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Proposed Coega Integrated Gas-to-Power Project: Gas Infrastructure Damara Tern Impact Assessment

Prepared for:

The Coega Development Corporation (CDC)

Dunefield with breeding Damara Terns adjacent to Zone 10 Gas to Power Projects. Above: Looking inland towards the proposed Gas Hub. Below: Looking over the dunefield, Port of Ngqura in background

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Table of Contents

ABBREVIATIONS

AENP	Addo Elephant National Park
BI	Biodiversity Importance
CBA	Critical Biodiversity Area
CDC	Coega Development Corporation
CI	Conservation Importance
CMS	Convention on Migratory Species
CWAC	Co-ordinated Waterbird Counts
dB	Decibels
DFFE	Department of Forestry, Fisheries and Environment (National)
E	East
ECBCP	Eastern Cape Biodiversity Conservation Plan
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMPr	Environmental Management Programme
FI	Functional Integrity
FSRU	Floating Storage Regasification Unit
ha	Hectares
IBA	Important Bird and Biodiversity Area
IUCN	International Union for the Conservation of Nature
km	kilometres
LNG	Liquified Natural Gas
Gas Hub	Gas storage, regasification and distribution hub, Zone 10
m	metre
MPA	Marine Protected Area
MW	Mega Watts
NEMA	National Environmental Management Act (Act 107 of 1998)
NMB	Nelson Mandela Bay
OSMP	Open Space Management Plan
PAOI	Project Area of Influence
PoN	Port of Ngqura
RR	Receptor Resilience
SA	South Africa
SEZ	Special Economic Zone
S	South
TNPA	Transnet National Ports Authority
W	West
Zone 10N Power Plant	Coega Zone 10 North 1000 MW Gas to Power plant
Zone 10S Power Plant	Coega Zone 10 South 1000 MW Gas to Power plant

Acoustic Glossary

To ensure that there is a clear interpretation of this report the following meanings should be applied to the acoustic terminology.

- **Ambient sound level** or **ambient noise** means that the totally encompassing sound in a given situation at a given time, and usually composed of sound from many sources, both near and far. Note that ambient noise includes the noise from the noise source under investigation. The use of the word *ambient* should however always be clearly defined (compare with *residual noise*).
- **A-weighted sound pressure level (SPL) (noise level) (L_{pA}), in decibels:**

  The sound pressure level of A-weighted sound pressure is given by the equation:

  $L_{pA} = 10 \log (p_A/P_o)^2$ where:

  P_A is the A-weighted sound pressure, in Pascals; and

  P_o is the reference sound pressure (p_o = 20 micro Pascals (µPa))

  Note: The internationally accepted symbol for sound pressure level, dB(A), is used.
- **dB(A)** means the value of the sound pressure level in decibels, determined using a frequency weighting network A. (The "A"-weighted noise levels/ranges of noise levels that can be expected in some typical environments are given in Table A1 at the end of this appendix).
- C-weighting is used for high level measurements and peak sound pressure levels. Approximately following the 100 phon curve - also written as dB(C) or dBC. The A-weighting curve is used extensively for general purpose noise measurements but the C-weighting correlates better with the human response to high noise levels. This weighting scale is useful for monitoring sources such as engines, explosions, and machinery.
- **Noise** means any acoustic phenomenon producing any aural sensation perceived as disagreeable or disturbing by an individual or group. Noise may therefore be defined as any *unwanted* sound or sound that is *loud, unpleasant or unexpected*.
- **Noise Control Regulations** means the regulations as promulgated by the Department of Environmental Affairs and Tourism and to be used by the provincial authorities to prepare their specific regulations. The Gauteng and Western Cape Provinces have promulgated their own regulations.
- **Noise impact criteria** means the standards applied for assessing noise impact.
- **Noise level** means the reading on an integrating impulse sound level meter taken at a measuring point in the presence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation, and, if the alleged disturbing noise has a discernible pitch, for example, a whistle, buzz, drone or music, to which 5dBA has been added. (the "A" weighted noise levels/ranges of noise levels that can be expected in some typical environments are given in Table A2 at the end of this appendix).

- **Noise-sensitive Development** means and Interested or Affected Party (I&AP), receptor or any other party that has a concern about an activity.
- **Sound (pressure) level** means the reading on a sound level meter taken at a measuring point.
- SANS 10103 means the latest edition of the South African Bureau of Standards Code of Practice SANS 10103 titled The Measurement and Rating of Environmental Noise with Respect to Land *Use, Health, Annoyance and to Speech Communication.*
- **Sound** means the aural sensation caused by rapid, but very small, pressure variations in the air. In quantifying the subjective aural sensation, "loudness", the letters dBA after a numeral denote two separate phenomena:

  "dBA", short for decibel, is related to the human's subjective response to the change in amplitude (or largeness) of the pressure variations.

  The "A" denotes the ear's different sensitivity to sounds at different frequencies. The ear is very much less sensitive to low (bass) frequency pressure variations compared to mid-frequencies.

  The level of environmental sound usually varies continuously with time. A human's subjective response to varying sounds is primarily governed by the total sound energy received. The total sound energy is the average level of the fluctuating sound, occurring during a period of time, multiplied by the total time period. In order to compare the effects of different fluctuating sounds, one compares the average sound level over the time period with the constant level of a steady, non-varying sound that will produce the same energy during the same time period. The average energy of sound varying in amplitude is thus equivalent to the continuous, non-varying sound. The two energies are equivalent.

Refer also the various South African National Standards referenced above and the Noise Control Regulations for additional, in some instances, more detailed definitions.

Profile of the Specialists

Dr AP (Paul) Martin Pr.Sci.Nat.

Role in the project: Avifauna Specialist responsible for the Damara Tern field work, research and report writing with respect to the Damara Terns. Impact assessment was undertaken jointly with Mr O Knoppersen of Acoustech.

Qualifications: BSc (Hons) Zoology

PhD. Title: Feeding Ecology of Birds on the Swartkops Estuary

Professional Registration: South African Council for Natural Scientific Professions Registration number: 400507/14. Professional Natural Scientist: Ecological Science; Environmental Science.

Experience: See Curriculum Vitae
40 years' experience in the environmental field including specialist avifauna impact assessments for powerlines, renewable energy, sand mining and gas to power projects. Avifauna monitoring for renewable energy facilities, environmental assessments for tourism plans.

Environmental Control Officer for the Coega Special Economic Zone (SEZ) and Port of Ngqura from August 2007 to February 2018. Monitoring of bird populations and breeding colonies within the Coega SEZ and wetlands in Nelson Mandela Bay.

Research Associate, Department of Zoology, Nelson Mandela University

Oliver Knoppersen AMIOA

Role in the project: Noise Specialist responsible for the noise assessment of the Damara Tern CBA, research and report writing with respect to the noise impact on the Damara Tern CBA. Impact assessment was undertaken jointly with Dr Paul Martin.

Qualifications: Diploma in Acoustics and Noise Control, AMIOA, Institute of Acoustics (UK)

Professional Registration: Institute of Acoustics (UK) Registration number: 51074

Experience: See Curriculum Vitae

13 years' experience in the environmental field including specialist noise impact assessments for power stations, mines, industrial sites and pump stations. Noise monitoring for mines.

EXECUTIVE SUMMARY

An Integrated Gas to Power Project is proposed in Zone 10 of the Coega Special Economic Zone (SEZ). Phase 1 development of the Gas Infrastructure comprises gas terminal infrastructure and up to two Floating Storage Regasification Units (FSRUs) in the Port of Ngqura and gas pipelines to up to two proposed 1000 MW Gas to Power Plants in Zone 10 and a road loading facility at a Gas Hub in Zone 10. Phase 2 developments include removing the FSRUs and replacing them with two large liquid natural gas storage tanks and a regasification facility at the Gas Hub.

A colony of Damara Tern *Sternula balaenarum*, Critically Endangered in South Africa breeds in a dunefield adjacent to the proposed Gas Hub and Power Plants.

This Damara Tern Specialist Impact Assessment documents the Damara Tern breeding population in Algoa Bay and assesses the impacts, particularly disturbance impacts, associated with the Gas Infrastructure and the Cumulative Impacts associated with the Integrated Gas to Power Projects in Zone 10.

Damara Tern Population

In South Africa there are an estimated 52 breeding pairs of Damara Terns of which 43 pairs (83%) breed in Algoa Bay in four colonies (Table A). At the Abalone Farm colony on the dunefield in Zone 10 adjacent to the proposed Gas Hub 9-11 pairs (17% of the South African population) have bred during the past two seasons but with a median of 3 pairs (7% of the South African population) since 2007. South Africa has only 6.7% of the estimated global population of 773 breeding pairs with nearly all the others breeding in Namibia. Damara Terns nest where there are large coastal dunefields and are sensitive to disturbance at their breeding sites.

Table A: Best estimate of the number of breeding pairs (range in brackets) of Damara Terns at each breeding locality in Algoa Bay prior to 2018/19 and during the 2018/19-2022/23 breeding seasons

Location	No. Breeding Pairs		% South African Breeding Population
	Pre 2018	2018/19 - 2022/23	
Alexandria Dunefield	20 (14-24)	17 (1-34)	32,7
Schelm Hoek Dunefield	1 (0-1)	14 (1-33)	26.9
Dunes E Boundary of Coega SEZ	2 (0-10)	3 (0-5)	5.8
Dunes Abalone Farm, Coega SEZ	4 (0-12)	9 (2-11)	17.3
Dunefield W of Cape Recife	0 (0-4)	0	
TOTAL	**27**	**43**	**82.7**

Impact Assessment

The proposed site for the Gas Hub in Zone 10 is 200m from the Damara Tern colony and the proposed sites for the Zone 10S and Zone 10N 1000 MW Power Plants are 300m from the colony. The impacts on the sustainability of the Damara Tern colony were assessed for

anthropogenic disturbance (noise, visual, lights, movement of vehicles and people), catastrophic events, marine impacts and dunefield sand starvation.

Impacts due to anthropogenic disturbance for both construction and operations of the Phase 1 Gas Infrastructure developments were assessed to be Moderate Negative reducing to Low Negative after mitigation (**Table B**).

Disturbance impacts for both construction and operations of the Phase 2 Gas Infrastructure and for the Cumulative Impacts of the Integrated Gas to Power projects were assessed to be High Negative. Recommended mitigation is unlikely to adequately address the impacts and the residual impacts remain High Negative (**Table B**).

The likely mechanism of the impact is that fewer breeding pairs will establish territories, they may more readily abandon the breeding area mid-season and breeding success is likely to decrease, ultimately resulting in the extinction of the colony. It is probable that breeding pairs will eventually move to one of the other Algoa Bay colonies.

Sand mining has impacted 50% of the dunefield to date and the impact of past and future sand mining was assessed to be of Moderate Negative significance for the No-Go Alternative reducing to Low negative in the very unlikely scenario of no further sand mining taking place (**Table B**).

Table B. Assessed Impact of the Gas Infrastructure on Damara Terns

Impact on Damara Tern Colony	Construction Phase		Operational Phase		Cumulative
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation	With Mitigation
Phase 1	Moderate	Low	Moderate	Low	
Phase 2	High	High	High	High	High
No-Go			Medium	Low	

Following the Species Environmental Assessment Guidelines, the Site Ecological Importance of the Damara Tern colony was determined to be High. The SANBI Guidelines indicate that limited activities of low impact are acceptable. Consequently development of Phase 1 of the Gas Infrastructure Project is acceptable with respect to the sustainability of the Damara Tern colony if mitigation recommendations are implemented.

The most appropriate mitigation for Phase 2 of the Gas Infrastructure Project that has high residual impacts is avoidance. Finding an alternative site with lower impacts beyond the minimum buffer for high impact developments of approximately 1km from the Damara Tern colony is the preferred option. There is the possibility of an offset opportunity to provide the important Damara Tern colony at Schelm Hoek with formal protection, ideally by including it in the adjacent Addo Elephant National Park, but the feasibility of this would need to be investigated.

1. INTRODUCTION

Coega Development Corporation (CDC) would like to develop an Integrated Gas to Power Project in the Coega Special Economic Zone (SEZ). The proposed project is comprised of three 1000 MW gas to power plants (one in Zone 13, two in Zone 10) and supporting gas infrastructure. The Gas Infrastructure includes a Liquid Natural Gas (LNG) terminal at the Port of Ngqura, a LNG and Gas Hub near the two power plants in Zone 10 and gas pipelines between the Port of Ngqura, the power plants, Gas Hub and Dedisa power plant in Zone 13.

This Environmental Impact Assessment (EIA) is for the Gas Infrastructure component of the Integrated Gas to Power Project. CES Environmental and Social Advisory Services has been appointed by CDC to undertake the EIA process required in terms of the National Environmental Management Act 107 of 1998 (NEMA). On 16 August 2021 CDC received a Record of Refusal from the Department of Forestry, Fisheries and Environment (DFFE) for a very similar Gas Infrastructure project due to several deficiencies in the EIA Report. One of the deficiencies identified was the impact of the project on a Damara Tern colony located close to the Zone 10 Gas to Power projects.

CES has appointed Acoustech to undertake a specialist Damara Tern Impact Assessment with respect to the Gas Infrastructure component of the Integrated Gas to Power Project.

1.1. Scope of Work

1. Conduct a desktop assessment of the conservation status of the Damara Tern globally, in South Africa and the local situation in Algoa Bay.
2. Using historical records on breeding in Algoa Bay from their first discovery in 1980 and data on breeding in the rest of South Africa document and assess the importance and the attributes of the Damara Tern colony in Zone 10 of the Coega SEZ in the context of the Algoa Bay, South African and the global breeding population.
3. Determine the main feeding areas of Damara Terns in the Coega SEZ
4. Review the previous noise impact assessment, review and investigate noise sources from the proposed Gas to Power gas infrastructure.
5. Identify potential noise sources from construction and operational activities that may cause a noise nuisance to the Damara Tern population.
6. Collection and archiving of spectral acoustic/ noise data applicable for each noise source.
7. Advise on the potential project noise levels and characteristics in the terrestrial environment.
8. Determine what other impacts, including noise, might affect the viability of the tern colony (e.g. human traffic, increased shipping) given that human disturbance is known to influence tern productivity.
9. Determine the combined effects of sound and other impacts (e.g. light, visual cues, general movement and disturbance) that will impact on the Damara Terns.

10. Prepare a Damara Tern Impact Assessment Report compliant with the NEMA: Environmental Impact Regulations, 2014 as amended, GN1150 (30 October 2020) Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species and Species Environmental Assessment Guideline (SANBI 2020).

2. PROJECT DESCRIPTION

2.1. Project Overview

It is proposed to develop the Coega Integrated Gas-to-Power project within the Coega SEZ in phases. The project entails three 1000 MW power stations (two in Zone 10 and one in Zone 13), a LNG terminal in the Port of Ngqura, a LNG Gas Hub in Zone 10 comprising a LNG landside gas transport hub and an LNG Regasification Unit and cryogenic and natural gas pipelines linking the LNG terminal with the power plants, Gas Hub and Dedisa power plant in Zone 13 (**Figure 2-1**).

Figure 2-1: Coega Integrated Gas to Power Project Layout

This EIA is for the Gas Infrastructure component of the Integrated Gas to Power Project. The Zone 10 North and Zone 10 South 1000 MW gas to power plants are the subject of separate EIAs. A marine seawater intake and outfall infrastructure servitude has been approved (Environmental Authorisation dated 27 September 2021).

The Gas Infrastructure component of the project will comprise:

- Initially one, with up to two, Floating Storage Regasification Units (FSRU) moored in the Port of Ngqura. These vessels will receive, store and re-gasify the LNG received from a LNG carrier vessel. If all components of the Integrated Gas to Power project run at maximum capacity, a LNG carrier delivery will be required every three days.
- A new jetty with offloading platform and berthing facilities in the Port of Ngqura. This will require localised dredging and disposal of material at the offshore site used during maintenance dredging.
- A trestle structure to support the gas and cryogenic pipelines running within the port from the offloading platform parallel to the eastern breakwater, to the point where the pipelines will cross under the breakwater near the admin craft basin, thereafter running underground
- Gas Hub, Zone 10: Initially a gas distribution hub with truck loading facility allowing for 3rd party offtake of LNG and Natural Gas. LNG Storage Tanks (2x 160,000 m^3 tanks) and regasification facilities will be added to replace the FSRUs once demand for Natural Gas reaches a point where this is the more feasible option. The Gas Hub will include gas metering, admin, control rooms, workshops and tall stack vents and will cover an area of c.23 ha.
- Gas pipelines (for transmission of Natural Gas), placed underground in 10m wide servitudes, from the FSRU and jetty to the three proposed power plants, the Gas Hub (for third party offtakers) as well as the boundary of the Dedisa power plant in Zone 13.
- Double cryogenic pipelines (for transmission of LNG), placed underground in 20m wide servitudes from the FSRUs to the truck loading facility at the Gas Hub (for third party offtake of LNG). When the FSRUs are replaced by the gas storage and regasification unit at the Gas Hub, double cryogenic pipelines will bring LNG from the LNG Carrier vessel to the storage and regasification unit.

The Gas Infrastructure will therefore be constructed in two phases. Phase 1 when LNG and Natural Gas is supplied by the FSRUs moored in the Port. Phase 2 when the FSRUs are replaced by the LNG Storage and regasification units at the Gas Hub and LNG is supplied direct to the Gas Hub by the LNG Carrier. At the Gas Hub, Phase 1 will comprise the Road Loading Facility and Weighbridge in the north-western portion of the site. Phase 2 will comprise the balance of the infrastructure, in the south-eastern portion of the site, closest to the mobile dunefield (**Figure 2-2**).

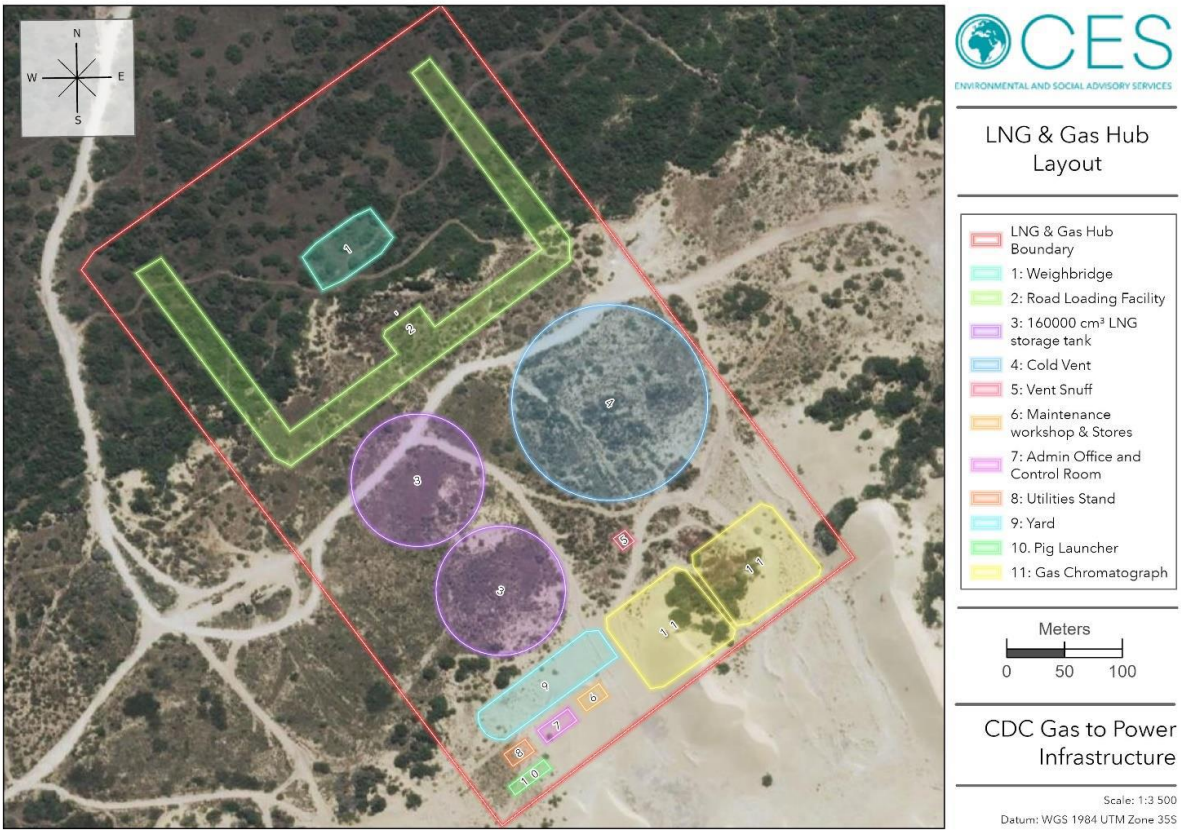

Figure 2-2: Gas Hub Layout

3. METHODOLOGY

3.1. Avifauna: Environmental Sensitivity & Damara Tern Population

3.1.1 Environmental Sensitivity

Two high resolution terrestrial biodiversity plans that include the Coega SEZ have been developed. The bioregional plan for the Nelson Mandela Bay (NMB) Municipality has been gazetted (PN13 dated 30 March 2015) and is based on the NMB Conservation Assessment and Plan (Stewart *et.al* 2004, SRK 2010).

The Coega Open Space Management Plan (OSMP) Revision 1 (CDC 2014) was developed in response to a condition of the Environmental Authorisation for the development of the Coega SEZ. Critical Biodiversity Areas (CBAs) in the OSMP maintain and where possible link environmentally important areas whilst allowing for development. Identified Service Corridors also provide habitat linkages. The Coega OSMP is the primary environmental planning tool to guide development proposals within the Coega SEZ. In general, developments must avoid CBAs and services (such as transmission lines) should be located within the Service Corridors.

As the NMB Bioregional Plan and Coega OSMP are legally enforceable, the Eastern Cape Biodiversity Conservation Plan 2019 (ECBCP 2019) has incorporated, without modification, the CBAs and Ecological Support Areas in the NMB and Coega OSMP plans.

The Important Bird and Biodiversity Area Programme (Marnewick *et al*. 2015), Addo Elephant National Park (AENP) and associated Marine Protected Area are also very relevant to this project.

Current impacts in the vicinity of the Integrated Gas-to-Power Project (primarily sand mining) were obtained from Martin (2019) and the avifauna specialist's knowledge of the area.

3.1.2 Damara Tern Population

The conservation status, ecology, distribution, population size and breeding of Damara Terns globally and in South Africa is summarized from the literature. The primary source of information is the Atlas of marine turtles, seabirds and seals in the Benguela Current and adjacent regions (Makhado *et al* in press 2023). The atlas documents Damara Tern breeding between Angola and Algoa Bay for the period 1976 to 2021/22 and assesses numbers, trends, movement and conservation of Damara Terns, including a re-assessment of their IUCN conservation status (Braby *et al*. in press 2023a,b; Martin *et al*. in press 2023). Other sources of information include the Namibian and South Africa Red Data Books and IUCN Red List citation (Simmons *et al*. 2015; Taylor *et al*. 2015; Birdlife International 2022).

3.1.2.1 Algoa Bay Colonies

During the Damara Tern breeding seasons (early October to early March) for the years 2018/19 to 2022/23 the avifauna specialist undertook between 12-20 surveys each year at the Damara Tern breeding colonies in Algoa Bay and the confidence level in the estimates of breeding pairs in Algoa Bay for these years is high (Martin 2019; Martin *et al*. in press 2023).

The avifauna specialist has monitored the Damara Tern breeding colonies in Algoa Bay as follows:

- The two colonies in the Coega SEZ (Abalone Farm and E Boundary): 1-6 visits per season for the years 2007/08 to 2022/23.
- Alexandria Coast (Sundays River to Woody Cape): Period 2015/16 to 2017/18 at least one survey per season. Two to four surveys per season during the period 2018/19 to 2022/23.
- Schelm Hoek (west of the Sundays River): A survey January 2012 and 3-6 surveys for the period 2018/19 to 2022/23.
- The dunefields between Maitland River Mouth and Gamtoos River Mouth were surveyed on 25 November 2018 and the Cape Recife dunefields were surveyed on 14 December 2018.

The number of nests and young present on any one date determines the minimum number of pairs breeding. As nests and young are cryptic and difficult to locate, not all will be found and the presence of adults on territory (mobbing the observer and/or occupying a dune slack) was also used as an indication of a nesting attempt, providing an estimate of the

maximum number of pairs breeding. The number of adult birds present during each visit was recorded.

Co-ordinated Waterbird Counts (CWAC) of the Coega Saltpans and adjacent Coega River have been undertaken in mid-summer and mid-winter from 2008 to 2023. Observations of feeding and roosting Damara Terns were documented whilst the avifauna specialist was the Independent Environmental Control Officer for the Port of Ngqura / Coega SEZ during the period 2007-2018.

3.2. Noise Impact Assessment

3.2.1 Legal Framework

SANS 10103:2008:

SANS 10103:2008, the Measurement and Rating of Environmental Noise with Respect to Annoyance, and to Speech Communication. Besides measurement techniques etc, this document provides noise levels that are expected in various areas (Rating Level). These are used by the Noise Regulations as limits of noise in the various areas. The acceptable rating levels for various districts are given in **Table 3-1** below, being the maximum noise level that is acceptable at the boundary of the property for any district. However, NOTE 6 states "*The noise from individual noise sources produced, or caused to be produced, by humans within natural quiet spaces such as national parks, wilderness areas and bird sanctuaries, should not exceed a maximum A-weighted sound pressure level of 50 dBA at a distance of 15 m from each individual source."* This noise requirement ensures that disturbance to the wildlife is kept to a minimum.

According to the Coega Open Space Management Plan (OSMP) Revision 1 (CDC 2014), the Damara Tern Colony within the Coega SEZ was identified as a Critical Biodiversity Area and it will be regarded as a bird sanctuary.

Species Environmental Assessment Guideline:

GN 1150 of 30 October 2020 provides a protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species. A guideline for the implementation of this protocol was developed (SANBI 2020). Table 10.9 of the guideline "*Factors determining appropriate buffers for bird Species of Conservation Concern*" identifies high intensity noise as "frequent, loud (i.e. more than 10 dB above ambient levels; or greater than about 50 dB), and/or long term (years)". For nesting/breeding sites of bird Species of Conservation Concern "noise/visual disturbance that could cause abandonment, avoidance, reduced densities, fitness and/or breeding success", the likely buffer size for high intensity disturbance is a minimum of 1 km for raptor nests and other large bodied Species of Conservation Concern (smaller buffers may be appropriate for other species) (Table 10.9, SANBI 2020).

Table 3-1: SANS 10103:2008 Table 2

1	2	3	4	5	6	7
Type of district	**Equivalent continuous rating level ($L_{Req,T}$) for noise** dBA					
	Outdoors			**Indoors, with open windows**		
	Day/night $L_{R,dn}$[a]	**Daytime $L_{Req,d}$[b]**	**Night-time $L_{Req,n}$[b]**	**Day/night $L_{R,dn}$[a]**	**Daytime $L_{Req,d}$[b]**	**Night-time $L_{Req,n}$[b]**
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with one or more of the following: 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

NOTE 1 If the measurement or calculation time interval is considerably shorter than the reference time intervals, significant deviations from the values given in the table might result.

NOTE 2 If the spectrum of the sound contains significant low frequency components, or when an unbalanced spectrum towards the low frequencies is suspected, special precautions should be taken, and specialist advice should be obtained. In this case the indoor sound levels might significantly differ from the values given in columns 5 to 7. (See also annex B.)

NOTE 3 In districts where outdoor $L_{R,dn}$ exceeds 55 dBA, residential buildings (e.g. dormitories, hotel accommodation and residences) should preferably be treated acoustically to obtain indoor $L_{Req,T}$ values in line with those given in table 1.

NOTE 4 For industrial districts, the $L_{R,dn}$ concept does not necessarily hold. For industries legitimately operating in an industrial district during the entire 24 h day/night cycle, $L_{Req,d} = L_{Req,n} = 70$ dBA can be considered as typical and normal.

NOTE 5 The values given in columns 2 and 5 in this table are equivalent continuous rating levels and include corrections for tonal character, impulsiveness of the noise and the time of day.

NOTE 6 The noise from individual noise sources produced, or caused to be produced, by humans within natural quiet spaces such as national parks, wilderness areas and bird sanctuaries, should not exceed a maximum A-weighted sound pressure level of 50 dBA at a distance of 15 m from each individual source.

a The values given in columns 2 and 5 are equivalent continuous rating levels and include corrections for tonal character and impulsiveness of the noise and the time of day.

b The values given in columns 3, 4, 6 and 7 are equivalent continuous rating levels and include corrections for tonal character and impulsiveness.

Low Frequency and Vibration:

Currently there is no legal framework regarding vibration caused by low frequency noise. However, the document "A Simple Criterion for Low Frequency Noise Emission Assessment" by N. Broner reprinted from Journal of LOW FREQUENCY NOISE, VIBRATION AND ACTIVE CONTROL VOLUME 29 NUMBER 1 2010, has been used in this report to assess the low frequency annoyance. The document has identified various European methods of

assessment of low frequency noise (LFN) and provides a simple criterion to assess low frequency noise. This criterion is used for human exposure. However, as there is no current research relating low frequency impacts on avifauna, it is still considered good engineering practice to keep the recommended low frequency criterion as recommended from this research.

The document specifically mentions that Open Cycle Gas Turbines, gas engines, boilers, forced draft fans and other sources related to power generation generate low frequency noise due to combustion and turbulent air flow. Based on a review of many case histories and the literature, the author of the document recommends the following criteria:

Criteria for Assessment of LFN

	Sensitive Receiver	Range	Criteria Leq (dBC)
Residential	Night time or plant operation 24/7	Desirable	60
		Maximum	65
	Daytime or Intermittent (1 – 2 hours)	Desirable	65
		Maximum	70
Commercial/ Office/	Night time or plant operation 24/7	Desirable	70
		Maximum	75
Industrial	Daytime or Intermittent (1 – 2 hours)	Desirable	75
		Maximum	80

For the purpose of this study, the recommended criteria for low frequency noise (LFN) is a maximum of 75 dBC at the proposed property boundaries.

3.2.2 Existing Baseline - Noise Measurements

Two noise measurements (Points 1 and 2) were conducted on the 26 – 28 July 2021 near the Damara Tern Breeding Area.

Two Svantek 957 SANAS calibrated type 1 sound level meters was used to perform the noise measurements. The sound level meters were calibrated before and after the noise measurements with a 01dB sound calibrator. Further details of the sound level meters can be found in Appendix C.

$L(A)_{eq}$ values of ambient noise levels were calculated for the measurement point from the readings. The $L(A)_{eq}$ value is an A-weighted noise level integrated over the period of measurement.

Weather conditions during the noise measurements:

Measurement Date	Average Temperature (H/L)	Average Wind Speeds
26/07/2021	23 / 16 Degrees	13 km/h NE
27/07/2021	28 / 15 Degrees	23 km/h NE
28/07/2021	17 / 10 Degrees	15 km/h NE

3.2.3 Estimation of Potential Noise Impacts

The noise impact was determined with reference to SANS 10103:2008 and the specifications and guidelines provided in good engineering practice have therefore been used in each case to determine what is reasonable.

To make the judgment, we have compared the predicted noise levels provided in the noise impact assessment at the Damara Tern colony of the following:

- The noise requirements for a bird sanctuary in accordance with the SANS 10103:2008 noise requirements (50 dBA).
- Guideline for noise disturbance to species of conservation concern (50dBA) (Table 10.9, SANBI 2020).

3.2.4 Noise Prediction Modelled Scenario

The modelled scenario was detailed in the Specialist Study on Noise Impacts for the 2021 Gas Infrastructure EIA (Safetech 2021). From the report the following predicted noise levels were provided.

Area	Predicted Noise Levels		
	Gas Infrastructure Only (Construction Noise)	**Gas Infrastructure Only (Operational Noise)**	**Cumulative Operational Noise (Gas Hub, Zone 10S & Zone 10N Power Plants)**
Damara Tern Colony	56.9 dBA	34.5 dBA	70.1 dBA

3.3. Environmental Impact Assessment Methodology

3.3.1 Terrestrial Fauna Species Protocols

To implement The Terrestrial Fauna Species Protocols for environmental impact assessments required by GN 1150 dated 30 October 2020 the Species Environmental Assessment Guidelines in SANBI (2020) were applied.

The Project Area of Influence (PAOI) (SANBI 2020) was determined by including the areas of importance to breeding Damara Terns (i.e. the breeding and feeding areas in the vicinity of the proposed Zone 10 Gas to Power Projects), the proposed development footprints of the two CDC Zone 10 Power Plants, the Gas Hub, FSRU mooring area and areas used by Damara Terns for feeding and roosting in the Port of Ngqura and the gas pipelines between the Port of Ngqura and the Gas Hub.

The Potential Impact Receptors were determined within the PAOI by identifying the Damara Tern colony and the main area used by breeding pairs for feeding.

The Site Ecological Importance was determined for both Impact Receptors (breeding colony and feeding area) using the methodology and matrices in SANBI (2020). This entails:

- Determining the Conservation Importance (CI) of Damara Terns (i.e. threat status) and assessing the Functional Integrity (FI) of the Impact Receptor (i.e. the ability of the Damara Tern colony and feeding area to maintain function under present circumstances).
- Biodiversity Importance (BI) is a function of CI and FI and is obtained from the matrix in SANBI (2020).
- Assessing Receptor Resilience (RR) for each Impact Receptor (the capacity of the breeding colony and feeding area to resist damage from disturbance and/or to recover to their original state with limited human intervention)
- Site Ecological Importance is a function of BI and RR and is obtained from the matrix in SANBI (2020).

Recommended buffers around the Impact Receptors (breeding colony and feeding area) were determined using:

- Birdlife South Africa guidelines for determining buffers for avifauna species of conservation concern (SANBI 2020).
- Observations made by the avifauna specialist of the effect of impacts on Damara Terns in Algoa Bay as a function of distance from the source of impact.
- Information in the literature on impacts to Damara Terns as a function of distance from the source of impact.

3.3.2 Impact Assessment Methodology

The CES Impact Assessment Methodology (**Appendix A**) was used to rank the potential direct, indirect and cumulative impacts of the proposed Gas Infrastructure during the construction and operational phases of the project, prior to mitigation and after mitigation. The emphasis is on potential impacts in terms of the sustainability (survival and reproduction) of the Damara Tern population at a local (site vicinity) and regional (Algoa Bay / South Africa) level.

Recommendations are made for practical mitigation, management and monitoring measures for inclusion in the project Environmental Management Programme (EMPr)

3.4. Assumptions and Limitations

3.4.1 Avifauna Impact Assessment

a) This assessment is based on the project description provided to the Specialists by CES. The 2021 Final Environmental Impact Assessment Report for the Proposed Gas Infrastructure (SRK 2021) and associated Specialist Reports, especially the Quantitative Risk Assessment, Noise and Marine Impact Assessments were used to inform this assessment.

b) Damara Tern nests are difficult to find, nests that fail may result in pairs making several breeding attempts and pairs in a colony do not nest synchronously. Consequently it is difficult to obtain accurate estimates of breeding pairs and breeding success.

c) The continued existence of the Abalone Farm Damara Tern colony adjacent to the project site is not guaranteed, even if the Integrated Gas to Power project does not proceed. Existing impacts (notably sand mining) and other factors such as food availability and possible future declines in the Damara Tern population in South Africa could lead to the future extinction of the colony.

3.4.2 Acoustical Measurements

There are limitations and uncertainties regarding acoustical measurements. Noise levels have the potential to fluctuate based on numerous components, including:

- The noise level may change from day to day due to activities within the area;
- Seasonal changes have the potential to influence sound levels directly (e.g. rain);
- Measurements near mining and industries fluctuate depending on equipment in use, capacity load in use, unforeseen equipment in care and maintenance. Certain equipment may not be running optimally, with the consequence being excessive elevated noise levels (e.g. gas leaks, conveyor pulley roller squeaking, excessive vibrations (and associated noise) from unmaintained dampers on equipment etc);
- Metrological conditions can influence noise measurements. These include inversion and diffraction in the temperature layer, change in temperature and humidity etc.

4. RESULTS: ENVIRONMENTAL SENSITIVITY AND BIRD POPULATIONS

4.1. Protected Areas and Important Bird and Biodiversity Areas

There are three Global Important Bird and Biodiversity Areas (IBAs) close to the Coega SEZ (Marnewick *et al*. 2015) (**Figure 4-1**). These are areas that regularly hold significant numbers of globally threatened bird species or are of importance to species with restricted ranges. The IBAs are discussed with respect to their relevance to the Integrated Gas to Power project and Damara Terns:

a) *Woody Cape Section: Addo Elephant National Park (AENP).* This IBA starts at the Sundays River 17 km E of the Port of Ngqura and stretches 60 km E to Cannon Rocks. It includes the Alexandria Coastal Dunefield and grassland inland of the dunefield and Alexandria Forest. Of consequence to this project is that the dune system between the Port of Ngqura and Sundays River is an extension of the Alexandria dunefield and there is good connectivity between them. Damara Tern is one of the trigger species for the IBA due to the breeding colony in the Alexandria dunefield.

b) *Algoa Bay Islands: Addo Elephant National Park.* This IBA includes Jahleel, Brenton and St Croix Islands, the latter located 5.5km ESE of the proposed Zone 10 Gas Hub and Power Plants. In 2018 the St Croix Island group had the largest breeding population (approximately 5663 pairs) of African Penguins *Spheniscus demersus* in the world. However, the population has since collapsed. Of consequence to the Integrated Gas to Power project is that impacts that extend into the marine environment may impact on the IBA.

c) *Swartkops Estuary, Redhouse and Chatty Saltpans.* This IBA is 10km SW of the Port of Ngqura and is important for its coastal wetlands. Damara Tern is one of the trigger species for the IBA as they sometimes use the estuary and saltpans for roosting and feeding, especially during the post-breeding period.

The closest terrestrial Protected Areas of consequence to the Integrated Gas to Power project are the portions of AENP that form part of the Woody Cape Section. The Algoa Bay Islands are part of the AENP and Jahleel Island is located 530m from the Eastern Breakwater of the Port of Ngqura, close to the proposed mooring of the FSRU.

The AENP Marine Protected Area (MPA) gazetted on 23 May 2019 covers much of Algoa Bay east of the Port of Ngqura below the high water mark. At its closest point the MPA is 200m from the Damara Tern CBA and the feeding areas of Damara Terns breeding in Algoa Bay fall mostly within the MPA. The main consequence for the Integrated Gas to Power project is that impacts that extend into the marine environment may impact the MPA and the regulations for the MPA promulgated on 23 May 2019 need to be complied with (e.g. no unauthorized effluent outlets).

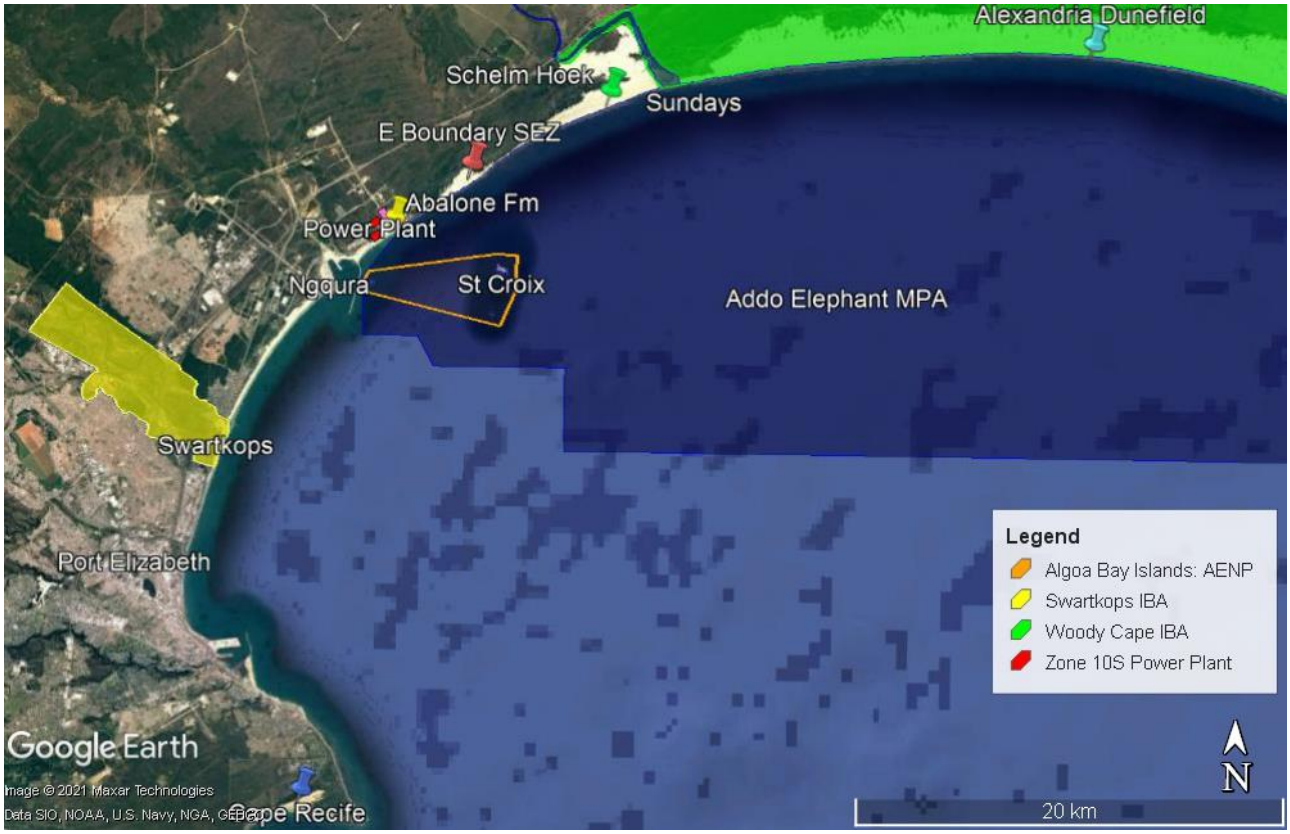

Figure 4-1: Important Bird Areas, Marine Protected Area and Damara Tern Colonies in Algoa Bay

4.2. Description of the Affected Environment

The vegetation types in this account follow the classification in the NMB Bioregional Plan (Stewart *et.al* 2004; SRK 2010 in Provincial Notice No. 13 dated 30 March 2015). The dense evergreen bush thicket on the northern half of the Gas Hub site is Algoa Dune Thicket, classified as Vulnerable (Stewart *et.al* 2004; SRK 2010). Much of the alien invasive Rooikranz *Acacia cyclops* vegetation that had invaded the vegetated dune areas has been cleared. West of the Zone 10 Power Plants and Gas Hub is a large disturbed area called the Eastern Reclamation – an area used to stockpile cut and fill material during Port construction projects.

The southern half of the Gas Hub site is on what was formerly a mobile un-vegetated primary dune system that, together with the adjacent beach is named "Sandy Beach vegetation", classified as Least Threatened (Stewart *et.al* 2004, SRK 2010). Most of the sand was removed by Sunshine Coast Quarry prior to 2016 and by Mandela Bay Sand & Stone Mine during 2018-2020 leaving a calcrete / gravel / sandy surface. This landscape stretches approximately 120-220m south of the southern boundary of the Gas Hub to where the remaining dunefield approximately 50ha in extent now starts. The dunefield is moving north-east under the influence of the prevailing south-west wind.

The Coega OSMP is the primary environmental planning tool to guide development proposals within the Coega SEZ (CDC 2014). In the south-west of the dunefield, 200m from the southern boundary of the Gas Hub is an area approximately 340m x 310m (10ha) that has been included in the OSMP as CBA no. 1.5 (**Figure 4-3**). This CBA is there to protect the

breeding habitat of a Damara Tern colony. The OSMP states that “Any development proposed in this coastal area must take into consideration the impact on Damara Terns”. Recommendations with respect to this portion of OSMP include:

- Protect the Damara Tern areas and ensure that they remain undisturbed from the effects of recreational or industrial development.
- Fence off (or demarcate) the areas to prevent access and accidental habitat destruction.
- Prevent access into these areas, except at designated access points (e.g. access for monitoring).
- Where development is unavoidable, a specialist study is required.
- Monitor the Damara Tern populations to see if adjacent activities are resulting in any impacts. Produce an annual report to build up a database on possible impacts.

4.2.1 Description of Current Impacts

To interpret the Damara Tern breeding data for the Abalone Farm colony on the dunefield south of the Gas Hub, background is provided on past and current developments at the dunefield.

Prior to 2003 the dunefield comprised of approximately 100ha of mobile dunes. Sand mining started in the northwest of the dunefield in 2003 and to date approximately 50% of the dune area has been mined, with sand removed from the north and west portions of the dunefield (Sunshine Coast, Dove and Mandela Sand & Stone mines)(**Figure 4-2**). The portion of the Dove mining area where the Zone 10S Power Plant is proposed, 300m west of the Damara Tern CBA, was being mined during the 2017/18 Damara Tern breeding season. The southern portion of the Gas Hub site falls within the Mandela Sand & Stone mine, adjacent to the northern boundary of the Damara Tern CBA that was active from mid-2018 to early 2020. There was mining activity near the southern boundary within 100m of the Damara Tern colony during the 2018/19 Damara Tern breeding season and in the northern section, approximately 250m from the Damara Tern CBA during the 2019/20 breeding season. The Ngqura sand mine has been active since June 2020 and is located approximately 600m north-east of the Damara Tern CBA. The sand mining operations are low key, comprising a tractor loader backhoe (TLB) excavating sand and loading it onto trucks. Sometimes a diesel engine sieve is used to remove vegetation and other impurities from the sand. A Coega Mining Right has been authorized covering approximately 35 ha of the remaining 50 ha of dunes (**Figure 4-2**).

The old Abalone Farm is located 200m east of the Damara Tern CBA and was abandoned in 2010. There is no evidence that the breeding Damara Terns were negatively affected by the Abalone Farm operations.

The Port of Ngqura became operational in September 2009. The port has interfered with sand movement along the coast and together with mining effects the dunefield is experiencing sand starvation, with little new sand entering the system. The existing dunes are moving in a north-easterly direction under the influence of the prevailing south-westerly winds.

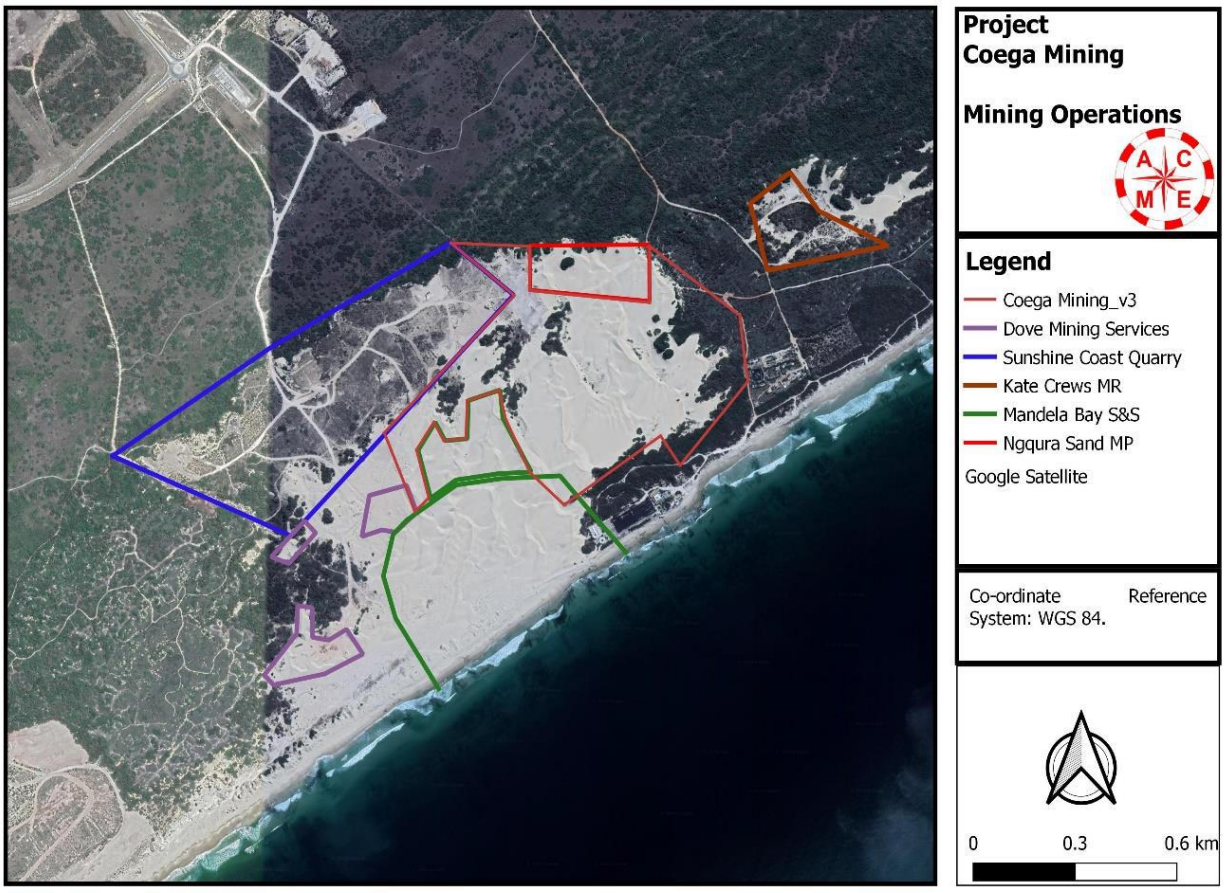

Figure 4-2: Sand mining areas in relation to the Damara Tern Colony (green boundary)

4.3. Damara Tern

4.3.1 Conservation Status

The Damara Tern *Sternula balaenarum* is a southern African near endemic breeding species, breeding at coastal sites between Algoa Bay, Eastern Cape and southern Angola during summer and migrating to the coasts of tropical Africa during the non-breeding season. Globally the Damara Tern was previously classified as Vulnerable in the IUCN Red List with a declining global population estimate of up to 5370 breeding individuals. In 2021 it was downlisted to Globally Least Concern with a global population of 2,200-5,700 mature individuals that, together with its large range, is not declining at a rate rapid enough to justify a Vulnerable status (Birdlife International 2022).

Recent surveys indicate a minimum of 773 breeding pairs globally, of which 6 pairs (0.8%) breed in southern Angola, 715 pairs (92.5%) breed in Namibia and 52 pairs (6.7%) breed in South Africa (Braby *et al.* in press 2023a; Martin *et al*. in press 2023). This is a decline from a minimum of 1010 breeding pairs globally in 2010 and justifies a global classification of Endangered based on IUCN criteria (Braby *et al*. in press 2023b).

In the Namibian Red Data Book the Damara Tern is classified as Near Threatened (Simmons *et al.* 2015). Based on recent data a classification of Endangered in Namibia is advocated (Braby *et al*. in press 2023a).

The South African Red Data Book of Birds (Taylor *et al*. 2015) estimated less than 100 mature individuals in South Africa with an estimated decline of at least 25% over one generation and consequently the Damara Tern is one of the thirteen bird species classified as Critically Endangered in South Africa (Taylor *et al.* 2015).

Surveys during the period 2018-2021 indicate that the South African Damara Tern population satisfied IUCN criteria for Regionally Endangered based on a small population of <200 mature individuals declining at >50% over three generations (Criterion A2), small geographic range (Criterion B2(a)), small and declining population (Criteria C1 and C2) and very small population (Criterion D(1)) (Martin *et al*. 2023).

The Damara Tern is included in Annex 2 of the Agreement on the Conservation of African-Eurasian Migratory Waterbirds and in Appendix II of the Convention for the Conservation of Migratory Species of Wild Animals (the Bonn Convention), of which South Africa is a signatory (CMS 2006). It is listed as Critically Endangered in the Marine Threatened or Protected Species Regulations (Government Notice No. 476 dated 30 May 2017).

In South Africa Damara Terns have been recorded breeding at 14 localities between Alexander Bay (Northern Cape) and Woody Cape (Algoa Bay) of which six are no longer used (Martin *et al*. in press 2023). In the late 1970s there were an estimated 150 breeding pairs, mostly on the West Coast (Barnes 2000). In 2010 an estimated minimum of 65 pairs bred in South Africa (Braby 2011) reducing to a best estimate of 52 pairs for the period 2018-2021 (Martin *et al*. in press 2023).

Prior to the 2018/19 breeding season, the number of Damara Terns breeding in Algoa Bay was thought to be 27 pairs with a maximum count of 55 adult birds (Whittington *et al*. 2015; Martin 2019; Martin *et al*. in press 2023). Surveys of the Algoa Bay colonies for the period 2018/19 to 2022/23) have raised this to a best estimate of 43 pairs and 113-169 adults (Martin *et al*. in press 2023).

Surveys along the rest of the South African coast during the 2018/19 breeding season found only 9 pairs at four localities (5 pairs in the Northern Cape and 4 pairs at Struis Bay, Western Cape) (Martin *et al*. in press 2023). There are now an estimated 52 pairs of Damara Tern breeding in South Africa of which 43 (83%) breed in Algoa Bay, representing 5.6% of the global breeding population.

4.3.2 Ecology

Almost all of the Damara Tern population was thought to migrate to the coastal waters of the Gulf of Guinea, West Africa during the non-breeding season (Hockey *et al*. 2005; Taylor *et al*. 2015). However, since 2018 100+ birds have been observed over-wintering at Vilanculous, Central Mozambique. A colour flagged chick from the Coega colony was re-sighted at Vilanculous and back at Cape Recife, confirming a recent change in the migration habits of birds from the Eastern Cape (Allport *et al*. 2022; Martin *et al*. in press 2023).

In Algoa Bay, since 2010, small numbers (up to 10) Damara Terns over-winter, roosting at Cape Recife. There is usually an influx to Cape Recife during late August / September but birds are not usually seen on the breeding grounds before October with the earliest egg recorded by the author on 18 October and the latest nest with an egg recorded on 13 February. After breeding, birds disperse away from the breeding areas and can be seen

along the beaches and at the mouth of estuaries and at saltpans in Algoa Bay. The last sightings before the birds migrate are usually in the third week of March.

Damara Terns breed in small, loose colonies, but sometimes individually, laying one egg (very rarely two) in an exposed location. In Algoa Bay they always breed where there are large, un-vegetated mobile dunes, usually within 400m of the sea. They nest in dune slacks on calcrete or mixed sand/pebble substrates or on the sand/pebble substrate at the back of the beach with occasional nests on dune sand. It is thought that they nest in these isolated and un-vegetated locations to avoid predators such as mongooses, genets, Vervet Monkeys, Black-backed Jackals, Caracal, snakes, Kelp Gulls and Pied Crows. In Namibia, where predation caused 70-80% of nest failures, there is Black-backed Jackal activity along the coast and the terns may nest several kilometres inland to avoid this (Braby 2011; Simmons *et al*. 2015).

The incubation period is 18-22 days followed by a fledgling period of 20 days and a dependency period of 2 months. If the breeding attempt fails the birds may re-locate the nest and re-try. Survival rate to adulthood is high (59%) as is adult survival rate (88%) and adults are long-lived with a generation period of 12.3 years. Adults are faithful to their breeding colonies with only a 6% probability of a breeding bird moving to another colony and they first breed at 3-4 years old (Hockey *et al*. 2005; Braby 2011; Taylor *et a*l. 2015; Birdlife International 2022).

Damara Terns feed by shallow plunge diving in shallow relatively sheltered inshore waters. They avoid murky, sediment filled water and feed on small fish usually about 50mm in length (Braby *et al*. 2011).

4.3.3 Threats and Conservation Measures

The following threats have been identified (Braby 2011; Simmons *et al*. 2015; Taylor *et al.* 2015; Martin *et al* in press 2023):

- Diamond mining (in Namibia and the Northern Cape) and sand mining. In Namibia pairs resorted to breeding on bedrock after the dunes were worked for diamonds.
- Disturbance. Especially by off-road vehicles. Although driving in the coastal zone is illegal in South Africa, it still happens and affects Damara Tern colonies in the Northern, Southern and Eastern Cape.
- Fish offal (e.g. left by anglers), refuse and in Namibia seal colonies increase predator and scavenger populations (e.g. crow, gull and jackal populations).
- Coastal development (a colony near Walvis Bay went extinct due to residential development where the birds were nesting).
- Invasion of un-vegetated dunes by alien invasive vegetation.
- Swamping of eggs by wind-blown sand.
- A change in the availability of small fish (e.g. due to water turbidity, climate change).
- Reduced fitness at low population size

The following conservation and research measures have been proposed (Simmons *et al*. 2015; Taylor *et al.* 2015; Martin *et al*. in press 2023; Braby *et al*. in press 2023b):

- Formal protection for important breeding sites.

- Designate disturbance-free areas on nesting beaches, especially from off-road vehicles.
- Organic waste control to prevent an increase in scavengers and predators.
- Monitor and publish population trends.
- Identify reasons for the abandonment of breeding sites.
- Studies on diet composition and linkages with relevant fish populations.
- A Population and Habitat Viability Assessment and Biodiversity Management Plan culminating in National Species Recovery Plan is recommended (Taylor *et al.* 2015).
- If the Damara Tern is classified as Globally Endangered, as advocated (Braby *et al* in press 2023b), sites holding at least 15 individuals / 5 breeding pairs qualify as Important Bird Areas (Birdlife International 2020).

4.3.4 Algoa Bay Colonies

Damara Terns have been recorded breeding at the following five localities in Algoa Bay (Martin *et al*. in press 2023)(**Figure 4-1**):

a) Dunes adjacent to the old abalone farm, Zone 10 of the Coega SEZ (near the proposed Integrated Gas to Power project).
b) Alexandria dunefield between Sundays River Mouth and Woody Cape.
c) Schelm Hoek dunefield west of Sundays River Mouth.
d) Dunes on the eastern boundary of Zone 10 of the Coega SEZ.
e) Headland by-pass dunefield 3km west of Cape Recife point.

4.3.4.1 Abalone Farm, Zone 10 of Coega SEZ

This dunefield is adjacent to the proposed Gas Hub and the portion where the Damara Tern colony is located is demarcated as CBA 1.5 in the Coega OSMP. This Damara Tern colony is discussed in detail with results of the seasonal breeding surveys and nest locations discussed in relation to adjacent sand mining activities.

Numbers breeding and success rate:
The first recorded breeding of Damara Terns at the Abalone Farm dunefield was in 1983 (Whittington *et al*. 2015). Since the 2007/08 breeding season the site has been well monitored, being surveyed between 1 and 6 times each season. Usually 3-5 pairs breed each year with a minimum of 0 in 2014/15, median 3 and maximum 10-12 in 2015/16 and 10-11 in 2022/23 (Martin *et al*. in press 2023)(**Table 4-1**).

For the period 2007/08 to 2016/17 the minimum breeding success was 47% (minimum of 21 chicks from a maximum of 45 nests). This dropped substantially for the four years 2017/18 to 2020/21 with a minimum of one and maximum of four chicks raised from a maximum of 13 nesting pairs, giving a breeding success of 8-31%. During 2021/22 and 2022/23 breeding success improved with a minimum of 7 and probable maximum of 10 (if all current chicks at the site fledge) from a maximum of 20 nesting pairs, giving a breeding success of 35-50% (**Table 4-1**).

Table 4-1: Numbers of breeding Damara Terns recorded each season at the Abalone Farm colony, Coega SEZ

Date of Peak Count	No. Breeding Pairs	Max. No. Adults	No. Surveys in season	Notes
1983	1	2	1	Whittington *et a*l. 2015
13 Dec 1990	1	2	1	Martin 1991
1 Dec 1999	1	2	1	Crawford *et al.* 2009
30 Nov 2007	3	9	1	3 chicks
25 Nov 2008	3-5	10	2	3 fledged chicks
6 Jan 2010	Min 5	7	6	4 fledged chicks
14 Dec 2010	2-3	6	1	2 fledged chicks
28 Dec 2011	3-4	6	3	No chicks seen
19 Nov 2012	5	13	3	4 fledged chicks
17 Dec 2013	2	4	2	1 fledged chick
15 Dec 2014	0	1	1	8 adults, PoN 4/12/2014
5 Jan 2016	10-12	16	5	3-8 chicks fledged
21 Nov 2016	4-6	12	3	Min 1 fledged chick.
27 Nov 2017	1	2	2	12/1/2018: No birds or chicks
23 Nov 2018	2	6	6	0-1 chick fledged. Another pair on territory 175m from Mandela S&S face did not nest
15 Jan 2020	3-5	9	6	1-2 chicks fledged
15 Jan 2021	5	18	5	0-1 chicks fledged
15 Dec 2021	9	13	4	3 chicks fledged
16 Dec 2022	10-11	34	5	4-7 chicks fledged

A probable reason for the low breeding success for the four years 2017/18 to 2020/21 is the mining activity near the colony during these periods. During the 2017/18 season when the single nesting pair abandoned the site, there was a lot of truck movement to the Dove mine where the Zone 10S Power Plant is proposed. The pair nested on the north east boundary of the Damara Tern Colony, approximately 600m from the mining area and 500m from the truck access route. A feature of this mining area, close to the sea, is that it was very visible from the Damara Tern Colony whereas all the other mining areas are inland of the dune ridge and visible only from a height (Martin 2019).

During the 2018/19 season a pair of terns on territory 175m from the active Mandela Sand & Stone mining face failed to nest. The two pairs that did lay eggs were 245m and 315m from the mine operations (Martin 2019). During the 2019/20 season when mining activity at Mandela Sand & Stone was near the southern boundary of the proposed Gas Hub, the 3-5 nesting pairs made nine nesting attempts between October and February with 1-2 chicks fledged. Nests were located between 250m and 390m from the active mining operations (Martin 2020). In the 2020/21 to 2022/23 seasons mining activities were at the Ngqura sand mine 600m north-east of the core Damara Tern Colony and are unlikely to have caused any disturbance to the colony. In 2020/21 the Damara Terns arrived and started nesting only in January and a maximum of one chick fledged (Martin 2021).

Initially it was thought that the low breeding success during the 2019/20 and 2020/21 seasons, despite an average number of pairs attempting to nest, could have been due to the removal of the inland portion of the dunefield, allowing terrestrial predators such as mongoose to access to the colony. However, during the 2021/22 and 2022/23 seasons the numbers of pairs nesting were respectively the 3rd and 2nd highest for the site and breeding success recovered to pre-2016 levels (**Table 4-1**).

Dune and colony movement

There is little replenishment of sand from the coastal zone and the dunefield continues to move north-east under the influence of south westerly winds leaving an expanding gravel plain behind it to the south-west. This has resulted in the Damara Tern colony moving north east over the past decade (Martin 2019, 2021, 2022). Comparing nest positions during the seven years 2007/08 to 2013/14 with those in 2020/21 to 2022/23 there has been a general movement of the colony of 200m in a north-easterly direction at a rate of approximately 20m per year (**Figure 4-3**). The north-easterly movement of the colony has resulted in about half the nests found in 2020/21 to 2022/23 now falling outside of the boundary of the Damara Tern CBA that is meant to protect the colony. There were two nests at sites 222m and 500m north east of the CBA boundary (**Figure 4-3**).

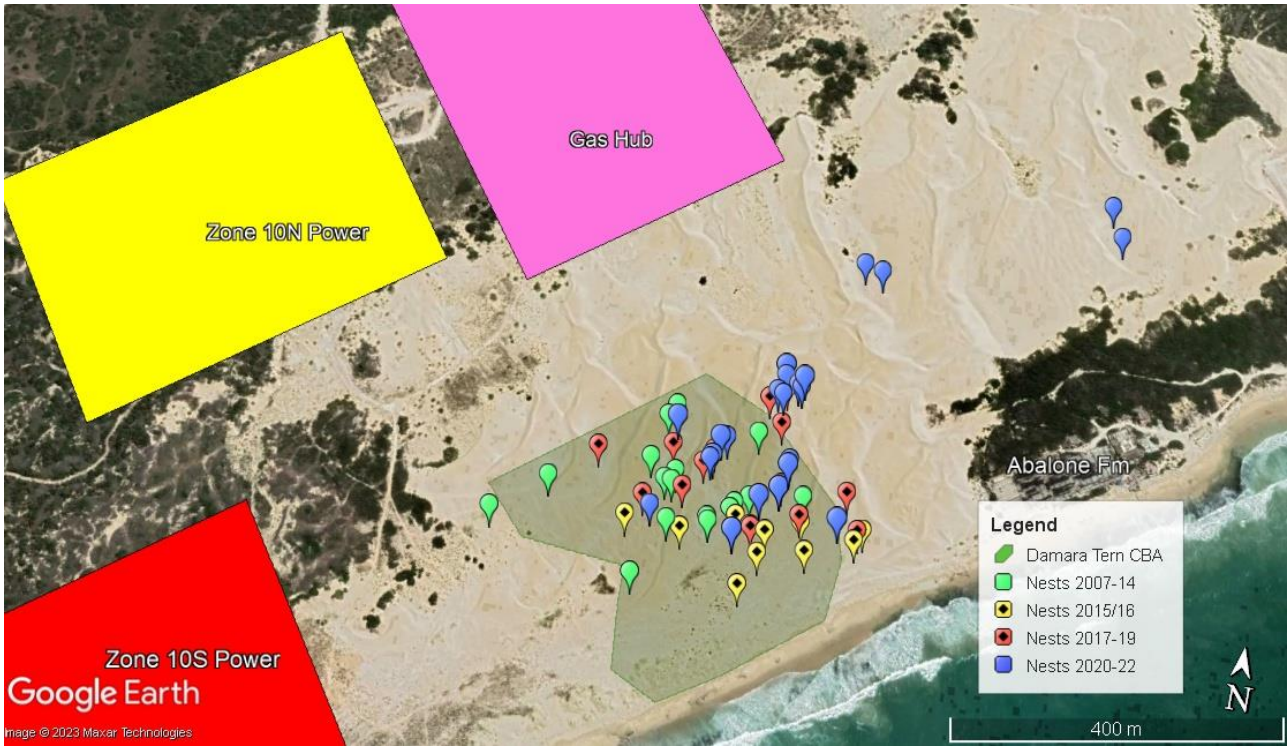

Figure 4-3: Time Series of Damara Tern Nest Locations

4.3.4.2 Alexandria Dunefield

Damara Terns were first observed at the Alexandria dunefield, most of which is included in the Addo Elephant National Park, in January 1979 and were confirmed breeding in November 1980, the first breeding record for Algoa Bay (Randall & McLachlan 1982).

Reasonably accurate estimates of the number of pairs breeding were obtained during the periods 1991-1994 (Crawford *et al.* 2009), 2009/10 (Whittington *et al*. 2015) and 2018/19 and 2019/20 breeding seasons (Martin 2019, 2020). It is likely that the Damara Tern population on the Alexandria dunefield has been stable since at least the early 1990s at around 20 pairs (Martin *et al*. in press 2023) (**Table 4-2)**. The surveys at this site were not comprehensive enough to estimate breeding success.

The distance between Sundays River mouth and Woody Cape is approximately 44km. For approximately 28km of this distance the habitat appears to be suitable for breeding Damara Terns. However, only a few kilometres of coast are occupied by breeding birds each year. This indicates that the availability of suitable breeding habitat is probably not limiting the numbers of Damara Terns breeding at the Alexandria Dunefield.

4.3.4.3 Schelm Hoek Dunefield

The first record for this site was a nest found in January 2012 and it is likely that only 1-2 pairs bred at this site until the 2018/19 season (Martin 2019).

During the breeding seasons 2018/19 to 2021/22 there was a large influx of birds to this colony with a minimum of 11 and maximum of 33 pairs nesting and a maximum of 113 adult birds counted (Martin *et al*. in press 2023)(**Table 4-2**). However, during the 2022/23 breeding season only one pair nested. During the past five breeding seasons 24-27 chicks have fledged from 71-98 nesting pairs giving a minimum breeding success of 24.4% and a maximum of 38.0%.

Peak breeding at this site was during December / January during the three years 2018/19 to 2020/21, approximately a month later than peak numbers at the other breeding localities. These could be new birds to Algoa Bay, perhaps birds that have relocated from colonies in Namibia (Martin 2019).

4.3.4.4 Dunes E Boundary of Coega SEZ

The first breeding record for this site was a nest in October 2013. Since then 0-10 pairs have bred each year (Martin *et al*. in press 2023)(**Table 4-2**). For the period 2014/15 to 2021/22 a minimum of ten chicks fledged from 21-27 nesting pairs, giving a high breeding success of 37%-48%.

4.3.4.5 Cape Recife

The Cape Recife colony is no longer occupied. A maximum of four pairs bred on the headland by-pass dunefield west of Cape Recife during 2001/02 (Martin *et al*. in press 2023). A chick ringed in December 2001 was found breeding at the Alexandria Dunefield colony in February 2010 (Whittington *et al*. 2015).

Breeding has not been recorded at any other dunefields in the Eastern Cape.

4.3.4.6 Summary of Breeding in Algoa Bay

The breeding population of Damara Terns in Algoa Bay remained stable between the early 1990s (an estimated 16-21 pairs) and 2007 to 2017/18 with an estimated 27 pairs (and

maximum count of 55 adults) in most years, of which approximately 20 pairs bred in the Alexandria Dunefield (Whittington *et al*. 2015; Martin *et al*. in press 2023) (**Table 4-2**).

In January 2019 a minimum of 18 pairs were found at the Schelm Hoek colony where they have bred every year since, that increasing the Algoa Bay breeding population to an estimated 43 pairs with a maximum of 113-169 adults. The other colonies in Algoa Bay remained stable during this period (Martin 2019, Martin *et al*. in press 2023)(**Table 4-2**). The most likely source of the additional birds is from colonies in Namibia.

Combining data for the Schelm Hoek and Coega SEZ colonies for all years for which sufficient data is available, overall breeding success is between 26.1% and 48.4%.

Of the estimated 52 pairs of Damara Tern breeding in South Africa, 43 (82.7%) breed in Algoa Bay (Martin *et al*. in press 2023). The Alexandria and Schelm Hoek colonies are currently the largest in South Africa (33% and 27% of the South African breeding population respectively). The 9 pairs (range 2-11 pairs) at the Abalone Farm colony near the proposed Gas Hub represent 17% (range 3.8-21.1%) of the South African population and is the third largest colony in South Africa (Martin *et al*. in press 2023) (**Table 4-2**).

Table 4-2: Best estimate, with month of highest count, of the number of breeding pairs (range in brackets) and the maximum number of adult Damara Terns counted at each breeding locality in Algoa Bay prior to 2018/19 and during the 2018/19-2022/23 breeding seasons

Location	No. Breeding Pairs		Max. No. Adults		% South African Breeding Population
	Pre 2018	2018/19 - 2022/23	Pre 2018	2018/19 - 2022/23	
Alexandria Dunefield	20 (14-24) Dec 2009	17 (1-34) Nov 2019	38 Nov 2015	94 Nov 2021	32.7
Schelm Hoek Dunefield	1 (0-1) Jan 2012	14 (1-33) Dec 2020	5 Jan 2012	113 Jan 2019	26.9
Dunes E Boundary of Coega SEZ	2 (0-10) Dec 2015	3 (0-5) Nov 2022	14 Dec 2016	8 Nov 2022	5.8
Dunes old Abalone Farm, Coega SEZ	4 (0-12) Jan 2016	9 (2-11) Dec 2022	16 Jan 2016	34 Dec 2022	17.3
Dunefield W of Cape Recife	0 (0-4) Jan 2002	0	12 Dec 2001	0	
TOTAL	**27**	**43**	**55**	**113-169**	**82.7**

4.3.5 Feeding and Roosting Areas

In Algoa Bay, during the breeding season, Damara Terns usually feed by shallow plunge diving immediately behind the surf zone close inshore. Breeding pairs mostly feed close to (within a few hundred metres) of their breeding colonies. Breeding pairs and pairs with recently fledged young usually roost close to the nest or on the adjacent beach.

During the period late September to mid-March there are usually adults and non-breeding birds roosting at the mouth of the Sundays River and on the Alexandria dunefield beach and feeding along the adjacent shoreline.

After breeding the adults and juveniles start dispersing and from January they can be seen feeding and roosting, sometimes in flocks of 30-40 birds, at places such as the Port of Ngqura and adjacent Coega Saltpans, at the mouth of the Swartkops Estuary and at Cape Recife (**Figure 4-1**).

The last sightings prior to the birds migrating are around the third week of March. A few birds over-winter and roost at Cape Recife point where numbers build up during the period late August to September before the birds return to their breeding areas.

4.4. Baseline Noise Levels

The results of the noise measurements are presented in Table 4-3 for Point 1 and 2**.** The detailed noise histograms are shown in Appendix B. Measurement Point 1 and 2 are indicated in **Figure 4-4**.

Table 4-3: Rating level – Noise Measurements at Point 1 and 2

Measurement Point	Measurement Date	Recorded Ambient Noise Level during the Day (06:00 – 22:00) (L_{Aeq})	Recorded Ambient Noise Level during the Night (22:00 – 06:00) (L_{Aeq})	Recommended Noise Level Requirement for a Bird Sanctuary (SANS10103:2008)
Point 1	26/07/2021	40.8 dBA	42.3 dBA	**50 dBA**
	27/11/2020	No result due to excess wind	42.3 dBA	
Point 2	26/07/2021	45.4	41.9 dBA	**50 dBA**
	27/11/2020	No result due to excess wind	45.5 dBA	

The existing measured noise levels are within the SANS 10103:2008 recommended noise level requirement for a bird sanctuary and within the guidelines for sensitive locations for species of conservation concern (SANBI 2020).

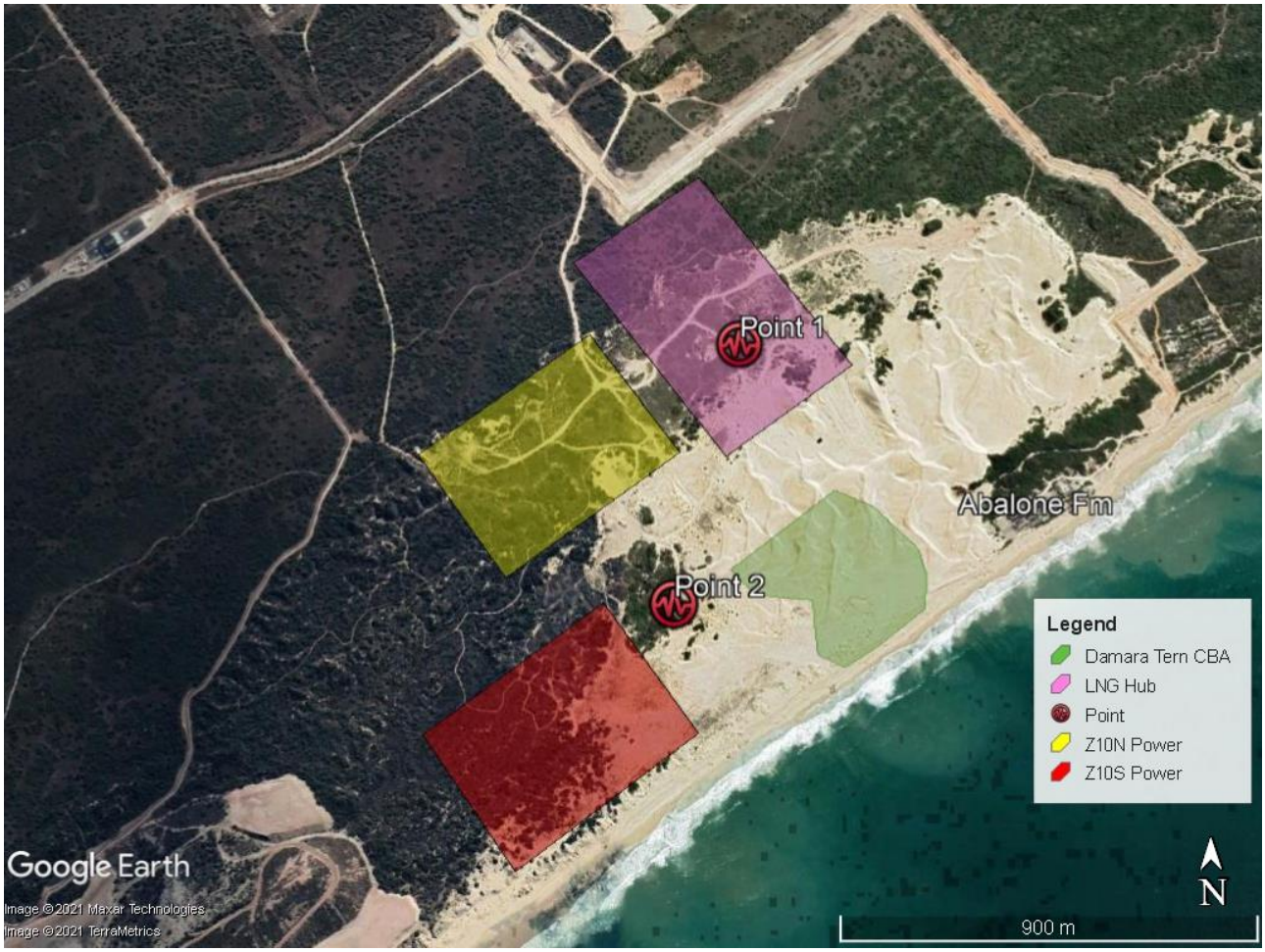

Figure 4-4: Noise Measurement Locations

5. TERRESTRIAL FAUNA SPECIES PROTOCOLS

This section applies the detailed guidelines for the implementation of The Terrestrial Fauna Species Protocols for environmental impact assessments required by GN 1150 dated 30 October 2020 to the Damara Tern Abalone Farm breeding colony and is specific to the proposed Integrated Gas to Power Project and associated gas infrastructure (SANBI 2020).

5.1. Project Area of Influence

The Project Area of Influence (PAOI) for this Damara Tern assessment was determined by including the areas used for breeding and feeding by the Abalone Farm colony of Damara Terns. A buffer of 700m (inland to the edge of the original dunefield) to 1 km (along the coast) was then applied around the Damara Tern Colony (**Figure 5-1**). This conveniently includes the footprints of the Zone 10S & N Power Plants and Gas Hub and the coastal portions of the Aquaculture Development Zone civil infrastructure that has recently been constructed. It also includes the primary feeding area of the breeding Damara Terns. The PAOI was then extended westwards to include the footprint of the gas pipelines, the FSRU(s) moored in the Port of Ngqura and the areas within the Port of Ngqura that are sometimes used by Damara Terns for feeding and roosting. As such the PAOI includes the areas of primary importance to the sustainability of the colony during the breeding period

and the Integrated Gas to Power Project infrastructure that is located within the coastal areas (**Figure 5-1**).

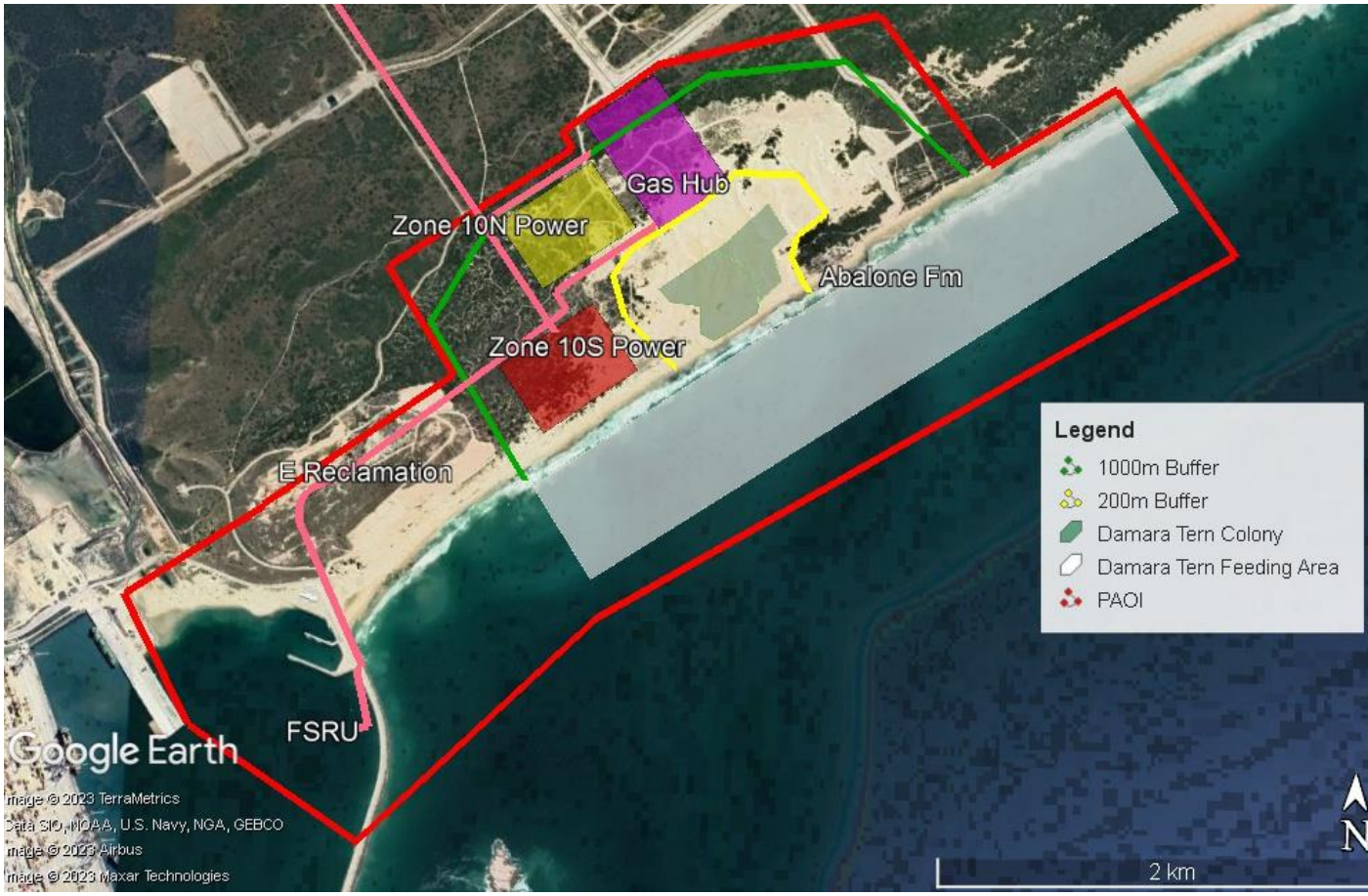

Figure 5.1: PAOI, Damara Tern Colony and Feeding Area with 200m and approx 1000m Buffers

5.2. Identification of Impact Receptors

For the Abalone Farm Damara Tern colony the primary Impact Receptor is the breeding area in the dunefield. This has been defined as the Damara Tern CBA that includes all but one of the nest locations for the period 2007/08 to 2013/14 and currently incorporates most of the remaining mobile sand dunes in the south west portion of the dunefield. This Impact Receptor then includes an extension to the Damara Tern CBA 300m in a north-easterly direction to include all but two of the Damara Tern nests found subsequent to 2013/14 (the colony has been moving north east with the dunefield). The resultant Damara Tern Colony Impact Receptor is shown in **Figure 5-1**. The dunefield is expected to continue moving in a north-easterly direction and the colony (and therefore the Impact Receptor) is expected to continue moving north east over the coming years.

The secondary Impact Receptor is the main feeding area used by the breeding Abalone Farm Damara Terns. This has been identified from direct observations during the colony surveys and extends along the shoreline approximately 1.5 km north-east and 1 km south-east of the colony and approximately 500m out to sea (**Figure 5-1**).

5.3. Site Ecological Importance

The Site Ecological Importance is determined for both the breeding area and feeding area Impact Receptors taking potential impacts related to the Gas Infrastructure into consideration and following the guidelines and matrices in SANBI (2020) (**Table 5-1**).

The Functional Integrity of the dunefield breeding area has been assessed to be medium because it has been compromised by ongoing sand mining activities (50ha – 50% currently mined and a further 35ha likely to be mined within 15 years, leaving a residual dunefield area of 15ha). The Receptor Resilience is assessed to be low as breeding Damara Terns are sensitive to noise, visual and general disturbance and indirect impacts (e.g. increased predation, increased sand starvation) that could cause avoidance of the breeding area, abandonment whilst breeding or reduced breeding success. Consequently **the Site Ecological Importance for the Damara Tern breeding area is assessed to be high**. This means that developments impacting the area should be avoided where possible with only limited developments of low impact acceptable. Offsets may be required for developments with a high impact (SANBI 2020; **Table 5-1**).

The Functional Integrity of the feeding area along the adjacent near-shore has been assessed to be high because a large area is available for feeding, there is good connectivity between other feeding areas along the coast and it is not currently subjected to any major impacts. The Receptor Resilience is assessed to be very high as, as long as their small fish prey remain available, Damara Terns can tolerate relatively high levels of disturbance on their feeding areas (they sometimes feed within the operational Port of Ngqura) and the near-shore environment is very dynamic and can quickly recover from impacts (e.g. increased turbidity and temperature). Consequently the **Site Ecological Importance for the feeding area is assessed to be low**. This means that activities associated with the Gas Infrastructure that may have a medium to high impact on the adjacent near-shore environment are, from a Damara Tern perspective, likely to be acceptable (SANBI 2020; **Table 5-1**).

Table 5-1: Evaluation of Site Ecological Importance of Damara Tern breeding and feeding areas in the PAOI

Impact Receptor	Conservation Importance (CI)	Functional Integrity (FI) Ability to maintain function under present circumstances	Biodiversity Importance (BI) Function of CI & FI (see matrix SANBI 2020)	Receptor Resilience (RR) Capacity to resist damage from disturbance and/or recover to its original state with limited human intervention	Site Ecological Importance Function of BI & RR (see matrix SANBI 2020)
Breeding area in dune-field	**HIGH** Confirmed breeding colony of Critically Endangered Damara Tern (SA) with global Extent of	**MEDIUM** Semi-intact dunefield. Original extent 100ha. 50ha mined & another 35ha subject to a Mining Right that will	**MEDIUM**	**LOW** Low likelihood of birds remaining at site (breeding) during or post impact. <50% of original functionality	**HIGH** Avoidance mitigation where possible. Limited development activities of

	Occurrence of >10km^2 within PAOI	leave 15ha within 15 years. Good connectivity with other breeding sites in Algoa Bay via an undeveloped coastline. One major current impact (sand mining). Rehabilitation potential low unless sand replenishment into the dunefield can be substantially increased.		(breeding success) likely. Impact period >15yrs.	low impact acceptable. Offset mitigation may be required for high impact activities
Feeding area along coastline	**HIGH** Confirmed feeding area of Critically Endangered Damara Tern (SA) with global Extent of Occurrence of >10km^2 within PAOI	**HIGH** Large (approx 100ha) of primary feeding area available. High habitat connectivity along coastline to other suitable feeding areas. Minor current negative ecological impacts (disused Abalone Farm seawater intake / outlet, Port of Ngqura 2.4km south-west), good recovery potential.	**HIGH**	**VERY HIGH** Habitat can recover rapidly (much less than 5yrs) to restore >75% of functionality as a Damara Tern feeding area. High likelihood of area being used as a feeding area during disturbance / impact and very high likelihood of birds returning to feed at the site post impact.	**LOW** Development activities of medium to high impact acceptable and restoration activities may not be required.

5.4. Determining Buffers

5.4.1 General Buffer Guidelines

Birdlife South Africa in SANBI (2020) has developed guidelines for appropriate buffers for bird species of conservation concern.

Aspects of the general guidelines that are applicable to the Abalone Farm Damara Tern colony in respect of the Integrated Gas to Power Project are that it is a species of conservation concern that is sensitive to impacts and disturbance at the breeding colony. There is evidence that current and past impacts (sand mining) may have resulted in pairs failing to establish territories at the start of the breeding season, abandoning breeding mid-season or experiencing a decrease in breeding success. Impacts may include noise, visual habitat alteration and the movement of humans, vehicles and equipment. The degree of disturbance is influenced by the frequency, level and duration of disturbance (high intensity requires larger buffers).

The general guideline for high intensity noise disturbance is frequent, loud (>10dB above ambient, or >50dB) and/or long term (years). Low intensity noise disturbance is near ambient levels, infrequent, short duration (hours), affecting a small area,

High intensity disturbance for sensitive species (such as breeding Damara Terns) normally requires a minimum buffer of 1km. Minimum buffers for low intensity developments near sensitive species should generally be no less than 200m.

5.4.2 Recommended Buffers

Using observations at the Algoa Bay Damara Tern colonies, the consequences of impacts to breeding Damara Terns in relation to the distance from active nests is shown in **Table 5-2**. No active nests were recorded within 200m of any type of disturbance. Breeding success is lower at nests located 200-400m from low (human activity) to medium (sand mining, aquaculture facility) impacts. When Dove Sand Mine at the site of the Zone 10S Power Plant was operational 150m-300m west of the Damara Tern CBA, only one nest was recorded, 500-600m from the operations and the breeding attempt failed. The Dove Mine was not hidden from the breeding area by dunes and perhaps visual impacts were the main factors impacting breeding during this season. Low to medium impacts located >500m from the nests and hidden from the colony by dune ridges appeared to have no impact on the number of pairs breeding or breeding success. Major developments visible from the colony (Eastern Reclamation, 1.1km and Port of Ngqura, 2.1km) had no observed disturbance effect on the colony (**Table 5-2**).

In Namibia the number of chicks hatched doubled at a colony of 30 nests when vehicle passes through the colony were reduced from 870 per month to zero (Braby *et al*. 2001). There was no observed impact due to diamond mining (dune stripping) 1.5 km from a colony, however, a residential development near Walvis Bay directly adjacent to a colony of 32 birds caused most birds to fail in the first season and the colony then became extinct (Braby 2011; Simmons *et al*. 2015).

For breeding Damara Terns there is consequently evidence to support the general guidelines for bird species of conservation concern that are sensitive to impacts and disturbances at their breeding site (SANBI 2020). The recommended buffers around the Abalone Farm Damara Tern colony are therefore (**Figure 5-1**):

- A minimum No-Go buffer of 200m from the Damara Tern Colony (the Damara Tern CBA including the 300m extension to the north-east) in which no activities or human movement are permitted. Essential management activities (e.g. litter picking) must not be done during the breeding season (1 October to end February).
- A buffer of 1km from the Damara Tern Colony (Damara Tern CBA including the 300m extension to the north-east) for activities that may have a high impact. Approximately 700m north east to north-west of the colony is the vegetated transverse dune ridge that separates the littoral active zone (dunefield) from the inland plateau. The recommended buffer for high impact activities excludes the area inland of the transverse dune ridge as this area has low visibility from the colony and it is well inland of any Damara Tern activities (**Figure 5-1**).

- Activities with low to medium impacts within the 700m – 1 km high impact buffer will need to be assessed on a case by case basis. There is evidence that activities not hidden by the mobile dune ridges surrounding the colony have a greater impact on breeding attempts and success.

No buffer is required around the Damara Tern feeding area due to the high connectivity of the habitat and the resilience of Damara Terns to disturbance whilst feeding (e.g. they feed in the Port of Ngqura during ship movements and other port operations).

Table 5-2: Observed consequences of impacts to breeding Damara Terns in relation to distance from nests in Algoa Bay

Source of Impact	Nature of Impact	Distance of Impact from Nests	Observed Consequence
Damara Tern nest surveys	Researcher(s) walking through dunefield (Low Intensity)	150-180m	1st bird flies when approached within 150-180m. Many birds in colony then fly until researcher(s) sit down >c.200m away for c.5 mins
Maintenance activities at Schelmhoek pump station	Movement of people, TLB, 4x4 vehicles around pump station for several days (Low intensity)	Closest nest = 240m	Pairs on territory at a distance of 95m and 140m failed to lay eggs. Pairs >250m distance laid eggs and continued to incubate
Abalone Farm	Aquaculture operations (hidden from colony by dunes)	Closest nest during operations = 213m	No observed impact on colony
Sonop Sand Mine	Sand mining – inland (behind) high dune ridge – approx position of Gas to Power (N) Plant	Closest nest during operations = 400m	No observed impact on colony
Dove Mine	Sand mining at site of proposed Gas to Power (S) Plant (not hidden from colony by dunes)	Closest nest 600m from operations, 500m from truck access route	Only 1 nest in NE of colony (furthest from mine) – failed.
Mandela Sand & Stone Mine	Sand mining – excavating dune ridge inland of colony – approx position of Gas Hub	Closest nest during operations 245m	Pair on territory 175m from operations failed to nest. Reduced number of pairs breeding and poor breeding success.
Ngqura Sand Mine	Sand mining in NE corner of dunefield (hidden by dunes)	Closest nest during operations 320m. Main colony >500m	No impact on main colony. 4 closest nests 320-360m away failed.
Mine administration and haul road	Movement of a few people and medium number of sand haulage trucks, NNE of	Approx 600m from main colony	No observed impact.

	main colony-near Phase 1 of Gas Hub		
Aquaculture Civil Infrastructure Development	Civil works plant & equipment operating E of dunefield (hidden by dunes)	Closest nest during operations 230m. Main colony >680m	No impact on main colony. 4 closest nests 230-560m away failed.
Woodcutting	Chainsaws, people & 4x4 vehicles at site of proposed Zone 10S Power Plant	Closest nest 500m	No observed impact
Eastern Reclamation	Heavy plant & machinery – east of proposed Zone 10S Power Plant (visible from colony)	Closest nest 1100m	No observed impact
Port of Ngqura	Operational Port with high cranes and infrastructure (visible from colony)	Closest nest 2100m	No observed impact

6. ASSESSMENT OF POTENTIAL IMPACTS

The objective of this assessment is to identify and assess impacts due to the construction and operation of the proposed Gas to Power Infrastructure that may influence the sustainability of the Damara Tern population. As Damara Terns occur only in coastal areas, the impacts of Gas to Power Infrastructure planned at the Port of Ngqura, the gas pipelines between the Port, Gas Hub and the two Zone 10 Power plants and the construction and operation of the Gas Hub itself are assessed. The gas pipelines in the services corridor between Zone 10 and Zone 13 / Dedisa Power Plant will have no impact on Damara Terns and are not assessed further.

The impacts associated with Phase 1 construction and operation (Port of Ngqura infrastructure, pipelines and the gas loading and distribution centre in the north-west portion of the Gas Hub) are considered separately from the impacts associated with Phase 2 construction and operation (LNG storage and regasification infrastructure) in the south-east portion of the Gas Hub. The reasons for assessing Phase 1 and 2 impacts separately are that Phase 1 may operate for several years before Phase 2 commences. Much of the Phase 1 infrastructure is located >600m from the Damara Tern colony whereas Phase 2 infrastructure is located 200-550m from the closest Damara Tern nests and the storage tanks and regasification unit are large structures.

Cumulative Impacts (primarily due to the proposed Zone 10 North & South Power Plants nearby) are assessed as is the No-Go Option.

The Impact Assessment entails the following activities:

- Identification and assessment of potential impacts
- Prediction of the nature, magnitude, extent and duration of the impacts

- Recommendation of mitigation measures to avoid or reduce impacts
- Evaluation of the significance of the impact after mitigation measures have been implemented
- Consideration of any residual impacts of high significance that cannot be adequately mitigated

The primary Impact Receptor, the Abalone Farm Damara Tern breeding colony (referred to as the Damara Tern colony in this assessment), is defined in Section 5.2 above. It comprises the Damara Tern CBA in Zone 10 plus an extension to the north-east to incorporate all but two of the Damara Tern nest sites (**Figure 5-1**).

In the assessment tables the extent of the impact is considered to be Regional as the Damara Tern colony is the third largest in South Africa, supporting 17% of the breeding pairs. The South African population comprises only 6.7% of the global Damara Tern population. Intensity of the impact is assessed in terms of the continued sustainability of the Damara Tern colony.

The following potential impacts on Damara Terns were identified for assessment or discussion:

a) General disturbance due to airborne noise, the physical presence of the proposed infrastructure and associated anthropogenic activities including lighting, movement of people, machinery and vehicles. Indirect disturbance impacts include potential increases in predation due to the attraction of scavengers.
b) Risks due to catastrophic events
c) Impacts on the marine environment
d) Impacts due to dunefield sand starvation

The Site Ecological Importance of the Damara Tern colony is high and consequently avoidance mitigation is required wherever possible, although limited development activities of low impact are acceptable (Species Environmental Assessment Guideline - SANBI 2020).

6.1. Impacts on Damara Terns due to Disturbance

The Site Ecological Importance of the Damara Tern colony has been determined to be high (**Table 5-1**). The potential impact is that the Damara Tern colony may be negatively affected by the visible physical structures, airborne noise, lights and general disturbance caused by human activities, vehicle and equipment movements during construction and operations of the Gas Infrastructure. Indirect disturbance impacts include potential increases in predation due to scavengers (e.g. domestic animals, monkeys, black-backed jackals, mongooses, crows and gulls) being attracted by domestic waste.

Anthropogenic activities, noise and artificial light produce physiological and behavioural responses in a wide variety of bird species and can affect breeding, predation rates and overall fitness (Jagerbrand & Bouroussis 2021; Senzaki *et al*. 2020). In a review of the effects of noise on wildlife, responses of terrestrial species started at 40 dB and 20% of studies reported a response at 50 dB (Shannon *et al*. 2015).

Damara Terns generally nest in large, open coastal sand dune and desert areas where there is little disturbance. Relatively low levels of anthropogenic disturbance (e.g. off-road

vehicles, increase in predation due to fish offal left by anglers) can significantly reduce breeding success and a colony became extinct near a residential development near Walvis Bay, see Section 4.3.3 (Braby 2011; Birdlife International 2021; Simmons *et al*. 2015; Taylor *et al*. 2015). There was very low breeding success at the Damara Tern colony whilst sand mining was taking place within 200-400m of the colony (Section 5.4.2).

The south-east boundary of the Gas Hub (Phase 2 development) is located 200m from the Damara Tern colony and the closest portion of the gas distribution facility (Phase 1 development) is 550m from the colony. The closest section of gas pipeline, between the Z10S Power Plant and the Gas Hub (that may be constructed only in Phase 2) is 250m from the colony (**Figure 5-1**). The

Predicted noise levels at the Damara Tern colony were ascertained from the Noise Specialist Report in the 2021 EIA for Gas Infrastructure (Safetech 2021) and were used to help identify potential issues, identify the significance rating and potential noise impacts in terms of legislation and guidelines for avifauna species of conservation concern (**Table 6-1**).

Table 6-1: Predicted noise levels for Gas Infrastructure and Cumulative noise levels

Area	Predicted Noise Levels		
	Gas Infrastructure Only (Construction Noise)	**Gas Infrastructure Only (Operational Noise)**	**Cumulative Operational Noise (Gas Hub, Zone 10S & Zone 10N Power Plants)**
Damara Tern Colony	56.9 dBA	34.5 dBA	70.1 dBA

6.1.1 Phase 1: Impact due to Construction Phase Disturbance

Most of the Gas Infrastructure development required for Phase 1 of the project is located outside of the 700m–1 km buffer around the Damara Tern colony. Exceptions are the eastern sections of the Natural Gas and LNG pipelines and the south-east portion of the Road Loading Facility, 550m from the Damara Tern colony (**Figure 5-1; Figure 2-2**). Disturbance from construction areas outside of this buffer, including at the Port of Ngqura, are not expected to have an impact on the sustainability of the Damara Tern colony (Section 5.4.2). The impact rating due to Phase 1 Construction Phase Disturbance is consequently based on the construction activities planned within the 700m-1 km buffer around the Damara Tern colony,

For Phase 1 (road loading facility, weighbridge and presumably some administrative offices), no large structures are planned and the pipelines will be buried underground. Consequently visual impacts of construction of permanent structures are expected to be low. Noise, lighting and movement of personnel and construction machinery is very likely to have an impact on the colony if not controlled and mitigated.

Based on a worst case of combined construction noise sources of 118 dBA the predicted noise level expected at the Damara Tern Colony (510m away) due to construction site noise

emissions from the Gas Hub is 56.9 dBA (**Table 6-1**; Safetech 2021). This is 14.6 dBA above the ambient noise measurement of 42.3 dBA at the Gas Hub (**Table 4-3**) and 6.9 dBA above the recommended noise level requirement of 50 dBA for a bird sanctuary (SANS 10103:2008) and the general guideline (50 dBA) for noise disturbance to avifauna species of conservation concern that are sensitive to disturbance (SANBI 2020).

The construction phase is temporary and is expected to take three years for Phases 1 and 2 but the portions of Phase 1 within the 700m-1km buffer zone are likely to take less than a year to construct.

The negative impact of disturbance during construction of Phase 1 of the Gas Infrastructure on the Damara Tern colony is assessed to be **Moderate,** reducing to **Low** following successful implementation of mitigation measures (**Table 6-2**).

The likely mechanism of the impact on the Damara Tern colony is that fewer pairs may establish breeding territories due to the disturbance and breeding success may be reduced if nesting birds are repeatedly disturbed.

Mitigation Requirements

The mitigation measures below apply to that portion of the Phase 1 Gas Infrastructure construction east of the south-north pipeline corridor.

1. The Phase 1 development within the Gas Hub (road loading facility, weighbridge, entrance gate, administrative offices, construction site offices and facilities) must be located in the north-west portion of the Gas Hub, as far from the Damara Tern colony as possible.
2. Ideally, to avoid some of the mitigation measures below, all Phase 1 construction activities east of the south-north pipeline corridor, located approximately 500m west of the Damara Tern colony, should take place outside of the Damara Tern breeding season, 1 October to end February.
3. During the Damara Tern breeding season, 1 October to end February, construction must take place only during daylight hours to take advantage of the unstable atmospheric conditions during the day to ameliorate noise and to prevent lights from vehicles, machinery and the construction site from disturbing the colony.
4. A noise reduction plan, approved by a Professional Engineer and a practitioner qualified in acoustics must be developed with the objective of ensuring that daytime noise levels attributable to construction activities do not exceed 50 dBA at the boundaries of the Damara Tern colony during the Damara Tern breeding season. The plan must detail how this will be measured, monitored and reported on.
5. Loud construction activities, especially those causing sudden loud noises (e.g. piling) must be scheduled for periods outside of the Damara Tern breeding season, 1 October to end February.
6. All construction vehicles and equipment must be well maintained and in good condition.
7. Construction staff should receive “noise sensitivity” training such as switching off vehicles and equipment when not in use.

8. A No-Go buffer of 200m around the Damara Tern colony must be permanently demarcated and no activities or human movement are permitted within this buffer. Exceptions would be management activities (such as litter picking) outside the breeding season only and specialist monitoring of the breeding colony.
9. During the Damara Tern breeding season 1 October to end February, the boundaries of the construction footprints closest to the Damara Tern colony (generally the southern and south-eastern boundaries) must be fenced off to prevent human access and disturbance and must be screened off to prevent visual disturbance (fence should be a minimum of 2m high with e.g. shade cloth able to withstand the strong winds). There must be no activity between the fence and the Damara Tern colony.
10. CDC's Standard Environmental Specifications for Construction must be strictly adhered to. These control most of the negative impacts associated with construction activities (e.g. minimise construction footprint, management of construction material, chemicals and equipment, dust control, waste management, provision and control of ablutions and dining areas, worker induction and toolbox talks).
11. All lighting must be down / shielded lighting, not directed towards the Damara Tern colony and should be kept within the site boundaries and at the minimum required for security and health and safety.
12. A light audit on a moonless night must be undertaken near the (north-west) boundary of the Damara Tern colony closest to the Gas Hub before construction starts, to establish a baseline and in September of each year (prior to the Damara Tern breeding season). The target should be to ensure a light level of <1 lux on the ground (Jagerbrand & Bouroussis 2021).
13. No domestic animals (e.g. feral cats and dogs) are to be tolerated. If present they must be removed to a suitable facility.
14. CDC must establish a Damara Tern Management Programme that includes specialist monitoring of the Damara Tern colonies in Algoa Bay by a suitably qualified and experienced professional. An annual report on the status of the Damara Tern population in the Coega SEZ and Algoa Bay, providing management recommendations where appropriate, must be submitted for approval to CDC and the Coega Environmental Monitoring Committee.
15. The key performance indicators for the sustainability of the Damara Tern colony are at least three pairs of Damara Terns nesting per year and at least a 33% fledging rate (i.e. at least one chick being successfully reared per year).

Table 6-2: Impact Assessment of Phase 1 Gas Infrastructure Construction Disturbance

Nature	Negative				
Type	Direct. Disturbance during construction of Phase 1 of Gas Infrastructure				
Impact	Effect			Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Regional	Moderate	Probable	MODERATE NEGATIVE

Impact	Reversibility	Irreplaceable Loss	Mitigation Potential	Overall Significance
With Mitigation	Reversible	Resource will not be lost	Achievable	LOW NEGATIVE

6.1.2 Phase 1: Impact due to Operational Phase Disturbance

Most of the Gas Infrastructure for Phase 1 of the project is located outside of the 700m–1km buffer around the Damara Tern colony. Exceptions are the eastern sections of the Natural Gas and LNG pipelines and the south-east portion of the Road Loading Facility, 550m from the Damara Tern colony (**Figure 5-1; Figure 2-2**). Disturbance from operations outside of this buffer, including operations of the FSRUs at the Port of Ngqura, are not expected to have an impact on the sustainability of the Damara Tern colony (Section 5.4.2). The impact rating due to Disturbance during Phase 1 Operations is consequently based on activities planned within the 700m-1 km buffer around the Damara Tern colony,

For Phase 1 (road loading facility, weighbridge and presumably some administrative offices), no large structures are planned and the pipelines will be buried underground. Consequently visual impacts of permanent structures from the Damara Tern colony are expected to be low. Lighting (for operations and security), movement of personnel and especially gas transport trucks (including the impact of headlights at night) is very likely to have an impact on the colony if not controlled and mitigated.

The predicted noise level expected at the Damara Tern Colony due to noise emissions at the Gas Hub once fully developed (i.e. Phases 1 and 2) is 34.5 dBA (**Table 6-1**; Safetech 2021). This is less than the ambient noise measurement of 42.3 dBA at the Gas Hub (**Table 4-3**) and below the recommended noise level requirement of 50 dBA for a bird sanctuary (SANS 10103:2008) and the general guideline (50 dBA) for noise disturbance to avifauna species of conservation concern that are sensitive to disturbance (SANBI 2020). Consequently operational noise due to the Gas Infrastructure is not expected to have an impact on the Damara Tern colony.

The Gas Infrastructure for Phase 1 is likely to be required long-term (20-40 years).

The negative impact of disturbance during operations of Phase 1 of the Gas Infrastructure on the Damara Tern colony is assessed to be **Moderate,** reducing to **Low** following successful implementation of mitigation measures (**Table 6-3**).

The likely mechanism of the impact on the Damara Tern colony is that fewer pairs may establish breeding territories due to the disturbance and breeding success may be reduced if nesting birds are repeatedly disturbed.

Mitigation Requirements

The mitigation measures below apply to Phase 1 operations at the Gas Hub (i.e. operations at the road loading facility) and pipeline maintenance activities east of the south-north pipeline corridor.

1. The Phase 1 development within the Gas Hub (road loading facility, weighbridge, entrance gate, administrative offices) must be located in the north-west portion of the Gas Hub, as far from the Damara Tern colony as possible.
2. Phase 1 of the Gas Hub (the road loading facility) must be fenced off to contain human access and disturbance to within the facility. The south east boundary (closest to the Damara Tern colony) must be sufficiently high (e.g. 3m) and screened off (ideally with a wall) to prevent visual disturbance to the colony, especially from vehicle headlights. Ideally the road loading facility should operate during daylight hours only (during the Damara Tern breeding season, 1 October to end February) to minimise disturbance to the colony from vehicle headlights.
3. A No-Go buffer of 200m around the Damara Tern colony must be permanently demarcated and no activities or human movement are permitted within this buffer. Exceptions would be management activities (such as litter picking) outside the breeding season only and specialist monitoring of the breeding colony.
4. Planned maintenance of the gas pipelines east of the south-north corridor must not take place during the Damara Tern breeding season, 1 October to end February. If emergency repairs or inspections are required during the Damara Tern breeding season they should be undertaken during daylight hours and the work site should be screened off (e.g. high fence, shadecloth), in a similar manner to that required by the construction phase mitigation.
5. CDC's Operational Safety, Health and Environmental Management Plan for the Coega SEZ must be complied with. This management plan is applicable to all tenants and governs the management, monitoring and reporting requirements for most operational activities (e.g. environmental awareness, waste, storm-water, waste-water, air quality management, noise control, pollution control, management of hazardous substances, emergency preparedness, visual impacts, alien vegetation management, species of conservation concern, problem animal control, resource management).
6. All lighting must be down / shielded lighting, not directed towards the Damara Tern colony and should be kept within the Phase 1 boundaries and at the minimum required for security, operations and health and safety.
7. A light audit on a moonless night must be undertaken near the (north-west) boundary of the Damara Tern colony closest to the Gas Hub before construction starts, to establish a baseline, before operations start and in September of each year (prior to the Damara Tern breeding season). The target should be to ensure a light level of <1 lux on the ground (Jagerbrand & Bouroussis 2021).
8. No domestic animals (e.g. feral cats and dogs) are to be tolerated. If present they must be removed to a suitable facility.
9. CDC must establish a Damara Tern Management Programme that includes specialist monitoring of the Damara Tern colonies in Algoa Bay by a suitably qualified and experienced professional. An annual report on the status of the Damara Tern population in the Coega SEZ and Algoa Bay, providing management recommendations where appropriate, must be submitted for approval to CDC and the Coega Environmental Monitoring Committee.

10. The key performance indicators for the sustainability of the Damara Tern colony are at least three pairs of Damara Terns nesting per year and at least a 33% fledging rate (i.e. at least one chick being successfully reared per year).

Table 6-3: Impact Assessment of disturbance during operations of Phase 1 of Gas Infrastructure

Nature	Negative				
Type	Direct. Disturbance during operations of Phase 1 of gas infrastructure				
Impact	Effect			Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Moderate	Probable	MODERATE NEGATIVE
Impact		Reversibility	Irreplaceable Loss	Mitigation Potential	Overall Significance
With Mitigation		Reversible	Resource will not be lost	Achievable	LOW NEGATIVE

6.1.3 Phase 2: Impact due to Construction Phase Disturbance

The Gas Infrastructure required for Phase 2 of the project is mostly located in the south-east portion of the Gas Hub, 200m-550m from the Damara Tern colony. The infrastructure includes large structures including a regasification facility, two 160,000 m^3 LNG Storage Tanks and a tall stack vent (**Figure 5-1; Figure 2-2**). The impact rating due to disturbance during construction of Phase 2 infrastructure is consequently based on the Phase 2 construction activities planned within the Gas Hub as these impacts will outweigh other developments further from the colony. Likely disturbance impacts include visual impacts, noise, lighting and movement of personnel and construction machinery.

Based on a worst case of combined construction noise sources of 118 dBA the predicted noise level expected 510m from the source (i.e. at the core of the Damara Tern Colony) due to construction site noise emissions from the Gas Hub is 56.9 dBA (**Table 6-1**; Safetech 2021). This is 14.6 dBA above the ambient noise measurement of 42.3 dBA at the Gas Hub (**Table 4-3**) and 6.9 dBA above the recommended noise level requirement of 50 dBA for a bird sanctuary (SANS 10103:2008) and the general guideline (50 dBA) for noise disturbance to avifauna species of conservation concern that are sensitive to disturbance (SANBI 2020).

The construction phase is temporary and is expected to take three years.

The negative impact of disturbance during construction of Phase 2 of the Gas Infrastructure on the Damara Tern colony is assessed to be **High**. The close proximity of the Damara Tern colony and the size of the infrastructure to be constructed means that the impacts will be difficult to mitigate and the impact remains **High Negative** after mitigation (**Table 6-4**).

The likely mechanism of the impact on the Damara Tern colony is that fewer or zero pairs may establish breeding territories due to the disturbance and breeding success may be reduced.

Mitigation Requirements

The mitigation measures below apply to that portion of the Phase 2 Gas Infrastructure construction east of the south-north pipeline corridor, especially construction within the Gas Hub. Even if the mitigation measures are fully implemented, it is likely that high residual impacts will remain that cannot be mitigated.

1. Ideally, to avoid some of the mitigation measures below, all Phase 2 construction activities east of the south-north pipeline corridor, located approximately 500m west of the Damara Tern colony, should take place outside of the Damara Tern breeding season, 1 October to end February. However, it is very unlikely that this will be possible with a project of this magnitude.
2. During the Damara Tern breeding season, 1 October to end February, construction must take place only during daylight hours to take advantage of the unstable atmospheric conditions during the day to ameliorate noise and to prevent lights from vehicles, machinery and the construction site from disturbing the colony.
3. A noise reduction plan, approved by a Professional Engineer and a practitioner qualified in acoustics must be developed with the objective of ensuring that daytime noise levels attributable to construction activities do not exceed 50 dBA at the boundaries of the Damara Tern colony during the Damara Tern breeding season. The plan must detail how this will be measured, monitored and reported on.
4. Loud construction activities, especially those causing sudden loud noises (e.g. piling) must be scheduled for periods outside of the Damara Tern breeding season, 1 October to end February.
5. All construction vehicles and equipment must be well maintained and in good condition.
6. Construction staff should receive “noise sensitivity” training such as switching off vehicles and equipment when not in use.
7. A No-Go buffer of 200m around the Damara Tern colony must be permanently demarcated and no activities or human movement are permitted within this buffer. Exceptions would be management activities (such as litter picking) outside the breeding season only and specialist monitoring of the breeding colony.
8. Fencing around the Gas Hub will contain human access and disturbance within the Gas Hub precinct. In addition, during the Damara Tern breeding season 1 October to end February, the south-eastern boundary of the Gas Hub and the west and east boundaries for a distance of at least 200m northwest of their junction with the south-eastern boundary, must be screened off to prevent visual disturbance to the Damara Tern colony (e.g. with shade cloth able to withstand the strong winds). Unfortunately, even a 3m high fence will not adequately screen construction of the larger components of the project.
9. CDC’s Standard Environmental Specifications for Construction must be strictly adhered to. These control most of the negative impacts associated with construction activities (e.g. minimise construction footprint, management of construction material, chemicals and equipment, dust control, waste management, provision and control of ablutions and dining areas, worker induction and toolbox talks).

10. All lighting must be down / shielded lighting, not directed towards the Damara Tern colony and should be kept within the site boundaries and at the minimum required for security and health and safety.
11. A light audit on a moonless night must be undertaken near the (north-west) boundary of the Damara Tern colony closest to the Gas Hub before construction starts, to establish a baseline and in September of each year (prior to the Damara Tern breeding season). The target should be to ensure a light level of <1 lux on the ground (Jagerbrand & Bouroussis 2021).
12. No domestic animals (e.g. feral cats and dogs) are to be tolerated. If present they must be removed to a suitable facility.
13. CDC must establish a Damara Tern Management Programme that includes specialist monitoring of the Damara Tern colonies in Algoa Bay by a suitably qualified and experienced professional. An annual report on the status of the Damara Tern population in the Coega SEZ and Algoa Bay, providing management recommendations where appropriate, must be submitted for approval to CDC and the Coega Environmental Monitoring Committee.
14. The key performance indicators for the sustainability of the Damara Tern colony are at least three pairs of Damara Terns nesting per year and at least a 33% fledging rate (i.e. at least one chick being successfully reared per year).

Table 6-4: Impact Assessment of Phase 2 Gas Infrastructure Construction Disturbance

Nature	Negative				
Type	Direct. Disturbance during construction of Phase 2 of Gas Infrastructure				
Impact	Effect			Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Regional	Severe	Probable	HIGH NEGATIVE
Impact		Reversibility	Irreplaceable Loss	Mitigation Potential	Overall Significance
With Mitigation		Reversible	Resource will be partly lost	Difficult	HIGH NEGATIVE

6.1.4 Phase 2: Impact due to Operational Phase Disturbance

The Gas Infrastructure required for Phase 2 of the project is mostly located in the south-east portion of the Gas Hub, 200m-550m from the Damara Tern colony. The infrastructure includes large structures including a regasification facility, two 160,000 m^3 LNG Storage Tanks and a tall stack vent (**Figure 5-1; Figure 2-2**). The impact rating due to disturbance during the operations of Phase 2 infrastructure is consequently based on the Phase 2 activities planned within the Gas Hub as these impacts will outweigh other developments further from the colony. Likely disturbance impacts include visual impacts, noise, lighting and movement of personnel, vehicles and machinery.

The predicted noise level expected at the Damara Tern Colony due to noise emissions at the Gas Hub once fully developed (i.e. Phases 1 and 2) is 34.5 dBA (**Table 6-1**; Safetech 2021). This is less than the ambient noise measurement of 42.3 dBA at the Gas Hub (**Table 4-3**) and below the recommended noise level requirement of 50 dBA for a bird sanctuary (SANS 10103:2008) and the general guideline (50 dBA) for noise disturbance to avifauna species of conservation concern that are sensitive to disturbance (SANBI 2020). Consequently operational noise due to the Gas Infrastructure is not expected to have an impact on the Damara Tern colony.

The Gas Infrastructure for Phase 2 is likely to be required long-term (20-40 years).

The negative impact of disturbance during operations of Phase 2 of the Gas Infrastructure on the Damara Tern colony is assessed to be **High**. The close proximity of the Damara Tern colony and the size of the infrastructure means that the impacts will be difficult to mitigate and the impact remains **High Negative** after mitigation (**Table 6-5**).

The likely mechanism of the impact on the Damara Tern colony is that fewer or zero pairs may establish breeding territories due to the disturbance (especially the visual aspect) and breeding success may be reduced. It is likely that the colony will cease to exist within a few years. Some breeding pairs may relocate to other colonies within Algoa Bay.

The Site Ecological Importance of the Damara Tern colony is high and consequently avoidance mitigation is required wherever possible and offset mitigation may be required for high impact activities (Species Environmental Assessment Guideline - SANBI 2020). Residual Impacts are discussed in Section 8.2 below.

Mitigation Requirements

The mitigation measures below apply primarily to operations within the Gas Hub due to its close proximity to the Damara Tern colony. Even if the mitigation measures are fully implemented, it is likely that high residual impacts will remain that cannot be mitigated.

1. The Gas Hub must be fenced off to contain human activities within the Gas Hub precinct. The south east boundary (closest to the Damara Tern colony) and the west and east boundaries for a distance of at least 200m northwest of their junction with the south-eastern boundary, must be screened off to prevent visual disturbance to the Damara Tern colony (ideally with a wall). Unfortunately, even a 5m high wall will not adequately screen the larger components of the project.
2. A No-Go buffer of 200m around the Damara Tern colony must be permanently demarcated and no activities or human movement are permitted within this buffer. Exceptions would be management activities (such as litter picking) outside the breeding season only and specialist monitoring of the breeding colony.
3. Planned maintenance of the gas pipelines east of the south-north corridor must not take place during the Damara Tern breeding season, 1 October to end February. If emergency repairs or inspections are required during the Damara Tern breeding season they should be undertaken during daylight hours and the work site should be screened off (e.g. high fence, shadecloth), in a similar manner to that required by the construction phase mitigation.

4. CDC's Operational Safety, Health and Environmental Management Plan for the Coega SEZ must be complied with. This management plan is applicable to all tenants and governs the management, monitoring and reporting requirements for most operational activities (e.g. environmental awareness, waste, storm-water, waste-water, air quality management, noise control, pollution control, management of hazardous substances, emergency preparedness, visual impacts, alien vegetation management, species of conservation concern, problem animal control, resource management).
5. All lighting must be down / shielded lighting, not directed towards the Damara Tern colony and should be kept within the Gas Hub boundaries and at the minimum required for security, operations and health and safety. Unfortunately, despite mitigation, it is likely that lighting will have an impact due to the close proximity of the colony.
6. A light audit on a moonless night must be undertaken near the (north-west) boundary of the Damara Tern colony closest to the Gas Hub before construction starts, to establish a baseline, before operations start and in September of each year (prior to the Damara Tern breeding season). The target should be to ensure a light level of <1 lux on the ground (Jagerbrand & Bouroussis 2021).
7. No domestic animals (e.g. feral cats and dogs) are to be tolerated. If present they must be removed to a suitable facility.
8. CDC must establish a Damara Tern Management Programme that includes specialist monitoring of the Damara Tern colonies in Algoa Bay by a suitably qualified and experienced professional. An annual report on the status of the Damara Tern population in the Coega SEZ and Algoa Bay, providing management recommendations where appropriate, must be submitted for approval to CDC and the Coega Environmental Monitoring Committee.
9. The key performance indicators for the sustainability of the Damara Tern colony are at least three pairs of Damara Terns nesting per year and at least a 33% fledging rate (i.e. at least one chick being successfully reared per year).

Table 6-5: Impact Assessment of disturbance during operations of Phase 2 of Gas Infrastructure

Nature	Negative				
Type	Direct. Disturbance during operations of Phase 2 of Gas Infrastructure				
Impact	Effect			Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Severe	Probable	HIGH NEGATIVE
Impact		Reversibility	Irreplaceable Loss	Mitigation Potential	Overall Significance
With Mitigation		Reversible	Resource will be partly lost	Very Difficult	HIGH NEGATIVE

6.2. Other Impacts on Damara Terns

6.2.1 Risks due to Catastrophic Events

The Quantitative Risk Assessment prepared as part of the 2021 Gas Infrastructure EIA process assessed the risks due to catastrophic events, primarily loss of LNG resulting in fire / explosion (SRK 2021).

During Phase 1, the risk is primarily due to operations of the FSRUs in the Port of Ngqura. Consequences are high but the probability of occurrence is low and the significance was assessed to be medium before and after mitigation (SRK 2021). During Phase 1, the risk is largely confined to the Port of Ngqura. Consequently impacts on the Damara Tern colony 2km away are very unlikely and the probability of occurrence is further reduced as Damara Terns are present in the Coega SEZ for approximately five months of the year.

During Phase 2, the primary risk is located at the Gas Hub adjacent to the Damara Tern colony. SRK (2021) assessed the risk to be medium before and low after mitigation. A gas explosion at the Gas Hub during the Damara Tern breeding season would likely cause breeding to cease for the rest of the season and may cause some direct fatalities. Extensive de-commissioning and repair work would be required after such an event that would have impacts on the Damara Terns similar to those of Phase 2 Construction. However, the likelihood of such an event is very low and the negative impact of a catastrophic event at the Gas Hub was assessed to be **Moderate** and **Low** after mitigation (**Table 6-6**). Mitigation is the same design, management and emergency preparedness mitigation required for operation of the Gas Hub (SRK 2021) and no special additional mitigation is required to protect the Damara Tern colony.

Table 6-6: Impact Assessment of catastrophic event at the Gas Hub

Nature	Negative				
Type	Direct. Disturbance due to fire/explosion at Gas Hub				
Impact	Effect			Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study area	Severe	Unlikely	MODERATE NEGATIVE
Impact		Reversibility	Irreplaceable Loss	Mitigation Potential	Overall Significance
With Mitigation		Reversible	Resource will be partly lost	Achievable	LOW NEGATIVE

6.2.2 Impacts on the Marine Environment

There will be some impacts on the marine environment during construction of Phase 1 Gas Infrastructure at the Port of Ngqura. However, the main impacts on the Damara Tern colony are likely to be due to marine intake and outfall servitudes in the vicinity of the Damara Tern colony for which an EIA has been completed and an environmental

authorisation has been issued (CES 2021). Consequently potential impacts on Damara Terns from the breeding colony due to impacts on the marine environment are discussed under the Cumulative Impact section (Section 7.2).

6.2.3 No-Go Alternative

The No-Go Alternative without mitigation is on the basis of present and potential future impacts from the sand mining that is currently underway approximately 600m from the Damara Tern CBA and that will continue for up to 15 years and that may eventually come to within 200m of the closest Damara Tern nests.

To date approximately 50ha (50% of the original 100ha dunefield) has been mined and the Coega Mining Right allows for an additional 35ha to be mined, leaving a residual 15ha (15%) of dunefield around the Damara Tern colony within the next 15 years. The No-Go Alternative impact assessment (before mitigation) assumes that the dunefield remaining after mining will continue to support a reduced number of breeding pairs of Damara Terns.

There is evidence that disturbance due to mining activities 200m-400m from the Damara Tern breeding colony results in fewer birds nesting and reduced breeding success but that the numbers and breeding success can recover once mining moves further away from the colony (Section 4.3.4.1; Section 5.4.2).

The No-Go Alternative prior to mitigation assessed the impact of past and future sand mining (assuming that the 35ha Coega Mining Right will be fully mined) as **Moderate Negative** (**Table 6-7**). The impact is fully reversible by ceasing sand mining once the current 5ha Ngqura Sand Mine is exhausted (probably within the next 2 years) and not commencing with mining of the Coega Mining Right, resulting in a Low Negative impact after mitigation (**Table 6-7**). However, this mitigation is very unlikely to be implemented and consequently the impact of the No-Go Alternative is considered to be **Moderate Negative**.

While Damara Terns have high site fidelity for their breeding colonies, there is evidence of between colony movements in Algoa Bay within and between breeding seasons (Martin 2019; Martin *et al*. in press 2023). It is likely that if Damara Terns ceased to breed at the Abalone Farm colony, the breeding pairs would move to one of the other three colonies in Algoa Bay. However, the number of breeding pairs and breeding success at each Algoa Bay colony varies between years (Section 4.3.4.1). If Damara Terns cease to breed at the Abalone Farm colony the Algoa Bay population will be at higher risk, such as from high predation or disturbance at one or more of the remaining colonies.

Table 6-7: Impact Assessment of No-Go Alternative

Nature	Negative				
Type	No-Go Alternative. Sand Mining (Coega Mining Right) will continue				
Impact	Effect			Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		

Without Mitigation	Medium term	Regional	Moderate	Probable	MODERATE NEGATIVE
Impact		Reversibility	Irreplaceable Loss	Mitigation Potential	Overall Significance
With Mitigation		Reversible	Resource will not be lost	Achievable	LOW NEGATIVE

7. CUMULATIVE IMPACTS

There are nine other projects in Zones 7, 8 and 10 of the Coega SEZ that are at the EIA stage or that have Environmental Authorisations and operations have not yet started. Not included in the cumulative assessment or discussed further are the Karpowership Gas to Power Project, two bulk liquid storage facilities, additional marine infrastructure in the Port of Ngqura and the sea-based aquaculture zone. The most relevant projects to Damara Terns are the other Zone 10 Gas to Power Projects adjacent to the proposed Gas Infrastructure and Gas Hub comprising the Zone 10S and Zone 10N 1000 MW Gas to Power Plants (EIAs in progress) (**Figure 2-1**) and the Marine Intake and Outfall Infrastructure for which environmental authorisation has been received (CES 2021).

Civil infrastructure for the Aquaculture Development Zone has recently been constructed. Past and current sand mining activities have resulted in c.50ha of sand being mined from the c.100ha dunefield and another c.35ha is expected to be mined over the next 10-15 years.

The cumulative impact of the Zone 10 Gas to Power Projects during operations are expected to have the greatest disturbance impacts on Damara Terns and general disturbance (noise, visual, lighting and human and vehicle/machinery) cumulative impacts are assessed below.

The distances from the closest boundary of the Zone 10 Gas to Power Projects to the boundary of the Damara Tern colony are as follows (**Figure 5-1**):

- Gas Hub to Damara Tern colony: 200m south
- Zone 10S Power Plant to Damara Tern colony: 300m east
- Zone 10N Power Plant to Damara Tern colony: 300m SSE

7.1. Cumulative Disturbance from Zone 10 Gas to Power Projects

The cumulative impact of disturbance on the Damara Tern colony, comprising noise, the presence of large physical structures, lighting and general disturbance caused by human activities, vehicle and equipment movements at the two Zone 10 Power Plants and Gas Hub during the operational phase of the Integrated Gas to Power Project is assessed.

The Site Ecological Importance of the colony has been determined to be high.

Anthropogenic activities and artificial light produce physiological and behavioural responses in a wide variety of bird species and can affect breeding, predation rates and overall fitness (Jagerbrand & Bouroussis 2021; Senzaki *et al*. 2020). Damara Terns generally nest in large, open coastal sand dune and desert areas where there is little disturbance.

Relatively low levels of anthropogenic disturbance (e.g. off-road vehicles, increase in predation due to fish offal left by anglers) can significantly reduce breeding success and a colony became extinct near a residential development near Walvis Bay, see Section 4.3.3 (Braby 2011; Birdlife International 2021; Simmons *et al*. 2015; Taylor *et al*. 2015). There was no successful breeding at the Damara Tern colony whilst sand mining was taking place on the site of the Zone 10S Gas to Power Plant (Section 4.3.4.1).

The Zone 10 Integrated Gas to Power Projects will cover an area in excess of 54 ha and while the technology and design parameters of the infrastructure are still to be decided, they will be very large developments with multiple exhaust stacks approximately 40m high (SRK 2021).

From the noise specialist report in the 2021 EIA (Safetech 2021), the predicted noise level expected at the Damara Tern colony due to the operational site emissions is summarized in **Table 7-1**.

Table 7-1: Predicted unmitigated operational noise levels (dBA) and excess noise levels.

Area	Predicted Noise Levels (Operational Noise)	Recommended Noise Level Requirement for a Bird Sanctuary (SANS10103:2008)	Predicted Excess Noise Levels
Damara Tern Colony	70.1 dBA	50 dBA	20.1 dB

At the Damara Tern colony the predicted operational noise will exceed the SANS recommended noise levels (50 dBA) for a bird sanctuary and the general guideline (50 dBA) for noise disturbance to avifauna species of conservation concern (SANBI 2020) by 20.1 dBA.

Breeding Damara Terns frequently fly around calling, especially when disturbed (when they mob intruders) and when returning with fish to feed mates or chicks. The predicted noise levels from the Zone 10S and Zone 10N Power Plants are expected to contain mainly low frequency noise. From recorded audio of the Damara Tern communication, they communicate within the frequency range of 2kHz to 8kHz. Consequently it is unlikely the noise emitted from the Power Plants will affect the Damara Tern communication (**Figure 7-1**).

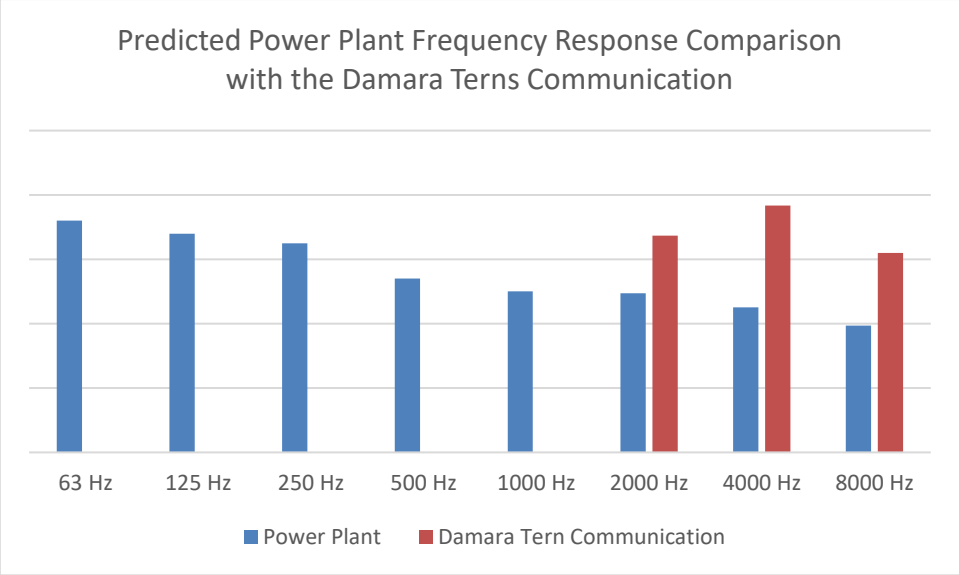

Figure 7-1: Predicted Power Plant Frequency Response Comparison with the Damara Terns Communication

Disturbance impacts on the Damara Tern colony during the operational phase of the Integrated Zone 10 Gas to Power Facilities due to noise, the visual intrusion and physical presence of the two Power Plants and Gas Hub with associated lights, movement of vehicles, machinery and people are assessed to be **High Negative.** The Residual Impacts after implementation of on-site mitigation measures are assessed to remain **High Negative** as mitigation will be very difficult and the physical presence and size of the proposed Zone 10 Gas to Power Facilities cannot be mitigated (**Table 7-2**).

The likely mechanism of the impact on the Damara Tern colony is that fewer pairs will establish breeding territories due to the physical presence of the nearby infrastructure, pairs may abandon the site during the breeding season and breeding success may be reduced, eventually leading to extinction of the colony.

The Site Ecological Importance of the Damara Tern colony is high and consequently avoidance mitigation is required wherever possible and offset mitigation may be required for high impact activities (Species Environmental Assessment Guideline - SANBI 2020). Residual Impacts are discussed in Section 8.2 below.

Mitigation Requirements

Even if the mitigation measures are fully implemented, it is likely that high residual impacts will remain that cannot be mitigated.

1. In order to meet the 50 dBA noise requirement at the Damara Tern Colony the noise level requirement at the property boundary of each power plant and the Gas Hub must not exceed 65 dBA
2. Low frequency airborne noise which can be caused by gas generator exhaust systems can cause damaging vibration in light-weight buildings in the surrounding area and may affect the Damara Tern colony negatively. The noise level requirement at the property boundary of each power plant and the Gas Hub must not exceed 70 dBC

3. Noise Monitoring will be required annually around the site boundaries as well as around the Damara Tern colony in accordance with SANS 10103:2008. The measured noise levels must be documented and must include the following descriptors and performed in 1/3 octave bands: dBA, dBC, dBZ, LA90. Noise Measurements at noise sensitive sites must be performed for a full 24-hour period. Site and boundary measurements can be performed for shorter period as long as they are representative of the soundscape. Noise monitoring must commence before operations start in order to obtain baseline information.
4. It is recommended that a professional engineer who is qualified in acoustics with more than 15 years of experience, is employed to review, model the predicted noise of the final generator plant design and provide additional detailed acoustic design (where necessary) to ensure the power plant meets the noise requirements set out in this report. Examples of essential acoustic design include:
    - Install acoustic enclosures around all noise emitting components (e.g. engines) to reduce noise emissions.
    - Install silencers on equipment such as exhaust stacks
5. The Power Plants and Gas Hub must be fenced off to contain human activities within their precincts. The boundaries closest to the Damara Tern colony must be screened off to prevent visual disturbance to the Damara Tern colony (ideally with a wall). Unfortunately, even a 5m high wall will not adequately screen the larger components of the facilities.
6. A No-Go buffer of 200m around the Damara Tern colony must be permanently demarcated and no activities or human movement are permitted within this buffer. Exceptions would be management activities (such as litter picking) outside the breeding season only and specialist monitoring of the breeding colony.
7. CDC's Operational Safety, Health and Environmental Management Plan for the Coega SEZ must be complied with. This management plan is applicable to all tenants and governs the management, monitoring and reporting requirements for most operational activities (e.g. environmental awareness, waste, storm-water, waste-water, air quality management, noise control, pollution control, management of hazardous substances, emergency preparedness, visual impacts, alien vegetation management, species of conservation concern, problem animal control, resource management).
8. All lighting must be down / shielded lighting, not directed towards the Damara Tern colony and should be kept within the site boundaries and at the minimum required for security and health and safety.
9. A light audit on a moonless night must be undertaken on the boundaries of the 200m No-Go buffer around the Damara Tern colony before operations start, to establish a baseline and in September of each year (prior to the Damara Tern breeding season). The target should be to ensure a light level of <1 lux on the ground (Jagerbrand & Bouroussis 2021).
10. No domestic animals (e.g. feral cats and dogs) are to be tolerated. If present they need to be removed to a suitable facility.

11. CDC must establish a Damara Tern Management Programme that includes specialist monitoring of the Damara Tern colonies in Algoa Bay by a suitably qualified and experienced professional. An annual report on the status of the Damara Tern population in the Coega SEZ and Algoa Bay, providing management recommendations where appropriate, including the position of the 200m No-Go buffer should the colony move, must be submitted for approval to CDC and the Coega Environmental Monitoring Committee.
12. The key performance indicators for the sustainability of the Damara Tern colony are at least three pairs of Damara Terns nesting per year and at least a 33% fledging rate (i.e. at least one chick being successfully reared per year).

Table 7-2: Cumulative Disturbance Impacts of Operations of the Integrated Gas to Power Facilities

Nature	Negative				
Type	Cumulative. Disturbance during operations of Integrated Gas to Power Facilities				
Impact	Effect			Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Severe	Definite	HIGH NEGATIVE
Impact		Reversibility	Irreplaceable Loss	Mitigation Potential	Overall Significance
With Mitigation		Reversible	Resource will be partly lost	Very Difficult	HIGH NEGATIVE

7.2. Impacts on the Marine Environment Affecting Damara Terns

The marine impact assessment for the 2021 EIAs for the Integrated Gas to Power Projects assessed the significance of marine impacts during construction and operations. During construction impacts are largely confined to the Port of Ngqura and include increased turbidity and underwater noise that were assessed to be of Very Low significance after mitigation (SRK 2021). During operation of the Integrated Gas to Power project, discharges to the marine environment of large volumes of water with depressed or elevated temperatures and waste discharges to sea via the marine intake and outfall servitudes that are located close to the Damara Tern colony were assessed to be of Low to Very Low significance (SRK 2021).

An Environmental Authorisation was issued on 27 September 2021 for marine intake and outfall servitudes, the closest of which is 200m west of the Damara Tern CBA. The impacts on the Damara Tern colony during construction were assessed to be high even after mitigation, mainly aimed at avoiding disturbance to the Damara Tern colony (CES 2021). Operational impacts including increases in turbidity, impacts on small pelagic fish and cumulative impacts on the marine environment were assessed to be Low to Very Low after mitigation (CES 2021).

Damara Terns feed by visual shallow plunge diving and consequently they are unlikely to be affected by anthropogenic underwater noise (e.g. they continue to feed in the Port of

Ngqura during ship movements). Very turbid water is known to negatively affect Damara Tern populations by decreasing feeding success (Simmons 2005; Braby *et al* 2011).

The Site Ecological Importance of the Damara Tern feeding area was assessed to be low (Section 5.3 above) primarily due to the high connectivity and resilience of this receptor. Consequently development activities of medium to high impact with appropriate minimisation are acceptable for the Damara Tern feeding area (Species Assessment Guidelines – SANBI 2020). Both the marine impact assessment for the Gas to Power Projects and the marine intake and outfall servitudes EIA predict Low to Very Low impacts on the aspects of the marine environment likely to affect Damara Terns (CES 2021; SRK 2021). Consequently cumulative impacts on the marine environment affecting Damara Terns are anticipated to be **Low** if the mitigation recommendations in the relevant EIAs are implemented.

7.3. Impacts on Damara Terns due to Dunefield Sand Starvation

In Algoa Bay Damara Terns nest where there are large, un-vegetated mobile dunes. Illenberger (2018) estimated the volume of sand entering the Hougham Park dunefield from the beach at the south-western toe of the dunefield to be 9000m^3 per year. However, the construction of the Port of Ngqura that became operational in September 2009 appears to have drastically decreased the volume of sand entering the dunefield from the beach and Dove Sand Mine removed most of the mobile sand west of the Damara Tern colony during 2016-18. The entire dunefield is moving in a north-easterly direction under the influence of the prevailing south-westerly winds at a rate of up to 20m per year (Martin 2019, 2021). To date approximately 50% (50ha) of the original dune area has been mined and a further 30% (35ha) is expected to be mined over the next 15 years.

The impact of dunefield sand starvation on the Damara Tern colony due to mining was assessed to be High reducing to Medium after mitigation (Martin 2019). The marine intake and outfall servitude downwind of the Damara Tern colony will further reduce sand entering the dunefield by obstructing the coastal and hummock dune sand transport corridor and the EIA for the marine servitude project assessed impacts on the dune system to be High reducing to Moderate after mitigation (CES 2021). The Zone 10 Gas to Power Projects especially the Zone 10S Power Plant are likely to further reduce sand transport into the dunefield. The Cumulative Impact of reduced sand transport into the dunefield, thereby reducing the area of habitat available for Damara Tern breeding is assessed to be **High** reducing to **Moderate** after mitigation (**Table 7-3**). The impact is likely to remain moderate even after mitigation because the Port of Ngqura and previous sand mining has already interfered with the sand transport system.

Mitigation Requirements

1. Avoid obstructing coastal and hummock / frontal dune sand transport by not placing infrastructure in these areas or by placing it (e.g. pipes) underground and do not stabilise the sand in these areas.
2. Sand cleared during site preparation of the Gas to Power Projects could be placed in the sand transport corridor immediately south-west of the Damara Tern colony outside of the Damara Tern breeding season 1 October to end February.

3. Only clean dune sand with no rooikrans seeds should be used and an alien plant removal plan must be implemented, avoiding the Damara Tern breeding season 1 October to end February..

Table 7-3: Cumulative Dunefield Sand Starvation

Nature	Negative				
Type	Cumulative. Sand starvation of dunefield impacting Damara Tern colony				
Impact	Effect			Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Severe	Probable	HIGH NEGATIVE
Impact		Reversibility	Irreplaceable Loss	Mitigation Potential	Overall Significance
With Mitigation		Reversible	Resource will be partly lost	Achievable	MODERATE NEGATIVE

8. IMPACT ASSESSMENT SUMMARY

Impact ratings for those activities that have residual impacts (i.e. after mitigation) of greatest significance determine the overall assessed impact (SANBI 2020).

8.1. Phase 1 Gas Infrastructure

Phase 1 of the Gas Infrastructure project comprises Port of Ngqura infrastructure, gas pipelines and road loading facility in the north-west portion of the Gas Hub. The overall impact, based on disturbance due to visible physical structures, airborne noise, lights and general disturbance caused by human activities, vehicle and equipment movements during both the construction and operations of Phase 1 of the Gas Infrastructure is assessed to be **Moderate Negative** reducing to **Low Negative** after mitigation.

8.2. Phase 2 Gas Infrastructure

Phase 2 of the Gas Infrastructure comprises the LNG storage tanks and regasification unit at the Gas Hub, close to the Damara Tern colony. The overall impact, based on disturbance due to visible physical structures, airborne noise, lights and general disturbance caused by human activities, vehicle and equipment movements during both the construction and operations of Phase 2 of the Gas Infrastructure is assessed to be **High Negative** and remains **High Negative** even after mitigation.

8.3. Discussion of Residual Impacts

The Species Environmental Assessment Guideline (SANBI 2020) provides guidelines for the type of mitigation that is acceptable in the context of Site Ecological Importance and the assessed significance of the impact of the proposed development (Table 8-1).

Table 8-1: Guidelines for interpreting Site Ecological Importance in the context of the proposed development activities (from SANBI 2020)

Site ecological importance	Interpretation in relation to proposed development activities
Very high	Avoidance mitigation – no destructive development activities should be considered. Offset mitigation not acceptable/not possible (i.e. last remaining populations of species, last remaining good condition patches of ecosystems/ unique species assemblages). Destructive impacts for species/ecosystems where persistence target remains.
High	Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted; limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities.
Medium	Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities.
Low	Minimisation and restoration mitigation – development activities of medium to high impact acceptable followed by appropriate restoration activities.
Very low	Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required.

The Site Ecological Importance of the Damara Tern colony was determined to be **High** (Section 5.3).

The assessed overall impact after mitigation of Phase 1 of the Gas Infrastructure Project is assessed to be Low Negative. The guidelines in Table 8-1 indicate that limited activities of low impact are acceptable.

The assessed overall impact after mitigation of Phase 2 of the Gas Infrastructure Project is assessed to be High Negative. The guidelines in Table 8-1 indicate that avoidance mitigation is required wherever possible and offset mitigation may be required for high impact activities.

8.3.1 Avoidance mitigation

For Phase 2 of the Gas Infrastructure Avoidance mitigation that entails changing the design of the project such that it will no longer cause noise, visual or general disturbance of high impact to Damara Terns will not be possible due to the size of the infrastructure required at the Gas Hub so close to the Damara Tern colony.

The most practical avoidance mitigation will be to move the Gas Hub (and both Zone 10 power plants) inland, behind the transverse dune ridge marking the edge of the littoral active zone and beyond the 700m-1 km buffer zone around the Damara Tern colony within which activities of high impact should be avoided (Section 5.4.2; **Figure 5-1**).

For logistical and development planning reasons alternative sites for the Gas Hub are not available and have not been assessed.

8.3.2 Offset Mitigation

The most important conservation measure to protect Damara Tern colonies is to ensure formal protection for important breeding sites (Section 4.3.3; Simmons *et al*. 2015; Taylor *et al*. 2015; Martin *et al*. in press 2023).

Of the four Damara Tern colonies In Algoa Bay, only the Alexandria dunefield colony that falls mostly (but not entirely) within the Addo Elephant National Park (AENP) is formally

protected. The two Coega SEZ colonies are within Coega OSMP CBA areas. The colony on the East Boundary of the Coega SEZ is small and it is not used every year. The Abalone Farm colony that is the subject of this assessment is under great pressure from existing (sand mining) and future authorized and proposed projects (e.g. Aquaculture Development Zone, Zone 10 Gas to Power Projects, marine intake and outfall servitude). The No-Go Option assessed the impact of past and future sand mining on the Damara Tern colony to be Moderate and the long-term sustainability of this colony is consequently at risk even without the proposed Zone 10 Gas to Power projects.

A reduction in breeding pairs and breeding success when mining was 200m-400m from the Damara Tern colony has been reversed in the past two seasons now that mining is 600m from the colony. The colony currently supports approximately 17% of the South African population and over the past two seasons may have produced the most fledged young of any of the Algoa Bay colonies (Section 4.3.4.6).

While Damara Terns have high site fidelity for their breeding colonies, there is evidence of between colony movements in Algoa Bay within and between breeding seasons (Martin 2019; Martin *et al*. in press 2023). Breeding failures at one colony are often offset by successes at another colony. Ideally, to spread the risk of colony breeding failures (due to e.g. predation or disturbance) all four Algoa Bay colonies require formal protection and management actions to prevent disturbance. At the Abalone Farm colony this would ideally entail stopping sand mining of the Coega Mining Right and protection of the remaining approximately 50ha of dunefield.

It is likely that if Damara Terns ceased to breed at the Abalone Farm colony, the breeding pairs would move to other colonies in Algoa Bay – the Schelm Hoek colony being the closest large colony. The Schelm Hoek Damara Tern colony west of the Sundays River is currently the second largest in South Africa with 14 pairs, 27% of the South African breeding population (Table 4-2; Martin *et al*. in press 2023). It is not protected, even though it is across the Sundays River from the AENP Alexandria Section and the view of the dunefield from AENP is one of the primary attractions of the area. PPC Cement has a current mining right over portions of the Schelm Hoek dunefield but indications are that this may not be utilized (this would require verification). Currently the only impact on the Schelm Hoek dunefield is the Cerebos (National Salt) seawater intake and pump station for the Tankatara Saltpans. Without formal protection, there is a reasonable likelihood that at some stage in the future the sand dunes at Schelm Hoek will be targeted for sand mining and/or development between the sand dunes and the N2 freeway, putting the colony at risk.

Offset mitigation that involves formal protection of the Schelm Hoek dunefield, ideally by incorporation into Addo Elephant National Park, if feasible, is a possible consideration if the proposed developments in Zone 10 of the Coega SEZ are approved. Funding and logistics would be required to engage with SANParks and other stakeholders, prepare the conservation management plans, fund whatever land transfers may be required and provide budgets for the operational conservation management of the area.

9. DECOMMISSIONING

The Phase 1 road loading facility in the north-west portion of the Gas Hub could be relatively easily decommissioned. If similar mitigation as recommended for the Phase 1

construction phase was implemented, the after mitigation impacts of the decommissioning process on the Damara Tern colony should be **Low negative**.

Though the lifespan of Phase 2 of the Gas Infrastructure is anticipated to be 25 years, large facilities such as this are usually mothballed or re-purposed at the end of their useful life. It will be very difficult to restore the site to its natural state and to do so would probably entail impacts equivalent to, or greater than the **High Negative** construction impacts, that is if the Damara Tern colony is still active.

10. SITE ALTERNATIVES AND NO-GO ALTERNATIVE

Section 8.3 discussed the alternatives for the proposed Gas Hub. No alternative site is currently available. The feasibility of offset mitigation involving the formal protection of the Schelm Hoek Damara Tern colony would require further investigation.

The No-Go Alternative for the Integrated Gas to Power projects is not guaranteed to ensure the sustainability of the Abalone Farm Damara Tern colony. The impact of past and future sand mining was assessed to be of Moderate negative significance and the EIA for the Marine Intake and Outfall Infrastructure assessed the construction phase impacts on the Damara Tern colony to be High even after mitigation (CES 2021).

11. CONCLUSIONS AND RECOMMENDATIONS

The Damara Tern is Critically Endangered in South Africa with an estimated 52 breeding pairs of which 43 pairs (83%) breed in Algoa Bay in four colonies, two of which are in the Coega SEZ. At the Abalone Farm colony on the dunefield in Zone 10 adjacent to the proposed Gas Hub 9-11 pairs (17% of the South African population) have bred during the past two seasons but with a median of 3 pairs (7% of the South African population) since 2007. South Africa has only 6.7% of the estimated global population of 773 breeding pairs with nearly all the others breeding in Namibia. Damara Terns nest where there are large coastal dunefields and are sensitive to disturbance at their breeding sites.

The proposed site for the Gas Hub in Zone 10 is 200m from the Damara Tern colony and the proposed sites for the Zone 10S and Zone 10N 1000 MW Power Plants are 300m from the colony.

Phase 1 of the Gas Infrastructure project comprises Port of Ngqura infrastructure, gas pipelines and road loading facility in the north-west portion of the Gas Hub furthest from the Damara Tern colony. The overall impact, based on disturbance due to visible physical structures, airborne noise, lights and general disturbance caused by human activities, vehicle and equipment movements during both the construction and operations of Phase 1 of the Gas Infrastructure is assessed to be **Moderate Negative** reducing to **Low Negative** after mitigation (**Table 11-1**).

Phase 2 of the Gas Infrastructure comprises the LNG storage tanks and regasification unit at the Gas Hub, close to the Damara Tern colony. The overall impact, based on disturbance due to visible physical structures, airborne noise, lights and general disturbance caused by human activities, vehicle and equipment movements during both the construction and operations of Phase 2 of the Gas Infrastructure is assessed to be **High Negative** and remains

High Negative after mitigation. Cumulative Impacts are also High Negative after mitigation (**Table 11-1**).

The likely mechanism of the impact is that fewer breeding pairs will establish territories, they may more readily abandon the breeding area mid-season and breeding success is likely to decrease, ultimately resulting in the extinction of the colony. It is probable that breeding pairs will eventually move to one of the other Algoa Bay colonies.

Sand mining has impacted 50% of the dunefield to date and the impact of past and future sand mining was assessed to be of **Moderate Negative** significance for the No-Go Alternative reducing to Low negative in the very unlikely scenario of no further sand mining taking place (**Table 11-1**).

Table 11-1. Assessed Impact of the Gas Infrastructure on Damara Terns

Impact on Damara Tern Colony	Construction Phase		Operational Phase		Cumulative
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation	With Mitigation
Phase 1	Moderate	Low	Moderate	Low	
Phase 2	High	High	High	High	High
No-Go			Medium	Low	

Following the Species Environmental Assessment Guidelines (SANBI 2020), the Site Ecological Importance of the Damara Tern colony was determined to be High. The SANBI Guidelines indicate that limited activities of low impact are acceptable. Consequently development of Phase 1 of the Gas Infrastructure Project is acceptable with respect to the sustainability of the Damara Tern colony if mitigation recommendations are implemented.

For high Site Ecological Importance the most appropriate mitigation for developments with high residual impacts (i.e. Phase 2 of the Gas Infrastructure) is avoidance (selecting an alternative site with lower impacts), failing which offset mitigation may be required. A minimum buffer for high impact developments of approximately 1km from the Damara Tern colony is required (this also conforms to general guidelines for bird Species of Conservation Concern) and this is the preferred option. There is the possibility of an offset opportunity to provide the important Damara Tern colony at Schelm Hoek with formal protection, ideally by including it in the adjacent Addo Elephant National Park, but the feasibility of this would need to be investigated.

11.1. Recommended Mitigation Measures

Mitigation measures with respect to the Gas Infrastructure development are recommended below for inclusion in the Project EMPr.

11.1.1 Mitigation Applicable to Construction and Operations

Mitigation and monitoring measures applicable to the construction and operational phases for both Phase 1 and Phase 2 of the Gas Infrastructure development include:

1. A No-Go buffer of 200m around the Damara Tern colony must be permanently demarcated and no activities or human movement are permitted within this buffer. Exceptions would be management activities (such as litter picking) outside the breeding season only and specialist monitoring of the breeding colony.
2. All lighting must be down / shielded lighting, not directed towards the Damara Tern colony and should be kept within the site boundaries and at the minimum required for security and health and safety.
3. A light audit on a moonless night must be undertaken on the boundaries of the 200m No-Go buffer around the Damara Tern colony before construction and operations start, to establish a baseline and in September of each year (prior to the Damara Tern breeding season). The target should be to ensure a light level of <1 lux on the ground (Jagerbrand & Bouroussis 2021).
4. No domestic animals (e.g. feral cats and dogs) are to be tolerated. If present they need to be removed to a suitable facility.
5. CDC must establish a Damara Tern Management Programme that includes specialist monitoring of the Damara Tern colonies in Algoa Bay by a suitably qualified and experienced professional. An annual report on the status of the Damara Tern population in the Coega SEZ and Algoa Bay, providing management recommendations where appropriate, including the position of the 200m No-Go buffer should the colony move, must be submitted for approval to CDC and the Coega Environmental Monitoring Committee.
6. The key performance indicators for the sustainability of the Damara Tern colony are at least three pairs of Damara Terns nesting per year and at least a 33% fledging rate (i.e. at least one chick being successfully reared per year).

11.1.2 Mitigation Applicable to Construction of Phase 1

Additional mitigation measures applicable to the construction of Phase 1 of the Gas Infrastructure include:

1. The Phase 1 development within the Gas Hub (road loading facility, weighbridge, entrance gate, administrative offices, construction site offices and facilities) must be located in the north-west portion of the Gas Hub, as far from the Damara Tern colony as possible.
2. Ideally, to avoid some of the mitigation measures below, all Phase 1 construction activities east of the south-north pipeline corridor, located approximately 500m west of the Damara Tern colony, should take place outside of the Damara Tern breeding season, 1 October to end February.
3. During the Damara Tern breeding season, 1 October to end February, construction must take place only during daylight hours to take advantage of the unstable atmospheric conditions during the day to ameliorate noise and to prevent lights from vehicles, machinery and the construction site from disturbing the colony.
4. A noise reduction plan, approved by a Professional Engineer and a practitioner qualified in acoustics must be developed with the objective of ensuring that daytime noise levels attributable to construction activities do not exceed 50 dBA at the

western boundary of the Damara Tern colony during the Damara Tern breeding season. The plan must detail how this will be measured, monitored and reported on.

5. Loud construction activities, especially those causing sudden loud noises (e.g. piling) must be scheduled for periods outside of the Damara Tern breeding season, 1 October to end February.
6. All construction vehicles and equipment must be well maintained and in good condition.
7. Construction staff should receive "noise sensitivity" training such as switching off vehicles and equipment when not in use.
8. During the Damara Tern breeding season 1 October to end February, the boundaries of the construction footprints closest to the Damara Tern colony (generally the southern and south-eastern boundaries) must be fenced off to prevent human access and disturbance and must be screened off to prevent visual disturbance (fence should be a minimum of 2m high with e.g. shade cloth able to withstand the strong winds). There must be no activity between the fence and the Damara Tern colony.
9. CDC's Standard Environmental Specifications for Construction must be strictly adhered to. These control most of the negative impacts associated with construction activities (e.g. minimise construction footprint, management of construction material, chemicals and equipment, dust control, waste management, provision and control of ablutions and dining areas, worker induction and toolbox talks).

11.1.3 Mitigation Applicable to Operations of Phase 1

The additional mitigation measures below apply to Phase 1 operations at the Gas Hub (i.e. operations at the road loading facility) and pipeline maintenance activities east of the south-north pipeline corridor.

1. Phase 1 of the Gas Hub (the road loading facility) must be fenced off to contain human access and disturbance within the facility. The south east boundary (closest to the Damara Tern colony) must be sufficiently high (e.g. 3m) and screened off (ideally with a wall) to prevent visual disturbance to the colony, especially from vehicle headlights. Ideally the road loading facility should operate during daylight hours only (during the Damara Tern breeding season, 1 October to end February) to minimise disturbance to the colony from vehicle headlights.
2. Planned maintenance of the gas pipelines east of the south-north corridor must not take place during the Damara Tern breeding season, 1 October to end February. If emergency repairs or inspections are required during the Damara Tern breeding season they should be undertaken during daylight hours and the work site should be screened off (e.g. high fence, shadecloth), in a similar manner to that required by the construction phase mitigation.
3. CDC's Operational Safety, Health and Environmental Management Plan for the Coega SEZ must be complied with. This management plan is applicable to all tenants and governs the management, monitoring and reporting requirements for most operational activities (e.g. environmental awareness, waste, storm-water, waste-

water, air quality management, noise control, pollution control, management of hazardous substances, emergency preparedness, visual impacts, alien vegetation management, species of conservation concern, problem animal control, resource management).

11.1.4 Mitigation Applicable to Construction of Phase 2

The additional mitigation measures below apply to that portion of the Phase 2 Gas Infrastructure construction east of the south-north pipeline corridor, especially construction within the Gas Hub. Even if the mitigation measures are fully implemented, it is likely that high residual impacts will remain that cannot be mitigated.

1. Ideally, to avoid some of the mitigation measures below, all Phase 2 construction activities east of the south-north pipeline corridor, located approximately 500m west of the Damara Tern colony, should take place outside of the Damara Tern breeding season, 1 October to end February. However, it is very unlikely that this will be possible with a project of this magnitude.
2. During the Damara Tern breeding season, 1 October to end February, construction must take place only during daylight hours to take advantage of the unstable atmospheric conditions during the day to ameliorate noise and to prevent lights from vehicles, machinery and the construction site from disturbing the colony.
3. A noise reduction plan, approved by a Professional Engineer and a practitioner qualified in acoustics must be developed with the objective of ensuring that daytime noise levels attributable to construction activities do not exceed 50 dBA at the boundaries of the Damara Tern colony during the Damara Tern breeding season. The plan must detail how this will be measured, monitored and reported on.
4. Loud construction activities, especially those causing sudden loud noises (e.g. piling) must be scheduled for periods outside of the Damara Tern breeding season, 1 October to end February.
5. All construction vehicles and equipment must be well maintained and in good condition.
6. Construction staff should receive “noise sensitivity” training such as switching off vehicles and equipment when not in use.
7. Fencing around the Gas Hub will contain human access and disturbance within the Gas Hub precinct. In addition, during the Damara Tern breeding season 1 October to end February, the south-eastern boundary of the Gas Hub and the west and east boundaries for a distance of at least 200m northwest of their junction with the south-eastern boundary, must be screened off to prevent visual disturbance to the Damara Tern colony (e.g. with shade cloth able to withstand the strong winds). Unfortunately, even a 3m high fence will not adequately screen construction of the larger components of the project.
8. CDC’s Standard Environmental Specifications for Construction must be strictly adhered to. These control most of the negative impacts associated with construction activities (e.g. minimise construction footprint, management of construction material, chemicals

and equipment, dust control, waste management, provision and control of ablutions and dining areas, worker induction and toolbox talks).

11.1.5 Mitigation Applicable to Operations of Phase 2

The additional mitigation measures below apply primarily to operations within the Gas Hub due to its close proximity to the Damara Tern colony. Even if the mitigation measures are fully implemented, it is likely that high residual impacts will remain that cannot be mitigated.

1. The Gas Hub must be fenced off to contain human activities within the Gas Hub precinct. The south east boundary (closest to the Damara Tern colony) and the west and east boundaries for a distance of at least 200m northwest of their junction with the south-eastern boundary, must be screened off to prevent visual disturbance to the Damara Tern colony (ideally with a wall). Unfortunately, even a 5m high wall will not adequately screen the larger components of the project.
2. Planned maintenance of the gas pipelines east of the south-north corridor must not take place during the Damara Tern breeding season, 1 October to end February. If emergency repairs or inspections are required during the Damara Tern breeding season they should be undertaken during daylight hours and the work site should be screened off (e.g. high fence, shadecloth), in a similar manner to that required by the construction phase mitigation.
3. CDC's Operational Safety, Health and Environmental Management Plan for the Coega SEZ must be complied with. This management plan is applicable to all tenants and governs the management, monitoring and reporting requirements for most operational activities (e.g. environmental awareness, waste, storm-water, waste-water, air quality management, noise control, pollution control, management of hazardous substances, emergency preparedness, visual impacts, alien vegetation management, species of conservation concern, problem animal control, resource management).

11.2. Reasoned Opinion of the Authors

The Authors are of the opinion that development of Phase 1 of the Gas Infrastructure project comprising the gas infrastructure and FSRUs in the Port of Ngqura, gas pipelines and road loading facility in the north-west portion of the Gas Hub can proceed with acceptable impacts on the sustainability of the Abalone Farm Damara Tern colony subject to the implementation of the mitigation measures in 11.1.1, 11.1.2 and 11.1.3.

The Authors are of the opinion that development of Phase 2 of the Gas Infrastructure Project that includes two LNG Storage tanks and a regasification facility at the Gas Hub will result in adverse impacts to the nearby Damara Tern (Critically Endangered) colony that supports 9 pairs (17%) of the South African population. The impacts due to the physical (visual) presence of the infrastructure and the associated anthropogenic disturbance cannot, in the opinion of the Authors, be adequately mitigated and the residual impact is assessed to be of high negative significance. This is likely to result in a decrease in the number of breeding pairs, a decrease in breeding success and ultimately extinction of this Damara Tern colony.

The No-Go Alternative assessed the impact of past and future sand mining operations to be of moderate negative significance (50% of the dunefield has already been mined) and the future sustainability of the colony is uncertain. The ideal scenario would be to protect the remaining dunefield from further mining, development or disturbance, but this is very unlikely.

Avoidance mitigation would involve moving the Integrated Gas to Power Project comprising the Zone 10s and Zone 10N 1000MW Power Plants and the Gas Infrastructure outside of the c.1 km buffer for high impact developments around the Damara Tern colony.

Possible offset mitigation is suggested to secure formal protection for the Damara Tern colony at the nearby Schelm Hoek dunefield colony located west of the Sundays River mouth opposite the Addo Elephant National Park, Alexandria Section. This area could come under development pressure (e.g. mining and/or, developments between the dunefield and N2 freeway) in future. However, the feasibility of implementation of this option is not known at this stage and would require commitment from the relevant stakeholders. This is outside the scope of this study.

In considering whether to grant an Environmental Authorisation for this project the authorities are requested to apply their minds to the options available to ensure the continued sustainability of the Damara Tern population in Algoa Bay where 83% of the South African population is found.

12. ACKNOWLEDGEMENTS

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APPENDIX A: IMPACT ASSESSMENT METHODOLOGY

CES
ENVIRONMENTAL AND SOCIAL ADVISORY SERVICES

IMPACT RATING METHODOLOGY

Six factors are considered when assessing the significance of the identified issues, namely:

1. **Significance** - Each of the below criterion (points 2-6 below) are ranked with scores assigned, as presented in Table 1 to determine the overall significance of an activity. The total scores recorded for the effect (which includes scores for duration; extent; consequence and probability) and reversibility / mitigation are then read off the matrix presented in Table 1, to determine the overall significance of the issue. The overall significance is either negative or positive.
2. **Consequence** - the consequence scale is used in order to objectively evaluate how severe a number of negative impacts might be on the issue under consideration, or how beneficial a number of positive impacts might be on the issue under consideration.
3. **Extent** - the spatial scale defines the physical extent of the impact.
4. **Duration** - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.
5. The **probability** of the impact occurring - the likelihood of impacts taking place as a result of project actions arising from the various alternatives. There is no doubt that some impacts would occur (e.g. loss of vegetation), but other impacts are not as likely to occur (e.g. vehicle accident) and may or may not result from the proposed development and alternatives. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.
6. **Reversibility / Mitigation** – The degree of difficulty of reversing and/or mitigating the various impacts ranges from very difficult to easily achievable. The four categories used are listed and explained in Table 1 below. Both the practical feasibility of the measure, the potential cost and the potential effectiveness is taken into consideration when determining the appropriate degree of difficulty.

The relationship of the issue to the temporal scale, spatial scale and the severity are combined to describe the overall importance rating, namely the significance of the assessed impact.

The impact is first classified as a positive (+) or negative (-) impact. The impact then undergoes an evaluation according to a set of criteria.

Table 1: Ranking of Evaluation Criteria.

Effect	**Duration**	
	Short term	**Less than 5 years**
	Medium term	**Between 5-20 years**
	Long term	**More than 20 years**
	Permanent	**Over 40 years or resulting in a permanent and lasting loss**
	Extent	
	Localised	Impacts affect a small area of a few hectares in extent. Often only a portion of the project area.
	Study area	The proposed site and its immediate surroundings.

Coastal and Environmental Services (Pty) Ltd
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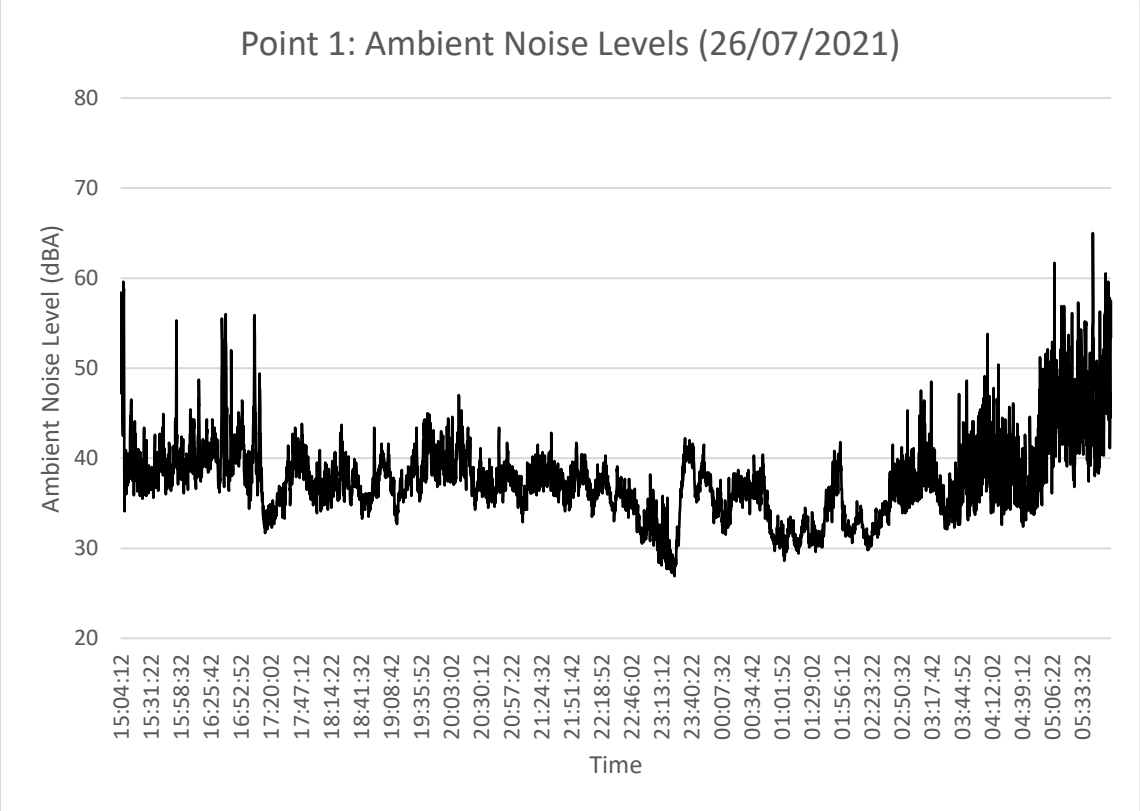
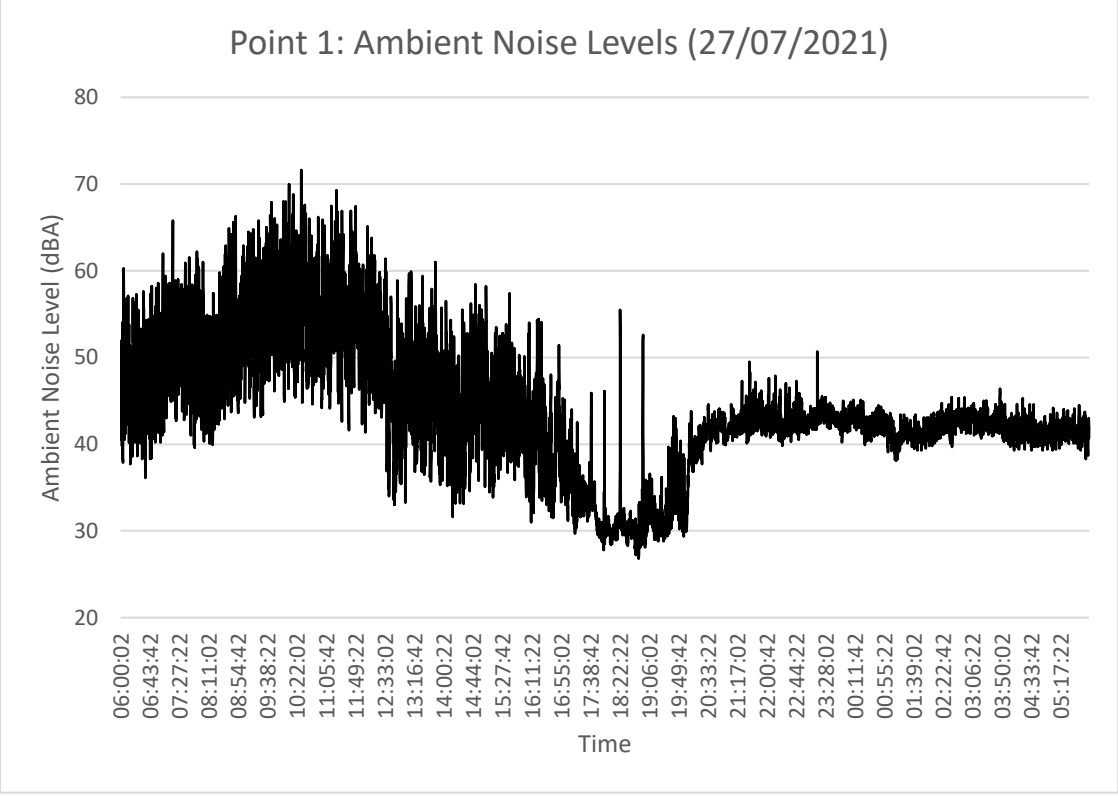
1st Floor, Block E, Pinmill Farm Office Park, 164 Katherine Street, Sandton, 2148 | PO Box 934, Grahamstown, 6140
Reg no: 2012/151672/07
www.cesnet.co.za

Directors: SD Bennett, RL Pole, AG Hingeston, AN Umichand

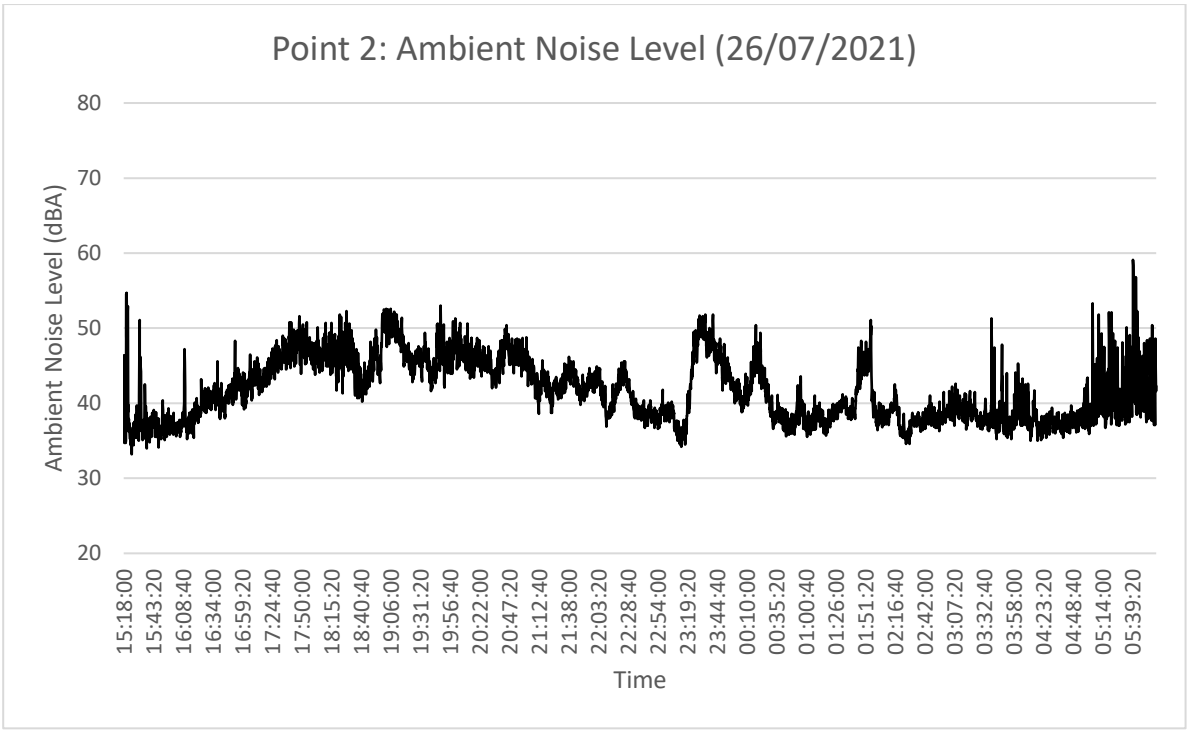
Appendix B

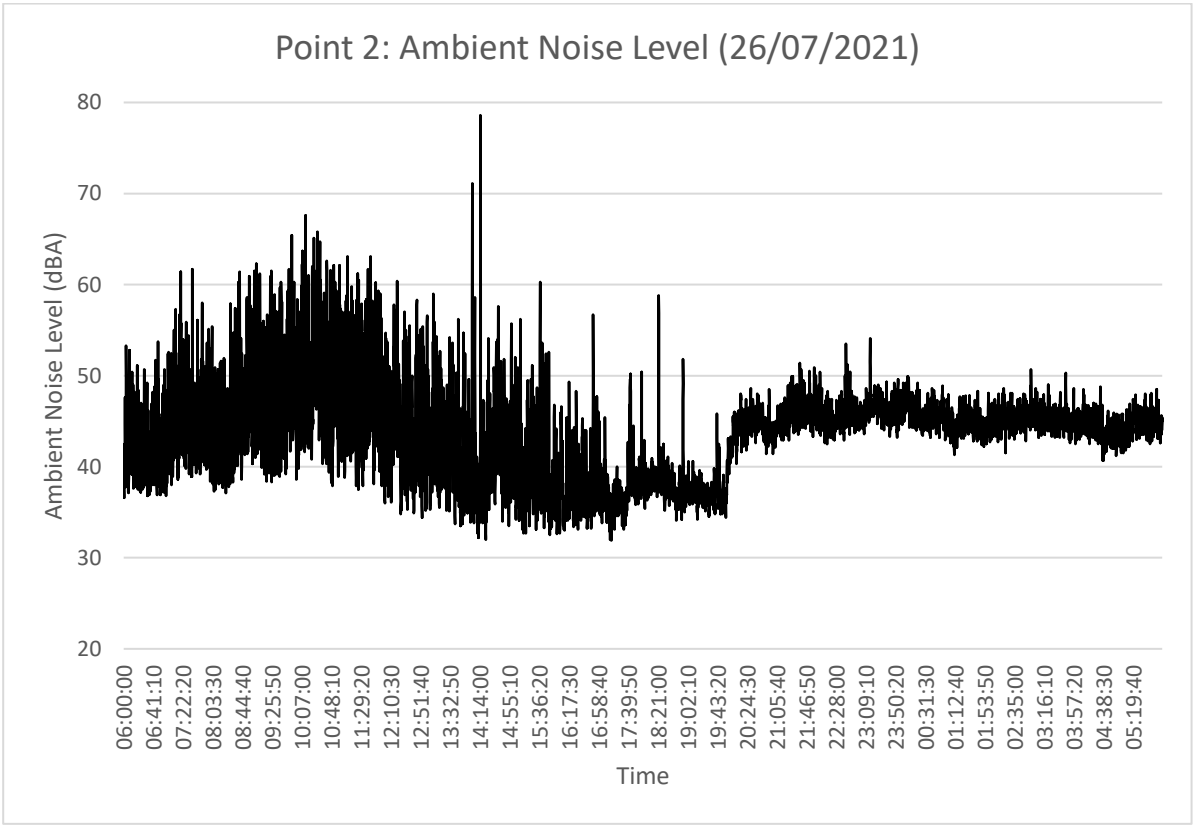
APPENDIX B: BASELINE NOISE MEASUREMENT HISTOGRAMS





acoustech
ACOUSTIC ENGINEERING CONSULTANTS


Point 2: Ambient Noise Level (26/07/2021)
Ambient Noise Level (dBA)
80
70
60
50
40
30
20
15:18:00
15:43:20
16:08:40
16:34:00
16:59:20
17:24:40
17:50:00
18:15:20
18:40:40
19:06:00
19:31:20
19:56:40
20:22:00
20:47:20
21:12:40
21:38:00
22:03:20
22:28:40
22:54:00
23:19:20
23:44:40
00:10:00
00:35:20
01:00:40
01:26:00
01:51:20
02:16:40
02:42:00
03:07:20
03:32:40
03:58:00
04:23:20
04:48:40
05:14:00
05:39:20
Time


Point 2: Ambient Noise Level (26/07/2021)
Ambient Noise Level (dBA)
80
70
60
50
40
30
20
06:00:00
06:41:10
07:22:20
08:03:30
08:44:40
09:25:50
10:07:00
10:48:10
11:29:20
12:10:30
12:51:40
13:32:50
14:14:00
14:55:10
15:36:20
16:17:30
16:58:40
17:39:50
18:21:00
19:02:10
19:43:20
20:24:30
21:05:40
21:46:50
22:28:00
23:09:10
23:50:20
00:31:30
01:12:40
01:53:50
02:35:00
03:16:10
03:57:20
04:38:30
05:19:40
Time

APPENDIX C

APPENDIX C: SITE INVESTIGATION LOCALITIES & EQUIPMENT/CALIBRATION

Table 0-1: Site investigation localities

Measurement Locality	Latitude	Longitude
Measurements		
Point 1	33°46'41.4"S	25°42'40.0"E
Point 2	33°47'01.5"S	25°42'33.5"E

Table 0-2: Equipment & Calibration

Equipment	Calibration	Certification number Laboratory (M & N) Acoustic Services
Svantek 957, 14528 (SLM)	10-11 December 2020	2020-AS-1157
Svantek 957, 14529 (SLM)	24-25 August 2020	2020-AS-0685
01dB Calibrator	25 August 2020	2020-AS-0684

APPENDIX D

APPENDIX D: CURRICULUM VITAE OF SPECIALISTS

CV
Oliver Knoppersen
Acoustic Consultant

Profile

Oliver worked for Pro Acoustic Consulting Engineers from 2009 to 2015 in an internship that shaped his knowledge of acoustics. In 2015 he joined Acoustech Consulting. He specialises in many areas of acoustics, but his main interests lie in building acoustics, Industrial acoustics, Studio Acoustics and Environmental Acoustics. He has been involved in a number of projects in South Africa as well as on the African Continent. He has been involved in Green Star Rated buildings, offices, studios, a number of industrial projects and environmental projects in South Africa and abroad. Some of his most prestigious projects include Menlyn Park Shopping Centre, , YFM Radio Studios (South Africa), Kusile Power Station (South Africa), Ingula Power Station (South Africa), KCM Copper Mine (Zambia) and the initial phase of Hillside Aluminium Plant.

Experience and skills

Oliver's skills and experience include a working knowledge of all SABS standards (SANS, South African National Standards) South African Regulations, ISO Acoustic Standards and international best practice relating to architectural and environmental acoustics.

As a consultant, the ability to assess existing layouts and designs, and provide carefully designed solutions in cross disciplinary environments is critical. Oliver brings the following skills to the team – Environmental acoustic modelling and simulation -SoundPLAN), manipulation and creation of dxf/dwg drawings, internal acoustical design, sound insulation design, noise mitigation design, noise measurement & analysis, project management, producing design documentation and excellent communication.

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Selected Projects

SANRAL - THE PROPOSED N2/N3 CORRIDOR CAPACITY UPGRADES BETWEEN EB CLOETE INTERCHANGE AND CEDARA – Noise impact assessment and noise mitigation design (Low noise surfaces, noise barriers ect.) to be completed early 2021.

Globeleq - Kribi Power Development Company. Noise assessment, noise and low frequency mitigation design of a 216MW Gas to Power Station (13 closed cycle combustion engines). To be completed in early 2021.

Kusile Power Station

Design of the desulphurisation Plant to meet max. 85dBA at 1 m from the plant façade. Completed 2012

KMC Copper Mine, Zambia

Noise reduction to meet the noise specifications for an adjacent hospital. Completed in 2018

Ingula Pump Storage Scheme, South Africa

Internal Noise Control from pumps and generators. Completed 2017

Richards Bay Hillside Aluminium Smelter

Industrial Noise Survey in order to provide Noise Control Recommendations. Completed in 2018.

South32 Wolvekrans Colliery Mega-facility

Noise Impact Assessment . Completed in 2019

Bidvest Quarry 2 Extension Durban Noise Impact Assessment

Noise Impact Assessment at a terminal at the Durban Harbour. Completed in 2016

National Multi Product Pipeline (NMPP) – Noise Impact Assessment and Noise Mitigation Design

Pipeline from Durban to Jameson Park with Pump Stations. Noise Impact Assessment and Noise Control Recommendations. Completed in 2014

Position
Director and Senior Acoustic Consultant

ID Number
8608245163086

Nationality
South African

Languages
English

Residential address
24 Orwell Street
Kensington
Johannesburg
2094

Contact detail
oliver@acoustech.co.za
082 807 4895
011 648 4998

Formal qualifications
AMIOA Institute of Acoustics (IOA UK) 2018

Key skills
Architectural Acoustics
Industrial Acoustics
Noise Control
Environmental Acoustics
Broadcasting Studios Acoustics

Experience
11 years

References

Thinga Nethanani
NTC Group
Project Manager
083 260 8877

Yovka Raytcheva-Schaap
Aurecon
Environmentally Sustainable Design (ESD) Consulting & Project Management
082 779 2551

Marlin Nadasen
Naidu Consulting
Manager
083 780 4809

Professional Experience

2009-2015: Trainee Consultant: Worked for Pro Acoustic with two professional engineers (Jean Knoppersen and Ivan Lin) and my colleague Steven Liddell (Now owner of Venta Acoustics UK) in the field of acoustics.

I underwent training in the use of Soundplan to produce large scale terrain models; acquire and interpret source noise levels for use in the model, run calculations using the appropriate methodologies/standards; interpret the results of the noise model calculations; assess the results against appropriate criteria and write reports in preparation for issue to clients, subject to checks by senior staff.

Understood GreenStar Assessment (a rating system similar to BREEAM), Prepared technical letters and reports under guidance from senior staff;

I attended client meetings and design team workshops with senior staff to gain experience and understanding. I would usually action the items discussed.

I understood Environmental Noise Surveys, source noise measurements and sound insulation testing. Initially, this was under the supervision of experienced staff. Later I undertook this work on my own.

Assistant project manager in the design and construction of radio studios, working closely with a specialist contractor including frequent site visits. Gained exposure to practical operational requirements of the studios, construction methodologies and consideration of onsite factors and limitations,

I was responsible for the maintenance and calibration of equipment (sound level meters).

2015 to Present: Worked with a professional engineer (Jean Knoppersen) in the field of acoustics.
I was responsible for the maintenance and calibration of equipment (sound level meters).

I understood Environmental Noise Surveys, source noise measurements and sound insulation testing. I undertook this work on my own.

Prepared technical letters and reports under guidance from senior staff;

I attended client meetings and design team workshops. I would usually action the items discussed.

Proficient at Noise prediction modelling to produce large scale terrain models; acquire and interpret source noise levels for use in the model, run calculations using the appropriate methodologies/standards; interperate the results of the noise model calculations; assess the results against appropriate criteria and write reports in preparation for issue to clients, subject to checks by senior staff.

2019: Promoted to Directorship in Acoustech Consulting

Project List

Nedcore Sandton
9-hour Noise Measurements - Green Star Design

Mpower Radio Studio Witbank
Studio Design + Project Management

NMPP Pipeline and Pump Stations
24-hour Noise Measurements

O.R Tambo Hotel
Sound Insulation Measurements

Tanza Night Club
Noise Measurements

VOPAK (Chemical Storage Facility)
Industrial Noise Measurements + Noise Modelling (Soundplan)

YFM Radio Studio Craighall Park
Studio Design + Project Management

Stark TV Studios
Sound Insulation Measurements

Department of international Relations & Cooperation Conference Room
Room Acoustics + Sound Insulation Measurements

Discovery Data Centre
Noise Measurements

Holiday Inn Express Hotel Roodepoort
Sound Insulation Measurements

Jacaranda FM Radio Studio Nelspruit
Studio Design + Project Management

Park Inn Hotel Sandton
Sound Insulation Measurements

KPMG Campus
Noise Measurements

Menlyn Maine
Noise Measurements

Nedcor Phase 2 Greenstar
Green Star Internal Noise Measurements

NMPP Pipeline and Pump Stations
Enclosure Design + Noise Modelling

Radioheads Radio Studio
Studio Design+Project Management

Voice of WITS (University Radio Studio)
Design+Project Management

Zouk Night Club
Noise Measurements

ABSA Towers West Green Star
Measurements

Able Partitions
Sound Insulation Measurements+Report

CheckersHyper Mayville
HVAC Measurements

Danone Factory
Factory Noise Measurements

Gautrain Sandton Extract Fans
Fan Noise Measurements

Hilton Hotel Sandton
Noise+ Sound Insulation Measurements+Report

Jan Smuts Research Project
Road Traffic Noise Research+Presentation

Kusile Power Station
Industrial Noise Modelling+Report

Middelburg Eastern Bypass
Road Traffic Noise Modelling+Report

Nedbank Newtown Noise Measurements+Report

Ilanga Mall HVAC Noise Measurements

NMPP
Site Inspection+Noise Measurements

Planet Fitness Bedfordview
Structural borne Investigation+Noise Measurements+Report

Planet Fitness Village Walk
Noise Measurements

SCAW Metals
Environmental Noise Measurements+Report

South Point Braamfontein
Office HVAC Noise Measurements

Vodafone Innovation Centre
Noise Measurements and Façade Design

WITS Generators
Generator Noise Measurements

8 Melville Road
Noise survey + Report

90 Grayston Drive
Green Star 9 hour Noise survey + Report

102 Rivonia Road
Green Star 9 hour Noise survey + Report

Erf 108 Corlett Drive
1 hour Measurement

DSTV City Green Star
9 hour Noise survey + Report

Formula One Hotel
Sound Insulation Measurements + Report

Grayston Sun Hotel
Noise survey + Report

Grosvenor Studio (EWH)
Studio Design and Project Management

Grundfos Green Star
9 hour Noise survey + Report

Hyundai Head Office
Green Star 9 hour Noise survey + Report

Jet Blast and Drilling Middelburg
Sound Insulation Measurements

Kusile Power Station Noise Study Review
Industrial Noise Modelling+Report

Lakeside Office Park
1 hour Measurement+Report

Market Theatre
STI+Reverb+room Impulse Response Measurements

Newtown Junction Green Star
9 hour Noise survey + Report

Newtown Majestic Green Star 9 hour Noise survey + Report

NWU Potchesfstroom Amphitheatre
Room Impulse Response Measurements

Pentad Office Pretoria
Office Measurements+Report

Swaziland Broadcast Studios (SBIS)
Project Management

Unilever depot
Noise Modelling+Measurements+Report

USAID Pretoria Green Star
9 hour Noise survey + Report

Vodacom Data Park
Noise Measurements+Façade Design+Report

Vopak Revision (Chemical Storage Facility)
Industrial Noise Modelling+Report

Abbotts College
Room Impulse Response Measurements (Study with Ecophon)

The Baron Restaurant, Bryanston
Room Acoustics

Kathleen Close Apartment Building
Attenuator Design for Heat Exchangers

Michelangelo Legacy Hotel Nightclub
Measurements+Report

MTN Gallo Manor Call Centre
Open Plan Office Measurements

Primedia 94.7 Radio Studio
Independent Consulting on Studio Building to ensure compliance with clients specifications

ABSA Tower South+270RR
HVAC Measurements+ Noise Modelling

MIS Engineering
Noise Measurements+Report

5 Packard Street
Road Noise Study – Noise Modelling and Noise Mitigation Design

ABSA Contact Centre Service Yard
12-hour Noise Measurements
Mechanical Noise Mitigation Design

Anglo-American 55 Marshall Street
Site Inspections of implementation of boardroom acoustic design

Bretton Wood Apartment Building
Heat Exchangers
Noise Mitigation Design

Davar Partners International
Studio Design and Project Management

Oscar Pistorius Trial
Noise Modelling and Research

Joe Public Voice Over and Recording Studio
Studio Design

Margate Indoor Shooting Range
Noise Mitigation and Internal Acoustic Design

Planet Fitness Gym Bedfordview
Sound Insulation Measurements and Noise Mitigation Design

Rheinmettal Denel Munitions
Noise Mitigation and Internal Acoustic Design

SAMHS Military Hospital Generators
Noise Measurements and Noise Mitigation Design

Universal Music Studio
Music Studio Design and Project Management

Vodacom MTB Data Building
Occupational Noise Measurements and Report

Advantedge Generator
Generator Noise Measurements and Report

Big Brother House
Sound Insulation Recommendations and Noise Survey

Bounce
16-hour Noise Survey and Report

DSTV
Mechanical Noise Investigation

Johnny's Restaurant Generator
Noise Measurements and Report

Kansanshi Smelter Zambia
Industrial Noise Measurements and Report

Life Wilgers Hospital
Mechanical Noise Measurements and Noise Mitigation Report

Menlyn Park Shopping Centre
Green Star Acoustic Analysis and Report

Quantum Foods
Mechanical Noise Mitigation Design

Rebel Foods
Mechanical Noise Mitigation Design

Revelation Church of God Music Studio
Music Studio Design and Project Management

SASRIA Generator
Generator Noise Mitigation Design

Southlands Food Depot
12 Hour Noise Measurements, Noise Nuisance Assessment and noise mitigation design

St Andrews School for Girls
New Hall Internal Acoustic Design

St Johns College
Room Acoustic Design

USAID Southern Africa
Green Star Internal Noise Audit

Waterkloof Glen Pretoria
9-Hour Noise Measurements

Sun City Casino Entertainment Centre Refurbishment
Sound Insulation and Room Acoustic Design

Times Square Menlyn Maine Casino, Arena and Hotel
Façade Design, Sound Insulation and Room Acoustics Design, Hotel Room Acoustic Design, Conference Centre Design, Arena Acoustic Design

Bidvest Chemical Storage Terminal
Noise Measurements, Noise Modelling and Environmental Noise Impact Assessment

Bloemfontein Advocate Office Building Sound Insulation Measurements and recommendations

Broadwalk Office Park
Noise Measurements

Econet
Acoustic Investigation into existing TV Studios and provided recommendations to achieve better acoustic performing studios.

Krank'ed Up Music Festival
Noise Monitoring during a Music Festival

Menlyn Park Shopping Centre Phase 1
Green Star As Built Audit Retail Tool

Optimum Mine Ventilation Shaft
Environmental Impact Assessment

Statistics of South Africa Office Building
Sound Insulation Measurements to ensure compliance with clients specifications

Studio Blu Conference Venue
Noise Impact assessment and noise mitigation design

Unilever Dust Extractors
Noise Measurements and noise mitigation design to reduce noise from dust extractors to the rest of the plant area.

Assemblies of God Church Nelspruit
Noise Impact Assessment

BMW M Festival
Noise Monitoring during the Music Festival

El Devino Complex Noise Complaint
Noise Nuisance Assessment

Houghton Hotel Conference Centre
Internal Acoustic Design

I4C Office
Measurement Reverberation Time Measurement before and after acoustic treatment

Ingula Pump Storage Eskom
Noise Mitigation Design

Jehovah Witness Hostel Rwanda
Acoustic Recommendations to reduce noise from the city (Night clubs, restaurants and a stadium) to the existing hostel

Midstream College Music Festival
Noise Monitoring during a Music Festival

NOOA Petroleum Chemical Storage
Noise Measurements, Noise Modelling and Environmental Noise Impact Assessment

199 Bryanston Drive Office Park Generator
Noise Measurements and Noise Mitigation Design

Accenture Office Building
Sound Insultation measurements to ensure compliance with clients specifications

Andiccio24 Restaurant
Noise Nuisance Assessment

Booysens Magistrate Court
Sound Insultation measurements to ensure compliance with the acoustic design

Discovery Head Office Boardroom
Acoustic recommendations

DSTV Delicious Festival, Kyalami
Noise Management Plan and Noise Monitoring during a Music Festival

Formfunc Office
Greenstar IEQ 5 Audit

FSM
Sound Insulation Tests of existing prefabricated mining accommodation

Generator Noise Wapadrand
Noise Measurements of a Generator

Hillside Aluminium Smelter Richards Bay
Noise Survey to assess the noise levels that the employees experience with a view to provide noise mitigation measures. Next phase would be to provide noise mitigation design for each area.

Jolly Roger Tavern Pretoria
Noise Nuisance Assessment and noise mitigation design

KCM Copper Mine Ball Mills
Noise Impact Assessment, Noise Mitigation Design. The project is awaiting the go ahead for the implementation of the noise mitigation (approx. $6 million project)

Menlyn Park Shopping Centre Phase 2
Green Star Acoustic Design Retail Tool

Nampak House Boardroom
Acoustic recommendations

Natural Dehydrated Foods Nelspruit
Noise Impact Assessment

Silver Stream Office Park Generator
Noise Measurements and Noise Mitigation Design

Talco Grain and Milling
Noise Measurements, Mechanical Noise Mitigation Design

Times Square: Sun Arena
Compliance Measurements: Reverberation Time, Sound Insulation Tests, HVAC noise Measurements

Vodacom Boardroom
Acoustic recommendations

Fort Ikapa Cape Town Shooting Range
Noise Impact Assessment

Altitude Beach Restaurant
Noise Impact Assessment

Sudor Coal Weltevreden Colliery
Noise Impact Assessment

140 West Street Sandton
5th Floor demising wall design

Standard Bank Head Office Rosebank
Gas Generator Noise Mitigation Design

Alpla Office Design
Noise mitigation to ensure office noise levels specifications are met.

Castle Gate Lifestyle Centre
Generator noise measurements

Illovo Central
Chiller Noise Mitigation Design

UIF Sunnyside Office Development
Architectural Acoustic Design of the building

Curriculum Vitae – Paul Martin

Name	MARTIN Anthony Paul	Date of Birth	2 June 1960
Work Address	30 Himeville Drive Bluewater Bay 6210 Cell: 0732524111 email: pmartin@axxess.co.za		

Education

1971-1978	Caldew Comprehensive School, Dalston, Carlisle, UK
1978-1981	University of Durham: BSc (Hons) Zoology (Class 2:1)
1984-1991	University of Port Elizabeth: PhD
Thesis Title	Feeding Ecology of Birds on the Swartkops Estuary, South Africa

Employment History

1981-1982	British Antarctic Survey, Cambridge Zoological Assistant in two man field detachment studying Fur Seals on subantarctic island of South Georgia
1982-1983	British Trust for Ornithology, Tring, Hertfordshire Assistant in Ringing Office
1983-1988	University of Port Elizabeth (Nelson Mandela University) Research Assistant studying estuarine birds and ecology. Participated in several Environmental Impact Assessments Wrote Management Plan for Zwartkops Valley Nature Reserve
1988-2002	Port Elizabeth (now Nelson Mandela Bay) Municipality Nature Conservation Officer, later Manager: Nature Conservation Appointed as the city's first conservation officer, responsible for the Swartkops Valley and control of the Swartkops estuary. In 1992 responsible for setting up and managing the Nature Conservation Division within the Parks & Recreation Department. Responsibilities included managing approx 10,000 ha of natural area, including four local nature reserves, and controlling vegetation on undeveloped Council land. Designed the Port Elizabeth Metropolitan Open Space System. Responsible for setting up 120 km of hiking & bicycle trails in the city. In 2001 duties were extended into the new metropolitan area, including incorporation of an additional four nature reserves, Sundays estuary control, environmental education unit. Staff complement 98.
Nov 2002 – Jul 2007	*Executive Director: Environmental Services*, Nelson Mandela Bay Municipality (a 5-year, performance based, contractual senior management position reporting to the Municipal Manager). Responsible for setting up, leading, managing, reporting on and being accountable for a new Environmental Services Business Unit providing Waste Management, Environmental Health, Environmental Management, Parks & Conservation Services to approximately 280,000 households with a population of 1.3 million in an area of 1952 km^2. Accountable for 1100 staff members, an operating budget of R 250 million and a capital budget of R 36 million. Unit produced the metro's Environmental Plan, including Spatial Biodiversity Plan (Nelson Mandela Metropolitan Open Space System); Environmental Policy and Environmental Management System Framework (2004); Integrated Waste Management Plan (2005) and was developing the State of Environment Report, Alien Organism Control Plan, Air Quality Management Plan, Coastal Management Plan and site specific Environmental Management Programmes. Acted as Municipal Manager on numerous occasions.
Aug 2007 – Present	*Self-Employed Environmental Professional:* *Environmental Control Officer* for the Coega Industrial Development Zone and Port of Ngqura (Aug 2007-Feb 2018). Responsible for auditing and monitoring adherence to Environmental Management Systems and Records of Decision and reporting to an

	independent multi-stakeholder Environmental Monitoring Committee. *Environmental Control Officer* for the Coegakop Return Effluent Reservoir (2013-15 & 2017-18). *Environmental Specialist in association with Kyle Business Projects*: *Strategic Environmental Assessments (SEA)* for Responsible Tourism Sector Plans in Kou-Kamma, Kouga, Camdeboo, Ikwezi, Blue Crane Route, Sundays River Valley, Makana and Ndlambe Local Municipalities (2008), Knysna and King Sabata Dalinyebo Local Municipalities (2009). SEA for the Tourism Master Plans for Cacadu and Chris Hani District Municipalities (2009), *Environmental Assessments (Tourism Plans)* for Amathole (2009) & Mopani (2010) District Municipalities (Agri-Tourism Projects); Nelson Mandela Metro (Tourism Plan); Cradock Tourism Project (2009); Maqoma Eco-Tourism (2011); Addo Elephant National Park Coastal Development Plan (2012); Baviaanskloof Tourism Development Plan (2012); Dwaai Holiday Resort, Wild Coast (2012). Assessment of Nature Reserves in Cacadu District Municipality (2010). Environmental component for Richtersveld & Mazelsfontein community development projects 2017-18. *Environmental Impact Assessments*: Fauna and Avifauna Specialist Assessment Coega Ridge, Motherwell. *Avifauna Specialist Assessments*: Three powerlines, Nelson Mandela Bay Municipality (2008-09); Universal Wind Energy Project, Coega (2011); Manganese Export Facility, Coega (2012); Eskom powerlines, Coega (2013); Sand Mining, Coega (2018-19); Gas to Power Projects, Coega (2021-22); Solar PV (2021-present). *Avifauna Baseline Monitoring, Wind Energy Facilities 2011-Present:* Electrawinds, Coega, including Bat & Bird mortality; Universal Wind, Coega; MetroWind, Van Stadens; Grassridge:Ukomeleza; Choje Wind. Waterbird & Coastal Bird counts and monitoring of breeding colonies on wetlands and coastal areas around Port Elizabeth (1983 –present) *Research Associate*, Department of Zoology, NMU: 2013- Present.
Professional Registrations	Member, International Association for Impact Assessment (SA); Professional Natural Scientist (Environmental Science & Ecological Science). Registration No. 400507/14 (SACNASP) Author of 19 refereed scientific papers and many research reports and popular articles..

APPENDIX E

APPENDIX E: DETAILS OF SPECIALIST AND DECLARATION