APPENDIX 9
PALAEONTOLOGICAL IMPACT ASSESSMENT

Palaeontological Impact Assessment for the proposed Tawana Hotazel Mine, Northern Cape Province

Desktop Study (Phase 1)

For

Prime Resources (Pty) Ltd

22 April 2021

Prof Marion Bamford
Palaeobotanist
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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 31 years research; 23 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Prime Resources (Pty) Ltd, Johannesburg, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A palaeontological Impact Assessment was requested for the Mining Right application for the Tawana Hotazel Mine, Northern Cape Province. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed project.

The mining site lies on the aeolian sands of the Kalahari Group (Quaternary age). Rocks bearing iron and manganese are below the surface and they do not preserve any fossils. Aeolian sands do not preserve fossils as they are windblown. Rarely the sands will entrap more robust fossils, such as fragments of bones or wood, but these are not in situ. If palaeopans or palaeosprings are in the area they might preserve fossils but no such feature is evident from the Google Earth imagery. There is an extremely small chance that fossils occur on the land surface, nonetheless a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no palaeontological site visit is required and mining may proceed.

Table of Contents

1. Background

Tawana Hotazel Mining (Pty) Ltd intends on submitting an application for a Mining Right (MR) to the Department of Mineral Resources and Energy (DMRE) for the proposed Tawana Hotazel Mine (THM). The Mining Right Application area is 145.1 Ha. The types of minerals applied for are: all (Code UN); Iron and Iron bearing minerals including hematite, goethite, specularite and limonite (Code (Fe) Type (B)) and Manganese and manganese bearing minerals (Code (Mn) Type (B)).

The THM covers portions of two farms within the Joe Morolong Local Municipality in the Northern Cape Province; Hotazel 280 and York 279 and is located approximately 1 km south-east of the town of Hotazel (Figure 1). The THM largely incorporates the historical Hotazel Manganese Mine (HMM), including the residual opencast void, surface dumps of low-grade material and the mothballed processing plant and rail loadout facility. HMM stopped production in 1989. The area was historically mined by both opencast and underground means and yielded high grade manganese ore. All current plans for the project specifically exclude underground mining.

Surface infrastructure will include the opencast pit (incorporating the historical HMM void and further expansion of the opencast footprint), in-pit waste dumps (residue material), vehicle yard, workshop, access and haul roads, offices, stores, processing plant, product stockpile area, run of mine pad, refuel bay and water management infrastructure (Figure 2).

A Palaeontological Impact Assessment was requested for the mining right application. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed project and is reported herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (amended 2017)

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5

d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
k	Any mitigation measures for inclusion in the EMPr	Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	N/A
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies if any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A

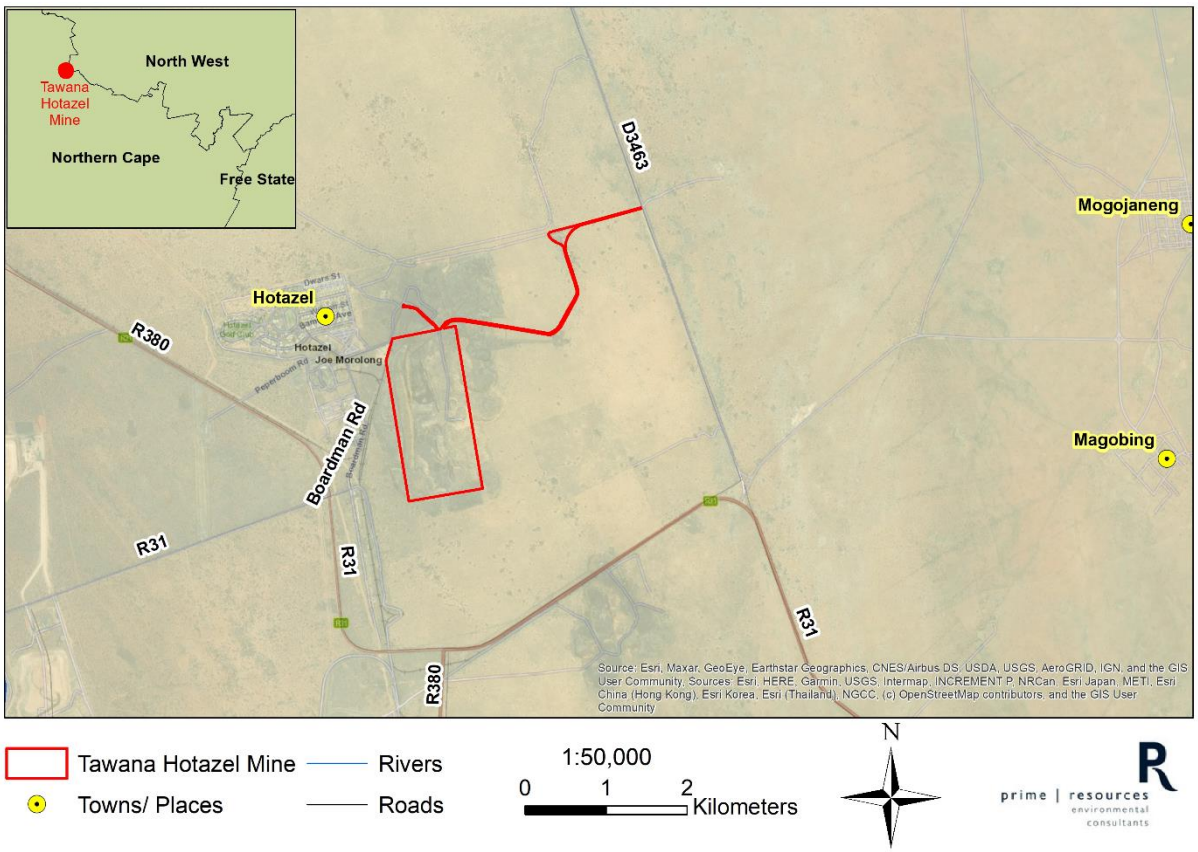

Figure 1: Locality map of the proposed THM. Map supplied by Prime Resources.

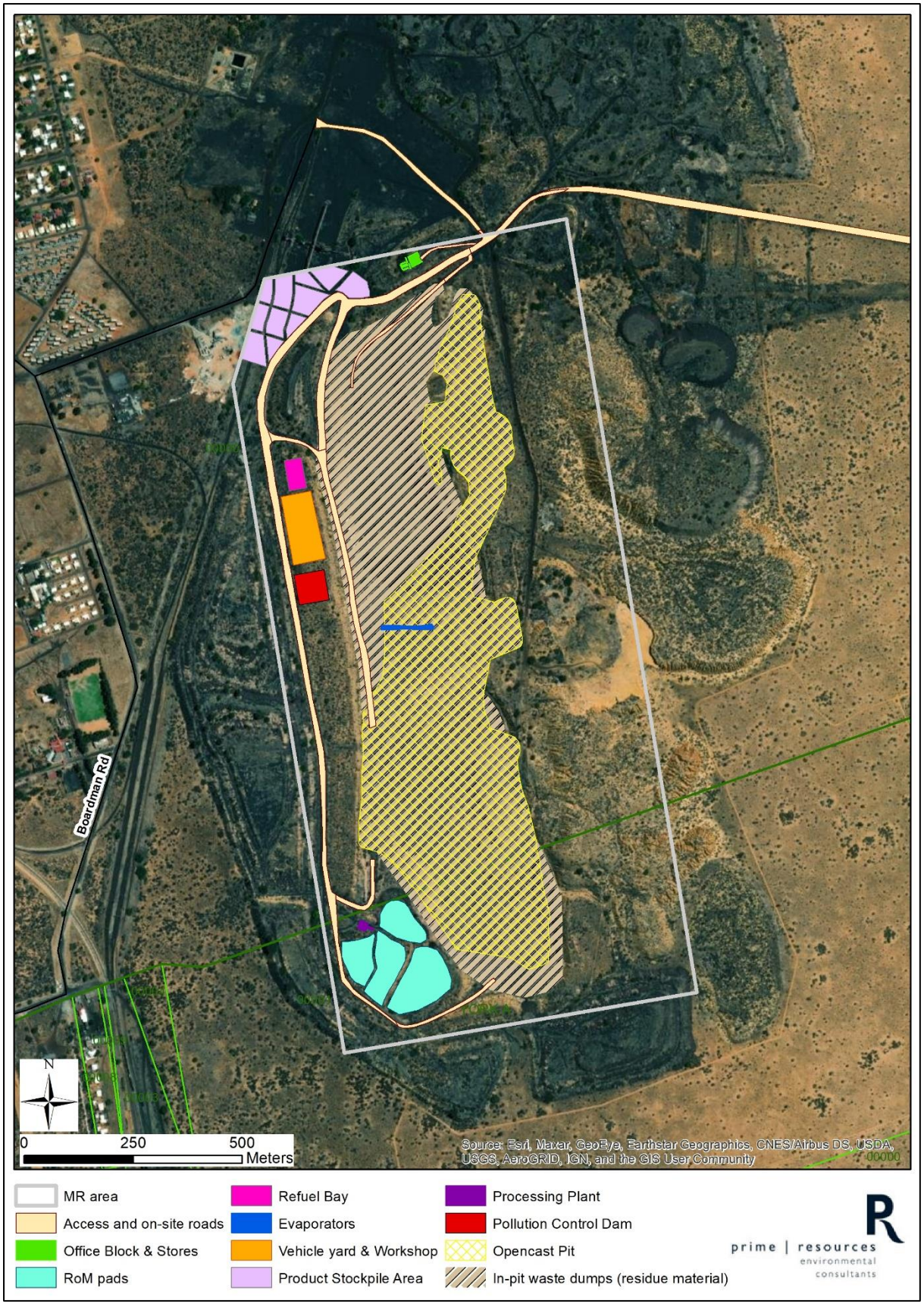

Figure 2: Proposed layout of the proposed THM. Map supplied by Prime Resources.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

The Hotazel Mine site is on the northeastern margin of the Griqualand West Sequence of Neoarchaean intrusive rocks, in the Prieska Subbasin of the Transvaal Basin that is filled with the sequence of the Transvaal Supergroup. Outcrops of the two main iron and manganese-bearing rocks are exposed to the east of the mine, but below the Kalahari sands are layers of banded iron formation (BIF) that is in primary context in the Kuruman Formation, and reworked in the overlying Danielskuil Formation (Beukes et al., 2016). These ancient rocks are the target of the mining operation but they are non-fossiliferous so will not be considered any further in this palaeontological report.

Overlying much of the area are the Kalahari Group sands. This is the largest and most extensive palaeo-erg in the world (Partridge et al., 2006) and is composed of extensive aeolian and fluvial sands, sand dunes, calcrete, scree and colluvium. Periods of aridity have overprinted the sands, and calcrete and silcrete are common.

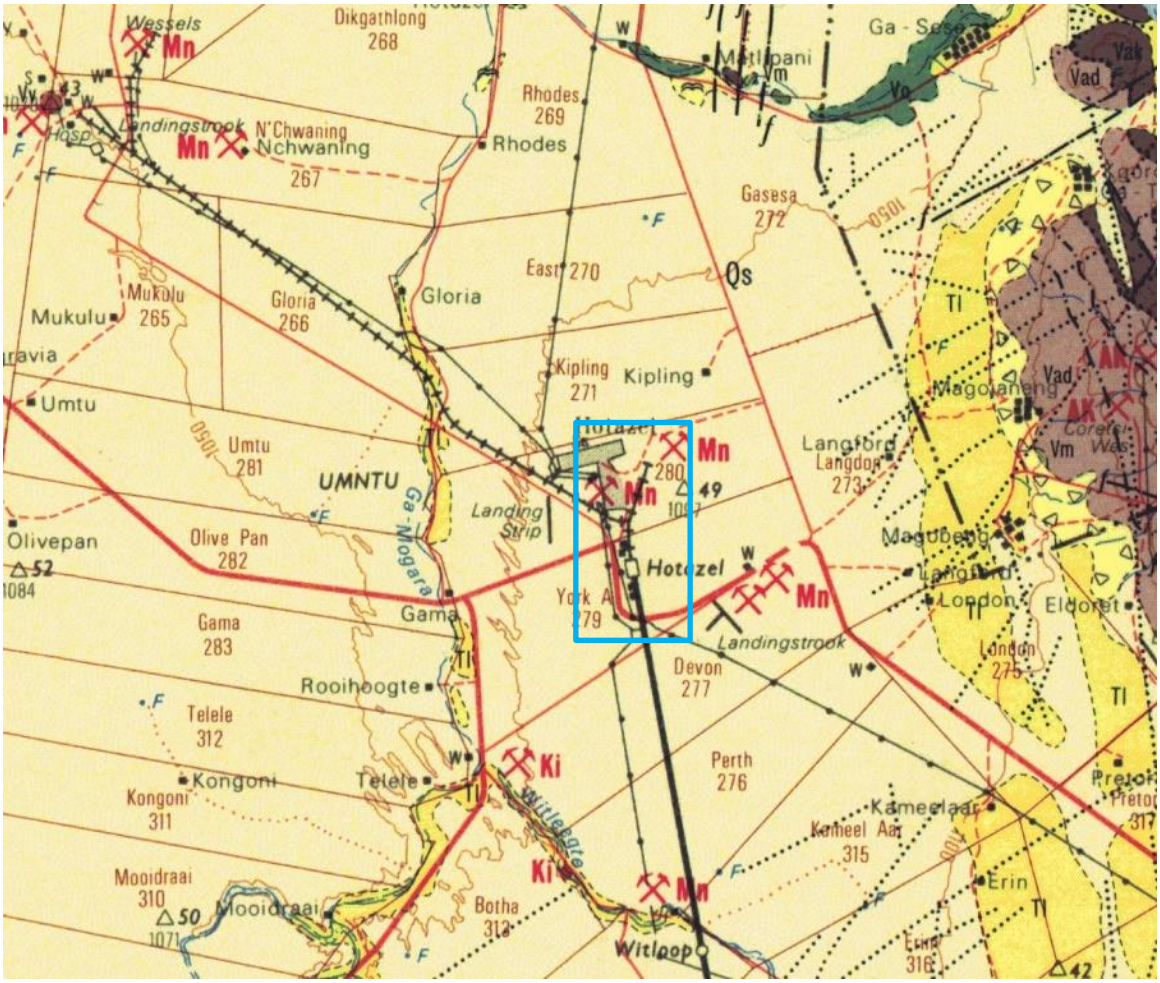

Figure 3: Geological map of the area around Hotazel, Northern Cape Province. The location of the proposed project is indicated within the blue rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2722 Kuruman.

Table 2: Explanation of symbols for the geological map and approximate ages (Partridge et al., 2006; Schröder et al., 2016). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Kalahari Group	Aeolian sand,	Quaternary ca 2.5 Ma to present
Tl	Tertiary limestone	Sand and limestone	Quaternary ca 2.5 Ma to present
Vad	Danielskuil Fm, Asbestos Hills Subgroup, Ghaap Group, Griqualand West Sequence	Banded or massive jaspilite or crocidilite	Ca 2440 -2460 Ma
Vak	Kuruman Fm, Asbestos Hills Subgroup, Ghaap Group, Griqualand West Sequence	Banded iron formation	Ca 2440 -2460 Ma

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for mining is covered by aeolian Kalahari sands that were derived from farther to the northwest (Goudie and Wells, 1995) and finally deposited in this region during the Quaternary. Since they are windblown the sands are not in primary context, nor do they preserve any fossils.

Fossils can only be preserved if there are palaeo-spring or palaeo-pan deposits where wood, plants or bones can be entrapped and preserved in the calcrete or silcrete that occasionally forms in such settings. No such deposits have been recorded from this site, and the Google Earth imagery does not show any pan or spring deposits. According to Goudie and Wells (1995) three factors are required for the formation of pans, namely a setting where the fluvial system is not fully integrated, and where salt weathering and aeolian deflation occur. The latter two conditions apply to this environmental setting, but the first does not as the site is on a slope and is far from any major river or drainage system. Therefore, it is extremely unlikely that there are any pans in the site or any fossils in the sands. Since most of the area has been disturbed by previous mining operations it is unlikely that any pan or spring features remain (Figure 5).

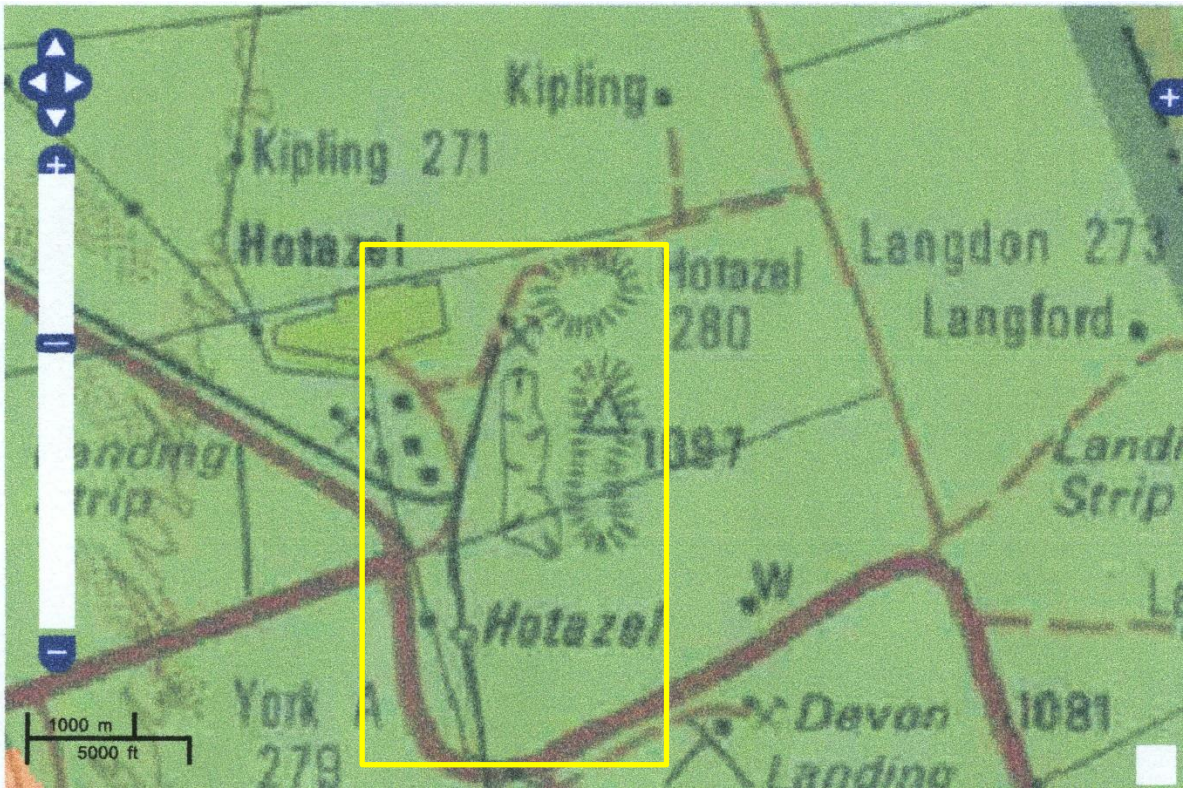

Figure 4: SAHRIS palaeosensitivity map for the site for the Hotazel Mine MR application, shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above the area is indicated as moderately sensitive (green) and this applies to the Kalahari sands.

Figure 5: Photograph of an abandoned pit from the earlier mining operations. The area is already highly disturbed and no pans or springs would be preserved. (Photograph courtesy of Prime Resources).

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

TABLE 3A: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

TABLE 3B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	**H**	-
	M	-
	L	Aeolian sands do not preserve fossils; only palaeopan or palaeosprings might preserve fossils. So far there are no records from the area nor are such features visible so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since only the possible fossils within the area would be fossil wood or bone fragments in pan or spring deposits, the spatial scale will be localised within the site boundary.
	M	-
	H	-

PART B: ASSESSMENT		
PROBABILITY	H	-
	M	-
	L	It is extremely unlikely that any fossils would be found in the loose sand that will be disturbed, nonetheless a Fossil Chance Find Protocol should be added to the eventual EMPr.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks below the surface are much too old to contain fossils and of the wrong kind, and aeolian sands do not preserve fossils. Only if there are palaeo-pans or palaeo-springs in the area, and none is visible from the Google Earth imagery, is there a very small chance of fossil wood or bone fragments occurring in the footprint. Furthermore, the material to be targeted does not preserve fossils. Since there is an extremely small chance that fossils from the Quaternary Kalahari sands may have entrapped fossils, a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the banded iron formation, jaspilite and crocidolite, sandstones and aeolian sands are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. The aeolian sands of the Quaternary period would not preserve fossils.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the aeolian sands of the Quaternary. There is very small chance that fossils from pans or springs may have been entrapped in the sands of the Kalahari Group (Quaternary). Therefore, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once drilling and excavations have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

7. References

Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodromus of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Beukes, N.J., Swindell, E.W.P., Wabo, H., 2016. Manganese Deposits of Africa. Episodes, 39(3), 1-33. DOI: 10.18814/epiiugs/2016/v39i2/95779

Goudie, A.S., Wells, G.L., 1995. The nature, distribution and formation of pans in arid zones. Earth Science Reviews 38, 1-69.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 461 – 499.

Partridge, T.C., Botha, G.A., Haddon, I.G., 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 585-604.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.

Schröder, S., Beukes, N.J., Armstrong, R.A., 2016. Detrital zircon constraints on the tectonostratigraphy of the Paleoproterozoic Pretoria Group, South Africa. Precambrian Research 278, 362 – 393.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, coal) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figure 6, 7). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer/miners then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are

removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.

7. If no good fossil material is recovered then no site inspections by the palaeontologist will not be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Examples of fossils from the Quaternary Aeolian sands

Figure 6: Fossil bone fragments from a Quaternary pan.

Figure 7: Silicified wood fragments from a fluvial deposit.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
July 2020

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) Academic qualifications

Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) Professional qualifications

Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) Membership of professional bodies/associations

Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees

All at Wits University

Degree	Graduated/completed	Current
Honours	7	0
Masters	10	4
PhD	12	5
Postdoctoral fellows	10	3

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year

Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 2-8 students per year.

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Cretaceous Research: 2014 – 2019; Associate Editor: 2020 -

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga

- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for Enviropro
- Skeerpoort Farm Mast 2020 for HCAC
- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells

xi) Research Output

Publications by M K Bamford up to December 2019 peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 8 book chapters.
Scopus h-index = 29; Google scholar h-index = 36; -i10-index = 80
Conferences: numerous presentations at local and international conferences.

xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)

APPENDIX 10

HERITAGE IMPACT ASSESSMENT

Archaetnos Culture & Cultural
Resource Consultants
BK 98 09854/23

A REPORT ON A HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED TAWANA HOTAZEL MINE, HOTAZEL, NORTHERN CAPE PROVINCE

For:

Prime Resources
E-mail: Louise Jones - louise@resources.co.za

REPORT: **AE02118V**

By:

Prof. A.C. van Vollenhoven (L. Akad. S.A.)
Accredited member of ASAPA
Accredited member of SASCH
&
Johan Smit, BA (Hons)

21 April 2021

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DISCLAIMER:

Although all possible care is taken to identify all sites of cultural importance during the survey of study areas, the nature of archaeological and historical sites is as such that it always is possible that hidden or subterranean sites could be overlooked during the study. Archaetnos and its personnel will not be held liable for such oversights or for costs incurred as a result thereof.

The South African Heritage Resources Agency (SAHRA) or one of its subsidiary bodies needs to comment on this report and clients are advised not to proceed with any action before receiving these. It is the responsibility of the client to submit this report to the relevant heritage authority.

EXECUTIVE SUMMARY

Archaetnos cc was appointed by Prime Resourcesto conduct a cultural heritage study for the proposed Tawana Hotazel Mine. The project is situated on the farms Hotazel 280 and York 279, approximately 1 km south-east of the town of Hotazel in the Northern Cape Province.

The Hotazel Project largely incorporates the historical Hotazel Manganese Mine (HMM), including the residual opencast void, surface dumps of low-grade material and the mothballed processing plant and rail loadout facility. The area was historically mined by both opencast and underground means.

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Tawana Hotazel Mining (Pty) Ltd intends on submitting an application for a Mining Right (MR) to the Department of Mineral Resources and Energy (DMRE) for the proposed Tawana Hotazel Mine (THM). Surface infrastructure will include the opencast pit (incorporating the historical HMM void and further expansion of the opencast footprint), in-pit waste dumps (residue material), vehicle yard, workshop, access and haul roads, offices, stores, processing plant, product stockpile area, run of mine pad, refuel bay and water management infrastructure.

A survey of literature was undertaken in order to obtain background information regarding the area. The field survey was conducted according to generally accepted HIA practices and was aimed at locating all possible objects, sites and features of cultural significance in the area of proposed development.

No sites of cultural heritage importance were identified. However Stone Age sites were previously identified in the wider geographical area.

The final recommendations are as follows:

- This report is seen as ample mitigation and the development may therefore continue, but only after receiving the necessary approval from SAHRA.

- It should be remembered that due to archaeological sites being subterranean in essence, it is possible that all cultural sites may not have been identified. Care should therefore be taken when development work commences that, if any more artifacts are uncovered, a qualified archaeologist be called in to investigate.

- Proposed management measures for potential impacts, which should be followed as heritage protocol and Chance Find Procedure :

- Loose stone tools found are usually of minor significance and should just be left as it is.
- Areas where a substantial number of stone tools are found together should be geo-referenced and left alone until such time as an archaeologist can visit the site to determine its significance.
- Although chances of finding Iron Age remains are slim, it should be treated similar to the above. Potshards found out of context should be left alone, but areas with stone walling or substantial pottery and other cultural remains should be geo-referenced and left alone until investigated by an archaeologist.
- All buildings and remains of buildings and other structures believed to be older than 60 years should be geo-referenced and left alone until and a heritage expert can be called in to determine the cultural significance thereof.
- Graves should be left in situ, geo-referenced and left alone until investigated by an archaeologist.
- Should any of the above be identified, the area should be demarcated to ensure no impact until further investigation has been done.

CURRICULUM VITAE
Prof. Anton Carl van Vollenhoven

PERSONAL INFORMATION

- Born: 20 January 1966, Pretoria, RSA
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TERTIARY EDUCATION

- BA 1986, University of Pretoria
- BA (HONS) Archaeology 1988 (cum laude), University of Pretoria
- MA Archaeology 1992, University of Pretoria
- Post-Graduate Diploma in Museology 1993 (cum laude), University of Pretoria
- Diploma Tertiary Education 1993, University of Pretoria
- DPhil Archaeology 2001, University of Pretoria.
- MA Cultural History 1998 (cum laude), University of Stellenbosch
- Management Diploma 2007 (cum laude), Tshwane University of Technology
- DPhil History 2010, University of Stellenbosch

EMPLOYMENT HISTORY

- *1988-1991:* Fort Klapperkop Military Museum - Researcher
- *1991-1999:* National Cultural History Museum. Work as Archaeologist, as well as Curator/Manager of Pioneer Museum (1994-1997)
- *1999-2002:* City Council of Pretoria. Work as Curator: Fort Klapperkop Heritage Site and Acting Deputy Manager Museums and Heritage.
- *2002*-2007: City of Tshwane Metropolitan Municipality. Work as Deputy Manager Museums and Heritage.
- *August 2007* – present – Managing Director for Archaetnos Archaeologists.
- *1988-2003*: Part-time lecturer in Archaeology at the University of Pretoria and a part-time lecturer on Cultural Resources Management in the Department of History at the University of Pretoria.
- *2014-2015*: Part-time lecturer for the Honours degree in Museum Sciences in the Department of History and Heritage Studies at the University of Pretoria
- *Since 2015*: Extraordinary Professor of History at the Mahikeng campus of the Northwest University

OTHER

- Has published 34 peer-reviewed and 42 popular articles.
- Hs written 11 books/book contributions/conference proceedings .
- Has been the author and co-author of over 911 unpublished reports on cultural resources surveys and archaeological work.
- Has delivered more than 72 papers and lectures at national and international conferences.
- Member of SAHRA Council for 2003 – 2006.
- Member of the South African Academy for Science and Art.
- Member of Association for South African Professional Archaeologists.

- Member of the South African Society for Cultural History (Chairperson 2006-2008; 2012-2014; 2018-2020).
- Has been editor for the SA Journal of Cultural History 2002-2004.
- Editorial member of various scientific journals.
- Member of the Provincial Heritage Resources Agency, Gauteng's Council.
- Member of Provincial Heritage Resources Agency, Gauteng's HIA adjudication committee (Chairperson 2012-2019).

A list of reports can be viewed on www.archaetnos.co.za.

DECLARATION OF INDEPENDENCE

I, Anton Carl van Vollenhoven from Archaetnos, hereby declare that I am an independent specialist within the field of heritage management.

Signed:  Date: 21 April 20121

LIST OF ACRONYMS:

AIA – Archaeological Impact Assessment
CMP – Cultural Management Plan
EAP – Environmental Assessment Practitioner
EIA – Environmental Impact Assessment
HIA – Heritage Impact Assessment
PIA – Palaeontological Impact Assessment
SAHRA –South African Heritage Resources Agency

CONTENTS

1. INTRODUCTION

Archaetnos cc was appointed by Prime Resources to conduct a cultural heritage study for the proposed Sebilo Perth Mine. This is located at Hotazel in the Joe Morolong Local Municipality, John Taolo Gaetsewe District Municipality, Northern Cape Province (Figure 1). The project is situated on the farms Hotazel 280 and York 279, approximately 1 km south-east of the town of Hotazel.

FIGURE 1: LOCATION OF HOTAZEL IN THE NORTHERN CAPE PROVINCE (NORTH REFERENCE IS TO THE TOP).

The Hotazel Project largely incorporates the historical Hotazel Manganese Mine (HMM), including the residual opencast void, surface dumps of low-grade material and the mothballed processing plant and rail loadout facility. HMM stopped production in 1989. The area was historically mined by both opencast and underground means and yielded high grade manganese ore.

Tawana Hotazel Mining (Pty) Ltd intends on submitting an application for a Mining Right (MR) to the Department of Mineral Resources and Energy (DMRE) for the proposed Tawana Hotazel Mine (THM). The types of minerals applied for are all (Code UN); Iron and Iron bearing minerals including hematite, goethite, specularite and limonite (Code (Fe) Type (B)) and Manganese and manganese bearing minerals (Code (Mn) Type (B)).

The THM largely incorporates the historical Hotazel Manganese Mine (HMM), including the residual opencast void, surface dumps of low-grade material and the

mothballed processing plant and rail loadout facility. HMM stopped production in 1989. The area was historically mined by both opencast and underground means and yielded high grade manganese ore. All current plans for the project specifically exclude underground mining.

Surface infrastructure will include the opencast pit (incorporating the historical HMM void and further expansion of the opencast footprint), in-pit waste dumps (residue material), vehicle yard, workshop, access and haul roads, offices, stores, processing plant, product stockpile area, run of mine pad, refuel bay and water management infrastructure (Figure 2-4).

FIGURE 2: LOCATION OF THE PROPOSED MINING AREA IN RELATION TO HOTAZEL IN THE NORTHERN CAPE PROVINCE.

FIGURE 3: THE PROPOSED MINING DEVELOPMENT.

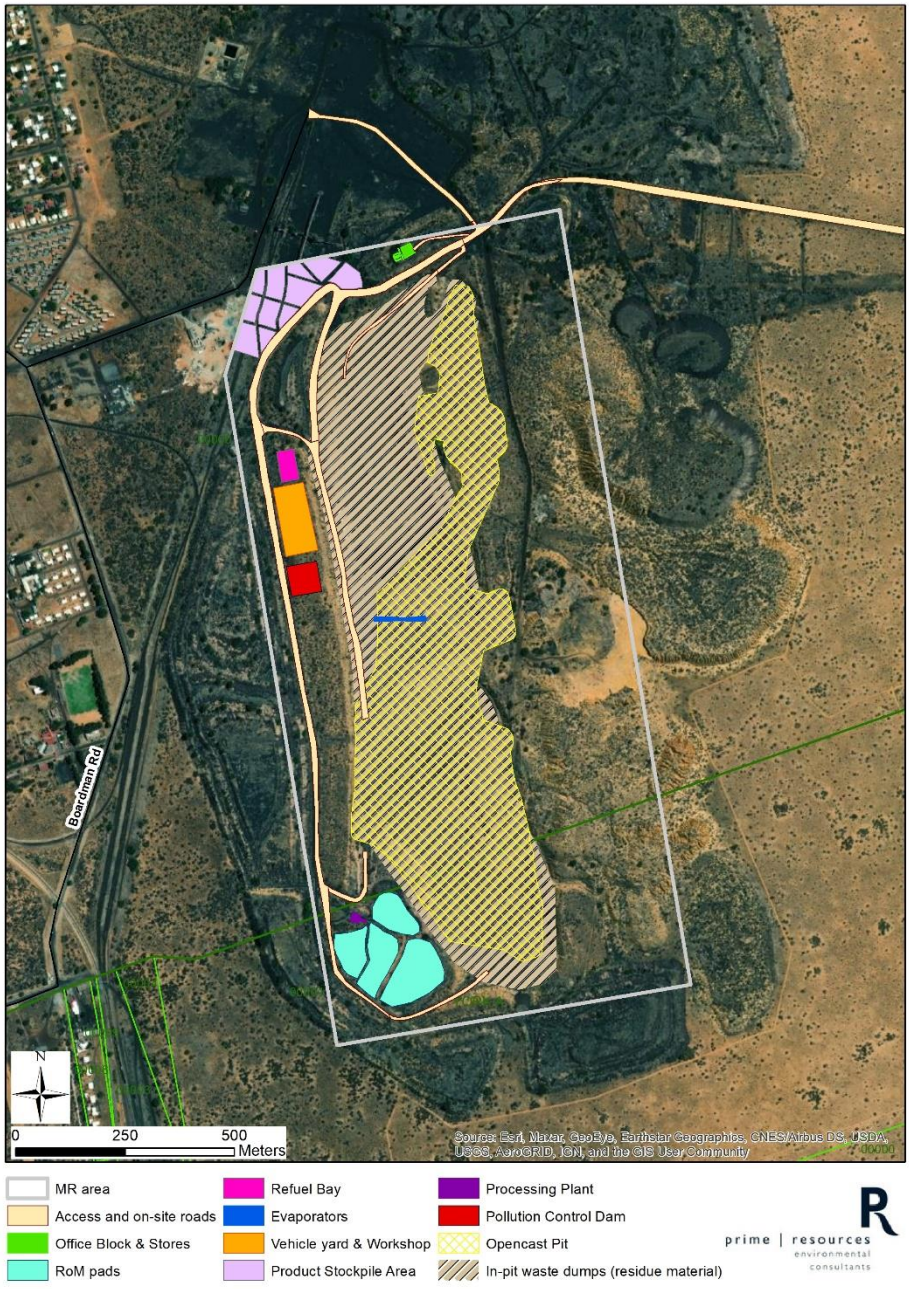

FIGURE 4: PROPOSED MINE LAYOUT.

2. TERMS OF REFERENCE

The Terms of Reference for the survey were to:

1. Identify objects, sites, occurrences and structures of an archaeological or historical nature (cultural heritage sites) located on the property (see Appendix A).

2. Assess the significance of the cultural resources in terms of their archaeological, historical, scientific, social, religious, aesthetic and tourism value (see Appendix B).

3. Describe the possible impact of the proposed development on these cultural remains, according to a standard set of conventions.

4. Recommend suitable mitigation measures to minimize possible negative impacts on the cultural resources by the proposed development.

5. Review applicable legislative requirements.

3. CONDITIONS & ASSUMPTIONS

The following conditions and assumptions have a direct bearing on the survey and the resulting report:

1. Cultural Resources are all non-physical and physical man-made occurrences, as well as natural occurrences associated with human activity (Appendix A). These include all sites, structure and artifacts of importance, either individually or in groups, in the history, architecture and archaeology of human (cultural) development. Graves and cemeteries are included in this.

2. The significance of the sites, structures and artifacts is determined by means of their historical, social, aesthetic, technological and scientific value in relation to their uniqueness, condition of preservation and research potential. The various aspects are not mutually exclusive, and the evaluation of any site is done with reference to any number of these aspects.

3. Cultural significance is site-specific and relates to the content and context of the site. Sites regarded as having low cultural significance have already been recorded in full and require no further mitigation. Sites with medium cultural significance may or may not require mitigation depending on other factors such as the significance of impact on the site. Sites with a high cultural significance require further mitigation (see Appendix C).

4. The latitude and longitude of any archaeological or historical site or feature, is to be treated as sensitive information by the developer and should not be disclosed to members of the public.

5. All recommendations are made with full cognizance of the relevant legislation.

6. It has to be mentioned that it is almost impossible to locate all the cultural resources in a given area, as it will be very time consuming. Developers should however note that the report should make it clear how to handle any other finds that might occur. In this particular case the area was very large and some areas inaccessible due to the vegetation cover being high and dense in certain areas.

7. It never is possible to know all sites previously recorded in a certain area to be investigated. However, providing this background only gives a broad base as to what can be expected and apart from predicting what may be found, it has no influence on the study.

8. It should be noted that access could not be gained to the entire project area due to it being a dangerous area resulting from past mining activities. However, those areas could be viewed from a distance and are entirely disturbed and thus are likely not containing any heritage features.

4. LEGISLATIVE REQUIREMENTS

Aspects concerning the conservation of cultural resources are dealt with mainly in two acts. These are the National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998).

4.1 The National Heritage Resources Act

According to the above-mentioned act the following is protected as cultural heritage resources:

a. Archaeological artifacts, structures and sites older than 100 years
b. Ethnographic art objects (e.g. prehistoric rock art) and ethnography
c. Objects of decorative and visual arts
d. Military objects, structures and sites older than 75 years
e. Historical objects, structures and sites older than 60 years
f. Proclaimed heritage sites
g. Grave yards and graves older than 60 years
h. Meteorites and fossils
i. Objects, structures and sites or scientific or technological value.

The national estate (see Appendix D) includes the following:

a. Places, buildings, structures and equipment of cultural significance
b. Places to which oral traditions are attached or which are associated with living heritage
c. Historical settlements and townscapes
d. Landscapes and features of cultural significance
e. Geological sites of scientific or cultural importance
f. Archaeological and palaeontological importance
g. Graves and burial grounds
h. Sites of significance relating to the history of slavery
i. Movable objects (e.g. archaeological, palaeontological, meteorites, geological specimens, military, ethnographic, books etc.)

A Heritage Impact Assessment (HIA) is the process to be followed in order to determine whether any heritage resources are located within the area to be developed as well as the possible impact of the proposed development thereon. An

Archaeological Impact Assessment only looks at archaeological resources. The different phases during the HIA process are described in Appendix E. An HIA must be done under the following circumstances:

a. The construction of a linear development (road, wall, power line canal etc.) exceeding 300m in length
b. The construction of a bridge or similar structure exceeding 50m in length
c. Any development or other activity that will change the character of a site and exceed 5 000m^2 or involve three or more existing erven or subdivisions thereof
d. Re-zoning of a site exceeding 10 000 m^2
e. Any other category provided for in the regulations of SAHRA or a provincial heritage authority

Structures

Section 34 (1) of the mentioned act states that no person may demolish any structure or part thereof which is older than 60 years without a permit issued by the relevant provincial heritage resources authority.

A structure means any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith.

Alter means any action affecting the structure, appearance or physical properties of a place or object, whether by way of structural or other works, by painting, plastering or the decoration or any other means.

Archaeology, palaeontology and meteorites

Section 35(4) of this act deals with archaeology, palaeontology and meteorites. The act states that no person may, without a permit issued by the responsible heritage resources authority (national or provincial):

a. destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
b. destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
c. trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
d. bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment that assists in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
e. alter or demolish any structure or part of a structure which is older than 60 years as protected.

The above mentioned may only be disturbed or moved by an archaeologist, after receiving a permit from the South African Heritage Resources Agency (SAHRA). In

order to demolish such a site or structure, a destruction permit from SAHRA will also be needed.

Human remains

Graves and burial grounds are divided into the following:

a. ancestral graves
b. royal graves and graves of traditional leaders
c. graves of victims of conflict
d. graves designated by the Minister
e. historical graves and cemeteries
f. human remains

In terms of Section 36(3) of the National Heritage Resources Act, no person may, without a permit issued by the relevant heritage resources authority:

a. destroy, damage, alter, exhume or remove from its original position of otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;
b. destroy, damage, alter, exhume or remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or
c. bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) any excavation, or any equipment which assists in the detection or recovery of metals.

Unidentified/unknown graves are also handled as older than 60 until proven otherwise. Human remains that are less than 60 years old are subject to provisions of the **National Health Act** (**Act 61 of 2003**) and to local regulations. Exhumation of graves must conform to the standards set out in the **Ordinance on Exhumations** (**Ordinance no. 12 of 1980**) (replacing the old Transvaal Ordinance no. 7 of 1925).

Permission must also be gained from the descendants (where known), the National Department of Health, Provincial Department of Health, Premier of the Province and local police. Furthermore, permission must also be gained from the various landowners (i.e. where the graves are located and where they are to be relocated) before exhumation can take place. Human remains can only be handled by a registered undertaker or an institution declared under the **National Health Act** (**Act 61 of 2003**).

4.2 The National Environmental Management Act

This act (Act 107 of 1998) states that a survey and evaluation of cultural resources must be done in areas where development projects, that will change the face of the environment, will be undertaken. The impact of the development on these resources should be determined and proposals for the mitigation thereof are made.

Environmental management should also take the cultural and social needs of people into account. Any disturbance of landscapes and sites that constitute the nation's cultural heritage should be avoided as far as possible and where this is not possible the disturbance should be minimized and remedied.

5. THE INTERNATIONAL FINANCE CORPORATIONS' PERFORMANCE STANDARD FOR CULTURAL HERITAGE

This standard recognizes the importance of cultural heritage for current and future generations. It aims to ensure that clients protect cultural heritage in the course of their project activities.

This is done by clients abiding to the law and having heritage surveys done in order to identify and protect cultural heritage resources via field studies and the documentation of such resources. These need to be done by competent professionals (e.g. archaeologists and cultural historians). Possible chance finds, encountered during the project development, also needs to be managed by not disturbing it and by having it assessed by professionals.

Impacts on the cultural heritage should be minimized. This include the possible maintenance of such sites in situ, or when impossible, the restoration of the functionality of the cultural heritage in a different location. When cultural historical and archaeological artifacts and structures need to be removed is should be done by professionals and by abiding to the applicable legislation.

The removal of cultural heritage resources may however only be considered if there are no technically or financially feasible alternatives. In considering the removal of cultural resources, it should be outweighed by the benefits of the overall project to the effected communities. Again professionals should carry out the work and adhere to the best available techniques.

Consultation with affected communities should be engaged in. This entails that access to such communities should be granted to their cultural heritage if this is applicable. Compensation for the loss of cultural heritage should only be given in extra-ordinary circumstances.

Critical cultural heritage may not be impacted on. Professionals should be used to advise on the assessment and protection thereof. Utilization of cultural heritage resources should always be done in consultation with the effected communities in order to be consistent with their customs and traditions and to come to agreements with relation to possible equitable sharing of benefits from commercialization.

6. METHODOLOGY

6.1 Survey of literature

A survey of literature was undertaken in order to obtain background information regarding the area. Sources consulted in this regard are indicated in the bibliography.

6.2 Reference to other specialist studies

On the existing SAHRA Database (SAHRIS) there are a number of reports that were done in the wider area (SAHRIS database). The SAHRIS database is an internet-based tool, updated constantly. These will be referred to below. Archaetnos has also done many surveys here in the past (Archaetnos database), which will also be referred to. The latter is a computer-based tool, updated constantly. Graves and Stone Age sites were mainly identified during these surveys.

6.3 Field survey

The survey was conducted according to generally accepted HIA practices and was aimed at locating all possible objects, sites and features of cultural significance in the area of proposed development. If required, the location/position of any site was determined by means of a Global Positioning System (GPS)[1], while photographs were also taken where needed.

The size of the project site is approximately 145 Ha. The survey was undertaken by a physical survey on foot and took 4 hours to complete (Figure 5). The survey was done in December at the peak of summer and also the wet season. The vegetation cover was reasonably open, with a few dense bushes in between. Both the vertical as the horizontal archaeological visibility was thus reasonably good. However, most of the site has been disturbed by recent human interventions mainly former mining activities.

6.4 Oral histories

People from local communities are interviewed in order to obtain information relating to the surveyed area. It needs to be stated that this is not applicable under all circumstances. When applicable, the information is included in the text and referred to in the bibliography.

6.5 Documentation

All sites, objects, features and structures identified were documented according to the general minimum standards accepted by the archaeological profession. Co-ordinates of individual localities were determined by means of the Global Positioning System (GPS). The information was added to the description in order to facilitate the identification of each locality.

[1] A Garmin Oregon 550 with an accuracy factor of a few meters.

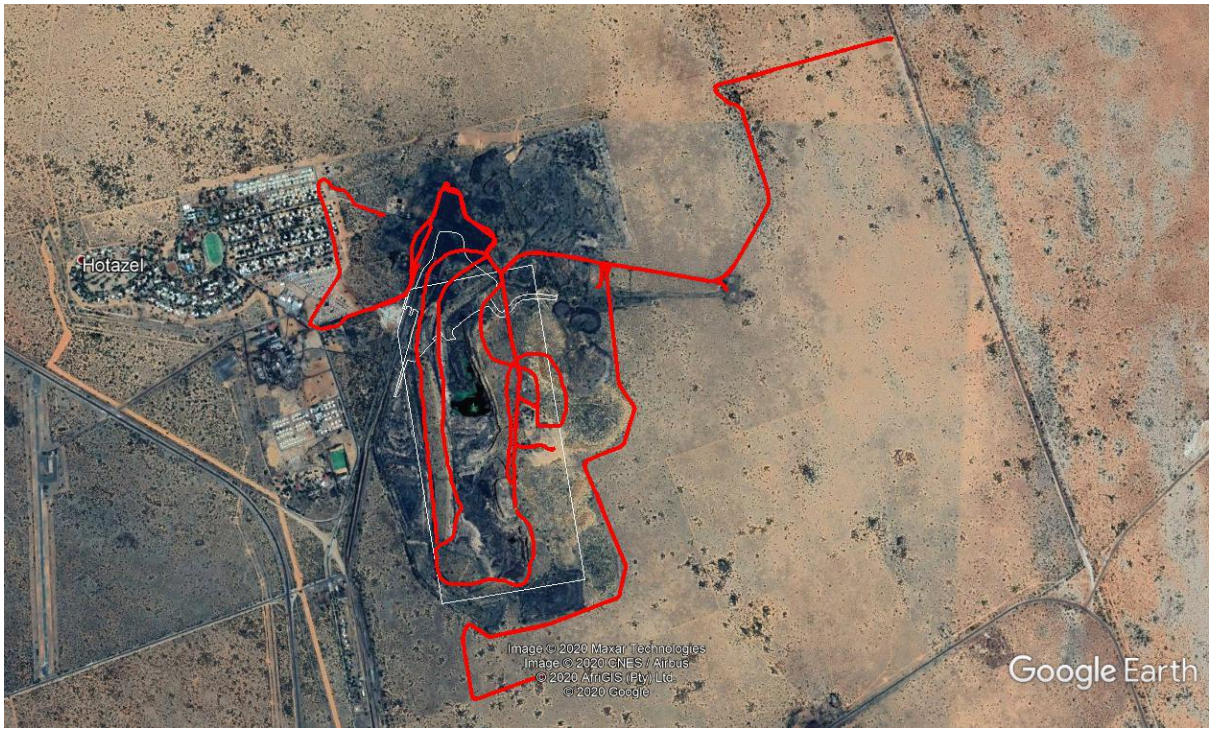

FIGURE 5: TRACK ROUTE OF THE SURVEYED AREA. NOTE THAT THE CENTRAL AREA CONSISTING OF AN OLD OPENCAST PIT COULD NOT BE ACCESSED.

6.6 Evaluation of Heritage sites

The evaluation of heritage sites is done by giving a field rating of each (see Appendix C) using the following criteria:

- The unique nature of a site
- The integrity of the archaeological deposit
- The wider historic, archaeological and geographic context of the site
- The location of the site in relation to other similar sites or features
- The depth of the archaeological deposit (when it can be determined or is known)
- The preservation condition of the site
- Uniqueness of the site and
- Potential to answer present research questions.

7. DESCRIPTION OF THE ENVIRONMENT

The area that was surveyed is typical of the Kalahari landscape. It is surrounded by sand dunes. The Gamagara River, a non-perennial water course, runs towards the west of the town of Hotazel, with the town just west of the study area. The natural topography is flat with no outstanding features, except for a few dunes and the large opencast pit in the centre of the surveyed site.

Most of the surveyed area is totally disturbed by mining activity and related infrastructure. This includes the large opencast pit, gravel roads and old mining infrastructure (Figure 6-11). The vegetation cover in the less disturbed areas varies between open patches with minimal ground cover and areas with a few low bushes. Here and there the bushes are a bit denser (Figure 12-13). Both the horizontal and vertical archaeological visibility was thus good.

FIGURE 6: NORTHERN SECTION OF THE SURVEYED AREA. NOTE THE DISTURBANCE CAUSED BY FORMER MINING ACTIVITIES.

FIGURE 7: OLD MINE HEAP INCLUDING SIGNS OF ILLEGAL DUMPING ACTIVITIES.

FIGURE 8: ANOTHER MINE HEAP IN THE SURVEYED AREA.

FIGURE 9: VIEW OF ANOTHER MINE DUMP ALSO SHOWING VEGETATION.

FIGURE 10: VIEW OF OPENCAST PIT IN THE SURVEYED AREA.

FIGURE 11: OLD INFRASTRUCTURE IN THE SURVEYED AREA.

FIGURE 12: GENERAL VIEW OF THE SURVEYED AREA SHOWING A GRAVEL ROAD.

FIGURE 13: GENERAL VIEW OF VEGETATION IN THE STUDY AREA.

8. HISTORICAL CONTEXT

During the survey no sites of cultural heritage significance were located. On the existing SAHRA database no such sites are indicated here, but there are a few heritage surveys that were done here (SAHRIS database; Archaetnos database). Some historical sites are known in the wider geographical area, located during the mentioned surveys (see below). In order to enable the reader to better understand archaeological and cultural features, it is necessary to give a background regarding the different phases of human history.

8.1 Stone Age

The Stone Age is the period in human history when lithic material was mainly used to produce tools (Coertze & Coertze 1996: 293). In South Africa the Stone Age can be divided in three periods. It is however important to note that dates are relative and only provide a broad framework for interpretation. The division for the Stone Age according to Korsman & Meyer (1999: 93-94) is as follows:

Early Stone Age (ESA) 2 million – 150 000 years ago
Middle Stone Age (MSA) 150 000 – 30 000 years ago
Late Stone Age (LSA) 40 000 years ago – 1850 - A.D.

This geographical area is not well-known as one containing many prehistoric sites. One however has to realize that this most likely only indicates that not much research has been done here before.

Stone Age sites are known to occur in the larger geographical area, including the well-known Wonderwerk Cave in the Kuruman Hills to the east, Tsantsabane, an ancient specularite working on the eastern side of Postmasburg, Doornfontein, another specularite working north of Beeshoek and a cluster of important Stone Age sites near Kathu. Additional specularite workings with associated Ceramic Later Stone Age material and older Fauresmith sites (early Middle Stone Age) are known from Lylefeld, Demaneng, Mashwening, King, Rust & Vrede, Paling, Gloucester and Mount Huxley to the north (Morris 2005: 3).

The nearest substantial site is the Doornlaagte Early Stone Age archaeological site close to Kimberley, some buildings at Postmasburg and a specularite mine close to Postmasburg (SAHRA database).

The onset of the Middle Stone Age coincided with a widespread demand for coloured or glittering minerals that arose at the time for still unknown reasons. The intensive collection of such substances soon exhausted surface exposures and led to the quest being extended underground and thus to the birth of mining practice. As mentioned, specularite was commonly mined in the Postmasburg area. In 1968 AK Boshier, working in collaboration with P Beaumont, found a number of underground specularite mines on Paling (De Jong 2010: 35). Stone and Iron Age communities mined specularite associated with iron ores for cosmetic purposes at Blinkklipkop, Paling, Gloucester and other farms (De Jong 2010: 41; Snyman 2000: 3).

Many Middle and Late Stone Age tools have been found by Archaetnos during surveys in the Northern Cape. These sites are located close to Griekwastad, Hotazel. Postmasburg and Kenhardt (www.archaetnos.co.za). On the farm Konkooksies 91 in the Pofadder district, five sites with Middle and Late Stone Age tools were identified (Pelser 2011). The environment here seems very similar to that at the study area, indicating that sites are most likely to be found within the proposed mining area.

Rock engraving (rock pecking) sites are known from Beeshoek and Bruce (Morris 2005: 3; Snyman 2000: 3). The latter are associated with the Late Stone Age.

A number of Stone Age sites and scattered finds of Stone Age material were identified by Küsel et.al. (2009) and Archaetnos close to the town of Hotazel and adjacent to the Gamagara River during 2011 (Archaetnos database). Further away sites were identified close to Postmasburg on the farm Paling during an earlier survey (Pelser & Van Vollenhoven 2010: 12-17). On neighbouring farms some stone tools were identified (Fourie & Van der Walt 2006: 26-27).

The mentioned Late Stone Age sites are associated with the San people. Mitchell (2002: 126) indicates that the language group who occupied the Northern Cape is the /Auni-//Khomani and Eastern /Hoa. These people were hunters and gatherers which means that they would have moved around, leaving little trace of their existence.

From the above mentioned it is clear that Stone Age people did utilize and settled in the area. A few such sites are known toward the Gamagara River. These have been plotted on a Google Earth image in order to contextualize it with the study area (Figure

14). These lies on the opposite side of the town of Hotazel and will therefore not be affected by the proposed project (Van Vollenhoven 2019:18).

FIGURE 14: KNOWN STONE AGE OCCURRENCES IN THE SURROUNDING AREA OF THE SURVEYED SITE.

8.2 Iron Age

The Iron Age is the name given to the period of human history when metal was mainly used to produce metal artifacts (Coertze & Coertze 1996: 346). In South Africa it can be divided in two separate phases according to Van der Ryst & Meyer (1999: 96-98), namely:

Early Iron Age (EIA) 200 – 1000 A.D.
Late Iron Age (LIA) 1000 – 1850 A.D.

Huffman (2007: xiii) however indicates that a Middle Iron Age should be included. His dates, which now seem to be widely accepted in archaeological circles, are:

Early Iron Age (EIA) 250 – 900 A.D.
Middle Iron Age (MIA) 900 – 1300 A.D.
Late Iron Age (LIA) 1300 – 1840 A.D.

No Early or Middle Iron Age sites have been identified in the area of study. Iron Age people occupied the central and eastern parts of southern Africa from about 200 A.D., but the San and Khoi remained in the western and southern parts (Inskeep 1978: 126; see also Huffman 2007).

During the Late Iron Age (LIA), people stayed in extensive stonewalled settlements, such as the Thlaping capital Dithakong, 40 km north of Kuruman. Sotho-Tswana and Nguni societies, the descendants of the LIA mixed farming communities, found the region already sparsely inhabited by the Late Stone Age (LSA) Khoisan groups, the so-called 'first people'.

Most of them were eventually assimilated by LIA communities and only a few managed to survive, such as the Korana and Griqua. This period of contact is sometimes known as the Ceramic Late Stone Age and is represented by the Blinkklipkop specularite mine near Postmasburg and finds at the Kathu Pan (De Jong 2010: 36).

It is however known that Late Iron Age people did utilize the area further to the west, albeit briefly, as they did mine copper in the Northern Cape. This was much further to the west of the study area, closer to the Orange River (Inskeep 1978: 135).

Iron Age people therefore probably did not settle in the study area. The chances of finding any Iron Age remains in the study area are thus extremely slim, if not impossible.

8.3 Historical Age

The historical age started with the first recorded oral histories in the area. It includes the moving into the area of people that were able to read and write. This era is sometimes called the Colonial era or the recent past.

Due to factors such as population growth and a decrease in mortality rates, more people inhabited the country during the recent historical past. Therefore and because less time has passed, much more cultural heritage resources from this era have been left on the landscape. It is important to note that all cultural resources older than 60 years are potentially regarded as part of the heritage and that detailed studies are needed in order to determine whether these indeed have cultural significance. Factors to be considered include aesthetic, scientific, cultural and religious value of such resources.

Factors such as population expansion, increasing pressure on natural resources, the emergence of power blocs, attempts to control trade and penetration by Griquas, Korana and white communities from the south-west resulted in a period of instability in Southern Africa that began in the late 18th century and effectively ended with the settlement of white farmers in the interior. This period, known as the *difaqane* or *Mfecane*, also affected the Northern Cape Province, although at a relatively late stage compared to the rest of Southern Africa. Here, the period of instability, beginning in the mid-1820s, was triggered by the incursion of displaced refugees associated with the Tlokwa, Fokeng, Hlakwana and Phuting tribal groups (De Jong 2010: 36).

The *Difaqane* coincided with the penetration of the interior of South Africa by white traders, hunters, explorers and missionaries. The first traders in the Northern Cape were PJ Truter's and William Somerville's journey of 1801, which reached Dithakong at Kuruman. They were again followed by Cowan, Donovan, Burchell and Campbell

and resulted in the establishment of a London Mission Society station near Kuruman in 1817 by James Read (De Jong 2010: 36). During the 1870's William Sanderson, John Ryan and John Ludwig passed through the area close to Postmasburg (Snyman 2000: 3).

The Great Trek of the Boers from the Cape in 1836 brought large numbers of Voortrekkers up to the borders of large regions known as Bechuanaland and Griqualand West, thereby coming into conflict with many Tswana groups and also the missionaries of the London Mission Society. The conflict between Boer and Tswana communities escalated in the 1860s and 1870s when the Korana and Griqua communities became involved and later also the British government. The conflict mainly centered on land claims by various communities. For decades the western border of the Transvaal Boer republic was not fixed. Only through arbitration (the Keate Arbitration), triggered by the discovery of gold at Tati (1866) and diamonds at Hopetown (1867) was part of the western border finally determined in 1871. Ten years later, the Pretoria Convention fixed the entire western border, thereby finally excluding Bechuanaland and Griqualand West from Boer domination (De Jong 2010: 36).

Geographically, the study area is part of a region known as Griqualand West. At the end of the 18th century and the beginning of the 19th century Griqua tribes coming from the south settled in the region in order to escape encroachment of Afrikaner Trekboere who was active along the Orange River. They established the town of Klaarwater, renamed Griquatown in 1813. After the discovery of diamonds in 1867 a serious dispute over the ownership of the diamond fields ensued, involving the Transvaal and Orange Free State Boer republics, Griqua, Korana and Thlaping communities and the Cape colonial government. In October 1871 the diamond fields were proclaimed British territory under the name Griqualand West. In 1879 it was annexed to the Cape Colony (De Jong 2010: 36).

The incorporation of Griqualand West into the Cape Colony promoted colonial settlement in the area from the 1880s. Government-owned land was surveyed and divided into farms, which were transferred to farmers. Surveyors were given the task of surveying and naming some of the many farms in this region. These farms were allocated to prospective farmers, but permanent settlement only started in the late 1920s and the first farmsteads were possibly built during this period (De Jong 2010: 36).

The Griqua town of Blinkklip (established in 1882), originally a mission station, was renamed Postmasburg in 1892 and became the centre of a magisterial district (Snyman 2000: 6). Another town, Olifantshoek, was established in the 1880s. The region remained sparsely populated until the advent of the 20th century, when cattle farming became popular (De Jong 2010: 36).

Prospecting started in the Postmasburg area during 1882 and manganese was discovered here during 1886 (Snyman 2000: 6, 13). Henry George Brown, who was commissioned in 1888 by the government of British Bechuanaland to erect the first government buildings in Kuruman, became interested in the iron ores that were known from the Klipfontein Hills. While prospecting there in the late 19th century, he became

the first person to identify manganese in what is today known as the Eastern Belt of the Postmasburg Manganese Field.

The first Geologist to have surveyed the Northern Cape was Dr A. W. Rogers of the Geological Commission of the Cape Colony in 1906. One of the features he noted was a small hill called Black Rock and reported on the presence of manganese ore at the base of the hill. In 1940 Associated Manganese Mines of South Africa acquired the manganese outcrop known as Black Rock and shortly afterwards started mining the deposit.

The ore is extracted by both underground and open cast operations. Mines in the area include Wessels, N'Chwaning I, N'Chwaning II, Black Rock, Hotazel, Langdon, Devon, Perth, Smart, Adams, Mamatwan (largest opencast mine in the area), Middleplaats and Gloria. Gloria Mine was opened in 1978 (Küsel et.al. 2009: 3).

The strata bound ore deposits of the Kalahari Manganese field represent the largest land bound sedimentary manganese deposits in the world and originated from a single episode of manganese deposition about 2200 million years ago. A widespread hypothermal event occurred in the north western portion of the Kalahari Manganese field 1300 million years ago with temperatures reaching a maximum of 450 degrees centigrade in the Wessels, N'Chwaning and Black Rock areas. This event resulted in the upgrading of the Manganese-content of the ore and produced a wide range of rare minerals as well as mineral assemblages. Of the approximately 150 minerals, 10 have to date only been found in the Kalahari manganese field and a further 26 are found at four or fewer mineral localities worldwide (Küsel et.al. 2009: 3).

One may therefore expect sites associated with the first white farmers, early missionaries and mining companies. This may include graves. In fact, buildings, including farm houses and outbuildings typical of the earliest white farmers of the area were identified during a previous survey on some of the farms mentioned as being part of the wider mining area. A few graves were also identified, but these are on adjacent farms (Van Vollenhoven 2012; Van Vollenhoven & Collins 2015; Fourie & Van der Walt 2006).

9. DISCUSSION OF SITES IDENTIFIED DURING THE SURVEY

As indicated no sites of cultural heritage importance was identified within the surveyed area.

10. CONCLUSIONS AND RECOMMENDATIONS

It is concluded that the assessment of the area was conducted successfully. Known heritage sites lies much further to the west on the opposite side of the town of Hotazel and are therefore not threatened by the proposed development.

The final recommendations are as follows:

- This report is seen as ample mitigation and the development may therefore continue, but only after receiving the necessary approval from SAHRA.

- It should be remembered that due to archaeological sites being subterranean in essence, it is possible that all cultural sites may not have been identified. Care should therefore be taken when development work commences that, if any more artifacts are uncovered, a qualified archaeologist be called in to investigate.

- Proposed management measures for potential impacts, which should be followed as heritage protocol and Chance Find Procedure :

    - Loose stone tools found are usually of minor significance and should just be left as it is.
    - Areas where a substantial number of stone tools are found together should be geo-referenced and left alone until such time as an archaeologist can visit the site to determine its significance.
    - Although chances of finding Iron Age remains are slim, it should be treated similar to the above. Potshards found out of context should be left alone, but areas with stone walling or substantial pottery and other cultural remains should be geo-referenced and left alone until investigated by an archaeologist.
    - All buildings and remains of buildings and other structures believed to be older than 60 years should be geo-referenced and left alone until and a heritage expert can be called in to determine the cultural significance thereof.
    - Graves should be left in situ, geo-referenced and left alone until investigated by an archaeologist.
    - Should any of the above be identified, the area should be demarcated to ensure no impact until further investigation has been done.

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APPENDIX A

DEFINITION OF TERMS:

Site: A large place with extensive structures and related cultural objects. It can also be a large assemblage of cultural artifacts, found on a single location.

Structure: A permanent building found in isolation or which forms a site in conjunction with other structures.

Feature: A coincidental find of movable cultural objects.

Object: Artifact (cultural object).

(Also see Knudson 1978: 20).

APPENDIX B

DEFINITION/ STATEMENT OF HERITAGE SIGNIFICANCE:

Historic value:	Important in the community or pattern of history or has an association with the life or work of a person, group or organization of importance in history.
Aestetic value:	Important in exhibiting particular aesthetic characteristics valued by a community or cultural group.
Scientific value:	Potential to yield information that will contribute to an understanding of natural or cultural history or is important in demonstrating a high degree of creative or technical achievement of a particular period
Social value:	Have a strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.
Rarity:	Does it possess uncommon, rare or endangered aspects of natural or cultural heritage.
Representivity:	Important in demonstrating the principal characteristics of a particular class of natural or cultural places or object or a range of landscapes or environments characteristic of its class or of human activities (including way of life, philosophy, custom, process, land-use, function, design or technique) in the environment of the nation, province region or locality.

APPENDIX C

SIGNIFICANCE AND FIELD RATING:

Cultural significance:

- Low — A cultural object being found out of context, not being part of a site or without any related feature/structure in its surroundings.

- Medium — Any site, structure or feature being regarded less important due to a number of factors, such as date and frequency. Also any important object found out of context.

- High — Any site, structure or feature regarded as important because of its age or uniqueness. Graves are always categorized as of a high importance. Also any important object found within a specific context.

Heritage significance:

- Grade I — Heritage resources with exceptional qualities to the extent that they are of national significance

- Grade II — Heritage resources with qualities giving it provincial or regional importance although it may form part of the national estate

- Grade III — Other heritage resources of local importance and therefore worthy of conservation

Field ratings:

- National Grade I significance — should be managed as part of the national estate
- Provincial Grade II significance — should be managed as part of the provincial estate
- Local Grade IIIA — should be included in the heritage register and not be mitigated (high significance)
- Local Grade IIIB — should be included in the heritage register and may be mitigated (high/ medium significance)
- General protection A (IV A) — site should be mitigated before destruction (high/ medium significance)
- General protection B (IV B) — site should be recorded before destruction (medium significance)
- General protection C (IV C) — phase 1 is seen as sufficient recording and it may be demolished (low significance)

APPENDIX D

PROTECTION OF HERITAGE RESOURCES:

Formal protection:

National heritage sites and Provincial heritage sites – grade I and II
Protected areas - an area surrounding a heritage site
Provisional protection – for a maximum period of two years
Heritage registers – listing grades II and III
Heritage areas – areas with more than one heritage site included
Heritage objects – e.g. archaeological, palaeontological, meteorites, geological specimens, visual art, military, numismatic, books, etc.

General protection:

Objects protected by the laws of foreign states
Structures – older than 60 years
Archaeology, palaeontology and meteorites
Burial grounds and graves
Public monuments and memorials

APPENDIX E

HERITAGE IMPACT ASSESSMENT PHASES

1. Pre-assessment or scoping phase – establishment of the scope of the project and terms of reference.
2. Baseline assessment – establishment of a broad framework of the potential heritage of an area.
3. Phase I impact assessment – identifying sites, assess their significance, make comments on the impact of the development and makes recommendations for mitigation or conservation.
4. Letter of recommendation for exemption – if there is no likelihood that any sites will be impacted.
5. Phase II mitigation or rescue – planning for the protection of significant sites or sampling through excavation or collection (after receiving a permit) of sites that may be lost.
6. Phase III management plan – for rare cases where sites are so important that development cannot be allowed.

APPENDIX 11

NOISE IMPACT ASSESSMENT

Noise Specialist Study for the Proposed Tawana Hotazel Mine in Northern Cape Province

Project done for **Prime Resources (Pty) Ltd**

Report compiled by:
Natasha Shackleton

Report No: 20PRE01b | **Version:** Draft | **Date:** January 2022

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Report Details

Report Title	Noise Specialist Study for the Proposed Tawana Hotazel Mine in Northern Cape Province
Environmental Impact Practitioners	Prime Resources (Pty) Ltd
Applicant	Tawana Hotazel Mining (Pty) Ltd
Report Number	20PRE01b
Report Version	Draft
Date	January 2022
Prepared by	Natasha Shackleton, Pr. Sci. Nat., BSc Hons: Meteorology (University of Pretoria)
Reviewed by	Nick Grobler, BEng: Chem, BEng Hons: Env (University of Pretoria) Renee von Gruenewaldt, Pr. Sci. Nat., MSc: Earth Sciences (University of Pretoria)
Field work by:	Moeketsi Moletsane, MSc (China Agricultural University, Beijing) Tinashe Mukota, MEng: Env (University of Pretoria)
Notice	Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in all aspects of air quality, ranging from nearby neighbourhood concerns to regional air pollution impacts as well as noise impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003.
Declaration	Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference. I, Natasha Anne Shackleton as the appointed independent specialist for the "Noise Specialist Study Report for the Proposed Tawana Hotazel Mine in Northern Cape Province", hereby declare that I: • acted as the independent specialist in this scoping assessment; • performed the work relating to the study in an objective manner; • regard the information contained in this report as it relates to my specialist input/study to be true and correct, • do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment; • declare that there are no circumstances that may compromise my objectivity in performing such work; • have expertise in conducting the specialist report relevant to this application; • have no, and will not engage in, conflicting interests in the undertaking of the activity; • have no vested interest in the proposed activity proceeding; • undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing the decision of the competent authority; and all the particulars furnished by me in this specialist input/study are true and correct.
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Revision Record

Version	Date	Section Revised	Reason for Revision
Draft	January 2022	Original	For review by Applicant and Environmental Assessment Practitioners.
Final v1	January 2022	Section 1	Updated based on EAP comments, correction of the stage of the application including addition of the reference number.

Competency Profiles

Report author: N A Shackleton (née Gresse) (Pr. Sci. Nat., BSc Hons: Meteorology - University of Pretoria)

Natasha Shackleton is a registered Professional Natural Scientist with the South African Council for Natural Scientific Professions (SACNASP) (registration number 116335). Natasha is also a member of the South African Society for Atmospheric Sciences (SASAS) and the National Association for Clean Air (NACA). Natasha started her professional career in Air Quality in 2011 when she joined Airshed Planning Professionals (Pty) Ltd after completing her Undergraduate Degree at the University of Pretoria in Science. In 2011 she completed her Honours Degree at the University of Pretoria in Meteorology. Natasha has worked on noise specialist studies since 2015. She has experience on the various components including ambient and sources noise sampling; emissions quantification for a range of source types; simulations using SANS 10201, CONCAWE, and DataKustic CadnaA; impact assessments; and management plans. The majority of her noise working experience has been in South Africa; but she has also undertaken noise assessments for projects in other African countries.

NEMA EIA Regulation (2014, as amended) - Appendix 6

NEMA Regulations (2014, as amended) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report.	Report Details (page i)
The expertise of that person to compile a specialist report including curriculum vitae.	Competency Profiles (page i) Appendix H – Author's Curriculum Vitae (page 107)
A declaration that the person is independent in a form as may be specified by the competent authority.	Report Details (page i)
An indication of the scope of, and the purpose for which, the report was prepared.	Section 1.1: Background (page 1) Section 1.2 (page 1)
An indication of quality and age of base data used.	Section 2: Approach and Methodology (page 1) Section 5: Description of the Receiving Environment (page 19)
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change.	Section 5: Description of the Receiving Environment (page 19) To be determined in next phase Section 4: Legal Requirements and Noise Level Guidelines (page 15)
The date and season of the site investigation and the relevance of the season to the outcome of the assessment.	Section 5.3: Noise Survey and Results (page 25) Description of the current land use in the region, noise sampling data and meteorological data included in the study are considered representative
A description of the methodology adopted in preparing the report or carrying out the specialised process.	Section 2: Approach and Methodology (page 1)
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.	Section 5.1: Noise Sensitive Receptors (page 19)
An identification of any areas to be avoided, including buffers.	To be determined in the next phase
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	Figure 5: Locality map (page 20), Figure 9: Study area, NSRs, and baseline noise measurement sites (page 30) To be determined in the next phase
A description of any assumptions made and any uncertainties or gaps in knowledge.	Section 2: Approach and Methodology (page 1)
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment.	Section 6
Any mitigation measures for inclusion in the EMPr.	Section 7
Any conditions for inclusion in the environmental authorisation	Section 7
Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	Section 7

NEMA Regulations (2014, as amended) - Appendix 6	Relevant section in report
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised.	Section 7
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan.	Section 7
A description of any consultation process that was undertaken during the course of carrying out the study.	None received
A summary and copies if any comments that were received during any consultation process.	Summary included in Annexure I – I&APs Comments and Responses No copies received
Any other information requested by the competent authority.	None received

Glossary and Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
dB	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure.
dBA	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure that has been A-weighted to simulate human hearing.
C_i	Correction for impulsiveness
Ct	Correction for tonality
EC	European Commission
EHS	Environmental, Health, and Safety (IFC)
EIA	Environmental Impact Assessment
HV	Heavy vehicles
Hz	Frequency in Hertz
IEC	International Electro Technical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
Kn	Noise propagation correction factor
K1	Noise propagation correction for geometrical divergence
K2	Noise propagation correction for atmospheric absorption
K3	Noise propagation correction for the effect of ground surface;
K4	Noise propagation correction for reflection from surfaces
K5	Noise propagation correction for screening by obstacles
kW	Power in kilowatt
L_{Aeq} (T)	The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
L_{Aleq} (T)	The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
$L_{Req,d}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.
$L_{Req,n}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the night-time period, i.e. from 22:00 to 06:00.
$L_{R,dn}$	The L_{Aeq} rated for impulsive sound and tonality in accordance with SANS 10103 for the period of a day and night, i.e. 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10dB in order to account for the additional disturbance caused by noise during the night.
L_{A90}	The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels (L_{A90}) (in dBA)
L_{AFmax}	The A-weighted maximum sound pressure level recorded during the measurement period
L_{AFmin}	The A-weighted minimum sound pressure level recorded during the measurement period
LDV's	Light delivery vehicles
L_{me}	Sound power level 25 m from a road, 4 m above ground (in dBA)

L_P	Sound pressure level (in dB)
L_{PA}	A-weighted sound pressure level (in dBA)
L_{PZ}	Un-weighted sound pressure level (in dB)
Ltd	Limited
L_W	Sound Power Level (in dB)
m^2	Area in square meters
m/s	Speed in meters per second
masl	Meters above sea level
MR	Mining Rights
MRA	Mining Rights Application
MPRDA	Mineral and Petroleum Resources Development Act (No. 28 of 2002)
NEMA	National Environmental Management Act (No. 107 of 1998)
NEM:AQA	National Environment Management: Air Quality Act (No. 39 of 2004)
NBA	Noise Baseline Assessment
NIA	Noise Impact Assessment
NLG	Noise level guideline
NSR	Noise sensitive receptor
NWA	National Water Act (No 36 of 1998)
p	Pressure in Pa
Pa	Pressure in Pascal
µPa	Pressure in micro-pascal
p_{ref}	Reference pressure, 20 µPa
Prime Resources	Prime Resources (Pty) Ltd
Pty	Proprietary
rpm	Rotational speed in revolutions per minute
SABS	South African Bureau of Standards
SANS	South African National Standards
SAWS	South African Weather Service
SLM	Sound Level Meter
STRM	Shuttle Radar Topography Mission
Tawana	Tawana Hotazel Mining (Pty) Ltd
THM	Tawana Hotazel Mine
USGS	United States Geological Survey
WG-AEN	Working Group – Assessment of Environmental Noise (EC)
WHO	World Health Organisation
WRF	Weather Research and Forecasting
WUL	Water Use Licence
%	Percentage

Executive Summary

The Department of Mineral Resources and Energy (DMRE) has accepted an application for Environmental Authorisation (EA) (ref No. NC 30/5/1/2/3/2/1/10197MR) in support of a Mining Right (MR) made by Tawana Hotazel Mining (Pty) Ltd (THM) in terms of Section 22 of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA) (Republic of South Africa, 2004), as amended in 2008 (Republic of South Africa, 2009) for the proposed Tawana Hotazel Mine (hereafter referred to as "THM" or "the Project"). The types of minerals applied for are: all (Code UN); Iron and Iron bearing minerals including hematite, goethite, specularite and limonite (Code (Fe) Type (B)) and Manganese and manganese bearing minerals (Code (Mn) Type (B)). The Project covers portions of two farms (Hotazel 280 and York 279) and is located approximately 1 km south-east of the town of Hotazel within the Joe Morolong Local Municipality (LM) in the John Taolo Gaetsewe District Municipality (DM) of the Northern Cape Province of South Africa.

The THM largely incorporates the historical Hotazel Manganese Mine (HMM), and the MR area includes the residual opencast void and surface dumps of low-grade material. The mothballed processing plant and rail loadout facility fall outside the MR area. HMM stopped production in 1989. The area was historically mined by both opencast and underground means and yielded high grade manganese ore. All current plans for the project specifically exclude underground mining. The overall area applied for is approximately 154 hectares (Ha) (inclusive of the MR application area and access roads). Surface infrastructure will include the opencast pit (incorporating the historical HMM void and further expansion of the opencast footprint), in-pit waste rock dumps (residue material), surface residue handling / storage, vehicle yard, workshop, access and haul roads, offices, stores, processing plant for the crushing and screening of mined ore, product stockpile area, run of mine pad, refuel station and water management

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Prime Resources (Pty) Ltd (Prime Resources) to undertake a Noise Impact Assessment (NIA) as part of the EA process to identify key aspects that may have significant noise impacts during the various project phases. As such the report conforms to the amended regulated format requirements for specialist reports as per Appendix 6 of the Environmental Impact Assessment (EIA) Regulations (as amended by Government Notice [GN] 326 of 7 April 2017; GN 706 of 13 July 2018 and GN 320 of 20 March 2020).

Receiving Environment

Noise sensitive receptors (NSRs) generally include places of residence and areas where members of the public may be affected by noise generated by the proposed activities. Only those within a 5 km radius of activities are likely to be affected; however, all NSRs within a 10 km radius were identified. Receptors located within 10 km of the Project are residences, schools and medical facilities within Hotazel as well as farmsteads/homesteads and Gloria Mine village.

There were no on-site or nearby South African Weather Service (SAWS) weather stations thus it was decided to use the WRF (Weather Research and Forecasting) modelled meteorological data for a point on-site. The WRF

data indicates a wind field dominated by winds from the northern sectors during the day. During the night, the wind field is mostly from the northeast, east-northeast and south-southeast. The average temperature in the study area over the three-year period was 21°C and the average humidity 31%. Noise impacts are expected to be slightly more notable to the south of the operations during the day and to the southwest and north-northwest of the operations during the night.

The topography of the surrounding area is mostly flat with the main terrain features in the study area being lower lying riverbeds (as low as 995 metres above sea level [masl]) to the north and west of the proposed operational area and hills to the east beyond 10 km from the proposed Project. The topography of the study area ranges in height from 995 masl to the north-west, 1020 masl to the west, and up to 1170 masl to the east of the operations. The land use in the vicinity of the operations comprises primarily mining, residential and farming. The vegetation is classified as part of the Savanna Biome and is mostly used for grazing.

Baseline Noise Sampling

Day- and night-time noise measurements were conducted on the 1st and 2nd of December 2020 at six locations. Survey sites were selected taking into consideration the location of proposed activities, NSRs, accessibility and safety. The site locations, continuous day-time noise levels ($L_{Req,d}$) and continuous night-time noise levels ($L_{Req,n}$) measured at the different sites described as per the SANS 10103 in the table below.

Description of Sites Location	**Continuous day-time noise levels ($L_{Req,d}$) as per the SANS 10103**	**Continuous night-time noise levels ($L_{Req,n}$) as per the SANS 10103**
Site 1 South of R31	Typical of urban district with main roads	Typical of urban districts
Site 2 North of Hotazel Manganese Mine	Typical of urban districts	Sound levels measured at this site are lower than rural districts
Site 3 East of Hotazel near Dwarsstraat	Sound levels measured at this site are lower than rural districts	Typical of suburban districts
Site 4 Between Wessels Clinic and Hotazel Combined School in Hotazel	Typical of rural districts	Sound levels measured at this site are lower than rural districts
Site 5 Residential area near railway line	Sound levels measured at this site are lower than rural districts	Typical of urban districts
Site 6 North of mine access road (likely Hotazel Manganese Mine)	Typical of suburban districts	Typical of rural districts

Noise Impact Assessment

Noise generating activities at THM include mainly engine and exhaust noise generated by the on-site mobile ans stationary equipment, the crusher, screen and conveyor, as well as handling of run-of-mine, waste, product, topsoil and sand material. Noise propagation simulations indicate that noise generated during day will be detectable in Hotazel town but will likely not result in disturbance or complaints. However, due to low baseline night-time noise

levels, night-time activities at THM could have a significant impact on environmental noise levels at Hotazel town during the night (22:00 to 06:00).

For the reasons described above, the noise component of the THM operational activities is given a **"moderate"** significance, using the Prime Resources impact assessment methodology, if left unmitigated and a **"low"** significance if mitigation (good engineering practices, enclosure of processing plant equipment and berms), management and monitoring measures as recommended are applied.

Conclusions and Recommendations

It is the noise specialist's opinion that, from an environmental noise perspective, the project may be authorised. Due to low baseline noise levels in Hotazel town, especially during the night, strong community action can be expected if noise generating sources are not properly mitigated and controlled.

Recommended mitigation and management measures include regular servicing and maintenance of the vehicle fleet, minimising the need for trucks to reverse, maintenance of road surfaces, minimising of idling times, choosing equipment and vehicles with low noise profiles, considering using 'smart' reverse alarms and possible establishment of a barrier, such as an earth berm, between the THM operations and Hotazel town.

Regular (at least annual) monitoring of environmental noise is recommended. The recommended locations for noise monitoring are the same as for the baseline survey, described in the table on the previous page.

It is recommended that wherever possible, significant noise generating activities be limit to the daytime (06:00 to 22:00).

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1 INTRODUCTION

1.1 Background

The Department of Mineral Resources and Energy (DMRE) has accepted an application for Environmental Authorisation (EA) (ref No. NC 30/5/1/2/3/2/1/10197MR) in support of a Mining Right (MR) made by Tawana Hotazel Mining (Pty) Ltd (THM) in terms of Section 22 of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA) (Republic of South Africa, 2004), as amended in 2008 (Republic of South Africa, 2009) for the proposed Tawana Hotazel Mine (hereafter referred to as "THM" or "the Project"). The types of minerals applied for are: all (Code UN); Iron and Iron bearing minerals including hematite, goethite, specularite and limonite (Code (Fe) Type (B)) and Manganese and manganese bearing minerals (Code (Mn) Type (B)). The Tawana Hotazel Mine covers portions of two farms (Hotazel 280 and York 279) and is located approximately 1 km south-east of the town of Hotazel within the Joe Morolong Local Municipality in the John Taolo Gaetsewe District Municipality of the Northern Cape Province of South Africa (Figure 1 and Figure 5).

The THM largely incorporates the historical Hotazel Manganese Mine (HMM), and the MR area includes the residual opencast void and surface dumps of low-grade material. The mothballed processing plant and rail loadout facility fall outside the MR area. HMM stopped production in 1989. The area was historically mined by both opencast and underground means and yielded high grade manganese ore. All current plans for the project specifically exclude underground mining. The overall area applied for is approximately 154 hectares (Ha) (inclusive of the MR application area and access roads). Surface infrastructure (Figure 4) will include the opencast pit (incorporating the historical HMM void and further expansion of the opencast footprint), in-pit waste rock dumps (residue material), surface residue handling / storage, vehicle yard, workshop, access and haul roads, offices, stores, processing plant for the crushing and screening of mined ore, product stockpile area, run of mine pad, refuel station and water management. A detailed project description is given in Section 3.

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Prime Resources (Pty) Ltd (Prime Resources) to undertake a Noise Impact Assessment (NIA) as part of the EA process to identify key aspects that may have significant noise impacts during the various project phases. As such the report conforms to the amended regulated format requirements for specialist reports as per Appendix 6 of the Environmental Impact Assessment (EIA) Regulations (Republic of South Africa, 2014) (as amended by Government Notice [GN] 326 of 7 April 2017; GN 706 of 13 July 2018 and GN 320 of 20 March 2020). This report covers the baseline and impact assessment phases of the specialist study.

1.2 Study Objective and Scope of Work

The main objective of this noise specialist study is to assess the impacts of the proposed Tawana Hotazel Mine operations on Noise Sensitive Receptors (NSRs) within the area and recommend mitigation, management, and monitoring measures based on the results of the assessment.

To meet the above objective, the following tasks were included in the scope of work:

- **A short-term noise sampling campaign** at six locations during the day and night and in accordance with SANS 10103 (2008) and International Finance Corporation's (IFC) General Environmental, Health and Safety Guidelines (EHS) of 2007. As per the National Environmental Management Act (NEMA),1998 requirements published in GN 320, the evening and night sampling was undertaken twice at each site on different calendar days.
- Desktop study of the **receiving noise environment**, incl.:
    - The identification of noise sensitive receptors from available maps.
    - A study of atmospheric noise attenuation by referring to weather records, land use and topography data sources from the air quality study.
    - A review of environmental noise guidelines.
    - Analysis of sampled noise levels.
    - The screening of sampled environmental noise levels against noise criteria.
- The **quantification and assessment of noise impacts**, incl.:
    - The establishment of a noise emissions inventory for the operations. Reference was made to equipment specific sound power levels and sound power level predictions for machinery.
    - Noise propagation modelling to determine environmental noise levels. Use was made of the CadnaA model.
    - The screening of simulated environmental noise levels against noise criteria.
    - The ranking of the significance of noise impacts in accordance with the procedure adopted by Prime Resources.
    - A noise impact assessment report including a management, mitigation and monitoring plan in the format for specialist studies as prescribed by NEMA.

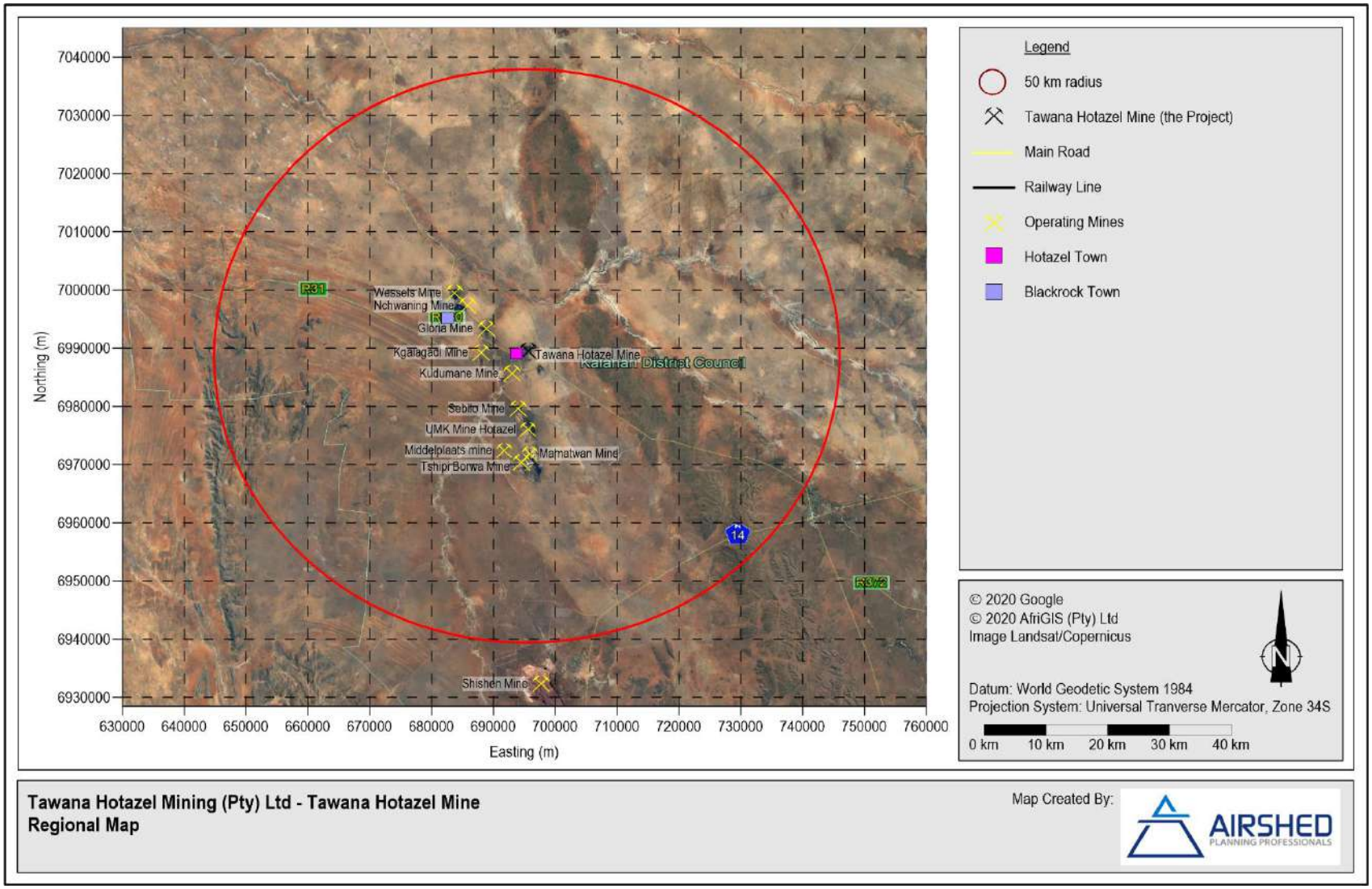


Figure 1: Regional map

1.3 Background to Environmental Noise and the Assessment Thereof

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

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

A direct application of linear scales (in pascal (Pa)) to the measurement and calculation of sound pressure leads to large and unwieldy numbers. And, as the ear responds logarithmically rather than linearly to stimuli, it is more practical to express acoustic parameters as a logarithmic ratio of the measured value to a reference value. This logarithmic ratio is called a decibel or dB. The advantage of using dB can be clearly seen in Figure 2. Here, the linear scale with its large numbers is converted into a manageable scale from 0 dB at the threshold of hearing (20 micro-pascals (µPa)) to 130 dB at the threshold of pain (~100 Pa) (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

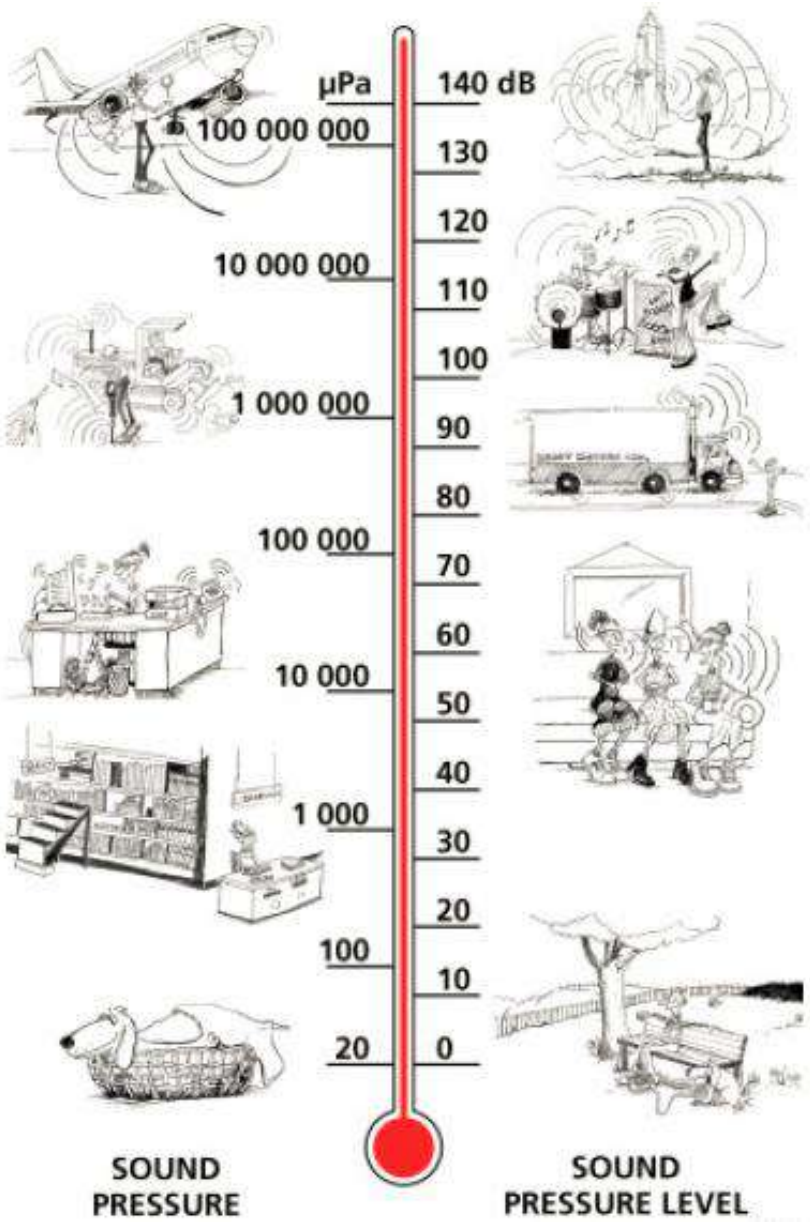


Figure 2: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

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

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

Where:

L_p *is the sound pressure level in dB;*

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

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

1.3.1 Perception of Sound

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

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

1.3.2 Frequency Weighting

Since human hearing is not equally sensitive to all frequencies, a 'filter' has been developed to simulate human hearing. The 'A-weighting' filter simulates the human hearing characteristic, which is less sensitive to sounds at low frequencies than at high frequencies (Figure 3). "dBA" is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities, that have the same units (in this case sound pressure) that has been A-weighted.

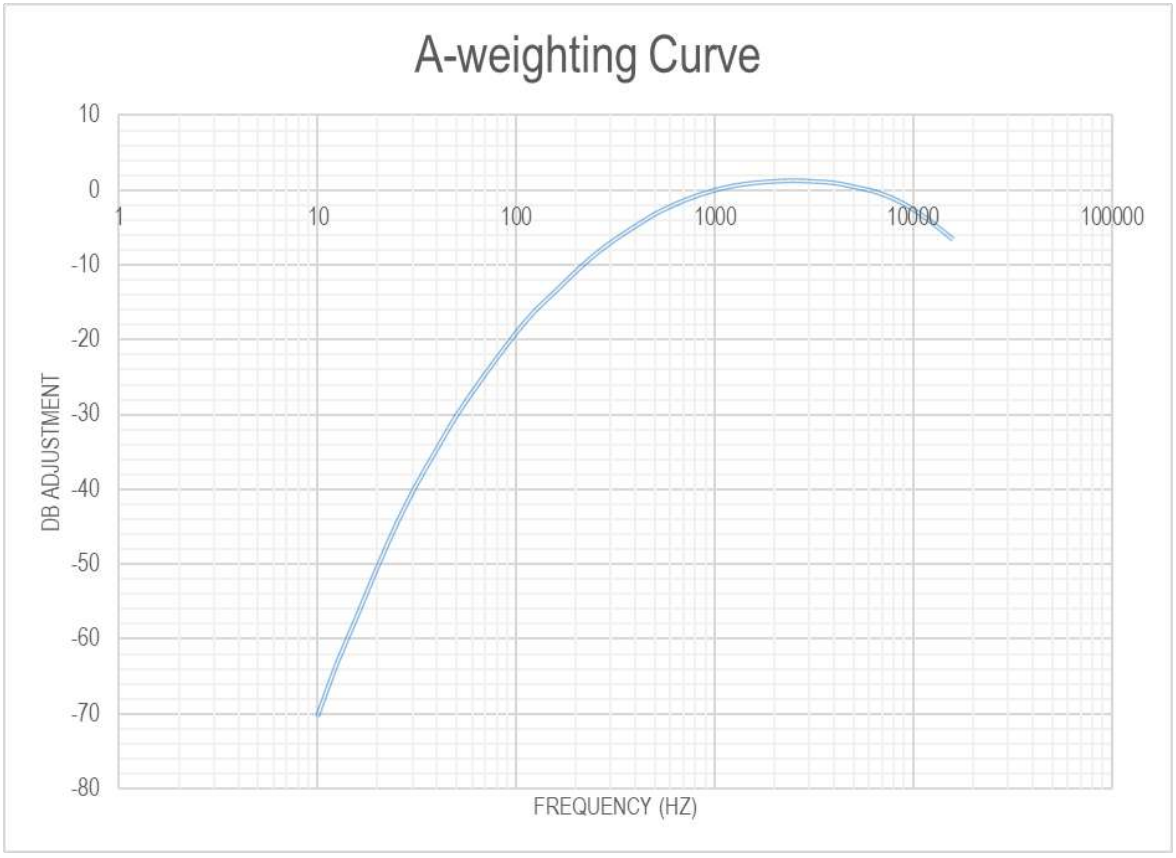


Figure 3: A-weighting curve

1.3.3 Adding Sound Pressure Levels

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

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

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

1.3.4 Environmental Noise Propagation

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

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

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

1.3.5 Environmental Noise Indices

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

- **L_{Aeq} (T)** – The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured). The International Finance Corporation (IFC) provides guidance with respect to L_{Aeq} (1 hour), the A-weighted equivalent sound pressure level, averaged over 1 hour.
- **L_{Aleq} (T)** – The impulse corrected A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured). In the South African Bureau of Standards' (SABS) South African National Standard (SANS) 10103 of 2008 for 'The measurement and rating of environmental noise with respect to annoyance and to speech communication' prescribes the sampling of L_{Aleq} (T).
- **$L_{Req,d}$** – The L_{Aeq} rated for impulsive sound (L_{Aleq}) and tonality in accordance with SANS 10103 for the day-time period, i.e. from 06:00 to 22:00.

- **$L_{Req,n}$** – The L_{Aeq} rated for impulsive sound (L_{Aleq}) and tonality in accordance with SANS 10103 for the night-time period, i.e., from 22:00 to 06:00.
- **$L_{R,dn}$** – The L_{Aeq} rated for impulsive sound (L_{Aleq}) and tonality in accordance with SANS 10103 for the period of a day and night, i.e., 24 hours, and wherein the $L_{Req,n}$ has been weighted with 10 dB in order to account for the additional disturbance caused by noise during the night.
- **L_{A90}** – The A-weighted 90% statistical noise level, i.e., the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels.
- **L_{AFmax}** – The maximum A-weighted noise level measured with the fast time weighting. It's the highest level of noise that occurred during a sampling period.

2 APPROACH AND METHODOLOGY

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

2.1 Review of Assessment Criteria

In South Africa, provision is made for the regulation of noise under the National Environmental Management: Air Quality Act (NEM:AQA) (No. 39 of 2004) (Republic of South Africa, 2005) but environmental noise limits have yet to be set. It is believed that when published, national criteria will make extensive reference to SANS 10103 of 2008 '*The measurement and rating of environmental noise with respect to annoyance and to speech communication'*. This standard has been widely applied in South Africa and is frequently used by local authorities when investigating noise complaints. These guidelines, which are in line with those published by the IFC in their *General EHS Guidelines* (IFC, 2007) and World Health Organisation (WHO) *Guidelines for Community Noise* (WHO, 1999), were considered in the assessment.

2.2 Study of the Receiving Environment

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

The ability of the environment to attenuate noise as it travels through the air was studied by considering local meteorology, land use and terrain. Atmospheric attenuation potential was described based on modelled meteorological parameters from WRF meteorological data for a location on-site. Wind speed, wind direction, temperature and parameters describing atmospheric stability for the period January 2017 to December 2019 were assessed.

Readily available terrain data was obtained from the United States Geological Survey (USGS) web site (https://earthexplorer.usgs.gov/). A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

2.3 Noise Survey

The data from a baseline noise survey conducted on the 1st and 2nd of December 2020 was studied to determine current noise levels within the area.

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

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

Table 1: Sound level meter details

Equipment	Serial Number	Purpose	Calibration Date
Brüel & Kjær Type 2250 Lite SLM	S/N 2731851	Attended 30/60-minute sampling.	24 October 2019
Brüel & Kjær Type 4950 ½" Pre-polarized microphone	S/N 2709293	Attended 30/60-minute sampling.	24 October 2019
SVANTEK SV33 Class 1 Acoustic Calibrator	S/N 57649	Testing of the acoustic sensitivity before and after each daily sampling session.	24 October 2019
Kestrel 4000 Pocket Weather Tracker	S/N 559432	Determining wind speed, temperature and humidity during sampling.	Not Applicable

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

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

Where

- $L_{Req,T}$ is the equivalent continuous rating level;
- $L_{Aeq,T}$ is the equivalent continuous A-weighted sound pressure level, in decibels;
- C_i is the impulse correction;
- C_t is the correction for tonal character; and

- K_n is the adjustment for the time of day (or night), 0 dB for day-time and +10 dB for night-time.

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

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

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

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

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

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

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

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

Where

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

2.4 Data Gathering

Detailed operational information is required for the compilation of a noise source inventory and the subsequent propagation simulations and environmental noise impact assessment. The following information was supplied by Prime Resources and Tawana:

- A detailed process description;
- Project and site layout maps;
- Material throughputs; and,
- List of equipment for various areas.

2.5 Source Inventory

Noise emissions from crushers, screens, conveyors and materials handling were estimated from a measurements database. Noise levels from transport trucks were estimated using L_W predictions for industrial machinery (Bruce & Moritz, 1998), where L_W estimates are a function of the power rating of the equipment engine.

Decommissioning activities are expected to result in noise impacts similar to or less significant than impacts associated with the operational phase. A source inventory was therefore only developed for the operational phase of the project.

2.6 Noise Propagation Simulations

The propagation of noise from proposed activities was simulated with the DataKustic CadnaA software. Use was made of the International Organisation for Standardization's (ISO) 9613 module for outdoor noise propagation from industrial noise sources.

2.6.1 ISO 9613

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

The method also predicts an average A-weighted sound pressure level. The average A-weighted sound pressure level encompasses levels for a wide variety of meteorological conditions. The method specified in ISO 9613 consists specifically of octave-band algorithms (with nominal midband frequencies from 63 Hz to 8 kHz) for calculating the attenuation of sound which originates from a point sound source, or an assembly of point sources. The source (or sources) may be moving or stationary. Specific terms are provided in the algorithms for the following

physical effects; geometrical divergence, atmospheric absorption, ground surface effects, reflection and obstacles. A basic representation of the model is given in the equation below:

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

Where;

L_P *is the sound pressure level at the receiver;*
L_W *is the sound power level of the source;*
K_1 *is the correction for geometrical divergence;*
K_2 *is the correction for atmospheric absorption;*
K_3 *is the correction for the effect of ground surface;*
K_4 *is the correction for reflection from surfaces; and*
K_5 *is the correction for screening by obstacles.*

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

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

2.6.2 Simulation Domain

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

2.7 Presentation of Results

Noise impacts were calculated in terms of:

- The day-time noise level ($L_{Aeq,d}$);
- The night-time noise level ($L_{Aeq,n}$); and
- The day/night noise level ($L_{Aeq,dn}$).

Results are presented in isopleth form. An isopleth is a line on a map connecting points at which a given variable (in this case sound pressure, L_P) has a specified constant value. This is analogous to contour lines on a map

showing terrain elevation. In the assessment of environmental noise, isopleths present lines of constant noise level as a function of distance.

Simulated noise levels were assessed according to guidelines published in SANS 10103 and by the IFC. To assess annoyance at nearby places of residence, the increase in noise levels above the baseline at NSRs was calculated and compared to guidelines published in SANS 10103.

2.8 Recommendations of Management and Mitigation

The findings of the noise specialist study were used to inform the recommendation of suitable noise management and mitigation measures.

2.9 Impact Significance Assessment

The significance of environmental noise impacts was quantitatively assessed and considered the future operations scenario. The Prime Resources impact significance rating methodology was used to determine the significance of the impact.

2.10 Managing Uncertainties

The environmental noise specialist study was based on a few assumptions and is subject to certain limitations, which should be borne in mind when considering information presented in this report. The validity of the findings of the study is not expected to be affected by these assumptions and limitations:

1. All project information was provided by Prime Resources and Tawana; it is assumed that all this information is the most recent data and correct.
2. Meteorology:
    a. There was neither an on-site weather station nor a nearby South African Weather Service (SAWS) weather stations thus it was decided to use the WRF (Weather Research and Forecasting) modelled meteorological data for a point on-site. Data for the period January 2017 to December 2019 was used in the noise propagation simulations. The closest SAWS stations are Kuruman and Kathu which are both approximately 50 kilometres (km) away from this site and based on the terrain and land use in the area these sites most likely will not be representative.
3. No recent baseline data was available thus a baseline noise survey was conducted on the 1st and 2nd of December 2020 to determine current noise levels within the area.
4. Assessment of impacts:
    a. The environmental noise assessment focussed on the evaluation of impacts for humans. It is important to note that the applicability of environmental noise assessments to wildlife is limited as it is not possible simply to infer the impacts of anthropogenic noise on wildlife from the human literature. This is because the hearing ranges and sensitivities of non-human animals can be

very different from those of humans. Noise studies on humans understandably use methodologies that tailors the quantification of anthropogenic noise to our hearing capabilities: for example, the use of microphones limited to the human hearing range (20 Hz – 20 kHz) and the implementation of frequency filters effectively mimicking human auditory sensitivity (A-weighting). As such, noise measurements may cover only part of the relevant acoustic range for other species. Moreover, species differences in behaviour, physiology and ecology, in addition to hearing capabilities and perception, mean that extrapolations from human studies can provide only a limited understanding of the potential impact of anthropogenic noise on wildlife.

b. The EA process will be completed by Prime Resources. For this reason, the expected impact significance of the operations was determined based on the Prime Resources impact significance methodology.

5. Blasting and Vibration:
    a. A blasting and vibration assessment was not included in the scope of work.

3 PROJECT DESCRIPTION

Timeframes and scheduling of phases

- 2 years have been allowed for pre-stripping and mining infrastructure construction.
- The Life of mine (LoM) indicated by the conversion of the resource to reserve is 30 years for the open pit operation.
- Backfilling/rehabilitation will commence immediately after the commencement of the mining operation and its advance will match the depletion rate of the open pit.
- A period of 3 years is expected for final rehabilitation after closure.

3.1 Pre-development and Construction Phase

During the construction phase several facilities need to be established. These include contractor's laydown areas, workshops (instrumentation, electrical and mechanical), stores for the storing and handling of fuel, lubricants, solvents, paints and construction materials, a wash bay, laboratory, construction waste collection and storage facilities, a store, a parking area for cars and equipment, site offices, portable ablution facilities, electricity supply (generators), portable water supply (bowsers), change houses, soil stockpiles, water management infrastructure, security and access control, and the two main access roads and haul roads. These facilities will either be removed at the end of the construction phase or incorporated into the layout of the operation phase facilities. Access to site will be via the project access roads. The following activities are likely:

- Void/pit dewatering activities, including a diesel powered barge with a pump system that will pump water to evaporators;
- Site establishment of construction phase facilities;
- Clearing of vegetation;
- Stripping and stockpiling of soil resources and earthworks;
- Possibly drilling and blasting;
- Handling and storage of construction materials;
- Collection, storage and removal of construction related waste;
- Transportation of materials and waste on-site and along the access roads; and
- Construction of all infrastructure required for the operational phase.

3.2 Operational Phase

Only opencast mining methods will be used, i.e., no underground mining is proposed. Noise impacts will likely decrease as the opencast mining area deepens as the "pit walls" will dampen the noise, thus in the simulations all operations will be at the surface to establish the simulated worst-case impact area. Backfilling/rehabilitation will commence immediately after the commencement of the mining operation and its advance will match the depletion rate of the open pit.

The main operations during the operational phase are opencast mining, material storage, crushing and screening of ore, grading of roads, bulldozing of stockpiles for stockpile management. Backfilling/rehabilitation will be undertaken simultaneously with the mining operations and its advance will match the depletion rate of the open pit. There will an all-weather access road with the main road users being Heavy Vehicles (HV) which will have a dedicated access road running from the product stockpile area to the east of the operations, Light Delivery Vehicles (LDV's) and personnel vehicles, and buses will have a desiccated access road to extending to the west of the operations from the Hotazel town. In addition, on-site access roads will be required for use by the secondary support fleets and haul trucks. There will also be transportation via rail with the mine having a dedicated siding and load out station situated near the site. More detail all the functions associated with the proposed project is provided below.

Mining

- Opencast mining methods will be used to a maximum depth of 95 m.
- The orezone of the various seams is found at depths from 25 to 91 m below the surface and the manganese seam thicknesses varies from 3 to 27 m.
- The proposed mining process is as follows: drilling → blasting → load and haul → dry crushing and screening plant → product stockpiling → road truck loading.
- The annual Run of Mine (RoM) ore production is estimated at 0.5 Mt.
- The mining of the opencast pit will require as many as two active work areas in certain schedule overlap years.

Blasting

- The blast designs will aim for productive blasting, whilst achieving the environmental controls that are needed for mining safely at the proposed THM.
- The blast designs (including timing and stemming requirements) will take the rock type descriptions, mining methods including planned bench height and hole diameter and the distribution of sensitive receptors surrounding the mine into account.
- The following limits will be applied:
    - Ground vibration: A maximum peak particle velocity (PPV) of 6 mm/s for the closest house.
    - Air blast: A peak air blast level of 120 dBL.
    - Maximum fly rock range: Three fly-rock limits will apply using a factor of safety of two for the safety of people, these being 100 m maximum for all blasts, a 300 m alert or exceedance range for which a special internal investigation is needed if fly rock occurs in this range at distances more than 100 m, and a 500 m clearance zone.
- Cartridge explosives and detonators will be sourced from a licensed explosive magazine provided for use by the blasting contractor, the location which will not be situated within the mining area and adjacent residential area. The blasting contractor office and ammonium nitrate silos and emulsion tank will be stored within a fenced compound to be developed in accordance with the legislated requirements.
- If ammonium nitrate prill is required in the future it will be delivered to site by truck.

Loading and hauling

- Due to the mixing requirements, where high-grade ore will be mixed with the lower grade material from the lower benches within the pit, the loading equipment will be mobile.
- The excavators will load the 40t haulage units with three to four passes and will be supported by a bulldozer to assist with oversize handling, ore crowding and road construction.
- RoM ore will be trucked out of the open pit and tipped onto the RoM ore stockpile.

Processing

- From the RoM stockpile, front end loaders (FELs) will feed the ore into the primary crusher (jaw crusher).
- The primary crusher will feed the screening plant. In the initial stages these will be mobile units.
- The different size fractions will be sampled and stockpiled into separate stockpiles according to grade and size at the dedicated stockpile area.
- From these stockpiles, the product will be loaded onto road trucks using a FEL according to the customer's requirements in terms of size and grade (some blending may be required).
- Water mist will be added to all processes to reduce dust generation.
- Fines will be stockpiled for sale as and when the demand arises.
- The mobile crushing and screening plant is currently planned to be located at the southern end of the new open pit.
- Road transport loading with suitable weighbridges will take place via a dedicated loading facility. Road trucks will then transport product to Lohatla for train loading, after passing over the weighbridge.

Mine entrance and access roads

- There are two main access roads to the mine, one intersects with Provincial Road D3463 from Kuruman to Severn and enters the mine at the north-eastern corner, while the other road is from Hotazel town in the west and enters the mine from the north. The two roads intersect before entering the mining area.
- The main transport route to the north-east will be for HVs, potentially 80 – 100 trucks per day, and the main entrance to the west (near Hotazel) will be for LDV's.
- In addition, on-site access roads will be required for use by the secondary support fleets and earthmoving haul trucks, with ramps that lead in and out of the pit and haul roads for the transportation of processed products and waste amongst others.
- In order to improve mobility around the mine and to potentially reduce road user costs, a ring road (haul road) around the mine pit has been proposed. This road will also intercept stormwater which will be channelled to the stormwater ponds.
- The minimum width of all the roads is 10m as they generally have to accommodate large trucks, with sufficient space for surface water flow.

Support Equipment

- Four excavators (5 m^3 capacity) and FELs (5 m^3 capacity) will be required for flexibility and management of the various stockpiles.
- Eight trucks (in the 40 t class with 320 kW engines) will be required in the initial production period with this increasing to sixteen once steady state RoM production has been achieved.

- Three primary blast hole drill rigs will be required
- One road grader will maintain the roads on the property.
- One water truck for dust suppression on main haul routes.
- Two track dozer will be used for typical dozer functions including maintenance of dumps, drill site preparation, road building, ditching, bench repair, shovel clean-up and stockpile dozing.
- A rubber-tired dozer for lighter dozer work such as shovel excavator clean-up and road sweeping.
- Diesel LDVs will be supplied for the Mine Superintendent, Engineering Superintendent, Mining Supervisor, Blaster, Geologist, Surveyors, and the plant production crew. A total of eight units are provided for initially.
- Maintenance support vehicles and equipment will include flat deck trucks and fuel, water, and lube trucks for servicing the excavators.
- Miscellaneous units such as personnel carriers, lighting towers etc. are also provided for the support of mine operations.

Electricity

- The mine reticulation will be provided from the existing 11 kV Eskom overhead power supply line from a substation in Hotazel, which terminates close to the north-western corner of the mine, next to the existing railway line.
- A new mini-substation will be connected to the incoming Eskom overhead powerline, from where the mine's offices and weighbridge will be connected by an underground power cable.
- A single Eskom 132 kV line will be brought into the main substation switching yard.
- The expected full load power requirement is calculated as 3 326 kVA. An application for 4.0 mVA has been submitted to cover the power requirements for the proposed THM.
- The remaining facilities and plant (i.e. processing plant) will not be connected to the grid as they will use their own power. The entire processing plant will be diesel operated.
- Until such time as power infrastructure is installed on site a mix of solar and diesel generators will be used as an alternate supply source.

Water

- All potable water will be supplied through the Vaal Gamagara water scheme via a bulk water meter, managed by Sedibeng Water.
- Sedibeng Water has therefore been engaged and has provisionally approved a connection point for water supply approximately 2km south-west of the mine. A design is required to be submitted to Sedibeng Water for approval.
- Water will be required for processing, mining, change houses, offices, and workshops. Each supply area will be individually metered to enhance control and minimize wastage.
- Water supply for other purposes (i.e. dust suppression and industrial use on site) will be sourced from the either the stormwater ponds or the PCD.
- The estimated that the potable water consumption volumes per day is 4800 – 6480 litres per day plus 10% for wastage/losses.
- The remainder of the water to be used for general purposes (i.e. dust suppression and process water purposes) will be sourced from the PCD and the stormwater ponds.

- An application for a water connection has been submitted to Sedibeng Water.
- Precipitation has collected in the open void and underground workings since the mine stopped production in 1989. Thus this water will need to be fully removed before mining work can commence. A forced-evaporation system to eliminate water from the initial void may be implemented for water management purposes.
- A lined 5 m deep Pollution Control Dam (PCD) is planned with a minimum capacity of 20 000 $m^{3.}$
- The site has been split into three main catchment areas, excluding the mining pit, resulting in a total of three planned stormwater ponds to store as much of the surface water as practically possible. The surface water will mainly be intercepted by the roads and channelled to the respective stormwater ponds. The capacity of the stormwater ponds is as follows: stormwater pond 1 (12 250 m^3), stormwater pond 2 (6500 m^3) and stormwater pond 3 (7 313 m^3). The ponds have been sized for a 1 in 50-year return flood.
- Mine dewatering will be carried out using diesel powered submersible pumps installed in sumps at the bottom of the pit. Water will be pumped from the open pit and discharged into the freshwater tank for use in the plant with any excess water discharged to the PCD.

Waste

- The mining project will generate general (domestic) waste and mining waste.
- Sanitation from the mine will be piped to a septic tank which will be located on the eastern side of the offices. This septic tank will have a capacity of a minimum two (2) weeks before it is filled-up. Design drawings are to be submitted to the municipality for approval prior to start of construction. Similar to the water supply, sanitation infrastructure will only be connected to the office block.
- Non-hazardous domestic and industrial waste will be stored temporarily within a hard-standing area for covered bins / skips.
- All recyclable waste will be collected by a contractor where it will be recycled off-site. Only materials which cannot be reused, recycled or recovered will be disposed of at an appropriately licensed facility by a licensed contractor.
- An estimated stripping ratio is set at 2.98 t of waste per tonne of ore. Residue material (overburden and waste rock) arising from the development and ongoing operation of the opencast mine pit will be disposed back into the existing historical opencast void and the trailing mined out opencast void through backfilling. There will be 3 waste dumps with the following capacities and maximum heights:
    - Waste dump no.1 (3 859 493 m^3) – 15 m above current surface
    - Waste dump no.2 (3 487 682 m^3) - level with current surface
    - Waste dump no.3 (5 783 722 m^3) – 30 m above current surface
- There will also be a topsoil stockpile with a capacity of 210 000 m^3 and estimated height of 10 m and a sand stockpile with a capacity of 1 185 000 m^3 and estimated height of 20m.

Other infrastructure

- A new weighbridge facility, which will comprise of a weighbridge and an office, is planned to be constructed between the offices and the product stockpile area, close to the northern boundary of the of the mine. This facility will be manned as per the operational requirements of the mine. In order to cater for trucks that may be overload or underloaded, a turning loop will be constructed next to the weighbridge facility to allow for easy access back to the product stockpile area.

- The new offices and parking will be located along the northern boundary of the mine. The offices will be accessible via the new access road that ties-in with the main access road from the north, used by LDVs.
- A plant yard/ workshop will be located on the western side of the pit, between the mine pit and a haul road that links the processing plant and the product stockpile area. This facility will mainly be used for repairs, servicing and washing of vehicles/plant. The surface will be a concrete slab with a slope towards various sumps to contain oil and contaminated water.
- A Refuelling Station will be located on the western side of the pit. This facility is anticipated to have at least two 30 000 litre (ℓ) refuelling tanks and will have a concrete slab with sumps to contain oil and contaminated water.

Operating hours and staff

- The mine and plant will operate on a continuous basis, with 330 working days per annum.
- The mine will employ approximately 177 people (inclusive of outsourced service providers).

3.3 Decommissioning and Closure Phase

The removal of infrastructure as well as sloping and revegetation of the area are planned for the decommissioning phase. This phase will include removal of plant and equipment, shaping of disturbed and formed areas of the landscape, land rehabilitation/revegetation and construction of structures to make the site safe. Closure monitoring usually occurs periodically over five (5) years to determine if the decommissioning and rehabilitation works have been successfully completed.

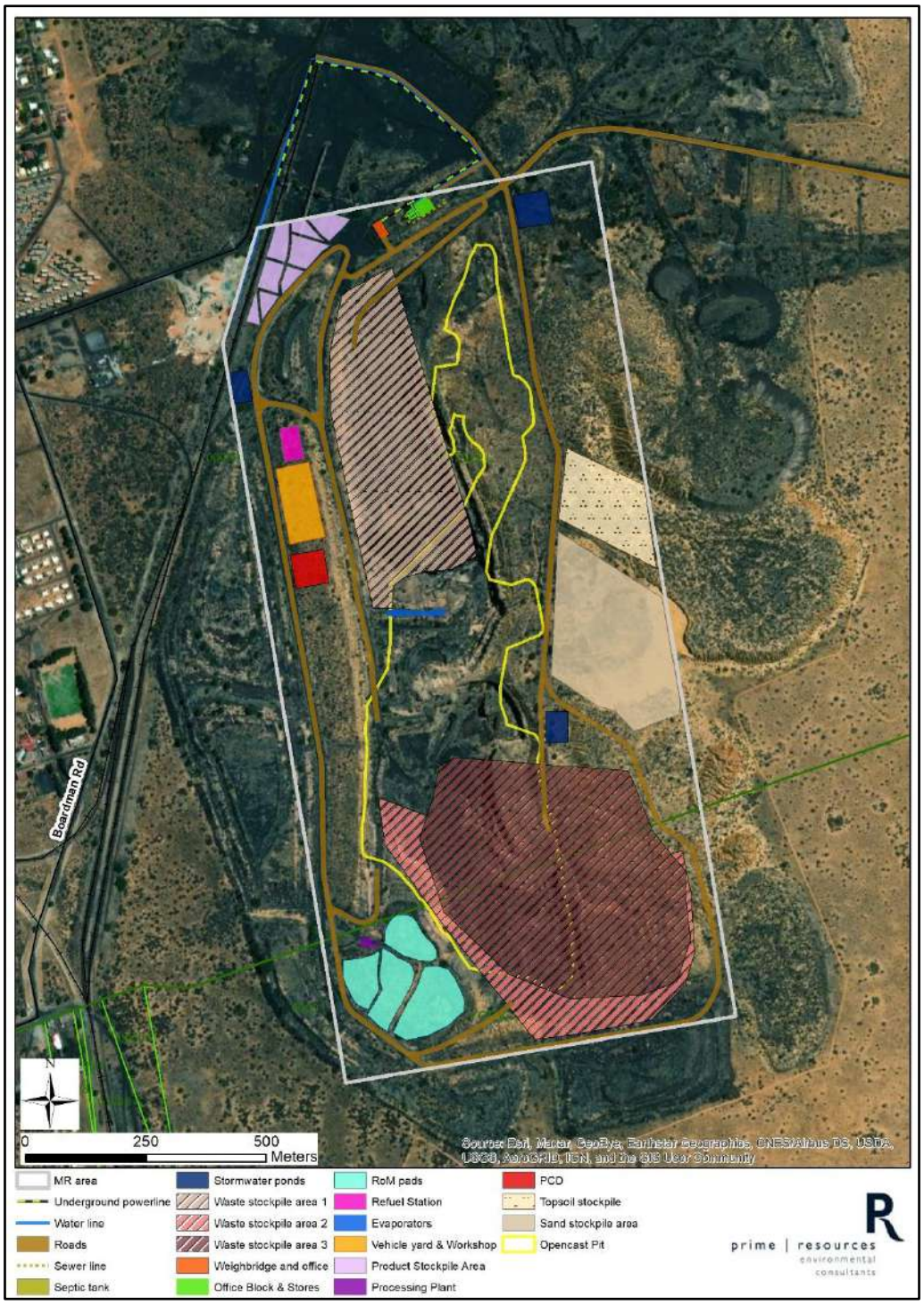


Figure 4: Layout map

4 LEGAL REQUIREMENTS AND NOISE LEVEL GUIDELINES

4.1 NEMA EIA Regulations

In terms of the National Environmental Management Act (No. 107 of 1998) (NEMA) Environmental Impact Assessment (EIA) Regulations (Republic of South Africa, 2014; Republic of South Africa, 1998) (as amended by GN 326 of 7 April 2017; GN 706 of 13 July 2018 and GN 320 of 20 March 2020) a specialist report must contain certain information (see table on page ii for full list of information required). A site environmental sensitivity screening must also be conducted for the specialist assessment using the Department screening tool to determine among other information the development incentives, restrictions, exclusions or prohibitions that apply to the proposed development site as well as the most environmental sensitive features on the site based on the site sensitivity screening results for the application classification that was selected. Based on the site sensitivity screening the only requirement for this report is that it fulfils the Appendix 6 Specialist Report requirements.

4.2 South African Noise Regulations

The 1992 Noise Control Regulations (The Republic of South Africa, 1992) published in terms of Section 25 of the Environment Conservation Act (Act no. 73 of 1989) defines a “disturbing noise” as a noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more.

In Gauteng, the 1992 Noise Control Regulations were replaced by the Gauteng Noise Control Regulations in 1999 (The Gauteng Provincial Government, 1999). It defines “controlled” areas as areas where calculations or measurements over 24-hours indicate noise levels in exceedance of 60 dBA. It defines a “disturbing noise" as a noise level that causes the ambient noise level to rise above the designated zone level, or if no zone level has been designated, the typical rating levels for ambient noise in districts, as per SANS 10103 (2008). Although the project is not located in the Gauteng Province the buffers of the Gaute111 Pollution Buffer Zones Guideline, March 2017 is a decent indication of a potential buffer to be used. This guideline now part of the Gauteng Provincial Environmental Management Framework (GPEMF) was adopted as gazetted on 2 March 2018 (Gazette No.: 41473). The GPEMF includes buffer zones for various industrial facilities, sewage treatment works, landfill sites, mine slimes and ash dumps to be adhered to, to ensure healthy and safe environments, and to reduce nuisance to developments, and to protect populations from potential risks.

The specific sizes for the preferred buffer or minimum buffer to be complied with is as follows:

- Best case buffer of 1 500 m and worst-case buffer of 750 m must be maintained in Category 1 industries which include those associated with:
    - Large volumes of air pollution;
    - Producing effluent and / or solid waste;
    - Excessive noise, including those with railway infrastructure incorporating shunting yards; and
    - Power generation sources.

- Best case buffer of 500 m and worst-case buffer of 250 m must be maintained in Category 2 industries which include those associated with:
    - General manufacturing with less significant emissions;
    - Noisy operations;
    - Noisy service industries; and
    - Certain agricultural industries.
- Best case buffer of 100 m and worst-case buffer of 50 m must be maintained in Category 3 industries which include those associated with:
    - Clean manufacturing processes with little effluent or other nuisance factors;
    - High technology research and development activities;
    - Industries centered around warehousing and distribution operations with low noise levels; and
    - Industries centered around packaging operations.
- Best case buffer of 800 m and worst-case buffer of 500 m must be maintained for Sewage treatment works
    - These facilities for the storage of raw sewage, treatment processing and safe disposal or release into the natural environment have the potential for water, groundwater and air pollution.
- Best case buffer of 400 m and worst-case buffer of 200 m must be maintained for General Landfill sites (Communal, small, medium and large).
- Best case buffer of 2000 m and worst-case buffer of 1000 m must be maintained for Hazardous Landfill sites
- Best case buffer of 100 m and worst-case buffer of 0 m must be maintained for Mine dumps (rock dumps or stockpiles)
- Best case buffer of 1000 m and worst-case buffer of 500 m must be maintained for Mine slimes dams and ash dumps
- Best case buffer of 5000 m and worst-case buffer of 2000 m must be maintained for The Pelindaba nuclear facility complex

Although the proposed project site is not located within the Gauteng province, the buffer zone delineation is useful for the qualitative assessment of the project. According to the Gauteng GPEMF, Category 1 is likely to be the most applicable to the proposed Project, this category has a preferred buffer of 1 500 m and minimum buffer of 750 m.

4.3 South African National Standards

SANS 10103 (2008) successfully addresses the manner in which environmental noise measurements are to be taken and assessed in South Africa and is fully aligned with the WHO guidelines for Community Noise (WHO, 1999). Table 3 provides the typical rating levels for noise in districts as listed in the SANS 10103 (2008).

Table 3: Typical rating levels for outdoor noise

Type of district	Equivalent Continuous Rating Level ($L_{Req,T}$) for Outdoor Noise		
	Day/night $L_{R,dn}$[c] (dBA)	Day-time $L_{Req,d}$[a] (dBA)	Night-time $L_{Req,n}$[b] (dBA)
Rural districts	45	45	35
Suburban districts with little road traffic	50	50	40

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

Notes

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

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

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

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

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

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

4.4 International Finance Corporation Guidelines on Environmental Noise

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

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

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

Table 4: IFC noise level guidelines

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

5 DESCRIPTION OF THE RECEIVING ENVIRONMENT

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

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

5.1 Noise Sensitive Receptors

NSRs generally include places of residence and areas where members of the public may be affected by noise generated by the proposed activities. Only those within a 5 km radius of activities are likely to be affected; however, all NSRs within a 10 km radius were identified. Receptors located within 10 km of the Project are listed in Table 5 and shown in Figure 5. These were included in the propagation modelling as discrete receptors.

Table 5: Identified individual noise sensitive receptors

ID/Name	Type	Longitude	Latitude
R1	Farmstead	22.977907761	-27.292087813
R2	Farmstead	23.023908003	-27.240601303
R3	Farmstead	23.034036496	-27.216124110
R4	Farmstead	23.038256702	-27.226252604
R5	Farmstead	23.062311874	-27.206839657
R6	Farmstead	23.042898928	-27.154931127
R7	Farmstead	22.931907518	-27.137628284
R8	Farmstead	22.910384469	-27.168013765
R9	Farmstead	22.919668922	-27.265500517
Hotazel Combined School	School	22.963981082	-27.208105719
Hotazel College	School	22.956806732	-27.197977225
Wessels Clinic	Medical Facility	22.963981082	-27.211059863
Gloria Mine Village	Mine Village	22.909962449	-27.170123868

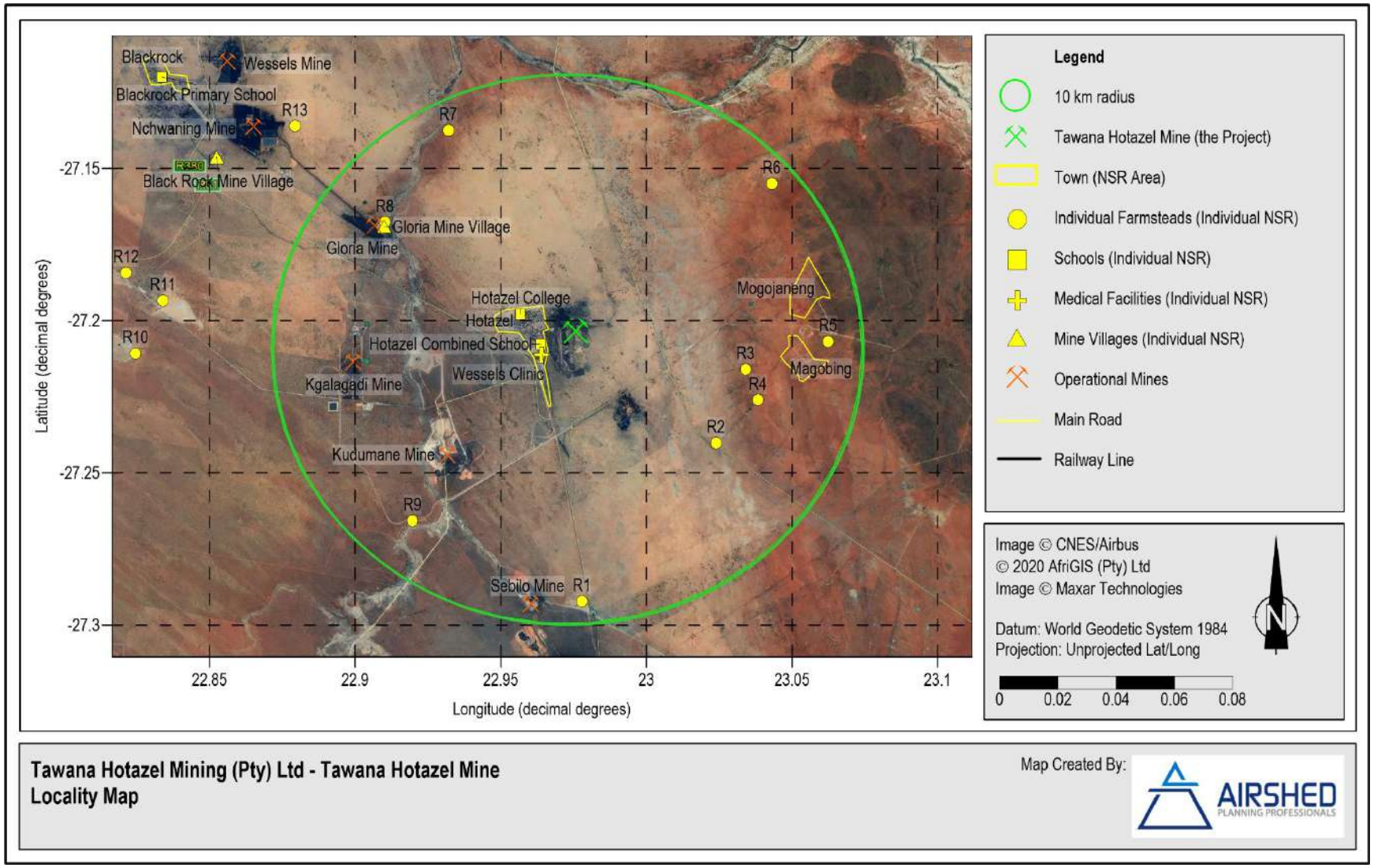


Figure 5: Locality map

5.2 Environmental Noise Propagation and Attenuation Potential

5.2.1 Atmospheric Absorption and Meteorology

Atmospheric absorption and meteorological conditions have already been mentioned with regards to their role in the propagation on noise from a source to receiver (Section 1.3.4). The main meteorological parameters affecting the propagation of noise include wind speed, wind direction and temperature. These along with other parameters such as relative humidity affect the stability of the atmosphere and the ability of the atmosphere to absorb sound energy. Use is made of the WRF modelled meteorological data for a point on-site for the period January 2017 to December 2019.

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

The diurnal wind field for the area is presented in Figure 6. Wind roses represent wind frequencies for 16 cardinal wind directions. Frequencies are indicated by the length of the shaft when compared to the circles drawn to represent a frequency of occurrence. Wind speed classes are assigned to illustrate the frequencies with high and low winds occurring for each wind vector. The frequencies of calms, defined as periods for which wind speeds are below 1 m/s, are also indicated.

The WRF data indicates a wind field dominated by winds from the northern sectors during the day. During the night, the wind field is mostly from the northeast, east-northeast and south-southeast (Figure 6). Day- and night-time average wind speeds are 4.55 m/s and 3.93 m/s, respectively. Calm conditions (wind speeds of less than 1 m/s) occur 3.46% of time during the day and 4.42% during the night.

The average temperature in the study area over the three-year period was 21°C and the average humidity 31%. Noise impacts are expected to be slightly more notable to the south of the operations during the day and to the southwest and north-northwest of the operations during the night.

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a 'shadowing' effect for sounds. On a clear night, temperatures may increase with altitude thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night. The diurnal temperature profile for the WRF data is shown in Figure 7. During the day, temperatures increase to reach maximum at around 14:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 06:00 i.e. just before sunrise.

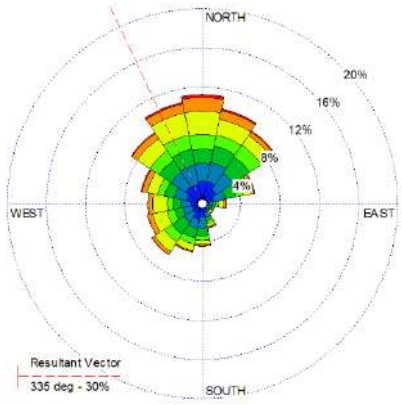
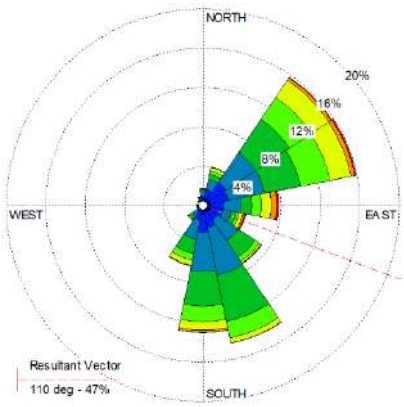
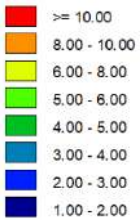
(a) Day-time wind field (06:00 to 22:00)	(b) Night-time wind field (22:00 to 06:00)	Wind speed (m/s)
 Calms = 3.46%	 Calms = 4.42%	

Figure 6: Day- and night-time wind field for AERMET processed WRF data (January 2017 to December 2019)

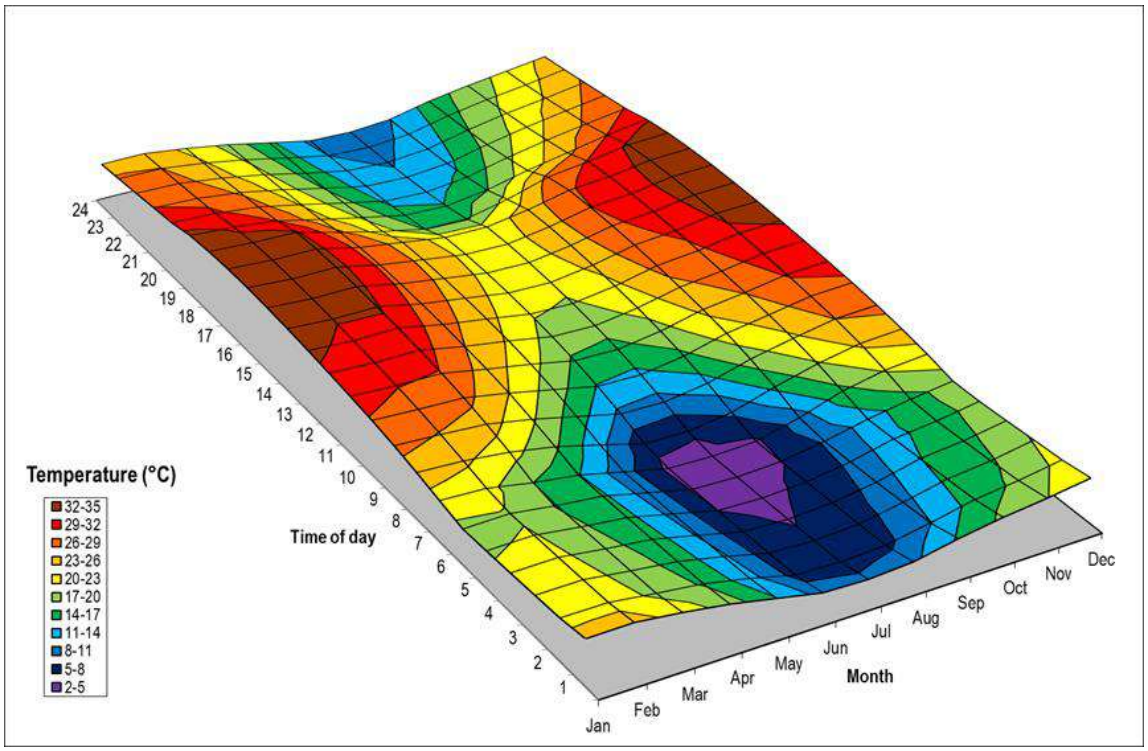


Figure 7: Monthly average temperature profile for AERMET processed WRF data (January 2017 to December 2019)

5.2.2 Terrain, Ground Absorption and Reflection

Noise reduction caused by a barrier (i.e., natural terrain, installed acoustic barrier, building) depends on two factors namely the path difference of a sound wave as it travels over the barrier compared with direct transmission to the receiver and the frequency content of the noise (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

The terrain of the study area is shown in Figure 8. The topography of the surrounding area is mostly flat with the main terrain features in the study area being lower lying riverbeds (as low as 995 metres above sea level [masl]) to the north and west of the proposed operational area and hills to the east beyond 10 km from the proposed Project. The topography of the study area ranges in height from 995 masl to the north-west, 1020 masl to the west, and up to 1170 masl to the east of the operations. The land use in the vicinity of the operations is comprises primarily mining, residential and farming. The vegetation is classified as part of the Savanna Biome and is mostly used for grazing.

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

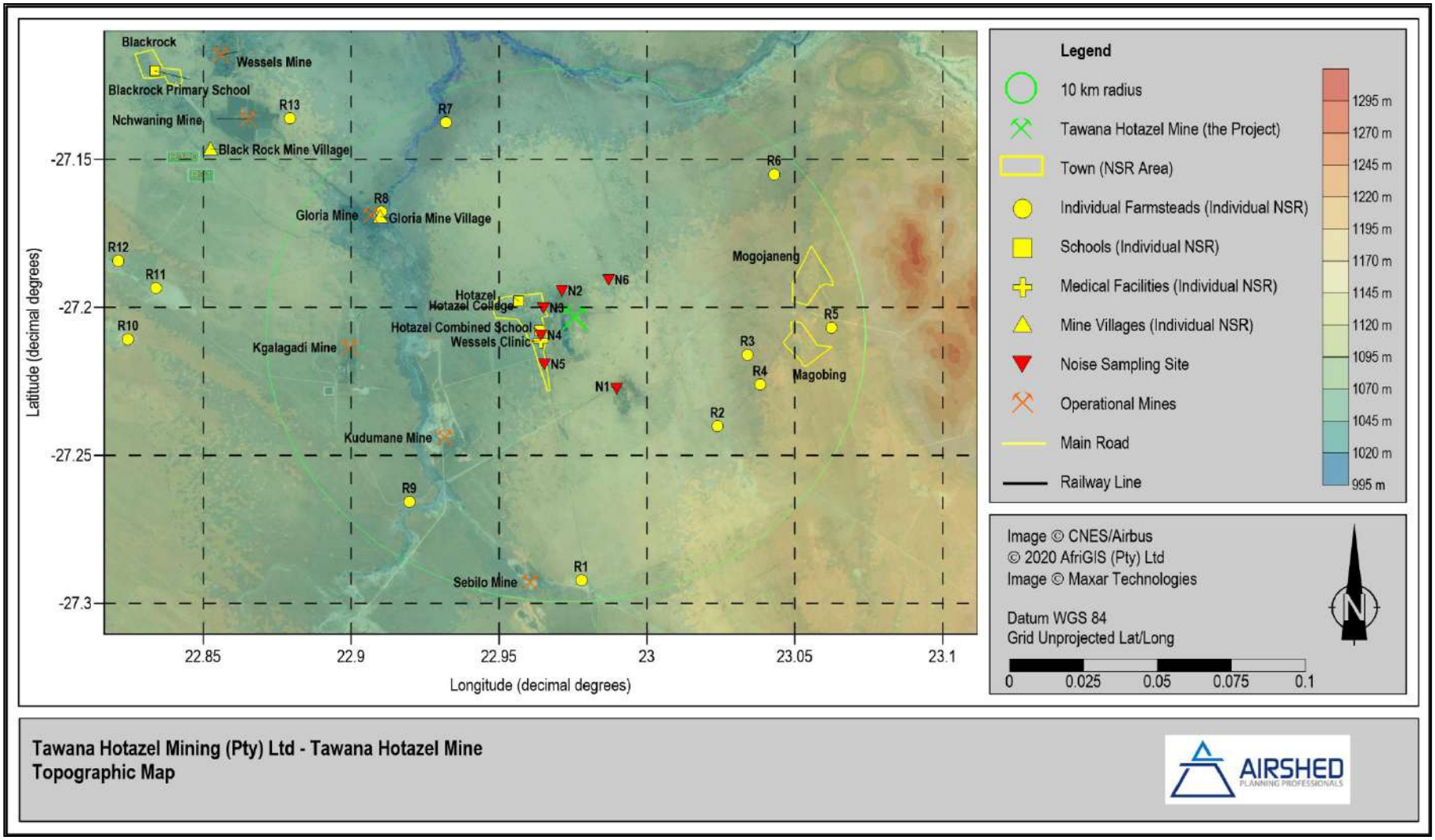


Figure 8: Topographic map

5.3 Noise Survey and Results

Day- and night-time noise measurements were conducted on the 1st and 2nd of December 2020 at six locations shown in Figure 8 and Figure 9. Survey sites were selected taking into consideration the location of proposed activities, NSRs, accessibility and safety. The coordinates as well as a description of the noise sampling locations is given in Table 6 to Table 11. Time series broadband sampling results, frequency spectra and statistics for each measurement, as well as fieldwork log sheets, photographs of the sampling sites and microphone placement are included in Appendix A to F for each of the sampling sites. The time at which the evening measurements were taken (i.e., 18:00 – 22:00) is within the defined SANS 10103 day-time period (i.e., from 06:00 to 22:00). Day-time measurements thus consisted of one day and two evening measurements.

During the day, temperatures ranged between 23°C and 34°C, with 0% to 80% cloud cover. Winds were between 0.4 and 2.8 m/s from a southerly direction; between 0.4 and 4.6 m/s from a south-westerly direction; and, between 1.7 and 3.7 m/s from the westerly direction. The humidity was between 13% and 27%; with 0% to 80% cloud cover. At night, temperatures ranged between 19°C and 25°C, mostly calm wind conditions with a maximum wind speed of 1.8 m/s from the south-west. Humidity was between 20% and 35%; with 0% to 60% cloud cover.

It should be noted that insects were audible at all the sampling locations. Acoustic observations made during the survey are summarised in Table 6 to Table 11. The day-time and night-time acoustic climate at the six sampling points was heavily influenced by local noise generating sources, with the R31 (regional main road) activities only audible at Site 1 (Table 6); and railway operations at Site 5 (Table 10). Noise sources at Sites 3, 4 and 5 (Table 8, Table 9 and Table 10, respectively) which were located either in or nearby Hotazel residential areas were mostly influenced by local sources such as community activity, vehicle traffic and domestic animals. The acoustic sources at Point 6 (Table 11), located close to what appeared to be an unused mine access road, included insects, birds, cows and community activity.

Measured day-time L_{A90} levels (Table 6 to Table 11) indicate that the day-time background noise levels were low with isolated noise incidents, which were observed to have L_{AFmax} values of between 55.0 dBA (Site 4) to 68.8 dBA (Site 6), lead to higher average L_{Req}'s, especially at Sites 1 and 6. At Site 1 the regional road (R31) near the sampling point lead to a continuous higher background noise level (L_{A90} = 58.5 dBA).

The continuous day-time noise levels ($L_{Req,d}$) measured at the different sites (Table 6 to Table 11) are described as per the SANS 10103 as follow:

- Site 1 - Typical of urban district with main roads (Table 6)
- Site 2 - Typical of urban districts (Table 7)
- Site 3 - Sound levels measured at this site are lower than rural districts (Table 8)
- Site 4 - Typical of rural districts (Table 9)
- Site 5 - Sound levels measured at this site are lower than rural districts (Table 10)
- Site 6 - Typical of suburban districts (Table 11)

The continuous night-time noise levels ($L_{Req,n}$) measured at the different sites (Table 6 to Table 11) are described as per the SANS 10103 as follow:

- Site 1 - Typical of urban districts (Table 6)
- Site 2 - Sound levels measured at this site are lower than rural districts (Table 7)
- Site 3 - Typical of suburban districts (Table 8)
- Site 4 - Sound levels measured at this site are lower than rural districts (Table 9)
- Site 5 - Typical of urban districts (Table 10)
- Site 6 - Typical of rural districts (Table 11)

Table 6: Site 1 baseline noise measurement survey details

Sampling point	**Site 1**				
Description	**South of R31**				
Coordinates	**27.227571 °S; 22.989763 °E**				
Time of day	**Day**	**Evening**	**Evening**	**Night**	**Night**
Start date and time	**01/12/2020 09:19**	**01/12/2020 18:31**	**02/12/2020 18:00**	**01/12/2020 22:01**	**02/12/2020 22:00**
Duration	00:20:00	00:15:00	00:15:00	00:15:00	00:15:00
Visual and acoustic observations	Shrubs, trees, uncultivated land, R31 road to the north and unoperational mine to the south. Noise sources included birds (daytime and evening), vehicle traffic from the R31 and insects (day and night).				
General weather conditions	Winds of 2.8 m/s from the S 26°C 27% humidity No cloud cover	Winds of 0.8 m/s from the SW 28°C 18% humidity No cloud cover	Winds of 0.4 m/s from the SW 30°C 16% humidity No cloud cover	No wind 20°C 28% humidity No cloud cover	No wind 25°C 21% humidity No cloud cover
LAleq (dBA)	61.6			54.5	
LAFmin (dBA)	53.3			30.5	
LAFmax (dBA)	67.1			75.8	
LA90 (dBA)	58.5			35.4	
LAeq	60.9			48.1	
Ct	0.0			0.0	
LReq,d and LReq,n (dBA)	60.9			48.1	
LR,dn (dBA)	60.2				

Table 7: Site 2 baseline noise measurement survey details

Sampling point	**Site 2**				
Description	**North of Hotazel Manganese Mine**				
Coordinates	**27.194422 °S; 22.971219 °E**				
Time of day	**Day**	**Evening**	**Evening**	**Night**	**Night**
Start date and time	**01/12/2020 11:05**	**01/12/2020 18:50**	**02/12/2020 18:20**	**01/12/2020 22:31**	**02/12/2020 22:29**
Duration	00:20:00	00:15:00	00:15:00	00:15:00	00:15:00
Visual and acoustic observations	Shrubs, trees, uncultivated land, non-operational mine to the south. Noise sources included insects, birds (day and evening) and dogs (night).				
General weather conditions	Winds of 1.6 m/s from the SW 33°C	Winds of 0.5 m/s from the S 27°C	Winds of 1.1 m/s from the S 29°C 16% humidity	Winds of 1.4 m/s from the S 21°C 21% humidity	No wind 25°C 22% humidity No cloud cover

Sampling point	Site 2				
Description	North of Hotazel Manganese Mine				
Coordinates	27.194422 °S; 22.971219 °E				
Time of day	Day	Evening	Evening	Night	Night
Start date and time	01/12/2020 11:05	01/12/2020 18:50	02/12/2020 18:20	01/12/2020 22:31	02/12/2020 22:29
	18% humidity No cloud cover	18% humidity No cloud cover	10% cloud cover	50% cloud cover	
LAIeq (dBA)	58.1			41.2	
LAFmin (dBA)	50.0			23.2	
LAFmax (dBA)	68.1			59.6	
LA90 (dBA)	54.5			26.4	
LAeq	57.2			34.1	
Ct	0.0			0.0	
LReq,d and LReq,n (dBA)	57.2			34.1	
LR,dn (dBA)	55.6				

Table 8: Site 3 baseline noise measurement survey details

Sampling point	Site 3				
Description	East of Hotazel near Dwarsstraat				
Coordinates	27.200186 °S; 22.965032 °E				
Time of day	Day	Evening	Evening	Night	Night
Start date and time	01/12/2020 12:07	01/12/2020 19:32	02/12/2020 19:05	01/12/2020 23:20	02/12/2020 23:16
Duration	00:20:00	00:15:00	00:15:00	00:15:00	00:15:00
Visual and acoustic observations	Uncultivated land, short grass, near residential properties and road. Noise sources included birds (day), insects (day and evening), dogs (evening and night), music (evening), community noise (evening) and vehicle traffic from the residential road.				
General weather conditions	Winds of 3.7 m/s from the W 30°C 15% humidity No cloud cover	Winds of 2.2 m/s from the W 25°C 18% humidity 80% cloud cover	Winds of 0.4 m/s from the S 27°C 19% humidity 10% cloud cover	Winds of 1.8 m/s from the SW 21°C 22% humidity 40% cloud cover	No wind 25°C 24% humidity No cloud cover
LAIeq (dBA)	41.6			51.9	
LAFmin (dBA)	28.2			24.9	
LAFmax (dBA)	55.0			62.9	
LA90 (dBA)	31.7			27.1	
LAeq	38.2			42.7	
Ct	0.0			0.0	
LReq,d and LReq,n (dBA)	38.2			42.7	
LR,dn (dBA)	48.2				

Table 9: Site 4 baseline noise measurement survey details

Sampling point	**Site 4**				
Description	**Between Wessels Clinic and Hotazel Combined School in Hotazel**				
Coordinates	**27.209304 °S; 22.964193 °E**				
Time of day	**Day**	**Evening**	**Evening**	**Night**	**Night**
Start date and time	**01/12/2020 12:50**	**01/12/2020 19:50**	**02/12/2020 19:25**	**01/12/2020 23:44**	**02/12/2020 23:36**
Duration	00:20:00	00:15:00	00:15:00	00:15:00	00:15:00
Visual and acoustic observations	Uncultivated land, near unused sports field and mine village. Noise sources included insects (day and evening), birds (night), dogs (evening and night), community noise (evening and night), and vehicle traffic (night).				
General weather conditions	Winds of 3.2 m/s from the W 34°C 13% humidity No cloud cover	Winds of 0.5 m/s from the SW 24°C 19% humidity 40% cloud cover	No winds 25°C 19% humidity No cloud cover	No wind 19°C 27% humidity No cloud cover	No wind 23°C 24% humidity No cloud cover
LAleq (dBA)	48.2			39.4	
LAFmin (dBA)	43.2			26.8	
LAFmax (dBA)	55.6			55.6	
LA90 (dBA)	45.3			29.0	
LAeq	47.1			32.8	
Ct	0.0			0.0	
LReq,d and LReq,n (dBA)	47.1			32.8	
LR,dn (dBA)	46.1				

Table 10: Site 5 baseline noise measurement survey details

Sampling point	**Site 5**				
Description	**Residential area near railway line**				
Coordinates	**27.219179 °S; 22.965386 °E**				
Time of day	**Day**	**Day**	**Evening**	**Evening**	**Night**
Start date and time	**01/12/2020 09:19**	**01/12/2020 13:51**	**01/12/2020 20:12**	**02/12/2020 19:44**	**02/12/2020 00:05**
Duration	00:20:00	00:20:00	00:15:00	00:15:00	00:15:00
Visual and acoustic observations	Uncultivated land within residential area and near railway line. Noise sources included birds (day and night), insects (evening), dogs, music (day), community noise (day and evening), vehicle traffic from the residential road (day and evening), and cows (day).				
General weather conditions	Winds of 2.8 m/s from the S 26°C 27% humidity No cloud cover	Winds of 2.8 m/s from the S 31°C 12% humidity No cloud cover	Winds of 0.4 m/s from the SW 23°C 23% humidity 80% cloud cover	No wind 26°C 18% humidity No cloud cover	No wind 17°C 34% humidity No cloud cover
LAleq (dBA)	52.0			55.1	
LAFmin (dBA)	34.1			31.1	
LAFmax (dBA)	64.1			63.7	
LA90 (dBA)	36.7			33.9	
LAeq	44.9			47.7	
Ct	0.0			0.0	

Sampling point	Site 5				
Description	Residential area near railway line				
Coordinates	27.219179 °S; 22.965386 °E				
Time of day	Day	Day	Evening	Evening	Night
Start date and time	01/12/2020 09:19	01/12/2020 13:51	01/12/2020 20:12	02/12/2020 19:44	02/12/2020 00:05
LReq,d and LReq,n (dBA)	44.9			47.7	
LR,dn (dBA)	53.3				

Table 11: Site 6 baseline noise measurement survey details

Sampling point	Site 6				
Description	North of mine (likely Hotazel Manganese Mine) access road				
Coordinates	27.190689 °S; 22.986969 °E				
Time of day	Day	Evening	Evening	Night	Night
Start date and time	01/12/2020 15:19	01/12/2020 19:14	02/12/2020 18:42	01/12/2020 22:55	02/12/2020 22:51
Duration	00:20:00	00:15:00	00:15:00	00:15:00	00:15:00
Visual and acoustic observations	Uncultivated land, long grass and shrubs near mine access road. Noise sources included birds and insects.				
General weather conditions	Winds of 3.5 m/s from the W 33°C 13% humidity No cloud cover	Winds of 1.7 m/s from the W 26°C 17% humidity No cloud cover	Winds of 1.1 m/s from the SW 26°C 20% humidity 10% cloud cover	No wind 22°C 23% humidity 60% cloud cover	No wind 22°C 23% humidity No cloud cover
LAleq (dBA)	55.0			45.9	
LAFmin (dBA)	39.4			19.5	
LAFmax (dBA)	68.8			64.6	
LA90 (dBA)	45.6			21.8	
LAeq	53.7			37.4	
Ct	0.0			0.0	
LReq,d and LReq,n (dBA)	53.7			37.4	
LR,dn (dBA)	52.4				

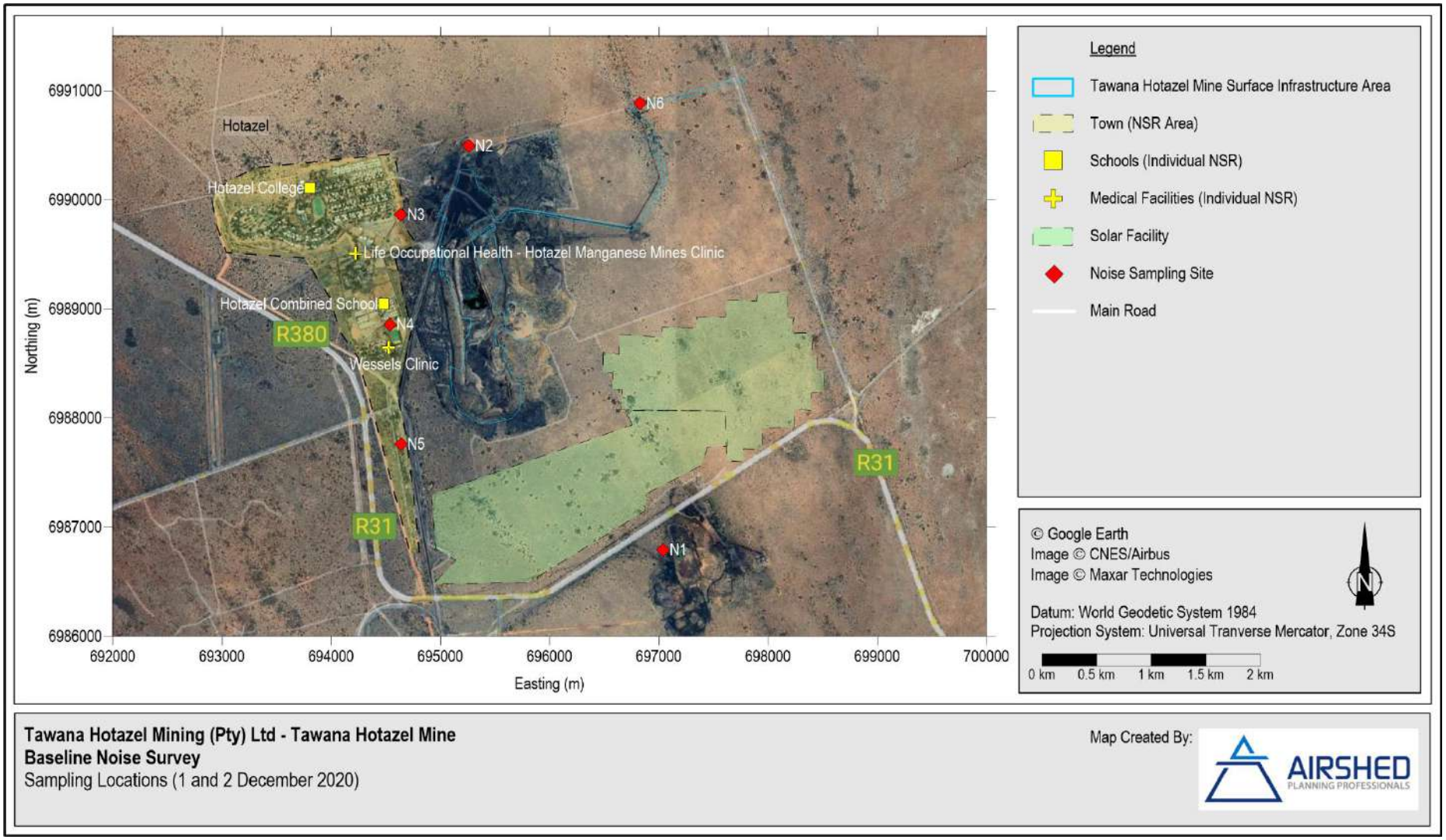


Figure 9: Study area, NSRs, and baseline noise measurement sites

6 IMPACT ASSESSMENT

6.1 Noise Sources and Sound Power Levels

Source noise levels for the mobile and stationary equipment were calculated using the L_W predictive equations for stationary power generation equipment and mobile equipment (Bruce & Moritz, 1998), where L_W estimates are a function of the power rating of the equipment engine.

6.1.1 Tawana Hotazel Mine Operations

The list of mobile equipment types and quantities was supplied. The make and model of the equipment was not available thus the power rating of the equipment engines and operational speeds were acquired from equipment specification sheets for equipment models used by similar operations in the area. The power rating of 320 kW for the truck engines was provided by Prime Resources. The processing plant mobile generator power rating was determined based on the power requirements of the equipment that is located at the plant. The frequency adjustment for mobile equipment and generators was used to determine the L_W for the frequency bands included in the CadnaA model for the noise source input data. L_W's for the drill rigs, handling and dumping of ore, waste rock, and product, conveyor transfers, primary crushing, and screening were obtained from the Airshed database. The noise sources included in the CadnaA model are provided in Table 12.

6.1.2 Void/Pit Dewatering Operations

As the void/pit dewatering operations were highlighted as a concern by I&APs for these operations, a noise source inventory was compiled and CadnaA simulations undertaken to determine the potential noise levels from the dewatering operations as well as for the proposed Project operations. The dewatering will take place during the site preparation prior to initiation of the mining and processing operations (operational phase).

Frequency adjustment for generators was used to determine the L_W for the frequency bands included in the CadnaA model for the noise source input data. L_W's for the pumps and evaporators were obtained from the Airshed database.

Table 12: Noise source inventory for the proposed operations

Operational Area	Mobile Equipment	Equipment Make and Model used for Power Rating	Quantity of Mobile Equipment	Stationary Equipment	Quantity of Stationary Equipment	Other Sources
Pit	Excavator	Volvo EC380D	4	-	-	Handling
	Drill rig	SANDVIK D55SP	3	-	-	-
	Truck	320 kW/ Volvo A45Gfs		-	-	-
	Water bowser	Volvo A45Gfs	1	-	-	-
Waste stockpiles	Bulldozer	Caterpillar 824K	3	-	-	Handling
	Truck	320 kW/ Volvo A45Gfs	3	-	-	-
	Water bowser	Volvo A45Gfs	1	-	-	-
Topsoil, sand, ore and product stockpiles	Frontend loader	Volvo L60F	1		1	Handling
	Truck	320 kW/ Volvo A45Gfs	3		2	
Processing plant	Frontend loader	Volvo L60F	1	Primary Crusher	2	Handling
	Truck	320 kW/ Volvo A45Gfs	1	Screen	2	Standard Conveyor
	-	-	-	Mobile diesel generators - Caterpillar XQP150	3	Conveyor transfer points
Haul roads	Truck	320 kW/ Volvo A45Gfs	3	Primary Crusher	1	-
	Grader	Caterpillar 18	1	Screen	1	-
	Water bowser	Volvo A45Gfs	1	-	-	-
Heavy vehicles access road	Truck	320 kW/ Volvo A45Gfs	4	Primary Crusher	1	-
	Grader	Caterpillar 18	1	Secondary Crusher	2	-
	Water bowser	Volvo A45Gfs	1	Screen	4	-
Light vehicles access road	Light delivery vehicle/passenger vehicle	120 kW	8	-	-	-
	Grader	Caterpillar 18	1	-	-	-
	Water bowser	Volvo A45Gfs	1			

6.2 Noise Propagation and Simulated Noise Levels

The propagation of noise was calculated with CadnaA in accordance with ISO 9613. Meteorological and site-specific acoustic parameters as discussed in Section 5 along with source data discussed in Section 6.1, were applied in the model.

6.2.1 Tawana Hotazel Mine Operations

Results are presented in tabular form (at selected NSRs included to be representative of noise levels within community/residential areas) in Table 13, Table 14 and Table 15 and as isopleths in Figure 10, Figure 11 and Figure 12. Estimates of the 3 dBA increase impact zones (using the lowest of baseline noise levels) are presented Figure 13 and Figure 14 for day- and night-time respectively.

The simulations indicate that there may be exceedances of the IFC NLG during the day at residences in Hotazel town (Figure 10). The simulations indicate that there may be exceedances of the IFC NLG during the night at multiple residences in Hotazel town as well as Hotazel Combined School, Life Occupational Health - Hotazel Manganese Mines Clinic and Wessels Clinic (Figure 11). Due to low baseline noise levels, the increase in noise levels in a large portion of Hotazel town may exceed the 3-dBA limit and complaints should be expected. The increase in noise levels at multiple receptors near the proposed THM site are expected to be “very strong”; and complaints are expected. The increase in noise levels at the receptors outside Hotazel town will be slight or mostly undetectable; complaints are not expected.

Given the above findings, it is evident that mitigation and management measures are needed to reduce noise impacts at Hotazel town. Such measures are discussed in Section 6.2.2.

Table 13: Summary of simulated day-time noise levels (provided as dBA) due to the project and baseline noise measurements at NSR within the study area

ID	Noise Receptor	Simulated Future Operations	Measured Baseline	Maximum Increase Above Measured Baseline[(d)]
N4	Hotazel, between Wessels Clinic and Hotazel Combined School in Hotazel	48.2	47.1	3.6
N5	Hotazel, residential area near railway line	47.9	44.9	4.7
34	Hotazel College	37.9	38.2	2.9[(c)]
35	Hotazel Combined School	48.1	47.1	3.6[(c)]
36	Life Occupational Health - Hotazel Manganese Mines Clinic	45.1	38.2	7.7[(c)]
37	Wessels Clinic	48.4	47.1	3.7[(c)]

Notes:

(a) Exceeds IFC guideline of 70 dBA for industrial areas

(b) Exceeds daytime IFC guideline of 55 dBA for residences

(c) Assumed based on most relevant noise sampling location(s)

(d) Likely community response:

- 0 to 1 dBA – No reaction, increase not detectable
- 1 to 3 dBA – Increase just detectable to persons with average hearing acuity, annoyance unlikely.
- 3 to 5 dBA – There will be 'little' reaction with 'sporadic complaints'.
- 5 to 10 dBA – There will be 'little' to 'medium' reaction with 'sporadic' to 'widespread' complaints.
- 10 to 15 dBA – There will be a 'strong' reaction with 'threats of community action'.
- > 15 dBA – There will be a 'very strong' reaction with 'vigorous community action'.

Table 14: Summary of simulated night-time noise levels (provided as dBA) due to the project and baseline noise measurements at NSR within the study area

ID	Noise Receptor	Simulated Future Operations	Measured Baseline	Maximum Increase Above Measured Baseline[(d)]
N4	Hotazel, between Wessels Clinic and Hotazel Combined School in Hotazel	37.9	42.7	15.8
N5	Hotazel, residential area near railway line	48.1[(b)]	32.8	3.5
34	Hotazel College	45.2[(b)]	42.7	1.3[(c)]
35	Hotazel Combined School	48.8[(b)]	32.8	15.4[(c)]
36	Life Occupational Health - Hotazel Manganese Mines Clinic	37.9	42.7	4.5[(c)]
37	Wessels Clinic	48.1[(b)]	32.8	16.1[(c)]

Notes:

(a) Exceeds IFC guideline of 70 dBA for industrial areas

(b) Exceeds daytime IFC guideline of 45 dBA for residences

(c) Assumed based on most relevant noise sampling location(s)

(d) Likely community response:

- 0 to 1 dBA – No reaction, increase not detectable
- 1 to 3 dBA – Increase just detectable to persons with average hearing acuity, annoyance unlikely.
- 3 to 5 dBA – There will be 'little' reaction with 'sporadic complaints'.
- 5 to 10 dBA – There will be 'little' to 'medium' reaction with 'sporadic' to 'widespread' complaints.
- 10 to 15 dBA – There will be a 'strong' reaction with 'threats of community action'.
- > 15 dBA – There will be a 'very strong' reaction with 'vigorous community action'.

Table 15: Summary of simulated day/night noise levels (provided as dBA) due to the project and baseline noise measurements at NSR within the study area

ID	Noise Receptor	Simulated Future Operations	Measured Baseline	Maximum Increase Above Measured Baseline[(b)]
N4	Hotazel, between Wessels Clinic and Hotazel Combined School in Hotazel	51.5	48.2	5.0
N5	Hotazel, residential area near railway line	51.1	46.1	6.3
34	Hotazel College	49.8	46.1	5.3[(a)]
35	Hotazel Combined School	48.6	48.2	3.2[(a)]
36	Life Occupational Health - Hotazel Manganese Mines Clinic	49.5	46.1	5.1[(a)]
37	Wessels Clinic	52.5	52.4	3.0[(a)]

Notes:

(a) Assumed based on most relevant noise sampling location(s)

(b) Likely community response:

- 0 to 1 dBA – No reaction, increase not detectable
- 1 to 3 dBA – Increase just detectable to persons with average hearing acuity, annoyance unlikely.
- 3 to 5 dBA – There will be 'little' reaction with 'sporadic complaints'.
- 5 to 10 dBA – There will be 'little' to 'medium' reaction with 'sporadic' to 'widespread' complaints.
- 10 to 15 dBA – There will be a 'strong' reaction with 'threats of community action'.
- > 15 dBA – There will be a 'very strong' reaction with 'vigorous community action'.

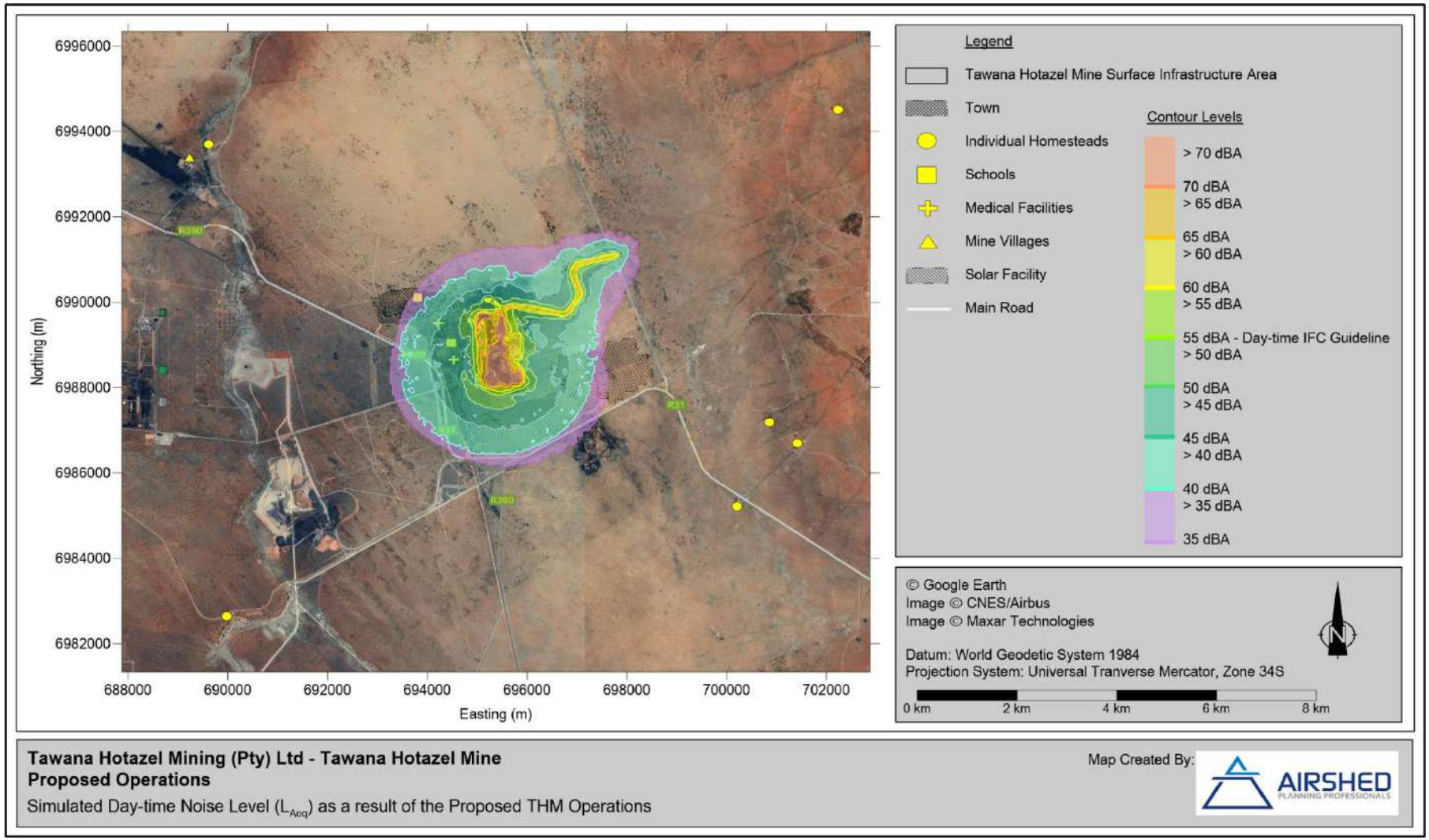


Figure 10: Simulated incremental day-time noise levels associated with the THM project

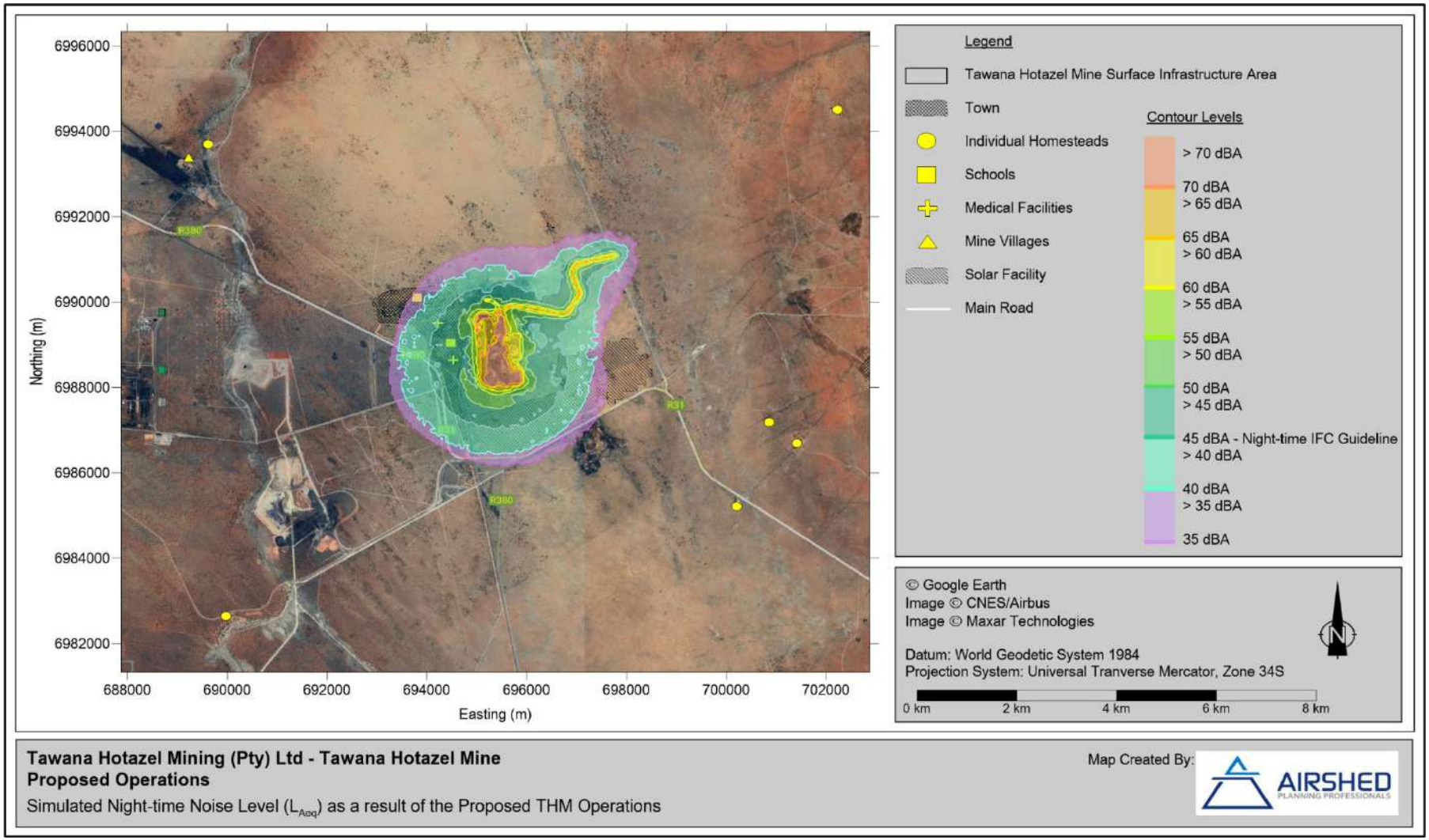


Figure 11: Simulated incremental night-time noise levels associated with the THM project

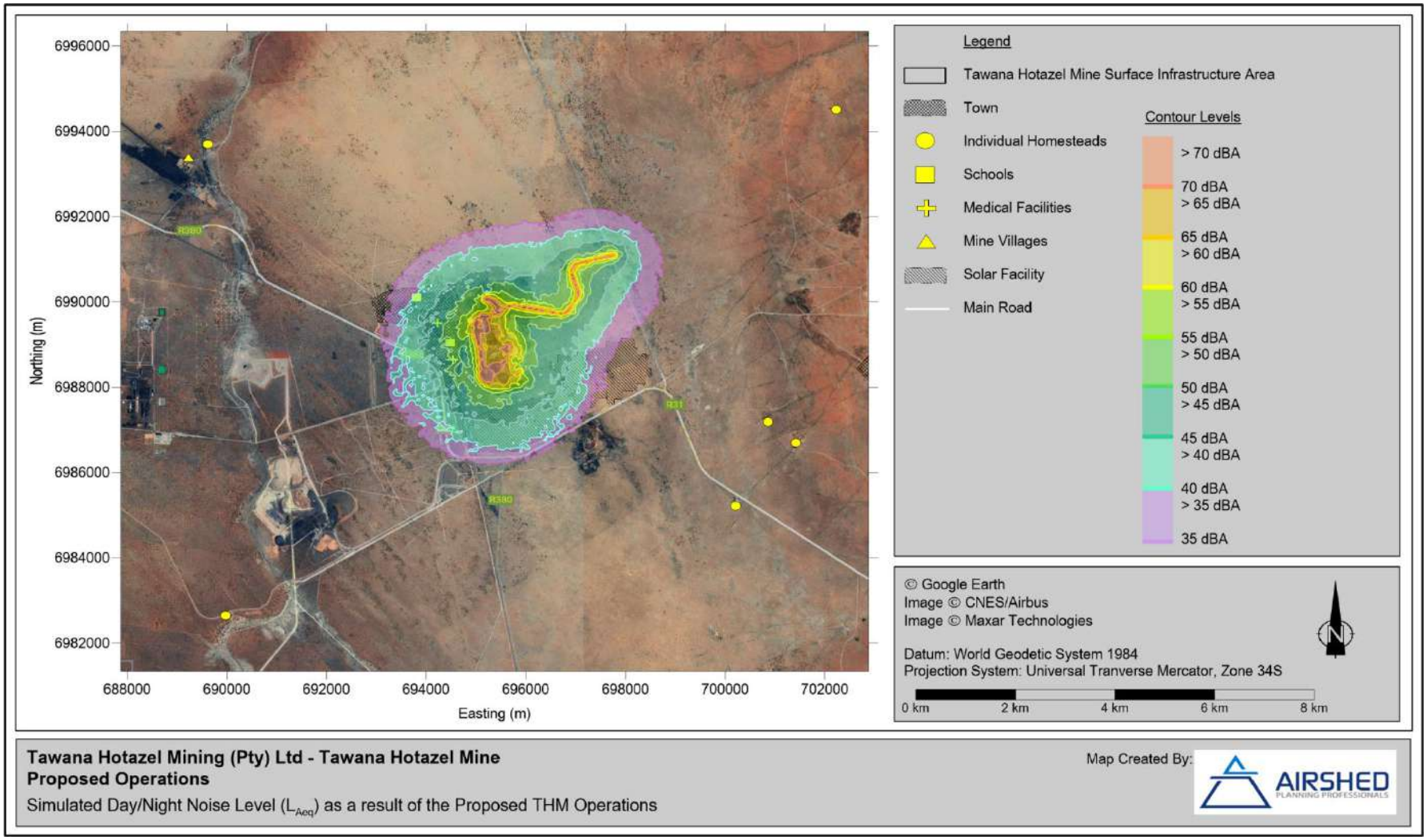


Figure 12: Simulated incremental day/night noise levels associated with the THM project

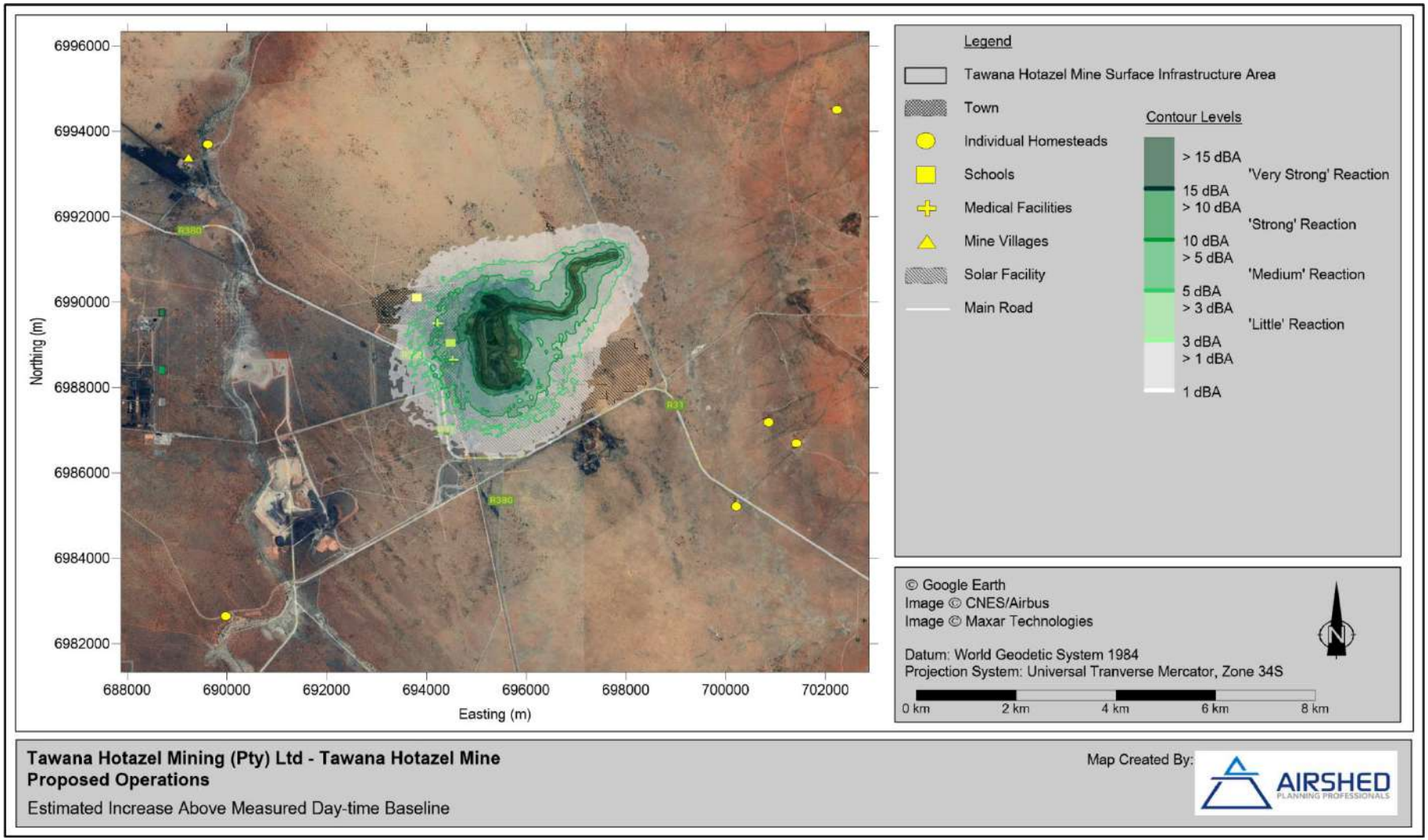


Figure 13: Increase in day-time noise levels associated with the THM project assuming a baseline level of 32.8 dBA

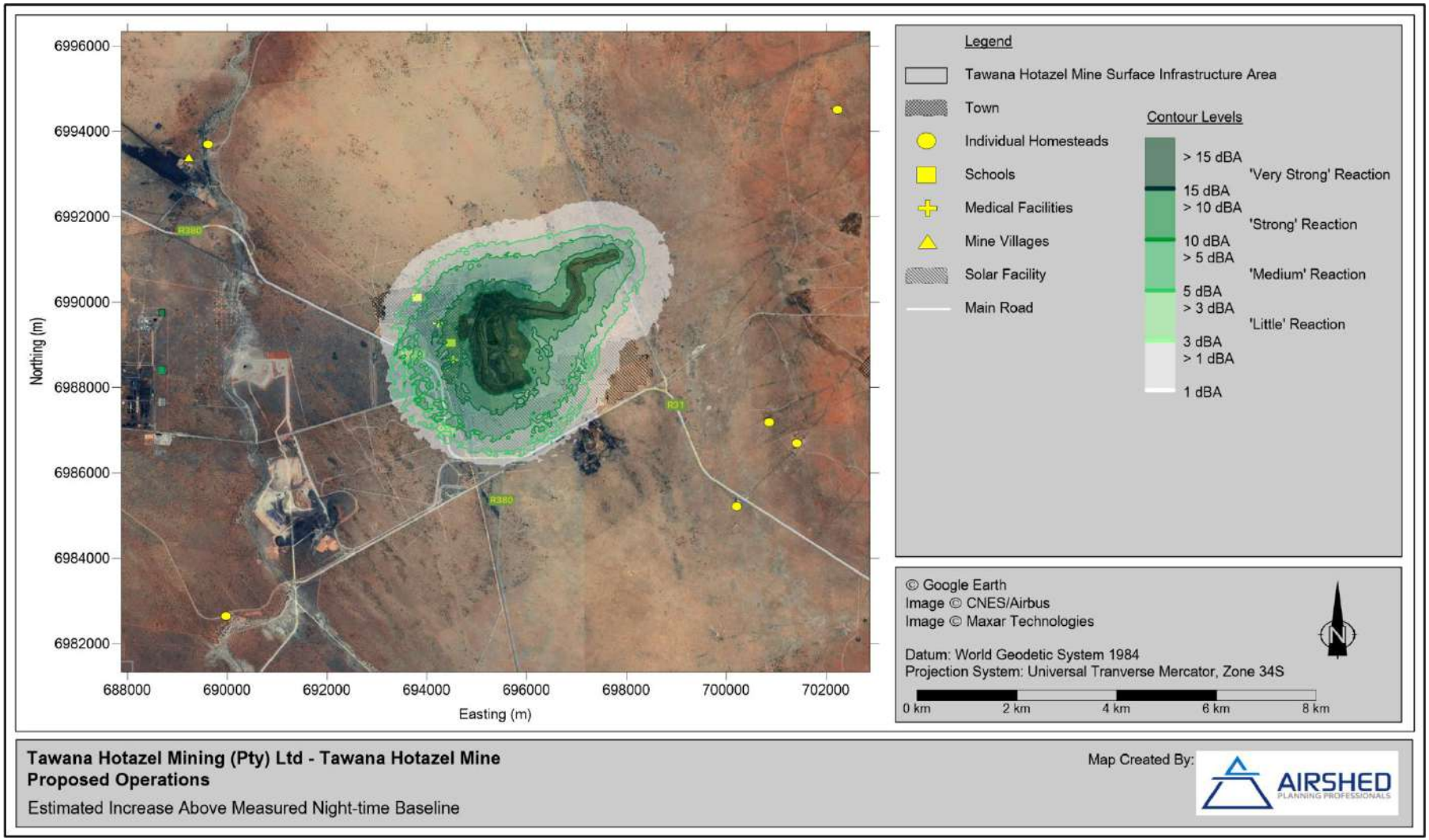


Figure 14: Increase in night-time noise levels associated with the THM project assuming a baseline level of 32.8 dBA

6.2.2 Void/Pit Dewatering Operations

Results are as isopleths in Figure 15, Figure 16 and Figure 17. The simulations indicate that no exceedance of the IFC NLG at the NSRs during the day (Figure 15). The simulations indicate that there may be exceedances of the IFC NLG at the NSRs during the night (Figure 16).

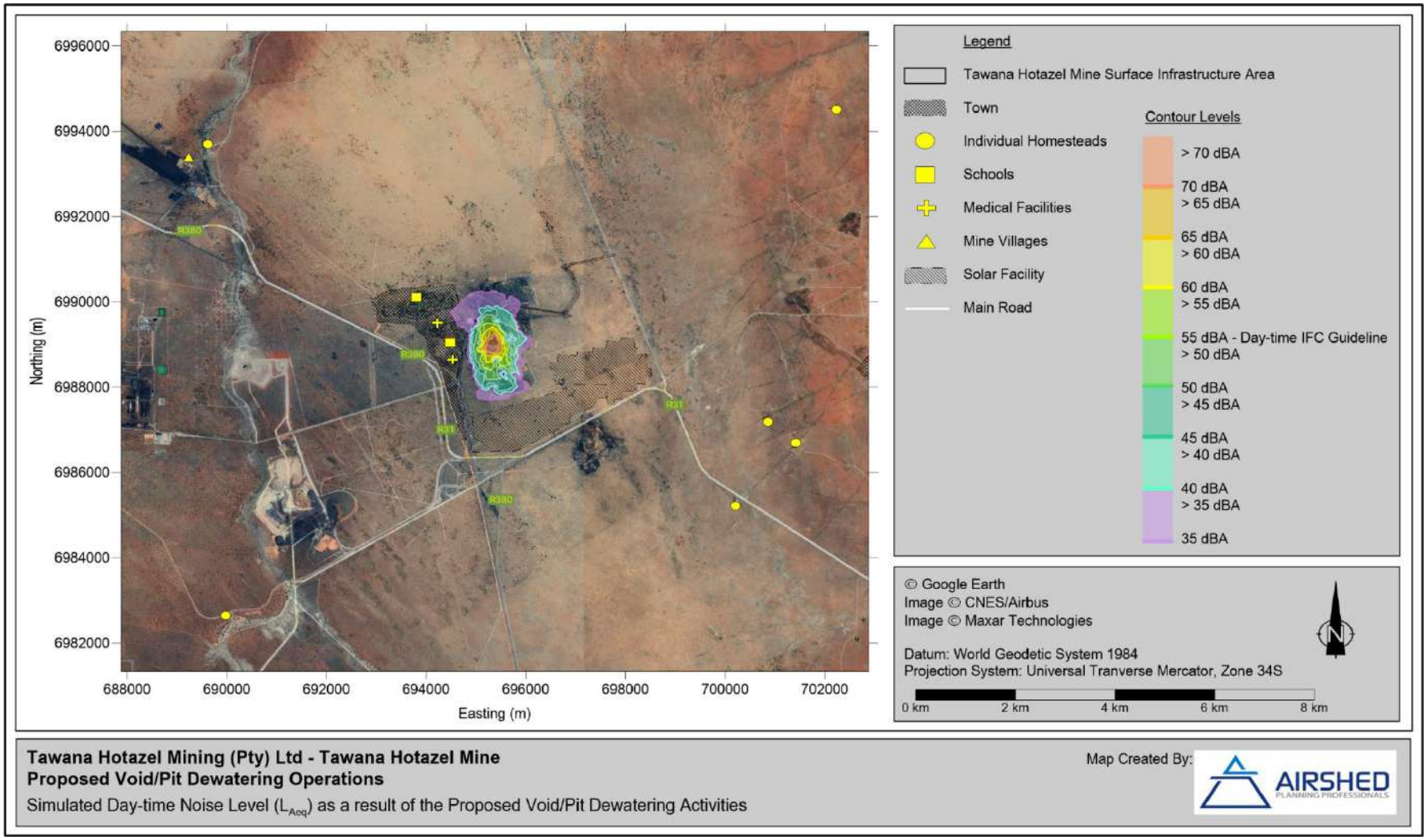


Figure 15: Simulated incremental day-time noise levels associated with the void/pit dewatering

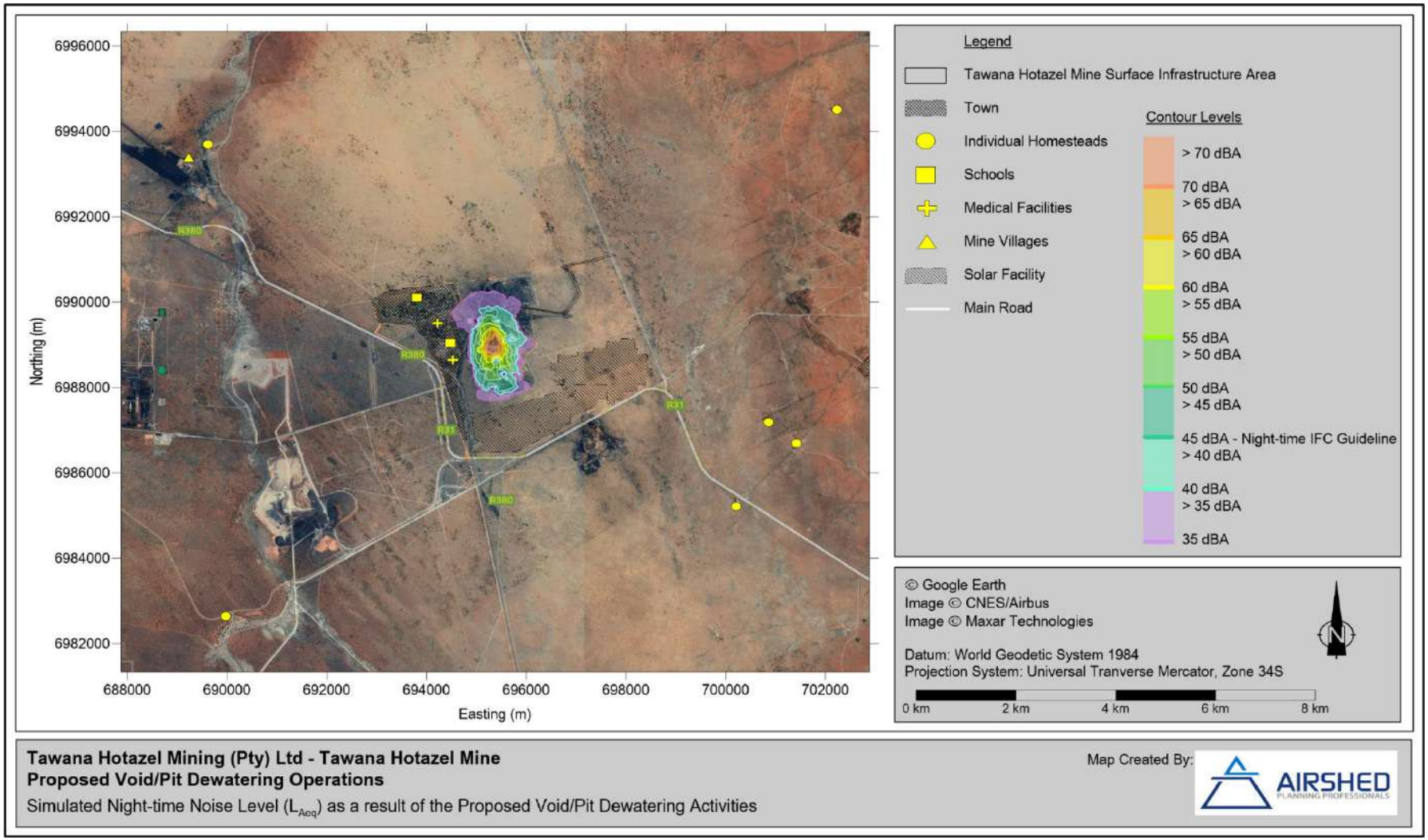


Figure 16: Simulated incremental night-time noise levels associated with the void/pit dewatering

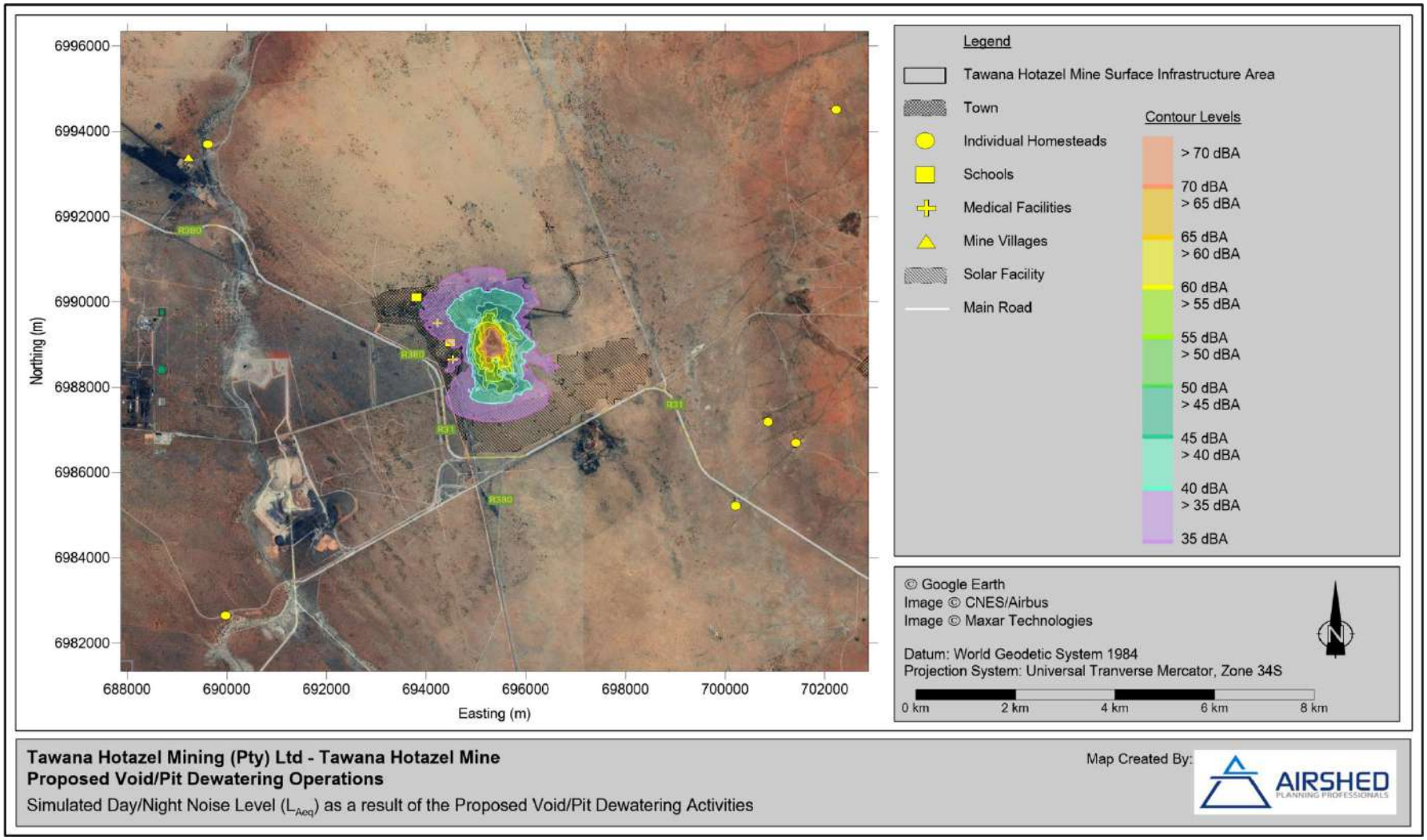


Figure 17: Simulated incremental day/night noise levels associated with the void/pit dewatering

6.3 Impact Significance

Exceedance of the IFC NLGs at NSRs could result not only in nuisance impacts but also possibly human health impacts. A quantitative assessment of the potential impacts noise during the operational phase is discussed below. The Prime Resources rating methodology was used.

Table 16: Impact significance summary table for the proposed THM operational activities only

Noise	Occurrence		Severity		Significance		Status	Loss of resources	Degree of mitigation (%)
	Probability	Duration	Extent/Scale	Magnitude					
Significance of potential impact without mitigation measures applied									
Operational phase	Highly probable	Long-term	Local	High	**40**	**Moderate**	–'ve	Significant loss (75%-99%)	n/a
	4	4	2	4				4	
Significance of potential impact with design mitigation measures applied									
n/a									
Design mitigation measures: None.									
Significance of potential impact with additional mitigation measures applied									
Operational phase	Medium probability	Long-term	Local	Moderate	**27**	**Low**	–'ve	Moderate loss (50%-74%	33%
	3	4	2	3				3	
Additional mitigation measures: Good engineering practices, enclosure of processing plant equipment and berms.									

7 MANAGEMENT MEASURES

In the quantification of noise emissions and simulation of noise levels as a result of the proposed THM operations, it was calculated that ambient noise evaluation criteria (IFC guidelines) for residential, educational, and institutional receptors will not be met in parts of Hotazel town due to low baseline noise levels and that the difference from the baseline could result in a very strong community reaction.

Noise from construction works and opencast mines can be difficult to control for several reasons, including:

- Activities are carried out in the open;
- Although variable in nature, they can cause notable disturbances while they last or when in close proximity to NSRs; and
- Noise arises from many different activities and the intensity and character can vary significantly at different phases of construction and mining;

The measures discussed in this section are measures typically applicable to construction and mining sites and considered good practice by the IFC (2007) and British Standard BSI (2008). Noise control measures can be applied at the source, at the receiver, or the path from source to receiver.

It is the noise specialist's opinion that the project may be authorised. Due to low baseline noise levels in Hotazel town, especially during the night, strong community action can be expected if noise generating sources are not properly mitigated and controlled. It is recommended that wherever possible, significant noise generating activities be limited to the daytime (6:00 to 22:00).

7.1 Controlling Noise at the Source

7.1.1 General Good Practice Measures

Good engineering and operational practices will reduce levels of annoyance specifically at off-site NSRs near mining activities. For general activities, it is recommended that the following good engineering practice be applied to all project phases:

- All diesel-powered equipment should be kept at a high level of maintenance. This should particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment should serve as trigger for withdrawing it for maintenance.
- In managing noise specifically related to vehicle traffic, efforts should be directed at:
    - Minimising individual vehicle engine, transmission, and body noise/vibration. This is achieved through the implementation of an equipment maintenance program.
    - Maintain road surfaces regularly to avoid corrugations, potholes etc.
    - Keep all roads well maintained and avoid steep inclines.

- Using rubber linings in for instance chutes and dump trucks to reduce impact noise of dropped material.
- Avoid unnecessary idling times.
- Minimising the need for trucks/equipment to reverse. This will reduce the frequency at which disturbing but necessary reverse warnings will occur. Alternatives to the traditional reverse 'beeper' alarm such as a 'self-adjusting' or 'smart' alarm could be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm is so that it is 5 to 10 dB above the noise level near the moving equipment. The promotional material for some smart alarms does state that the ability to adjust the level of the alarm is of advantage to those sites 'with low ambient noise level' (Burgess & McCarty, 2009). Also, when reversing, vehicles should travel in a direction away from NSR's if possible.
- Limiting traffic to hours between 06:00 and 18:00 as far as possible.

- Where possible, other non-routine noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.
- A noise complaints register must be kept.

7.1.2 Specifications and Equipment Design

If a construction site or mining activity is within an especially sensitive area or very close to NSRs, equipment and methods to be employed should be reviewed to ensure the quietest available technology is used. Equipment with lower sound power levels must be selected in such instances and vendors/contractors should be required to guarantee optimised equipment design noise levels.

7.1.3 Enclosures

As far as is practically possible, source of significant noise should be enclosed. The extent of enclosure will depend on the nature of the machine and their ventilation requirements. Generators, crushers and screens are examples of such equipment. It should be noted that the effectiveness of partial enclosures and screens can be reduced if used incorrectly, e.g., noise should be directed into a partial enclosure and not out of, there should not be and reflecting surfaces such as parked vehicles opposite the open end of a noise enclosure.

7.1.4 Use and Siting of Equipment

The processing plant and equipment should be sited as far away from NSRs as possible. Also:

a) Machines (e.g., drill rigs) used intermittently should be shut down between work periods or throttled down to a minimum and not left running unnecessarily. This will reduce noise and conserve energy.
b) Equipment from which noise generated is known to be particularly directional (such as those related to the processing plant), should be orientated so that the noise is directed away from NSRs.
c) Acoustic covers of engines should be kept closed when in use or idling.
d) Construction materials such as beams, and bricks should be lowered and not dropped.

7.1.5 Maintenance

Regular and effective maintenance of equipment is essential to noise control. Increases in equipment noise are often indicative of eminent mechanical failure. Also, sound reducing equipment/materials can lose effectiveness before failure and can be identified by visual inspection.

Noise generated by vibrating machinery and equipment with vibrating parts can be reduced through the use of vibration isolation mountings or proper balancing. Cutting tools and saws must be kept sharp to reduce frictional noise. Noise generated by friction in conveyor rollers, trolley etc. can be reduced by sufficient lubrication.

7.2 Controlling the Spread of Noise

Naturally, if noise activities can be minimised or avoided, the amount of noise reaching NSRs will be reduced. Alternatively, the distance between source and receiver must be increased, or noise reduction screens, barriers, or berms must be installed. This should be considered for the western side of the THM project where NSRs are closely located to the operations.

7.2.1 Distance

To increase the distance between source and receiver is often the most effective method of controlling noise since, for a typical point source at ground level, a 6-dB decrease can be achieved with every doubling in distance. It is however conceded that it might not always be possible. Relocation or increasing distances between activities and the Hotazel town is expected not to be possible.

7.2.2 Screening

If noise control at the source and the use of distance between source and receiver is not possible, screening methods must be considered. The effectiveness of a noise barrier is dependent on its length, effective height, and position relative to the source and receiver as well as material of construction. To optimize the effect of screening, screens should be located close to either the source of the noise, or the receiver.

The careful placement of barriers such as screens or berms can significantly reduce noise impacts but may result in additional visual impacts. Although vegetation such as shrubs or trees may improve the visual impact of site, it will not significantly reduce noise impacts and should not be considered as a control measure.

Earth berms can be built to provide screening for large scale earth moving operations and can be landscaped to become permanent features once construction is completed. Care should be taken when constructing earth berms since it may become a significant source dust.

Noise barriers are recommended on the western side of the operations or at the eastern edge of Hotazel town.

7.3 Controlling Noise at the Receiver

Receiver noise control is mostly achieved through building design. Good hearing conditions are very important in especially institutional, business and educational buildings and adequate airborne sound insulation may be necessary in areas of the development likely to be exposed to road and air traffic noise. In any building, there are many possible transmission paths of sound and in most cases part of the sound produced in a room is transmitted indirectly via flanking elements, e.g., side walls, windows, ceiling and floors into adjacent rooms or to the outside.

Since the outside walls of buildings have a relatively low weight in comparison with that of the floor and the ceiling, outside walls can be considered as the main flanking path. Windows are the most important item of flanking paths of outside walls owing to the high sound transmission coefficient of glass panes (Elmallawany, 1983).

Suitable engineering methods for sound insulation of buildings typically include the consideration of single or double glazed of windows for classrooms and acoustically absorbent building materials. The introduction of sealed multiple glazed windows and doorways will necessitate the installation of air conditioning units properly designed, placed and maintained so as to minimize noise associate with such sources.

These control measures need be considered given the close proximity of the residential area, and especially if the recommended measures for source control are insufficient. This can be determined by undertaking sampling campaigns to determine the noise levels in the area and the volume and nature of complaints are received.

7.4 Monitoring

Noise monitoring at sites where noise is an issue or may become an issue is essential. The sites listed in Table 17 (and shown in Figure 9) should be included in the recommended environmental noise monitoring programme to be conducted annually.

Also, in the event that noise related complaints are received it is recommended that short term (24-hour) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions. The investigation of complaints should include an investigation into equipment or machinery that likely result or resulted in noise levels annoying to the community. This could be achieved with source noise measurements.

Table 17: Recommended noise monitoring points for inclusion in annual noise monitoring programme

ID	Description	Coordinates	
		Longitude	Latitude
N1	North-eastern edge of Hotazel town	22.96308 °E	27.19619 °S
N2	Hotazel town, area with predicted incremental night-time noise levels >50 dBA (IFC limit = 45 dBA) - Wesseliet Street/Kameel Doring Road	22.96528 °E	27.202712 °S

ID	Description	Coordinates	
		Longitude	Latitude
N3	Wessels Clinic	22.96408 °E	27.21122 °S
N4	Residential area near railway line	22.96536 °E	27.21913 °S
N5	Boundary of Solar Facility	22.97983 °E	27.21950 °S
N6	North of proposed HV access road	22.98596 °E	27.18998 °S

The following procedure should be adopted for all noise surveys:

- Any surveys should be designed and conducted by a trained specialist.
- Sampling should be carried out using a Type 1 or Type 2 SLM that meets all appropriate IEC standards and is subject to annual calibration by an accredited laboratory.
- The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session.
- Samples of 30 min to 24 hours in duration and sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time acoustic environment should be taken.
- The following acoustic indices should be recoded and reported: L_{Aeq} (T), statistical noise level $L_{A90,}$ L_{AFmin} and $L_{AFmax,}$ octave band or 3rd octave band frequency spectra.
- The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g., wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet.
- A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

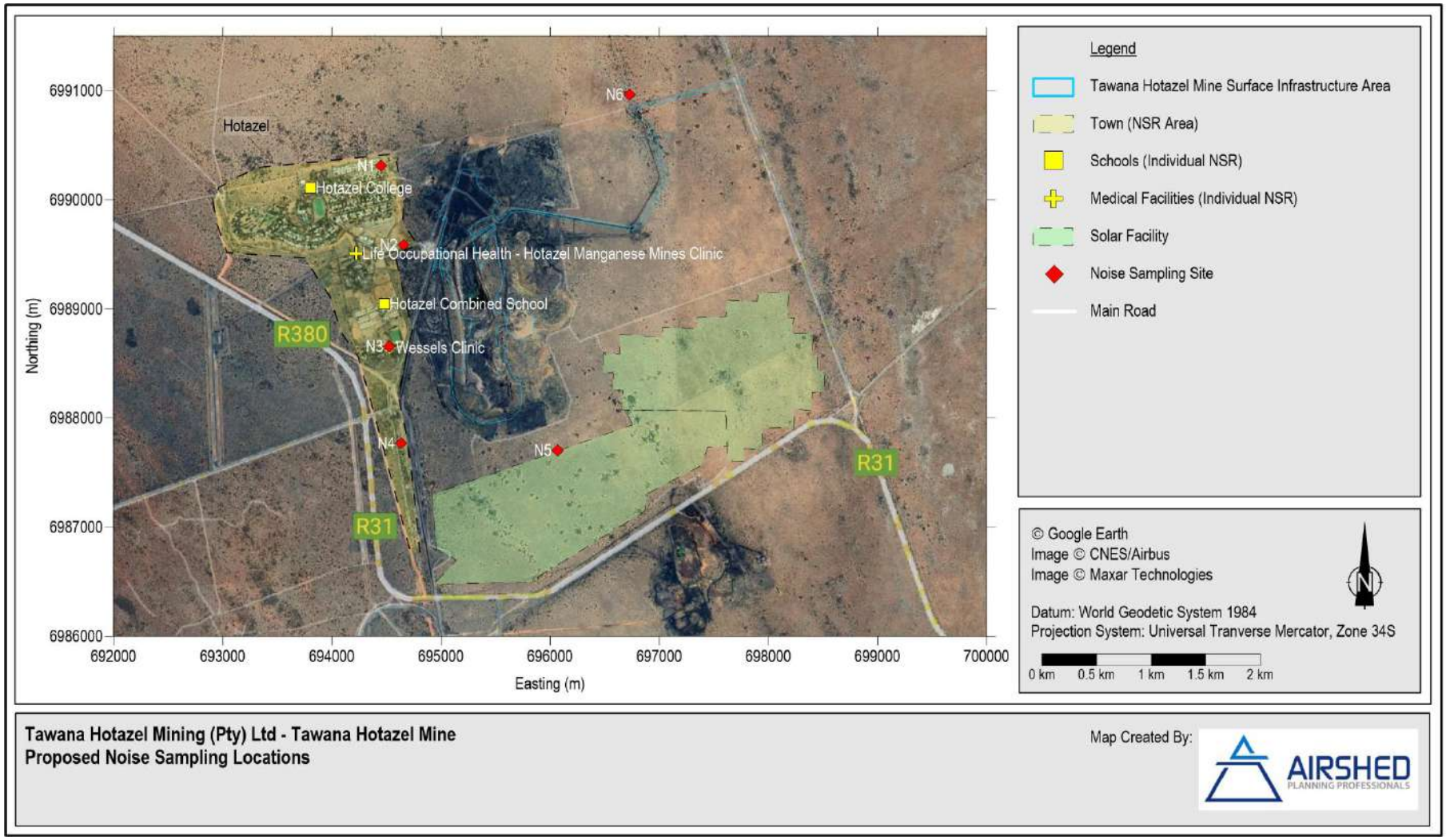


Figure 18: Proposed noise measurement sites for the recommended annual noise monitoring programme

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APPENDIX A – SITE 1 – PHOTOGRAPHS, LOGSHEETS AND SURVEY RESULTS

Facing north

Facing east

Facing south

Facing west

Figure 19: Photographs of environmental noise survey Site 1

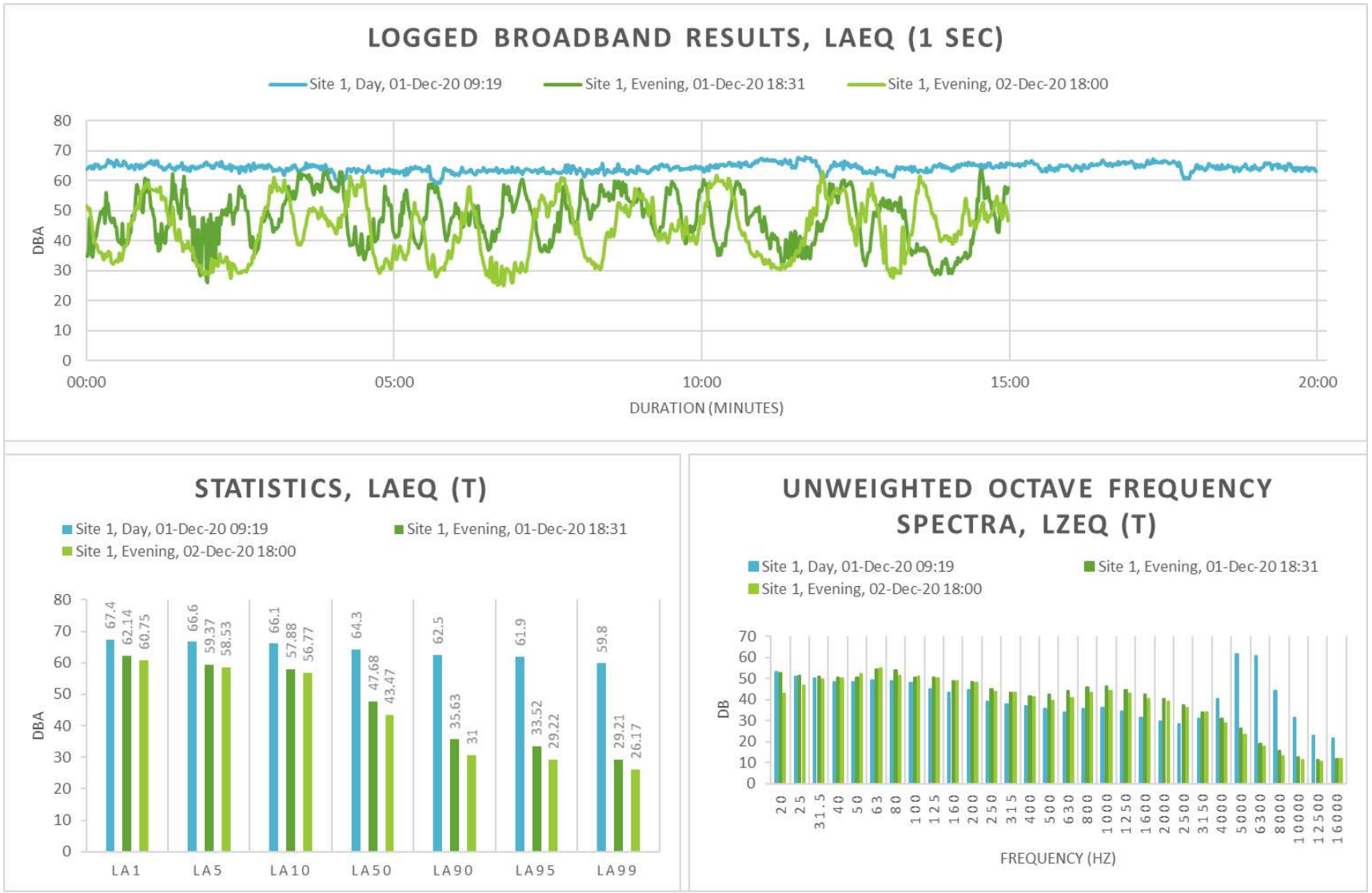


Figure 20: Broadband time series, frequency spectra and statistics – Site 1 day-time sampling

NOISE SAMPLING LOG SHEET

Day

SITE NUMBER: S1	SLM DATA RECORD: H72001	
Longitude/Easting: 22.938767	Latitude/Northing: -27.227569	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/2020 09:19		40.8	40.72 (Dev -0.02)

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	2.8	S	25.7	27.4	0/10	Insects 64-66 dB (Low Hmms) Road Traffic ±67dB

NOISE CLIMATE	☑Birds	☑Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	☑Road Traffic	□ Constr.	□ other

Description:

- Uncultivated land ~~next to~~ with shrubs and trees next to national road -(busy) and disused mine

Time	Description	Time	Description	Time	Description
09:19:53	Road Traffic	27:22	"	37:17	"
20:01	"	27:55	"	38:33	Road Traffic
20:09	"	28:39	"	38:40	"
20:35	"	29:13	"		
21:15	Insects	29:24	Insects		
21:51	"	29:59	Road Traffic		
22:15	Road Traffic	31:13	"		
22:42	Insects	31:31	Insects		
23:48	Road Traffic	31:41	Road Traffic		
24:07	"	33:07	"		
24:35	Insects	33:24	"		
25:16	Birds	33:52	"		
25:38	Road Traffic	34:53	"		
26:37	"	35:54	Insects		

Figure 21: Field logsheet – Site 1 day

NOISE SAMPLING LOG SHEET

Evening 1

SITE NUMBER: S1	SLM DATA RECORD: Htzen 001	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/20 18:31	01/12/20 12:46		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0.8	SW	28.1	17.6	0	Road Traffic ± 54dB Birds ± 42dB

NOISE CLIMATE	☑ Birds	□ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	☑ Road Traffic	□ Constr.	□ other
Description: •									

Time	Description	Time	Description	Time	Description
18:31:22	Road Traffic	37:03	"		
31:49	"	37:48	"		
32:00	"	38:06	"		
32:54	Birds	38:47	"		
33:02	"	39:05	"		
33:21	Road traffic	40:32	"		
33:30	"	41:03	"		
34:26	"	41:35	"		
33:57	"	42:24	Birds		
34:17	"	42:41	"		
34:56	"	43:10	Road Traffic		
35:20	"	43:26	"		
35:52	"	45:36	"		
32:24	"				
36:36	"				

Figure 22: Field logsheet – Site 1 evening 1

NOISE SAMPLING LOG SHEET

Evening 2

SITE NUMBER: S1	SLM DATA RECORD: HTZEV1001	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	02/12/20 18:00	02/12/20 12:15	40.72	40.97 (0.05) dev

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0 - 0.4	SW	29.5	16.2	0	Road traffic ±56 dB Birds ± 38 dB

NOISE CLIMATE	☑Birds	□ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	☑Road Traffic	□ Constr.	□ other

Description:

-

Time	Description	Time	Description	Time	Description
18:00:16	Road Traffic	06:49	Birds	13:15	Birds
01:16	"	06:54	"	13:32	Road traffic
01:38	"	07:00	"	13:48	"
02:42	Birds	07:33	Road Traffic		
03:15	Road Traffic	07:45	"		
03:28	"	07:57	"		
03:53	"	08:59	"		
04:47	"	09:10	"		
04:44	"	10:26	"		
04:59	"	10:33	"		
05:32	"	10:43	"		
05:41	"	11:43	Birds		
06:13	"	12:14	Road traffic		
06:27	"	12:59	"		

Figure 23: Field logsheet – Site 1 evening 2

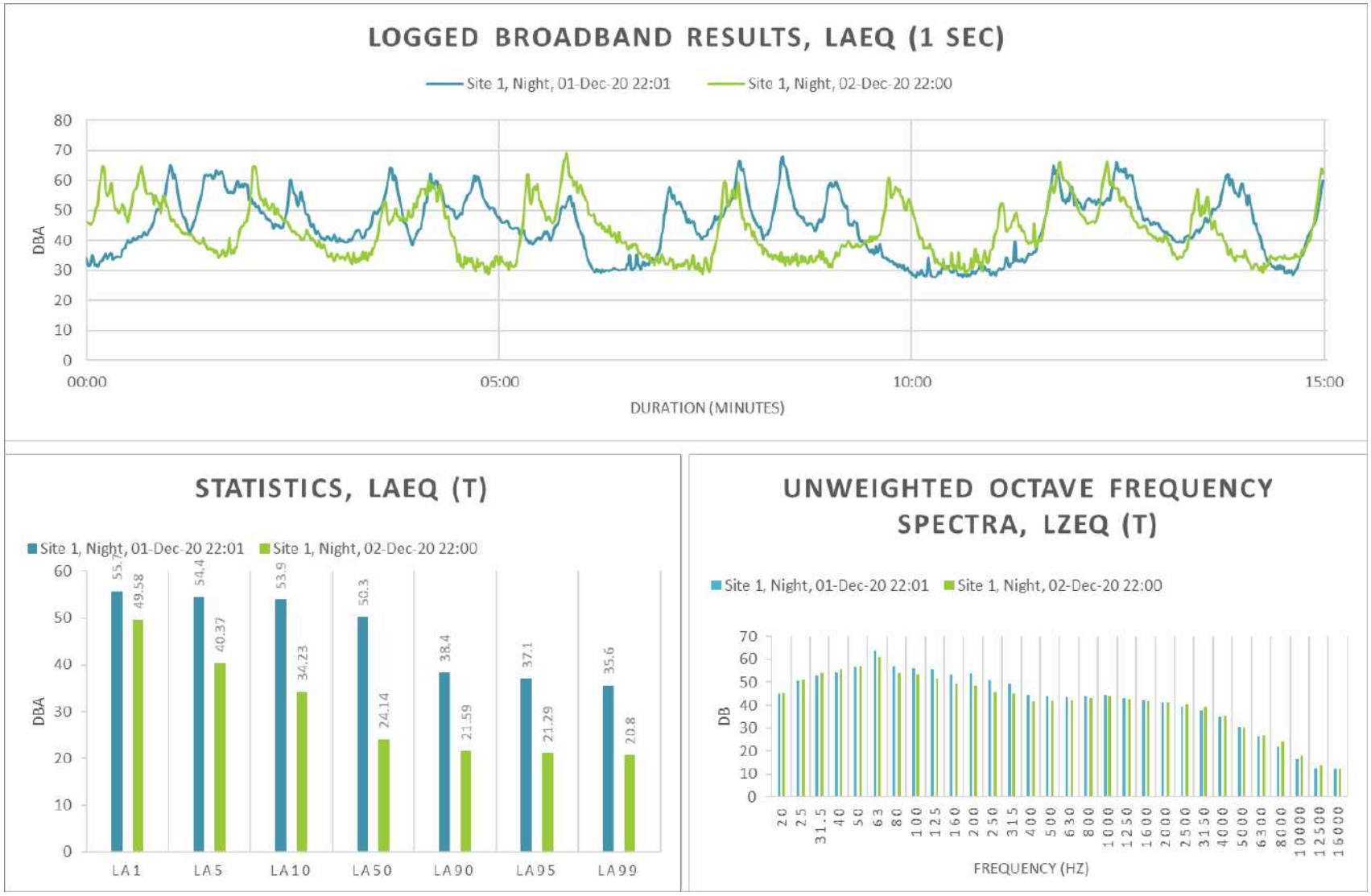


Figure 24: Broadband time series, frequency spectra and statistics – Site 1 night-time sampling

NOISE SAMPLING LOG SHEET

Night 1

SITE NUMBER: S1	SLM DATA RECORD: HT2nT001	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/20 22:01	01/12/20 22:16		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0	~~203~~ Not detectable	20.0	27.9	9/10	Road traffic ± 57dB

NOISE CLIMATE	□ Birds	☑ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	☑ Road Traffic	□ Constr.	□ other

Description:

-

Time	Description	Time	Description	Time	Description
22:01:37		09:24	"		
02:37	Road Traffic	10:02	"		
03:02	"	10:36	"		
03:~~26~~12	"	11:47	Insects		
03:25	"	13:19	Road Traffic		
04:04	"	14:05	"		
04:11	"	14:15	"		
05:14	"	15:25	"		
05:~~26~~	"				
06:17	"				
07:27	"				
08:08	Insects				
08:17	"				
08:40	"				

Figure 25: Field logsheet – Site 1 night 1

NOISE SAMPLING LOG SHEET

Night 2

SITE NUMBER: S1	SLM DATA RECORD: Htzn1001	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	02/12/2020 22:00	02/12/2020 22:15		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0	Undetectable	25.4	30.8	0%	Road traffic ± 65dB Insects ± 35 dB

NOISE CLIMATE	□ Birds	☑ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	☑ Road Traffic	□ Constr.	□ other

Description:

-

Time	Description	Time	Description	Time	Description
22:00:50	Road traffic	06:09	"	11:51	"
00:55	"	06:18	"	12:01	"
01:06	"	06:34	"	12:28	"
01:25	"	07:46	Insects	12:39	"
01:27	"	08:01	"	13:06	"
02:48	"	08:11	"	13:08	"
03:01	"	08:38	Road traffic	14:14	"
03:37	Insects	08:45	"	15:45	"
04:01	"	10:33	"		
04:09	"	10:42	"		
04:19	Road traffic	11:15	Insects		
04:23	"	11:20	"		
04:38	"	11:32	"		
04:55	"	11:47	Road Traffic		

Figure 26: Field logsheet – Site 1 night 2

APPENDIX B – SITE 2 – PHOTOGRAPHS, LOGSHEETS AND SURVEY RESULTS

Facing north

Facing east

Facing south

Facing west

Figure 27: Photographs of environmental noise survey Site 2

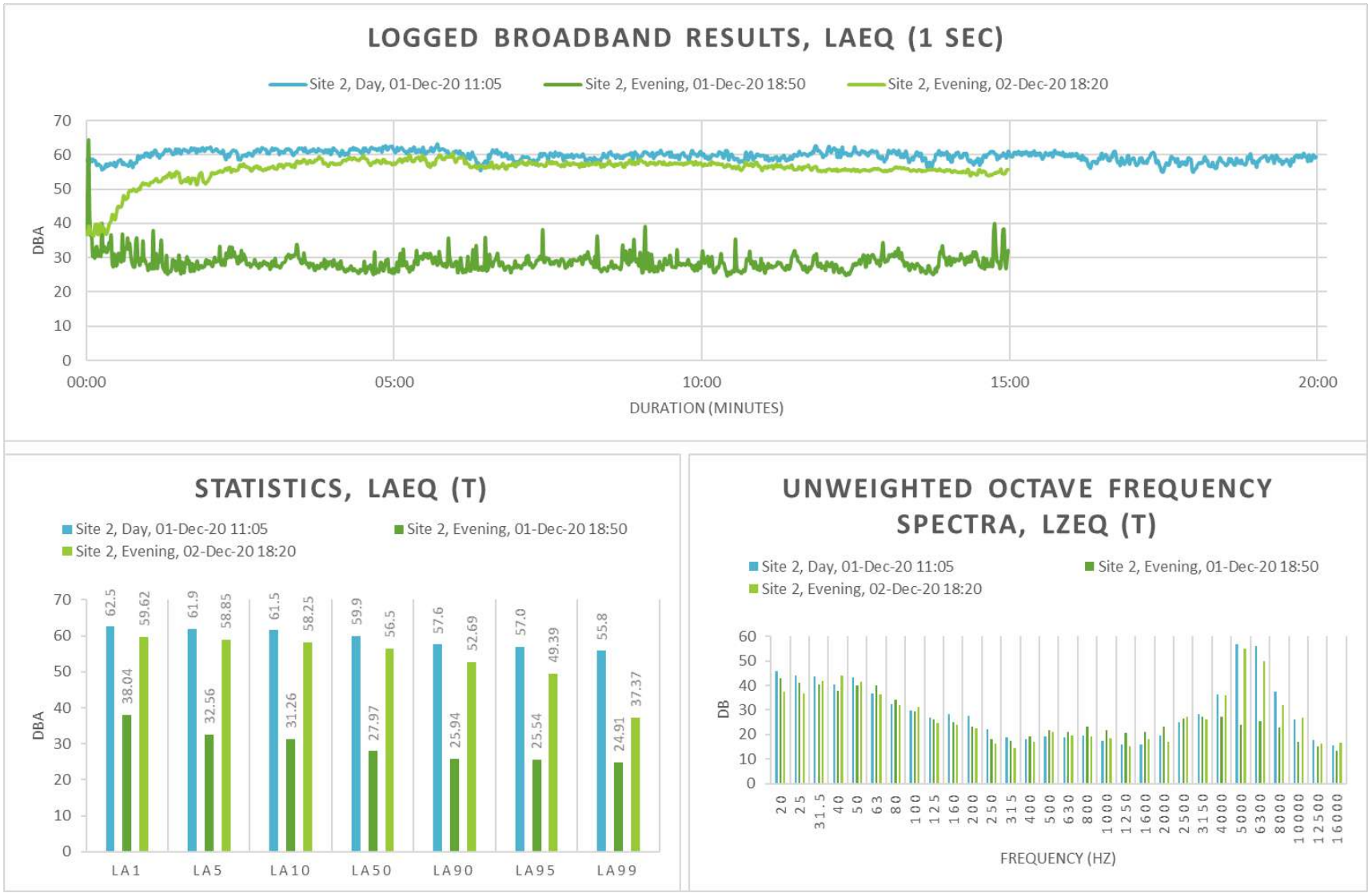


Figure 28: Broadband time series, frequency spectra and statistics – Site 2 day-time sampling

NOISE SAMPLING LOG SHEET

Day

SITE NUMBER: S2	SLM DATA RECORD: Fl2 002	
Longitude/Easting: 21.971156	Latitude/Northing: -27.194632	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/2020 11:05	11:25		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	1.6	SW	33	18		Insects & Birds ± 59dB

NOISE CLIMATE	☑ Birds	☑ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other

Description:

- Uncultivated Bushland with lots of trees and crickets sounding continuously in background

Time	Description	Time	Description	Time	Description
11:05:46	Insects	17:38	"		
06:19	"	18:21	"		
07:33	"	18:48	"		
08:38	Birds	22:28	Wind gus		
08:51	"	23:24	"		
09:14	"	24:41	Birds		
09:47	"	25:25			
10:38	"				
11:28	"				
11:41	Insects				
12:24	wind gust				
14:52	Birds				
16:34	"				
16:29	"				

Figure 29: Field logsheet – Site 2 day

NOISE SAMPLING LOG SHEET

Evening 1

SITE NUMBER: S 2	SLM DATA RECORD: Hz ew 002	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/20 18:50	01/12/20 19:05		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0.5 m/s	~~Undetectable~~ S	26.6	17.5	0	Birds ± 3dB

NOISE CLIMATE	☑Birds	☑Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other
Description: •									

Time	Description	Time	Description	Time	Description
18:50:46	Internal noise (paper)	54:50	"		
51:00	Birds	19:00:46	Birds		
51:32	"	01:26	"		
51:49	"	01:18	Internal (paper)		
52:54	"	01:31	Birds		
54:10	"	02:40	Wind		
55:25	"	03:22	"		
56:07	"	03:51	Insects		
56:37	Internal noise (weather)	04:34	Wind		
57:13	"	05:20	Birds		
57:25	Birds	05:30	"		
57:54	"				
59:03	Insects				
59:27	"				

Figure 30: Field logsheet – Site 2 evening 1

NOISE SAMPLING LOG SHEET

Evening 2

SITE NUMBER: S2	SLM DATA RECORD: H72e1002	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	02/12/2020 18:20	02/12/2020 18:35		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	1.1	S	28.3	16.1	1/10	Insects ± 57 dB (Crickets) Birds ± 50dB

NOISE CLIMATE	☑ Birds	☑ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other

Description:

-

Time	Description	Time	Description	Time	Description
18:20:56	Insects	25:35	"		
21:14	"	25:47	"		
21:40	"	26:04	"		
21:47	"	26:45	"		
22:14	"	26:55	"		
22:21	Birds	27:24	"		
22:40	Insects	29:21	"		
22:49	"	31:03	"		
23:05	"	31:18	"		
23:34	Birds	33:30	"		
23:51	Insects				
24:08	"				
24:32	"				
24:50	"				

Figure 31: Field logsheet – Site 2 evening 2

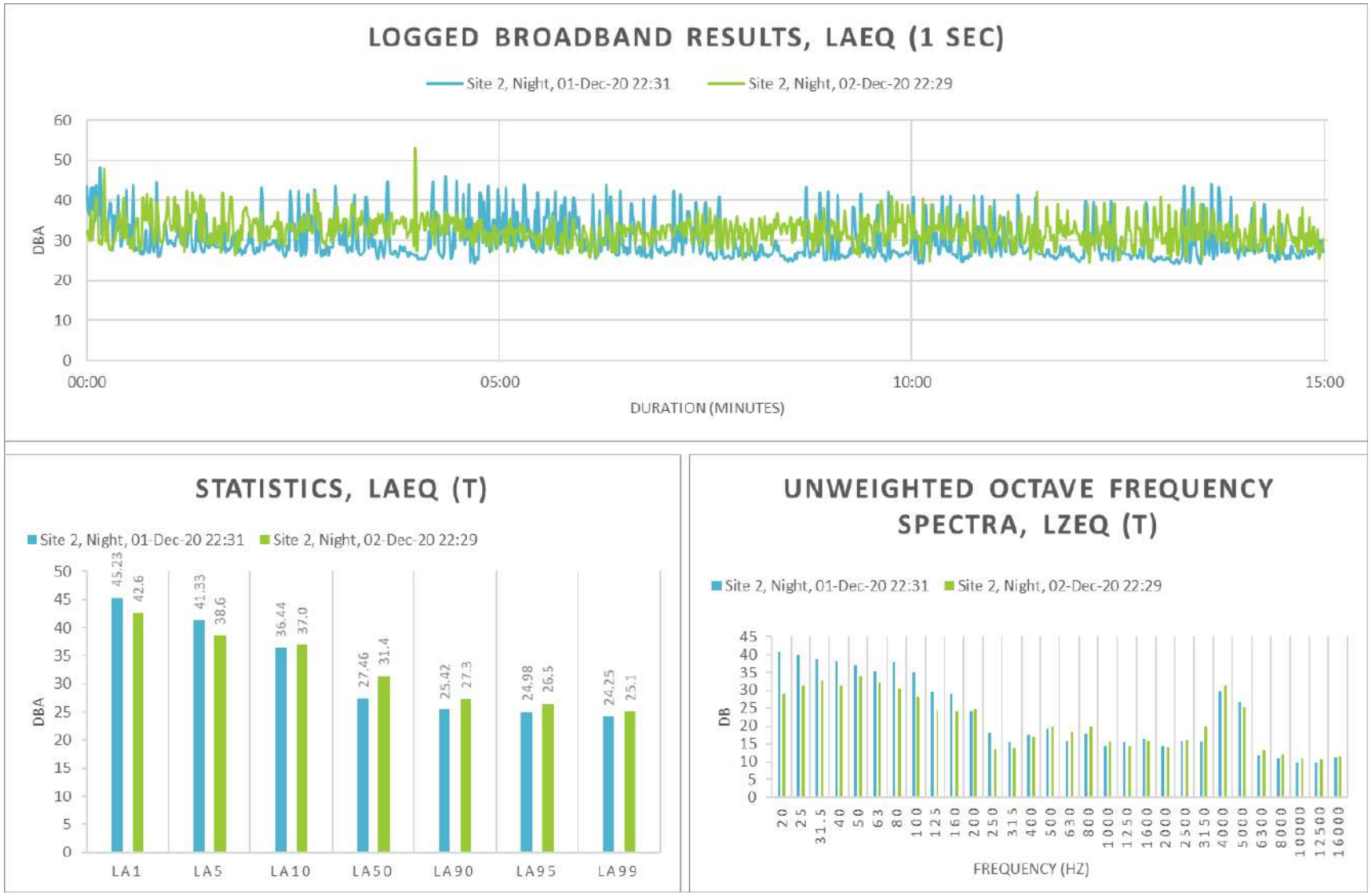


Figure 32: Broadband time series, frequency spectra and statistics – Site 2 night-time sampling

NOISE SAMPLING LOG SHEET

Night 2

SITE NUMBER: S2	SLM DATA RECORD: Htzn 002	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/20 22:31	02/12/20 22:35		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	1.4	5	20.7	21.2	5/10	Insects

NOISE CLIMATE	□ Birds	☑ Insects	☑ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other
Description: •									

Time	Description	Time	Description	Time	Description
29:31:16	Ins ects	36:44	"		
31:50	"	37:44	"		
32:07	"	37:52	"		
33:18	Dog (distant)	38:01	"		
33:40	insects	39:09	"		
33:40	insects	38:55	"		
33:23	"	39:59	"		
34:18	"	40:04	"		
34:37	"	41:38	"		
34:05	Dogs	42:45	"		
35:26	Insects	43:41	"		
35:57	"	44:06	"		
35:44	"	44:24			
36:34	"				

Figure 33: Field logsheet – Site 2 night 1[1]

[1] Incorrectly labelled as Night 2 on original logsheet

NOISE SAMPLING LOG SHEET

Night 2

SITE NUMBER: S 2	SLM DATA RECORD: Htznt1 002	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	02/12/20 22:29	02/12/20 22:44		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0		24.9	21.9	0/10	Dogs ± 32 dB Insects ± 33 dB

NOISE CLIMATE	□ Birds	☑ Insects	☑ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other

Description:

-

Time	Description	Time	Description	Time	Description
22! 29 :06	Dogs	40: 24	"		
29 : 16	"	40 : 37	"		
29 : 31	"	40 : 45	"		
30 : 02	"	41 : 44	"		
30 : 17	"	42 : 28	"		
30 : 27	"	43 : 21	"		
30 : 43	"	43 : 47	"		
31 : 50	Insects				
32 : 20	"				
33 : 03	Internal noise (paper)				
34 : 13	insects				
38 : 05	"				
38 : 22	"				
39 : 43	"				

Figure 34: Field logsheet – Site 2 night 2

APPENDIX C – SITE 3 – PHOTOGRAPHS, LOGSHEETS AND SURVEY RESULTS

Facing north

Facing east

Facing south

Facing west

Figure 35: Photographs of environmental noise survey Site 3

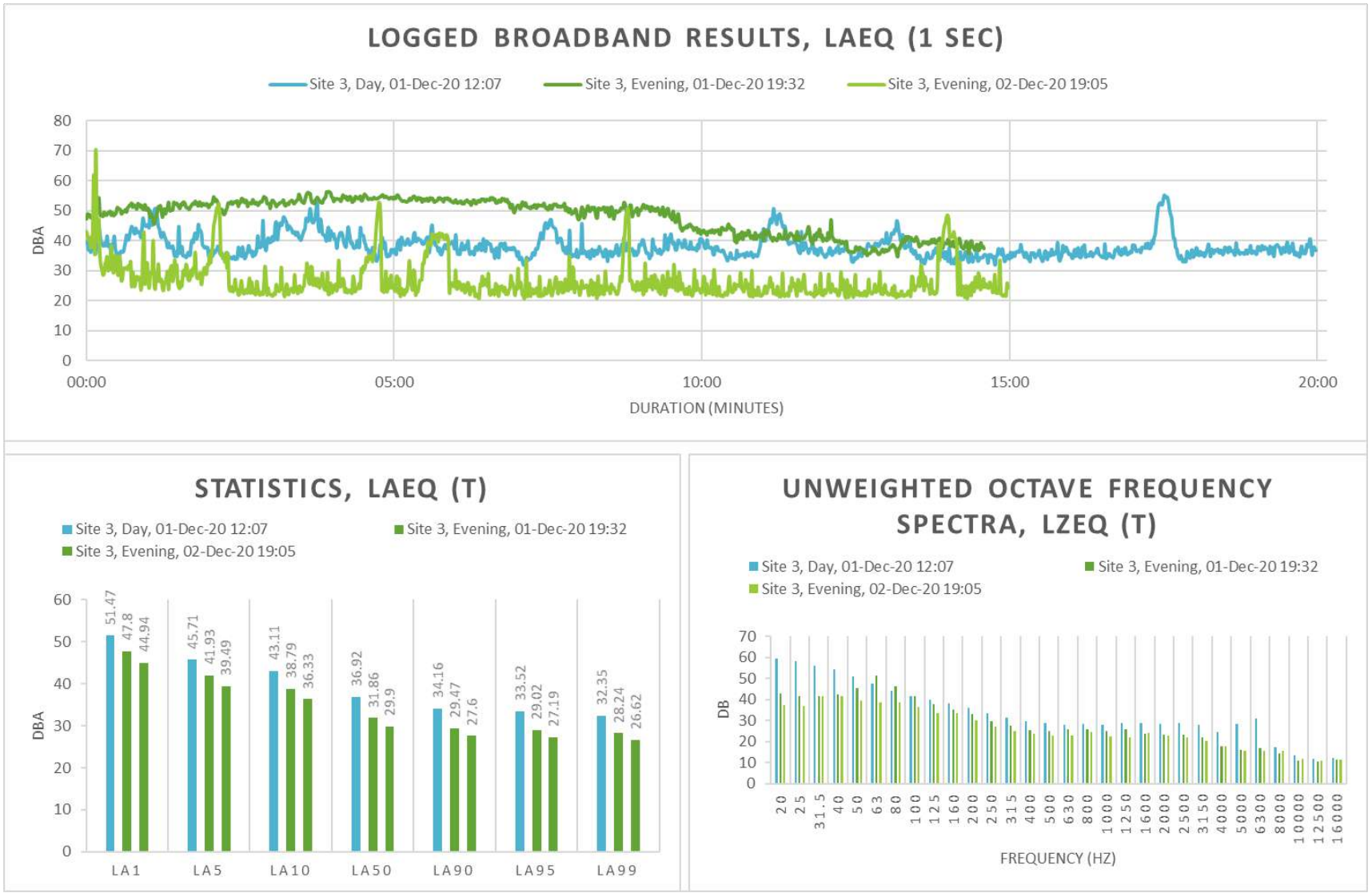


Figure 36: Broadband time series, frequency spectra and statistics – Site 3 day-time sampling

NOISE SAMPLING LOG SHEET

Day

SITE NUMBER: S3	SLM DATA RECORD:	
Longitude/Easting:	Latitude/Northing: HH2 003	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/2020 11:25	01/12/2020 12:27		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	~~1-2~~ 1.9-3.7	W	29.5	14.5	0%	Insects, birds (±35 dB), Road Traffic

NOISE CLIMATE	☑Birds	☑Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	☑Road Traffic	□ Constr.	□ other

Description:

- Site located on uncultivated grassland next to the residential properties and a home access road.

Time	Description	Time	Description	Time	Description
12:07:05	Bird	16:04	Wind gust		
07:56	Road Traffic	16:25	"		
08:06	"	16:42	"		
08:15	"	18:12	Road Traffic		
08:41	Internal Noise	18:23	"		
09:02	Wind gust	18:49	Car hooter		
10:04	Internal	19:54	Road Traffic		
10:24	Road Traffic	20:22	"		
10:57	"	22:01	Birds		
12:32	Wind	22:24	Community		
12:48	"	24:43	Road Traffic		
14:45	Road Traffic	26:01	Insects		
15:09	Birds	26:39	"		
15:15	"				

Figure 37: Field logsheet – Site 3 day

NOISE SAMPLING LOG SHEET

Evening 1

SITE NUMBER: S 3	SLM DATA RECORD: Hitech 04	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/20 19:32	01/12/20 19:47		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	1.8 - 2.2	W	25.1	18.1	2/10	Road traffic, dogs & insects

NOISE CLIMATE	□ Birds	☑ Insects	☑ Dogs	□ Music	□ Community	□ Air Traffic	☑ Road Traffic	□ Constr.	□ other
Description:									
•									

Time	Description	Time	Description	Time	Description
19:32:54	Internal	37:50	"		
33:07	Road traffic	38:22	Dogs		
33:22	"	39:13	Road Traffic		
33:39	Car moving	39:23	"		
34:18	Community	39:52	"		
34:30	"	40:34	"		
34:42	"	40:47	"		
35:21	Dogs	40:57	"		
35:34	"	43:05	Car moving		
35:39	"	44:06	Road Traffic		
35:59	"	45:21	Dogs		
36:25	"	45:32	"		
36:35	"	46:43			
37:36	Road Traffic (distant)				

Figure 38: Field logsheet – Site 3 evening 1

NOISE SAMPLING LOG SHEET

Evening 2

SITE NUMBER: S3	SLM DATA RECORD: Htzev1004	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	02/12/20 19:05	02/12/20 19:20		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0.4	S	26.9	18.6	1.0	Dogs ; Road traffic, music

NOISE CLIMATE	□ Birds	□ Insects	☑ Dogs	☑ Music	☑ Community	□ Air Traffic	☑ Road Traffic	□ Constr.	□ other
Description: •									

Time	Description	Time	Description	Time	Description
19:05:51	Dogs	11:56	"	20:04	"
06:04	Music	12:06	"	20 33	"
06:12	"	12:19	"		
06:47	Dogs	14:06	distant shouts		
07:04	Road traffic + music	14:27	"		
07:19	"	14:35	"		
07:28	"	15:03	"		
07:39	"	16:03	Road traffic		
07:51	"	16:13	"		
07:59	"	16:20	"		
08 09:04	Dog	17:01	Road traffic (distant)		
09:49	Man passing	17:38	"		
11:03	Internal noise (paper)	17:51	"		
11:47	Road traffic + Music	18:47	Community (laughing)		

Figure 39: Field logsheet – Site 3 evening 2

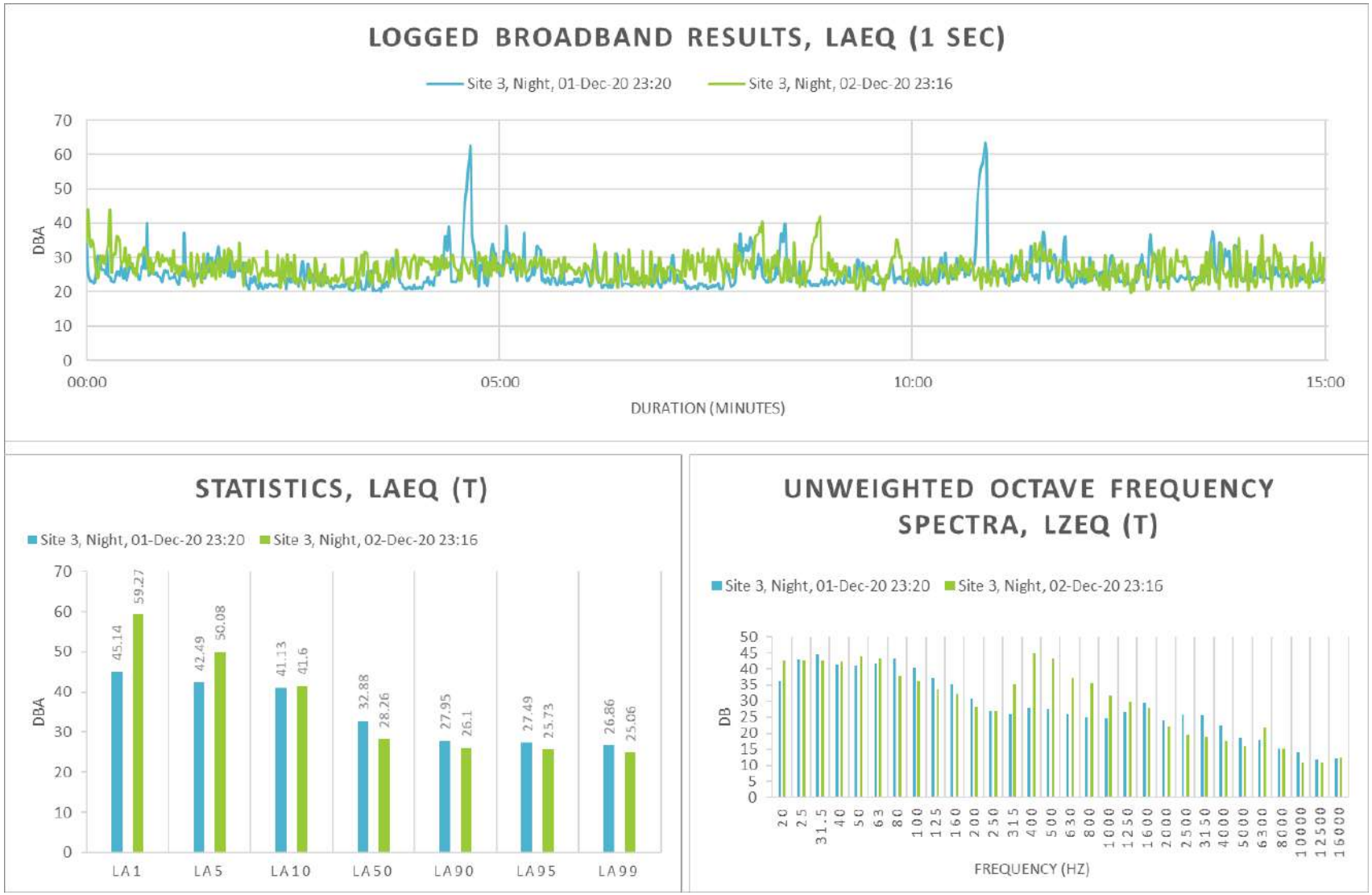


Figure 40: Broadband time series, frequency spectra and statistics – Site 3 night-time sampling

NOISE SAMPLING LOG SHEET

Night 1

SITE NUMBER: 53	SLM DATA RECORD: Htzn1004	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/20 23:21	01/12/20 23:35		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	1.2 - 1.8	SW	20.3	22.2	4/10	Dogs ± 37 dB

NOISE CLIMATE	□ Birds	□ Insects	☑ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other

Description:

-

Time	Description	Time	Description	Time	Description
23:01:03	Dogs	26:09	"		
21:23	"	26:55	"		
21:34	"	27:11	"		
21:42	"	27:18	"		
22:04	"	27:52	"		
22:19	"	28:00	"		
22:27	"	28:24	"		
22:37	"	31:02	"		
23:23	"	32:02	"		
23:34	"	32:27	"		
23:48	"	32:51	"		
24:09	"	33:36	"		
24:32	"	34:18	"		
24:45	"				
25:18	"				
25:30	"				
25:34	"				

Figure 41: Field logsheet – Site 3 night 1

NOISE SAMPLING LOG SHEET

Night 2

SITE NUMBER: S3	SLM DATA RECORD: Htzn 004	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	02/12/20 23:16	02/12/20 23:3		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0	Undetectable	24.7	24.1	0/10	Dogs ± 51dB

NOISE CLIMATE	□ Birds	□ Insects	☑ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other
Description:									
•									

Time	Description	Time	Description	Time	Description
23:16:41	Dogs Barking	22:52	"		
16:47	"	23:03	"		
16:51	"	23:15	"		
16:59	"	23:26	"		
16:00	"	23:51	"		
17:03	"	24:36	"		
17:55	"	31:00	Road traffic		
19:36	"	31:13	"		
19:45	"	31:19	"		
19:54	"				
20:09	"				
20:23	"				
20:30	"				
21:30	"				

Figure 42: Field logsheet – Site 3 night 2

APPENDIX D – SITE 4 – PHOTOGRAPHS, LOGSHEETS AND SURVEY RESULTS

Facing north

Facing east

Facing south

Facing west

Figure 43: Photographs of environmental noise survey Site 4

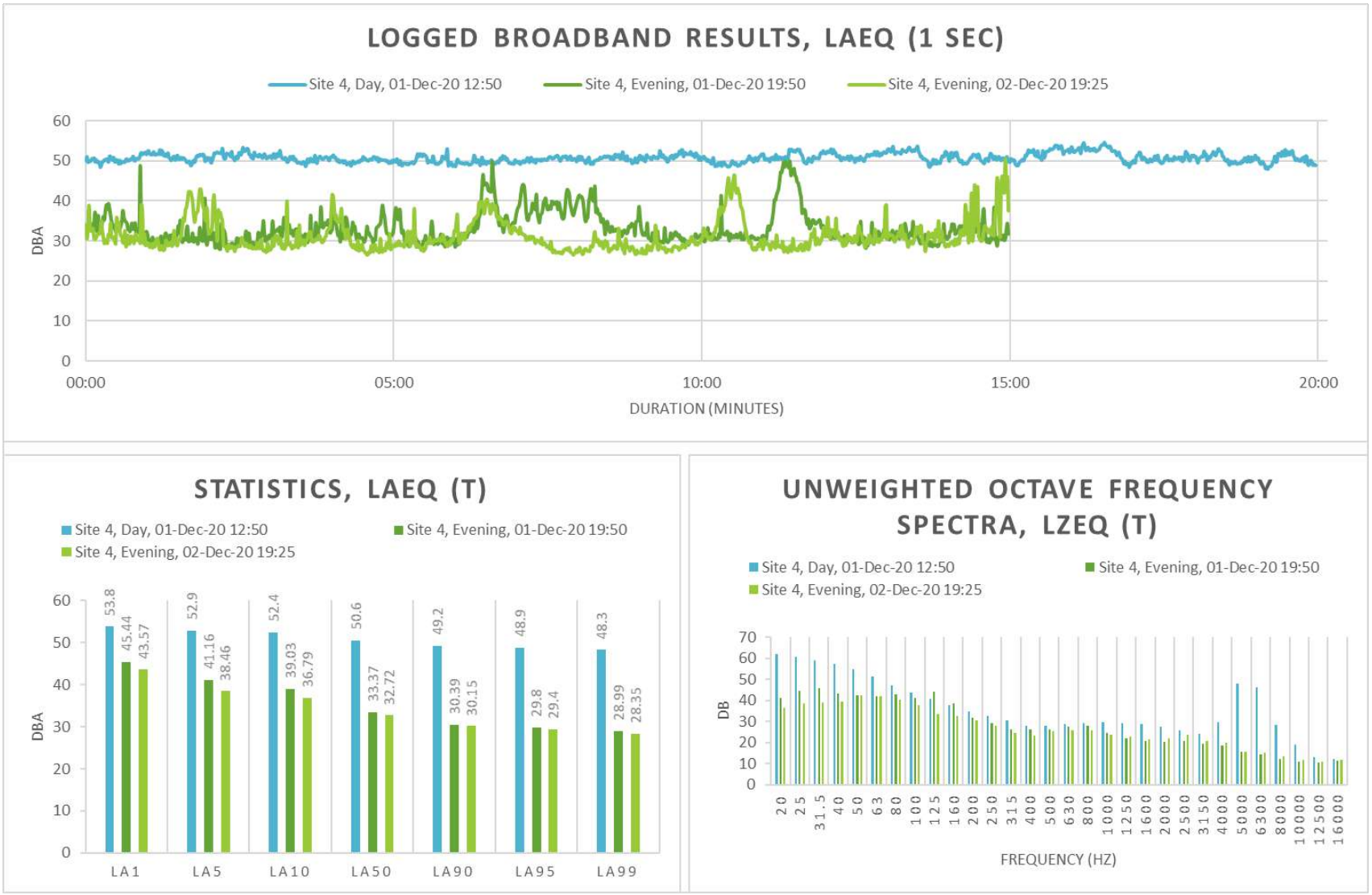


Figure 44: Broadband time series, frequency spectra and statistics – Site 4 day-time sampling

NOISE SAMPLING LOG SHEET

Day

SITE NUMBER: S4	SLM DATA RECORD: Hz 0034	
Longitude/Easting: 22.964297	Latitude/Northing: -27.209370	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/2020 12:50	01/12/2020 13:10		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	3.2	W	33.5	12.9	0	Insects ± 35dB Wind gust ± 52dB

NOISE CLIMATE	□ Birds	☑ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other

Description:
- Uncultivated land (disused pitch) close to mine residences & sports centre

Time	Description	Time	Description	Time	Description
12:50:59	insects	01:55	"		
52:30	"	02:04	"		
52:43	Wind	02:37	"		
53:04	"	02:56	Distant traffic		
55:00	Insects	03:36	Wind		
55:54	Wind	03:57	"		
56:22	"	04:47	"		
56:48	" 06:15	~~07:24~~	"		
57:16	"	06:42	"		
58:02	Insects	07:02	"		
58:56	Road Traffic	08:54	Insects		
59:13	Wind	09:36	Wind		
13:00:10	"				
00:19	"				

Figure 45: Field logsheet – Site 4 day

NOISE SAMPLING LOG SHEET

Evening 1

SITE NUMBER: S 4	SLM DATA RECORD: Htzv 005	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/20 19:50	01/12/20 20:05		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks (community (next to sports ground)
Start	0,5	SW	23.9	19.2	9/10	

NOISE CLIMATE	□ Birds	□ Insects	☑ Dogs	□ Music	☑ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other
Description:									
•									

Time	Description	Time	Description	Time	Description
19:50:36	Community	57:09	Road traffic (distant)	04:35	"
50;58	"	57;36	Community (children)	05:14	"
51;08	"	58;19	Road traffic		
52;10	Road traffic (distant)	58:27	"		
52;32	"	59;17	Community		
52;54	Community	59;34	"		
53;07	"	59;46	"		
53;33	Road traffic distant	20:00:17	Distant Road Traffic		
54;58	Community	00:34	"		
54;43	"	01:02	"		
55;19	"	01:26	Community (Men laughing)		
55;42	"	01:30	"		
56;18	"	02:51	Community (Children)		
56;26	"	02:59	"		
56;31	"				

Figure 46: Field logsheet – Site 4 evening 1

NOISE SAMPLING LOG SHEET

SITE NUMBER: S 4	SLM DATA RECORD: Hitzel005	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	02/11/20 • 19:25	02/11/201 19:40		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0.5	Undetectable	25.3	19.5		Dogs ± 55dB

NOISE CLIMATE	□ Birds	□ Insects	☑ Dogs	□ Music	☑ Community	□ Air Traffic	☑ Road Traffic	□ Constr.	□ other
Description:									
•									

Time	Description	Time	Description	Time	Description
19:25	Dogs	29:54	" (shooting)	37:53	Road traffic
25:24	"	30:47	Dogs	38:01	"
25:30	"	30:59	"	38:14	"
25:43	Road traffic (distant)	31:31	"	39:37	Dogs
26:14	Dogs	31:53	"		
26:24	Community	32:12	Community		
26:54	"	32:55	Road traffic (distant)		
27:22	Dogs	33:04	"		
27:35	"	34:10	"		
28:27	"	34:26	"		
28:44	Internal noise (paper)	34:39	Internal (paper)		
29:04	" (twigs)	37:10	Community (Baby crying		
29:32	Road traffic	37:23	"		
29:47	"	37:35	"		

Figure 47: Field logsheet – Site 4 evening 2

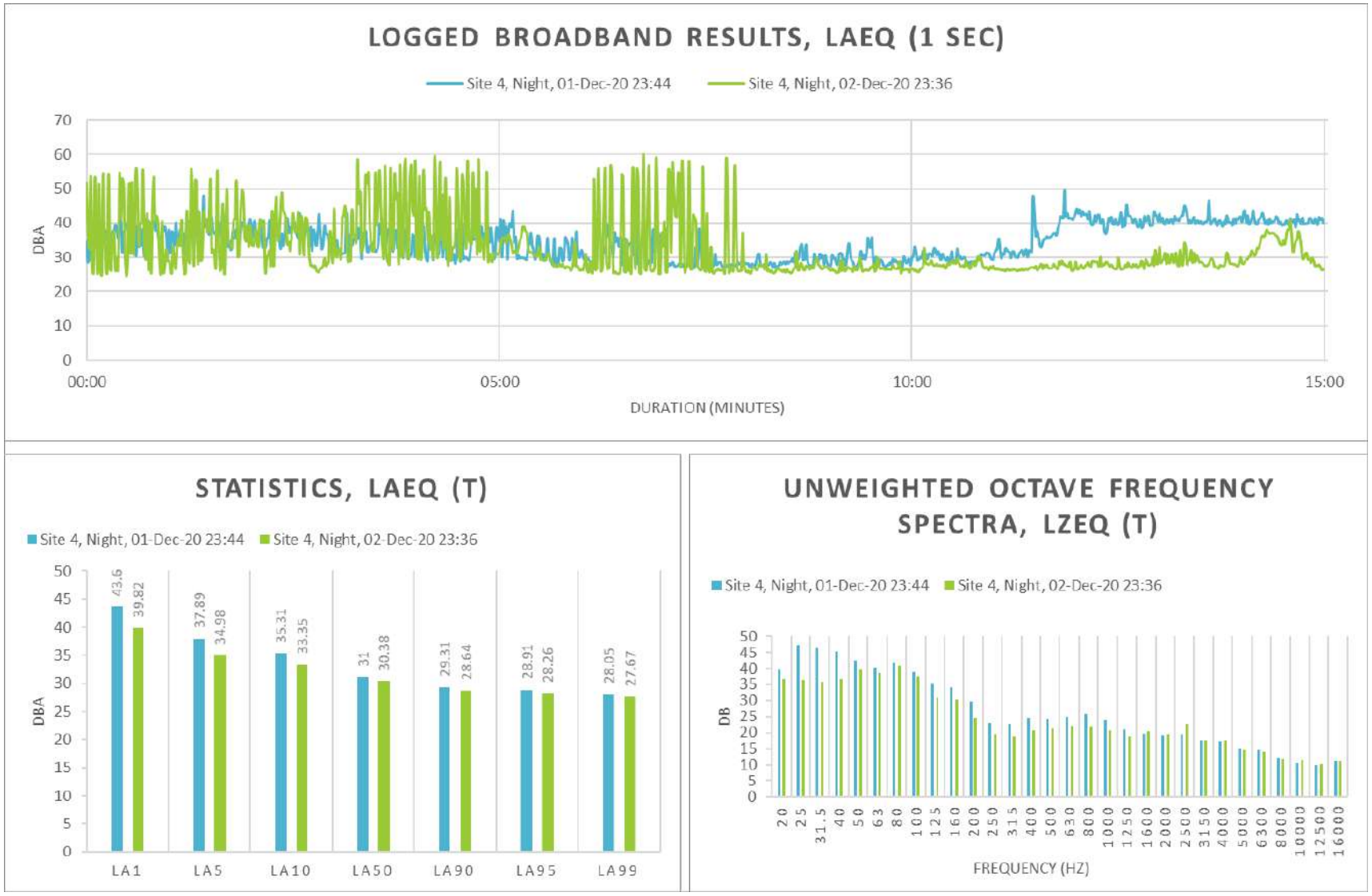


Figure 48: Broadband time series, frequency spectra and statistics – Site 4 night-time sampling

NOISE SAMPLING LOG SHEET

Night 1

SITE NUMBER: S4		SLM DATA RECORD: Htzn+005
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/20 23:44	01/12/20 23:59		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0	Not detectable	19.2	27.3	0/10	Dogs, distant traffic

NOISE CLIMATE	□ Birds	□ Insects	☑ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other

Description:

-

Time	Description	Time	Description	Time	Description
23:44:23	Internal noise (paper)	52:01	"		
23:44:40	Dogs	53:15	"		
44:52	"	53:41	"		
45:33	"	54:03	"		
47:12	"	54:19	"		
47:51	Road traffic (distant)	54:45	Internal noise (paper)		
48:36	"	55:02	"		
48:44	"	55:23	"		
48:51	"				
49:17	"				
49:43	"				
51:07	Dogs				
51:13	"				
51:51	"				

Figure 49: Field logsheet – Site 4 night 1

NOISE SAMPLING LOG SHEET

Night 2

SITE NUMBER: 4		SLM DATA RECORD: HTZ4T1005
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	23:36:40	23:51:39		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0.7		231	743	0	

NOISE CLIMATE	☒ Birds	□ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other
Description:									
•									

Time	Description	Time	Description	Time	Description
23:34:22	Birds	50:04	Car passing		
38:59	Birds	57:17			
-39:12					
42:20	Birds				
44:43	Hooter from far				
45:30	Car passing from far				
48:31					
49:18					
49:44	Geese sound of				
-49:1	Geese				

Figure 50: Field logsheet – Site 4 night 2

APPENDIX E – SITE 5 – PHOTOGRAPHS, LOGSHEETS AND SURVEY RESULTS

Facing north

Facing east

Facing south

Facing west

Figure 51: Photographs of environmental noise survey Site 5

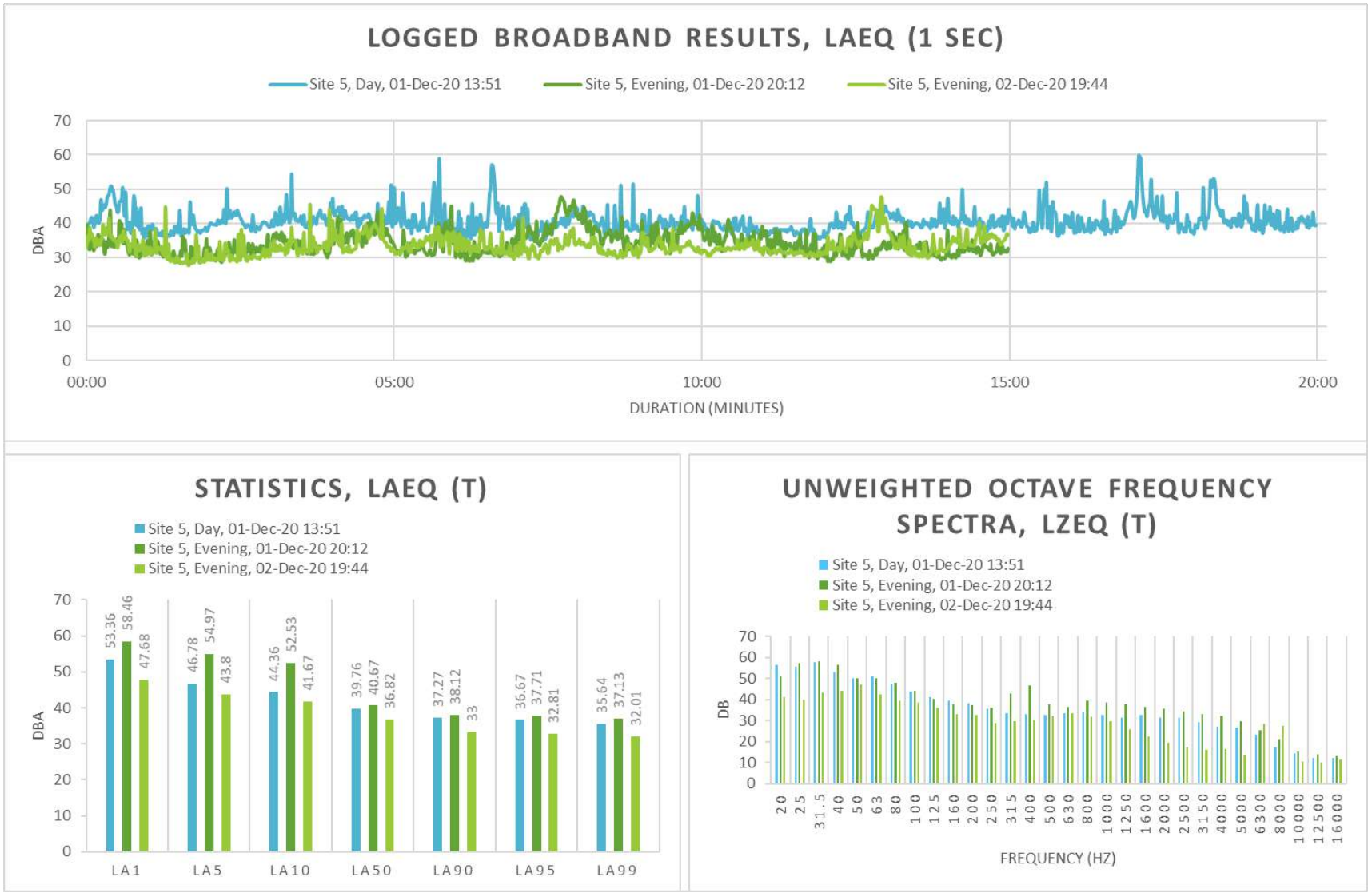


Figure 52: Broadband time series, frequency spectra and statistics – Site 5 day-time sampling

NOISE SAMPLING LOG SHEET

Day

SITE NUMBER: S 5	SLM DATA RECORD: Htz 005	
Longitude/Easting: 22.9653874	Latitude/Northing: -27,2191734	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/2020 13:58	01/12/2020 14:11		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	1.1 - 2.8	S	30.9	12.2	0	Music & children playing in community

NOISE CLIMATE	☑Birds	□ Insects	□ Dogs	□ Music	☑Community	□ Air Traffic	☑Road Traffic	□ Constr.	□ other

Description:

- Site on a residential area (unmultirated) next to a railway line. All houses have dogs.

Time	Description	Time	Description	Time	Description
13:51:52	Road Traffic	01:23	"		
52:13	Rail operations	03:13	Community		
52:59	"	03:39	"		
53:08	"	03:51	"		
53:44	"	04:08	"		
54:36	Community	05:27	Rail ops		
54:47	"	05:40	"		
55:23	"	06:58	"		
56:24	"	07:59	"		
57:06	"	08:34	Road Traffic		
57:30	"	09:43	"		
58:02	Road Traffic				
59:55	Rail operations				
14:01:10	"				

Figure 53: Field logsheet – Site 5 day

NOISE SAMPLING LOG SHEET

Evening 1

SITE NUMBER: 5	SLM DATA RECORD: HTZEV 006	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/11/20 20:12	20:27:26		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0.4	S.W	22.5	23.3	5/10	Dog @ 50dB - 55dB sound of train

NOISE CLIMATE	□ Birds	□ Insects	☒ Dogs	□ Music	☒ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other
Description: •									

Time	Description	Time	Description	Time	Description
20:12:40	Kids playing	18:52	Train		
12:53	"				
-13:34		21:02	Train		
13:53 -	Dogs barking	22:05	Sound of a train		
14:55					
		23:20	Hooter		
14:58	Dogs barking				
-15:38		26:38	Man sneezing/coughing		
15:40	Train	26:48	Car pass		
-15:50		-27:25			

Figure 54: Field logsheet – Site 5 evening 1

NOISE SAMPLING LOG SHEET

Evening 2

SITE NUMBER: S5	SLM DATA RECORD: Htev1 00 6	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time: 19:44	End Date & Time: 19:59	Sensitivity Before:	Sensitivity After:

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0,4	Undetectable	26,3	18,3	0/8	Road traffic. We moved further from barking dogs. Insects ± 34dB ± 51dB

NOISE CLIMATE	□ Birds	☑ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	☑ Road Traffic	□ Constr.	□ other
Description: •									

Time	Description	Time	Description	Time	Description
19:44:55	Road traffic	48:57	"	56:49	"
45:07	"	49:14	"	56:55	"
45:19	"	49:26	"	57:12	Road traffic
45:33	"	50:47	"	57:18	"
45:38	"	50:56	"	58:03	"
46:20	"	51:21	"	58:14	"
46:25	"	51:29	"	58:24	"
46:35	"	53:46	"	58:46	"
47:04	"	54:49	Insects	59:54	"
47:08	"	54:59	"		
47:19	"	55:17	Road traffic		
47:26	"	55:21	"		
47:55	"	55:37	"		
48:05	"	56:36	Community		

Figure 55: Field logsheet – Site 5 evening 2

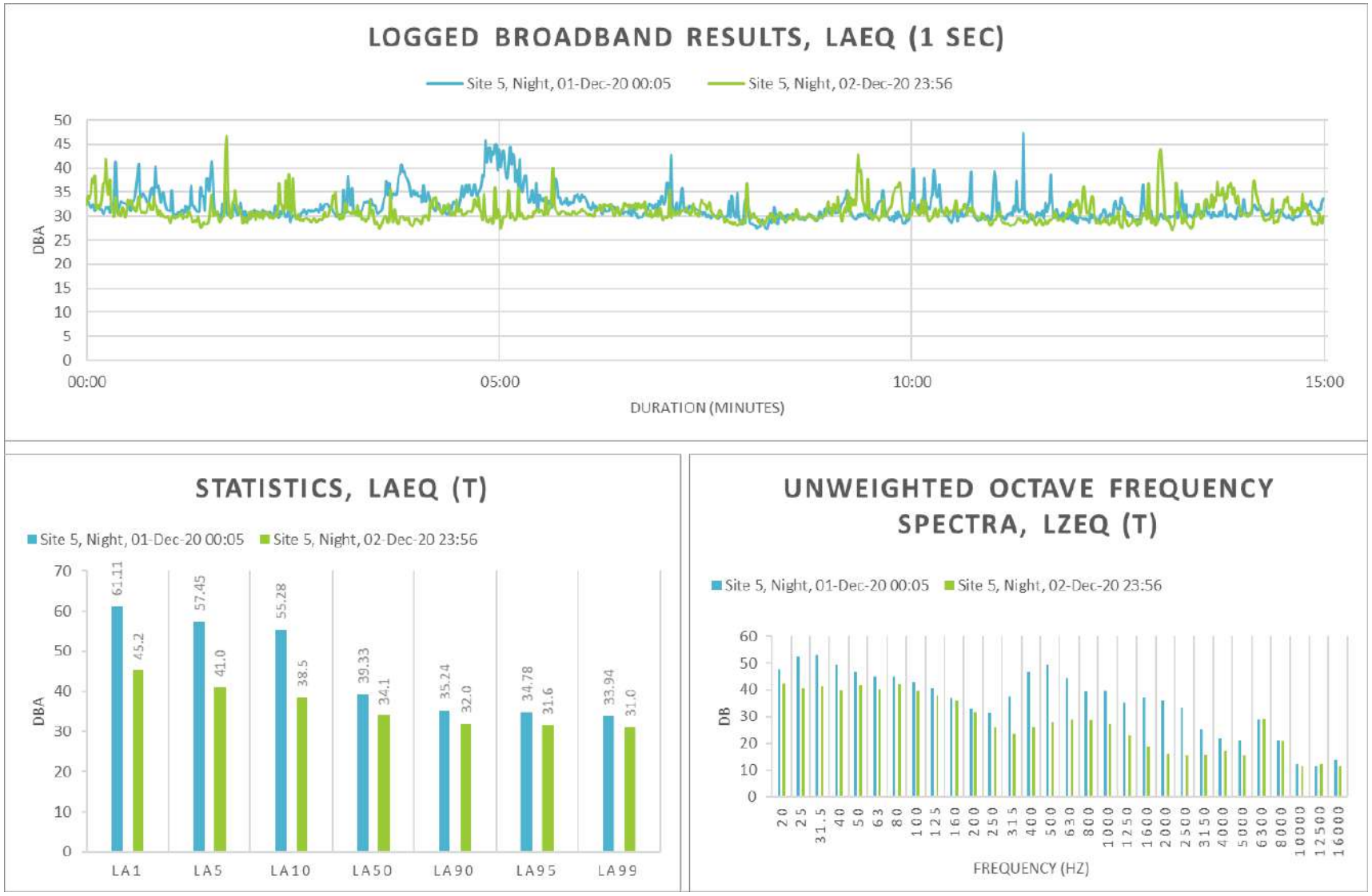


Figure 56: Broadband time series, frequency spectra and statistics – Site 5 night-time sampling

NOISE SAMPLING LOG SHEET

Night 1

SITE NUMBER: S5	SLM DATA RECORD: HTLNTD06	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

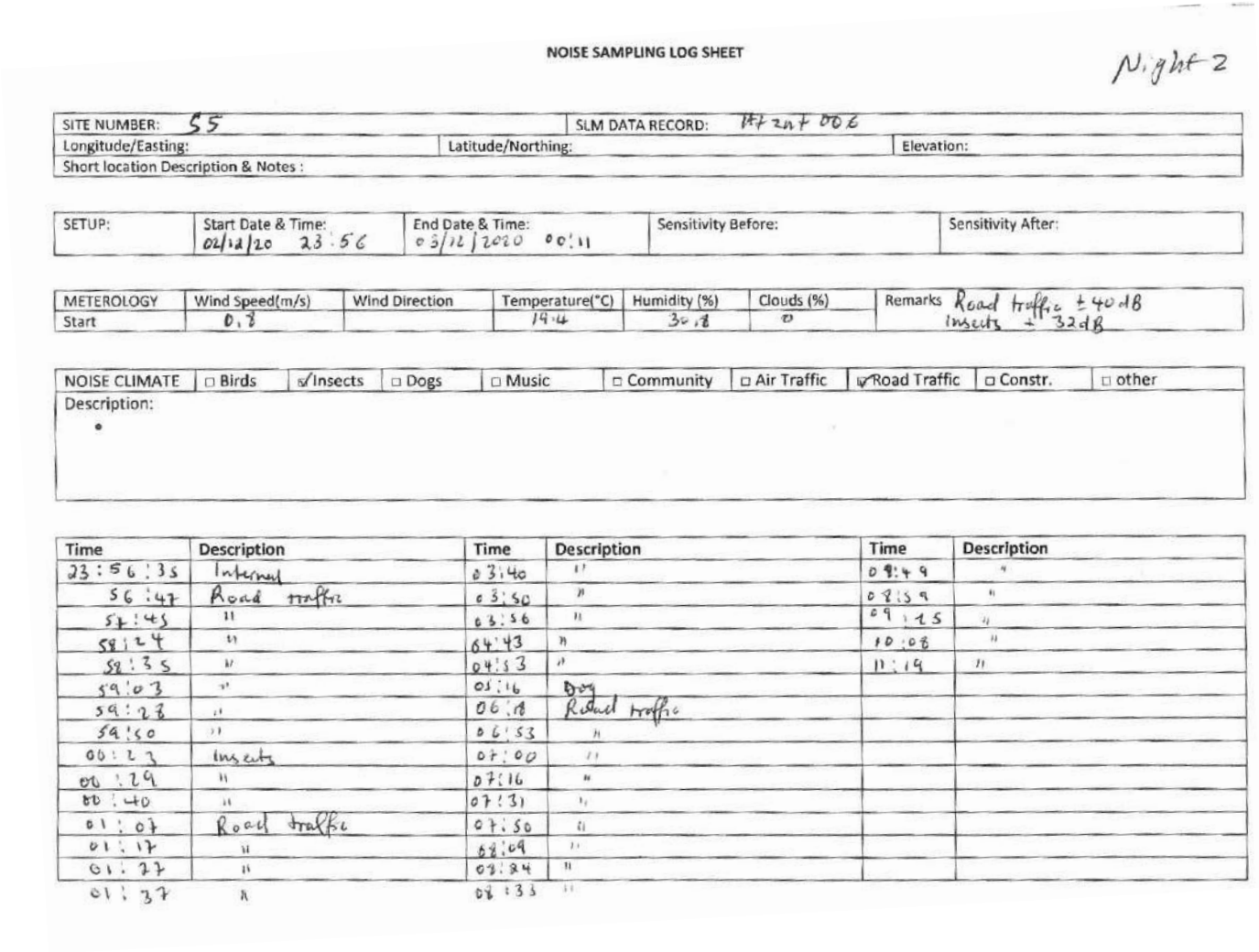
SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	00:05 02/12/2020	02/12/2020 : 20:50		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0.6	Not detectable	16.5	33.9	0%	

NOISE CLIMATE	□ Birds	□ Insects	☑ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other
Description:									
•									

Time	Description	Time	Description	Time	Description
00:0	Internal Noise	12:32	"		
00:05:51	Dogs	12:52	"		
06:14	"	13:47	"		
06:34	"	14:03	"		
06:48	"	14:37	"		
08:19	"	15:26	"		
09:26	Road traffic (distant)	17:09	"		
09:44	"	18:25	"		
10:22	Dogs	19:30	"		
10:27	"	19:47	"		
10:36	"				
10:52	"				
11:25	"				
11:42	"				

Figure 57: Field logsheet – Site 5 night 1



NOISE SAMPLING LOG SHEET

Night 2

SITE NUMBER: 55	SLM DATA RECORD: Rtzn 002	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	02/12/20 23:56	03/12/2020 00:11		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0.8		14.4	30.8	0	Road traffic ± 40 dB Insects ± 32 dB

NOISE CLIMATE	□ Birds	☑ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	☑ Road Traffic	□ Constr.	□ other

Description:

-

Time	Description	Time	Description	Time	Description
23:56:35	Internal	03:40	"	09:49	"
56:47	Road traffic	03:50	"	09:59	"
57:45	"	03:56	"	09:15	"
58:24	"	04:43	"	10:08	"
58:35	"	04:53	"	11:19	"
59:03	"	05:16	Dog		
59:23	"	06:18	Road traffic		
59:50	"	06:53	"		
00:23	Insects	07:00	"		
00:29	"	07:16	"		
00:40	"	07:31	"		
01:07	Road traffic	07:50	"		
01:17	"	08:09	"		
01:27	"	08:24	"		
01:37	"	08:33	"		

Figure 58: Field logsheet – Site 5 night 2

APPENDIX F – SITE 6 – PHOTOGRAPHS, LOGSHEETS AND SURVEY RESULTS

Facing north

Facing east

Facing south

Facing west

Figure 59: Photographs of environmental noise survey Site 6

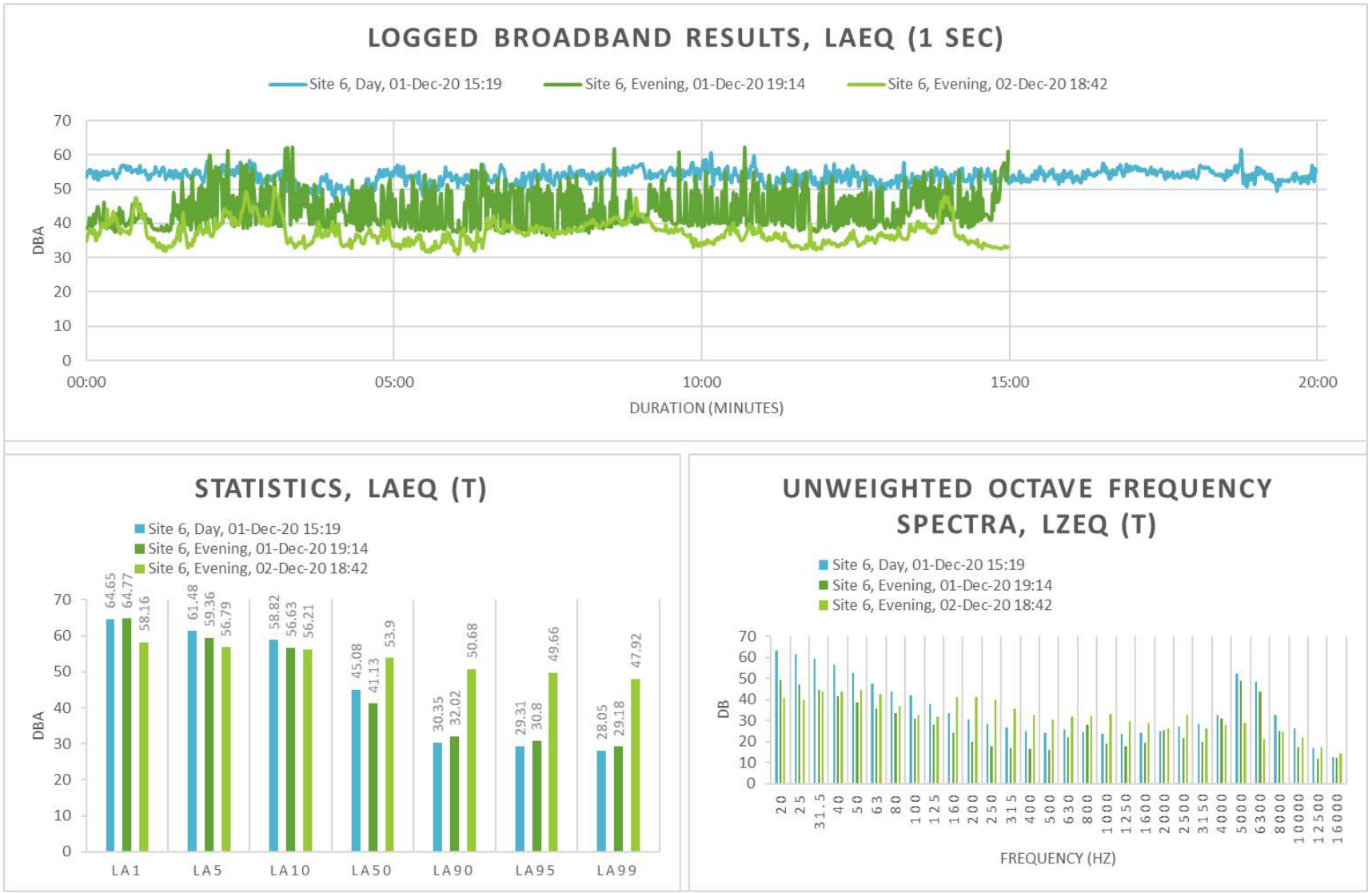


Figure 60: Broadband time series, frequency spectra and statistics – Site 6 day-time sampling

NOISE SAMPLING LOG SHEET

Day

SITE NUMBER: S6	SLM DATA RECORD: HT2 006	
Longitude/Easting: 22.986430	Latitude/Northing: -27.190 899	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/2020 15.20	01/12/2020 15.38		Nil

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	1.9 - 3.5	W	33.2	12.4		Insects & Birds

NOISE CLIMATE	☑Birds	☑Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other

Description:

- Site moved from original. It's next to the existing mine haul road an uncultivated bushland surrounded by lots of shrubs and grassland

Time	Description	Time	Description	Time	Description
15:20:50	Insects	31:56	"		
15:	"	32:12	"		
15:22:28	Insects	32:14	wind		
23:32	"	33:03	Internal		
24:33	"	34:52	Birds		
25:35	"	35:37	"		
26:31	Distant shouts	37:14	Insects		
26:52	"	38:37	Wind gust (Internal noise)		
27:11	"				
28:44	Insects				
29:38	Birds				
29:56	"				
30:37	Mem working (distant)				
31:10	"				

Figure 61: Field logsheet – Site 6 day

NOISE SAMPLING LOG SHEET

Evening 1

SITE NUMBER: S 6	SLM DATA RECORD: Htzeu 003	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/20 19:14	01/12/20 19:29		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	1.7	W	25.7	17.3	0	Insects 51.1 dB Birds ± 84 dB

NOISE CLIMATE	☑ Birds	☑ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other
Description:									
•									

Time	Description	Time	Description	Time	Description
19:14:39	Internal (paper)	22:30	"		
14:59	insects	23:11	"		
16:31	Birds	24:17	Insects		
16:48	"	24:43	"		
17:21	"	24:52	Birds		
18:11	"	26:20	"		
18:36	Insects	26:21	"		
19:00	"	26:32	"		
19:16	"	27:35	"		
19:46	Birds	27:48	"		
21:32	"	29:06	"		
21:24	"				
22:03	"				
22:13	"				

Figure 62: Field logsheet – Site 6 evening 1

NOISE SAMPLING LOG SHEET

Evening 2

SITE NUMBER: S 6		SLM DATA RECORD: HTzeN1003
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	02/12/20 18:42	02/12/2020 18:57		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0.8 – 1.1	SW	25.8	19.9	1/10	Birds (35 – 48 dB)

NOISE CLIMATE	☑ Birds	□ Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other

Description:

•

Time	Description	Time	Description	Time	Description
18:42:29	Cows	46:27	"	56:21	"
42:45	Birds	46:42	"	56:32	
43:00	"	47:07	"		
43:05	"	47:50	"		
43:18	Cows	47:59	"		
43:28	"	48:12	"		
43:32	Birds	48:49	"		
43:47	"	49:16	"		
43:59	"	49:24	"		
44:08	"	49:44	"		
44:31	"	51:09	"		
44:39	"	52:15	"		
45:15	"	55:57	"		
45:32	"	56:13	"		

Figure 63: Field logsheet – Site 6 evening 2

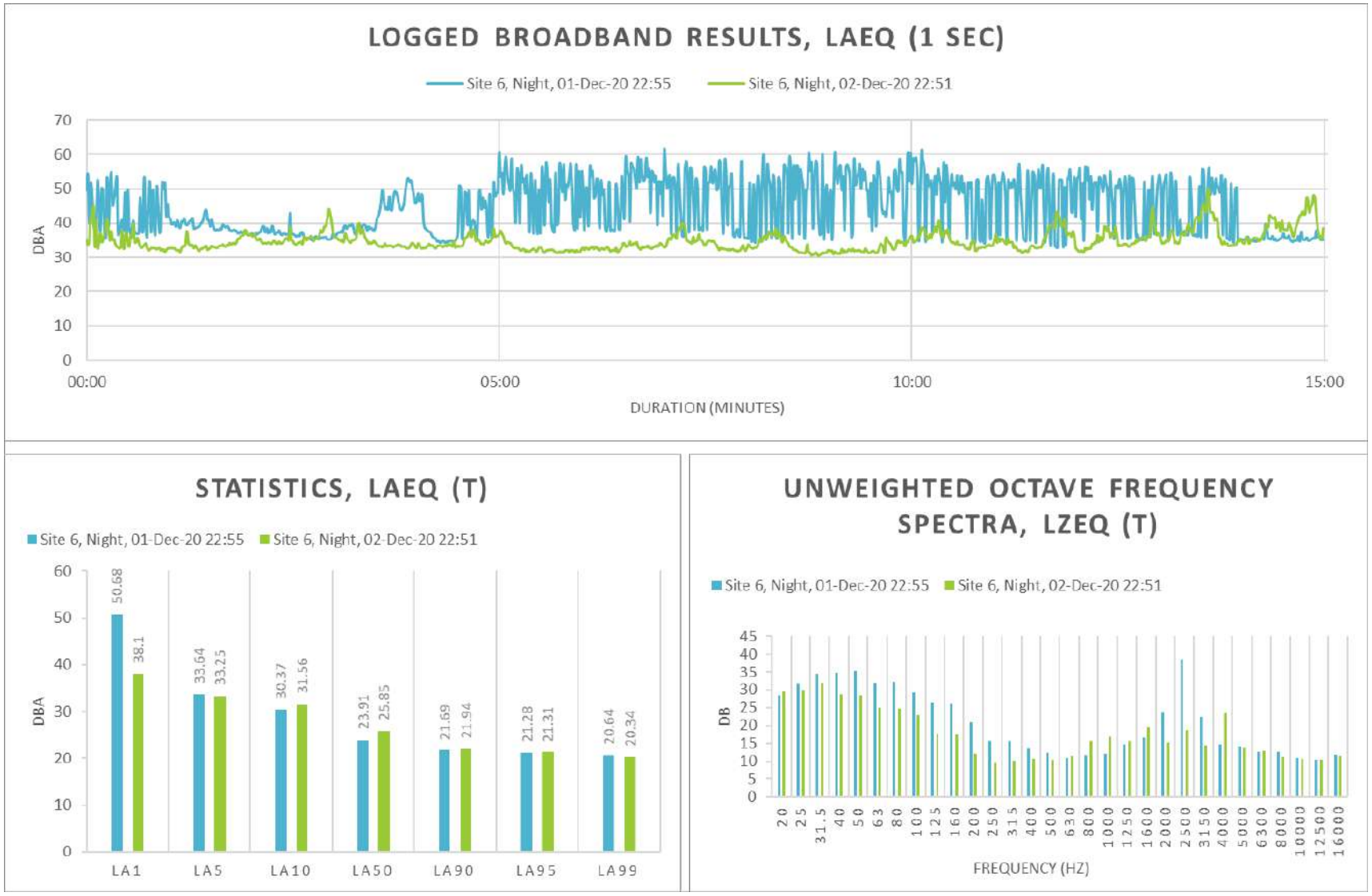


Figure 64: Broadband time series, frequency spectra and statistics – Site 6 night-time sampling

NOISE SAMPLING LOG SHEET

Night 1

SITE NUMBER: S6		SLM DATA RECORD: HTM703
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	01/12/20 22:55	01/12/20 23:10		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0	Not detectable	21.6	23.9	6/10	

NOISE CLIMATE	☑Birds	☑Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other
Description: •									

Time	Description	Time	Description	Time	Description
22:55:08	Internal Noise	05:59	"		
55:51	"	06:42	"		
56:18	Insects	06:58	"		
56:32	Birds	08:00	"		
56:41	"	08:45	"		
57:01	"				
58:52	"				
59:30	"				
59:45	"				
23 00:01	"				
00:24	"				
01:32	"				
03:01	"				
03:35	"				

Figure 65: Field logsheet – Site 6 night 1

NOISE SAMPLING LOG SHEET

Night 2

SITE NUMBER: S6	SLM DATA RECORD: HF21H003	
Longitude/Easting:	Latitude/Northing:	Elevation:
Short location Description & Notes :		

SETUP:	Start Date & Time:	End Date & Time:	Sensitivity Before:	Sensitivity After:
	02/12/20 22:51	02/12/20 23.06		

METEROLOGY	Wind Speed(m/s)	Wind Direction	Temperature(°C)	Humidity (%)	Clouds (%)	Remarks
Start	0.3	Undetectable	24.2	23.1	0/10	Insects ± 28 dB Birds ± 32dB

NOISE CLIMATE	☑Birds	☑Insects	□ Dogs	□ Music	□ Community	□ Air Traffic	□ Road Traffic	□ Constr.	□ other

Description:

-

Time	Description	Time	Description	Time	Description
22:51:37	Internal noise (turns)	57:51	"		
51:52	"	57:59	"		
52:02	Insects	59:28	Birds		
52:16	"	59:44	"		
52:26	"	00:14	"		
53:24	"	00:26	"		
53:31	Birds	00:33	"		
53:38	"	01:26	"		
53:47	Insects	03:04	"		
54:00	"	04:17	Insects		
54:41	"	04:25	"		
54:51	"	05:04	"		
54:57	"	05:20	"		
57:45	"				

Figure 66: Field logsheet – Site 6 night 2

APPENDIX G – CALIBRATION CERTIFICATES

nmisa
National Metrology Institute of South Africa

Certificate of Conformance

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

Calibration of:	SOUND LEVEL METER, OCTAVE BAND FILTER, THIRD OCTAVE BAND FILTER & MICROPHONE
Manufacturer:	BRÜEL & KJÆR
Model number:	2250-L, 4950
Serial number:	2731851, 2709293
Calibrated for:	AIRSHED PLANNING PROFESSIONALS (PTY) LTD Midrand
Calibration procedure:	AV\AS-0007 AV\AS-0010
Period of calibration:	10 – 11 May 2017

1 PROCEDURE

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

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

The following equipment was used:

Brüel & Kjær 4226 Multi-function calibrator	(AS-52)
Inline Capacitor	(AS-98)
Madgetech PRHTemp 2000	(AS-106)
Brüel & Kjær 3630 Calibration platform	(AS-109)

Calibrated by **R Nel** **Metrologist (Technical Signatory)**	Checked by **H Potgieter** **Metrologist**	For Chief Executive Officer
Date of Issue **11 May 2017**	**Page 1 of 3**	Certificate number **AV\AS-4634**

Your measure of excellence

2 RESULTS

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

Indication under reference conditions (SANS 656 clause 11.2)		U = 0,20 dB
Electrical self generated noise		
A-weighted	(12,9 dB)	U = 0,30 dB
C-weighted	(13,7 dB)	U = 0,30 dB
Linear	(19,2 dB)	U = 0,30 dB
Linearity range (primary indicator range) (SANS clause 9.9, table 11)		
1 kHz		U = 0,12 dB
4 kHz		U = 0,12 dB
8 kHz		U = 0,12 dB
Frequency Weightings (SANS 656 clauses 8.1, 11.2, tables 4 & 5)		
A-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
C-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
Linear	(25 Hz – 16 kHz)	U = 0,12 dB
Time weightings (SANS 656 clauses 9.2, 9.3, 9.5, 11.4, table 9, 7 & 10)		
Slow and Fast		U = 0,11 dB
Impulse		U = 0,11 dB
Peak		U = 0,09 dB
Time averaging, L_{Aeq} (SANS 658 clause 11.3.3, table 4)		U = 0,12 dB
Impulse weighted time averaging, L_{AIeq} (SANS 658 Annex C, table C1)		U = 0,12 dB
Overload indication (SANS 656 clause 11.3)		U = 0,31 dB

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

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

Calibrated by **R Nel** **Metrologist (Technical Signatory)**	Checked by **H Potgieter** **Metrologist**	For Chief Executive Officer
Date of Issue **11 May 2017**	**Page 2 of 3**	Certificate number **AVIAS-4634**

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

Relative attenuation — $U = 0{,}10$ dB @ f_m
(IEC 61260 clause 4.4, 5.3)
16 Hz - 8 kHz

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

Relative attenuation — $U = 0{,}10$ dB @ f_m
(IEC 61260 clause 4.4, 5.3)
12,5 Hz - 16 kHz

3 REMARKS

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

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

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

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

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

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

3.7 The firmware versions of the sound measuring device at the time of calibration were: BZ7130 V4.4; BZ7131 V4.4; BZ7132 V4.4.

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

Calibrated by	Checked by	For Chief Executive Officer
R Nel **Metrologist (Technical Signatory)**	**H Potgieter** **Metrologist**	
Date of Issue		Certificate number
11 May 2017	**Page 3 of 3**	**AV\AS-4634**

Prepolarized Free-field 1/2" Microphone Type 4950

Brüel & Kjær **Calibration Chart**

Serial No: 3177677

Open-circuit Sensitivity*, S_0:	***-26.9***	dB re 1V/Pa
Equivalent to:	***45.3***	mV/Pa
Uncertainty, 95 % confidence level	0.2	dB
Capacitance:	***12.8***	pF

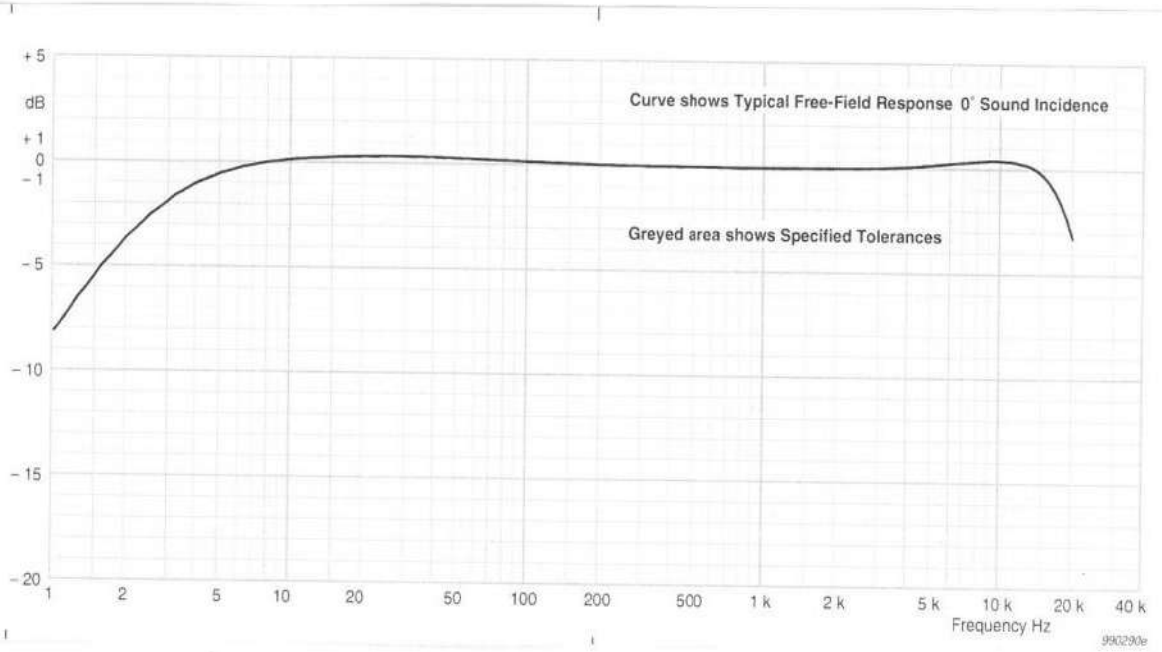
Valid At:

Temperature:	23	°C
Ambient Static Pressure:	101.3	kPa
Relative Humidity:	50	%
Frequency:	251.2	Hz
Polarization Voltage, external:	0	V

Sensitivity Traceable To:
DPLA: Danish Primary Laboratory of Acoustics
NIST: National Institute of Standards and Technology, USA

Environmental Calibration Conditions:
101.2 kPa 24 °C 55 % RH

Procedure: 704875 **Date:** 24. Jul. 2018 **Signature:**



APPENDIX H – AUTHOR'S CURRICULUM VITAE AND PROFESSIONAL REGISTRATION CERTIFICATE

CURRICULUM VITAE

Name	Natasha Anne Shackleton (née Gresse)
Date of Birth	12 September 1988
Nationality	South African
Identification Number	880912 0054 081
Passport Number	A05514095
Employer	Airshed Planning Professionals (Pty) Ltd
Position	Senior Consultant
Profession	Meteorologist employed as an Air Quality and Noise Consultant
Years with Firm	10
E-mail Address	natasha@airshed.co.za
Contact Numbers	+27 11 8051940 (Office Switchboard) +27 10 500 1147 (Office Direct)

MEMBERSHIP OF SOCIETIES

- Registered Professional Natural Scientist (Registration Number 116335) with South African Council for Natural Scientific Professions (SACNASP), 2018 to present.
- National Association for Clean Air (NACA), 2020 to present
- South African Society for Atmospheric Sciences (SASAS), 2016 to present.
- American Meteorological Society (AMS), 2017 and 2018.
- Golden Key International Honour Society, 2011 to present.

EXPERIENCE

Natasha has several years of experience in air quality and noise impact assessments and management. She is an employee of Airshed Planning Professionals (Pty) Ltd and is tasked with completing air, noise, greenhouse gas and climate change studies. These studies usually involve dustfall sampling data analysis, pollutant concentration measurements or sampling data analysis, meteorological data processing and preparation, noise sampling and data analysis; the compilation of emission inventories; undertaking of air dispersion and noise propagation modelling; impact and compliance assessment using her substantial knowledge of South African and international legislation and requirements pertaining to air quality, greenhouse gases emissions and noise; air quality, noise, greenhouse gas and climate change management plan preparation and report writing. Natasha has also assisted with South African Emissions Reporting (National Atmospheric Emission Inventory System [NAEIS] and South African Greenhouse Gas Emissions Reporting System [SAGERS]) for various mines and industries. She has worked on many projects within various countries in Africa which required international financing, providing her with an inclusive knowledge base of IFC guidelines and requirements pertaining to air quality and greenhouse gases emissions.

PROJECTS COMPETED IN VARIOUS SECTORS ARE LISTED BELOW:

Mining Sector

Air Quality Studies

- Coal mining: Argent Colliery; Commissiekraal Coal Mine; Estima Coal Project (Mozambique); Grootegeluk Coal Mine; Matla Coal Mine; Rietvlei Coal Mine; Vierfontein Coal Mine; Goedehoop Coal Mine.
- Metalliferous mines: AngloGold Ashanti Vaal River and West Wits Operations; Harmony Vaal River Operations as part of the Radionuclides Health and Environmental Risks Assessment; Atlantic Sands; Bakubung Platinum Mine; Bakubung Platinum Mine's new Tailings Storage Facility (TSF) Project; Bannerman Uranium Mine (Namibia); Gold Fields' South Deep Gold Mine; Kitumba Copper Project (Zambia); Lehating Manganese Mine; Lesego Platinum Mine; Lofdal Mining Project (Namibia); Marula Platinum Mine; Maseve Platinum Mine; Mkuju River Uranium Project (Tanzania); Namakwa Sands Quartz Rejects Disposal and Mine; Otjikoto Gold Project (Namibia); Otjikoto Gold Mine's Wolfshag Project (Namibia); Pan Palladium Project; Perkoa Zinc Project (Burkina Faso); Storm Mountain Diamonds (Lesotho); Tete Iron Ore Project / Tete Steel and Vanadium Project (Mozambique); Thabazimbi Iron Ore's Infinity Project; Toliara Sands Project (Madagascar); Tormin Mineral Sands Mine; Trekkopje Uranium Mine (Namibia); Tri-K Project (Guinea); Tschudi Copper Mine (Namibia); Wayland Iron Ore Project; Zulti South Project; West African Resources Sanbrado Project (Burkina Faso); Impala Platinum Rustenburg Mine and Smelter; Mn48 Manganese Mine.
- Quarries: AfriSam Saldanha Cement Project Limestone Quarry; Consol Industrial Minerals; Bundu Mining (air quality and noise), Tete Iron Ore Project / Tete Steel and Vanadium Project (Mozambique).

Noise Studies

- Metalliferous mines: Bakubung Platinum Mine's new TSF Project; West African Resources Sanbrado Project (Burkina Faso).
- Quarries: Bundu Mining.

Climate Change Studies

- Metalliferous mines: Bakubung Platinum Mine's new TSF Project; Tormin Mineral Sands Mine; West African Resources Sanbrado Project (Burkina Faso); Mn48 Manganese Mine.

Industrial Sector

Air Quality Studies

AfriSam Saldanha Project; CAH Chlorine Caustic Soda and HCl Plant; Consol Industrial Minerals Processing Plant; Corobrik Driefontein new Brick Kiln Project; Metal Concentrators SA Paarden Eiland; Tronox Namakwa Sands Un-Attritioned Magnetic Material (UMM) Plant Environmental Authorisation (EA) application process as well as the Atmospheric Impact Report (AIR) as part of the Atmospheric Emission Licence (AEL) application process and the LNG Project; Otavi Rebar Manufacturing; Phakisa Project; Pan Palladium Project; PPC Riebeeck Cement; Rare Earth Elements (REE) Saldanha Separation Plant; Saldanha Steel; Siyanda Project; Tete Iron Ore Project / Tete Steel and Vanadium Project (Mozambique); Tri-K Project (Guinea); Tormin Mineral Sands Mineral Separation Plant (MSP); Tronox Namakwa Sands Smelter; Tronox Namakwa Sands MSP including LNG Project; ZMY Steel Recycling Plant; Nyanza TiO_2 Pilot Plant; Musina-Makhado Special Economic Zone (SEZ); West African Resources Sanbrado Project Gold Processing (Burkina Faso), Mortar SA Operations in Darling; Impala Platinum Rustenburg Mine and Smelter including the proposed Second Flash Dryer Project; Mine Waste Solutions (Chemwes) operations including the proposed Kareerand TSF expansion; Sublime Technologies Silicon Carbide Plant; Vanchem Vanadium Products.

Noise Studies

West African Resources Sanbrado Project Gold Processing (Burkina Faso).

Climate Change Studies

Tormin Mineral Sands MSP; West African Resources Sanbrado Project Gold Processing (Burkina Faso); Mine Waste Solutions (Chemwes) operations including the proposed Kareerand TSF expansion.

Power Generation

Air Quality Studies

H2 Energy Power Station; Hwange Thermal Power Station Project (Zimbabwe); Ibhubesi Gas Project; Expansion of Staatsolie Power Company; Suriname Operations (Suriname); Tri-K Project (Guinea); Tete Iron Ore Project / Tete Steel and Vanadium Project (Mozambique); Medupi Power Station; Matimba Power Station; Acacia Peaking Power Station; Port Rex Peaking Power Station; Musina-Makhado SEZ.

Waste Disposal and Treatment Sector

Air Quality Studies

Fishwater Flats Waste Water Treatment Works; Khutala Water Treatment Project; Moz Environmental Industrial Landfill (Mozambique); Koedoeskloof Waste Disposal Site; Interwaste FG Landfill Midrand; Wolverand Crematorium; Green Oil and Lubricants Plant.

Petroleum Sector

Air Quality Studies

Chevron Refinery, Exol Oil Refinery, Puma South Africa's Fuel Storage Facility, Oilkol Depot, Astron Energy Cape Town Refinery; Saldanha Bay Industrial Development Zone Fuel Storage Facilities; Green Oil and Lubricants Plant.

Transport and Logistics Sector

Air Quality Studies

Saldanha Port Project.

Ambient Air Quality and Noise Sampling/Monitoring

Types of Sampling and Monitoring

Gravimetric particulate matter (PM) sampling; Dustfall sampling; Passive diffusive gaseous pollutant sampling; Continuous ambient air quality monitoring; Environmental noise sampling.

Locations of Sampling and Monitoring Projects

South Africa including Limpopo, North West, Mpumalanga, Gauteng and Northern Cape; Burkina Faso; Guinea; Zimbabwe.

SOFTWARE PROFICIENCY

Software utilised in conducting air and noise studies:

- WRPLOT View (wind and pollution rose generation);
- OpenAir (ambient and meteorological data processing);
- Golden Software Surfer (mapping);

- TANKS 4.0.9d (emission estimation model);
- GasSim (emission estimation model);
- SCREEN3 using ScreenView (screening model);
- AERMOD suite (air dispersion model);
- ADMS (air dispersion model);
- CALPUFF suite (air dispersion model);
- CALINE4, CAL3QHC, and CAL3QHCR (traffic air dispersion models);
- GRAL system (air dispersion model);
- DataKustic CadnaA (noise propagation model);
- CONCAWE (noise propagation model); and
- SANS 10201 (calculating and predicting road traffic noise).

EDUCATION

- 2010 to 2011 - BSc Honours (Meteorology) student at the University of Pretoria (Faculty of Natural and Agricultural Sciences), Pretoria. Completed 30 November 2011. Degree issued/conferred 13 April 2012. Research project supervisor: Dr S Venkataraman.
- 2007 to 2010 - BSc student at the University of Pretoria (Faculty of Natural and Agricultural Sciences), Pretoria. Completed 30 June 2010. Degree issued/conferred 2 September 2010.

CONFERENCES ATTENDED, ARTICLES PUBLISHED AND COURSES COMPLETED

- Conference: NACA (November 2020), attended.
- Conference: Innovation Bridge and Science Forum South Africa (December 2019), attended.
- Conference: NACA (October 2018), attended and presented a paper (Correlating Dust Concentration Measurements aloft with Opencast Mining Surface Operations).
- Conference: NACA (October 2017), attended and presented a paper (Correlating Dust Concentration Measurements aloft with Opencast Mining Surface Operations).
- Published Article: Beukes, JP; Van Zyl, PG; Sofiev, M; Soares, J; Liebenberg-Enslin, H; Shackleton, N; Sundstrom, AM (2018). The use of satellite observations of fire radiative power to estimate the availabilities (activity patterns) of pyrometallurgical smelters. Journal of the Southern African Institute of Mining and Metallurgy, 118(6), 619-624., co-author.
- Undergraduate courses passed: computer literacy (word processing, spreadsheet processing, Microsoft power point, Microsoft publisher, use of Internet and Microsoft front page); MATLAB; ArcGIS 9.0.; ERDAS Image; Aan Arbor; IDRISI TAIGA; FORTRAN, GRADS; TITAN; SUMO 3.00; and Danny Rosenfeld 2007-01.

COUNTRIES OF WORK EXPERIENCE

South Africa, Botswana, Burkina Faso, Guinea, Lesotho, Mozambique, Madagascar, Namibia, Suriname, Tanzania, Zambia and Zimbabwe.

LANGUAGES

Language	Proficiency
English	Full professional proficiency
Afrikaans	Limited working proficiency

REFERENCES

Name	Position	Contact Details
Dr Gerrit Kornelius	Associate of Airshed Planning Professionals	+27 82 925 9569 gerrit@airshed.co.za
Dr Lucian Burger	Director at Airshed Planning Professionals	+27 11 805 1940 lucian@airshed.co.za
Dr Hanlie Liebenberg-Enslin	Managing Director at Airshed Planning Professionals	+27 11 805 1940 hanlie@airshed.co.za

CERTIFICATION

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

09/04/2021

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Natasha Anne Shackleton

Registration Number: 116335

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Physical Science (Professional Natural Scientist)

Effective **6 June 2018** Expires **31 March 2022**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

ANNEXURE I – I&APS COMMENTS AND RESPONSES

Comment	Response
Hotazel town is fully occupied by mine workers and others working shifts and the noise from mining activities will have an impact on their sleeping patterns and fatigue recovery.	Section 6.2.1 discusses the noise levels expected from the proposed THM operations. The simulations indicate that there may be exceedances of the IFC NLG during the day at residences in Hotazel town (Figure 10). The simulations indicate that there may be exceedances of the IFC NLG during the night at multiple residences in Hotazel town as well as Hotazel Combined School, Life Occupational Health - Hotazel Manganese Mines Clinic and Wessels Clinic (Figure 11). Multiple potential mitigation measures have been discussed as well as the recommended measures for the best possible reduction in impacts on the town in Section 6.3.
Where will evaporators be positioned and how big are they? Is any chance for them adding to noise?	Section 6.2.2 discusses the noise levels expected from the pit dewatering, including the operation of the evaporators. The simulations indicate that no exceedance of the IFC NLG at the NSRs during the day (Figure 15). The simulations indicate that there may be exceedances of the IFC NLG at the NSRs during the night (Figure 16).

Declaration of Independence by Specialist

I, Natasha Anne Shackleton, in my capacity as a specialist consultant, hereby declare that I –

- act as an independent specialist;
  Where **"independent"** in relation **a specialist** means the following, as defined in GN982 of 2014 (*as amended*):
  (a) that such EAP, **specialist** or person has no business, financial, personal or other interest in the activity or application in respect of which that EAP, specialist or person is appointed in terms of these Regulations; or
  (b) that there are no circumstances that may compromise the objectivity of that EAP, specialist or person in performing such work;
  excluding -
  (i) normal remuneration for a specialist permanently employed by the EAP; or
  (ii) fair remuneration for work performed in connection with that activity, application or environmental audit;
- will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- declare that there are no circumstances that may compromise my objectivity in performing such work;
- do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998), regulations and any guidelines that have relevance to the proposed activity;
- based on information provided to me by the project proponent and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional ability; and
- undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study for which I am registered.

Signature of the Specialist

Airshed Planning Professionals (Pty) Ltd
Name of Company:

27/08/2021
Date