

Appendix L - Biovac Noise Assessment



Physical Address:
15 Alexandra Road, Pinelands
7405
Cape Town
South Africa
Tel: [+27 21 514 5000](tel:+27215145000)

Postal Address: Private Bag X3,
Pinelands, 7405, Cape Town
Email: general@biovac.co.za
Website: [Contact Us – Biovac](#)

Copyright and disclaimer

The information contained in this communication is confidential and may be legally privileged. It is intended solely for the use of Biovac, and others authorized to receive it. You are hereby notified that any disclosure, copying, distribution or acting in reliance of the contents of this information is strictly prohibited and may be unlawful. We wish to ensure you that all your personal information in our possession or under our control is processed only for the purpose for which it is collected. This document and its contents are subject to our Privacy Notice available at [Disclaimer – Biovac](#) or contact our information officer at general@biovac.co.za.



Noise Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

14 Alexander Road
Pinelands
Cape Town

Prepared by:

SLR Consulting (South Africa) Proprietary Limited

Unit 14, Braehead Office Park, 1 Old Main Road,
Kloof, Durban, KwaZulu-Natal, 3640

SLR Project No.: 723.000205.00001

6 May 2026

Revision: Final

Title	Noise Baseline Assessment
Project Manager	Lisa Ramsay
Project Manager Email	lramsay@slrconsulting.com
Author	Sheena Muttoo
Reviewer	Lisa Ramsay
Keywords	Noise, Vaccine Manufacturing, Cape Town
Status	Final
SLR Company	SLR Consulting (South Africa) Proprietary Limited
SLR Portfolio No.	723.000205.00001

Revision Record

Revision	Date	Prepared By	Checked By	Authorized By
Draft	9 February 2026	S. Muttoo	L. Ramsay	L. Ramsay
Draft	13 March 2026	S. Muttoo	L. Ramsay	L. Ramsay
Final	6 May 2026	S. Muttoo	L. Ramsay	L. Ramsay



Basis of Report

This document has been prepared by an SLR Group company with reasonable skill, care and diligence, and taking account of the timescales and resources devoted to it by agreement with The Biovac Institute (Pty) Ltd (the Client) as part or all of the services it has been appointed by the Client to carry out. It is subject to the terms and conditions of that appointment.

SLR shall not be liable for the use of or reliance on any information, advice, recommendations and opinions in this document for any purpose by any person other than the Client. Reliance may be granted to a third party only in the event that SLR and the third party have executed a reliance agreement or collateral warranty.

Information reported herein may be based on the interpretation of public domain data collected by SLR, and/or information supplied by the Client and/or its other advisors and associates. These data have been accepted in good faith as being accurate and valid.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

The copyright and intellectual property in all drawings, reports, specifications, bills of quantities, calculations and other information set out in this report remain vested in SLR unless the terms of appointment state otherwise.

This document may contain information of a specialised and/or highly technical nature and the Client is advised to seek clarification on any elements which may be unclear to it.

Information, advice, recommendations and opinions in this document should only be relied upon in the context of the whole document and any documents referenced explicitly herein and should then only be used within the context of the appointment.



Executive Summary

SLR Consulting (Pty) Ltd was appointed by The Biovac Institute (Pty) Ltd to undertake a baseline noise assessment for their proposed vaccine manufacturing facility in Pinelands, Cape Town, Western Cape. The assessment involved the collection and analysis of ambient noise data at representative fenceline and nearby receptor locations, during two phases of monitoring, characterisation of daytime and nighttime sound levels, review of relevant meteorological conditions, and comparison of measured noise levels against applicable standards/guideline limits, including SANS 10103:2008 and IFC/WHO guidance. The purpose of the study was to establish existing baseline noise conditions to inform appropriate management measures.

Vaccine manufacturing facilities typically generate low to moderate noise levels, as most operational equipment is enclosed or acoustically screened. While certain continuous or tonal noise sources may cause localised annoyance if not properly managed, the overall risk of significant noise impacts is considered low.

Baseline noise monitoring was initially conducted on 9 - 10 December 2025 (Phase 1), and upon review of the initial results a second phase of monitoring was undertaken from 23 - 28 February 2026, to characterise ambient noise conditions at fenceline and nearby receptor locations. Measurements were taken during both daytime (07:00 - 18:00) and nighttime (22:00 - 06:00). Results indicate that daytime noise levels are compliant with SANS 10103:2008 and IFC/WHO guideline limits. Nighttime exceedances were observed at two residential receptors. These are primarily associated with the more stringent night-time limits rather than a significant increase in noise emissions from existing sources. All sites (except NSR 3 during Phase 2) have lower nighttime readings than daytime readings. The reading at NSR 3 (Phase 2) may have been influenced by increased Friday night traffic and documented intermittent human voices. No increase in noise from the existing Biovac facility was noted for this measurement relative to other nighttime measurements. It should also be noted that ambient outdoor noise levels are influenced by multiple interacting sources and varying meteorological conditions. As a result, short-term variations in measured noise levels cannot be attributed to a single source with certainty.

This study constitutes a screening-level baseline assessment. While noise measurements at industrial sites were compliant, nighttime exceedances were observed at two residential receptors. SLR retains the recommendation of a noise modelling assessment to determine the likely contribution of the proposed facility to the noise levels at proximate residential receptors. This contribution is likely to be minor, but the facility cannot be ruled out as a contributor to future noise exceedances at residential receptors during the operational phase of the Project without such simulations.



Table of Contents

Basis of Report	ii
Executive Summary	iii
Acronyms and Abbreviations	vi
1. Introduction	1
1.1 Study Purpose and Objectives	1
1.2 Scope of Work.....	1
1.3 Specialist Reporting Requirements	1
2. Project Background	3
2.1 Locality and Study Area.....	3
2.2 Project Description	6
3. Legislative Requirements and International Guidelines.....	9
3.1 National Legislation / Standards	9
3.1.1 The Constitution of the Republic of South Africa Act, 1996 (Act No. 108 of 1996)	9
3.1.2 Environmental Conservation Act, 1989 (ECA) (Act No. 73 of 1989)	9
3.1.3 National Environmental Management Act, 1998 (NEMA) (Act No. 107 of 1998).....	9
3.1.4 National Environmental Management Air Quality Act, 2004 (NEM:AQA) (Act No. 39 of 2004).....	9
3.1.5 South African National Standard (SANS 10103:2008)	9
3.1.6 Noise Control Regulations (GN R154).....	10
3.2 Provincial Regulations	11
3.3 Local By-laws	11
3.4 International Guidance	12
3.4.1 International Finance Corporation	12
3.4.2 European Union Noise-Related Directives.....	13
3.4.3 Institute of Environmental Management & Assessment	13
4. Geographical Context	14
4.1 Topography and Vegetation	14
4.2 Prevailing Meteorology	16
4.2.1 Temperature, Rainfall and Humidity	16
4.2.2 Wind Field	17
5. Background Ambient Noise.....	19
6. Baseline Data Collection.....	19
6.1 Monitoring Protocol	19
6.1.1 Monitoring Locations	19
6.1.2 Equipment.....	21
6.2 Results and Interpretation	21



7. Recommended Management Measures	26
8. Conclusion	27

Tables in Text

Table 1-1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations	2
Table 3-1: Typical district noise rating levels (<i>SANS10103:2008, Table 2</i>)	10
Table 3-2: Categories of community or group response according to excess noise level (<i>SANS 10103:2008, Table 5</i>)	10
Table 3-3: IFC EHS Noise Guidelines	13
Table 3-4: IEMA impact ratings for change in sound levels	14
Table 4-1: Meteorological summary for the study area (Jan 2022 - Dec 2024)	16
Table 4-2: Local wind conditions	18
Table 6-1: Monitoring locations	19
Table 6-2: Environmental noise monitoring equipment	21
Table 6-3: Measured daytime and nighttime noise levels (dB(A))	23
Table 6-4: Summary of noise monitoring, meteorological parameters and soundscape characteristics	24
Table 7-1: Noise management recommendations	26

Figures in Text

Figure 2-1: Project locality	4
Figure 2-2: Proximity of sensitive receptors	5
Figure 2-3: Site layout plan	7
Figure 2-4: Biovac process flow	8
Figure 4-1: Regional topography	15
Figure 4-2: Meteorological summary for the study area (Jan 2022 - Dec 2024)	17
Figure 6-1: Monitoring locations	20

Appendices

Appendix A	Declaration of Independence - Practitioner
Appendix B	Curriculum Vitae
Appendix C	Calibration Certificate
Appendix D	Fieldwork Photographs
Appendix E	Acoustic Terminology



Acronyms and Abbreviations

°C	Degrees Celsius
BAT	Best Available Techniques
BREF	BAT reference documents
CoCT	City of Cape Town
dB(A)	Unit of A-weighted sound pressure level
ECA	Environmental Conservation Act
ECMWF	European Centre for Medium-Range Weather Forecasts
EHS	Environmental Health and Safety
EHS	Environmental, Health, and Safety
END	European Noise Directive
ERA 5	ECMWF Reanalysis v5
EU	European Union
FFF	Fill and finish facility
GIIP	Good International Industry Practice
IED	Industrial Emissions Directive
IEMA	Institute of Environmental Management and Assessment
IFC	International Finance Corporation
km	Kilometre
L _{Aeq}	A-weighted equivalent continuous sound level
m	Meter
m/s	Meters per second (speed)
mamsl	Meters above mean sea level
mRNA	Messenger ribonucleic acid
NCR	Noise Control Regulations
NEM:AQA	National Environmental Management Air Quality Act
NEMA	National Environmental Management Act
OCV	Oral cholera vaccine
SANS	South African National Standards
SLM	Sound level meter
SLR	SLR Consulting (South Africa)
WCNCR	Western Cape Noise Control Regulations
WHO	World Health Organisation



1. Introduction

SLR Consulting (South Africa) Proprietary Limited (SLR) was appointed by The Biovac Institute (Pty) Ltd (Biovac) to undertake an Environmental Impact Assessment (EIA) process for a proposed vaccine manufacturing facility in Pinelands, Cape Town, Western Cape (hereafter referred to as the proposed Project).

A specialist noise assessment is required as input to the EIA to assess potential impacts in the Project area. The Project is also required to align with the World Bank Group's International Finance Corporation (IFC) and other international guidance for environmental best practice.

This report presents a scoping level assessment of baseline conditions and potential risks for environmental noise associated with the proposed Project activities.

1.1 Study Purpose and Objectives

The purpose of this study is to collect baseline data and assess potential noise impacts associated with the proposed Project. The objectives of this assessment are to:

- Describe the existing baseline environment and identify proximate sensitive receptors¹.
- Determine the meteorological conditions that affect noise propagation in the region.
- Assess the noise related impacts for proximate sensitive receptors.

1.2 Scope of Work

The scope of work for this assessment is summarised as follows.

- Desktop review (using available information), including:
 - A description of the Project site and activities;
 - A summary of applicable noise legislation and international best practices;
 - Assessment of prevailing meteorological conditions; and
 - A review of the receiving environment including identification of possible sensitive receptors, and proximate noise sources.
- Baseline data collection surveys to measure existing noise levels in the vicinity of the Project site.
- Make recommendations for impact mitigation and monitoring (as required).

1.3 Specialist Reporting Requirements

Where applicable, this scoping report meets the reporting requirements of Appendix 6 of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA)² EIA Regulations³ (GN.R 982 of 2014, as amended). A summary of Appendix 6 requirements and the associated report section in which these are addressed is provided in **Table 1-1**.

¹ Sensitive receptors are places where sensitive individuals or habitats may be impacted, such as residences, schools, medical facilities, and natural reserves.

² Republic of South Africa (1998): National Environmental Management Act (No. R. 107 of 1998) Government Gazette, 27 November 1998 (No. 19519)

³ Department of Environmental Affairs (2014): Environmental Impact Assessment Regulations (GN. R982), Government Gazette, 4 December 2014, (No. 38282), as amended by GN 326 in 2017, GN 706 in 2018, GN 599 in 2020 and GN 517 in 2021.



Table 1-1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations

Appendix 6 section	A specialist report prepared in terms of the EIA Regulations must contain:	Report section
(a)	Details of: (i) Details of the specialist who prepared the report (ii) The expertise of that specialist to compile a specialist report including curriculum vitae	Page i Appendix B
(b)	A declaration that the specialist is independent in a form as may be specified by the competent authority	Appendix A
(c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1.
(cA)	An indication of the quality and age of base data used for the specialist report	Section 6.
(cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	6.
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 6.
(e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 6.
(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Proximity of sensitive receptors presented in Section 2. (no alternative assessed)
(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	Figure 2-2
(i)	A description of any assumptions made and any uncertainties or gaps in knowledge	N/A - this report presents the baseline assessment only.
(j)	A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	N/A - this report presents the baseline assessment only.
(k)	Any mitigation measures for inclusion in the Environmental Management Programme (EMPr)	Recommended management measures are presented in Section 7.
(l)	Any conditions for inclusion in the environmental authorisation	N/A - this report presents the baseline assessment only.
(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Recommended management measures are presented in Section 7.
(n)	A reasoned opinion - 1. whether the proposed activity, activities or portions thereof should be authorised; a) regarding the acceptability of the proposed activity or activities; and 2. if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measure that should be included in the EMPr, and, the closure plan in the case of a closure activity	N/A - this report presents the baseline assessment only.
(o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	N/A
(p)	A summary and copies of any comments that were received during any consultation process and where applicable all responses thereto	N/A
(q)	Any other information requested by the competent authority	N/A



2. Project Background

2.1 Locality and Study Area

The proposed Project site comprises approximately two hectares of undeveloped land in Pinelands, Cape Town in the Western Cape province (**Figure 2-1**). The site is zoned for general industrial use and falls within the jurisdiction of the City of Cape Town (CoCT) Metropolitan Municipality.

The property is situated within an established urban-industrial corridor and is surrounded by a mix of industrial, commercial, and residential land uses. Key proximate land uses and infrastructure include:

- The Pinelands railway line on the eastern boundary of the property, forming a physical buffer between the site and adjacent residential areas.
- Predominantly light industrial and commercial developments to the west and north, comprising offices, laboratories, small-scale manufacturing facilities, and associated infrastructure.
- The Ndabeni mixed use industrial area located approximately 0.4 km north of the proposed development site.
- Epping Industria, approximately 2.86 km east the proposed development site.
- Paarden Eiland, approximately 2.73 km north-northwest the proposed development site.
- The Port of Cape Town located approximately 4.51 km northwest of the proposed development site.
- Athlone Wastewater Treatment Works situated approximately 2.96 km southeast of the proposed development site.
- Several residential areas, including Pinelands (immediately east of the site), Maitland Garden Village (~0.10 km west), Oude Molen Village (~0.75 km south), Maitland (~1.36 km north-northeast), Kensington (~2.66 km north-northeast), Brooklyn (~2.81 km north-northwest), Thornton (~3.90 km northeast), Langa (~3.63 km east-southeast), Bridgetown (~4.45 km southeast), Kewtown (~3.56 km southeast), Athlone (~3.48 km south-southeast), Sybrandpark (~2.48 km south-southeast), Rondebosch (~3.42 km south-southwest), Rosebank (~2.55 km south-southwest), Mowbray (~1.96 km southwest), Observatory (~1.98 km west-southwest) and Woodstock (~3.74 km west-northwest).

Surrounding sensitive receptors (i.e. places where sensitive individuals or habitats may be impacted, such as residences, schools, medical facilities and places of worship) within 5 km of the site boundary are shown in **Figure 2-2**. The buffer of 5 km is conservatively selected on the basis that noise impacts from the proposed facility are not considered possible beyond this distance.





Figure 2-1: Project locality



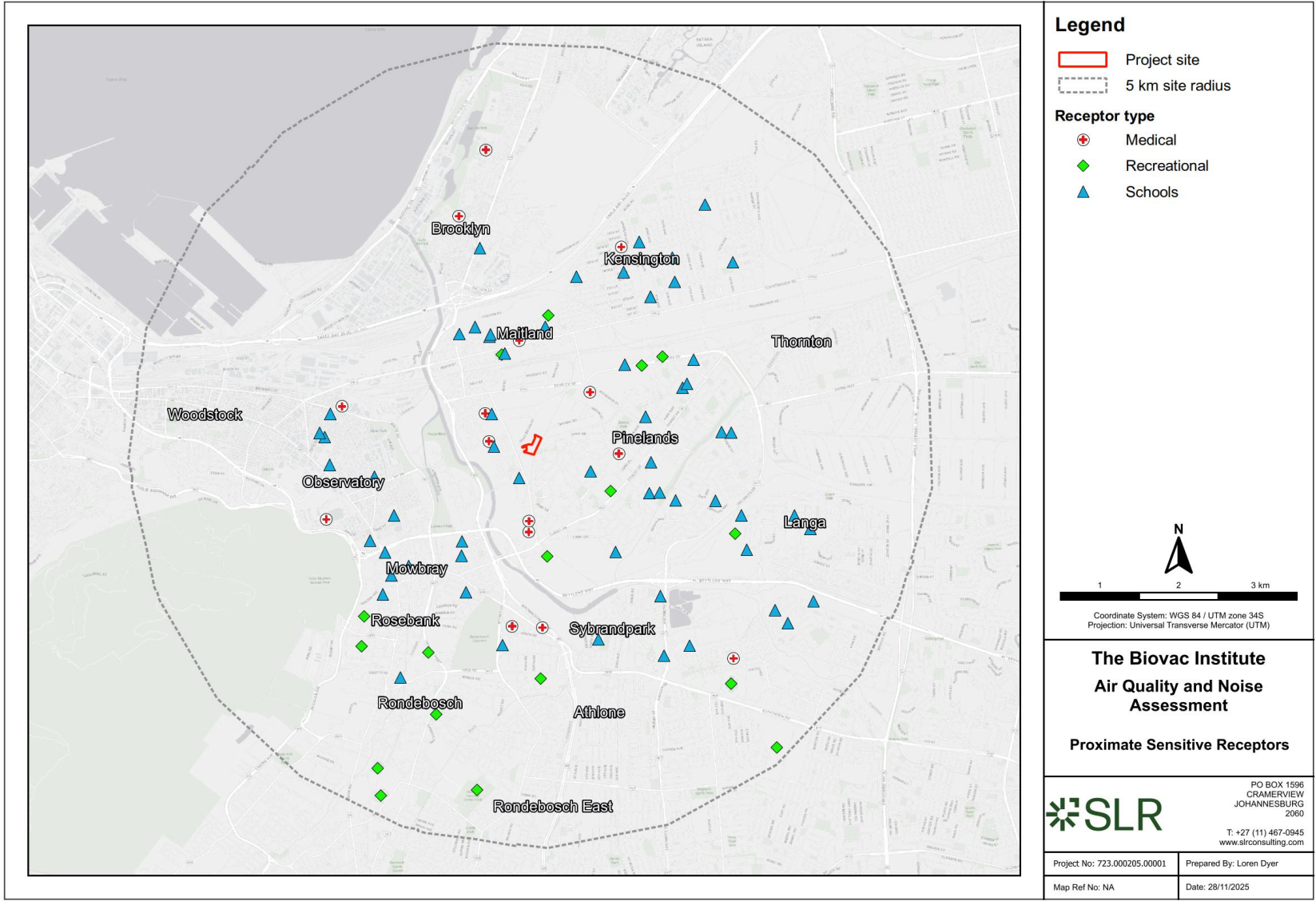


Figure 2-2: Proximity of sensitive receptors



2.2 Project Description

Biovac intends to develop a multi-vaccine plant with the capacity to produce ~250 million doses. The plant will be located adjacent to the existing Biovac facility in Cape Town on a site approximately two hectares in extent.

The new plant will facilitate end-to-end manufacturing of vaccines and comprise the following:

- One glass vial fill and finish suite, with an operational capacity of 50 million vials (~200 - 250 million doses), allowing a broad variety of vaccines to be manufactured;
- One drug substance suite, for the manufacture of up to 30 - 40 million doses of inactivated Oral Cholera Vaccine (OCV); and
- One blow-fill-seal (plastic line) for fill and finish of OCV, with an operational capacity of 60 million doses.

The Project will use solar power and other sources of renewable energy from external sources where feasible. The company's existing facility predominantly engages in filling and finishing of drug products, final product labelling, packaging, and distribution. Biovac's current product suite consists of vaccines for Tuberculosis, Measles, Pneumonia, Hepatitis B, Tetanus, and Diphtheria.

Key project components include:

- A biological production building with formulation, fill, and finish (FFF) suites.
- OCV processing facilities, bio-positive and bio-negative areas.
- A central utility building, tank farm, warehouse, and technical areas.
- Further future expansions include a mRNA (messenger ribonucleic acid) workshop, downstream processing (DSP) facilities, and lyophilisation (freeze-drying) suites.

A site layout plan is shown in **Figure 2-3** and process flow in **Figure 2-4**.





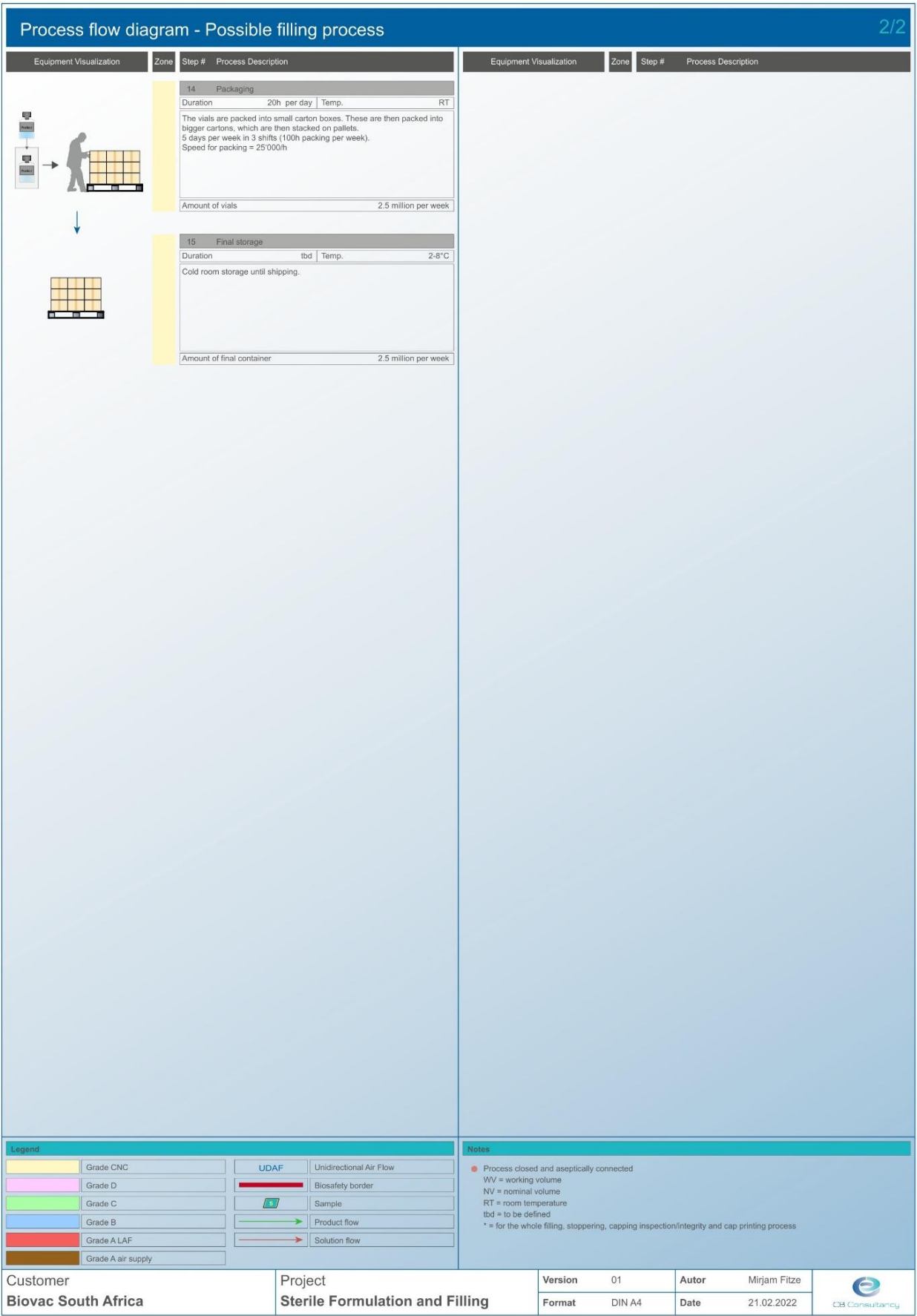
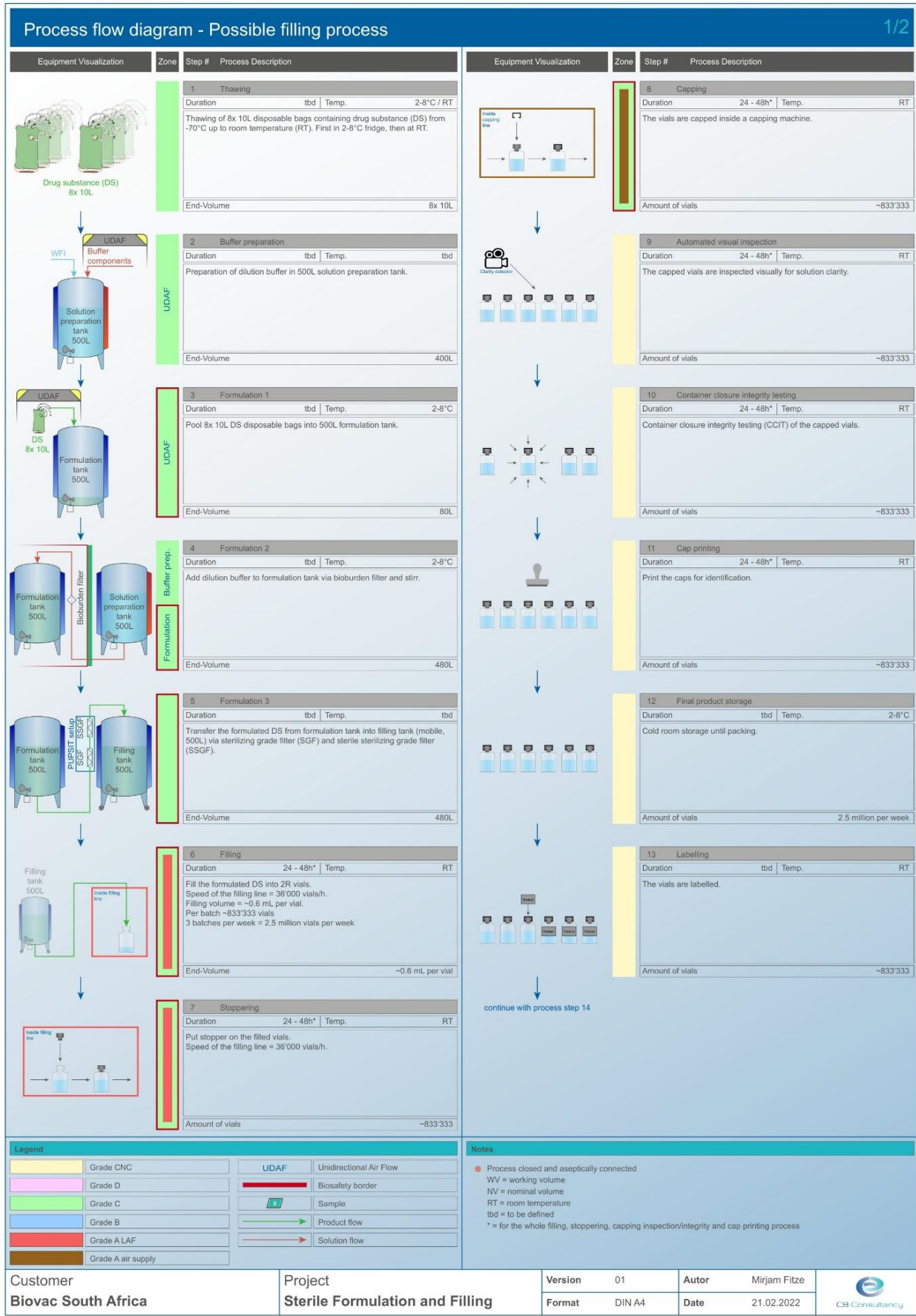


Figure 2-4: Biovac process flow



3. Legislative Requirements and International Guidelines

3.1 National Legislation / Standards

3.1.1 The Constitution of the Republic of South Africa Act, 1996 (Act No. 108 of 1996)

The overarching legislation of South Africa is the Constitution⁴. Section 24 places people and their needs at the forefront of environmental management. The Constitution provides the right to “*an environment that is not harmful to health or well-being*” and to have the environment protected, for the benefit of present and future generations, through reasonable legislative measures. These measures include the prevention of pollution and ecological degradation, the promotion of conservation, ecologically sustainable development and the utilisation of natural resources while promoting justifiable economic and social development.

3.1.2 Environmental Conservation Act, 1989 (ECA) (Act No. 73 of 1989)

This Act makes provision for the National Noise Control Regulations, but these relate only to local authorities that request the application of such regulations. In 1996, the responsibility of administering the Noise Control Regulations was devolved to provincial level but only Gauteng, Free State and Western Cape provinces have promulgated their regulations. Although this Act has been largely superseded by the National Environmental Management Act (Act No 107 of 1998), the Noise Regulations will be promulgated in terms of the original Act.

3.1.3 National Environmental Management Act, 1998 (NEMA) (Act No. 107 of 1998)

The NEMA is intended to promote co-operative governance and ensure the rights of people are upheld, while also recognizing the importance of economic development. It is the statutory framework to enforce Section 24 of the Constitution of the Republic of South Africa (Section 24: ‘...the right to a healthy environment and the right to have the environment protected.’)

3.1.4 National Environmental Management Air Quality Act, 2004 (NEM:AQA) (Act No. 39 of 2004)

With respect to noise control:

- The minister may prescribe essential national standards -
 - For the control of noise, either in general or by specified machinery or activities or in specified places or areas; and
 - For defining noise and maximum levels of noise.

The Act binds provincial and local spheres of government to any national standards prescribed.

3.1.5 South African National Standard (SANS 10103:2008)

The South African National Standard (SANS) 10103:2008 standard ‘The measurement and rating of environmental noise with respect to annoyance and to speech communication’

⁴ South Africa (1996): Constitution of the Republic of South Africa (No. 108 of 1996)



provides outdoor and indoor day and night-time rating levels for South African district types including central business districts, urban, suburban and rural districts (**Table 3-1**).

Table 3-1: Typical district noise rating levels (SANS10103:2008, Table 2)

Type of district	Equivalent continuous rating level for noise ($L_{Req,T}$) (dB(A))					
	Outdoors			Indoors with open windows		
	Day-night ($L_{Req,dn}$)	Daytime ($L_{Req,d}$)	Night-time ($L_{Req,n}$)	Day-night ($L_{R,Dn}$)	Daytime ($L_{Req,d}$)	Night-time ($L_{Req,n}$)
a) Rural districts	45	45	35	35	35	25
b) Suburban districts (little road traffic)	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts (with workshops, business premises and main roads)	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50
Notes: Daytime hours are defined as 06h00-22h00 and night-time as 22h00-06h00						

The expected or probable community response is based on the excess magnitude of noise (total ambient sound in dB(A) above of the specified rating levels) as summarised in **Table 3-2**.

The standard provides that where the ambient level is expected to increase by any amount, there is a (overlapping) probability of nuisance complaints. Where the expected ambient levels are below the limit, the impact is assessed as negligible (i.e. no complaints expected).

Table 3-2: Categories of community or group response according to excess noise level (SANS 10103:2008, Table 5)

Excess ($\Delta L_{Req,T}$) (dB(A))	Estimated community or group response	
	Category	Description
0 to 10	Little	Sporadic complaints
5 to 15	Medium	Widespread complaints
10 to 20	Strong	Threats of community or group action
> 15	Very Strong	Vigorous community or group action

3.1.6 Noise Control Regulations (GN R154)

The Noise Control Regulations (NCR)⁵ in terms of Section 25 of the Environmental Conservation Act, 1989 (Act No 73 of 1989) contains regulation pertaining to the control of noise on a provincial level, covering powers of local authority, general prohibitions, prohibitions of disturbing noise and noise nuisance, use of measurement apparatus, exemptions, attachments, and penalties. Disturbing noise and noise nuisance are uniquely defined in the regulations as follows:

- *Disturbing noise* refers to 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 dB(A) or more.

⁵ Department of Environmental Affairs (1992): Noise Control Regulations in Terms of Section 25 of the Environment Conservation Act 1989 (Act no. 73 of 1989) (GN. R. 154), Government Gazette, 10 January 1992, (No. 13717).



- *Noise nuisance* refers to any sound that disturbs or impairs or may disturb or impair the convenience or peace of any person.

The definition of disturbing noise, based on an exceedance of 7 dB(A) above the rating level determined in accordance with the methodology prescribed in SANS 10103:2008, forms the principal criterion for assessing regulatory non-compliance and identifying significant adverse noise impacts under South African legislation.

Noise nuisance is subjective due to several influencing factors (which may include among others, the character of the noise, intermittency, time of day, impulsiveness, and community tolerance) however the most appropriate standard to determine the probable onset of noise nuisance is provided in the South African National Standard SANS10103:2008.

In the Western Cape, the national NCR were repealed in 2013 and replaced by PN 200/2013. This provincial regulation establishes the current legislative framework for noise management within the province and gives effect to the principles contained in the NCR and SANS 10103:2008 at a provincial level (**Section 3.2**).

3.2 Provincial Regulations

The Western Cape Noise Control Regulations (WCNCR) set out requirements for defining and managing noise, including the prohibition of “disturbing” noise and noise “nuisance,” methods for measurement and calculation, compliance with SANS 10103 rating levels, rules for late-night entertainment and events, enforcement procedures, exemptions, and penalties.

The WCNCR defines:

- “Disturbing noise” as any noise (excluding the unamplified human voice) that:
 - exceeds the rating level by 7 dB(A) or more.
 - exceeds the residual noise level where the residual level is higher than the rating level.
 - Exceeds the residual noise level by 3 dB(A) where the residual level is lower than the rating level.
 - for low-frequency noise, exceeds the limits in Annex B of SANS 10103 (i.e. indoor sound pressure level of 25 - 55 dB(A)).
- “Noise nuisance” as any sound that impairs or may impair the convenience or peace of a reasonable person.

The definition of disturbing noise, specifically, 7 dB(A) above the SANS 10103:2008 rating level, forms the basis for determining non-compliance or a significant adverse impact under the WCNCR. However, for mechanical equipment, Section 5 of the WCNCR stipulates that devices such as pool pumps, irrigation pumps, refrigeration units, and HVAC or air-conditioning equipment may not exceed 50 dB(A) at the property projection plane, or the residual noise level by more than 5 dB(A), when operated in a residential area.

Noise nuisance remains inherently subjective due to factors such as character, intermittency, impulsiveness, time of day, and community tolerance. The most appropriate reference for assessing the likely onset of nuisance is provided in SANS 10103:2008 (**Section 3.1.5**).

3.3 Local By-laws

Section 156(2) of the Constitution permits municipalities to administer by-laws for the effective administration of matters that it has the right to administer. The management of air pollution is listed as a matter in which local government has authority, and national or provincial



government may not compromise or impede a municipality's right to exercise its power or perform its functions⁶.

The CoCT has promulgated an environmental health by-law (2003)⁷ to regulate activities that may affect public health nuisances, complementing national and provincial legislation. These by-laws provide the municipality with a legal framework to manage air emissions, noise, and general public nuisances to safeguard community well-being.

The overarching principles across these by-laws are to:

- Promote a safe and healthy environment for residents.
- Prevent or reduce public health hazards and nuisances to acceptable levels.
- Ensure that responsible parties bear the costs associated with mitigation and compliance.

Noise and nuisance-related issues are addressed mainly through the Environmental Health By-law which broadly defines a "health nuisance" as broadly, including any condition or activity that generates noise, odours, dust, effluent, vapours, or vibration in a manner considered offensive or potentially harmful to public health. This gives the CoCT wide authority to intervene where noise or associated disturbances materially interfere with the ordinary comfort or convenience of the public. Examples include noise arising from poorly managed commercial premises, construction activities, machinery, or other operations that cause avoidable disturbance.

The by-law empowers the CoCT to issue compliance notices, undertake inspections, and enforce corrective action. Non-compliance constitutes an offence and may result in penalties, which can include fines or imprisonment, depending on severity.

3.4 International Guidance

3.4.1 International Finance Corporation

The World Bank Group's IFC Environmental, Health, and Safety (EHS)⁸ guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)⁹. The General EHS Guidelines provide standards and recommendations for managing environmental, health, and safety risks, including the impacts of noise beyond the property boundary of a facility. The guideline makes reference to the World Health Organisation (WHO) Community Noise Guidelines¹⁰ for residential, industrial and commercial receptors. The IFC states that noise impacts should not exceed the levels presented in **Table 3-3** or result in a maximum increase of 3 dB(A) above background levels at the nearest receptor location offsite.

⁶ Department of Environmental Affairs (2018): The 2017 National Framework for Air Quality Management in the Republic of South Africa (No.R.1144 of 2018) Government Gazette, 26 October 2018 (No. 41996).

⁷ City of Cape Town (2003): Environmental Health By-Law. Western Cape Provincial Gazette 6041 on 30 June 2003

⁸ World Bank Group. 2007. IFC Environmental Health and Safety (EHS) General Guidelines. URL: www.ifc.org

⁹ GIIP is defined by the EHS as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally.

¹⁰ Berglund, Birgitta. "Guidelines for community noise." World Health Organization (1999).



Table 3-3: IFC EHS Noise Guidelines

Receptor	Daytime 07:00 - 22:00	Night-time 22:00 - 07:00
	One-Hour L_{Aeq} (dB(A))	
Residential, institutional, educational	55	45
Industrial, commercial	70	70

In addition to the General EHS Guidelines, the IFC has published sector-specific EHS Guidelines for Pharmaceuticals and Biotechnology Manufacturing¹¹. These guidelines address noise generation associated with typical operational activities within the sector, including heating, ventilation, and air-conditioning (HVAC) systems, compressors, vacuum pumps, cooling towers, emergency generators, material handling equipment, and process machinery. Such equipment may operate continuously or intermittently and can contribute to elevated ambient noise levels if not adequately controlled.

3.4.2 European Union Noise-Related Directives

The Environmental Noise Directive (END, 2002/49/EC), adopted by the European Union (EU), establishes a common framework for assessing and managing environmental noise across Member States. Its purpose is to avoid, prevent, or reduce the harmful effects of environmental noise exposure, particularly annoyance and sleep disturbance. It requires strategic noise mapping, the preparation of noise action plans and standardised assessment using the indicators L_{den} (day-evening-night level) and L_{night} (night level).

The END does not set EU-wide noise limits; these are determined by Member States. Industrial noise is regulated under national legislation and, where applicable, through environmental permitting regimes linked to the Industrial Emissions Directive (IED, 2010/75/EU). Under the IED, industrial installations must apply best available techniques (BAT) to prevent or minimise noise emissions in accordance with Article 14 and relevant BAT reference documents (BREFs), although the Directive itself does not set specific noise thresholds.

For this assessment, the END provides an international best practice framework. The L_{night} indicator has been applied to characterise night-time baseline conditions in line with IFC and WHO criteria for the standardised assessment of noise impacts and international benchmarking, while the IED/BREF framework informs potential noise management and mitigation measures.

3.4.3 Institute of Environmental Management & Assessment

The Institute of Environmental Management and Assessment (IEMA) has developed comprehensive guidelines to standardise and enhance the process of an environmental noise impact assessment¹². These guidelines are designed to be applicable across various scales of development, ensuring that noise impacts are effectively integrated into the EIA process. The framework highlights long-term impact classification due to sound level change and focuses on evaluating how predicted changes in sound levels affect sensitive receptors over an extended period.

Table 3-4 shows the four category classifications ascribed to the relevant ranges of level increase. This can be a useful impact assessment tool where noise level increases exceed 3

¹¹ World Bank Group. 2007. IFC EHS Guidelines for Guidelines for Pharmaceuticals and Biotechnology Manufacturing. URL: www.ifc.org

¹² IEMA (2014). Guidelines for Environmental Noise Impact Assessment, Version 1.2.



dB(A) (i.e. IFC increase allowance), and where the magnitude of increase and corresponding rating significance is needed.

Table 3-4: IEMA impact ratings for change in sound levels

Long-term Impact Classification	Short-term Impact Classification	Sound level change $L_{eq,T}$ (dB(A)) Day or night
Negligible	Negligible	≥ 0 and < 1
	Minor negative	≥ 1 and < 3
Minor negative	Moderate negative	≥ 3 and < 5
Moderate negative	Major negative	≥ 5 and < 10
Major negative		≥ 10

4. Geographical Context

4.1 Topography and Vegetation

Topography and atmospheric conditions influence noise propagation. Irregular surfaces like hills and slopes affect sound levels, with upward slopes reducing noise and downward slopes amplifying it. Surface types also matter, for example hard surfaces like concrete reflect most sound, while soft surfaces like grass absorb some¹³.

The Project area is at ~15 metres above mean sea level (mamsl). Regional topography within 50 km is shown in **Figure 4-1: Regional topography**, however, based on the nature of the proposed activity, emissions are expected to peak nearfield. The Project site and immediate surrounds is characterised as generally flat.

According to the Köppen-Geiger Classification¹⁴, the Project area is defined as having a warm summer Mediterranean climate (Csb) with dry summers and wet winters. The natural landcover is classified as Cape Flats Sand Fynbos, however, the CoCT is a densely populated developed region and therefore the study area is classed as predominantly urban.

¹³ Hannah L. 2006. Ground, Terrain and Structure Effects on Sound Propagation. Factors Affecting Outdoor Sound Propagation. Malcolm Hunt Associates. URL: https://www.acoustics.org.nz/sites/www.acoustics.org.nz/files/journal/pdfs/Hannah_L_NZA2007_c.pdf.

¹⁴ CSIR (undated): Köppen-Geiger Zones (URL: csir.maps.arcgis.com)



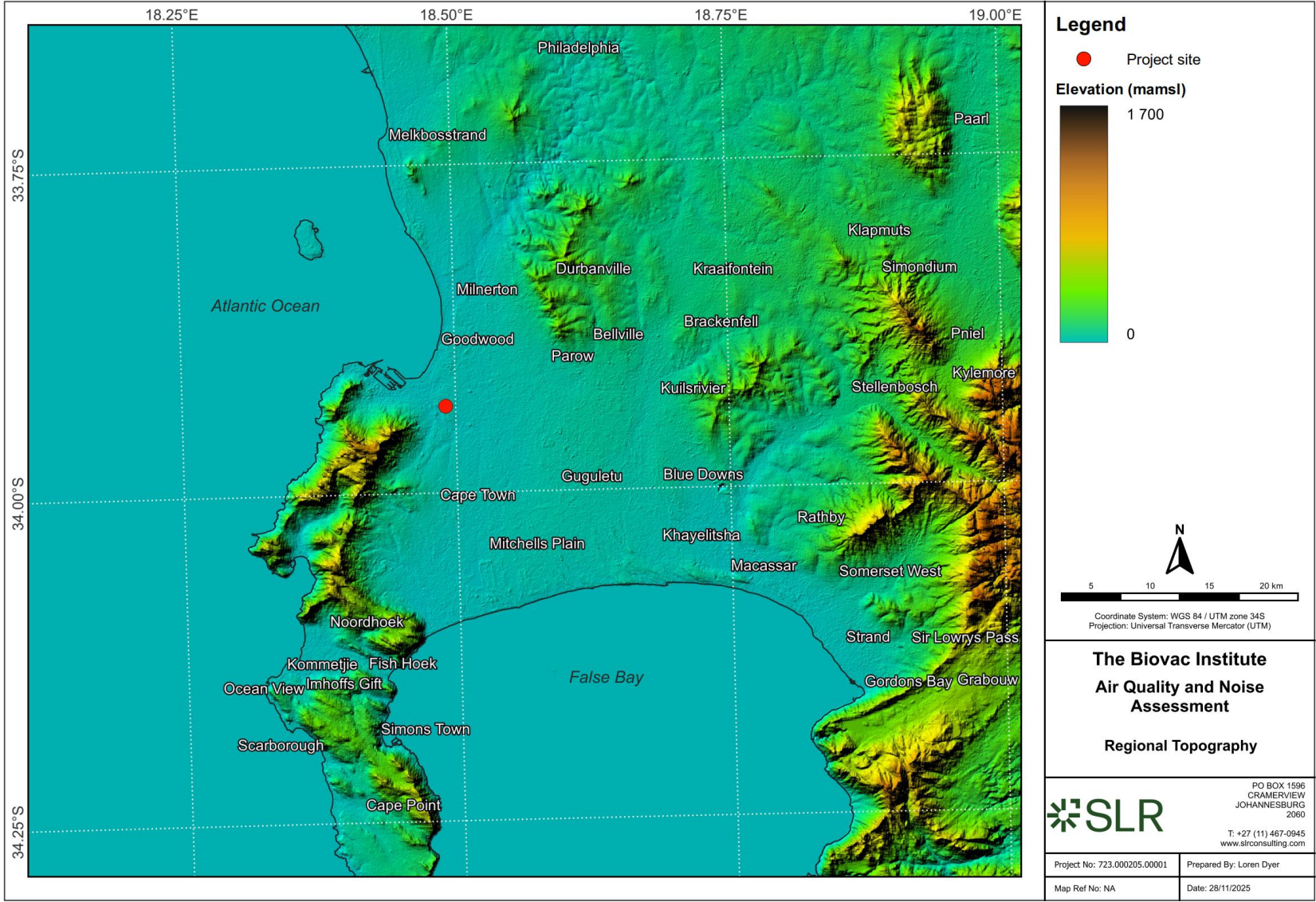


Figure 4-1: Regional topography



4.2 Prevailing Meteorology

Meteorological conditions influence how sound travels through the atmosphere. Factors like temperature, wind, humidity, and atmospheric stability affect the speed, direction, and attenuation of sound waves. The three most significant meteorological effects on sound propagation include refraction, atmospheric absorption and scattering by turbulence¹⁵.

In the absence of onsite measurements, a prognostic meteorological dataset (for temperature, rainfall, humidity, wind speed and wind direction) was sourced from the Copernicus Climate Change Service: ERA5 fifth generation European Centre for Medium-Range Weather Forecasts (ECMWF) atmospheric reanalysis model¹⁶. An hourly dataset was extracted for Cape Town (-34.0°S and 18.5°E) and analysed for the period January 2022 - December 2024 (i.e. the most recent three full calendar years available at the time of reporting).

4.2.1 Temperature, Rainfall and Humidity

Sound refraction occurs when sound waves curve due to temperature or wind speed gradients, with temperature inversions causing downward refraction that amplifies noise near the ground. Atmospheric absorption, influenced by humidity and temperature, reduces high-frequency noise, while turbulence scatters sound into shadow zones, weakening interference patterns. These meteorological factors interact in complex ways¹⁷.

A meteorological summary is provided in **Table 4-1** and **Figure 4-2**. Annual average temperature is 16.4°C. Highest average temperatures occur in summer (December, January and February) at 19.5°C with a peak hourly temperature of 27.7°C recorded in January and February. Lowest average temperatures are in winter (June, July and August) at 13.6°C, with a minimum hourly temperature of 7.8°C measured in August. Average humidity is 94%. Annual rainfall averages at 595 mm, with most occurring in winter (59%), followed by autumn (19%) and spring (14%). Summer (8%) is the driest season.

Table 4-1: Meteorological summary for the study area (Jan 2022 - Dec 2024)

Parameter	2022	2023	2024	Period average
Maximum hourly temperature (°C)	27.7	27.4	27.7	27.6
Minimum hourly temperature (°C)	8.0	7.8	8.3	8.1
Average temperature (°C)	16.6	16.2	16.4	16.4
Total rainfall (mm)	422	691	673	595
Average humidity (%)	94	94	94	94

¹⁵ Larsson C & Israelsson S. 1991. Effects of meteorological conditions and source height on sound propagation near the ground. *Applied Acoustics*, 33(2), 109-121.

¹⁶ Copernicus Climate Change Service (2025): ERA5 hourly data on single levels from 1940 to present (URL: cds.climate.copernicus.eu)

¹⁷ Waddington DC and Lam YW. 2002. The effect of weather conditions on the propagation of sound. *Proceedings of the Institute of Acoustics*.



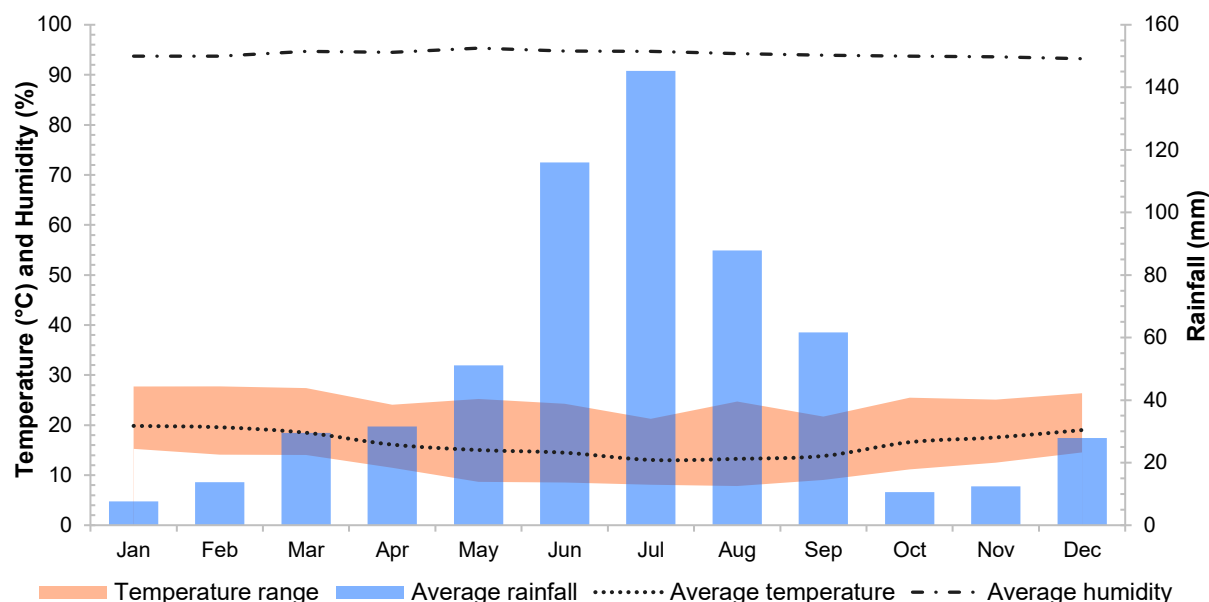


Figure 4-2: Meteorological summary for the study area (Jan 2022 - Dec 2024)

4.2.2 Wind Field

Wind affects sound propagation through speed and direction. Increasing wind speed with altitude causes sound waves to refract, with downwind conditions amplifying noise by reducing terrain and barrier attenuation. Upwind conditions refract sound away from the ground, creating shadow zones with reduced noise levels. Turbulent or gusty winds further disrupt sound transmission over long distances¹⁸.

The wind field is presented as wind rose charts that display wind speed and directional frequency. Each directional branch on a wind rose represents wind flow originating from that direction. Each directional branch is divided into segments of colour, representative of different wind speeds. The wind roses presented in **Table 4-2** were generated using Lakes Environmental WRPlot Freeware (Version 12.0.0) and the ERA5 dataset.

Temporal scales assessed include the full assessment period (January 2022 - December 2024), diurnally for early morning (00h00 - 06h00), morning (06h00 - 12h00), afternoon (12h00 - 18h00) and night (18h00 - 00h00), and seasonally for summer (December, January and February), autumn (March, April and May), winter (June, July and August) and spring (September, October and November).

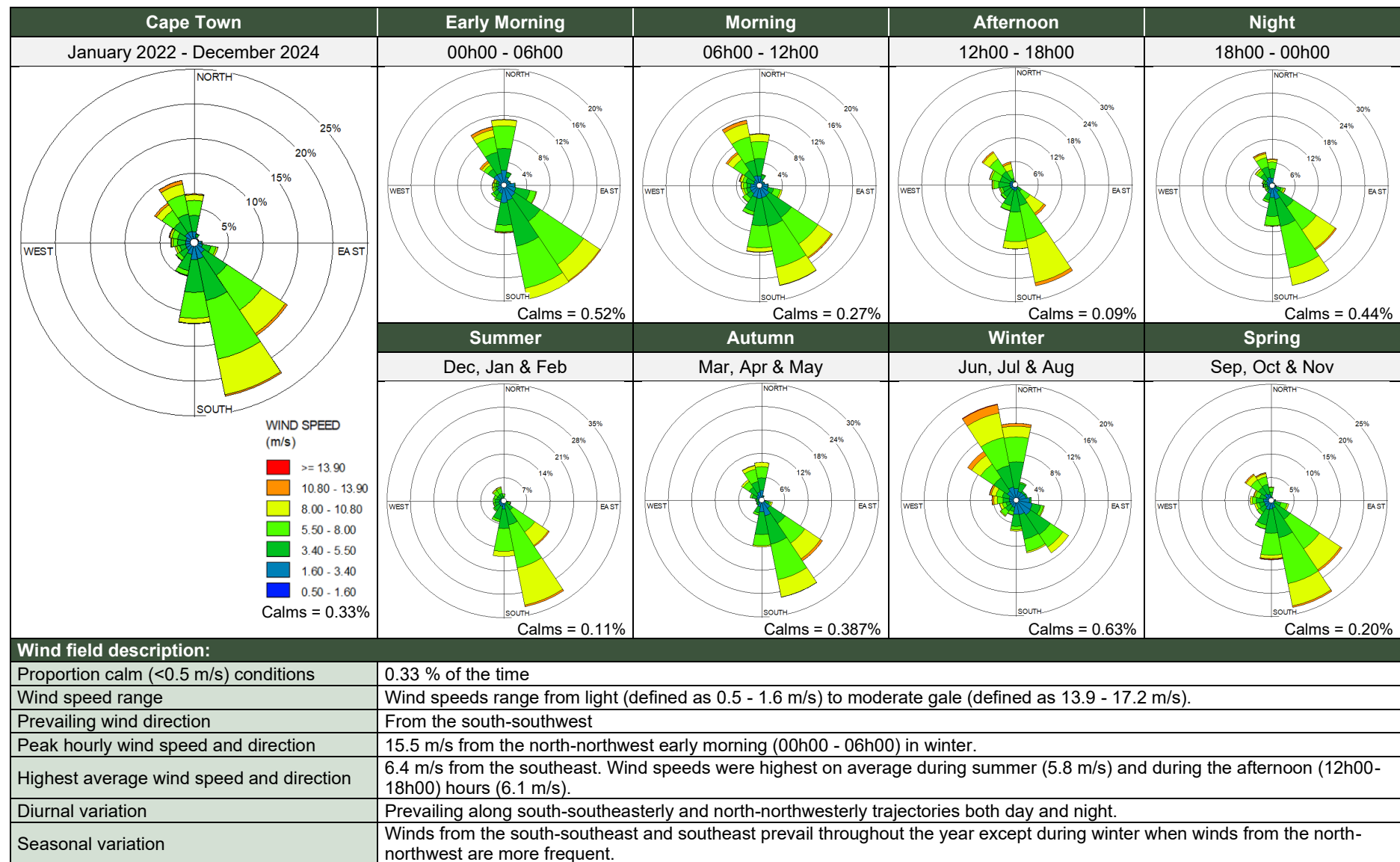
Wind speed classes and the descriptions applied in this study align with the *Beaufort Wind Force Scale*¹⁹.

¹⁸ Hannah L. Wind and temperature effects on sound propagation. artículo del paper Factors affecting outdoor sound propagation. Massey University. 2006.

¹⁹ The Beaufort wind force scale is an empirical measure that relates to observed conditions at sea or on land.



Table 4-2: Local wind conditions



5. Background Ambient Noise

The proposed Project site is situated in an urban industrial area where background noise is dominated by transport activity. The Pinelands railway line that runs adjacent to the eastern boundary of the development property is expected to produce occasional, clearly audible train movements, which may be noticeable or disruptive, especially during otherwise quiet periods. Surrounding roads generate more continuous traffic noise typical of metropolitan suburbs. Neighbouring industrial premises may add intermittent mechanical, loading, or vehicle sounds during daytime operating hours. Other contributors can include alarms, service vehicles, and building ventilation or HVAC systems.

This mixed-use urban sound environment is recognised in SANS 10103:2008, the Western Cape Noise Control Regulations (PN 200/2013), and international noise guidance, where transport and industrial activity are understood to be routine sources of environmental disturbance in cities and even suburban areas.

6. Baseline Data Collection

6.1 Monitoring Protocol

6.1.1 Monitoring Locations

Monitoring locations were selected based on site layout, prevailing meteorology, accessibility and safety considerations. Two phases of noise monitoring were undertaken. The first phase, conducted between 9 - 10 December 2025 consisted of baseline noise measurements at selected receptors and boundary locations. Following review of the initial results, additional monitoring was requested and subsequently undertaken between 23 - 28 February 2026, to ensure a robust baseline noise assessment. The selected monitoring locations are presented in **Table 6-1** and **Figure 6-1**. Fieldwork photos are provided in **Appendix D**.

Table 6-1: Monitoring locations

	Unit Name / Site ID	Site Description	Latitude (°S)	Longitude (°E)
Phase 1 & 2	Fenceline 1 (FL 1)	Southern corner of property		
	Fenceline 2 (FL 2)	Eastern corner of property		
	Fenceline 3 (FL3)	Northern fenceline		
	Noise sensitive receptor 1 (NSR 1)			
Phase 2	Noise sensitive receptor 2 (NSR 2)			
	Noise sensitive receptor 3 (NSR 3)			

For the purposes of public disclosure, direct addresses and geographic coordinates of the monitoring locations have been redacted in this section and subsequent sections (as applicable) in accordance with the South African Protection of Personal Information Act, 2013 (Act No. 4 of 2013) (POPIA).



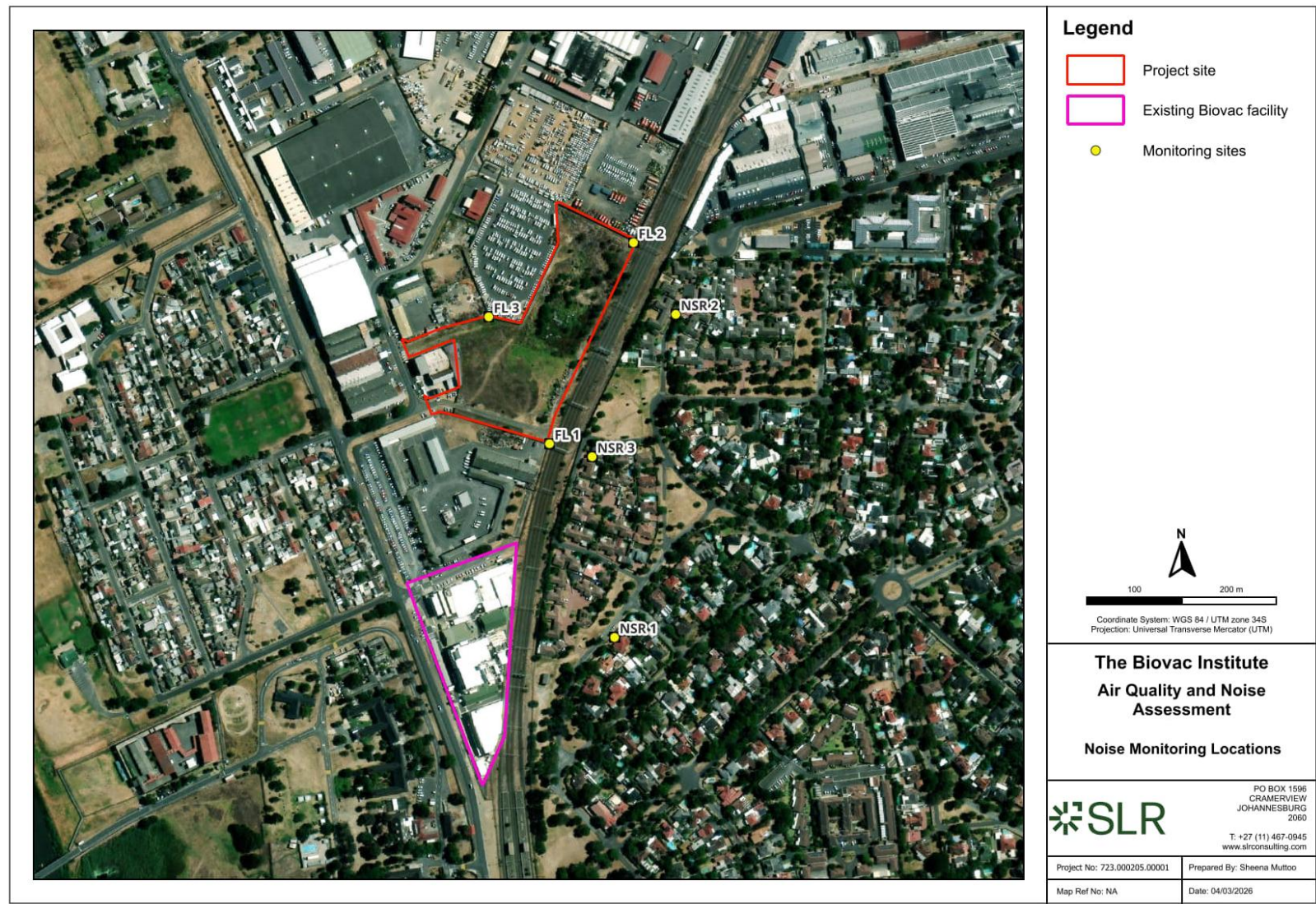


Figure 6-1: Monitoring locations



6.1.2 Equipment

The environmental noise monitoring survey was conducted using the equipment detailed in **Table 6-2**. The equipment conforms to the relevant standards for the measurement of environmental noise and is of Class 1 accuracy. The equipment is calibrated annually by a SANAS accredited laboratory. Calibration certificates are included in **Appendix C**.

Table 6-2: Environmental noise monitoring equipment

Equipment	Serial Number	Calibration Certificate Number
Svantek SV971A, 7152 Integrating Sound Level Meter, and ½" microphone	131629, 84686	2025-AS-1600
Svantek SV33B, Class 1 acoustic calibrator	134590	2025-AS-1599

The noise survey was undertaken between 9 - 10 December 2025 for Phase 1 and between 23 - 28 February 2026 for Phase 2. Daytime measurements were undertaken between the hours of 07h00-18h00 and night-time measurements between the hours of 22h00-06h00 to align with both SANS 10103:2008 and IFC guideline requirements.

The microphone of the sound level meter was positioned at 1.5 m above the ground level in free-field conditions at each location (i.e. at least 3.5 m from the nearest vertical reflecting surface). Logger function checks and calibration were carried out according to the manufacturer's recommendations before fieldwork. Noise levels captured by the instrument were logged every second and automatically saved in a high-capacity internal flash memory built into the instrument.

6.2 Results and Interpretation

Comparison of both phases

- For the fenceline monitoring locations, nighttime noise levels during Phase 2 were generally lower than during Phase 1. Daytime noise levels at FL 2 and FL 3 were also overall lower, up to ~ 6 dB(A) in Phase 2.
- NSR 1 was the only sensitive receptor monitored across both measurement periods. Noise levels at this location showed minimal variation between phases for both daytime and nighttime periods. However, nighttime measurements consistently exceeded the residential nighttime guideline limit of 45 dB(A) in terms of both SANS and the IFC/WHO guidelines.

Noise levels in outdoor environments are influenced by multiple interacting sources, and it is generally difficult to attribute any observed changes to a single source without source-specific modelling.



Table 6-3 presents the measured daytime and nighttime equivalent continuous sound pressure levels (LAeq) expressed in dB(A). In accordance with applicable assessment guidance, environmental noise criteria are typically defined for separate daytime and nighttime periods. A 24-hour continuous noise measurement was undertaken at NSR 1 for supplementary characterisation of ambient conditions. The 24-hour dataset was therefore processed to derive equivalent continuous sound pressure levels (LAeq) for the respective daytime and nighttime periods using standard energy-averaging procedures, consistent with accepted acoustic assessment practice.

Table 6-4 presents a summary of the observed meteorological conditions for both phases of monitoring, soundscape characteristics at the monitoring locations, including dominant noise sources, temporal variability, and contextual factors influencing ambient noise conditions. During Phase 1 daytime wind speeds averaged 5.8 m/s, slightly above the recommended limits for noise monitoring, while nighttime wind speeds were highest at the residential receptor, reaching 10.3 m/s. Cloud cover varied from clear to overcast, with no precipitation recorded. During Phase 2, wind conditions showed greater variability in direction and were generally lower at night (approximately 1.1 - 2.2 m/s), while reaching 8.8 m/s during the daytime. Cloud cover again varied from clear to overcast, with no precipitation recorded. The CoCT has a characteristically windy climate, and it is difficult to avoid such conditions during a field monitoring campaign. To reduce the influence of wind on acoustic measurements, standard field mitigation practices, including the use of wind screens on microphones and appropriate sensor positioning, were applied.

Key findings include:

Phase 1

- **Daytime fenceline:** The highest recorded daytime noise level was 58.83 dB(A) observed at FL 3. All fenceline sites complied with the recommended daytime limits in terms of SANS and IFC/WHO guidelines.
- **Nighttime fenceline:** The highest recorded nighttime noise level was 55.40 dB(A), observed once again at FL 3. All fenceline sites complied with the recommended nighttime limits in terms of SANS and IFC/WHO guidelines.
- **Daytime residential:** Daytime noise levels at NSR 1 approached the applicable guideline, measuring 53.63 dB(A) compared to the recommended limit (SANS and IFC/WHO) of 55 dB(A). A low-level humming noise, attributed to the existing Biovac facility, was perceptible at this residence during daytime measurements.
- **Nighttime residential:** Nighttime noise levels at NSR 1 were recorded at 49.49 dB(A), exceeding the SANS and IFC/WHO guideline limit of 45 dB(A). Distant industrial activity was audible at this location during the nighttime monitoring period. Elevated wind speeds may have contributed to increased background noise, potentially influencing the observed nighttime exceedance.

Phase 2

- **Daytime fenceline:** The highest recorded daytime noise level was 59.40 dB(A), observed at FL 1. All fenceline sites complied with the recommended daytime limits in terms of SANS and IFC/WHO guidelines.
- **Nighttime fenceline:** The highest recorded nighttime noise level was 47.70 dB(A), observed at FL 1. All fenceline sites remained compliant with the recommended nighttime limits in terms of SANS and IFC/WHO guideline values.
- **Daytime residential:** Daytime measurements at all NSR's comply with the recommended limits in terms of SANS and IFC/WHO guidelines.



- **Nighttime residential:** The highest recorded nighttime noise level was observed at NSR 3 of 63.20 dB(A), located ~140 m north northeast of the existing Biovac facility and ~60 m east of the Metro Emergency Medical Centre. This is followed by NSR 1 (~110 m east of the existing Biovac facility) reaching 46.05 dB(A). Both of these measurements exceed the SANS and IFC/WHO guideline limit of 45 dB(A). Traffic and background industrial noise were audible at these locations during the monitoring period. Wind speeds were generally low and unlikely to have influenced the measurements.

Comparison of both phases

- For the fenceline monitoring locations, nighttime noise levels during Phase 2 were generally lower than during Phase 1. Daytime noise levels at FL 2 and FL 3 were also overall lower, up to ~ 6 dB(A) in Phase 2.
- NSR 1 was the only sensitive receptor monitored across both measurement periods. Noise levels at this location showed minimal variation between phases for both daytime and nighttime periods. However, nighttime measurements consistently exceeded the residential nighttime guideline limit of 45 dB(A) in terms of both SANS and the IFC/WHO guidelines.

Noise levels in outdoor environments are influenced by multiple interacting sources, and it is generally difficult to attribute any observed changes to a single source without source-specific modelling.



Table 6-3: Measured daytime and nighttime noise levels (dB(A))

Site ID	Site Type	1-hour LA _{eq} (dB(A))		SANS		IFC/WHO	
		Day	Night	Day	Night	Day	Night
Phase 1: 09/12/2025 – 10/12/2025							
FL 1	Industrial	54.07	50.09	70	60	70	70
FL 2	Industrial	55.53	51.45	70	60	70	70
FL 3	Industrial	58.83	54.55	70	60	70	70
NSR 1	Residential	53.63	49.49	55	45	55	45
Phase 2: 23/02/2026 – 28/02/2026							
FL 1	Industrial	59.40	47.70	70	60	70	70
FL 2	Industrial	52.00	36.40	70	60	70	70
FL 3	Industrial	52.10	38.30	70	60	70	70
NSR 1 ^(a)	Residential	51.71	46.05	55	45	55	45
NSR 2	Residential	54.50	44.20	55	45	55	45
NSR 3	Residential	52.30	63.20	55	45	55	45
Notes:							
(a)	- 1-hour LA _{eq} values were calculated from the 24-hour continuous measurement dataset and averaged over the applicable daytime and nighttime periods in accordance with SANS and IFC.						
Red	- Exceeds SANS day / night limits						
Orange	- Exceeds IFC/WHO day / night limits						



Table 6-4: Summary of noise monitoring, meteorological parameters and soundscape characteristics

Site ID	Name or Location	Period (Day / Night)	Date	Start Time	End Time	Temperature (°C)	Wind Speed (m/s)	Wind Direction	Relative Humidity (%)	Weather Conditions	Soundscape Description
Phase 1 Noise Monitoring: 09/12/2025 – 10/12/2025											
FL 1	Southern corner of property	Day	09/12/2025	08:58	09:58	23	5.0	North	62	Mostly cloudy	Bird calls and worker activity audible. Light breeze. Intermittent railway noise from train passing by.
		Night	09/12/2025	23:26	23:45	19	9.2	North	70	Clear	Brief vehicle noise event within an otherwise low-level background soundscape.
FL 2	Eastern corner of property	Day	09/12/2025	11:05	12:18	18	5.8	North	61	Overcast	Bird calls present with intermittent human voices and occasional railway noise from train passing by.
		Night	10/12/2025	00:30	01:30	19	8.6	North	71	Mostly clear	Audible wind gusts
FL 3	Northern fenceline	Day	09/12/2025	10:03	11:03	24	5.0	North	61	Mostly cloudy	Continuous mechanical noise from vent, with nearby worker activity. Intermittent train movements and light wind.
		Night	10/12/2025	01:34	02:34	19	5.8	North	71	Clear	Audible wind gusts
NSR 1	[REDACTED]	Day	09/12/2025	13:09	14:09	21	5.8	North	59	Overcast	Rustling trees and passing vehicles audible. Low-level continuous humming from Biovac perceptible at approximately 200 m.
		Night	09/12/2025	22:07	23:10	19	10.3	North	69	Clear	Distant intermittent industrial activity audible.
Phase 2 Noise Monitoring: 23/02/2026 – 28/02/2026											
FL 1	Southern corner of property	Day	28/02/2026	11:30	12:30	22	8.0	Southeast	52	Mostly Cloudy	Intermittent industrial alarm events, nearby vehicular traffic, and train pass-by. Continuous low-level mechanical humming in the distance.
		Night	25/02/2026	22:35	23:35	25	2.2	North Northwest	81	Overcast	Low ambient noise environment dominated by insect activity and rustling trees. No significant industrial or traffic noise events observed during the measurement period.
FL 2	Eastern corner of property	Day	28/02/2026	13:38	14:38	22	6.0	Southeast	54	Mostly Cloudy	Birds chirping and train pass-by audible. Continuous distant mechanical humming present with occasional industrial alarm audible
		Night	25/02/2026	00:45	01:45	19	1.8	North Northwest	86	Overcast	Low background levels with dominant insect sounds and light wind through vegetation. No notable industrial alarms or significant traffic events observed.
FL 3	Northern fenceline	Day	28/02/2026	12:30	13:30	22	8.8	Southeast	54	Partly Cloudy	Intermittent industrial alarm events, nearby vehicular traffic, and train pass-by. Distant mechanical humming and faint music audible.



Site ID	Name or Location	Period (Day / Night)	Date	Start Time	End Time	Temperature (°C)	Wind Speed (m/s)	Wind Direction	Relative Humidity (%)	Weather Conditions	Soundscape Description
		Night	25/02/2026	23:40	00:40	19	1.8	North Northwest	85	Overcast	Low ambient background dominated by insect activity and light wind-induced vegetation rustling. No prominent industrial or transport-related noise events during the monitoring period.
NSR 1		Day & Night (24-hour)	23/02/2026	15:25	14:25	28	1.1	Southeast	16	Clear	Trees surrounding dwelling; typical residential environment. Intermittent road traffic and periodic railway pass-by audible. Background dominated by natural ambient sounds with transport-related noise events.
NSR 2		Day	28/02/2026	08:55	09:55	21	2.0	South Southeast	59	Partly Cloudy	Bird calls and light to moderate distant vehicle traffic. Intermittent train pass-by events, faint continuous mechanical/industrial humming in the distance, helicopter overflight, and distant human speech.
		Night	27/02/2026	23:30	00:30	18	2.0	North Northeast	69	Clear	Low ambient background levels dominated by distant road traffic. Occasional water dripping nearby and faint human speech audible intermittently.
NSR 3		Day	28/02/2026	10:05	11:05	21	2.5	South Southeast	59	Partly Cloudy	Natural ambient sounds including rustling of trees. Intermittent train pass-by and vehicular movements locally and at a distance. Helicopter overflight.
		Night	27/02/2026	22:22	23:22	18	1.1	North Northeast	65	Mostly Clear	Low to moderate background sound levels dominated by distant vehicular traffic and faint mechanical/industrial sounds. Insect (cricket) activity and intermittent local vehicle movements. Occasional distant human speech.



7. Recommended Management Measures

The objective of noise management is to principally:

- Identify and implement all appropriate measures to minimise the generation of noise and subsequent exposure or impact;
- Prevent off-site exposure to noise levels that could result in complaints; and
- Minimise the risk of unplanned or unexpected 'noisy' events with potential to cause off-site disturbance.

The recommendations provided aim to limit the types, timing, and intensity of noise that could materially affect the amenity of nearby sensitive receptors. Best practice measures for controlling noise within the site should be implemented throughout all phases of operation. The specific aims of these measures are to ensure that:

- Noise impacts are considered as part of all operational planning and activities;
- The risk of unplanned 'noisy' events leading to off-site complaints is minimised;
- Noise is controlled primarily at the source through good operational practices, proper selection and maintenance of plant and equipment; and
- All reasonable and practicable measures are taken to prevent, or where prevention is not feasible, to minimise noise emissions from the site.

The mitigation and monitoring measures listed in **Table 7-1** are based on GIIP and Best Available Techniques (BAT) for pharmaceutical and biotechnology manufacturing as provided by the IFC EHS Guidelines²⁰.

Table 7-1: Noise management recommendations

Activity	Management Measures
General	• Train all staff on noise awareness and operational controls, including site induction and annual refresher courses. • Maintain all equipment according to manufacturer schedules to prevent excessive noise from wear or misalignment. • Implement a community grievance procedure to log and respond to noise complaints, with clear response timelines.
Impact Reduction / Source Mitigation	Administrative Controls: • Schedule routine maintenance to prevent elevated noise from deteriorating equipment. • Plan operations and delivery routes to avoid peak residential disturbance times. • Limit high-noise activities near sensitive receptors, including short-term operational adjustments if complaints arise. Engineering Controls: • Enclose major mechanical systems such as HVAC units, cooling towers, and generators with acoustic enclosures. • Install silencers, vibration isolators, and dampers on pumps, compressors, and fans. • Strategically locate high-noise equipment as far as practicable from sensitive receptors (e.g., fenceline to nearest residence).

²⁰ International Finance Corporation (IFC). 2007. Environmental, Health and Safety Guidelines: Pharmaceuticals and Biotechnology Manufacturing, World Bank Group.



Activity	Management Measures
	- Use building design measures: sound-insulating materials, double-glazed windows, and façade treatments to reduce off-site noise propagation. - Maintain all noise-control equipment regularly to ensure ongoing effectiveness.
Complaints Management	A noise complaints management system should be maintained to ensure that all noise-related complaints are properly recorded, investigated, and addressed. Complaints should be logged in a dedicated register or electronic system, with details of the issue, investigation findings, and any corrective actions taken. All complainants should be responded to promptly and kept informed of the outcome. Records should be retained and made available for inspection by relevant authorities when required.
Monitoring and Evaluation	- Routine operational noise compliance monitoring is not required. However, procedures should be in place to respond to exceptional noise-related complaints during both construction and operational phases. All external complaints must be recorded, investigated, and retained in a complaints register. - Where necessary, follow-up noise monitoring should be undertaken at locations relevant to the complaint to assess compliance with SANS 10103:2008. The purpose of such monitoring will be to verify the validity of complaints and determine whether additional mitigation measures are required.
Construction Phase, Traffic, and Logistics	- Schedule high-noise construction activities during standard daytime hours (e.g., 07:00 - 17:00) to reduce residential disturbance. - Use low-noise construction equipment where feasible and maintain it properly. - Install temporary acoustic barriers around high-noise operations, such as generators, compressors, or material handling areas. - Plan construction and delivery traffic routes to avoid residential streets and sensitive receptors. - Limit idling of construction and delivery vehicles near sensitive areas. - Coordinate with local authorities to manage construction traffic in urban areas to minimize noise exposure.

8. Conclusion

SLR Consulting was appointed to undertake a baseline noise assessment for the proposed Biovac vaccine manufacturing facility. This report presents an overview of prevailing baseline noise conditions, including a summary of meteorological conditions and the methodology, collection, and analysis of ambient noise monitoring data, undertaken during two phases of monitoring.

Vaccine manufacturing facilities do not typically generate high noise levels, as most operational equipment is housed within enclosed or acoustically screened areas. However, certain noise sources, including HVAC systems, cooling infrastructure, and intermittent vehicle movements, may contribute to tonal or continuous noise that could result in localised annoyance if not appropriately managed. According to SANS, any increase of more than 7 dB(A) above reference levels may constitute a noise disturbance. The IFC EHS Guidelines similarly state that noise impacts should not result in a maximum increase above background levels of more than 3 dB(A) at the nearest off-site receptor, as increases below this threshold are typically not perceptible to a person with average hearing acuity.



Phase 1 comprised baseline measurements at selected fenceline and receptor locations. Following review of the initial results, Phase 2 monitoring was undertaken to supplement the dataset and strengthen baseline characterisation. The baseline noise assessment indicates that daytime noise levels measured at fenceline and sensitive receptors, during both phases, comply with applicable SANS 10103:2008 and IFC/WHO guideline limits. Nighttime exceedances were observed at NSR 1 (~110 m east of the existing Biovac facility), during both phases, with limited variability in measured noise levels between phases for both day and night. The highest nighttime exceedance occurred at NSR 3 (~140 m north northeast of the existing Biovac facility and ~60 m east of the Metro Emergency Medical Centre). These exceedances are primarily associated with the more stringent night-time limits rather than a significant increase in noise emissions from existing sources. All sites (except NSR 3 during Phase 2) have lower nighttime readings than daytime readings. The reading at NSR 3 (Phase 2) may have been influenced by increased Friday night traffic and documented intermittent human voices. No increase in noise from the existing Biovac facility was noted for this measurement relative to other nighttime measurements. It should also be noted that ambient outdoor noise levels are influenced by multiple interacting sources and varying meteorological conditions. As a result, short-term variations in measured noise levels cannot be attributed to a single source with certainty.

This study constitutes a screening-level baseline assessment. While noise measurements at industrial sites were compliant, nighttime exceedances were observed at two residential receptors. SLR retains the recommendation of a noise modelling assessment to determine the likely contribution of the proposed facility to the noise levels at proximate residential receptors. This contribution is likely to be minor, but the facility cannot be ruled out as a contributor to future noise exceedances at residential receptors during the operational phase of the Project without such simulations.

Regards,

SLR Consulting (South Africa) Proprietary Limited



Sheena Muttoo

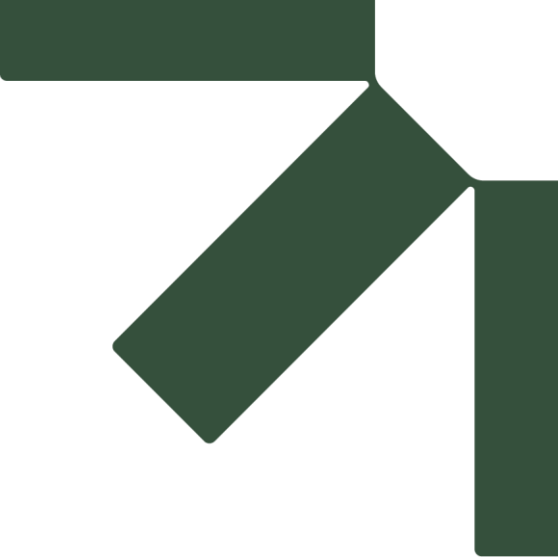
Senior Consultant - Environmental Health
HPCSA: HI 0075086
smuttoo@slrconsulting.com



Lisa Ramsay

Service Line Director - Environmental Sciences
lramsay@slrconsulting.com





Appendix A Declaration of Independence - Practitioner

Noise Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

SLR Project No.: 723.000205.00001

6 May 2026



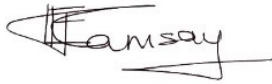
DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: Lisa Ramsay

Declaration of independence and accuracy of information provided:

I, Lisa Ramsay, declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for this report and have performed the work relating to the study in an objective manner, even if this resulted in views and findings that are not favourable to the applicant. I have disclosed to the applicant and the relevant authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the relevant authority. The information provided in this specialist noise baseline assessment report is, to the best of my knowledge, in all respects factually true and correct.

Signed at Kloof, on this 06th, day of May 2026

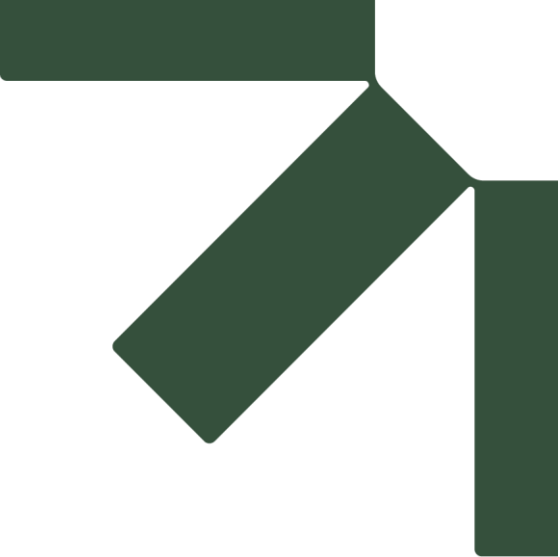


SIGNATURE

Service Line Director - Environmental Sciences

CAPACITY OF SIGNATORY





Appendix B Curriculum Vitae

Noise Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

SLR Project No.: 723.000205.00001

6 May 2026





Lisa offers various environmental management services, including atmospheric dispersion modelling; compilation of atmospheric emission inventories and greenhouse gas inventories; nuisance (noise and odour) monitoring, modelling and management; health impact assessments; climate change impact assessments; and strategic air quality management plans.

With a background in meteorology, Lisa has experience using ground-based station, weather balloon, radar and satellite data for interpreting meteorological and atmospheric dispersion contexts. She is skilled in an array of emission inventory tools and dispersion modelling software packages, including TANKS, Water9, LandGEM, ADMS, AERMOD and CALPUFF. She also has experience with downscaled climate models for regional climate change assessments. She has acted as an expert witness

in various fire, storm, wind and hail legal cases.

Lisa has consulting experience across Africa, including in Angola, Egypt, Ethiopia, Ghana, Guinea, Kenya, Mozambique, Namibia, Nigeria, Rwanda, South Africa, Tanzania, Zambia, Zanzibar and Zimbabwe. She also has experience in Europe, Asia, the Middle East and Australia. This includes air quality and health impact assessments to lender standards.

Lisa completed a PhD in 2010 at the University of Cambridge, looking at the political ecology of air pollution and environmental health in Durban, South Africa. She is currently an Associate Professor in the College of Health Sciences, University of KwaZulu-Natal, where she maintains a broad research portfolio and supervises postgraduate students researching air pollution exposure, climate change and health. She has a number of peer-reviewed publications in these fields.

Education

- Doctor of Philosophy - University of Cambridge (2010)
- Master of Philosophy - University of Cambridge (2006)
- Master of Science - Palaeoclimatology, University of KwaZulu-Natal (2005)
- Bachelor of Science (Hons) - Atmospheric Science, University of Natal (2003)
- Bachelor of Science, University of Natal (2002)

Project Experience

Advisory

Environmental and Social Policy Assessment (ESPA), The German Development Bank/ Kreditanstalt für Wiederaufbau (KfW) (2022-2023)

Appointment to compile an ESPA to support KfW's Policy Based Lending (PBL) financing agreement with the Government of South Africa (represented by the Minister of Finance) to provide support to the country's energy reforms for a Just Energy Transition.

Air Quality Impact Assessment (AQIA)

MINING

AQIA for Kabanga Mine, Tembo Nickel Corporation Limited, Tanzania (2025)

Compilation of emissions inventory and atmospheric dispersion modelling assessment of the proposed mining facility to support Environmental and Social Impact (ESIA) update process. Significance assessment of key emission sources, and recommendations for emission mitigation and management.

AQIA for Iduapriem Mine, AngloGold Ashanti, Ghana (2024 – 2025)

Appointment to develop, install and manage an air quality monitoring network (dust fallout, continuous particulate and gas monitoring) at the Iduapriem mine. The appointment also includes the compilation of an emissions inventory and atmospheric dispersion modelling of the facility.

AQIAs for Rutongo, Nyakabingo and Musha Mines, Trinity Metals, Rwanda (2023)

Baseline air quality monitoring (continuous particulate and passive gas monitoring) at three mines. Compilation of baseline assessment reports including emission mitigation and air quality management recommendations.

Der Brochen / Mototolo Mining Complex, Anglo American Platinum, Limpopo, South Africa (2022 - 2025)

Development of emission inventory and atmospheric dispersion model for the facility. Development of Air Quality Monitoring Plan, Air Quality Management Plan and compilation of Anglo Risk Register. Workshops with onsite team.

Mogalakwena Mining Complex, Anglo American Platinum, Limpopo, South Africa (2022 - 2025)

Development of emission inventory and atmospheric dispersion model for the facility. Development of Air Quality Monitoring Plan, Air Quality Management Plan and compilation of Anglo Risk Register. Workshops with onsite team. Three years of monthly dust fallout monitoring, and management of Polludrone continuous air quality monitoring network.

AQIA for Siguiri Mine, AngloGold Ashanti, Guinea (2012)

Compilation of an emissions inventory for mining processes and onsite electricity generation using United States Environmental Protection Agency AP42 and Australian National Pollution Inventory emission factors. A Level 2 dispersion model (ADMS) was used to calculate ambient concentrations of particulate matter and dust fallout in the region. Health impact and dust nuisance assessments were conducted for nearby sensitive receptors.

INFRASTRUCTURE

AQIA for Key Infrastructure Upgrades, Propav Infraestructuras Limited, Zanzibar (2023)

SLR was appointed to undertake air quality assessment for the proposed upgrade and rehabilitation of three road sections and an airport within the Zanzibar Archipelago. The study included a baseline ambient air quality monitoring survey and a screening level (SCREEN3) dispersion modelling assessment of the construction and operational phases of the proposed project and accounted for potential reductions in current emissions. Impacts were evaluated using IFC EHS guidelines.

POWER

Advisor to the Minister of Fisheries, Forestry and Environment (2025)

Appointment to advise the Minister of Fisheries, Forestry and Environment (Dr Dion George) on the technical aspects of the Eskom applications in terms of Section 59 of NEMA: AQA for eight coal-fired power stations.

AQIA for Thabametsi Power Plant, Eskom, Limpopo, South Africa (2019)

Peer review of the AQIA for Phase 1 (630 MW) of the proposed Thabametse Power Plant to support the AEL application. The study comprised a baseline assessment, emissions inventory, Level 3 (CALPUFF) atmospheric dispersion model and impact assessment. The emissions inventory compiled by the original service provider was updated for input to an atmospheric dispersion model.

AQIA for Power Generation, Saudi Electricity, Saudi Arabia (2016)

Peer review of an AQIA to establish whether the study aligned with international best practice and International Finance Corporation (IFC) requirements.

AQIA for Power Generation, Gigajoule Mozambique, Mozambique (2014 & 2016)

A Level 2 dispersion model (AERMOD) was run to assess the cumulative ambient impacts of both the natural gas-fired Gigawatt facility and one neighbouring facility. The ambient concentrations were compared with local standards and international guidelines. Recommendations for emissions reduction and ambient air quality improvement were provided. In 2016, a 40 MW expansion scenario was simulated and assessed.

RENEWABLE ENERGY

Specialist air quality opinion for Solar Photovoltaic (PV) Power Generation, Marula Platinum (Pty) Ltd, Limpopo, South Africa (2023)

Specialist air quality opinion describing potential air quality related risk associated with a proposed PV facility in the context of existing air pollution sources within an existing mining rights area. The opinion motivated against the need for a full AQIA, however provided recommendations for further assessment and management planning should the competent authority require it.

AQIA for Green Ammonia Production, ENERTRAG South Africa, Mpumalanga, South Africa (2022)

Specialist impact statement and provisional AEL application for two renewable energy complexes producing green ammonia.

AQIA for Solar Power Facilities, ACWA Power Energy Africa, Northern Cape, South Africa (2020)

Compiled an AQIA for 10 x 200 MW photovoltaic facilities in one of South Africa's eight renewable energy development zones. The study comprised a regulatory assessment, baseline air quality assessment, emissions assessment for the construction and operational phases of the project, with consideration of various technology options, and recommendations for minimising air quality impacts during the various phases of the project, including decommissioning.

AQIA for Solar Power Facility, Brightsource Energy, Northern Cape, South Africa (2014)

Compilation of an emissions inventory of 125 MW CSP for input to a Tier 2 atmospheric dispersion model (ADMS). Outputs were compared the NAAQS to assess potential impacts associated with operations of the proposed facility.

WASTE AND WASTEWATER

AEL Renewal and Transfer application for Healthcare Risk Waste Incineration, Eastern Cape Incineration Services (Pty) Ltd, Gauteng, South Africa (2023)

SLR was appointed by Buhle Waste to facilitate the AEL renewal and transfer of ownership application for their newly acquired ECIS facility in Roodepoort, Johannesburg. The process included engagement with both the licensing authority and the National Department of Forestry, Fisheries and the Environment (DFFE). Following a NEM:AQA compliant public participation process, the application was submitted via SAAELIP and successfully issued by City of Joburg (the licensing authority in this case).

AIR for New England Road Landfill, KZN EDTEA, KwaZulu-Natal, South Africa (2021)

An AIR was requested by KZN EDTEA following recurring fire incidents at the New England Road Landfill in Pietermaritzburg. The study assessed air quality impacts of the July 2020 fire on nearby receptors and to determine the long-range impact across the greater area. The Level 3 (CALPUFF) dispersion model simulated the effect of local topography and meteorology on the dispersion of over 70 pollutants emitted during the fire event. Ground-level concentrations were compared with relevant national standards and international guidelines.

AQIA for Wastewater Treatment, Metito Utilities Ltd, Serbia (2021)

Calculation of emissions from a proposed Wastewater Treatments plant (WWTP) in Zrenjanin, Serbia for input to a Level 2 (AERMOD) atmospheric dispersion model. Potential health impacts of emissions were assessed by comparing simulated ambient concentrations of air pollutants with international guidelines (e.g. those of the World Health Organisation). The study was conducted in line with International Finance Corporation (IFC) requirements.

AQIA for Wellington Landfill, Drakenstein Municipality, Western Cape, South Africa (2020)

A specialist AQIA was undertaken for the proposed height increase of the Wellington landfill. This study provided specialist input to the application for a variation of the landfill's Waste Management License (WML). The study comprised a Level 2 (AERMOD) dispersion modelling assessment to predict and assess ground level pollutant concentrations under five proposed height increase scenarios for comparison with relevant NAAQS. Lifetime cancer risk through inhalation exposure to carcinogenic compounds was also assessed.

AIR for Healthcare Risk Waste Incineration, Compass Medical Waste Services (Pty) Ltd, Gauteng, South Africa (2019)

Compilation of an AIR and AEL application for Compass Waste's proposed thermal desorption unit in Olifantsfontein. The assessment included a baseline assessment, emissions inventory, dispersion modelling using AERMOD and comparison of the predicted concentrations with national standards. Multiple dispersion scenarios were run to assess the existing air quality scenario (using emissions from neighbouring industries), impacts arising from the proposed development in isolation of surrounding emission sources, and cumulative impacts representative of the post-development situation, as well as a hypothetical stack height assessment to assist with the final engineering design. Lifetime cancer risk through inhalation exposure to carcinogenic compounds was also assessed.

AIR for Pet Crematoria, Legacy Pet (Pty) Ltd, Gauteng, South Africa (2018)

An AIR was compiled as part of an environmental authorisation and AEL application for Legacy Pet's proposed pet cremation facility. The assessment included a baseline assessment, emissions inventory, dispersion modelling using AERMOD and comparison of the predicted concentrations with national standards.

AQIA for Stellenbosch Landfill, Stellenbosch Municipality, Western Cape, South Africa (2014)

Compilation of an emissions inventory for an existing landfill using the United States Environmental Protection Agency's AP42 emission factors. Emission inventories for three potential end use scenarios were developed, including a gas-to-energy option. A Level 2 dispersion model (AERMOD) was applied to calculate ambient concentrations of key pollutants for a health impact assessment of nearby sensitive receptors under the various scenarios.

INDUSTRIAL

AQIA for Charcoal Manufacturing, E&C Charcoal (Pty) Ltd, KwaZulu-Natal, South Africa (2023)

An AQIA for an existing charcoal manufacturer near Pietermaritzburg. The study simulated atmospheric emissions from site processes using a Level 3 (CALPUFF) modelling assessment for the comparison of predicted ground-level concentrations with national standards and international guidelines. The study was conducted as part of a NEM:AQA Section 22A license rectification process. Following a NEM:AQA compliant public participation process, the license application was submitted via the South African Atmospheric Emission Licensing Portal (SAAELIP).

AQIA for Primary Aluminium Production, South32 Hillside Aluminium, KwaZulu-Natal, South Africa (2023)

Appointment to conduct an AQIA assessing atmospheric impacts from a primary aluminium smelter in Richards Bay, with specific focus on Casthouse operations. The study simulated pollutant dispersion using a Level 3 (CALPUFF) modelling assessment and compared impacts from Casthouse emissions with the facility's cumulative impact footprint. The assessment also provided a legal review and professional opinion regarding the applicability of additional NEM:AQA Section 21 listed activities and associated licensing requirements.

AQIA for Polyurethane Foam Production, Strandfoam Group (Pty) Ltd, Western Cape, South Africa (2022)

An AQIA and AEL application for Strandfoam Cape's polyurethane foam manufacturing facility in Strand. The study was conducted as part of a NEM:AQA Section 22A license rectification process. The study included the quantification and modelling of relevant pollutants using a Level 2 (AERMOD) dispersion assessment for comparison with national standards and international guidelines. Key emission sources comprised bulk chemical storage, fuel storage, fuel combustion and polyurethane foam production. This assignment required extensive engagement with the licensing authority (City

of Cape Town in this case) including the submission of a specialist opinion on the legal intention of NEM:AQA Section 21 and the potential applicability of license categories outside the ambit of the industrial process in question.

NAEIS Reporting for Foam Production, Strandfoam Group (Pty) Ltd, Western Cape, South Africa (2021)

Emissions inventory development for 2020 operations for annual reporting to NAEIS in line with reporting conditions for NEM:AQA Section 21 listed activities. Key emission sources include bulk liquid chemical storage, fuel storage, fuel combustion and polyurethane foam production.

AIR for Chemical Filling, Richbay Chemicals (Pty) Ltd, Gauteng, South Africa (2020)

Compilation of an AIR and AEL application for a proposed chemical filling plant. The applicant, Richbay Chemicals, is a manufacturer and exporter of speciality cleaning, maintenance and water treatment chemicals, including hydrochloric acid and sulphuric acid. The study assessed potential impacts to air quality from bulk chemical storage tanks, combustion installations and abatement equipment using a Level 2 (AERMOD) dispersion model. Simulated pollutant concentrations were compared with relevant national standards and international guidelines to assess degree of impact.

AEL Compliance Reporting for Safripol, Safripol (Pty) Ltd, KwaZulu-Natal, South Africa (2019-2021)

Contracted to provide AEL compliance support including annual compliance reporting and air quality monitoring obligations stipulated in Safripol's AEL. This comprised emissions inventory development (including emission rate modelling using TANKS), compilation of compliance reports and documents for submission to the online NAEIS and SAAELIP platforms, LDAR surveys, fenceline BTEX monitoring, and odour management planning.

AQIA for MES postponement for Paper Mill, Mondi, KwaZulu-Natal, South Africa (2019)

Compilation of a comprehensive emissions inventory of the Richards Bay Mill for various emission scenarios for input to a Level 3 atmospheric dispersion model (CALPUFF). Dispersion model outputs were used to assess changes in air quality impact associated with proposed site developments. Furthermore, the outputs were used to compile an application for the postponement of compliance timeframes of the 2020 Minimum Emission Standards (MES). The MES postponement process required public engagement, including presentations to community stakeholders and written responses to community comments.

AQIA for Paper Milling, Sappi Saiccor, KwaZulu-Natal, South Africa (2019)

Compilation of a comprehensive emissions inventory of the Umkomaas Mill for various emission scenarios for input to a Level 3 atmospheric dispersion model (CALPUFF). Dispersion model outputs were used to assess changes in air quality impact associated with proposed site developments.

NAEIS Reporting for Far Timbers, Far Timbers (Pty) Ltd, KwaZulu-Natal, South Africa (2018, 2019)

Emissions inventory development for 2017 and 2018 operations for annual reporting to NAEIS in line with license conditions for NEM:AQA Section 21 listed activities. Key emission sources included woodchip stockpiles, biomass combustion in boilers, drying kiln stack emissions and chemical treatment processes.

AQIA for Nut Processing, Golden Macadamias (Pty) Ltd, Mpumalanga, South Africa (2018)

A screening level AQIA was conducted for a macadamia nut processing facility to inform the environmental authorisation process for Golden Macadamia's proposed expansion of their existing plant onto an adjacent property. The assessment included a baseline assessment, emissions inventory, dispersion modelling using SCREEN3 and comparison of the predicted concentrations with the national ambient air quality standards.

AQIA for Lubricant Packaging, Indy Oils (Pty) Ltd, KwaZulu-Natal, South Africa (2017)

Compilation of an AQIA and AEL application for the proposed expansion of Indy Oil's Pietermaritzburg operations. Key activities included the storage of petroleum-based products in excess of 1000 m³ as well as the operation of a thermic fluid oil heater. The study included a baseline assessment, emissions inventory, Level 2 dispersion modelling using AERMOD and comparison of predicted concentrations with national standards.

AQIA for Iron Ore Bulk Terminal, Transnet Port Terminals, Western Cape, South Africa (2015)

Compilation of an emissions inventory for the iron ore bulk storage facility at Saldanha Bay. A Level 3 atmospheric dispersion model (CALPUFF) was used to calculate ambient concentrations of particulate matter and levels of dust fallout. The study included an assessment of the red staining of surfaces in the nearby suburbs of Vredenburg, Langebaan and Bluewater Bay.

Emissions Inventory and AEL Application for Chemical Storage Facility, Island View Storage, KwaZulu-Natal, South Africa (2013)

Compilation of an AEL application for the largest chemical storage facility in South Africa. The study required emission estimation for more than 300 tanks (loading and breathing losses) and for the loading areas (ship and road) using the United States Environmental Protection Agency's AP42 emission factors.

OIL & GAS

Adviser to the National Environmental Consultative and Advisory (NECA) Forum (2024)

Appointment as an expert advisor to the NECA Forum to advise the Minister of Fisheries, Forestry and Environment (Barbara Creecy) on the technical aspects of two Sasol air emission appeal processes.

AQIA for Offshore Gas Exploration Drilling, Confidential Client, Namibia (2024)

Appointment to undertake AQIAs for two proposed exploration and appraisal projects off the coast of southern Namibia. An emissions inventory was developed for fuel combustion (by support vessels and helicopters), electricity generation and flaring of hydrocarbons during well-flow testing. A screening model (SCREEN3) of pollutant dispersion from flaring activities was undertaken to understand worst-case downwind impacts. Impacts were evaluated using IFC EHS guidelines.

Emissions Inventories for Waste Oil Recycling and Bulk Petroleum Product Storage, FFS Refiners (Pty) Ltd, South Africa (2023, 2024)

Emissions inventory development for eight FFS petroleum product storage and oil recovery facilities, namely, Teakwood, Pietermaritzburg, Richards Bay, Chloorkop, Evander, Cape Town Harbour and Brackenfell. Evaporative and loading losses were calculated using US EPA TANKS 4.09d and international emission estimation technique guidelines for the bulk storage and handling of products which included an array of base oils and lubricants, fuel oils, chemicals, bitumen, solvents, waste oils, vegetable oils and animal fats. These inventories were submitted to the online National Atmospheric Emissions Inventory System (NAEIS) portal, as part of FFS' annual compliance reporting obligations.

ESG DD for debt financing of an Oil Mining Lease in Nigeria, Confidential Client (2022).

ESG DD for purchase of interest in Angolan offshore oil blocks, Confidential Client (2022).

AIR for Refinery Flare Stack Upgrade, SAPREF, KwaZulu-Natal, South Africa (2021)

An AIR in support of an AEL variation application was undertaken for the proposed increased flare capacity and increased flare stack height at South Africa's largest crude oil refinery, SAPREF. The study assessed four emission scenarios using a Level 3 (CALPUFF) dispersion modelling assessment. Impacts from emergency and planned shutdowns as well as cumulative and long-term scenarios were compared with national standards.

AIR for Refinery Shutdown and Startup, SAPREF, KwaZulu-Natal, South Africa (2020)

An AIR of emergency flaring events that occurred during the shutdown and start-up of South Africa's largest crude oil refinery. A Level 3 (CALPUFF) dispersion model was run for peak hourly and 24-hourly emission scenarios. The refinery's contribution to ambient pollutant concentrations measured by three municipal air quality monitoring stations was assessed using wind trajectory analyses.

NAEIS Reporting for Bulk Storage Facility, NATREF (Pty) Ltd, KwaZulu-Natal, South Africa (2016-2018)

Emissions inventory development for 2016, 2017 & 2018 operations for annual reporting to NAEIS in line with license conditions for NEM:AQA Section 21 listed activities. Key emission sources include bulk fuel storage (specifically ULP, diesel and crude oil).

AQIA for Refinery Process Changes, SAPREF, KwaZulu-Natal, South Africa (2013)

Assessment of air quality impacts associated with process changes required to meet revised fuel specifications. Emissions from onsite stacks and tanks were calculated using a mass balance approach and use of the United States Environmental Protection Agency's TANKS model respectively. Ambient concentrations of various pollutants were calculated using a Level 2 dispersion model (ADMS). Study results were presented at contentious community meetings in the South Durban Basin.

Air Quality Management Planning and Framework Development

AQMP for iLembe District Municipality, KwaZulu-Natal, South Africa (2022)

Appointment by iLembe District Municipality to develop an Air Quality Management Plan (AQMP) for their jurisdiction, including a baseline assessment and the quantification and simulation of atmospheric emissions using a Level 3 (CALPUFF) dispersion model. A gap and problems analysis determined institutional capacity and identified information gaps. Based on these findings, air quality goals were developed, and practical intervention strategies designed. The study included recommendations for a customised air quality management by-law as well as a licensing guideline for the Air Quality Office (AQO).

Air Quality Management Framework for the Cape Floral Region Protected Areas, Department of Forestry, Fisheries and Environment, Western Cape, South Africa (2020)

Specialist air quality input to the Cape Floral Region Protected Areas (CFRPA) Environmental Management Framework (EMF). Due to high species richness and exceptional endemism, CFRPA is recognised as a globally significant centre for terrestrial biodiversity and was thus declared a World Heritage Site in 2004 by UNESCO. The study comprised a review of ambient air quality and prevailing meteorological conditions influencing regional dispersion. Recommendations were made for air quality management for CFRPA clusters. Key emission sectors included industrial development, domestic fuel burning, road traffic, waste treatment and disposal, agricultural activity (including crop spraying) and biomass burning.

AQMP for Mbombela Local Municipality, Mpumalanga, South Africa (2020)

Compilation of an AQMP for the City of Mbombela Local Municipality. The study comprised a baseline assessment including comprehensive emissions inventory and Level 3 dispersion modelling (CALPUFF), a feasibility assessment to determine institutional capacity, identify information gaps and analyse air pollution problems, the development of air quality goals and intervention strategies to achieve them, and an AQMP for adoption and implementation.

AQMP for Msunduzi Local Municipality, KwaZulu-Natal, South Africa (2018 & 2019)

Appointment to develop an AQMP in a two phased approach for the Msunduzi Local Municipality. Phase one comprised a geographical characterisation of the region, assessment of the status quo of air quality based on available ambient air quality monitoring data, an emissions inventory of identified emission sources, and an institutional capacity assessment. The emissions inventory was used in Phase Two of the AQMP as input to a Level 3 (CALPUFF) dispersion model and to develop effective air quality management strategies for the Municipality.

AQMP for Capricorn District Municipality, Limpopo, South Africa (2017)

Appointment to review the Capricorn District Municipality's 1st generation AQMP developed in 2009. The study comprised an appraisal of the previous AQMP and updates required. The baseline assessment included the quantification and simulation of atmospheric emissions within the District using a Level 3 dispersion model (CALPUFF). The gap and problem analysis determined institutional capacity and identified information gaps. Based on these findings, the 2009 air quality goals were realigned, and new intervention strategies designed.

Odour Impact Assessment

Nuisance Impact Assessment and Management Plan for Poultry Farming, Glen Arum Farms, KwaZulu-Natal, South Africa (2019 & 2020)

Compilation of a nuisance risk assessment for Glen Arum's Kemell and Impangele egg layer operations in response to a non-compliance directive from the relevant authority. The directive required the development of a corrective management plan to address odour and control vectors.

The study included a baseline assessment of the locale, prevailing meteorology, and community concerns, with an assessment of odour and vector impacts linked to waste management. The odour assessment modelled the dispersion of odours into the surrounding landscape for comparison with relevant international guidance (in the absence of local standards).

Odour Risk Assessment for Phase Two of the Pelican Park Housing Development, City of Cape Town, Western Cape, South Africa (2018 & 2021)

Appointment by the City of Cape Town to conduct an odour risk assessment for Phase two of the proposed Pelican Park housing development. The proposed development site is located near the Cape Flats WWTW and Coastal Park landfill site. The aim of the specialist assessment was to determine the extent of odour nuisance and the long-term suitability of the proposed site for residential activity. The study applied monitoring (dynamic olfactometry) and dispersion modelling techniques (AERMOD) to assess the impact of neighbouring land use activities on local air quality. The study recommended additional odour monitoring, and this was conducted in 2020/2021.

Air Quality and Odour Assessment for Shongweni Landholdings, Tongaat Hulett Developments, KwaZulu-Natal, South Africa (2019)

Investigation into nuisance odour at Tongaat Hulett's landholdings earmarked for development purposes in Shongweni, KwaZulu-Natal. The study comprised ambient air quality measurements using both instantaneous and continuous monitoring methods. Odour levels were assessed using dynamic olfactometry and electronic nose (e-nose) technology. The study included a Level 3 (CALPUFF) dispersion modelling assessment of odour.

Odour Impact Assessment for the Shongweni Landfill, Upper Highway Air NPO, KwaZulu-Natal, South Africa (2018)

Appointment by the Upper Highway Air non-profit organisation to undertake an assessment of potential impacts of the EnviroServ Shongweni Landfill on the Upper Highway community. Field investigations included upwind, downwind and community comparative sampling of the odour plume for source appropriation and odorous compound identification. The study included an extensive literature review as well as statistical analysis of community complaints and wind direction data. A Level 3 (CALPUFF) dispersion modelling assessment of individual gases and cumulative odour was undertaken.

Odour Assessment for Denny Mushroom Farm, Denny Mushrooms (Pty) Ltd, KwaZulu-Natal, South Africa (2017)

Measurement of onsite and fenceline odour levels using an e-nose and a Level 1 dispersion modelling assessment of point source emissions to delineate an odour footprint.

Odour Assessment for Pet Food Manufacturing, AVI (Pty) Ltd, KwaZulu-Natal, South Africa (2015 & 2017)

Odour investigation for a pet food production facility. Odour monitoring was conducted using an e-nose at the site boundary and at selected community points at various times of the day, focusing on areas from which odour complaints originated. The findings of the investigation were incorporated to a comprehensive odour management plan (OMP) in line with international best practice and requirements stipulated by the local licensing authority. Reappointment in 2017 to audit the OMP.

Odour Assessment for Maggot Protein Production, AgriProtein (Pty) Ltd, Western Cape, South Africa (2014)

Odour assessment and development of an odour management plan for a nutrient recycling plant in the City of Cape Town. The site proposed to process organic waste, producing maggots for drying and milling as protein feedstock. A legal compliance assessment was conducted and AEL application compiled.

Odour Assessment for Waste Compaction, Transnet Port Terminals (Pty) Ltd, KwaZulu-Natal, South Africa (2013)

Assessment of the potential odour impact of a proposed galley waste compacting facility at the Port of Richards Bay. An odour emissions inventory was developed for input to a Level 2 atmospheric dispersion modelling (ADMS) to calculate odour concentrations at distances away from the proposed waste compactor. Odour plume maps were generated for impact interpretation.

Noise Impact Assessments (NIA)

Der Brochen / Mototolo Mining Complex, Anglo American Platinum (2023 - 2024)

Development of Noise Management and Monitoring Plans. Inventory development, RFI compilation, review of all previous applicable studies, risk assessment according to Anglo risk matrix and WRAC, provision of compliance requirements, reporting of Noise Management Plan and Noise Monitoring Programme.

Mogalakwena Mining Complex, Anglo American Platinum (2023 - 2024)

Undertaking 2nd annual monitoring campaign as per Anglo NMP (by SLR), and review and updates of noise model and Noise Management Plan for 2nd and 3rd year.

EMPr Updates for Nyakabingo and Rutongo Mines, Trinity Metals, Rwanda, (2023-2024)

Tin and Tungsten mining operations involving several sites at Rutongo and Nyakabingo mines. Review of all prior studies, RFI compilation and information collation, survey planning, site sub-consultant management, assessment, reporting, and provision of mitigation recommendations including BAT.

BUA Cement Sokoto Quarry & Cement Manufacturing Plant, BUAC Plc, Nigeria (2023 – 2024)

7.5 Mtpa cement production plant located in Sokoto in north-west Nigeria. Thorough review of all prior studies, collating information, further survey planning, source characterization measurements, H&S compliance, engaging suppliers, sub-consultant management, highly detailed propagation modelling, assessment, provision of mitigation strategy based on hierarchy of impacts, training of personnel, and a Noise Management and Monitoring Plan report compilation.

Pemba Airport Upgrade NIA, Propav Infraestructuras, Zanzibar (2023)

Proposed airport upgrade project on Pemba Island, Zanzibar. Survey planning, on-site surveys, H&S compliance, sub-consultant management, assessment, comprehensive noise management recommendations, and report compilation covering pre-construction, construction and operational phases.

Zanzibar 3 Roads Upgrade NIA, Propav Infraestructuras, Zanzibar (2023)

Proposed 3 new/upgrade road routes on Unguja and Pemba Islands, Zanzibar. Survey planning, on-site surveys, H&S compliance, desktop calculation and assessment, and report compilation covering pre-construction, construction and operational phases.

Health Risk Assessment (HRA)

HIA for Iron Ore Mining Operations, Jindal Iron Ore Project, KwaZulu-Natal, South Africa (2023)

Health Impact Assessment of the proposed iron ore mining operations in Melmoth, and associated Community Health Monitoring and Management Plan to detect impacts timeously, and to avoid or mitigate potential negative impacts, while enhancing positive opportunities. This assessment was framed by a broad definition of health, moving beyond a traditional biomedical focus on the assessment of incidence and spread of disease to incorporate various aspects of physical, psychological, social and cultural well-being.

HRA for Vectors from Poultry Farming, Glen Arum Farms, KwaZulu-Natal, South Africa (2020)

As part of the Nuisance Management Plan conducted for Glen Arums, Balgovan (see above) an assessment of vector related health risks for neighbouring sensitive receptors arising from facility design, operational procedures, waste management and vermin control practices were also assessed. The corrective action plan made recommendations for impact mitigation, effective waste management, community engagement and complaints investigations, based on international best practice.

HRA for Healthcare Risk Waste Incineration, Compass Medical Waste Services (Pty) Ltd, Gauteng, South Africa (2019)

Compilation of HRA for a proposed medical waste thermal desorption unit in Olifantsfontein, Midrand. The key potential health hazards associated with the proposed development were identified as atmospheric emissions, biohazards, pests, odour, and noise. This study assessed likely health impacts from the proposed facility via multiple exposure pathways using internationally recognised methodologies for establishing distribution, likelihood, and significance of impact.

HRA for Drakenstein Waste-to-Energy Project, Interwaste (Pty) Ltd, Western Cape, South Africa (2016)

Compilation of a HRA (human, plant and animal health) for a proposed waste recovery, beneficiation and energy project comprising anaerobic digestion and direct combustion facilities. Potential health hazards associated with the proposed development included atmospheric emissions, water and soil contamination, biohazards and pests, and odour and noise. This study assessed likely health impacts from the proposed facility via multiple exposure pathways (including inhalation, dermal contact, and ingestion of locally produced crops and meat) using internationally recognised methodologies for establishing distribution, likelihood and significance of impact.

HRA for Healthcare Risk Waste Incineration, Sirela Trading (Pty) Ltd, KwaZulu-Natal, South Africa (2013)

Compilation of a HRA (human, plant and animal health) for a proposed waste recovery, beneficiation and energy project comprising anaerobic digestion and direct combustion facilities. Potential health hazards associated with the proposed development included atmospheric emissions, water and soil contamination, biohazards and pests, and odour and noise. This study assessed likely health impacts from the proposed facility via multiple exposure pathways (including inhalation, dermal contact, and ingestion of locally produced crops and meat) using internationally recognised methodologies for establishing distribution, likelihood and significance of impact.

Greenhouse Gas (GHG) Inventories and Climate Change Risk Assessment (CCRA)

Future Pollutant Dispersion Scenarios for Holfontein Landfill, Enviroserv Waste Management (Pty) Ltd, Gauteng, South Africa (2023)

This study reviewed the possible impacts of changing climate on local meteorology and how this changing meteorology may influence landfill gas production and dispersion of pollutants from the Holfontein landfill. The assessment included a Level 1 (SCREEN3) model to determine maximum impacts under two development pathway scenarios (i.e. best and worst case policy based outcomes) to cover a range of uncertainties in future climate projections. Outputs were presented as the relative (unitless) increase or decrease in ambient pollutant concentrations downwind of the landfill. These results can be calibrated for comparison with ambient standards using emission rates for individual gases.

GHG Emissions Inventory for iLembe District Municipality, KwaZulu-Natal, South Africa (2022)

A GHG emissions inventory for the iLembe District Municipality was developed as part of the District's AQMP (see above). Emissions for industrial activities, road traffic, domestic fuel burning, pre-harvest sugarcane burning, and electricity usage were calculated using IPCC emission factors and presented by emission scope in line with the *Greenhouse Gas Protocol: Global Protocol for Community-scale Greenhouse Gas Emission Inventories*.

Emissions Inventory for Port of Durban, C40 Cities, KwaZulu-Natal, South Africa (2021)

Compilation of an inventory of industrial, cargo handling, vehicular, rail and shipping emissions for the Port of Durban in a study funded by the C40 Cities' Empowering Cities with Data mechanism. GHG emissions were calculated using documented emission factors and presented by emission scope in line with the *Greenhouse Gas Protocol: Global Protocol for Community-scale Greenhouse Gas Emission Inventories*.

CCIA for Hydrogen Manufacturing, SAPREF, KwaZulu-Natal, South Africa (2019)

Review and validation of an existing GHG inventory for the SAPREF facility, calculation of GHG emissions associated with the proposed hydrogen manufacturing (HMU) using IPCC emission factors and GHG Protocol toolkits, and contextualisation of climate change implications through comparison of GHG emissions with local, national and international GHG inventories.

Climate Change Adaptation and Resilience in Africa: Recommendations for Policy Makers, funded by the Network of African Science Academies and the German National Academy of Sciences Leopoldina Interacademy Partnership, Africa (2015)

Editor of an advisory book, funded by Network of African Science Academies (NASAC) and German National Academy Leopoldina, to assess projected climate changes across Africa and to make

recommendations to African leaders on adaptation and resilience. The following sectors were assessed regionally: Access to Water, Food Security: Agriculture and Fisheries.

Validity of Downscale Climate Models and the Implications of Possible Future Climate Change for Lake Kariba's Kapenta Fishery, funded by IDRC/CDRI and DFID under the African Climate Change Fellowship Program 2009–2010. Zimbabwe (2013)

Application of downscaled global climate models to investigate the regional impacts of future emission scenarios with validation through prediction of past, observed climate. The IPCC A2 and B1 emission scenarios for the near (2046–2065) and far (2081–2100) future. Nine models were employed and all reflected past climate (1961–2009) well. Results indicated that Kapenta fish production in Lake Kariba will continue to decline. Options and strategies for fishery management were recommended in the context of future climate changes. The study was funded by the International Development Research Centre (IDRC/CDRI) and the United Kingdom's Department for International Development (DFID), and published in a peer-reviewed journal.

Memberships and Associations

- National Association for Clean Air (NACA)
- South African Council for Natural Scientific Professions (SACNASP) (application under assessment)

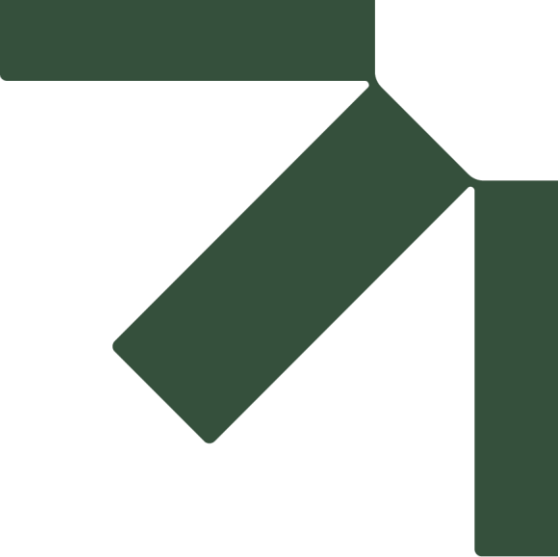
Publications and Conference Papers

- Manqele, N.M., Moolla, R. and Ramsay, L.F. (2024). "A mid-tier approach to estimating Durban's Port Marine Mobile Emissions: Gauging air quality impacts in South Durban". *Atmosphere*, 15, 1207.
- Ashram, K., Mitku, A., Ramsay, L.F., Jeena, P.M. and Naidoo, R.N. (2024). "Environmental exposures associated with early childhood recurrent wheezing in the Mother and Child in the Environment Birth Cohort: a time-to-event study". *Thorax*, doi:10.1136/thorax-2023-221150
- Manqele, N.M., Moolla, R. and Ramsay, L.F. (2024). "The health and economic impacts of exposure to marine mobile emissions from ships in Durban port, South Africa". *Atmospheric Environment: X*, 23, 1000277.
- Benschop, N.D., Chironda-Chikanya, G., Naidoo, S., Jafta, N., Ramsay, L.F., Naidoo, R.N. (2023). "El Niño, Rainfall and Temperature Patterns Influence Perinatal Mortality in South Africa: Health Services Preparedness and Resilience in a Changing Climate". In: Akhtar, R. (eds) *Climate Change and Human Health Scenarios. Global Perspectives on Health Geography*. Springer, Cham.
- Procheş Ş., Watkeys M.K., Ramsay L.F. and Cowling R.M. (2023). "Why we should be looking for longitudinal patterns in biodiversity". *Frontiers in Ecology and Evolution*. 11: 1032827.
- Tularam, H.; Ramsay, L.; Mutttoo, S.; Brunekreef, B.; Meliefste, K; De Hoogh, K. and Naidoo, R.N. (2019). "A hybrid air pollution / land use regression model for predicting air pollution concentrations in Durban, South Africa". *Environmental Pollution*. 274: 116513.
- Tularam, H.; Ramsay, L.; Mutttoo, S.; Naidoo, R.N.; Brunekreef, B.; Meliefste, K and De Hoogh, K. (2019). "Harbor and intra-city drivers of air pollution: Findings from a land use regression model, Durban, South Africa". *International Journal of Environmental Research and Public Health*, 17(15): 5406.
- Mutttoo, S.; Ramsay, L.; Brunekreef, B.; Beelen, R.; Meliefste, K. and Naidoo, R.N. (2018). "Land use regression modelling estimating nitrogen oxides exposure in industrial south Durban, South Africa". *Science of the Total Environment*, 610–611: 1439–1477.

- Ramsay, L. and Olago, D. (eds). (2016) "Climate Change Adaptation and Resilience in Africa: Recommendations to Policymakers", Network of African Science Academies (NASAC) and German National Academy Leopoldina.
- Pillay, K. and Ramsay, L.F. (2015). "Restructuring the Reduced Emissions from Deforestation and Forest Degradation (REDD+) mechanism for a Post Kyoto Agreement." *American Journal of Climate Change* 4(1): 69-76.
- Padayachee, Y.; Proches, S. and Ramsay, L.F. (2014). "Beetle assemblages of indigenous and alien decomposing fruit in subtropical Durban, South Africa." *Arthropod Plant Interactions* 8(2), pp. 135-142.
- Manqele, N.M. and Ramsay, L.F. "Evaluating the contribution of exhaust gas emissions to air pollution and the urban carbon footprint: A case study of the Port of Durban.", National Association for Clean Air (NACA) Annual Conference, Durban, 9-10 October 2014.
- Ndebele-Murisa, M.R.; Hill T. and Ramsay, L.F. (2013). "Validity of downscaled climate models and the implications of possible future climate change for Lake Kariba's Kapenta fishery." *Environmental Development*, 5: 109-130.
- Gumede, P. and Ramsay, L.F. "Community discernments of particulate matter emanating from a landfill site in Durban, KwaZulu-Natal," 16th International Union of Air Pollution Prevention and Environmental Protection Associations (IUAPPA) Clean Air Congress, Cape Town, South Africa, 29 September-4 October 2013.
- Simpson, A. and Ramsay, L.F. "Topographic control of wind field in the nearsurface boundary layer." 16th International Union of Air Pollution Prevention and Environmental Protection Associations (IUAPPA) Clean Air Congress, Cape Town, 29 September-4 October 2013.
- Ramsay, L.F. and Naidoo, R. (2012). "Carbon footprints, industrial, transparency and community engagement in a South Durban neighbourhood." *South African Geographical Journal*, 94 (2): 174-190.
- Ramsay, L.F. (2012). "Severe Weather Bill Warning." *The Mercury*, editorial, 1 February 2012, pp. 6.
- Tularam, H. and Ramsay, L.F. "Air quality in the Durban South Basin linked to synoptic events for the year 2009." National Association for Clean Air (NACA) Annual Conference, East London, 12-14 October 2011.
- Grenfell, S.E.; Ellery, W.N.; Grenfell, M.C.; Ramsay, L.F.; and Flugel, T.J. (2010). "Sedimentary facies and geomorphic evolution of a blocked-valley lake: Lake Futululu, Northern KwaZulu-Natal, South Africa." *Sedimentology* 57: 1159-1174.
- Ramsay, L.F. (2009). "Climate Change for the People of South Durban." *Changing Tomorrow* series, SDCEA and Oxfam Great Britain, pp. 34. Ellery, W.; Grenfell, M.; Grenfell, S.; Kotze, D.; McCarthy, T.; Tooth, S.; Grundling, P.-L.; Beckedahl, H.; Le Maitre, D. and Ramsay, L.F. (2008). "Controls on the distribution and dynamics of wetlands in South Africa." *Wetland Management Series: WET-Origins*.
- Ellery, W.; Grenfell, M.; Grenfell, S.; Kotze, D.; McCarthy, T.; Tooth, S.; Grundling, P.-L.; Beckedahl, H.; Le Maitre, D. and Ramsay, L.F. (2008). "Controls on the distribution and dynamics of wetlands in South Africa." *Wetland Management Series: WET-Origins*.
- Ramsay, L.F. "Asthma in the township communities of South Durban." *Workshop on Chronic Disease and African Communities: Research, Practice and Policy*, London School of Economics and Political Science, London, 23-24 June 2008.
- Ramsay, L.F. "Tropospheric ozone profiling for Irene, South Africa." *Global Change and Regional Sustainability in South Africa*, Kirstenbosch Gardens, 27-29 October 2003.

Awards

- WSP Innovation Award (2021)
- Overseas Research Studentship, University of Cambridge (2007-2009)
- Landscape Research Group Award, University of Oxford (2006)
- Commonwealth Scholarship, University of Cambridge (2005)
- Vice-Chancellor's Award, University of Natal (2000)



Appendix C Calibration Certificate

Noise Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

SLR Project No.: 723.000205.00001

6 May 2026



CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	2025-AS-1600
ORGANISATION	SLR CONSULTING AFRICA (PTY) LTD
ORGANISATION ADDRESS	UNIT 14, BRAEHEAD OFFICE PARK, 1 OLD MAIN ROAD, KLOOF, DURBAN, 3640
CALIBRATION OF	INTEGRATING SOUND LEVEL METER complete with built-in 1/3-OCTAVE/OCTAVE FILTER and 1/2" MICROPHONE
MANUFACTURERS	SVANTEK and ACO
MODEL NUMBERS	SV 971A and 7152
SERIAL NUMBERS	131629 and 84686
DATE OF CALIBRATION	27 - 28 MAY 2025
RECOMMENDED DUE DATE	----- (SEE REMARKS 4.7)
PAGE NUMBER	PAGE 1 OF 6

This certificate is issued in accordance with the conditions of approval granted by the South African National Accreditation System (SANAS). This Certificate may not be reproduced without the written approval of SANAS and M and N Acoustic Services.

The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the number of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.

The South African National Accreditation System (SANAS) is member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). This arrangement allows for mutual recognition of technical test and calibration data by member accreditation bodies worldwide. For more information on the arrangement please consult www.ilac.org

Calibrated by Calibration Technician:	 D.N. MASIMULA	Clause 3.1 & 3.2
Calibrated/Supervised by Calibration Technician:	 W.S. MBANYONI	Clause 3
Authorized/Checked by SANAS Technical Signatory:	 M. NAUDÉ	Date of Issue: 06 JUNE 2025

1. PROCEDURE

The Integrating Sound Level Meter was calibrated according to procedure 1002/P/013 and to the IEC 61672-3:2006 specifications as well as the manufacturer's specifications.

The ½" Microphone was calibrated according to procedure 1002/P/002 and 1002/P/011 as well as the manufacturer's specifications.

The ⅓-Octave/Octave Filters were calibrated according to procedure 1002/P/008 and to the IEC 61260 specification as well as the manufacturer's specifications.

2. MEASURING EQUIPMENT

Keysight	33522B	Function Generator	MY 52814359
Keysight	34461A	Digital Multimeter	MY 53223917
JFW	50BR-022	50 Ohm Step Attenuator	5636551033
Major Tech	MT 669	Data Logger	150828454
B&K	4226	Multi-Frequency Calibrator	2912645
Gems	PD6000-6RO	Pressure Gauge Digital	1606-0204475
Svantek	SV 35	Acoustic Calibrator	58106
Major Tech	MT 669	Data Logger	150828469
Keysight	34461A	Digital Multimeter	MY 53223905
G.R.A.S	42 AP	Piston Phone	256092
G.R.A.S	26 AG	½" Pre-Amplifier	189056
Yowexa	YEM-70AL	Data Logger	23020795068
B&K	2829	4-Ch Microphone Power Supply	2329283
G.R.A.S	40 AQ	½" Microphone	160815

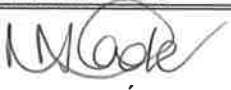
Calibrations performed by this laboratory are in terms of standards, the accuracies of which are traceable to national measuring standards as maintained by NMISA.

Calibrated by Calibration Technician:	 D.N. MASIMULA	Clause 3.1 & 3.2
Calibrated/Supervised by Calibration Technician:	 W.S. SIBANYONI	Clause 3
Authorized/Checked by SANAS Technical Signatory:	 M. NAUDÉ	Date of Issue: 06 JUNE 2025

3. RESULTS - ACCORDING TO THE IEC 61672-3: 2006:

3.1 The following parameters of the Integrating Sound Level Meter were calibrated:

Parameter	Specification	Uncertainty of Measurement in dB
Calibration Check Frequency at 114,0 dB at 1 000 Hz at Nominal Range: HIGH	IEC 61672-3: Clause 9	$\pm 0,3$
Self-Generated Noise:	IEC 61672-3: Clause 10	-----
A-Weighted Electrical 22,7 dB		
C-Weighted Electrical 7,0 dB		
Z-Weighted Electrical 11,1 dB		
B-Weighting Electrical 6,4 dB		
Level Linearity at 8 000 Hz Nominal Range: HIGH Reference Level at 114,0 dB: (39,7 dB to 129,0 dB)	IEC 61672-3: Clause: 14	$\pm 0,3$
Level Range Control at 1 000 Hz Reference Level at 114,0 dB	IEC 61672-3: Clause: 15	$\pm 0,3$
A-Weighting Network (31,5 to 20 000) Hz	IEC 61672-3: Clause 12	$\pm 0,3$
C-Weighting Network (31,5 to 20 000) Hz	IEC 61672-3: Clause 12	$\pm 0,3$
B-Weighting Network (31,5 to 20 000) Hz	IEC 61672-3: Clause 12	$\pm 0,3$
Z-Weighting Network (31,5 to 20 000) Hz	IEC 61672-3: Clause 12	$\pm 0,3$
Peak C HIGH Range	IEC 61672-3: Clause 17	$\pm 0,3$

Calibrated by Calibration Technician:	 D.N. MASIMULA	Clause 3.1 & 3.2
Calibrated/Supervised by Calibration Technician:	 W.S. SIBANYONI	Clause 3
Authorized/Checked by SANAS Technical Signatory:	 M. NAUDÉ	Date of Issue: 06 JUNE 2025

Parameter	Specification	Uncertainty of Measurement in dB
Frequency and Time Weightings at 1 000 Hz at 114,0 dB (A-, C-, B- and Z-Weighting Network) (Fast, Slow and Impulse)	IEC 61672-3: Clause 13	± 0,3
Tone Burst Response (Max. Fast, Max. Slow, Lae and LA _{eq} Levels)	IEC 61672-3: Clause 16	± 0,3
Overload Indication	IEC 61672-3: Clause 18	± 0,3

Conclusion: The Integrating Sound Level Meter complied with the above-specified clauses of the IEC 61672-3:2006 specifications recommended tests and requirements according to ARP 0109:2014, **Class 1**.

3.2 The following parameters of the 1/3-Octave/Octave built-in Filter were calibrated:

1/3-Octave Frequency Response (25 to 20 000) Hz	IEC 61260: Sections 4.7 & 5.6
Octave Frequency Response (31,5 to 16 000) Hz	IEC 61260: Sections 4.7 & 5.6

The uncertainty of measurements was estimated as follows: ± 0,3 dB

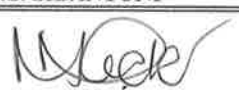
Conclusion: The built-in Octave Filter complied with the above-specified clauses of the IEC 61260 specifications, recommended tests and requirements according to ARP 0109:2014, **Class 1**.

3.2 The following parameters of the 1/2" Microphone were calibrated and the results were corrected to the ambient condition of 1 013,25 mBar:

Output Sensitivity at 250 Hz at 94,0
Frequency Response (31,5 to 16 000) Hz

The uncertainty of measurements was estimated as follows: ± 0,3 dB

Conclusion: The parameters measured for the 1/2" Microphone, complied with the manufacturer's specification, **Class 2**.

Calibrated by Calibration Technician:	 D.N. MASIMULA	Clause 3.1 & 3.2
Calibrated/Supervised by Calibration Technician:	 W.S. SIBANYONI	Clause 3
Authorized/Checked by SANAS Technical Signatory:	 M. NAUDÉ	Date of Issue: 06 JUNE 2025

3.4 The ½" Microphone was calibrated Electroacoustic according to Clause 12 of IEC 61672-3: 2006 complete with Integrating Sound Level Meter and ½" Pre-amplifier, free-field corrections were taken into consideration and the results were corrected to the ambient condition of 1 013,25 mBar:

FREQUENCY (Hz)	CALCULATED EXPECTED VALUE (dB)	MEASURED VALUE (dB)	DEVIATION (dB)	U _{95M} (dB)
1 000 (Ref)	114,2	114,2	0,0	± 0,3
31,5	111,2	111,3	+ 0,1	± 0,3
63	113,5	113,5	0,0	± 0,3
125	114,0	114,2	+ 0,2	± 0,3
250	114,1	114,2	+ 0,1	± 0,3
500	114,2	114,3	+ 0,1	± 0,3
1 000	114,1	114,2	+ 0,1	± 0,3
2 000	113,8	113,9	+ 0,1	± 0,3
4 000	112,9	113,1	+ 0,2	± 0,3
8 000	107,5	107,8	+ 0,3	± 0,3
12 500	101,5	101,9	+ 0,4	± 0,3
16 000	96,3	97,7	+ 1,4	± 0,3

Calibrated by Calibration Technician:	 D.N. MASIMULA	Clause 3.1 & 3.2
Calibrated/Supervised by Calibration Technician:	 W.S. SIBANYONI	Clause 3
Authorized/Checked by SANAS Technical Signatory:	 M. NAUDÉ	Date of Issue: 06 JUNE 2025

4. REMARKS

- 4.1 The reported expanded uncertainties of measurements are based on a standard uncertainty multiplied by a coverage factor of $k = 2$, providing a level of confidence of approximately 95,45%, the uncertainties of measurements have been estimated in accordance with the principles defined in the GUM (Guide to Uncertainty of Measurement) ISO, Geneva, 1993
- 4.2 The environmental conditions during calibration for items in Section 3 were:
Temperature: $(23 \pm 3) ^\circ\text{C}$
Relative Humidity: $(50 \pm 15) \%RH$
- The Environmental Conditions specified in the relevant IEC and ISO standards took precedence.*
- 4.3 Calibration labels bearing calibration date, due date (if requested), certificate number and serial number have been affixed to the instrument.
- 4.4 The above statement of conformance is based on the measurement values obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limits.
- 4.5 The above specified Integrating Sound Level Meter and ½" Microphone must be used as a unit. The ½" Microphone's frequency range determines the useful frequency range of the instrument vice versa. The results on this Certificate relates only to the items and parameters calibrated.
- 4.6 Abbreviation:
UoM = Uncertainty of Measurement
- 4.7 **Please Note: Client requested a no recommended due date.**

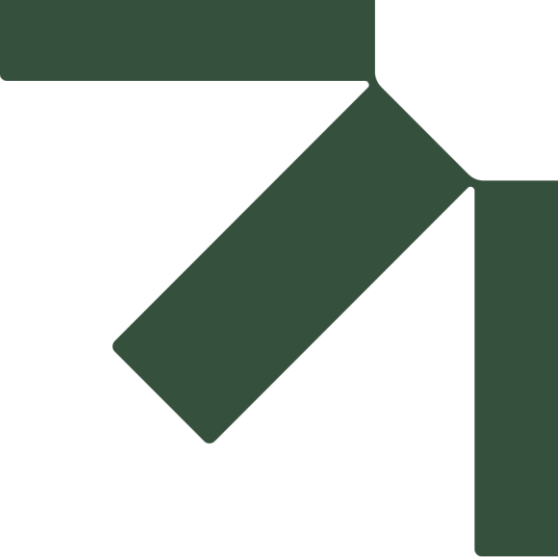
According to SANS 10083:2021, Clause 8.2.1 Page 14:

"Ensure that all items of sound measuring equipment used are so calibrated against the requirements of SANS 60942, SANS 61672-1 and SANS 61672-2 (by an accredited facility), at intervals not exceeding one year for the sound calibrator, and two years for the rest of the equipment, that they comply with the requirements for accuracy prescribed in 8.1."

The manufacturer's recommended calibration interval, Government Gazette, Noise Control Regulations Act and IEC/SANS Standards on Occupational Health and Safety should be taken into consideration regarding intervals for

-----SECTION 4.7 THE END OF CERTIFICATE-----

Calibrated by Calibration Technician:	 D.N. MASIMULA	Clause 3.1 & 3.2
Calibrated/Supervised by Calibration Technician:	 W.S. SIBANYONI	Clause 3
Authorized/Checked by SANAS Technical Signatory:	 M. NAUDÉ	Date of Issue: 06 JUNE 2025



Appendix D Fieldwork Photographs

Noise Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

SLR Project No.: 723.000205.00001

6 May 2026



Table D-1: Phase 1 noise monitoring field observations

Site	Monitoring methodology	Site Comments	Picture of Monitoring Equipment
FL 1	A Type 1 SLM, calibrated before and after use, was positioned at approximately 1.5 m above ground level under free-field conditions. Measurements were conducted using A-weighting (dB(A)) with fast response settings. Noise monitoring was conducted during one-hour daytime and nighttime sampling intervals between 09/12/2025 - 10/12/2025. Daytime measurements were undertaken from 07h00 to 18h00 and nighttime measurements from 22h00 to 06h00, in accordance with SANS 10103:2008 and IFC guidelines.	The SLM was installed in accordance with standard operating procedures and manufacturer guidelines. Sampling locations were selected to minimise the influence of nearby structures, vegetation, and other potential obstructions. Notes from site: No unusual site activities, or significant disturbances were observed during the monitoring period. Access to the sites was controlled, and monitoring equipment remained secure and undisturbed throughout the survey. Weather conditions were generally stable and suitable for monitoring activities.	 Sound level meter Lat: [REDACTED], Long: [REDACTED]
FL 2	A Type 1 SLM, calibrated before and after use, was positioned at approximately 1.5 m above ground level under free-field conditions. Measurements were conducted using A-weighting (dB(A)) with fast response settings. Noise monitoring was conducted during one-hour daytime and nighttime sampling intervals between 09/12/2025 - 10/12/2025. Daytime measurements were undertaken from 07h00 to 18h00 and nighttime measurements from 22h00 to 06h00, in accordance with SANS 10103:2008 and IFC guidelines.	The SLM was installed in accordance with standard operating procedures and manufacturer guidelines. Sampling locations were selected to minimise the influence of nearby structures, vegetation, and other potential obstructions. Notes from site: No unusual site activities, or significant disturbances were observed during the monitoring period. Access to the sites was controlled, and monitoring equipment remained secure and undisturbed throughout the survey. Weather conditions were generally stable and suitable for monitoring activities.	 Sound level meter Lat: [REDACTED], Long: [REDACTED]



Site	Monitoring methodology	Site Comments	Picture of Monitoring Equipment
FL 3	A Type 1 SLM, calibrated before and after use, was positioned at approximately 1.5 m above ground level under free-field conditions. Measurements were conducted using A-weighting (dB(A)) with fast response settings. Noise monitoring was conducted during one-hour daytime and nighttime sampling intervals between 09/12/2025 - 10/12/2025. Daytime measurements were undertaken from 07h00 to 18h00 and nighttime measurements from 22h00 to 06h00, in accordance with SANS 10103:2008 and IFC guidelines.	The SLM was installed in accordance with standard operating procedures and manufacturer guidelines. Sampling locations were selected to minimise the influence of nearby structures, vegetation, and other potential obstructions. Notes from site: No unusual site activities, or significant disturbances were observed during the monitoring period. Access to the sites was controlled, and monitoring equipment remained secure and undisturbed throughout the survey. Weather conditions were generally stable and suitable for monitoring activities.	 Sound level meter Lat: [REDACTED] Long: [REDACTED]
NSR 1 ([REDACTED])	A Type 1 SLM, calibrated before and after use, was positioned at approximately 1.5 m above ground level under free-field conditions. Measurements were conducted using A-weighting (dB(A)) with fast response settings. Noise monitoring was conducted during one-hour daytime and nighttime sampling intervals between 09/12/2025 - 10/12/2025. Daytime measurements were undertaken from 07h00 to 18h00 and nighttime measurements from 22h00 to 06h00, in accordance with SANS 10103:2008 and IFC guidelines.	The SLM was installed in accordance with standard operating procedures and manufacturer guidelines. Sampling locations were selected to minimise the influence of nearby structures, vegetation, and other potential obstructions. Notes from site: No unusual site activities, or significant disturbances were observed during the monitoring period. Access to the sites was controlled, and monitoring equipment remained secure and undisturbed throughout the survey. Weather conditions were generally stable and suitable for monitoring activities.	 Sound level meter Lat: [REDACTED], Long: [REDACTED]



Table D-2: Phase 2 noise monitoring field observations

Site	Monitoring methodology	Site Comments	Picture of Monitoring Equipment
FL 1	A Type 1 SLM, calibrated before and after use, was positioned at approximately 1.5 m above ground level under free-field conditions. Measurements were conducted using A-weighting (dB(A)) with fast response settings. Noise monitoring was conducted during one-hour daytime and nighttime sampling intervals between 23/02/2026 – 28/02/2026. Daytime measurements were undertaken from 07h00 to 18h00 and nighttime measurements from 22h00 to 06h00, in accordance with SANS 10103:2008 and IFC guidelines.	The SLM was installed in accordance with standard operating procedures and manufacturer guidelines. Sampling locations were selected to minimise the influence of nearby structures, vegetation, and other potential obstructions. Notes from site: No unusual site activities, or significant disturbances were observed during the monitoring period. Access to the sites was controlled, and monitoring equipment remained secure and undisturbed throughout the survey. Weather conditions were generally stable and suitable for monitoring activities. Insect activity and rustling trees noted during daytime measurements. Intermittent industrial alarms, traffic and train pass-by noted at night.	 Sound level meter Lat: [REDACTED], Long: [REDACTED]
FL 2	A Type 1 SLM, calibrated before and after use, was positioned at approximately 1.5 m above ground level under free-field conditions. Measurements were conducted using A-weighting (dB(A)) with fast response settings. Noise monitoring was conducted during one-hour daytime and nighttime sampling intervals between 23/02/2026 – 28/02/2026. Daytime measurements were undertaken from 07h00 to 18h00 and nighttime measurements from 22h00 to 06h00, in accordance with SANS 10103:2008 and IFC guidelines.	The SLM was installed in accordance with standard operating procedures and manufacturer guidelines. Sampling locations were selected to minimise the influence of nearby structures, vegetation, and other potential obstructions. Notes from site: No unusual site activities, or significant disturbances were observed during the monitoring period. Access to the sites was controlled, and monitoring equipment remained secure and undisturbed throughout the survey. Weather conditions were generally stable and suitable for monitoring activities. Bird chirping and train pass-by noted during daytime measurements. Insect activity and light wind through vegetation noted at night.	 Sound level meter Lat: [REDACTED], Long: [REDACTED]

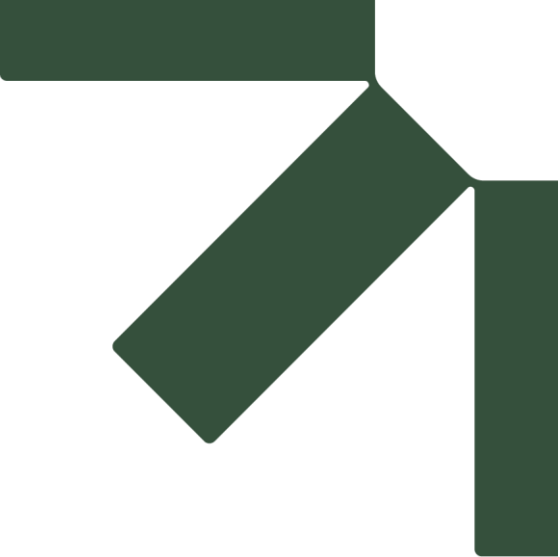


Site	Monitoring methodology	Site Comments	Picture of Monitoring Equipment
FL 3	A Type 1 SLM, calibrated before and after use, was positioned at approximately 1.5 m above ground level under free-field conditions. Measurements were conducted using A-weighting (dB(A)) with fast response settings. Noise monitoring was conducted during one-hour daytime and nighttime sampling intervals between 23/02/2026 – 28/02/2026. Daytime measurements were undertaken from 07h00 to 18h00 and nighttime measurements from 22h00 to 06h00, in accordance with SANS 10103:2008 and IFC guidelines.	The SLM was installed in accordance with standard operating procedures and manufacturer guidelines. Sampling locations were selected to minimise the influence of nearby structures, vegetation, and other potential obstructions. Notes from site: No unusual site activities, or significant disturbances were observed during the monitoring period. Access to the sites was controlled, and monitoring equipment remained secure and undisturbed throughout the survey. Weather conditions were generally stable and suitable for monitoring activities. Intermittent industrial alarms, traffic and train pass-by noted during daytime measurements. Insect activity and light wind through vegetation noted at night.	 Sound level meter Lat: [REDACTED], Long: [REDACTED]
NSR 1 ([REDACTED])	A Type 1 SLM, calibrated before and after use, was positioned at approximately 1.5 m above ground level under free-field conditions. Measurements were conducted using A-weighting (dB(A)) with fast response settings. Noise monitoring was conducted during one-hour daytime and nighttime sampling intervals between 23/02/2026 – 28/02/2026. Daytime measurements were undertaken from 07h00 to 18h00 and nighttime measurements from 22h00 to 06h00, in accordance with SANS 10103:2008 and IFC guidelines.	The SLM was installed in accordance with standard operating procedures and manufacturer guidelines. Sampling locations were selected to minimise the influence of nearby structures, vegetation, and other potential obstructions. Notes from site: No unusual site activities, or significant disturbances were observed during the monitoring period. Access to the sites was controlled, and monitoring equipment remained secure and undisturbed throughout the survey. Weather conditions were generally stable and suitable for monitoring activities. Natural ambient sounds with transport-related noise events.	 Sound level meter Lat: [REDACTED], Long: [REDACTED]



Site	Monitoring methodology	Site Comments	Picture of Monitoring Equipment
NSR 2 ([REDACTED])	A Type 1 SLM, calibrated before and after use, was positioned at approximately 1.5 m above ground level under free-field conditions. Measurements were conducted using A-weighting (dB(A)) with fast response settings. Noise monitoring was conducted during one-hour daytime and nighttime sampling intervals between 23/02/2026 – 28/02/2026. Daytime measurements were undertaken from 07h00 to 18h00 and nighttime measurements from 22h00 to 06h00, in accordance with SANS 10103:2008 and IFC guidelines.	The SLM was installed in accordance with standard operating procedures and manufacturer guidelines. Sampling locations were selected to minimise the influence of nearby structures, vegetation, and other potential obstructions. Notes from site: No unusual site activities, or significant disturbances were observed during the monitoring period. Access to the sites was controlled, and monitoring equipment remained secure and undisturbed throughout the survey. Weather conditions were generally stable and suitable for monitoring activities. Intermittent industrial alarms, traffic and train pass-by. Faint continuous mechanical/industrial humming noted during daytime measurements. Faint audible human speech noted at night.	 Sound level meter Lat: [REDACTED], Long: [REDACTED]
NSR 3 ([REDACTED])	A Type 1 SLM, calibrated before and after use, was positioned at approximately 1.5 m above ground level under free-field conditions. Measurements were conducted using A-weighting (dB(A)) with fast response settings. Noise monitoring was conducted during one-hour daytime and nighttime sampling intervals between 23/02/2026 – 28/02/2026. Daytime measurements were undertaken from 07h00 to 18h00 and nighttime measurements from 22h00 to 06h00, in accordance with SANS 10103:2008 and IFC guidelines.	The SLM was installed in accordance with standard operating procedures and manufacturer guidelines. Sampling locations were selected to minimise the influence of nearby structures, vegetation, and other potential obstructions. Notes from site: No unusual site activities, or significant disturbances were observed during the monitoring period. Access to the sites was controlled, and monitoring equipment remained secure and undisturbed throughout the survey. Weather conditions were generally stable and suitable for monitoring activities. Intermittent industrial alarms, traffic and train pass-by during the daytime. Natural ambient sounds including wind-induced rustling of trees, train pass-by and helicopter passing noted during daytime measurements. Faint mechanical / industrial noise and insect activity noted at night.	 Sound level meter Lat: [REDACTED], Long: [REDACTED]





Appendix E Acoustic Terminology

Noise Baseline Assessment

Proposed Vaccine Manufacturing Facility, Cape Town

The Biovac Institute (Pty) Ltd

SLR Project No.: 723.000205.00001

6 May 2026

1. Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that 'noise' often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_p are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dB, which if there is a subscript 'A' is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dB level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dB)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (e.g. B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear' or 'Z' weighted.

3. Sound Power Level

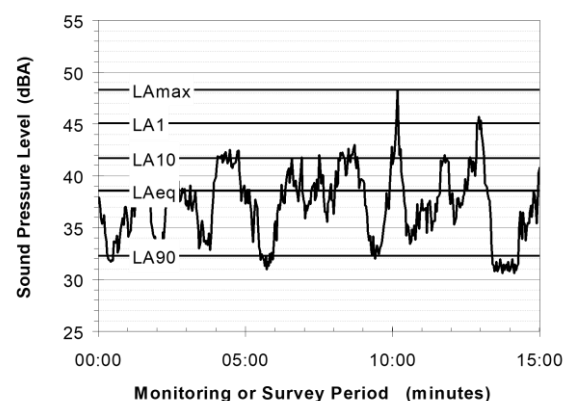
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are also expressed in decibels (dB), but in practice may be identified with a 'w' subscript, e.g. SWL, PWL or L_w , and by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise level exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15-minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

LA1 The noise level exceeded for 1% of the 15 minutes interval.

LA10 The noise level exceeded for 10% of the 15 minutes interval. This is commonly referred to as the average maximum noise level.

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

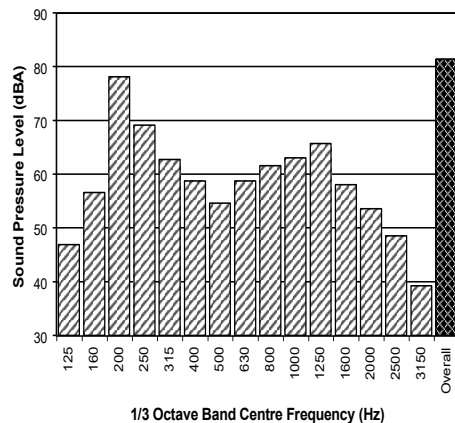
The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)



The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- **Tonality** - tonal noise contains one or more prominent tones (i.e. differences in distinct frequency components between adjoining octave or 1/3 octave bands) and is normally regarded as more annoying than 'broad band' noise.
- **Impulsiveness** - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- **Intermittency** - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- **Low Frequency Noise** - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V , expressed in mm/s can be converted to decibels by the formula $20 \log (V/V_0)$, where V_0 is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

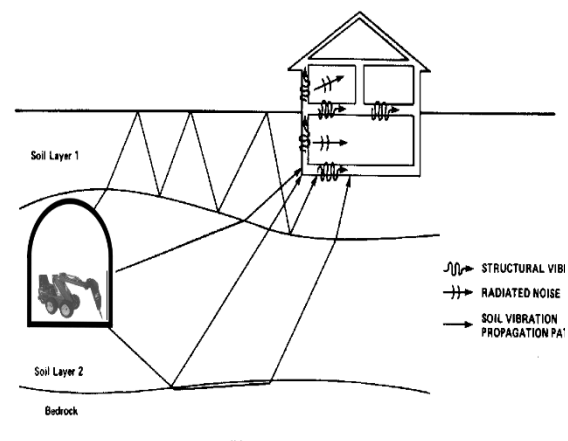
People can 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

9. Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (e.g. rock breakers), and building services plant (e.g. fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.





Making Sustainability Happen