.0	107.0	103.0	97.0
Grader	100.0	111.0	108.0	108.0	106.0	104.0	98.0
Vibrating Roller	107.8	106.4	103.7	104.8	104.1	103.8	97.7

APPENDIX C

Detailed measurement results

11. APPENDIX C: DETAILED MEASUREMENT RESULTS

The detailed measurement results are given in Figures C-1 to C-8.

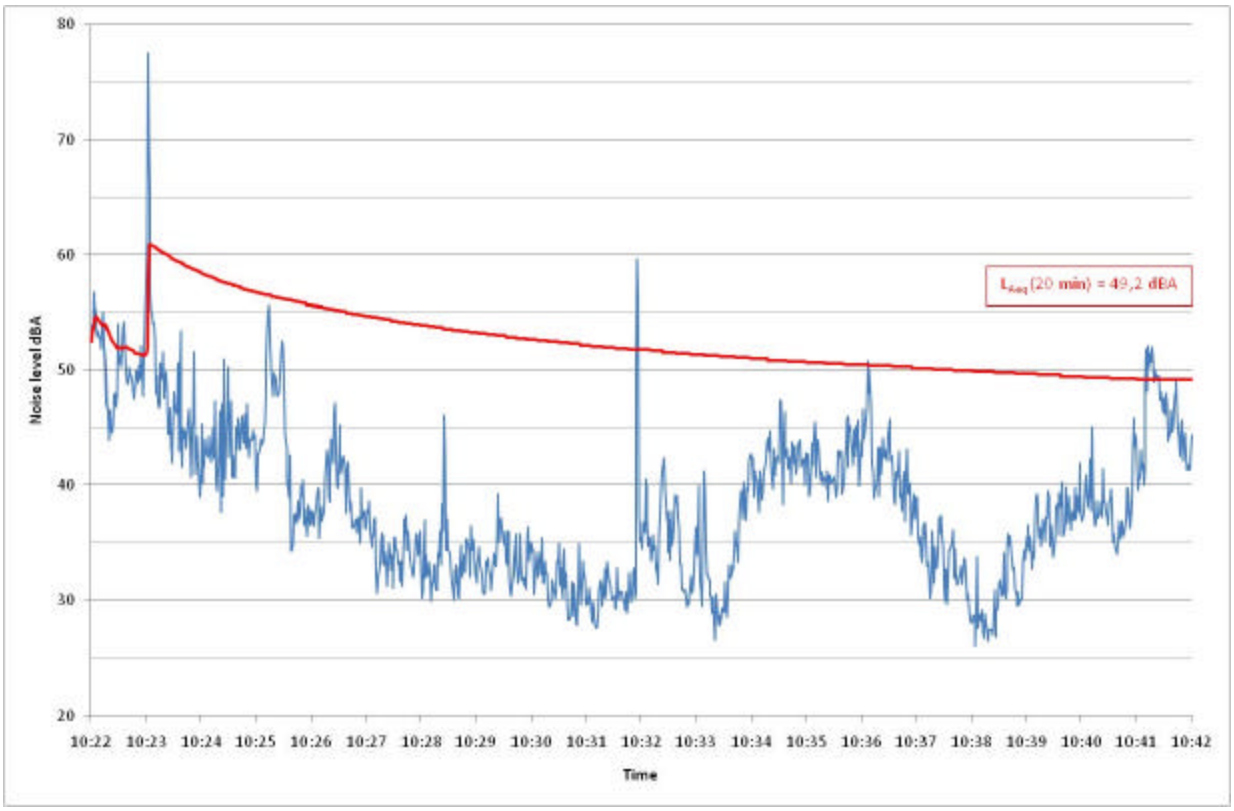

Figure C-1: Detailed measurement results for MP1 during the day.

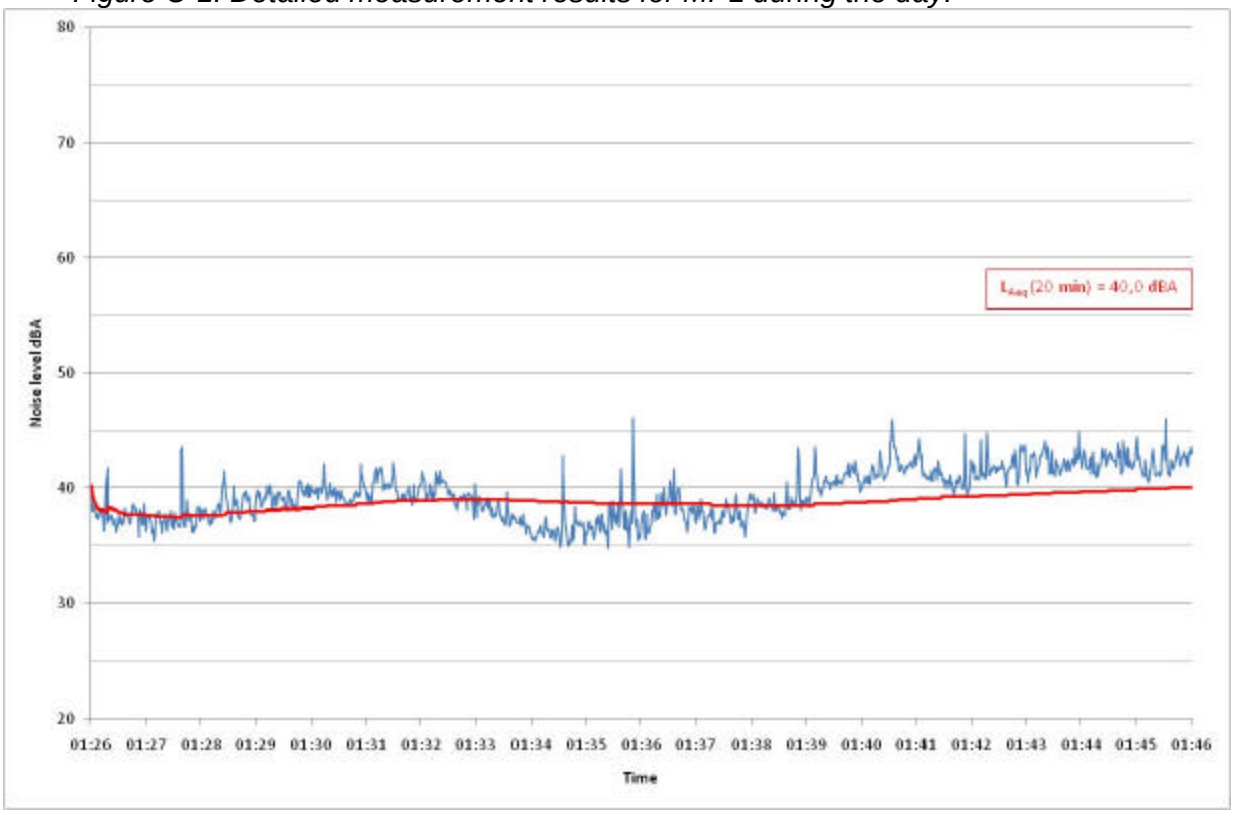

Figure C-2: Detailed measurement results for MP1 during the night.

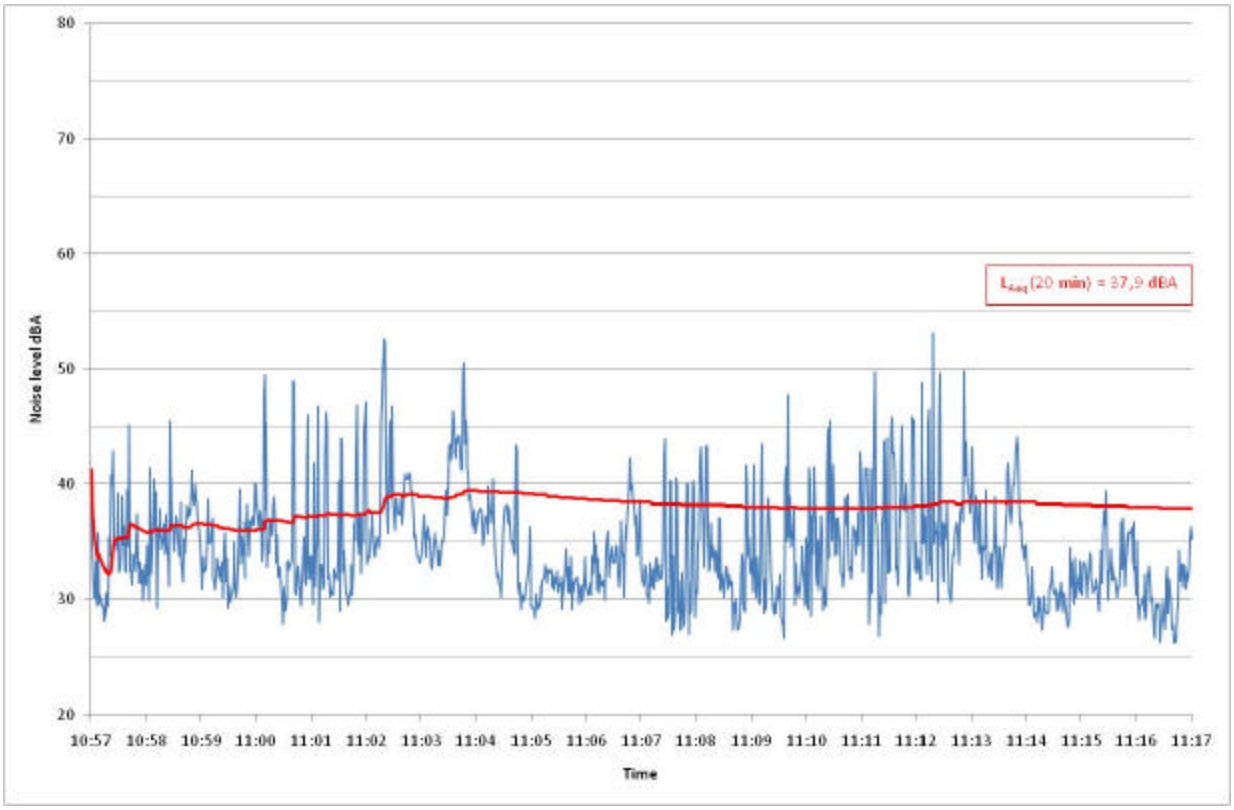

Figure C-3: Detailed measurement results for MP2 during the day.

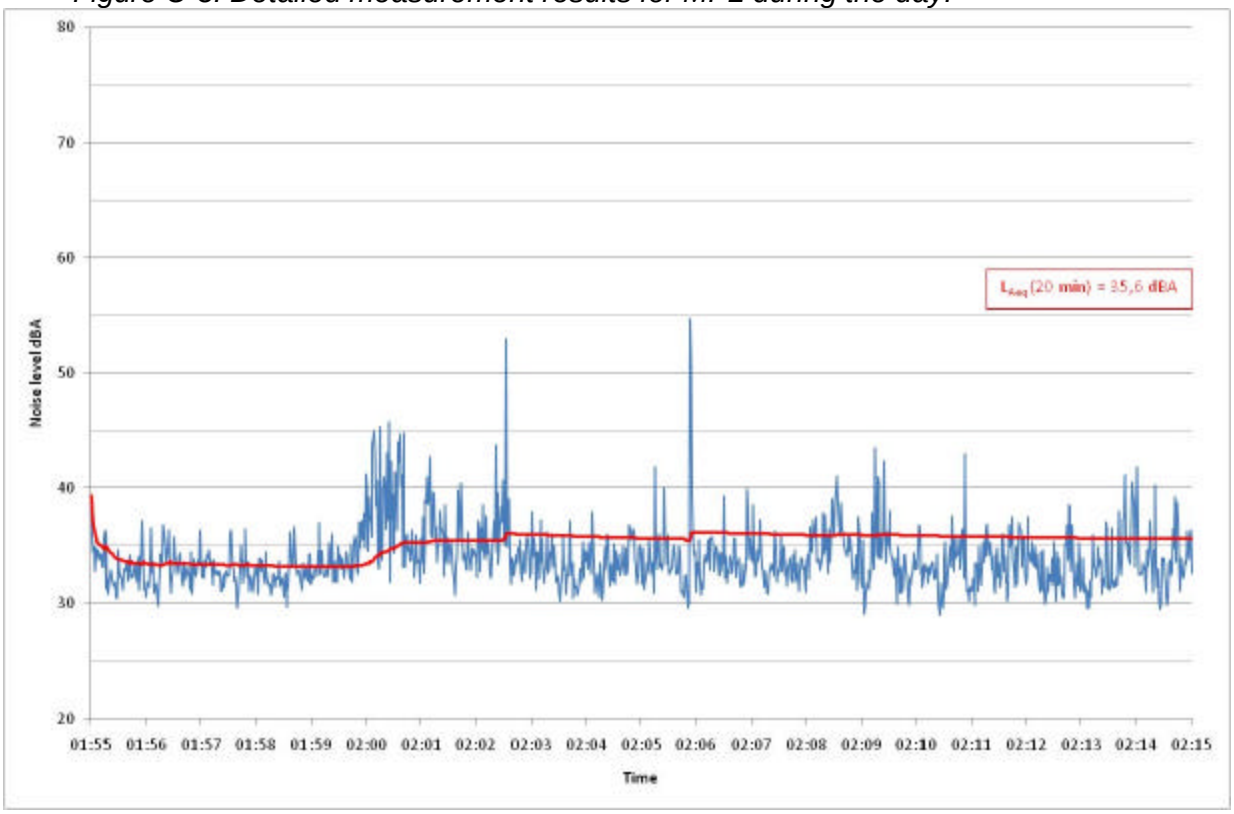

Figure C-4: Detailed measurement results for MP2 during the night.

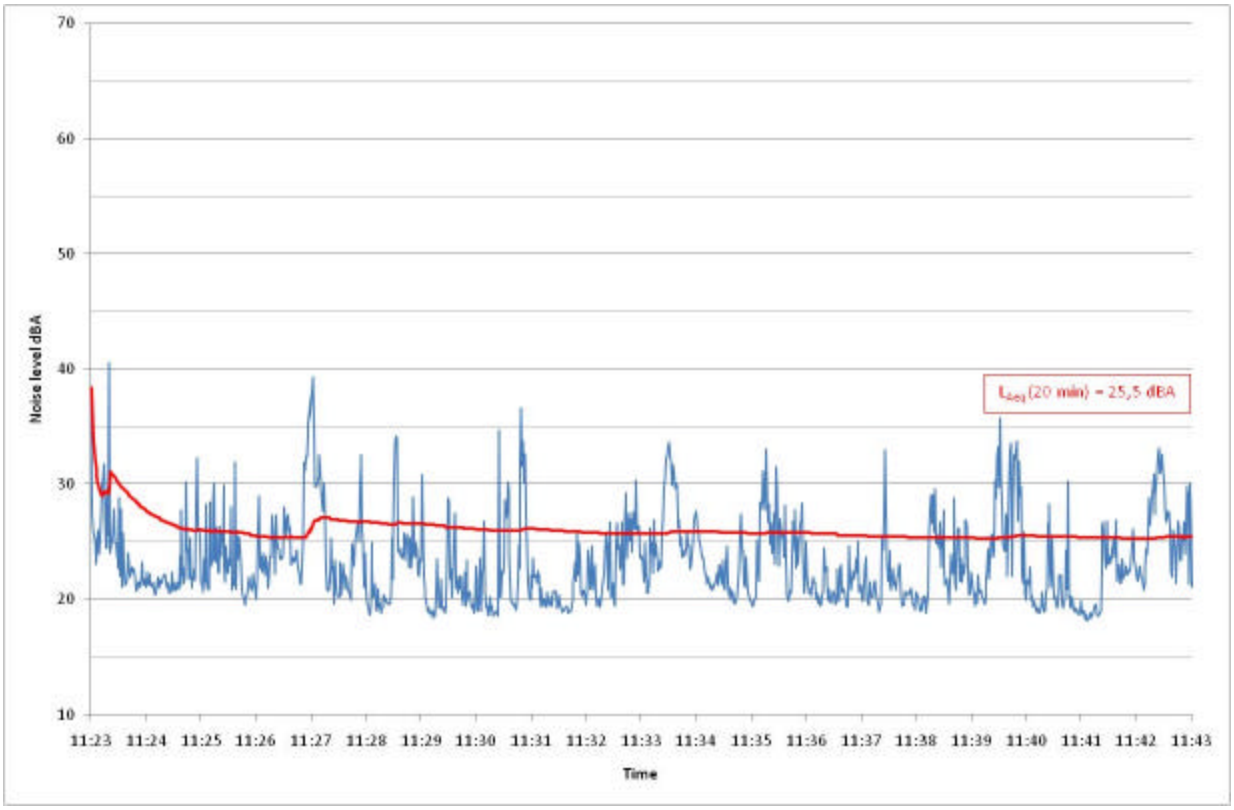

Figure C-5: Detailed measurement results for MP3 during the day.

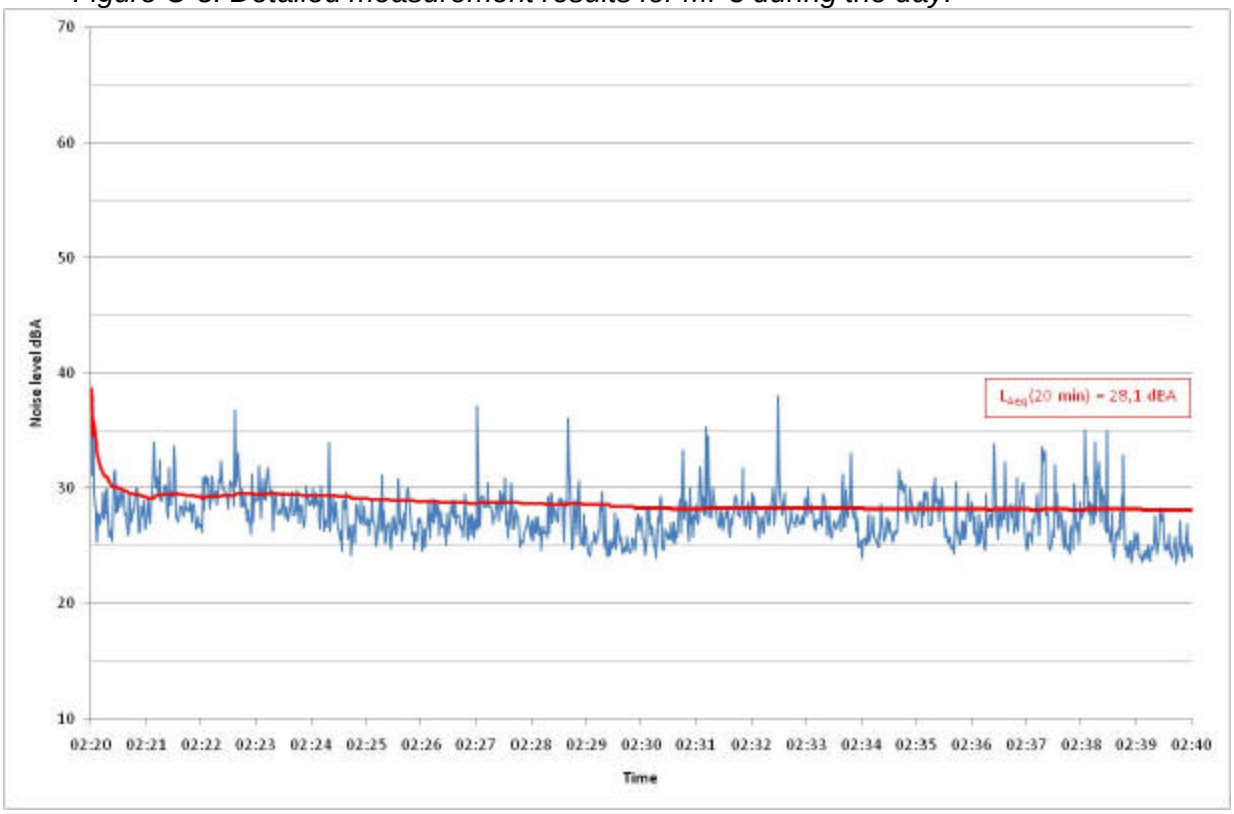

Figure C-6: Detailed measurement results for MP3 during the night.

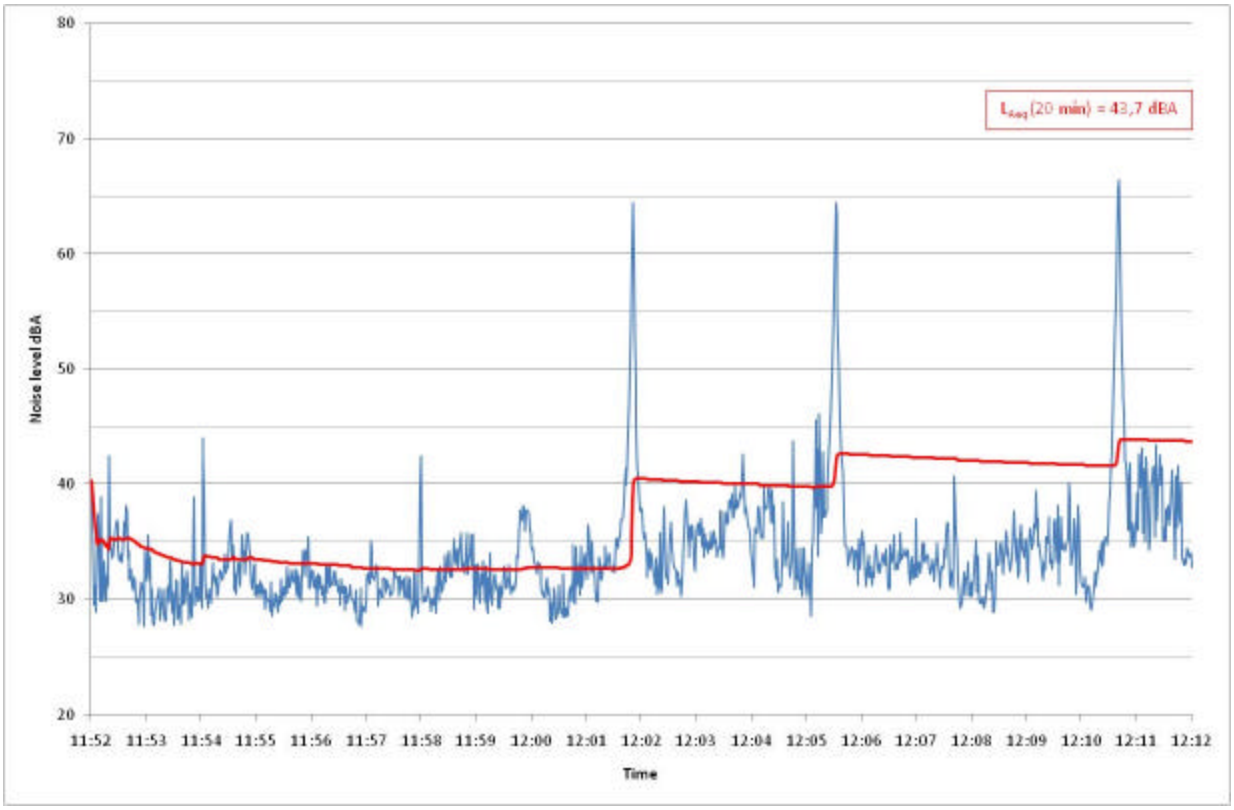

Figure C-7: Detailed measurement results for MP4 during the day.

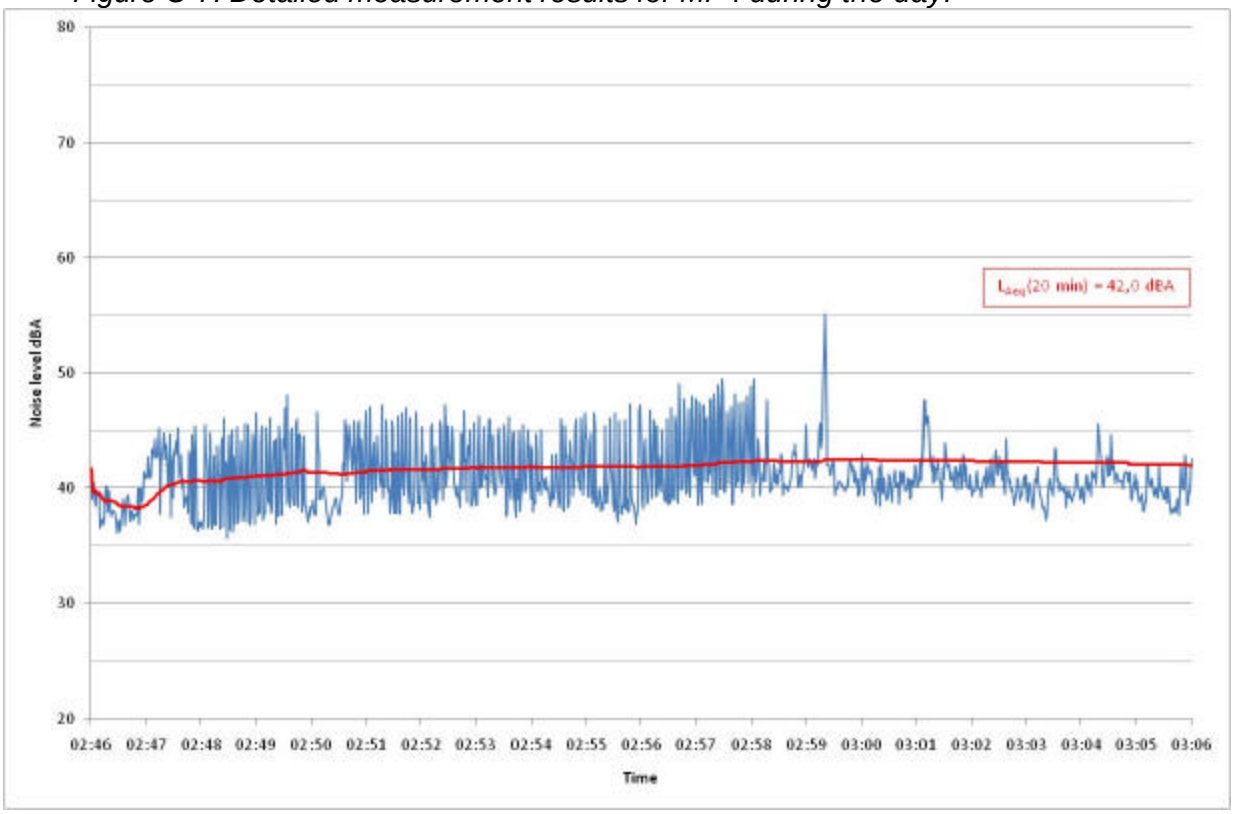

Figure C-8: Detailed measurement results for MP4 during the night.