CAMDEN GREEN ENERGY RF (PTY) LTD

ENVIRONMENTAL ACOUSTIC IMPACT ASSESSMENT

CAMDEN I GREEN HYDROGEN AND AMMONIA FACILITY

21 JULY 2022

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CAMDEN GREEN ENERGY RF (PTY) LTD

REPORT (VERSION 01)

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WSP
BUILDING C, KNIGHTSBRIDGE
33 SLOANE STREET
BRYANSTON, 2191
SOUTH AFRICA

T: +27 11 361 1380
F: +086 606 7121
WSP.COM

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GLOSSARY OF TERMS

Sound	Sound is small fluctuations in air pressure, measured in Newtons per square meter (N/m^2) or Pascals (Pa) that are transmitted as vibrational energy via a medium (air) from the source to the receiver. The human ear is a pressure transducer, which converts these small fluctuations in air pressure into electrical signals, which the brain then interprets as sound.
Noise	Noise is generally defined as unwanted sound.
Sound or noise level	A sound or noise level is a sound measurement that is expressed in decibels (dB or dB(A)).
dB or dB(A)	The human ear is a sensitive instrument that can detect fluctuations in air pressure over a wide range of amplitudes. This limits the usefulness of sound quantities in absolute terms. For this reason, a sound measurement is expressed as ten times the logarithm of the ratio of the sound measurement to a reference value, 20 micro (millionth) Pa. This process converts a scale of constant increases to a scale of constant ratios and considerably simplifies the handling of sound measurement quantities. The attached 'A' indicates that the sound measurement has been A-weighted.
dB(Z)	Historically sound levels were read off a hand-held meter and the noise levels were noted in dB, after the development of different weighting curves sound levels were noted as Z-weighting or dB(Z) to reduce the confusion with different type of weighting applied noise levels. dB(Z) refers to linear noise levels.
A-weighting	The human ear is not equally sensitive to sound of all frequencies, i.e. it is less sensitive to low pitched (or 'bass') than high pitched (or 'treble') sounds. In order to compensate when making sound measurements, the measured value is passed through a filter that simulates the human hearing characteristic. Internationally this is an accepted procedure when working with measurements that relate to human responses to sound/noise.
Ambient sound level	Ambient noise will be defined as the totally encompassing sound in a given situation at a given time, and is usually composed of sound from many sources, both near and far.
Annoyance	General negative reaction of the community or person to a condition creating displeasure or interference with specific activities**.**
Sound pressure	Sound pressure is the force of sound exerted on a surface area perpendicular to the direction of the sound and is measured in N/m^2 or Pa. The human ear perceives sound pressure as loudness and can also be expressed as the number of air pressure fluctuations that a noise source creates.
Sound pressure level	The sound pressure level is a relative quantity as it is a ratio between the actual sound pressure and a fixed reference pressure. The reference pressure is usually the threshold of hearing, namely 20 microPascals (µPa).
Sound power	Sound power is the rate of sound energy transferred from a noise source per unit of time in Joules per second (J/s) or Watts (W).
Sound power level	The sound power level is a relative quantity as it relates the sound power of a source to the threshold of human hearing (10^{-12} W). Sound power levels are expressed in dB(A), as they are referenced to sound detected by the human ear (A-weighted).
Noise nuisance	Noise nuisance means any sound which disturbs or impairs or may disturb or impair the convenience or peace of any person.
Octave bands	The octave bands refer to the frequency groups that make a sound. The sound is generally divided in to nine groups (octave bands) ranging from 32 Hertz (Hz) to 8,000 Hz. The lower frequency ranges of a sound have a vibrating character where the higher frequency of sound has the character of high-pitched sound. In viewing the total octave bands scale from 32 Hz to 8000 Hz the character of the sound can be described.

ACRONYMS AND ABBREVIATIONS

CGE	Camden Green Energy RF (Pty) Ltd
dB	Decibel
dB(A)	A-weighted sound measurement
dB(C)	C-weighted sound measurement
dB(Z)	Z-weighted sound measurement
DMRE	Department of Mineral Resources and Energy
ESIA	Environmental and Social Impact Assessment
ha	Hectare
Hz	Hertz
IFC	International Finance Corporation
km	Kilometre
kV	Kilovolt
LAES	Liquid Air Energy System
L_{A90}	Noise level exceeded for 90% of the measurement period
L_{Aeq}	Equivalent continuous sound pressure level
$L_{R,dn}$	Equivalent continuous day/night rating level
$L_{Req,d}$	Equivalent continuous rating level for day-time
$L_{Req,n}$	Equivalent continuous rating level for night-time
$L_{Req,T}$	Typical noise rating levels
m	Metres
m/s	Meters per second
MW	Megawatt
REIPP	Renewable Energy Independent Power Producer Procurement Programme
tpa	Tons per annum
WEF	Wind Energy Facility
WHO	World Health Organisation
WSP	WSP Group Africa (Pty) Ltd

EXECUTIVE SUMMARY

ENERTRAG South Africa (Pty) Ltd, a subsidiary of the renewable energy company, ENERTRAG SE, are proposing to establish the Camden I Green Hydrogen and Ammonia Facility near Ermelo, in the Mpumalanga Province. The facility forms part of the Camden Renewable Energy Complex.

WSP Group Africa (Pty) Ltd has been appointed to undertake the Environmental and Social Impact Assessment (ESIA) for the Project. For the proposed Camden I Green Hydrogen and Ammonia Facility, very minimal noise impacts are anticipated based on the remote location and minimal nearby receptors and thus a generic calculation-based environmental acoustic impact assessment has been carried out as part of the ESIA process to assess impacts. This report presents the findings of the Environmental Acoustic Impact Assessment performed.

To assess the existing noise climate in the area surrounding the proposed facility, ambient noise monitoring was conducted at three sensitive receptor locations surrounding the site. An acoustic inventory was developed to identify all potential sources of noise associated with the proposed facility. The acoustic impacts of the proposed facility were then assessed through the use of attenuation-over-distance acoustic calculations.

Baseline monitoring indicated that current day-time noise levels exceed the rural guideline rating level of 45 dB(A) at all three monitoring locations (receptors). Similarly, average night-time noise levels at all receptor locations exceed the rural guideline rating level of 35 dB(A). From the day-time monitoring campaign it is evident that the current noise climate surrounding the proposed site is predominantly natural, with small anthropogenic influences from the Camden Power Station and farm activities. At night, the current noise climate is predominantly natural, with no anthropogenic influences.

During the operational phase of the facility, day-time noise levels at all receptor locations are predicted to increase slightly. Noise levels will increase by between 0.1 and 0.2 dB(A) resulting in “little” community response. Such increases are so negligible that are likely to go unnoticed. It is noted that such increases are also below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

Predicted night-time noise levels at all the receptor locations are predicted to increase slightly with the operation of the facility. Noise levels will increase by between 0.4 and 1.5 dB(A) resulting in “little” community response. Such increases are negligible that are likely to go unnoticed. It is noted that such increases are also below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

It must be highlighted that these are worst-case assessments of noise impacts, with all equipment located in the same area on the boundary closest to the receptor in question, which will not occur in reality. Noise sources will essentially be spread out across the site. Additionally, many of the sources will be enclosed within buildings, creating further noise transmission loss.

Based on a risk rating methodology, the resultant environmental acoustic risks for residential receptors were ranked “low” to “very low” during the unmitigated and mitigated construction phase, respectively. Acoustic risks of the operational phase during both day and night-time are ranked as “very low”. As such, it is envisaged that the operation of the facility can be authorised without any major impacts or complaints. The facility is adequately positioned away from sensitive receptors and will not negatively impact the noise climate at the receptors.

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1 INTRODUCTION

ENERTRAG South Africa (Pty) Ltd, a subsidiary of the renewable energy company, ENERTRAG SE, proposes to establish the Camden Renewable Energy Complex near Ermelo, in the Mpumalanga Province. The proposed complex forms part of the Renewable Energy Independent Power Producer Procurement Programme (REIPPP) developed and instituted by the National Department of Mineral Resources and Energy (DMRE). The proposed Camden Complex includes the following:

- Camden I Wind Energy Facility (up to 200 MW).
- Camden I Wind Grid Connection (up to 132 kV).
- Camden I up to 400 kV Grid Connection and Collector substation.
- Camden I Solar (100 MW).
- Camden I Solar Grid Connection (up to 132 kV).
- Camden Green Hydrogen and Ammonia Facility, including grid connection infrastructure.
- Camden II Wind Energy Facility (up to 200 MW).
- Camden II Wind Grid Connection (up to 132 kV).

WSP Group Africa (Pty) Ltd has been appointed to undertake the Environmental and Social Impact Assessment (ESIA) for the Projects. This report specifically addresses the Camden I Green Hydrogen and Ammonia Facility proposed by Camden Green Energy (RF) Pty Ltd (CGE).

For the proposed Camden I Green Hydrogen and Ammonia Facility, very minimal noise impacts are anticipated based on the remote location and minimal nearby receptors. A calculation-based Environmental Acoustic Impact Assessment has been carried out as part of the ESIA process to assess impacts on such receptors. This report presents the findings of the Environmental Acoustic Impact Assessment performed.

1.1 TERMS OF REFERENCE

The terms of reference, designed to best meet the project requirements are summarised below:

- An assessment of the existing noise climate in the vicinity of the site through baseline noise monitoring.
- Assessment of monitored results against the relevant guideline rating levels.
- An assessment of the proposed project through the evaluation of potential sources related to the facility and their potential for creating noise in relation to surrounding receptors. This assessment includes basic attenuation-over-distance acoustic calculations in order to assess any potential impacts.
- Presentation of resultant impacts in the form of an environmental acoustic impact assessment report (this report).

1.2 DECLARATION OF INDEPENDENCE

Kirsten Collett is an air quality and acoustic consultant with a Master of Science (Atmospheric Sciences) degree obtained from the University of the Witwatersrand. She is currently employed by WSP and has worked on environmental acoustic impact assessments, monitoring and modelling for a variety of clients over the past nine years. She has provided acoustic consulting support to various client industries including petrochemical, mining and production industries among others. She is also a registered Professional Natural Scientist (Pr. Nat. Sci.) with the South African Council for Natural Scientific Professions (SACNASP). Please see **Appendix A** for a short CV detailing project experience.

I hereby declare that I am fully aware of my responsibilities in terms of the National Environmental Management Act: Environmental Impact Assessment Regulations of 2014 and that I have no financial or other interest in the undertaking of the proposed activity other than the imbursement of consultant’s fees.

Name: Kirsten Collett

Company: WSP Group Africa (Pty) Ltd

Contact Details: +27 11 361 1372

Kirsten.Collett@wsp.com

Signature:

2 BACKGROUND

2.1 LOCALITY

CGE are proposing to construct the Camden I Green Hydrogen and Ammonia Facility, near Camden in the Mpumalanga Province. The facility will be located ~ 12 km southeast of Ermelo, close to the Camden Power Station (**Figure 1)**.

From a high-level assessment of the area, two proposed site locations have been identified. The site closest to the Camden Power Station (Site A) is currently the preferred option and as such is assessed in this study.

2.2 TOPOGRAPHY

The Project area is largely characterised by a mix of undulating plains and greater relief in the form of higher lying plateaus intersected by river valleys. Slopes across the study area are relatively gentle to moderate, with steeper slopes being largely associated with the more incised river valleys. The main water course in the study area is the Vaal River in the south-eastern portion of the study area. Gently undulating terrain prevails across much of the Camden I Green Hydrogen and Ammonia Facility development site. A map showing the typical terrain across the area is presented in **Figure 2**.

2.3 SENSITIVE RECEPTORS

Sensitive receptors are identified as areas that may be impacted negatively due to noise associated with the proposed facility. Examples of receptors include, but are not limited to, schools, shopping centres, hospitals, office blocks and residential areas. Being such a remotely located site, dominant receptors in the area surrounding the site include small farmsteads and farmhouses. The specific sensitive receptors (farmhouses) considered in this study are presented in **Figure 3** and **Table 1**.

Table 1: Sensitive receptors surrounding the project site

ID	Description	Latitude (°S)	Longitude (°E)	Distance from Facility (m)	Direction from Facility
C1_Rec 01	Farmhouse	26.634611	30.033396	3,130	NW
C1_Rec 02	Farmhouse	26.632051	30.078345	1,595	NE
C1_Rec 03	Farmhouse	26.670771	30.069023	2,500	S

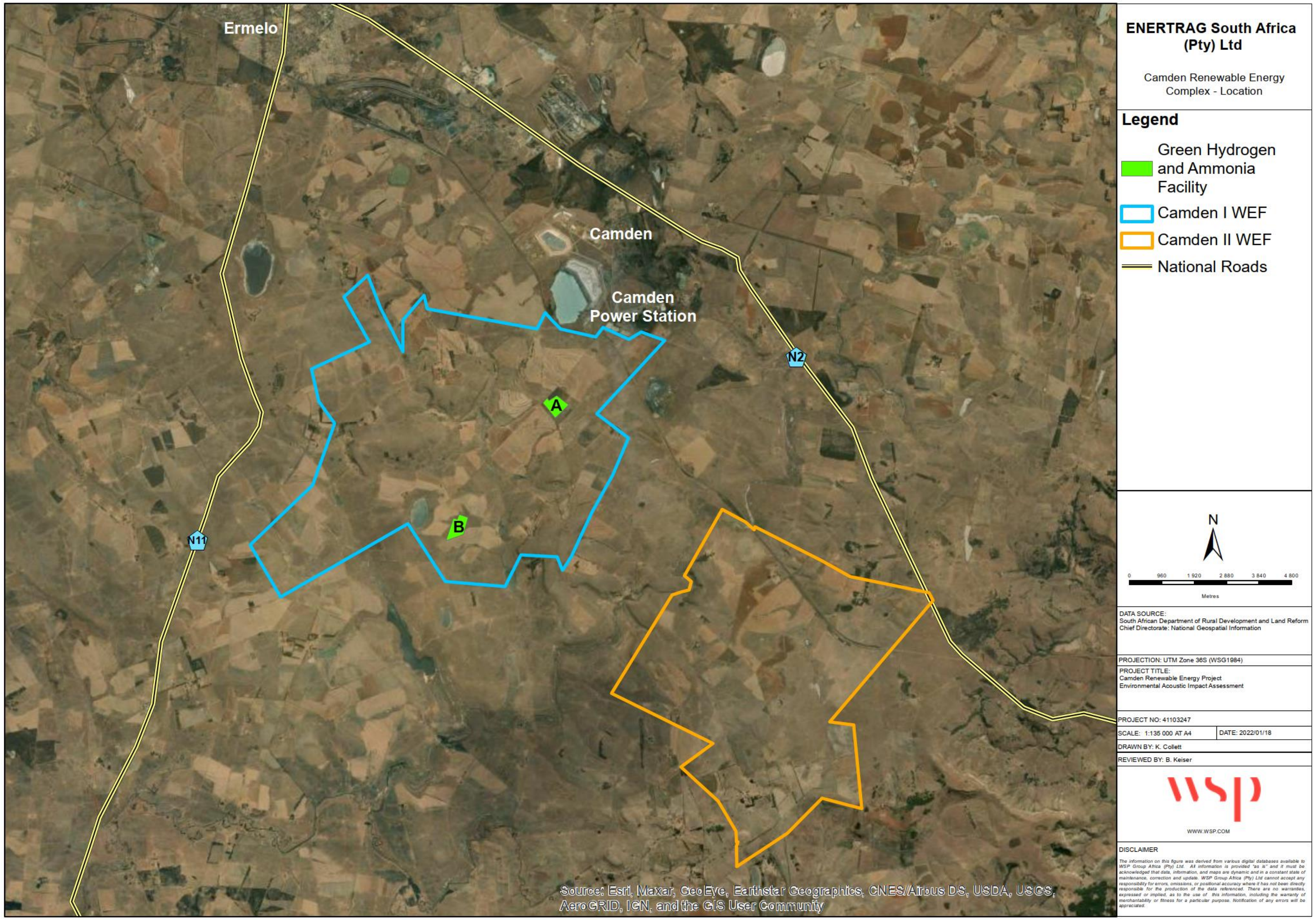

Figure 1: Location of the project site

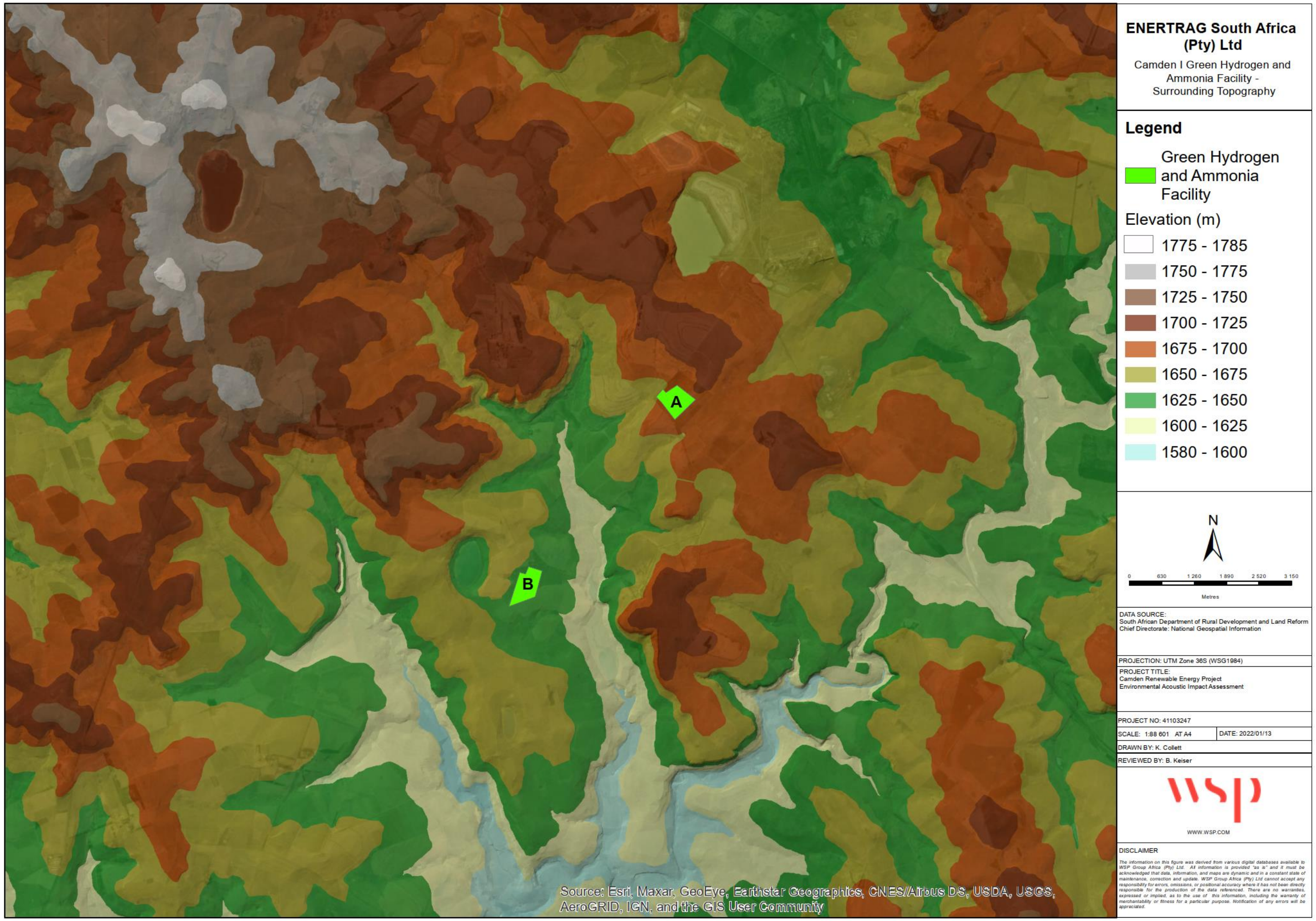

Figure 2: **Terrain map**

Figure 3: **Location of sensitive receptors surrounding site A**

2.4 PROJECT DESCRIPTION

2.4.1 CONSTRUCTION PHASE

The construction process will follow industry standard methods and techniques. Key activities associated with the construction phase are described in **Table 2**.

Table 2: Construction Activities

Activity	Description
Site preparation and establishment	Site establishment will include clearing of vegetation and topsoil at the authorised site, including laydown area and access routes. The temporary laydown area will be constructed, including establishment of the construction camp (temporary offices, storage containers, concrete batching plant etc). Site establishment will also entail the installation and/or connection of services (sanitation, electricity etc).
Transport of components and equipment to site	Bulk materials (aggregate, steel etc.), infrastructure components, lifting and construction equipment (excavators, trucks, compaction equipment etc.) will be sourced and transported to site via suitable National and provincial routes and designated access roads. The infrastructure components may be defined as abnormal loads in terms of the Road Traffic Act (Act 29 of 1989) due to their large size and abnormal lengths and loads for transportation. A permit may be required for the transportation of these loads on public roads.
Excavation and earthworks	Subject to the determination of foundation specifications, earthworks will be required. This is likely to entail: — Excavation of foundation holes for concrete foundations — Levelling of the plant area, construction camp area, substation area, and O&M building area, and excavation of foundations prior to construction. — Excavation of trenches for the installation of underground cables and material pipelines as needed.
Construction of Green Hydrogen and Ammonia facility	A large lifting crane will be required to lift the various components into place. The lifting crane/s will be brought on site.
Establishment of ancillary infrastructure	Ancillary infrastructure will include construction site office, temporary laydown area and workshop area for contractor's equipment.
Rehabilitation	Once all construction is completed on site and all equipment and machinery has been removed from the site, the site will be rehabilitated.

2.4.2 OPERATIONAL PHASE

"Green" hydrogen and ammonia production differs from traditional production technologies in that the process relies exclusively on renewable resources (renewable energy) and for input air and water (feedstock), to produce commercially usable green hydrogen and ammonia. The only solid waste stream is the production of brine from the water treatment plant. Ammonia spillages may occur; however, these will be accidental and mitigation measures will be developed and implemented, including amongst others suitable containment related to storage and emergency response measures. The Camden I Green Hydrogen and Ammonia Facility will be powered by the neighbouring proposed Camden I Wind Energy Facility (WEF) and Camden I Solar Energy Facility as well as battery storage, which are all part of the Camden Renewable Energy Complex.

A gaseous 'waste' (oxygen) is generated from the electrolysis process. Another source of gaseous 'wastes' is from the Air Separation Unit. This is where nitrogen is removed from the air and the other natural gases are expelled back to the environment.

Commercially, hydrogen is used as a fuel for transport in hydrogen fuel cells. Alternatively, hydrogen is used for welding and in the production of other chemicals such as methanol and hydrochloric acid and also has other commercial uses like the filling of balloons. It is also a primary input to the production of ammonia. Ammonia in turn is primarily used in the production of ammonium nitrate (fertiliser) and is also used as refrigerant gas and the manufacture of plastics, explosives, textiles, pesticides and other chemicals. Ammonia can also be used as a stable 'carrier' of hydrogen, allowing hydrogen to be readily stored and transported.

A process flow diagram of the Camden I Green Hydrogen and Ammonia Facility is presented in **Figure 4,** with a preliminary site layout depicted in **Figure 5**. Process activities are described below:

- **Water feedstock:** Water is required for the production of hydrogen and for heating and cooling purposes. Feedstock water will be stored in a water reservoir. Potential water sources include groundwater (from borehole), municipal water, purified wastewater (from surrounding commercial or mining facilities) or the Usutu pipeline (bulk water infrastructure currently feeding the surrounding coal mines and power stations). The Usutu pipeline is currently the preferred option.
- **Water treatment:** Water treatment facilities will contain multi-filtration stages and pumps. The feedstock water will be treated using reverse osmosis to remove wastes such as brine salt. An estimated consumption of 390 000 m^3 per annum is anticipated at the facility. Purified water from the water treatment facility is the main input to the next step in the process, namely the electrolyser.
- **Electrolyser:** Purified water from the treatment plant will be fed through the electrolyser using electric current (renewable energy provided from the WEF, solar energy facility and associated battery storages) to separate water molecules ($2H_2O$) through a reduction-oxidation process, into hydrogen gas ($2H_2$ on the cathode side) and oxygen gas (O_2 on the anode side). It is proposed that fifteen sets of 10 MW electrolysers (150 MW in total) will be installed with the capacity to produce 20,000 tons per annum (tpa) of 'green' hydrogen and up to 60,000 tpa of 'green' oxygen. Oxygen will either be released to atmosphere or stored and sold as a by-product. Hydrogen will either be directed to the ammonia production plant or sold directly to interested parties. Each electrolyser unit will be powered through its own set of transformers and rectifiers.
- **Air Separator Unit:** Air from the atmosphere (approximately 78% nitrogen, 21% oxygen and 1% trace gases) is separated into nitrogen and oxygen with the impurities removed. The process involves air compression and temperature manipulation in a pressure-controlled environment to separate gasses from one another and produce gaseous nitrogen. The air separation unit will have a capacity of 110,000 tpa.
- **Ammonia Processing Unit:** Nitrogen from the air separation unit and hydrogen from the electrolyser will be reacted over a bed of catalyst to form ammonia – as per the standard Haber-Bosch method. The ammonia gas will be rapidly cooled to form anhydrous ammonia. Unreacted nitrogen and hydrogen will be recycled back to the reactor. At full capacity, the facility will produce up to 100,000 tpa of green ammonia for market. Typical components of an ammonia production plant include compressors, filters, reactor chamber and beds, heat exchangers, water storage vessels, condensers, separators, circulators, absorbers and gas release valves.
- **Liquid Air Energy System (LAES):** The LAES will be used to store excess nitrogen collected from the air separation unit. Nitrogen will be cooled and stored in liquid form in insulated vessels at low pressure. The LAES will double as a backup energy source when needed. The system uses pressure changes from the superheating and evaporation of liquified air to turn gas turbines and generate electricity. Components in the LAES include compressors, ambient and cryogenic heat exchangers, expansion valves, storage vessels, pumps, small turbines and generators.
- **Storage:** Storage onsite will occur in a variety of specialised tanks. Nitrogen will be stored (7-14 days) as a liquid within large cylindrical cryogenic storage tanks with a combined volume of approximately 4,100 tons. It is proposed that the facility will house up to two cylindrical cryogenic storage tanks. Green ammonia will be stored as anhydrous liquid ammonia, using similar storage equipment as that utilised for storage of Liquid Natural Gas (LNG), i.e. in a bulk storage tank farm. Hydrogen will be stored in vertical or horizontal storage bullets. Compressed hydrogen can be stored as a gas or in liquid form. Up to 800 tons of hydrogen will be stored at the facility, in conjunction with that of the oxygen stored on site, in a tank farm of up to 12 ha. Oxygen will be stored in vertical or horizontal storage bullets and stored under high-pressures.
- **Dispatch:** Ammonia is easily transported by truck and rail as a pressurized liquid. The facility will include three loading gantries for the filling of containers for dispatch by Standard pressurised road tanker or ISOtainer (for road transport options), or via pressured rail container (Isotank).

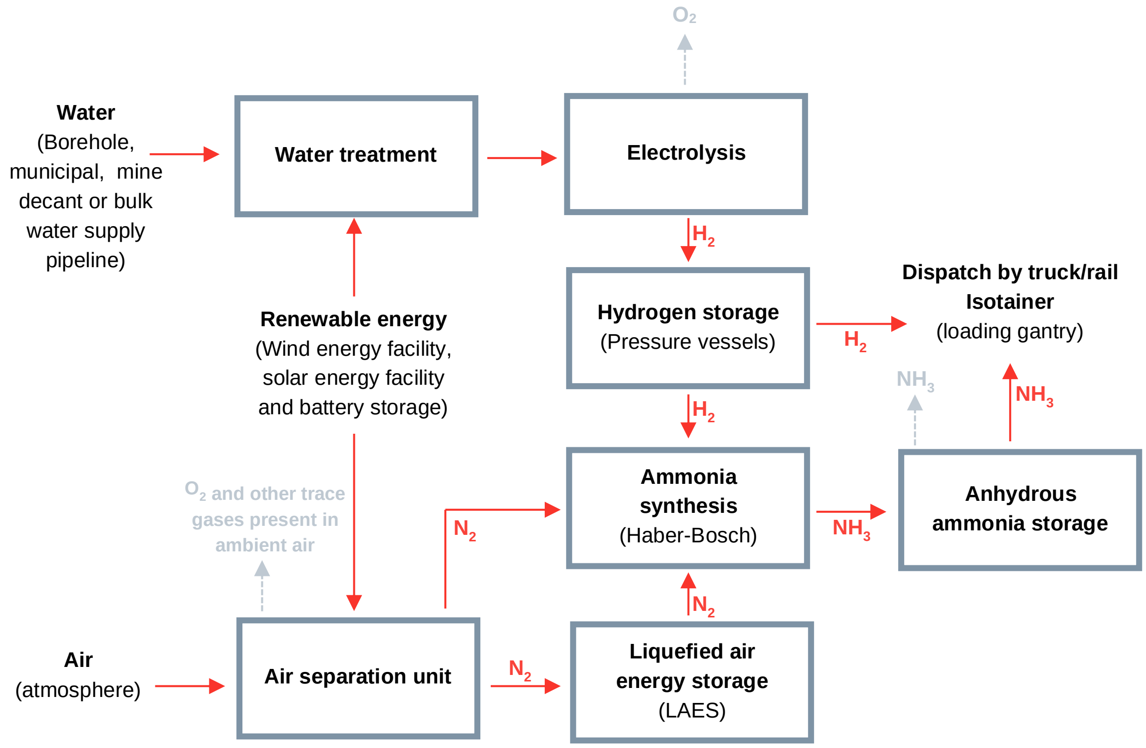

Figure 4: Process flow for the Camden I Green Hydrogen and Ammonia Facility

2.5 EXISTING NOISE CLIMATE

The existing noise climate surrounding the Camden I Green Hydrogen and Ammonia Facility is predominantly rural with very low baseline noise levels. Noise sources include birds, insects, livestock and activities of resident farmers. Anthropogenic influences may include traffic on local roads and on the nearby N2 National road as well as train activity along the railway line located just northeast of the study area. Noise from the nearby Camden Power Station is also evident at the receptor in closest proximity to the power station. Results from a baseline monitoring campaign undertaken at the three receptor locations are presented in **Section 7.1**.

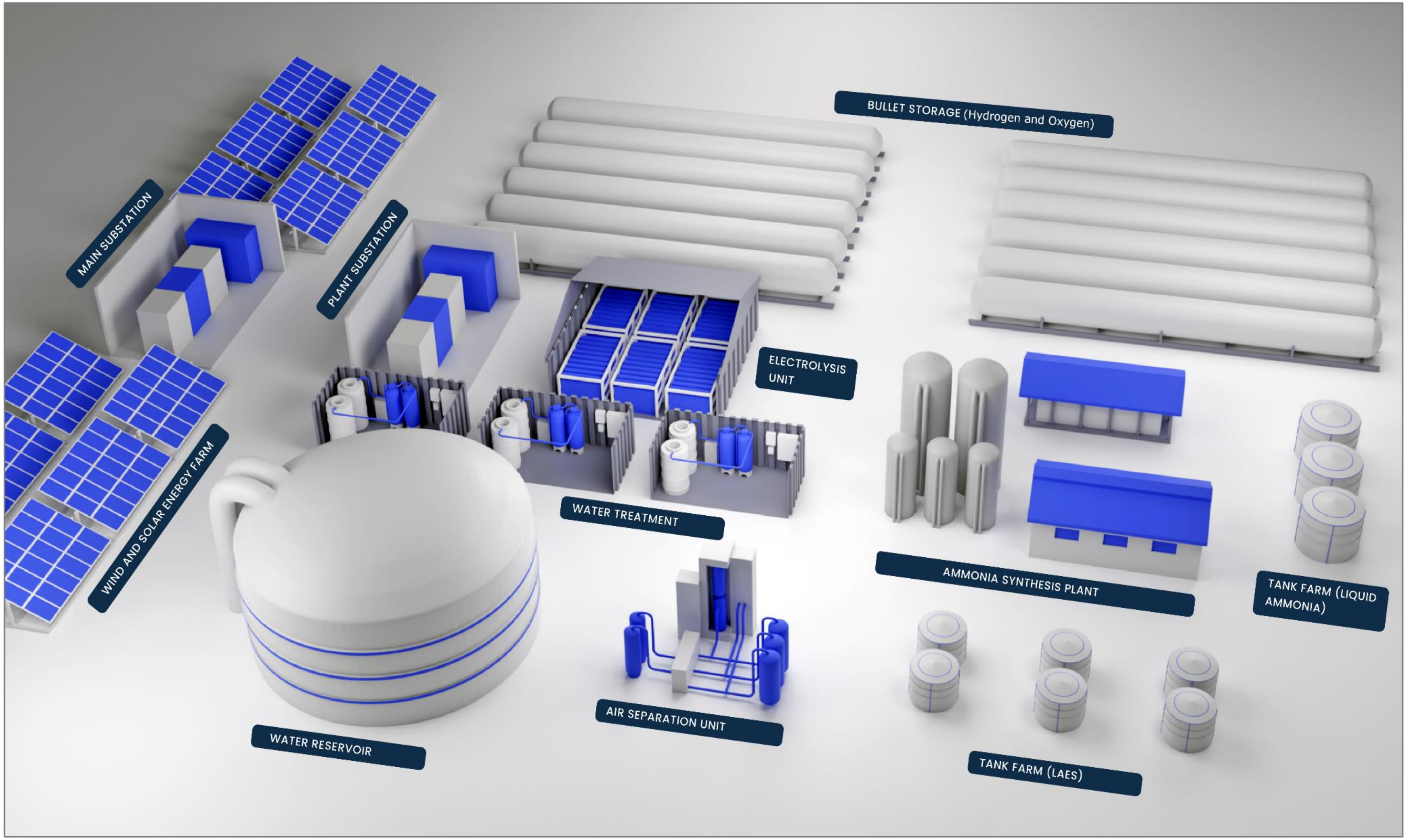

Figure 5: Preliminary site layout of the Camden I Green Hydrogen and Ammonia Facility

3 ACOUSTIC FUNDAMENTALS

3.1 PRINCIPLES

Sound is defined as any pressure variation (in air, water or other medium) that the human ear can detect. Noise is defined as "unwanted sound". Noise can lead to health impacts and can negatively affect people's quality of life. Hearing impairment is typically defined as a decrease in the threshold of hearing. Severe hearing deficits may be accompanied by tinnitus (ringing in the ears). Noise-induced hearing impairment occurs predominantly in the higher frequency range of 3,000 to 6,000 Hertz (Hz), with the largest effect at 4,000 Hz. With increasing L_{Aeq} and increasing exposure time, noise-induced hearing impairment occurs even at frequencies as low as 2,000 Hz. However, hearing impairment is not expected to occur at L_{Aeq} levels of 75 dB(A) or below, even for prolonged occupational noise exposure.

Speech intelligibility is adversely affected by noise. Most of the acoustical energy of speech is in the frequency range of 100 to 6,000 Hz, with the most important cue-bearing energy being between 300 and 3,000 Hz. Speech interference is basically a masking process in which simultaneous interfering noise renders speech incapable of being understood. Environmental noise may also mask other acoustical signals that are important for daily life such as doorbells, telephone signals, alarm clocks, music, fire alarms and other warning signals.

Sleep disturbance is a major effect of environmental noise. It may cause primary effects during sleep and secondary effects that can be assessed the day after night-time noise exposure. Uninterrupted sleep is a prerequisite for good physiological and mental functioning and the primary effects of sleep disturbance are: (a) difficulty in falling asleep; and (b) awakenings and alterations of sleep stages or depth. The difference between the sound levels of a noise event and background sound levels, rather than the absolute noise level, may determine the reaction probability.

The annoyance due to a given noise source is subjective from person to person, and is also dependent upon many non-acoustic factors such as the prominence of the source, its importance to the listener's economy (wellbeing), and his or her personal opinion of the source. Increased exposure to noise can have negative effects on individuals, both physiological (influence on communication, productivity and even impaired hearing) and psychological effects (stress, frustration and disturbed sleep). As such, noise impacts need to be understood to mean one or a combination of negative physical, physiological or psychological responses experienced by individuals, whether consciously or unconsciously, caused by exposure to noise.

More technically, noise impacts are defined as the capacity of noise to induce annoyance depending upon its physical characteristics, including the sound pressure level, spectral characteristics and variations of these properties with time. During day-time, individuals may be annoyed at L_{Aeq} levels below 55 dB(A), while very few individuals are moderately annoyed at L_{Aeq} levels below 50 dB(A). Sound levels during the evening and night should be 5 to 10 dB(A) lower than during the day (World Health Organisation, 1999).

Table 3: Typical noise levels

Sound Pressure Level (dB(A))	Typical Source	Subjective Evaluation
130	threshold of pain	intolerable
120 110	heavy rock concert grinding on steel	extremely noisy
100 90	loud car horn at 3 m construction site with pneumatic hammering	very noisy
80 70	kerbside of busy street loud radio or television	loud
60 50	department store general office	moderate to quiet
40 30	inside private office inside bedroom	quiet to very quiet
20	unoccupied recording studio	almost silent

3.2 NOISE PROPAGATION

Sound is a pressure wave that diminishes with distance from source. Depending on the nature of the noise source, sound propagates at different rates. The three most common categories of noise are point sources (specified single point of noise generation), line sources (multiple linear noise generating points, such as a road) and area sources (specified single area of noise generation). The most important factors affecting noise propagation are:

- The type of source (point, line or area).
- Obstacles such as barriers and buildings.
- Distance from source.
- Atmospheric absorption.
- Ground absorption.
- Reflections.

Research has shown that doubling the distance from a noise source results in a proportional decline in noise level. Sound propagation in air can be compared to ripples on a pond. The ripples spread out uniformly in all directions, decreasing in amplitude as they move further from the source. An acoustically hard site exists where sound travels away from the source over a generally flat, hard surface such as water, concrete, or hard-packed soil. These are examples of reflective ground, where the ground cover provides little or no attenuation. The standard attenuation rate for hard site conditions is 6 dB(A) per doubling of distance for point sources. Thus, if you are at a position one meter from the source and move one meter further away from the source, the sound pressure level will drop by 6 dB(A), moving to 4 meters, the drop will be a further 6 dB(A), and so on. When ground cover or normal unpacked earth (i.e. a soft site) exists between the source and receptor, the ground becomes absorptive to sound energy. Absorptive ground results in an additional noise reduction of approximately 1.5 dB(A) per doubling of distance.

This methodology is only applicable when there are no reflecting or screening objects in the sound path. When an obstacle is in the sound path, part of the sound may be reflected and part absorbed and the remainder may be transmitted through the object. How much sound is reflected, absorbed and/or transmitted depends on many factors, including the properties of the object. When receptor locations are not in the line of sight of the noise source, there may be up to 20 dB(A) attenuation for broadband noise, with a further 10 to 15 dB(A) attenuation when inside the average residence and the windows are open.

3.3 CHARACTERISTICS OF NOISE

The human ear simultaneously receives sound (normal un-weighted sound or Z-weighting dB(Z)) at many frequencies (octave bands) at different amplitudes. The ear then adjusts its sensitivity based on the amplitude of the sound observed. This focuses the sound and makes it audible by adjusting the amplitude of the low, middle and high frequencies. To measure how a person experiences sound, an electronic weighting adjusted to the Z-weighted sound was developed, including three different weighting curves, namely:

- **A-weighting -** This measurement is often noted as dB(A) and this weighting curve attempts to make the noise level meter respond closely to the characteristics of a human ear. It adjusts the frequencies at low and high frequencies. Various national and international standards relate to measurements recorded in the A-weighting of sound pressure levels;
- **B-weighting** - is similar to A-weighting but with less attenuation. The B-weighting is very seldom, if ever, used. The B-weighting follows the C-weighted trend.
- **C-weighting -** is intended to represent how the ear perceives sound at high decibel levels. C-weighted measurements are reported as dB(C).
- **Z-weighting -** this refers to linear, un-weighted noise levels.

The weighting is employed by arithmetically adding a table of values (**Table 4**), listed by octave bands, to the measured linear sound pressure levels for each specific octave band. The resulting octave band measurements are logarithmically added to provide a single weighted value describing the sound, based on the applied weighting curve (**Figure 6**). Thus, if the A-weighted curve was applied to the sound, the noise level is noted as dB(A).

Table 4: Frequency weighting table for the different weighting curves

Frequency (Hz)	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz
A-weighting	-39.4	-26.2	-16.1	-8.6	-3.2	0	1.2	1	1.1
B-weighting	-17.1	-9.3	-4.2	-1.3	-0.3	0	-0.1	-0.7	-2.9
C-weighting	-3	-0.8	-0.2	0	0	0	-0.2	-0.8	-3
Z-weighting	0	0	0	0	0	0	0	0	0

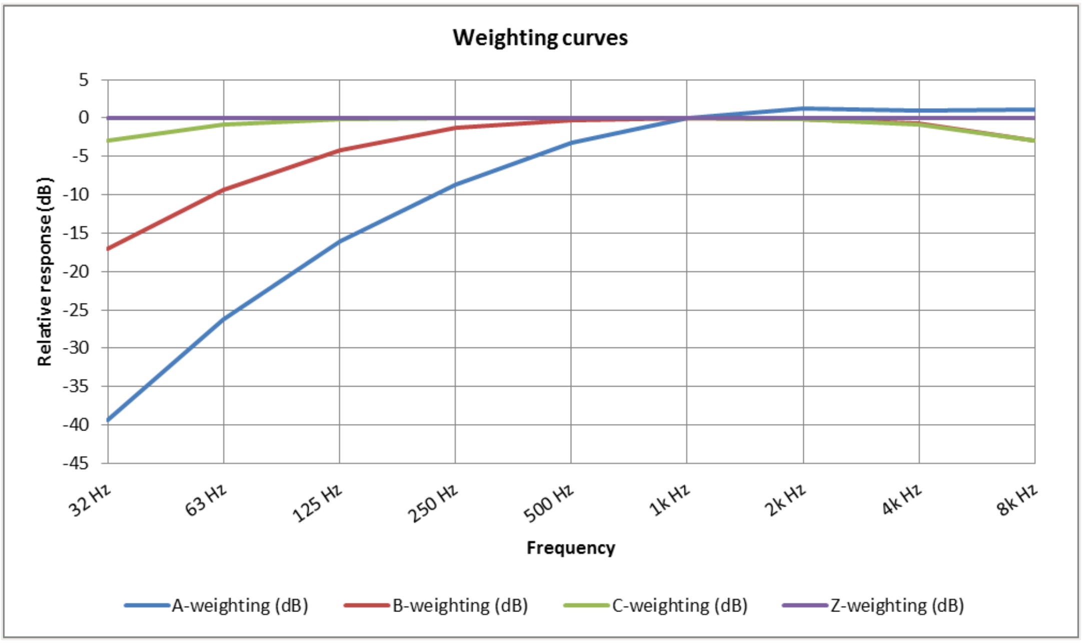

Figure 6: Weighting curves

4 LEGISLATIVE FRAMEWORK

4.1 SOUTH AFRICAN LEGISLATION

4.1.1 SOUTH AFRICAN NOISE CONTROL REGULATIONS

In South Africa, environmental noise control has been in place for three decades, beginning in the 1980s with codes of practice issued by the South African National Standards (formerly the South African Bureau of Standards, SABS) to address noise pollution in various sectors of the country. Under the previous generation of environmental legislation, specifically the Environmental Conservation Act 73 of 1989 (ECA), provisions were made to control noise from a National level in the form of the Noise Control Regulations (GNR 154 of January 1992). In later years, the ECA was replaced by the National Environmental Management Act 107 of 1998 (NEMA) as amended. The National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA) was published in line with NEMA and contains noise control provisions under Section 34:

> *"(1) The minister may prescribe essential national standards –*
>
> *(a) for the control of noise, either in general or by specific machinery or activities or in specified places or areas; or*
>
> *(b) for determining –*
>
> *(i) a definition of noise; and*
>
> *(ii) the maximum levels of noise.*
>
> *(2) When controlling noise, the provincial and local spheres of government are bound by any prescribed national standards."*

Under NEMAQA, the Noise Control Regulations were updated and are to be applied to all provinces in South Africa. The Noise Control Regulations give all the responsibilities of enforcement to the Local Provincial Authority, where location specific by-laws can be created and applied to the locations with approval of Provincial Government. Where province-specific regulations have not been promulgated, acoustic impact assessments must follow the Noise Control Regulations. These regulations define the following:

- **Ambient Sound Level:** the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes, after such meter had been put into operation.
- **Zone Sound Level**: a derived dB(A) value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area.
- **Disturbing Noise**: 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.

With the above definitions in mind, regulation 4 of the Noise Control Regulations stipulate that no person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof.

Furthermore, NEMAQA prescribes that the Minister must publish maximum allowable noise levels for different districts and National noise standards. These have not yet been accomplished and as a result all monitoring and assessments are done in accordance with the SANS 10103:2008 and 10328:2008 as discussed in the sections that follow.

4.1.2 SOUTH AFRICAN NATIONAL STANDARDS (SANS)

The SANS 10328:2008 (*Methods for Environmental Noise Impact Assessments*) presently inform environmental acoustic impact assessments in South Africa. This standard defines that the purpose of an Environmental Acoustic Impact Assessment is to determine and quantify the acoustical impact of, or on, a proposed development. It also stipulates the methods used to assess impacts as well as the minimum requirements to be investigated and included in the Environmental Acoustic Impact Assessment report as part of the EIA. These minimum requirements include:

1) The purpose of the investigation.

2) A brief description of the planned development or the changes that are being considered.

3) A brief description of the existing environment including, where relevant, the topography, surface conditions and meteorological conditions during measurements.

4) The identified noise sources together with their respective sound pressure levels or sound power levels (or both) and, where applicable, the operating cycles, the nature of sound emission, the spectral composition and the directional characteristics.

5) The identified noise sources that were not taken into account and the reasons as to why they were not investigated.

6) The identified noise-sensitive developments and the noise impact on them.

7) Where applicable, any assumptions, with references, made with regard to any calculations or determination of source and propagation characteristics.

8) An explanation, either by a brief description or by reference, of all measuring and calculation procedures that were followed, as well as any possible adjustments to existing measuring methods that had to be made, together with the results of calculations.

9) An explanation, either by description or by reference, of all measuring or calculation methods (or both) that were used to determine existing and predicted rating levels, as well as other relevant information, including a statement of how the data were obtained and applied to determine the rating level for the area in question.

10) The location of measuring or calculating points in a sketch or on a map.

11) Quantification of the noise impact with, where relevant, reference to the literature consulted and the assumptions made.

12) Alternatives that were considered and the results of those that were investigated.

13) A list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation.

14) A detailed summary of all the comments received from interested or affected parties as well as the procedures and discussions followed to deal with them.

15) Conclusions that were reached.

16) Proposed recommendations.

17) If remedial measures will provide an acceptable solution which would prevent a significant impact, these remedial measures should be outlined in detail and included in the final record of decision if the approval is obtained from the relevant authority. If the remedial measures deteriorate after time and a follow-up auditing or maintenance programme (or both) is instituted, this programme should be included in the final recommendations and accepted in the record of decision if the approval is obtained from the relevant authority.

18) Any follow-up investigation which should be conducted at completion of the project as well as at regular intervals after the commissioning of the project so as to ensure that the recommendations of this report will be maintained in the future.

The SANS 10103:2008 document (*The measurement and rating of environmental noise with respect to speech communication*) provides methods and guidelines to assess working and living environments with respect to acoustic comfort as well as respect to possible annoyance by noise. As applicable to this assessment, SANS 10103 provides guideline typical rating levels for noise in different districts. These rating levels are presented in **Table 5**.

Table 5: Typical rating levels for noise in districts (adapted from SANS 10103:2008)

Type of District	Classification	Equivalent Continuous Rating level for Noise ($L_{Req,T}$) (dB(A)) Outdoors	
		Day-time ($L_{Req,d}$)	Night-time ($L_{Req,n}$)
a) Rural	A	45	35
b) Suburban (with little road traffic)	B	50	40
c) Urban	C	55	45
d) Urban (with one or more of the following: workshops, business premises and main roads)	D	60	50
e) Central Business Districts	E	65	55
f) Industrial District	F	70	60

* Guidelines highlighted in red are applicable to this assessment

As stipulated in SANS 10103:2008, noise can pose as an annoyance to a community if the increase in average noise levels exceeds the ambient noise by a certain degree. These specified increases together with the relevant estimated community responses are presented in **Table 6**.

Table 6: Categories of community/group response (adapted from SANS 10103:2008)

Excess ($\Delta L_{Req,T}$)[a] dB(A)	Estimated Community or Group Response	
	Category	Description
0 – 10 5 – 15 10 – 20 >15	Little Medium Strong Very Strong	Sporadic Complaints Widespread Complaints Threats of community/group action Vigorous community/group action

Overlapping ranges for the excess values are given because a spread in the community reaction might be anticipated.
[a] $\Delta L_{Req,T}$ should be calculated from the appropriate of the following:
1) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS $L_{Req,T}$ of the residual noise (determined in the absence of the specific noise under investigation);
2) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the maximum rating level of the ambient noise given in Table 1 of the code;
3) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the typical rating level for the applicable district as determined from Table 2 of the code; or
4) $L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in the area because of the proposed development under investigation.

4.2 WORLD HEALTH ORGANISATION GUIDELINES FOR COMMUNITY NOISE

The World Health Organisation (WHO) together with the Organisation for Economic Co-operation and Development (OECD) are the main international bodies that have collected data and developed assessments on the effects of exposure to environmental noise. This has provided the following summary of thresholds for noise nuisance in terms of the outdoor day-time equivalent continuous A-weighted sound pressure level (L_{Aeq}) in residential districts:

— At 55 - 60 dB(A) noise creates annoyance.
— At 60 - 65 dB(A) annoyance increases considerably.
— Above 65 dB(A) constrained behaviour patterns, symptomatic of serious damage caused by noise.

The WHO therefore recommends a maximum outdoor day-time (07:00 – 22:00) L_{Aeq} of 55 dB(A) in residential areas and schools in order to prevent significant interference with normal activities. It further recommends a maximum night-time (22:00 – 07:00) L_{Aeq} of 45 dB(A) outside dwellings. No distinction is made as to whether the noise originates from road traffic, from industry, or any other noise source.

The WHO guideline for industrial noise is set at 70 dB(A) over a period of 24 hours. Anything above this level would cause hearing impairment, however, a peak noise level of 110 dB(A) is allowable on a fast response measurement.

4.3 INTERNATIONAL FINANCE CORPORATION GUIDELINES

From the International Finance Corporation (IFC) Environmental, Health and Safety (EHS) Guidelines, the impacts of noise beyond the property boundary of a facility are addressed in section 1.7 (IFC, 2007). The noise guidelines stipulated by the IFC are grouped into two categories, namely “Residential; institutional; educational” and “Industrial; commercial” (**Table 7**). Such guidelines are in-line with the WHO guidelines as discussed above and are as such applicable to this assessment. Noise impacts should not exceed these levels or result in a maximum increase in background noise levels of 3 dB(A) at the nearest off site receptor location.

Table 7: IFC Environmental Noise Level Guidelines

Receptor	One-hour L_{Aeq} (dBA)	
	Daytime (07:00 – 22:00)	Night-time (22:00 – 07:00)
Residential; institutional; educational	55	45
Industrial; commercial	70	70

The guideline also states that highly intrusive noise, such as noise from aircraft flyovers and passing trains should not be included when establishing background noise levels.

5 METHODOLOGY

5.1 ACOUSTIC MONITORING

Ambient sound level measurements were undertaken on 25 - 27 October 2021 at three off-site sensitive receptor locations (**Figure 3** and **Table 8**). All sound level measurements were free-field measurements (i.e. at least 3.5 m away from any vertical reflecting surfaces). Measurement procedures were undertaken according to the relevant South African Code of Practice, namely SANS 10103:2008 as well as in line with the IFC EHS Guidelines for Noise. Sound level measurements were taken with a SABS-calibrated Type 1 Integrating Sound Level Meter. The sound level meter was calibrated before and after measurements were conducted and no significant drifts (differences greater than 0.5 dB(A)) were found to occur. The make and model as well as serial number and calibration validity of the sound level meter and calibrator are presented in **Table 9**.

Day-time and night-time measurements were conducted for fifteen minutes each, allowing monitoring to be adequately representative. The monitoring was conducted during the relevant timeframe for day (07:00 to 22:00) and night (22:00 to 07:00) in accordance with the IFC methodology. The recently published GNR 320 of the NEMA, stipulates that night-time monitoring should take place over a minimum of two nights, with each sample taken at two different times of the night to record the typical ambient sound levels at the different times of the night. Due to rainy conditions on the first night, night-time measurements could only be undertaken on one night. Owing to the typically rural nature of the area and limited noise sources, such an approach is deemed sufficient to establish the baseline noise climate. The noise parameters recorded included:

- L_{Aeq} The equivalent continuous sound pressure level, normally measured (A-weighted).
- L_{Amax} The maximum sound pressure level of a noise event measured (A-weighted).
- L_{Amin} The minimum sound pressure level of a noise event measured (A-weighted).
- L_{A50} The average noise level the receptor is exposed to for 50% of the monitoring period.
- L_{A90} The average noise level the receptor is exposed to for 90% of the monitoring period.

Table 8: Noise monitoring locations

ID	Description	Latitude (°S)	Longitude (°E)	Distance from Facility Boundary (m)	Direction from Facility	SANS Classification*
C1_Rec 01	Farmhouse	26.633861	30.033389	3,195	NW	Rural
C2_Rec 02	Farmhouse	26.632472	30.078306	1,625	NE	Rural
C3_Rec 03	Farmhouse	26.671333	30.069056	2,645	S	Rural

* As per **Table 5**

Table 9: Sound level meter and calibrator specifications

Sound level meter	Calibrator
Make & model: CEL 63X	**Make & model:** CEL-120/1
Serial number: 3134723	**Serial number:** 3939145
Date calibrated: June 2021	**Date calibrated:** June 2021
Calibration due date: June 2022	**Calibration due date:** June 2022

5.2 ACOUSTIC INVENTORY

The sources of noise identified during the operational phase of the proposed facility are presented in **Table 10**. These sources and sound power level (PWL) specifications were used as input into the acoustic calculations. It is noted that all sources for the operational phase will operate for 24 hours a day, hence the predicted day and night-time noise levels will be identical. It is also noted that all sources for the operational phase were run as a worst-case scenario with no mitigation (enclosures or screens) included in the calculations, as well as all sources being grouped together at the facility boundary nearest to each respective receptor.

Table 10: Operational phase noise sources and sound power level data

Process Activity	Noise Source	Quantity	Sound Power Level (dB(A))	Comments/Source
Water Feedstock	None	-	-	No significant noise
Water Treatment	Reverse Osmosis System	-	-	No significant noise
	Feed Water Pumps	20	93.0	Based on a sound pressure level of 85.0 dB(A) @ 1 m from the source as provided by the Client
	Lye Mixing Pumps	2	93.0	As above
Waste Treatment Facility	Pumps	Unknown	93.0	As above
Electrolyser	Electrolyser Units	15	-	No significant noise
	Transformers	15	68.0	Petrovic *et al*., 2012
	Rectifiers	15	-	No significant noise
	Gas Separation Skid	15	-	No significant noise
Air Separation Unit	Air Compressors	1	109.5	Berger *et al*., 2016
Ammonia Processing Unit	Haber-Bosch process	-	-	No significant noise
LAES	None	-	-	No significant noise
Storage	None	-	-	No significant noise
Dispatch	Trucks	Unknown	85.0	Berger *et al*., 2016

5.3 ACOUSTIC CALCULATIONS

To represent a worst-case scenario, it is assumed that one of each piece of equipment as well as one of each type of truck will be operational simultaneously at the boundary of the facility, in closest proximity to each sensitive receptor. Such a worst-case scenario is unlikely to occur in reality, as noise sources will essentially be spread out across the site. The sum (logarithmic) of the PWLs from all noise sources was utilised to calculate resultant noise levels at specified distances from the facility. Such resultant receptor noise levels were calculated using attenuation-over-distance acoustic calculations.

6 ASSUMPTIONS AND LIMITATIONS

In this Environmental Acoustic Impact Assessment, various assumptions were made and limitations experienced that may impact on the results obtained. These include:

— The information provided regarding the proposed operational activities is assumed to be representative of what will occur in reality.
— Identification of sensitive receptors is based on a desktop assessment and it is assumed that all key receptors have been included.
— Night-time monitoring could only be conducted on one night due to inclement weather. Being such a remotely located rural sight, measurements on one night provide sufficient data to evaluate the current noise climate.
— This assessment represents a worst-case scenario, where it has been assumed that one of each piece of equipment will be operational simultaneously at the boundary of the plant area, in closest proximity to each sensitive receptor.
— The acoustic calculations do not take terrain or vegetation into account, thus representing an absolute worst-case scenario.

7 RESULTS

7.1 CURRENT NOISE CLIMATE

It is important to note that wind speed and direction play a vital role in determining baseline noise levels. Noise monitoring is usually discouraged when wind speeds exceed 5 m/s (>18 km/h) as wind noise distorts the baseline noise levels by masking other noise sources. However, no wind speeds exceeding 5 m/s were recorded during the monitoring period.

7.1.1 DAYTIME

The results from the daytime noise monitoring campaign conducted on 25 October 2021 are presented in **Table 11** and **Figure 7**. Conditions during the campaign were cloudy and cool with slight winds (up to 3.6 m/s). Noise levels at all receptor locations were compared to the typical daytime rating level for noise in rural areas (45 dB(A)).

Noise levels (L_{Aeq}) at all three monitoring locations were above the rural daytime guideline rating level of 45 dB(A). The main sources of noise identified at each location included:

— C1_Rec 01: Sheep and birds as well as small contributions from farm activities (vehicles and people).
— C1_Rec 02: Camden Power Station (including crusher noise and reverse beeping), nearby train, birds and insects.
— C1_Rec 03: Faint vehicle noise from Camden Power Station in the distance as well as insects and birds.

From the daytime monitoring campaign, it is evident that the current noise climate surrounding the project site is predominantly natural, with small anthropogenic influences from the Camden Power Station and farm activities.

Table 11: Day-time noise monitoring results

ID	Time	L_{Amax} (dB(A))	L_{Amin} (dB(A))	L_{Aeq} (dB(A))	L_{AF50} (dB(A))	L_{AF90} (dB(A))	SANS Guideline (dB(A))	Compliant
C1_Rec 01	16:12	69.4	29.8	49.0	41.0	35.5	45	No
C1_Rec 02	13:25	66.6	42.4	50.6	47.0	45.0	45	No
C1_Rec 03	14:24	78.1	33.2	49.6	37.5	35.5	45	No

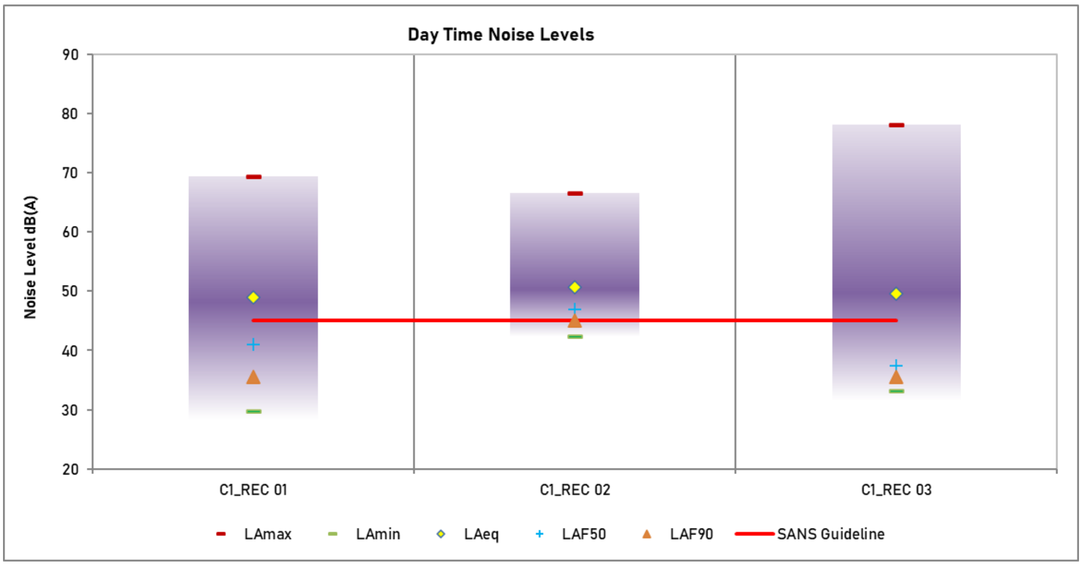

Figure 7: Daytime monitored noise levels. L_{Aeq} (yellow diamond) is compared with the SANS guideline.

7.1.2 NIGHT-TIME

The results from the night-time noise monitoring campaign conducted on 26 – 27 October 2021 are presented in **Table 12** and **Figure 8**. Due to inclement weather on the night of 25 October 2021, night-time measurements could only be undertaken at two different times on one night (26 October 2021). Due to the typically rural nature of the area and limited noise sources, such an approach is deemed sufficient to establish the baseline noise climate. Conditions during the campaign were partly cloudy and cool, with slight winds (up to 3.7 m/s). Noise levels at all receptor locations were compared to the typical night-time rating level for noise in rural areas (35 dB(A)).

Average L_{Aeq} noise levels at all three monitoring locations exceeded the rural night-time guideline level of 35 dB(A). The main sources of noise identified at all three locations was insects and wind. An occasional dog barking at C1_Rec 01 was also noted.

From the night-time monitoring campaign, it is evident that the current noise climate surrounding the project site is predominantly natural, with no anthropogenic influences at night.

It is noted that the logarithmic average over the two night-time monitoring campaigns was used as the baseline night-time noise levels in this impact assessment to determine changes as a result of the proposed Project.

Table 12: Night-time noise monitoring results

ID	Time	L_{Amax} (dB(A))	L_{Amin} (dB(A))	L_{Aeq} (dB(A))	L_{AF50} (dB(A))	L_{AF90} (dB(A))	SANS Guideline (dB(A))	Compliant
26 October 2021 (late night)								
C1_Rec 01	22:01	64.6	24.2	34.1	28.0	25.5	35	Yes
C1_Rec 02	22:33	71.3	26.7	46.5	44.5	38.5	35	No
C1_Rec 03	23:04	68.4	32.7	42.7	38.0	34.5	35	No
27 October (early morning)								
C1_Rec 01	23:34	68.9	31.7	48.0	44.0	37.5	35	No
C1_Rec 02	00:00	67.3	30.0	48.7	45.0	39.0	35	No
C1_Rec 03	00:28	52.2	31.4	36.2	35.5	33.0	35	No
Logarithmic Averages								
C1_Rec 01		64.3	26.4	42.2	38.1	31.7	35	No
C1_Rec 02		66.7	25.7	44.7	41.7	35.7	35	No
C1_Rec 03		62.5	29.1	37.6	33.9	30.8	35	No

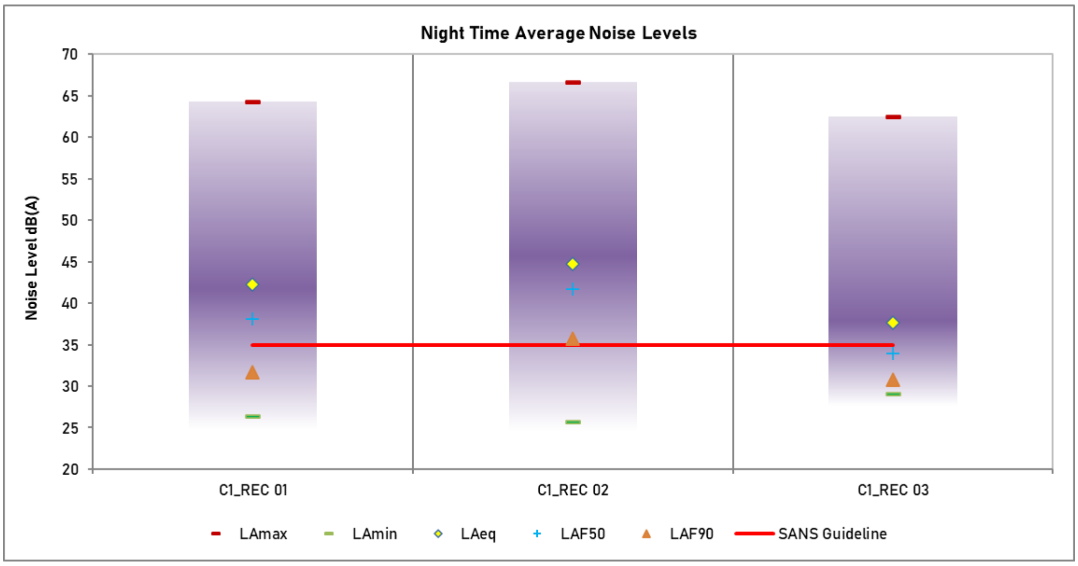

Figure 8: Night-time average (logarithmic) monitored noise levels. L_{Aeq} (yellow diamond) is compared with the SANS guideline.

7.2 FUTURE NOISE CLIMATE

7.2.1 CONSTRUCTION PHASE

Unlike general industry, construction activities are not always stationary and in one location. Construction activities at the proposed site will include civil works (including surveying), reinforced concrete works, masonry works, façade works, floor works, carpentry works and painting including mechanical, electrical, and plumbing installation works. Due to the erratic and transient nature of such construction activities as well as the fact that detailed construction phase plans have not yet been developed for the proposed Project, noise impacts from the construction phase of the facility could not be quantified.

However, during the construction phase of the facility various noise sources will be present onsite including earth-moving equipment (trucks, cranes, scrapers and loaders), compressors and generators, pumps, rotary drills, concrete mixers and materials handling activities among others. All of these sources will generate substantial amounts of noise and may impact on neighbouring sensitive receptors. As such, mitigation interventions are advised during the construction phase. These mitigation recommendations are detailed in the section that follows.

MITIGATION RECOMMENDATIONS

To minimise the acoustic impacts from the construction phase of the proposed Project, various mitigation techniques can be employed. These options include both management and technical options:

- Planning construction activities in consultation with local communities so that activities with the greatest potential to generate noise are planned during periods of the day that will result in least disturbance. Information regarding construction activities should be provided to identified and nearby receptors likely to be affected. Such information includes:
  - Proposed working times.
  - Anticipated duration of activities.
  - Explanations on activities to take place and reasons for activities.
  - Contact details of a responsible person on site should complaints arise.
- When working near a potential sensitive receptor, limit the number of simultaneous activities to a minimum, as far as possible.
- Using noise control devices, such as temporary noise barriers and deflectors for high impact activities, and exhaust muffling devices for combustion engines.
- Selecting equipment with the lowest possible sound power levels whilst still being suitable for the specific task.
- Ensuring equipment is well-maintained to avoid additional noise generation.

7.2.2 OPERATIONAL PHASE

The logarithmic sum (109.8 dB(A)) of one of each piece of equipment and one of each type of truck was applied as the noise level emanating from the nearest boundary to each respective sensitive receptor. The resultant noise levels at specified distances from the source are depicted in **Figure 9**. Noise levels in the immediate vicinity of the site are predicted to be high, as would be expected. From 50 m from the source, noise levels will reduce considerably, with noise levels at 735 m from the source dropping below the SANS daytime rural guideline rating level value of 45 dB(A) and at 2,323 m from the source dropping below the SANS night-time rural guideline rating level of 35 dB(A).

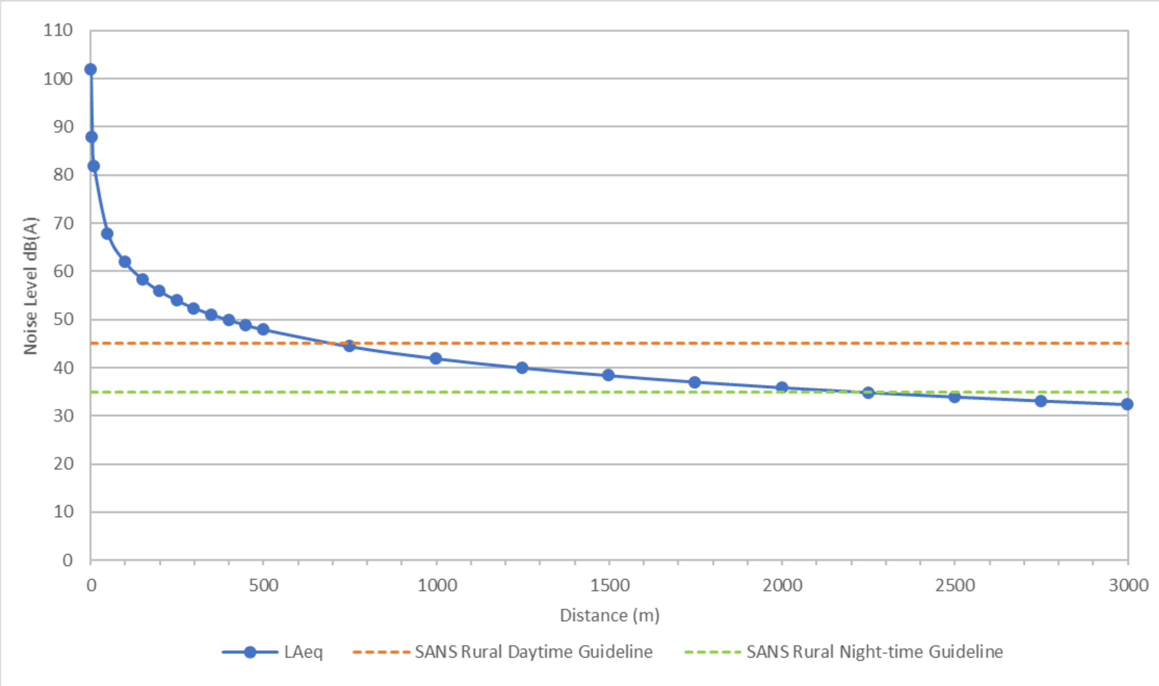

Figure 9: Worst-case predicted noise levels over distance associated with the operation of the Camden I Green Hydrogen and Ammonia Facility

The predicted day-time noise levels at the specified receptor locations associated with the operation of the Camden I Green Hydrogen and Ammonia Facility are presented in **Table 13**. The predicted noise levels were compared with the current baseline noise levels (monitored) to assess any changes and the resultant impacts on the surrounding receptors.

Predicted day-time noise levels at all the receptor locations are predicted to increase slightly with the operation of the facility. Noise levels will increase by between 0.1 and 0.2 dB(A) resulting in "little" community response. Such increases are so negligible that are likely to go unnoticed. It is noted that such increases are also well below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

Table 13: Predicted day-time noise levels at specified receptor locations during the operation of the Camden I Green Hydrogen and Ammonia Facility

Receptor	Predicted Noise Level (dB(A))	Current Noise Level (dB(A))	Cumulative Noise Level (dB(A))*	Change (dB(A))	Estimated Community Response
C1_Rec 01	31.9	49.0	49.1	+0.1	Little
C1_Rec 02	37.8	50.6	50.8	+0.2	Little
C1_Rec 03	33.9	49.6	49.7	+0.1	Little

* It is noted that noise levels are logarithmically added due to their logarithmic nature

NIGHT-TIME

The facility is anticipated to operate 24 hours a day, as such, night-time impacts are anticipated. The predicted night-time noise levels at the specified receptor locations associated with the operation of the Camden I Green Hydrogen and Ammonia Facility are presented in **Table 14**. The predicted noise levels were compared with the current baseline noise levels (monitored) to assess any changes and the resultant impacts on the surrounding receptors.

Predicted night-time noise levels at all the receptor locations are predicted to increase slightly with the operation of the facility. Noise levels will increase by between 0.4 and 1.5 dB(A) resulting in "little" community response. Such increases are negligible that are likely to go unnoticed. It is noted that such increases are also well below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

Table 14: Predicted night-time noise levels at specified receptor locations during the operation of the Camden I Green Hydrogen and Ammonia Facility

Receptor	Predicted Noise Level (dB(A))	Current Noise Level (dB(A))	Cumulative Noise Level (dB(A))*	Change (dB(A))	Estimated Community Response
C1_Rec 01	31.9	42.2	42.6	+0.4	Little
C1_Rec 02	37.8	44.7	45.5	+0.8	Little
C1_Rec 03	33.9	37.6	39.1	+1.5	Little

* It is noted that noise levels are logarithmically added due to their logarithmic

It must be highlighted that these are worst-case assessments of noise impacts, with all equipment located in the same area on the boundary closest to receptor in question, which will not occur in reality. Noise sources will essentially be spread out across the site. Additionally, many of the sources will be enclosed within buildings, creating further noise transmission loss.

8 ASSESSMENT OF IMPACTS

The purpose of this acoustic impact assessment is to identify the potential impacts and associated risks posed by the construction and operation of the proposed facility on the noise climate of the area. The outcomes of the impact assessment will provide a basis to identify the key risk drivers and make informed decisions on the way forward to ensure that these risks do not result in unacceptable social or environmental risk.

All impacts of the proposed project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. This system derives an environmental impact level based on the extent, duration, potential intensity and probability of potentially significant impacts. The overall risk level is determined using professional judgement based on a clear understanding of the nature of the impact, potential mitigatory measures that can be implemented and changes in risk profile as a result of implementation of these mitigatory measures. A full description of the risk rating methodology is presented in **Appendix B**. Key localised acoustic impacts associated with the proposed facility include:

1. Construction phase impacts of noise on residential receptors.
2. Operational phase impacts of noise on residential receptors.

Outcomes of the acoustic impact assessment are contained within **Table 15** outlining the impact of each parameter and the resulting risk level. The resultant environmental acoustic risks for residential receptors were ranked “low” to “very low” during the unmitigated and mitigated construction phase, respectively and “very low” during the unmitigated and mitigated operational phase.

Table 15: Impact assessment of risks associated with the operation of the Camden I Green Hydrogen and Ammonia Facility

Description	Without Mitigation							With Mitigation						
	Magnitude	Extent	Reversibility	Duration	Probability of Occurrence	Significance	**Risk Level**	Magnitude	Extent	Reversibility	Duration	Significance	Probability of Occurrence	**Risk Level**
Construction phase impacts of noise on sensitive receptors	2	2	1	1	3	18	**Low**	1	2	1	1	2	10	**Very Low**
Operational phase impacts of noise on sensitive receptors	2	1	1	4	1	8	**Very Low**	1	1	1	4	1	7	**Very Low**

9 CONCLUSIONS

WSP has been appointed to undertake the ESIA for the proposed Camden I Green Hydrogen and Ammonia Facility. Very minimal noise impacts are anticipated based on the remote location and minimal nearby receptors and thus a generic calculation-based environmental acoustic impact assessment has been carried out as part of the ESIA process to assess impacts.

To assess the existing noise climate in the area surrounding the proposed facility, ambient noise monitoring was conducted at three sensitive receptor locations surrounding the site. An acoustic inventory was developed to identify all potential sources of noise associated with the proposed facility. The acoustic impacts of the proposed facility were then assessed through the use of attenuation-over-distance acoustic calculations.

Baseline monitoring indicated that current day-time noise levels exceed the rural guideline rating level of 45 dB(A) at all three monitoring locations (receptors). Similarly, average night-time noise levels at all receptor locations exceed the rural guideline rating level of 35 dB(A). From the day-time monitoring campaign it is evident that the current noise climate surrounding the proposed site is predominantly natural, with small anthropogenic influences from the Camden Power Station and farm activities. At night, the current noise climate is predominantly natural, with no anthropogenic influences.

During the operational phase of the facility, day-time noise levels at all receptor locations are predicted to increase slightly. Noise levels will increase by between 0.1 and 0.2 dB(A) resulting in “little” community response. Such increases are so negligible that are likely to go unnoticed. It is noted that such increases are also below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

Predicted night-time noise levels at all the receptor locations are predicted to increase slightly with the operation of the facility. Noise levels will increase by between 0.4 and 1.5 dB(A) resulting in “little” community response. Such increases are negligible that are likely to go unnoticed. It is noted that such increases are also below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

It must be highlighted that these are worst-case assessments of noise impacts, with all equipment located in the same area on the boundary closest to the receptor in question, which will not occur in reality. Noise sources will essentially be spread out across the site. Additionally, many of the sources will be enclosed within buildings, creating further noise transmission loss.

Based on a risk rating methodology, the resultant environmental acoustic risks for residential receptors were ranked “low” to “very low” during the unmitigated and mitigated construction phase, respectively. Acoustic risks of the operational phase during both day and night-time are ranked as “very low”. As such, it is envisaged that the operation of the facility can be authorised without any major impacts or complaints. The facility is adequately positioned away from sensitive receptors and will not negatively impact the noise climate at the receptors.

10 REFERENCES

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- International Finance Corporation (IFC) (2007): Environmental, Health and Safety Guidelines: 1.7 Noise, 52 – 53.
- Petrovic, A., Lukic, L., Kolarevic, M. and Lukic, D. (2012): Noise Measurements of the Power Transformers. 23rd National Conference & 4th International Conference: Noise and Vibration. Available online at: http://www.mfkv.kg.ac.rs/urbanoise/media/1210_Nis__Petrovic_263-267.pdf.
- Republic of South Africa (2004): National Environment Management: Air Quality Act, Act No. 39 of 2004.
- South African National Standards (2008): SANS – Code of Practice 10103:2008, The measurement and rating of environmental noise with respect to annoyance and to speech communication, Standards South Africa, 6th Edition (ISBN 978-0-626-20832-5).
- World Health Organisation (WHO) (1999): Guidelines for Community Noise. Available online at: http://www.who.int/docstore/peh/noise/guidelines2.html.

APPENDIX

A CURRICULUM VITAE

KIRSTEN COLLETT, M.Sc. (Pr.Sci.Nat)

PRINCIPAL CONSULTANT (AIR QUALITY AND ACOUSTICS), ENVIRONMENT & ENERGY

Years with the firm

10

Years of experience

12

Professional qualification

Pri.Sci.Nat

Areas of expertise

Air Quality Impact Assessments

Air Quality Management

Ambient Air Quality and Acoustic Monitoring

Environmental Acoustic Assessments

CAREER SUMMARY

Kirsten is a Senior Air Quality and Acoustic Consultant with a Master of Science (Atmospheric Sciences) degree obtained from the University of the Witwatersrand. She is currently employed at the Johannesburg branch of WSP Environmental and has worked on various air quality and acoustic impact assessments; air quality management plans; air quality and acoustic monitoring projects; and air quality and acoustic modelling projects for a variety of clients over the past ten years. She has provided consulting support to various client industries including petrochemical, mining, metallurgical, manufacturing and local government bodies among others. She is also a registered Professional Natural Scientist (Pr.Nat.Sci.) with the South African Council for Natural Scientific Professions (SACNASP).

EDUCATION

Master of Science, Atmospheric Sciences, University of Witwatersrand, Johannesburg, South Africa	2009
Bachelor of Science (Honours) Geography and Environmental Studies, University of the Witwatersrand, Johannesburg, South Africa	2006
Bachelor of Science, Geography and Environmental Studies, University of Witwatersrand, Johannesburg, South Africa	2005

ADDITIONAL TRAINING

Business-focussed Project Management	2013
Snake Awareness Training	2016

PROFESSIONAL MEMBERSHIPS

South African Council for Natural Scientific Professions	SACNASP
National Association for Clean Air	NACA

PROFESSIONAL EXPERIENCE

Air Quality

- AQIA for a Proposed Cement Grinding Processing Facility, Umbogintwini, KwaZulu-Natal (2021): WSP was appointed to conduct an AQIA in the form of an Atmospheric Impact Report as part of an Atmospheric Emission Licence (AEL) application for a proposed cement grinding processing facility. The assessment consisted of the compilation of a comprehensive emissions inventory to account for emissions from the facility as well as dispersion modelling using the AERMOD dispersion model to assess the impacts of emissions on any surrounding receptors. Client: Platinum Cement Industries.
- Atmospheric Emission Licence (AEL) Audit, Annual Reporting and NAEIS submission for a Foundry, Isando, Gauteng (2021): Project Manager and Lead Consultant. WSP was appointed to undertake an audit of the facility's current AEL to assess the accuracy of what was represented in the AEL as well as to evaluate compliance with the conditions stipulated in the AEL. Additionally the scope of work included compilation of their Annual Report as well as reporting of emissions onto the National Atmospheric Emissions Inventory System (NAEIS). Kirsten was responsible for conducting the audit, compiling the audit report and annual report and submitting all information onto NAEIS. Client: Weir Minerals.
- AQIA for a Revised Production Rate for a Chemical Producer, Cape Town (2020): Project Manager and Lead Consultant. WSP was appointed to conduct an AQIA

in the form of an Atmospheric Impact Report as part of an Atmospheric Emission Licence (AEL) amendment application for a production rate change at the facility. The assessment consisted of the compilation of a comprehensive emissions inventory to account for emissions from the facility as well as dispersion modelling using the AERMOD dispersion model to assess the impacts of emissions on any surrounding receptors. Client: Protea Chemicals.

— AQIA for a Proposed Independent Power Project, Qatar (2020): Project Manager and Lead Consultant. WSP was contracted to undertake a screening-level air quality impact assessment to determine the suitability of the proposed stack heights in dispersing emission away from sensitive receptors. The project included a baseline assessment, emissions inventory, dispersion modelling using SCREEN3 and comparison of the predicted concentrations against the Qatar ambient air quality standards. Client: WSP Middle East.

— AQIA for a Proposed Expansion to an Iron Ore Loading Port, Saldanha (2019): Project Manager and Lead Consultant. WSP was contracted to undertake an air quality impact assessment to determine the impacts of a proposed increase in iron ore storage and handling capacity at the Saldanha Port. The project included a baseline assessment, compilation of a comprehensive emissions inventory and dispersion modelling using the CALPUFF dispersion model to assess the impacts of emissions on the surrounding communities. Client: Transnet Port Terminals Saldanha Bay.

— Isibonelo Colliery Air Quality Management Plan, Mpumalanga, South Africa (2019-2020): Project Manager and Lead Consultant. Anglo American Coal SA requested the compilation of an Air Quality Management Plan (AQMP) for the Isibonelo Colliery in the Mpumalanga province. The AQMP was aimed at improving air quality at the colliery through the identification of main sources of emissions and recommendations to reduce emissions from these sources. Kirsten was responsible for the compilation of the AQMP which was performed through a baseline assessment of activities at the colliery; identification of key emission sources; compilation of a detailed site specific emissions inventory; determination of the impact of emissions from the colliery on surrounding communities using the AERMOD dispersion modelling software; review of current management and mitigation techniques at the colliery; and development of strategies to minimise any impacts of emissions from the colliery going forward. Client: Anglo American Coal SA.

— Atmospheric Emission Licence (AEL) Audit for a Manganese Multipurpose Terminal, Saldanha (2019): Lead Consultant. WSP was contracted to undertake an audit of the current provisional AEL (PAEL) for the terminal and assist with conversion of the PAEL to a final AEL. The project included a site visit and audit, Client and Authority liaison and assistance with submission of the AEL on the South African Atmospheric Emission Licencing and Inventory Portal (SAAELIP). Client: Transnet Port Terminals Saldanha Bay.

— Air Quality Impact Assessment (AQIA) for a Proposed Waste to Energy Facility, Kuwait (2017-2018): Lead Consultant. WSP was contracted to undertake an air quality impact assessment to determine the impacts of a proposed waste to energy facility in Kuwait. The project included assessment of baseline monitoring data (conducted by a local partner), a baseline assessment, emissions inventory, dispersion modelling using CALPUFF and comparison of the predicted concentrations against the Kuwait and International ambient air quality guidelines/standards. A preliminary screening assessment was undertaken using SCREEN3 to determine the monitoring locations for the baseline monitoring campaign. Client: WSP Middle East.

— Dust Fallout and Particulate Matter Monitoring for nine Collieries, Mpumalanga, South Africa (2016-present): Project Manager. WSP was appointed to manage Anglo American Coal SA's air quality monitoring requirements at nine of their collieries. The contract includes dust fallout monitoring at all nine collieries, while continuous particulate matter (PM_{10} and $PM_{2.5}$) monitoring is conducted at seven collieries using mobile custom-designed solar system trailers. Kirsten is responsible for project management and quality control for the project. Client: Anglo American Coal SA.

Acoustics

- Environmental Acoustic Impact Assessment for a Proposed Manganese Mine, Kanye, Botswana (2021): Project Manager and Lead Consultant. WSP was appointed to undertake an environmental acoustic impact assessment for a proposed manganese mine in Botswana. Kirsten was responsible for conducting the assessment which included a baseline assessment; development of a comprehensive acoustic inventory; and determination of the impact of the proposed project on the surrounding sensitive receptors using the Computer Aided Noise Abatement (CadnaA) acoustic modelling software. Client: Loci Environmental.
- Environmental Acoustic Impact Assessment for the expansion to a refuse transfer station, Cape Town, South Africa (2020): Project Manager and Lead Consultant. WSP was appointed to undertake an environmental acoustic impact assessment for the proposed expansion to the Athlone Refuse Transfer Station in the city of Cape Town. Kirsten was responsible for conducting the assessment which included baseline acoustic monitoring; development of a comprehensive acoustic inventory; and determination of the impact of the proposed project on the surrounding sensitive receptors using the Computer Aided Noise Abatement (CadnaA) acoustic modelling software. Client: Resource Management Services.
- Environmental Acoustic Impact Assessment for the expansion to a tailings storage facility, North West Province, South Africa (2017-2020): Project Manager and Lead Consultant. WSP was appointed to undertake an environmental acoustic impact assessment for the proposed extension of the Kareerand Tailings Storage Facility. Kirsten was responsible for conducting the assessment which included baseline acoustic monitoring; development of a comprehensive acoustic inventory for both the construction and operational phases of the project; and determination of the impact of the proposed project on the surrounding sensitive receptors using the Computer Aided Noise Abatement (CadnaA) acoustic modelling software. Client: AngloGold Ashanti.
- Environmental Acoustic Impact Assessment for three wind energy facilities, Northern and Western Cape, South Africa (2016-2019): Project Manager and Lead Consultant. WSP was appointed to undertake an environmental acoustic impact assessment for three proposed wind energy facilities located between Sutherland and Matjiesfontein in the Northern and Western Cape provinces. Kirsten was responsible for conducting the assessments which included baseline acoustic monitoring; development of a comprehensive acoustic inventory for both the construction and operational phases of the project; and determination of the impact of the proposed wind energy facilities on the surrounding sensitive receptors (farm houses) using the Computer Aided Noise Abatement (CadnaA) acoustic modelling software. Client: BioTherm Energy.
- Environmental Acoustic Impact Assessment for the proposed rehabilitation of the Sekoma-Morwamosu road section, Botswana (2017): Project Manager and Lead Consultant. WSP was appointed to undertake an environmental acoustic impact assessment for the proposed rehabilitation of a section of road within the southern part of Botswana. Kirsten was responsible for conducting the assessment. Current operational noise levels in the vicinity of the road section where determined using an acoustic modelling platform, with current (2017) traffic count data as input. The acoustic impacts of the proposed rehabilitation were determined using attenuation-over-distance calculations (construction phase) and acoustic modelling (operational phase). Changes in noise levels at specific receptor locations were then assessed for each phase and the resultant community responses were evaluated. Client: Loci Environmental.

APPENDIX

B IMPACT ASSESSMENT METHODOLOGY

APPENDIX

ASSESSMENT OF IMPACTS AND MITIGATION

The assessment of impacts and mitigation evaluates the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

The key objectives of the risk assessment methodology are to identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts. The assessment considers direct[1], indirect[2], secondary[3] as well as cumulative[4] impacts.

A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e. residual impact). The significance of environmental aspects is determined and ranked by considering the criteria[5] presented in the table below.

Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				

[1] Impacts that arise directly from activities that form an integral part of the Project.
[2] Impacts that arise indirectly from activities not explicitly forming part of the Project.
[3] Secondary or induced impacts caused by a change in the Project environment.
[4] Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.
[5] The definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

APPENDIX

IMPACT SIGNIFICANCE RATING

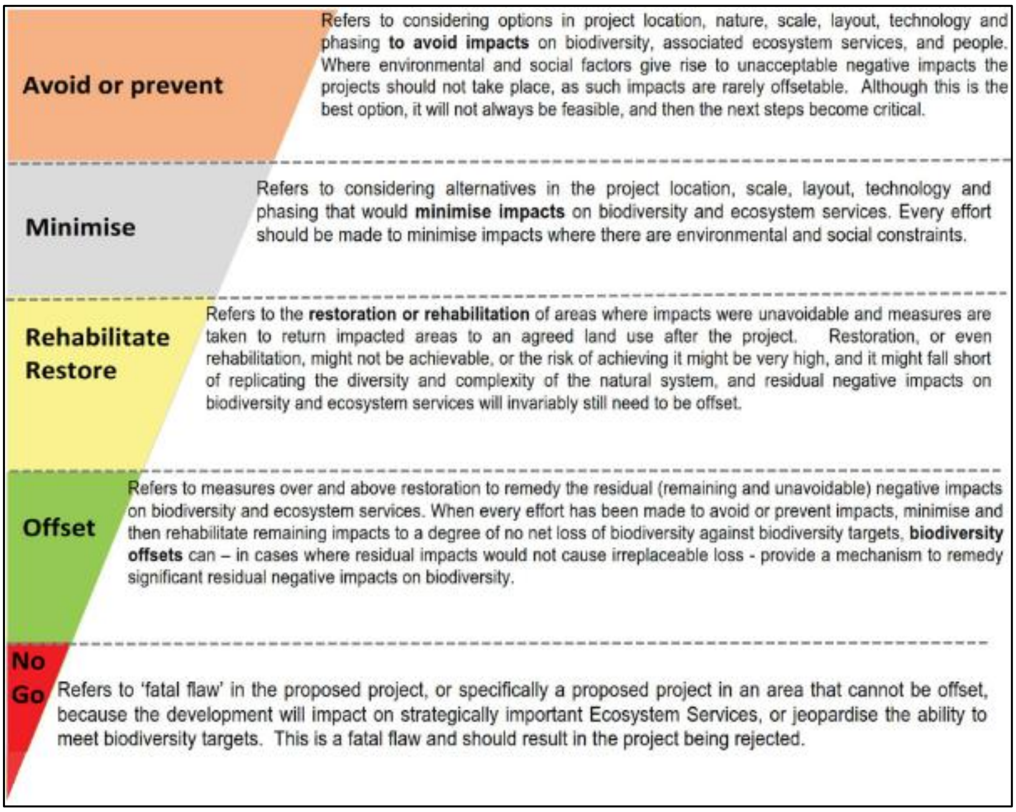
Total Score	4 to 15	16 to 30	31 to 60	61 to 80	81 to 100
Environmental Significance Rating (Negative (-))	Very low	Low	Moderate	High	Very High
Environmental Significance Rating (Positive (+))	Very low	Low	Moderate	High	Very High

IMPACT MITIGATION

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the proposed development's actual extent of impact and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this report.

The mitigation measures chosen are based on the mitigation sequence/hierarchy which allows for consideration of five (5) different levels, which include avoid/prevent, minimise, rehabilitate/restore, offset and no-go in that order. The idea is that when project impacts are considered, the first option should be to avoid or prevent the impacts from occurring in the first place if possible, however, this is not always feasible. If this is not attainable, the impacts can be allowed, however they must be minimised as far as possible by considering reducing the footprint of the development for example so that little damage is encountered. If impacts are unavoidable, the next goal is to rehabilitate or restore the areas impacted back to their original form after project completion. Offsets are then considered if all the other measures described above fail to remedy high/significant residual negative impacts. If no offsets can be achieved on a potential impact, which results in full destruction of any ecosystem for example, the no-go option is considered so that another activity or location is considered in place of the original plan.

The mitigation sequence/hierarchy is shown in the figure below.



Mitigation Sequence/Hierarchy