environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

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File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

PROJECT DAO

Kindly note the following:

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2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
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Departmental Details

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Pretoria
0001

Physical address:
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473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

SPECIALIST INFORMATION

Specialist Company Name:	[redacted]
B-BBEE	
Specialist name:	
Specialist Qualifications:	
Professional affiliation/registration:	
Physical address:	
Postal address:	
Postal code:	
Telephone:	
E-mail:	

1. DECLARATION BY THE SPECIALIST

I, OWEN RHYS DAVIES, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

[redacted]

D

Date

2. UNDERTAKING UNDER OATH/ AFFIRMATION

I, OWEN RHYS DAVIES, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

[redacted]

Date

SOUTH AFRICAN POLICE SERVICE
STATION COMMANDER
DIEPRUIER K/P.O.P.
2021 -11- 09
SUID-AFRIKAANSE POLISIEDIENS

COMPLIANCE WITH GN320 AND GN1150

Lusani Jacqueeline Madali
ACWA Power Energy Africa (Pty) Ltd
Bokpoort II Solar Facilities
Farm Bokpoort 390

DEFF Reference Numbers: 14/12/16/3/3/2/879, 880 and 881

15 February 2022

Dear Lusani,

RE: Department of Foresty, Fisheries and Environment Comments on the Application for the Addition of 2 x 9.9MW Internal Combustion Engines (ICEs) for the Bokpoort II Solar Facilities, near Groblershoop in the Northern Cape Province

ACWA Power Energy Africa (Pty) Ltd (ACWA Power) obtained environmental authorisation for seven Internal Combustion Engines (ICEs). Since receiving authorisation the applicant has decided to allow the authorisation for four of the ICE to lapse and apply for two more ICEs to have a overall total of five internal combustion engines for the Bokpoort II Solar Facilities (2 x 75MW photovoltaic (PV) facilities (PV 1 and PV 2) as well as a 150 MW concentrated solar power (CSP) tower facility).

Since the submission of the application the National Department of Forestry, Fisheries and the Environment (DFFE – the Compentent Authority) submitted comments on the application, during the public participation period. The following comment applies to the Avifaunal Specialist Letter and Assessmenf for the abovementions application:

"Ensure that specialist studies, where applicable comply with the requirements of GN 320 of 20 March 2020 and GN 1150 of 30 October 2020 unless proof is provided that indicates that the specialist study was commissioned within 50 days after the date of gazetting of the notice i.e. 20 Mach 2020 and was commissioned prior to 30 October 2020 respectively. Failure to comply with the abovementioned notices presents a risk to this application."

Arcus Consultancy Services South Africa (Pty) Ltd (Arcus) was appointed in 2015 to provide avifaunal specialist input in the form of a specialist Impact Assessment Report for the original Environmental Authorisations, which included pre-construction avifaunal monitoring, the results of which advised the initial impact assessment. As no formal solar facility guidelines for bird monitoring are currently in place in South Africa, the survey was designed by the avifaunal specialist to be broadly in line with the best practice guidelines for wind farms. Four seasonal surveys were carried out: winter (03-11 June 2015); spring (14-21 September 2015); summer (07 and 14 December 2015); and autumn (01-08 April 2016). The following survey types were performed in the broader project area and control site during the 12-month pre-construction surveys:

- Walked transects;
- Drien transects;
- Vantage point surveys;
- Focal site surveys; and
- Incidental observation recording.

ACWA Power is in the process of amending the project description applying for authorisation of 7 x 200 MW PV components and associated infrastructure on the same site as the authorised CSP development. In October 2019, Arcus was appointed to update the specialist Impact Assessment Report to reflect changes associated with the proposed amendment. An additional two day site

visit was conducted in early December 2019 to assess the environmental status quo as it pertains to avifauna.

In addition to the above amendment, the application will include the addition of 2 x 9.9 MW Internal Combustion Engines (ICEs) (three of the five ICE have already been authorised). Arcus has been appointed to provide an avifaunal specialist letter for inclusion in the amendment application regarding the potential avifaunal impacts associated with the proposed ICE additions. The aim of the avifaunal specialist letter is to determine if the addition of the proposed ICEs would significantly alter any avifaunal impacts as identified in the Avifaunal Specialist Amendment Report (Arcus, 2020) and to identify any additional mitigation measures that may be required.

The original assessment and the subsequent amendment, were both commissioned prior to the publication of GN 320 of 20 March 2020 and GN 1150 of 30 October 2020. The Statement letters were produced to confirm that no highlhy negative avaifuanl impact is expected to occur due to the addition of the 2 x 9.9 MW ICE's.

As the development footprint of the proposed ICEs (Figure 1) falls within the footprint assessed for the original Environmental Authorisations and the Avifaunal Specialist Amendment Report, the data collected for those impact assessments remain valid and sufficient to inform the assessment of the currently proposed ICE additions (2 x 9.9 MW ICEs).

We trust this letter will provide the competent authority with sufficient information required to make an informed decision on the amendment application.

Yours Sincerely,

[redacted]

Dr Owen Rhys Davies ***Pr. Sci. Nat.***
Avifaunal Specialist

[redacted]

ADDITION OF 2 X 9.9MW INTERNAL COMBUSTION ENGINES

(NOVEMBER 2021)

Lusani Jacqueeline Madali
ACWA Power Energy Africa (Pty) Ltd
Bokpoort II Solar Facilities
Farm Bokpoort 390

DEFF Reference Numbers: 14/12/16/3/3/2/879, 880 and 881

04 November 2021

Dear Lusani,

RE: Avifaunal Specialist Letter of Potential Impacts for the Addition of 2 x 9.9MW Internal Combustion Engines (ICEs) for the Bokpoort II Solar Facilities, near Groblershoop in the Northern Cape Province

ACWA Power Energy Africa (Pty) Ltd (ACWA Power) obtained environmental authorisation for seven Internal Combustion Engines (ICEs). Since receiving authorisation the applicant has decided to allow the authorisation for four of the ICE to lapse and apply for two more ICEs to have a overall total of five internal combustion engines for the Bokpoort II Solar Facilities (2 x 75MW photovoltaic (PV) facilities (PV 1 and PV 2) as well as a 150 MW concentrated solar power (CSP) tower facility).

Arcus Consultancy Services South Africa (Pty) Ltd (Arcus) was appointed to provide avifaunal specialist input in the form of a specialist Impact Assessment Report for the original Environmental Authorisations, which included pre-construction avifaunal monitoring, the results of which advised the initial impact assessment. ACWA Power is in the process of amending the project description applying for authorisation of 7 x 200 MW PV components and associated infrastructure on the same site as the authorised CSP development. Arcus was appointed to update the specialist Impact Assessment Report to reflect changes associated with the proposed amendment.

Further to the above amendment, the application will include the addition of 2 x 9.9 MW Internal Combustion Engines (ICEs) (three of the five ICE have already been authorised). Arcus has been appointed to provide an avifaunal specialist letter for inclusion in the amendment application regarding the potential avifaunal impacts associated with the proposed ICE additions. The aim of the avifaunal specialist letter is to determine if the addition of the proposed ICEs would significantly alter any avifaunal impacts as identified in the Avifaunal Specialist Amendment Report (Arcus, 2020) and to identify any additional mitigation measures that may be required.

As the development footprint of the proposed ICEs (Figure 1) falls within the footprint assessed for the original Environmental Authorisations and the Avifaunal Specialist Amendment Report, the data collected for those impact assessments remain valid and sufficient to inform the assessment of the currently proposed ICE additions (2 x 9.9 MW ICEs).

The specifications relating to each ICE are as follows:

Generation Capacity	9.9nMW
Fuel Type	LPG/LNG
Number of Engines	1 for each plot
Fuel Storage Tanks	5 for each plot
Fuel Volume	500 m^3 for each plot
Water Requirements	Limited water for cooling
Area Size	0.5 ha

The impacts of the proposed addition of ICEs related to avifauna are largely associated with the operation phase. A potential increase in disturbance and displacement of birds resulting from the noise generated during the operational cycles of the ICEs was considered. However this is unlikely to increase the impact significance rating above that as assessed in the Avifaunal Specialist Amendment Report (Arcus, 2020) based on the location of the ICE footprints. Avian species particularly sensitive to disturbance would unlikely be in the vicinity of the ICEs due to the routine operational activities already present on the site. Therefore, the mitigation measures recommended in Arcus (2020) remain applicable and are sufficient to reduce this impact without the need for additional mitigation measures to reduce the impacts of disturbance and displacement on birds.

An increase in nesting opportunities on the ICE infrastructure would not likely attract target or priority species to the facility as these species generally avoid areas of human traffic. Therefore, the presence of ICEs will not increase the likelihood or significance rating of impacts associated with electrocutions or collisions beyond those already assessed. The mitigation measures recommended in the Avifaunal Specialist Amendment Report remain applicable (such as exclusion covers or spikes to prevent nesting of smaller bird species) and are sufficient without the need for additional mitigation measures to reduce these impacts.

An increase in traffic in and around the proposed facility may result from refuelling requirements of the ICEs. This has the potential to increase disturbance and displacement and the risk of collisions with motor vehicles along the main access routes to the facility. The significance of this impact to birds would likely be low and within acceptable limits; **however, the following additional mitigation measures are to be added to the existing EMPr to reduce these impacts further**:

- **Driving at night should be avoided where possible, and speed limits of 40 km/h for refuelling tankers should be strictly enforced along all gravel roads to the facility to reduce collisions as well as unnecessary dust and noise; and**
- **Further speed limit restrictions of 20 km/h for refuelling tankers should be strictly enforced within all nest buffer areas.**

From an avifaunal perspective, the proposed addition of two x 9.9MW ICEs to **the amendment will result in no (zero) changes to the significance ratings assessed in the Avifaunal Specialist Amendment Report (Arcus, 2020)**. The proposed additions are therefore supported provided that the mitigation measures originally specified in the Avifaunal Specialist Amendment Report (Arcus, 2020) and those detailed above are implemented accordingly and where applicable.

We trust this letter will provide the competent authority with sufficient information required to make an informed decision on the amendment application.

Yours Sincerely,

Dr Owen Rhys Davies *Pr. Sci. Nat.*
Avifaunal Specialist

[redacted]

AVIFAUNAL SPECIALIST AMENDMENT REPORT FOR THE PROPOSED BOKPOORT II SOLAR FACILITY (NOVEMBER 2020)

AVIFAUNAL SPECIALIST AMENDMENT REPORT FOR THE PROPOSED BOKPOORT II SOLAR FACILITY

On behalf of

Royal HaskoningDHV (Pty) Ltd

November 2020

Prepared By:

Arcus Consultancy Services South Africa (Pty) Limited

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Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	**Section of Report**
(a) details of the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a *curriculum vitae*;	*Attached*
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	*Attached*
(c) an indication of the scope of, and the purpose for which, the report was prepared;	*1*
(cA) an indication of the quality and age of base data used for the specialist report;	*2.2.1*
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	*2.3, 6*
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	*2.2*
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	*2*
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	*6*
(g) an identification of any areas to be avoided, including buffers;	*5, 6, Figure 3*
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	*Figure 3*
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	*1.2*
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment, or activities;	*4, 5, 6, 7*
(k) any mitigation measures for inclusion in the EMPr;	*6*
(l) any conditions for inclusion in the environmental authorisation;	*6*
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	*6*
(n) a reasoned opinion— i. as to whether the proposed activity, activities or portions thereof should be authorised; iA. Regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr or Environmental Authorization, and where applicable, the closure plan;	*7*
(o) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	*N/A*
(p) any other information requested by the competent authority	*N/A*
Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	

1 INTRODUCTION

ACWA Power Energy Africa (Pty) Ltd (ACWA) obtained three Environmental Authorisations in 2016 for 2 x 75MW photovoltaic (PV) facilities (PV 1 and PV 2) as well as a 150MW concentrated solar power (CSP) tower facility near Groblershoop, Northern Cape Province. However, ACWA Power now propose to amend the project description and apply for authorisation of 8 x 200MW PV components and associated infrastructure, including access routes, substation, water pipeline connection, 132kV overhead powerline and shared infrastructure consisting of buildings, including a workshop area for maintenance, storage (i.e. fuel tanks, etc.), laydown area, parking, warehouse, and offices (previously approved) on the same site as the CSP development (Figures 1, 2 and 3). Previously, approval for 2 of the 10 PV facilities was obtained, PV 1 (Ndebele) and PV 2 (Xhosa), however the proposal for these two sites did not include the capacity increase from 75 to 200MW and will therefore undergo a separate basic assessment study.

The site is within one of South Africa's eight renewable energy development zones, and has therefore been identified as one of the most suitable areas in the country for renewable energy development, in terms of a number of environmental impact, economic and infrastructural factors.

Arcus Consultancy Services South Africa (Pty) Ltd (Arcus) were appointed to provide avifaunal specialist input in the form of a specialist Impact Assessment Report for the initial development as well as 12 months of pre-construction avifaunal monitoring, the results of which advised the initial impact assessment. Royal HaskoningDHV (Pty) Ltd (RHDHV) appointed Arcus to provide an update to the specialist Impact Assessment Report to reflect changes associated with the proposed amendment.

1.1 Terms of Reference

The report has been carried out under the following terms of references and provides:

- An assessment of all impacts related to the proposed amendment;
- Advantages and disadvantages associated with the amendment;
- An updated description of the avifaunal baseline, including a description of avifaunal microhabitats available on the project site;
- Identification of information gaps and limitations; and
- A comparative assessment of the potential predicted impacts to avifauna as well as a significance rating before and after the amendment, and associated mitigation measures.

1.2 Assumptions and Limitations

The SABAP1 data covers the period 1986-1997. Bird distribution patterns can change regularly according to availability of food and nesting substrate. (For a full discussion of potential limitations in the SABAP1 data, see Harrison et al. 1997[1]).

The two post-construction studies on impacts of solar energy facilities in the Northern Cape, South Africa have increased the confidence of impact assessments for birds in the area, but these studies were limited in that they only covered a period of three-months each.

The overall environmental impacts of solar energy facilities remain relatively poorly understood as do the specific impacts of these facilities on habitat destruction and fragmentation particularly with reference to birds.

[1]Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V & Brown, C.J. (eds). 1997. The atlas of southern African birds. Vol. 1&2. BirdLife South Africa: Johannesburg.

While sampling effort was as recommended in the solar guidelines, to achieve statistically powerful results it would need to be increased beyond practical possibilities. The data was therefore analysed at a relatively basic level and interpreted using a precautionary approach.

Relatively dry, drought conditions were experienced during the year of monitoring, and the study was therefore not able to consider the effects of inter-annual variation in avifauna, for example following a good rain season.

2 METHODOLOGY

2.1 Literature Review

The overall environmental impacts of solar energy developments globally remain poorly understood as do the specific impacts of these plants on birds[2]. This is particularly true in a southern African context, however some studies[3,4] have recently been conducted on the impact of solar energy developments on birds in the Northern Cape. These studies have assisted to improve the confidence in the avifaunal impact assessment.

2.2 Defining the Baseline

The baseline avifaunal environment for the broader project area was defined utilising a desk based study and informed by the results of the 12 month pre-construction monitoring programme, which included vantage point surveys, walked transects, drive transects and focal site records (Figure 2) over four seasonal site visits (winter, spring, summer and autumn) and was completed in April 2016. An additional two day site visit was conducted in early December 2019 to assess the environmental status quo as it pertains to avifauna. This information was examined to determine the potential location, abundance and behaviour of avifauna which may be sensitive to the proposed development, and to understand their conservation status and sensitivity.

2.2.1 Sources of information

- Bird distribution data of the Southern African Bird Atlas Project (SABAP1; Harrison *et al*. 1997) and Southern African Bird Atlas Project 2 (SABAP2) obtained from the Avian Demography Unit of the University of Cape Town;
- Co-ordinated Water-bird Count (CWAC) project (Taylor *et al*. 1999);
- The Important Bird Areas (IBA) of southern Africa project (Marnewick *et al*. 2015);
- Avifaunal Impact Assessment Report for the neighbouring Bokpoort I project (van Rooyen, UNDATED);
- The impact of a 'trough' Concentrated Solar Power facility on birds and other animals in the Northern Cape, South Africa (Jeal 2017, MSc thesis conducted on Bokpoort I);
- Publically available satellite imagery;
- Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al*. 2015); and
- Avifaunal Impact Assessment Report: Bokpoort II Solar Farm (Arcus 2016).

[2]Jenkins, A.R., Ralston-Paton, S., & Smit-Robinson, H.A. 2017. Birds and Solar Energy Best Practice Guidelines. BirdLife South Africa.

[3]Visser, I. 2016. The impact of South Africa's largest photovoltaic solar energy facility on birds in the Northern Cape, South Africa. Percy FitzPatrick Institute of African Ornithology, University of Cape Town. MSc. Thesis.

[4]Jeal, C. 2017. The impact of a 'trough' Concentrated Solar Power facility on birds and other animals in the Northern Cape, South Africa. Percy FitzPatrick Institute of African Ornithology, University of Cape Town. MSc. Thesis.

2.3 Identification and Rating of Potential Impacts

After collation of the baseline data from the sources of information listed above the potential impacts of the project were identified, for both the construction and operational phases. This was done by reviewing existing literature and data available (both locally and internationally) on the potential impacts of solar energy facilities on avifauna and considering the potential avifaunal community on the project site. The Birds and Solar Energy Best Practice Guidelines (2017) for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa were also considered in the compilation of this report. A significance rating and impact assessment has been done for each impact using set criteria (Appendix I) and impact tables in the following sections below. The impact tables include essential mitigation measures for each of the significance ('With Mitigation') is given for each impact, assuming correct implementation of the mitigations. Cumulative impacts for solar projects within a 50 km radius of the project site (Table 1) were assessed according to the same methodology.

Table 1. Solar Energy Projects within a 50 km radius of the project site[5].

No.	Approx. Distance from Bokpoort II (km)	DEA Reference Number	Applicant	Technology	Capacity (MW)	Status
1	Adjacent	Operational	Operational	Solar CSP	50	Operational
2	1	14/12/16/3/3/2/640	Scatec Solar (Pty) Ltd	Solar PV	86	In Process
3	10	14/12/16/3/3/2/738	Solafrica Photovoltaic Energy (Pty) Ltd	Solar PV	75	In Process
4	10	12/12/20/1920	Solafrica Thermal Energy Pty Ltd	Solar CSP	50	Approved
5	20	14/12/16/3/3/2/906	Marang Solar Farm (Pty) Ltd	Solar PV	unknown	In Process
6	20	14/12/16/3/3/2/907	Marang Solar Farm (Pty) Ltd	Solar PV	unknown	In Process
7	21	14/12/16/3/3/2/571/AM1	Gestamp Asetym Solar South Africa (Pty) Ltd	Solar PV	75	Approved
8	25	14/12/16/3/3/1/909	Siyathemba Solar One (Pty) Ltd	No Technology	unknown	Approved
9	27	12/12/20/2583	To Review	Solar PV	75	Approved
10	29	14/12/16/3/3/1/658	To Review	Solar PV	19	Approved
11	36	12/12/20/2647/48	To Review	Solar PV	225	Approved
12	39	12/12/20/2198	Vanguard Solar Pty Ltd	Solar PV	50	In Process
13	41	14/12/16/3/3/2/625	Ansolgenix (Pty) Ltd	No Technology	unknown	In Process
14	42	14/12/16/3/3/2/299	FG Emvelo Energy (Pty) Ltd	Solar CSP	100	Approved
15	42	14/12/16/3/3/2/639/1	Tewa Isitha Solar 2 (Pty) Ltd	Solar PV	75	Approved
16	47	14/12/16/3/3/2/905	FG Emvelo (Pty) Ltd	Solar CSP	150	Approved

3 LITERATURE REVIEW

The two broad types of utility scale solar energy facilities are PV and CSP, with each having different impacts on birds[2]. CSP facilities incorporating the use of large reflective surfaces such as heliostats or parabolic troughs introduce the risk of collision-related trauma and those technologies which focus solar energy onto a central tower expose passing birds to the risk of being singed or incinerated in the area of concentrated solar flux[1]. Water

[5]Renewable Energy EIA Application Database. Department of Environmental Affairs. 17 October 2019.

utilisation and wastewater management at CSP facilities are potential sources of impact by either draining local reserves or attracting species in naturally dry habitats[6].

The displacement or exclusion of species and changes to species composition through habitat removal, destruction or modification are potentially the most significant impacts of both types of utility scale solar energy facilities on birds[3]. CSP facilities typically have a higher level of habitat loss compared to PV facilities as vegetation is more intensively managed to reduce the fire risk from high temperatures associated with concentrated sunlight[4].

While there is presently no clear pattern in the types of birds negatively affected by solar energy facilities[1], a study on the impact of a photovoltaic solar energy facility on birds was however conducted on the nearby 96 MW Jasper PV solar facility in the Northern Cape Province[3]. The Jasper PV solar facility promoted the regrowth of natural vegetation such as grasses and forbs below the solar arrays to mitigate the total loss of natural habitat in the development area[4]. The removal of shrubland/woodland and the promotion of grasses and forbs below the panels resulted in an associated shift from an avifaunal community preferring shrubland/woodland to one dominated by open country and grassland species[3]. Shrubland/woodland species were therefore threatened by the land-use changes associated with the PV development, while open country and grassland and generalist species were favoured[3]. The study concluded that PV developments could potentially offset some of the widespread loss among open habitat species due to bush encroachment, which has led to increases in shrub-dependent species at the expense of open country and grassland birds[3].

Collision-related trauma and fatalities are associated with both broad types of solar energy facilities, however PV technology theoretically presents a lower risk of collisions to large bodied, high-flying or soaring species such as Verreaux's Eagle, Martial Eagle and Ludwig's Bustard compared to the initially proposed CSP development due to the absence of a central receiving tower. In terms of small birds, no bird collisions with mirror fields were recorded during a three-month fatality study in the neighbouring CSP (trough) facility (Bokpoort I) while seven fatalities associated with solar panels were recorded at the Jasper PV facility during a three-month fatality study[3]. The difference has been attributed to the lack of vegetation/habitat and the lower number of birds utilising the extensively cleared and managed area at the Bokpoort I CSP facility compared to the revegetated area within the Jasper PV facility[4].

The advantages of the proposed amendment to utilise PV technology on the project site instead of CSP tower technology include:

- The absence of concentrated solar flux, thereby avoiding fatalities associated with singing or incineration;
- Reduced collision risk for high-flying or soaring species due to the absence of a central receiving tower;
- Lower water requirements, thereby reducing the potential risk of depleting local reserves in an arid area;
- Lower wastewater production, thereby reducing the attractant effect of larger evaporation ponds; and
- A greater opportunity to promote the regrowth of natural vegetation below the panels to mitigate the total area of habitat loss and potentially offset the local effects of bush-encroachment.

[6]Hernandez, R.R., Easter, S.B., Murphy-Mariscal, M.L., Maestre, E.T., Tavassoli, M., Allen, E.B., Barrows, C.W., Belnap, J., Ochoa-Hueso, Ravi, S. & Allen, M.F. 2014. Environmental impacts of utility-scale solar energy. Renewable & Sustainable Energy Reviews 29: 766-779.

The disadvantages of the proposed amendment are less significant in terms of avifaunal impact. With reflective surfaces potentially covering a larger area with PV technology compared to the gaps that exist between heliostat arrays used with CSP tower technology the 'lake effect' may be greater with the proposed amendment. The 'lake effect' hypothesizes that man-made reflective surfaces such as PV panels reflect horizontally polarised light similar to water, which is the primary source of horizontally polarized light[4]. This effect is thought to act as an 'ecological trap' attracting insects and birds mistaking the PV panels for a lake but studies have been unable to substantiate or refute this potential impact[4]. The use of PV technology instead of CSP technology could increase the number of small bird mortalities occurring on the site, especially if the regrowth of natural vegetation is promoted between the solar panels. This would however be a function of improved habitat availability and utilisation by birds when compared to an extensively managed and cleared area associated with a CSP facility and should therefore not be considered a net-negative if mitigation is implemented with the proposed amendment.

4 BASELINE ENVIRONMENT

4.1 Vegetation, Land Use and Bird Micro-habitats

The project site is situated in the arid Northern Cape Province, within the Nama Karoo Biome. The most prominent vegetation type on the project site is Kalahari Karroid Shrubland, while elements of Gordonia Duneveld are present[7] (Figure 3). Other vegetation types present in the broader project area include Olifantshoek Plains Thornveld and Koranna-Langeberg Mountain Bushveld. Land use in the project site is predominantly stock farming. In the broader project area, there is also game farming/ranching, while agricultural activities (e.g. vineyards) are present in the Orange River Valley. The site visit in December 2019 confirmed that the main vegetation types and avifaunal micro-habitats that were originally identified in the initial avifaunal impact assessment report (Arcus 2016) remain largely unchanged. The micro-habitats include scattered kraals, reservoirs and associated water troughs for livestock farming, thornveld/scrubland, open grassy scrubland, gravel plains, and duneveld.

4.2 Avifaunal Community

The SABAP1 data was collected between 1986 and 1997 and, although somewhat outdated, is one of the best long term data sets on bird distribution and abundance available in South Africa at present. The project site is situated within the quarter degree squares 2821DB and 2822CA (Figures 1 and 2), each quarter degree square had eight and ten cards of reporting data respectively and these data remained unchanged since the initial impact assessment (Arcus 2016). A total of 117 species were recorded including six endemic or near-endemic species and five species with a regional Red Data Status (Appendix II). SABAP2 is part of an ongoing study by the Animal Demography Unit (ADU) based at the University of Cape Town. SABAP2 data was examined for the pentads (which are roughly 8 km x 8 km squares, and are smaller than the squares used in SABAP1). Several additional observation cards had been submitted from the area and surrounds since the initial bird impact assessment was conducted. The pentads examined for this report were 2845_2205, 2845_2200, 2845_2155, 2845_2150, 2840_2205, 2840_2200 2840_2155, 2840_2150, 2835_2205, 2835_2200 and 2835_2155 (Figures 1 and 2). These data combined with extensive walk transects conducted in the area by Jeal[4], and the initial 12 months of pre-construction monitoring conducted by Arcus result in a combined total of 190 bird species recorded from the area. This includes nine endemic or near-endemic species and 11 species with a regional Red Data Status (Appendix III).

[7]Mucina & Rutherford. 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

The initial Bird Impact Assessment Report (Arcus 2016) detailed the locations of three Verreaux's Eagle and one Martial Eagle nests (Figure 3). These sites were revisited by the avifaunal specialist in December 2019 to confirm their status. The three Verreaux's Eagle nests are close together and located approximately 4 km to the east of the project site and represent a primary nest and two alternative nests from a pair of Verreaux's Eagle. The pair of Verreaux's Eagle were observed perched next to the identified nesting site and these nests can be considered to still be active. The Martial Eagle nest, located approximately 1.55 km from the project site appeared to no longer be active during the December 2019 site visit. In 2015 the nest consisted of a stick structure placed on top of a sociable weaver nest in a transmission line tower with a lot of white-wash below. During the December 2019 site visit almost no stick structure remained, no new sticks had been added and significantly less white-wash was present below, therefore it appeared as if the nest had not been re-used for a few seasons. Martial Eagles exhibit strong fidelity to nesting sites[8] but a breeding pair may alternate breeding attempts between multiple nests in their breeding territory[9], which range in size from 100 – 800 km^2 in South Africa[10]. Martial Eagle was not recorded in the project area over three months of monitoring by Jeal (2017), nor has it been recorded in the project area or immediate surrounds by the SABAP2 project. The project area therefore many not constitute an important foraging area for these birds.

5 AVIFAUNAL SENSITIVITY ZONES

5.1 High Sensitivity Zones

High sensitivity zones were related to the identified eagle nest sites in the broader study area. These include a 3 km circular area around the Verreaux's Eagle primary and alternative nest sites and a 1.5 km circular area around the previously used, but currently inactive Martial Eagle nest site. As some areas within these buffers are already altered and disturbed (e.g. by existing transmission lines, roads and a major railway line), other project infrastructure (e.g. PV panels, pipelines and power lines) are allowed within the buffer areas if all the mitigations recommended are implemented.

5.2 Medium Sensitivity Zones

Medium Sensitivity Zones are areas identified on the project site that are currently important for avifauna, and/or support important species and/or support high abundances of birds at certain times. Two such types of zones were identified associated with gravel plains (which support important species such as coursers and bustards) and artificial water points. These areas are not sufficiently sensitive so as to preclude development and it is understood that should the project proceed these areas within the project site will be completely destroyed/removed. This has been taken into account when conducting the impact assessment for habitat destruction and disturbance.

5.3 Undetermined Sensitivity Zones

Undetermined Sensitivity Zones are all the remaining areas of the project site not buffered in Figure 3 or related to the features discussed above. These areas show no obvious avifaunal features, patterns or sensitivities and are preferred for infrastructure placement.

[8]Herholdt, J.J., Mendelsohn J.M. 1995. Survival and nest-site fidelity in the Martial Eagle in the Kalahari Gemsbok National Park, South Africa. J. Afr. Raptor Biol. 10:33-34.

[9]Machange, R.W., A.R. Jenkins, and Navarro, R.A. 2005. Eagles as indicators of ecosystem health: is the distribution of Martial Eagle nests in the Karoo, South Africa, influenced by variations in land-use and rangeland quality? Journal of Arid Environments 63(1): 223 – 243.

[10]Hockey, P.A.R., Dean, W.R.J. and Ryan, P.G. (eds). 2005. Roberts - Birds of southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

However, considering the general avifauna of the area and broader project area, it is likely that these zones are in fact of moderate sensitivity.

6 AVIFAUNAL IMPACT ASSESSMENT

Considering all the bird baseline data, resulted in the identification of a set of focal species. The focal species for the impact assessment were determined to be: Verreaux's Eagle, Lappet-faced Vulture, Cape Eagle-Owl, Lanner Falcon, Martial Eagle, Pygmy Falcon, Pale-chanting Goshawk, Greater Kestrel, Kori Bustard, Ludwig's Bustard, Northern Black Korhaan, Burchell's Courser, Eastern Clapper Lark, Fawn-coloured Lark, Black-eared Sparrow-Lark, Black-headed Canary, Sociable Weaver, Namaqua Sandgrouse, Rock Martin, Barn Swallow, and Namaqua Dove. By considering focal species we are not ignoring other birds, as in most cases these focal species serve as surrogates for other species, examples being Martial Eagle for Booted Eagle and Northern Black Korhaan for Karoo Korhaan.

6.1 Identification and rating of Potential Impacts

The following key potential impacts on avifauna, arising from the proposed project's construction and operational phases have been identified. The mitigations that were applicable to the original authorisation for CSP technology are no longer required, the following mitigations measures must be implemented for the proposed amendment.

6.1.1 Construction Phase

6.1.1.1 Habitat Destruction

As the original authorisation and the proposed amendment are located on the same footprint they both impose a risk to birds through habitat destruction as clearing activities during the construction phase will remove vegetation and therefore habitat that birds require for breeding, foraging and roosting. The proposed amendment may reduce the duration of total habitat loss compared to the original authorisation if rehabilitation of natural vegetation underneath the solar panels is implemented. This would provide habitat, albeit modified, for at least some important bird species such as coursers and francolins. The original authorisation obtained a significance score of 70 (Moderate) without mitigation and 65 (Moderate) with mitigation. The duration of the impact is reduced with the proposed amendment after mitigation is implemented, resulting in a significance score of 60 (Moderate).

Potential Impact: The removal and/or destruction and/or alteration of habitat used by birds, may impact on the foraging and/or breeding success of certain species, and will lead to numerous birds being displaced from the projects site, and needing to find suitable available habitat elsewhere. Habitat loss may effect, and be more significant for important terrestrial species such as coursers, korhaans and bustards. Raptors (e.g. Martial Eagle, Black-chested Snake-Eagle and Pale Chanting Goshawk) may also be effected to a lesser degree, through the loss of potential hunting habitat.							
Proposed Amendment							
	Magnitude	**Duration**	**Scale**	**Probability**	**Significance**	**Status**	**Confidence**
Without Mitigation	8	4	2	5	70 (Moderate)	Negative	Medium
With Mitigation	8	3	1	5	60 (Moderate)	Negative	Medium
Can the impact be reversed?			Partially (If suitably re-habilitated after construction).				
Will impact cause irreplaceable loss or resources?			Possibly.				
Can impact be avoided, managed or mitigated?			Unlikely. The entire project site is likely to be disturbed and cleared of vegetation. The mitigation measures below may help reduce the duration of total habitat loss.				

Required mitigation measures to reduce residual risk or enhance opportunities:

- A site specific environmental management programme (EMPr) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat;
- All contractors are to adhere to the EMPr and should apply good environmental practice during construction;
- High traffic areas and buildings such as offices, batching plants, storage areas etc. should, where possible be situated in areas that are already disturbed;
- Existing roads and farm tracks should be used where possible;
- The minimum footprint areas of infrastructure should be used wherever possible, including road widths and lengths;
- No off-road driving;
- Environmental Control Officer (ECO) to oversee activities and ensure that the EMPr is implemented and enforced; and
- Following construction, rehabilitation of areas underneath the solar panels and those disturbed by the temporary contractor's facility must be undertaken and to this end a habitat restoration plan is to be developed by a specialist and included within the EMPr.

6.1.1.2 Disturbance and Displacement

Both the original authorisation and the proposed amendment impose a risk of temporary or permanent disturbance and displacement of birds due to construction activities. The significance rating of this impact before mitigation was 48 (Moderate) and was reduced to 30 (Moderate) after mitigation in the original authorisation, these ratings remained unchanged with the proposed amendment.

Potential Impact: Birds are disturbed and displaced from the project site and surrounding areas due to construction activities and associated noise etc. Particularly at risk are sensitive species breeding on and around the site or regularly utilizing the project site for foraging/hunting e.g. eagles, korhaans, coursers and bustards.

Proposed Amendment							
	Magnitude	**Duration**	**Scale**	**Probability**	**Significance**	**Status**	**Confidence**
Without Mitigation	8	2	2	4	48 (Moderate)	Negative	Medium
With Mitigation	6	2	2	3	30 (Moderate)	Negative	Medium

Can the impact be reversed?	Yes.
Will impact cause irreplaceable loss or resources?	No.
Can impact be avoided, managed or mitigated?	Partially. The mitigation measures below may help to keep the impact to a practical minimum.

Required mitigation measures to reduce residual risk or enhance opportunities:

- A site specific EMPr must be implemented, which gives appropriate and detailed description of how construction activities must be conducted;
- All contractors are to adhere to the EMPr and should apply good environmental practice during construction;
- ECO to oversee activities and ensure that the site specific EMPr is implemented and enforced;
- The appointed ECO must be trained by an avifaunal specialist to identify the potential Red Data species as well as the signs that indicate possible breeding by these species;
- The ECO must then, during audits/site visits, make a concerted effort to look out for such breeding activities of Red Data species, and such efforts may include the training of construction staff (e.g. in Toolbox talks) to identify Red Data species, followed by regular questioning of staff as to the regular whereabouts on site of these species;
- If any of the Red Data species are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500 m of the breeding site must cease, and an avifaunal specialist is

to be contacted immediately for further assessment of the situation and instruction on how to proceed;
- Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road, pipeline and power line routes as well as the temporary contractors facility, to identify any nests/breeding/roosting activity of sensitive species, as well as any additional sensitive habitats;
- The results of which may inform the final construction schedule in close proximity to that specific area, including abbreviating construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise;
- No construction activities or staff are permitted within 1.5 km of the identified Martial Eagle nest buffer; and
- A construction phase bird monitoring programme must be implemented by a bird specialist, to document potential impacts on key species such as korhaans, bustards and eagles, and must include the ongoing monitoring of the active Verreaux's Eagle and Martial eagle nest sites.

6.1.2 Operational Phase

6.1.2.1 Disturbance and Displacement

Both the original authorisation and the proposed amendment impose a risk of disturbance and displacement of birds due to ongoing operational and maintenance activities. The significance rating of this impact before mitigation was 56 (Moderate) and was reduced to 24 (Low) after mitigation in the original authorisation, these ratings remained unchanged with the proposed amendment.

Potential Impact: Birds are disturbed and displaced from the project site and surrounding areas, or from the grid connection servitude and surrounding areas, due ongoing operational and maintenance activities. Particularly at risk are sensitive species breeding or foraging/hunting in close proximity to the activities, for example raptors that may nest on the new powerline tower being disturbed by power line and servitude maintenance.

Proposed Amendment							
	Magnitude	**Duration**	**Scale**	**Probability**	**Significance**	**Status**	**Confidence**
Without Mitigation	8	4	2	4	56 (Moderate)	Negative	Medium
With Mitigation	6	4	2	2	24 (Low)	Negative	Medium

Can the impact be reversed?	Yes.
Will impact cause irreplaceable loss or resources?	No.
Can impact be avoided, managed or mitigated?	Partially. The mitigation measures below may help to keep the impact to a practical minimum.

Required mitigation measures to reduce residual risk or enhance opportunities:

- A site specific operational EMPr must be implemented, which gives appropriate and detailed description of how operational and maintenance activities must be conducted to reduce unnecessary disturbance.
- All contractors are to adhere to the environmental management programme and should apply good environmental practice during all operations.
- The on-site operational facilities manager (or a suitably appointed Environmental Manager) must be trained by an avifaunal specialist to identify the potential Red Data species as well as the signs that indicate possibly breeding by these species.
- If a priority species or Red Data species is found to be breeding (e.g. a nest site is located) on or within 2 km of the operational facility (or the grid connection servitude), the nest/breeding site must not be disturbed and the avifaunal specialist must be contacted for further instruction.
- The on-site operational facilities manager (or a suitably appointed Environmental Manager) must conduct inspections every two months of the grid connection line, and all existing transmission line pylons within 2 km of the project site boundary to locate possible nesting raptors.
- Any such nests must not be disturbed and should be reported to the avifaunal specialist for further instruction.
- Operational phase bird monitoring, in line with the solar guidelines, must be implemented.
- No operational activities or staff are permitted within 1.5 km of the identified Martial Eagle nest.

6.1.2.2 Burning

This potential impact is restricted to CSP technologies and poses a significant risk to birds especially at CSP tower facilities as described for the original authorisation. Bird mortalities from burning were recorded in the USA at the Ivanpah CSP project where mortalities of falcons, hawks, warbles and sparrows (as well as other species) were found and a follow on detailed study at the same facility, estimated over 3500 birds to have died in a single year (many from being burnt or singed)[11]. This significant risk is completely avoided by the proposed amendment. The significance rating of this impact before mitigation was 85 (High) and was reduced to 70 (Moderate) after mitigation in the original authorisation, these ratings were zero (Low) with the proposed amendment.

Potential Impact: Large heliostat arrays focus solar flux on a central "power tower", exposing passing birds to the risk of being singed or burnt in the flux beams, particularly as they aggregate close to the receiver. Birds may be burnt in the stand-by focal points.							
Proposed Amendment							
	Magnitude	**Duration**	**Scale**	**Probability**	**Significance**	**Status**	**Confidence**
Without Mitigation	0	N/A	0	0	0 (Low)	Negative	High
With Mitigation	0	N/A	0	0	0 (Low)	Negative	High
Can the impact be reversed?			N/A				
Will impact cause irreplaceable loss or resources?			No.				
Can impact be avoided, managed or mitigated?			This impact is wholly avoided by the proposed amendment.				
Required additional mitigation measures specific to the amendment to reduce residual risk or enhance opportunities: None.							

6.1.2.3 Collision with Infrastructure (Excluding Power Lines)

Both the original authorisation and the proposed amendment impose a risk to birds from collision with reflective structures. The proposed amendment may impose an increased risk of collision for small birds due to an increased area of panels associated with PV technology compared to heliostat arrays of CSP technology and a potentially increased 'lake effect'. The risk of collision for small and medium sized birds may also increase from the proposed amendment if the recommended rehabilitation and regrowth of natural vegetation is implemented underneath the solar panels due to increased use of the area by birds when compared to more intensively managed vegetation generally associated with CSP technology. However, the lack of a central receiving tower in the proposed amendment would reduce the collision risk to high-flying or soaring species such as bustards, eagles and vultures compared to the original authorisation. The collision risk of the proposed amendment should therefore largely be confined to the site itself as the risk to birds commuting at higher altitude across the project site would be low. The significance rating of this impact before mitigation was 70 (Moderate) and was reduced to 52 (Moderate) after mitigation in the original authorisation, these ratings were 55 (Moderate) before mitigation and 27 (Low) after mitigation with the proposed amendment.

Potential Impact: Birds collide with heliostats and/or the PV panels and/or the central receiver tower. Birds may be attracted to the reflective surfaces which may be mistaken for large water bodies and can cause disorientation of flying birds, resulting in injury and/or death.
Proposed Amendment

[11]H.T. Harvey & Associates. 2014. California Valley Solar Ranch Project: Avian and Bat Protection Plan, Sixth Quarterly Postconstruction Fatality Report, 16 November 2013 - 15 February 2014. Unpublished report to HPR II, PLC, California Valley Solar Ranch.

	Magnitude	Duration	Scale	Probability	Significance	Status	Confidence
Without Mitigation	6	4	1	5	55 (Moderate)	Negative	Medium
With Mitigation	4	4	1	3	27 (Low)	Negative	Low
Can the impact be reversed?			No.				
Will impact cause irreplaceable loss or resources?			Yes.				
Can impact be avoided, managed or mitigated?			Partially. The mitigation measures below may help to keep the impact to a practical minimum.				

Required mitigation measures to reduce residual risk or enhance opportunities:

- All artificial water points (e.g. livestock water points and wind pumps) on the project site and within 500 m from the boundary of the project site, must be moved or shut down (if not already removed from the project site during construction) so that birds are not attracted to the project site and immediate surrounding areas.
- All water related infrastructure (e.g. pipes, pumps, reservoirs, toilets, taps etc.) must be regularly (twice weekly) checked for leaks, and repaired immediately.
- Lighting should be kept to a minimum to avoid attracting insects and birds and light sensors/switches should be utilised to keep lights off when not required.
- Lighting fixtures should be hooded and directed downward where possible, to minimize the skyward and horizontal illumination, lighting should be motion activated where possible.
- Careful selection of and modifications to solar facility equipment should be made where possible e.g. white borders could be applied to PV panels to reduce the resemblance of solar arrays to waterbodies.
- Develop and implement an operational monitoring programme for birds in line with applicable solar guidelines, which must include searching for mortalities.
- Frequent and regular review of operational phase monitoring data and results by an avifaunal specialist.
- If unacceptable impacts are observed (in the opinion of the bird specialist and independent review), the specialist should conduct a literature review specific to the impact and provide updated and relevant mitigation options to be implemented.
- As a starting point for the review of possible mitigations, the following may need to be considered: Assess the suitability of using deterrent devices to reduce collision risk, which may include the use of rotating/flashing mirrors, or sound deterrents.

6.1.2.4 Collision with Power Lines

Collisions with large (132 kV or above) power lines are a well-documented threat to birds in southern Africa[12,13] while smaller lines pose a higher threat of electrocution but can still be responsible for collision. Collisions with overhead power lines occur when a flying bird does not see the cables, or is unable to take effective evasive action, and is killed by the impact or impact with the ground. Especially heavy-bodies birds such as bustards, cranes and waterbirds, with limited manoeuvrability are susceptible to this impact[12]. Many of the collision sensitive species are also considered threatened in southern Africa. While many power lines associated with existing infrastructure and railway lines occur in the area, birds may collide with the new over-head power lines, particularly during times of low light or poor visibility. Species that are likely to be affected include Kori Bustard, Ludwig's Bustard, Northern Black Korhaan, Red-crested Korhaan, and Karoo Korhaan.

The proposed amendment potentially has a greater length of overhead power lines compared to the original authorisation and therefore imposes a greater risk of collision for birds. However, attracting insects and therefore insectivores to a PV facility may not pose

[12]van Rooyen, C.S. 2004. The Management of Wildlife Interactions with over-headlines. In The fundamentals and practice of Over-head Line Maintenance (132kV and above), pp217-245. Eskom Technology, Services International, Johannesburg.

[13]Shaw, J.M, Jenkins, A.R., Smallie, J.J & Ryan, P.G. 2010. Modelling power-line collision risk for the Blue Crane *Anthropoids paradiseus* in South Africa. Ibis 152: 590-599

as much of a risk to birds as to a CSP tower facility allowing for the use of ultraviolet lights to illuminate overhead power lines to be investigated. A recent study on the efficacy of pole-mounted near-ultraviolet light Avian Collision Avoidance System (ACAS) in the United States of America reported a 98% decrease in collisions of Sandhill Cranes with a stretch of overhead power line[14]. The significance rating of this impact before mitigation was 90 (High) and was reduced to 42 (Moderate) after mitigation in the original authorisation, these ratings were 90 (High) before mitigation, which was reduced to 24 (Low) after mitigation with the proposed amendment.

Potential Impact: Birds collide with the overhead power lines.							
Proposed Amendment							
	Magnitude	**Duration**	**Scale**	**Probability**	**Significance**	**Status**	**Confidence**
Without Mitigation	10	4	4	5	90 (High)	Negative	Medium
With Mitigation	6	4	2	2	24 (Low)	Negative	Medium
Can the impact be reversed?			No.				
Will impact cause irreplaceable loss or resources?			Yes.				
Can impact be avoided, managed or mitigated?			Yes. The mitigation measures below may help to keep the impact to a practical minimum.				

Required mitigation measures to reduce residual risk or enhance opportunities:

- Where possible, power lines/cables on the project site should be underground.
- Where possible, the routing of power line infrastructure should avoid Medium or High Sensitivity zones.
- Where possible, grid connection infrastructure should follow existing servitudes such as existing power lines, roads and fences.
- An avifaunal specialist must conduct a site walk through of the final Grid Connection route and pylon positions prior to construction to determine if, and where, bird flight diverters (BFDs) are required.
- Install bird flight diverters as per the instructions of the specialist following the site walkthrough, which may include the need for modified BFDs fitted with solar powered LED lights on certain spans.
- The operational monitoring programme for the associated CSP site must be in line with applicable monitoring guidelines and must include regular (at least monthly) monitoring of the grid connection power line for collision (and electrocution) mortalities.
- Any mortalities should be reported to the Endangered Wildlife Trust (EWT).
- Investigate the applicability of pole-mounted near-ultraviolet light (UV-A; 380–395 nm) Avian Collision Avoidance System (ACAS) on overhead power-lines in addition to bird flight diverters to increase visibility of power lines to birds in low light or poor visibility conditions.

6.1.2.5 Electrocution

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components[12]. With regard to the grid connection infrastructure, overhead power line infrastructure with a capacity of 132 kV or more do not generally pose a risk of electrocution due to the large size of the clearances between the electrical infrastructure components. Electrocutions are therefore more likely for larger species whose wingspan is able to bridge the gap such as eagles or vultures. Various large raptors (such as Martial Eagle, Verreaux's Eagle and Lappet-faced Vulture), susceptible to electrocution (particularly in the absence of safe and mitigated structures) may occur in the broader project area. Electrocution may also occur within newly

[14]Dwyer, J. F., Pandey, A. K., McHale, L. A., & Harness, R. E. (2019). Near-ultraviolet light reduced Sandhill Crane collisions with a power line by 98%. The Condor, 121(2). doi:10.1093/condor/duz008

constructed substations, the proposed amendment imposes a greater risk to birds as new substations and power lines are associated with each of the PV facilities. Mitigation measures nevertheless remain effective at reducing the potential risk of electrocution. The significance rating of this impact before mitigation was 72 (Moderate) and was reduced to 24 (Low) after mitigation in the original authorisation, these ratings remained unchanged with the proposed amendment.

Potential Impact: Electrocution of birds perching or attempting to perch on electrical structures.							
Proposed Amendment							
	Magnitude	**Duration**	**Scale**	**Probability**	**Significance**	**Status**	**Confidence**
Without Mitigation	10	4	4	4	72 (Moderate)	Negative	Medium
With Mitigation	6	4	2	2	24 (Low)	Negative	High
Can the impact be reversed?			No.				
Will impact cause irreplaceable loss or resources?			Yes.				
Can impact be avoided, managed or mitigated?			Yes. The mitigation measures below may help to keep the impact to a practical minimum.				
Required mitigation measures to reduce residual risk or enhance opportunities: • Any new power line/s must be of a design that minimizes electrocution risk by using adequately insulated 'bird friendly' monopole structures, with clearances between live components of 2 m or greater and which provide a safe bird perch. • The structures to be constructed must be approved by the Endangered Wildlife Trust's (EWT) Wildlife and Energy Programme or a suitably qualified bird specialist. • The operational monitoring programme for the associated WEF site must be in line with applicable guidelines and must include regular monitoring of the grid connection power line and all new associated substations for electrocution (and collision) mortalities. • Any mortalities should be reported to the EWT. • Prevent birds from nesting in and around substations through exclusion covers or spikes.							

6.1.2.6 Water Pollution and Wastewater

The utilisation of dust suppression or cleaning chemicals used on solar panels imposes a risk of contamination of pollution of water resources. The production of wastewater would be lower at the PV facilities proposed by the amendment than at the CSP facility assessed in the original authorisation. The need for artificial evaporation ponds is therefore reduced with the proposed amendment as are the significance scores of the associated risks, including the potential for evaporation ponds attracting birds in an arid environment that could be poisoned or drowned. The significance rating of this impact before mitigation was 39 (Moderate) and was reduced to 20 (Low) after mitigation in the original authorisation. The significance ratings of this impact were 30 (Moderate) before mitigation and 16 (Low) after mitigation for the proposed amendment.

Potential Impact: Pollution of water resources used by birds. Production of wastewater (brine), which can be difficult to manage and treat. Artificial evaporation ponds attract waterbirds, which could be poisoned and/or drown.							
Proposed Amendment							
	Magnitude	**Duration**	**Scale**	**Probability**	**Significance**	**Status**	**Confidence**
Without Mitigation	4	4	2	3	30 (Moderate)	Negative	Low
With Mitigation	2	4	2	2	16 (Low)	Negative	Low
Can the impact be reversed?			Possibly.				
Will impact cause irreplaceable loss or resources?			Unlikely.				

Can impact be avoided, managed or mitigated?	Partially. The mitigation measures below may help to keep the impact to a practical minimum.
Required mitigation measures to reduce residual risk or enhance opportunities: • Ensure that birds do not get in contact with any evaporation ponds that may be required i.e. ponds should be covered with wire mesh or netting to reduce the possibilities of, attracting, drowning, or poisoning birds. • All cleaning products used on the site should be environmentally friendly and bio-degradable. • The operational environmental management programme must include site specific measures for the effective management and treatment of any wastewater to be produced.	

6.1.2.7 Excessive use of Water

Using large amounts of water, may drain/deplete local reserves used by birds in naturally dry habitats. The proposed amendment will reduce the risk of depleting local water reserves as the water use requirements for PV facilities are lower than those of the CSP facility assessed in the original authorisation. The significance rating of this impact before mitigation was 39 (Moderate) and was reduced to 22 (Low) after mitigation in the original authorisation. The significance ratings of this impact were 33 (Moderate) before mitigation and 18 (Low) after mitigation for the proposed amendment.

Potential Impact: Excessive use of water, which may drain local reserves used by birds in naturally dry habitats.							
Proposed Amendment							
	Magnitude	**Duration**	**Scale**	**Probability**	**Significance**	**Status**	**Confidence**
Without Mitigation	4	4	3	3	33 (Moderate)	Negative	Low
With Mitigation	2	4	3	2	18 (Low)	Negative	Low
Can the impact be reversed?			No.				
Will impact cause irreplaceable loss or resources?			Possibly.				
Can impact be avoided, managed or mitigated?			Partially. The additional mitigation measures below may help reduce the effect of water-use on the water table.				
Required additional mitigation measures specific to the amendment to reduce residual risk or enhance opportunities: • Utilise water from sources other than ground-water to clean solar panels as to not deplete local groundwater levels.							

6.1.2.8 Disruption of Bird Movement Patterns

Utility scale solar energy facilities may form a physical barrier to movement of birds across the landscape, and this may alter migration routes and increase distances travelled and energy expenditure or block movement to important areas such as hunting and foraging areas. This potential impact is not yet well understood, is likely to be more significant as a cumulative impact with surrounding developments, is difficult to measure and assess, and therefore mitigation measures are difficult to identify. The 'lake effect' could potentially increase with the proposed amendment, evidence supporting this impact is not strong, however. The proposed amendment may reduce the risk of habitat fragmentation and permeability of the site to some species compared to the original authorisation if habitat rehabilitation and the regrowth of natural vegetation is promoted under the solar panels. This will reduce the open space and area of unsuitable habitat that would have been a barrier to movement across the site at a CSP facility with more intensive vegetation

management. Perimeter fencing must be adequately designed to prevent entrapment of large bodied species attempting to move across the site. The significance rating of this impact before mitigation was 39 (Moderate) and was reduced to 36 (Moderate) after mitigation in the original authorisation. The significance ratings of this impact were 39 (Moderate) before mitigation and 20 (Low) after mitigation for the proposed amendment.

Potential Impact: The development forms a physical barrier to movement of birds across the landscape, alters migration routes and increases distances travelled and energy expenditure for hunting or foraging.							
Proposed Amendment							
	Magnitude	**Duration**	**Scale**	**Probability**	**Significance**	**Status**	**Confidence**
Without Mitigation	6	4	3	3	39 (Moderate)	Negative	Low
With Mitigation	4	4	2	2	20 (Low)	Negative	Medium
Can the impact be reversed?			Unlikely.				
Will impact cause irreplaceable loss or resources?			No				
Can impact be avoided, managed or mitigated?			Partially. The mitigation measures below may help reduce the disruption of bird movement patterns.				

Required mitigation measures to reduce residual risk or enhance opportunities:

- Where not prescribed by technical or local and international requirements, external lighting to be of an intermittent and coloured nature rather than constant white light to reduce the potential impact on the movement patterns of nocturnal species. Habitat rehabilitation and promoting the regrowth of natural vegetation below the solar panels would reduce the barrier effect to some bird species reluctant to cross unsuitable habitat or cleared vegetation, such as francolins.
- Perimeter fencing must be designed to prevent entrapment of large bodied species such as korhaans between fence rows, giving them sufficient space for take-off, i.e. if a double-layer of parallel fencing is used, the gap between the fences should be large enough to allow for large birds to take-off and leave the area. Where this would result in unacceptable compromises to the security of the site, large-bodied birds should be prevented from entering the gaps between parallel fence rows. Perimeter fence design to be done in consultation with an avifaunal specialist.
- Markers or panel gaps on solar panels to break-up reflections and reduce the 'lake effect'.

6.2 Cumulative Impacts

Approximately 16 solar energy projects in various stages of the EIA application process fall within this 50 km radius of the project site (Table 1). Should 50% or more of these projects be constructed the cumulative impact of the residual impacts may have a significance rating of 85 (High). Depending on the type of solar technology employed and the level of mitigation implemented at each of the developments the cumulative impacts may have had a significance rating of 65 (Moderate) after mitigation.

It is difficult to say with high confidence at this stage what the cumulative impact of all the proposed developments will be on birds as the specifics of the final technologies to be utilised at each site, and levels of habitat rehabilitation within the project sites, is unknown.

Nevertheless the proposed amendment would impose a reduced cumulative impact compared to the original authorisation due to the move away from utilising CSP tower technology and the risks associated with it. The cumulative impact of the proposed amendment and the adjacent operational Bokpoort I project would similarly be reduced compared to the original authorisation. The cumulative impact if all the mitigation measures associated with the proposed amendment are followed would have a significance rating of 33 (Moderate).

Potential Impact: The impact of multiple utility scale solar developments in the area has the potential to significantly reduce available habitat for avifauna.							
Proposed Amendment							
	Magnitude	**Duration**	**Scale**	**Probability**	**Significance**	**Status**	**Confidence**
Without Mitigation	10	4	3	5	85 (High)	Negative	Low
With Mitigation	4	4	3	3	33 (Moderate)	Negative	Medium
Can the impact be reversed?			Unlikely.				
Will impact cause irreplaceable loss or resources?			No				
Can impact be avoided, managed or mitigated?			Partially. The cumulative impact can be significantly reduced if the mitigation measures are implemented at all surrounding developments.				
Required mitigation measures to reduce residual risk or enhance opportunities: • Implement the mitigation measures listed above.							

7 CONCLUSION

Based on a the above, the proposed amendment is preferred compared to the original authorisation due to the significantly reduced risk of collision for important high-flying and soaring species such as eagles, bustards and vultures commuting over the site as well as the removal of burning risks associated with CSP tower facilities. The reduced water use and wastewater production and management requirements in the proposed amendment are also preferred in such an arid landscape. The proposed amendment would also allow for additional bird flight deterrent devices to be investigated to reduce the potential impact of collisions with overhead power lines as well as reduced habitat fragmentation and disruption of bird movements across the project site for a number of ground dwelling species.

If temperatures rise in the medium to long term, some species will be living closer to the limits of their thermal tolerances, with species in arid environments expected to be among the first to reach the limits of their thermoregulatory capacities[15]. It is anticipated that much of the Kalahari's avian biodiversity will be lost by the end of the century due to loss of body condition, delayed fledging, reduced fledging size, and outright breeding failure as a result of increased exposure to higher temperatures[16]. PV panels may provide more shaded environments (thermal refugia) for ground dwelling and ground nesting birds near their thermal limits and also offer a certain amount of protection to more open habitat species against bush encroachment[17].

The proposed amendment, if mitigation such as the rehabilitation of natural vegetation under solar panels is implemented, could potentially therefore even provide an improvement of the habitat for certain important bird species such as coursers, francolins

[15]van de Ven, T.M.F.N. 2017. Implications of climate change on the reproductive success of the Southern Yellow-billed Hornbill, *Tockus leucomelas*. PhD Thesis. Percy FitzPatrick Institute of African Ornithology, DST-NRF Centre of Excellence, Department of Biological Sciences, Faculty of Science, University of Cape Town.

[16]Conradie, S.R., Woodborne, S.M., Cunningham, S.J. and McKechnie, A.E. 2019. Chronic, sublethal effects of high temperatures will cause severe declines in southern African arid-zone birds during the 21st century.

[17]Towards a policy on indigenous bush encroachment in South Africa (2019), Department of Environmental Affairs, Pretoria, South Africa.

and other open-country birds by offering shade and grassland in the face of potentially rising temperatures and bush encroachment.

The proposed amendment is therefore recommended over the original authorisation in terms of avian impact and the project may proceed subject to all recommendations (including construction and operational phase monitoring) and proposed mitigations in this report, as well as those applicable in the original authorisation being implemented.

APPENDIX I: IMPACT ASSESMENT METHODOLOGY

The significance of the identified impacts will be determined using the approach outlined below (terminology from the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998). This approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as follows:

Occurrence		**Severity**	
Probability of occurrence	Duration of occurrence	Scale / extent of impact	Magnitude (severity) of impact

To assess each of these factors for each impact, the following four ranking scales are used:

Probability	**Duration**
5 - Definite/don't know	5 - Permanent
4 - Highly probable	4 - Long-term
3 - Medium probability	3 - Medium-term (8-15 years)
2 - Low probability	2 - Short-term (0-7 years) (impact ceases after the operational life of the activity)
1 - Improbable	1 – Immediate
0 - None	
Scale	**Magnitude**
5 - International	10 - Very high/don't know
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 - None	

Once these factors are ranked for each impact, the significance of the two aspects, occurrence and severity, is assessed using the following formula:
SP (significance points) = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). The impact significance will then be rated as follows:

SP >75	**Indicates high environmental significance**	**An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.**
SP 30 – 75	Indicates moderate environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP <30	Indicates low environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.
+	Positive impact	An impact that constitutes an improvement over pre-project conditions

APPENDIX II: RAPTORS, ENDEMIC OR NEAR-ENDEMIC SPECIES RECORDED BY SABAP1 IN THE QUARTER DEGREE SQUARES

Quarter Degree Square			**2821DB**	**2822CA**
Number of cards			*8*	*10*
Number of species			*101*	*61*
Species	**Regional red data status (Taylor *et al.* 2015)**	**Endemic or near-endemic***	**Reporting rate (%) ** **	
Eagle, Verreaux's	VU			20
Eagle, Martial	EN		13	
Vulture, Lappet-faced	EN			10
Vulture, White-backed	EN			10
Falcon, Lanner	VU			30
Eagle, African Fish			13	
Eagle, Booted			13	
Goshawk, Pale Chanting			25	10
Kestrel, Greater				20
Kite, Black-shouldered			25	40
Owl, Spotted Eagle-				10
White-eye, Cape (Pre-split)		x	25	10
Flycatcher, Fairy		x	25	
Flycatcher, Fiscal		x	13	
Warbler, Namaqua		x	25	
Starling, Pied		x		60
Kestrel, Rock				30
Owl, Western Barn			13	
Owlet, Pearl-spotted			25	

*EN = Endangered; VU = Vulnerable. * Endemic or near endemic (i.e. ~70% or more of population in RSA) to South Africa (not southern Africa as in field guides) or endemic to South Africa, Lesotho and Swaziland. Taken from BirdLife South Africa Checklist of Birds in South Africa, 2014.**Reporting rates are percentages of the number of times a species was recorded in the square, divided by the number of times that square was counted. It is important to note that these species were recorded in the entire quarter degree square in each case and may not actually have been recorded on the proposed project area.*

APPENDIX III: BIRDS RECORDED IN THE PROJECT SITE AND IMMEDIATE SURROUNDING AREAS

Alphabetical Name	Red Data	Ende-mism*	Arcus 2016	Jeal 2017	SABAP2 Reporting Rate %**										
					2845_ 2205	2845_ 2200	2845_ 2155	2845_ 2150	2840_ 2205	2840_ 2200	2840_ 2155	2840_ 2150	2835_ 2205	2835_ 2200	2835_ 2155
No. of cards					*10*	*4*	*4*	*13*	*10*	*2*	*1*	*7*	*1*	*3*	*1*
No. of species					*92*	*66*	*74*	*122*	*91*	*57*	*45*	*101*	*30*	*65*	*29*
Barbet, Acacia Pied			X	X	42.9	75	100	100	83.3	50	100	60	100	100	100
Barbet, Crested			X				33.3	57.1				40			
Batis, Pririt			X	X	71.4	100	66.7	85.7	100	50	100	40	100	66.7	
Bee-eater, European			X		28.6			57.1	16.7						
Bee-eater, Swallow-tailed			X		28.6	25	33.3	71.4	16.7			20		33.3	
Bee-eater, White-fronted			X				33.3	14.3							
Bishop, Southern Red			X		28.6		66.7	85.7			100	80			100
Bokmakierie			X	X	100	75	100	85.7	100	100	100	40	100	100	100
Brubru					28.6			42.9	33.3	50			100	66.7	
Bulbul, African Red-eyed			X	X	42.9	25	100	100	83.3	100	100	100	100	66.7	
Bunting, Cape			X		28.6	25			100	50				66.7	
Bunting, Cinnamon-breasted			X		14.3				16.7						
Bunting, Golden-breasted			X												
Bunting, Lark-like			X	X	14.3	50		42.9	66.7	100		20	100	100	
Bustard, Kori	NT		X	X	14.3				33.3		100			66.7	100
Bustard, Ludwig's	EN		X												
Buttonquail, Common (Kurrichane)				X	14.3				16.7	50				33.3	
Canary, Black-headed		x	X												

Alphabetical Name	Red Data	Ende-mism*	Arcus 2016	Jeal 2017	SABAP2 Reporting Rate %**										
					2845_2205	2845_2200	2845_2155	2845_2150	2840_2205	2840_2200	2840_2155	2840_2150	2835_2205	2835_2200	2835_2155
Canary, Black-throated			X	X				42.9	16.7			20		33.3	
Canary, White-throated			X		28.6			42.9	33.3	50				33.3	
Canary, Yellow			X	X	42.9	75		100	50	50	100	100	100	66.7	100
Chat, Ant-eating			X	X	57.1	25		42.9	50	50	100	20	100	100	100
Chat, Familiar			X	X			66.7	57.1	50			40			
Chat, Sickle-winged		x	X												
Cisticola, Desert				X			33.3			50				66.7	
Cisticola, Grey-backed			X		57.1	50		14.3	100	50		20		100	
Cisticola, Levaillant's			X					71.4				60			
Cisticola, Zitting								42.9				40			
Coot, Red-knobbed				X											
Cormorant, Reed			X				33.3	42.9				60			
Cormorant, White-breasted			X	X				28.6				40			
Coucal, Burchell's			X					14.3				40			
Courser, Burchell's	VU		X												
Courser, Double-banded	NT		X								100				100
Crombec, Long-billed			X	X	71.4	75	33.3	85.7	100	100	100	20	100	66.7	
Crow, Pied			X	X	71.4	50	33.3	57.1	50		100		100	66.7	100
Cuckoo, Diederik					14.3	25	33.3	42.9	33.3			20			
Cuckoo, Jacobin			X		14.3	25		42.9	33.3						
Darter, African			X				0.0000	57.1				40			
Dove, Cape Turtle			X	X	100	75	100	100	66.7	100	100	40	100	100	100
Dove, Laughing			X	X	42.9	50	100	100	83.3	100	100	100	100	66.7	100
Dove, Namaqua			X	X	71.4	50	33.3	100	83.3	100	100	60		100	

Alphabetical Name	Red Data	Ende-mism*	Arcus 2016	Jeal 2017	SABAP2 Reporting Rate %**										
					2845_2205	2845_2200	2845_2155	2845_2150	2840_2205	2840_2200	2840_2155	2840_2150	2835_2205	2835_2200	2835_2155
Dove, Red-eyed							33.3	71.4				80			
Dove, Rock			X												
Drongo, Fork-tailed					14.3										
Duck, African Black			X									20			
Duck, Yellow-billed								14.3				20			
Eagle, African Fish			X	X			66.7	57.1				40			
Eagle, Black-chested Snake			X												
Eagle, Booted			X												
Eagle, Martial	EN		X												
Eagle, Verreauxs'	VU		X		42.9	25		14.3	16.7	50	100				
Egret, Little			X					28.6							
Egret, Western Cattle			X			25	66.7	57.1	16.7			80			
Eremomela, Yellow-bellied			X	X	28.6	75	66.7	71.4	50	100	100	40		100	100
Falcon, Lanner	VU		X						33.3						
Falcon, Pygmy			X	X	71.4	50		28.6	66.7	50		20		33.3	
Finch, Red-headed			X	X	28.6				83.3	50				66.7	
Finch, Scaly-feathered			X	X	71.4	25			66.7	100	100	20	100	66.7	100
Fiscal, Common			X	X	71.4	50	100	71.4	83.3	100	100	100	100	100	
Flycatcher, Chat				X	57.1	25	66.7	57.1	33.3		100	20		66.7	100
Flycatcher, Fiscal		x	X		14.3		100	100				20			
Goose, Egyptian			X	X	42.9		33.3	57.1	16.7			60			
Goose, Spur-winged			X		14.3			28.6				40			
Goshawk, Pale Chanting			X	X	85.7	25	66.7	28.6	66.7			20		66.7	
Grebe, Little			X	X											

Alphabetical Name	Red Data	Ende-mism*	Arcus 2016	Jeal 2017	SABAP2 Reporting Rate %**										
					2845_2205	2845_2200	2845_2155	2845_2150	2840_2205	2840_2200	2840_2155	2840_2150	2835_2205	2835_2200	2835_2155
Greenshank, Common				X											
Guineafowl, Helmeted			X		14.3		33.3	57.1	16.7			80			
Hamerkop								28.6				20			
Heron, Black-headed			X	X			33.3	28.6				40			
Heron, Goliath			X				33.3	42.9				20			
Heron, Grey			X					42.9				20			
Honeyguide, Lesser					14.3			57.1				20			
Hoopoe, African			X				33.3	42.9	16.7	50		60			
Hornbill, African Grey			X												
Hornbill, Southern Yellow-billed			X												
Ibis, African Sacred			X					28.6				60			
Ibis, Glossy								14.3							
Ibis, Hadeda			X	X	28.6	50	100	71.4				100			
Kestrel, Greater				X	14.3										
Kestrel, Rock			X		14.3	25	33.3		66.7	50				33.3	
Kingfisher, Brown-hooded								42.9							
Kingfisher, Giant			X					42.9							
Kingfisher, Malachite			X	X											
Kingfisher, Pied								42.9							
Kite, Black-shouldered			X									20			
Kite, Yellow-billed			X												
Korhaan, Karoo	NT		X				33.3	85.7				60			
Korhaan, Northern Black			X	X	28.6	25	33.3	85.7	16.7	50	100	20	100	66.7	100

Alphabetical Name	Red Data	Ende-mism*	Arcus 2016	Jeal 2017	SABAP2 Reporting Rate %**										
					2845_2205	2845_2200	2845_2155	2845_2150	2840_2205	2840_2200	2840_2155	2840_2150	2835_2205	2835_2200	2835_2155
Korhaan, Red-crested			X	X	57.1	50			50	50	100			100	100
Lapwing, Blacksmith			X	X				71.4	16.7			40			
Lapwing, Crowned			X				33.3	14.3	66.7		100	40		33.3	100
Lark, Black-eared Sparrow-		x	X												
Lark, Eastern Clapper			X	X	28.6	50		14.3	50	50	100	20		100	100
Lark, Fawn-coloured			X	X	100	100	66.7	57.1	100	100	100	40	100	100	100
Lark, Grey-backed Sparrow			X		14.3			57.1		50		20		33.3	
Lark, Karoo Long-billed							66.7	85.7	16.7	50	100	40			
Lark, Red-capped								14.3							
Lark, Sabota			X	X	28.6		100	85.7		100	100	60		33.3	
Lark, Spike-heeled			X	X	14.3	50	100	42.9	66.7	100	100	60		100	100
Lark, Stark's			X												
Martin, Brown-throated				X		25	66.7	57.1				40			
Martin, Common House								14.3							
Martin, Rock			X	X	71.4	75	66.7	28.6	100	50	100			100	
Mousebird, Red-faced			X		14.3	50	33.3	57.1	33.3	100	100	40	100	33.3	100
Mousebird, White-backed			X	X	42.9	50	66.7	57.1	33.3	100	100	60	100	33.3	100
Myna, Common						25									
Neddicky					14.3	25									
Nightjar, Fiery-necked					14.3				16.7						
Nightjar, Rufous-cheeked					42.9			14.3	16.7			20			

Alphabetical Name	Red Data	Ende-mism*	Arcus 2016	Jeal 2017	SABAP2 Reporting Rate %**										
					2845_2205	2845_2200	2845_2155	2845_2150	2840_2205	2840_2200	2840_2155	2840_2150	2835_2205	2835_2200	2835_2155
Ostrich, Common								42.9						100	
Owl, Cape Eagle-			X												
Owl, Spotted Eagle-					28.6	25			16.7						
Owl, Western Barn				X						50		20			
Owlet, Pearl-spotted			X					14.3							
Penduline-tit, Cape			X		57.1	25			16.7						
Pigeon, Speckled			X	X			33.3	28.6	66.7	50	100	40			
Pipit, African			X				33.3	71.4	16.7			80		33.3	
Pipit, African Rock	NT	x			57.1	25			100	50				66.7	
Pipit, Long-billed					14.3				16.7						
Plover, Grey				X											
Plover, Kittlitz's				X											
Plover, Three-banded			X	X				42.9							
Prinia, Black-chested			X	X	100	75	66.7	100	83.3	100	100	80	100	100	100
Quail, Common					14.3					50		20		33.3	
Quelea, Red-billed			X	X	14.3		33.3	57.1	16.7		100	80		66.7	
Robin, Kalahari Scrub			X	X	100	75		42.9	100	100	100	40	100	100	100
Robin, Karoo Scrub			X	X	28.6	25	33.3	85.7	16.7			80		66.7	
Robin-chat, Cape			X				66.7	57.1				80			
Ruff				X											
Sanderling				X											
Sandgrouse, Burchell's														33.3	
Sandgrouse, Namaqua			X	X	85.7	50	66.7	100	50	100	100	60	100	66.7	100
Sandpiper, Curlew				X											

Alphabetical Name	Red Data	Ende-mism*	Arcus 2016	Jeal 2017	SABAP2 Reporting Rate %**										
					2845_2205	2845_2200	2845_2155	2845_2150	2840_2205	2840_2200	2840_2155	2840_2150	2835_2205	2835_2200	2835_2155
Scimitarbill, Common			X	X	57.1	25			66.7	50	100	40	100	33.3	
Shelduck, South African			X	X				14.3							
Shoveler, Cape				X											
Shrike, Crimson-breasted			X		28.6	25			16.7				100	33.3	
Shrike, Lesser Grey					28.6	25									
Shrike, Red-backed					14.3	25		14.3	33.3						
Sparrow, Cape			X	X	28.6	25	66.7	71.4	66.7	50	100	80		66.7	100
Sparrow, Great			X												
Sparrow, House			X	X	14.3		33.3	57.1	50		100	20			
Sparrow, Southern Grey-headed								57.1	16.7			40			
Sparrow-weaver, White-browed			X	X	57.1	25	100	71.4	100	100	100	80		100	
Starling, Cape Glossy			X		14.3		100	85.7	16.7			40			
Starling, Pale-winged			X		57.1	50			83.3	100				33.3	
Starling, Wattled					14.3		33.3	28.6				20			
Stilt, Black-winged				X				14.3							
Stint, Little				X											
Sunbird, Dusky			X	X	85.7	100	66.7	100	83.3	100	100	40	100	100	100
Swallow, Barn			X		71.4	50	33.3	57.1	83.3			40			
Swallow, Greater Striped							33.3	71.4	66.7			40			
Swallow, South African Cliff		x										20			
Swallow, White-throated			X	X				57.1				80			
Swift, African Palm								14.3				20			

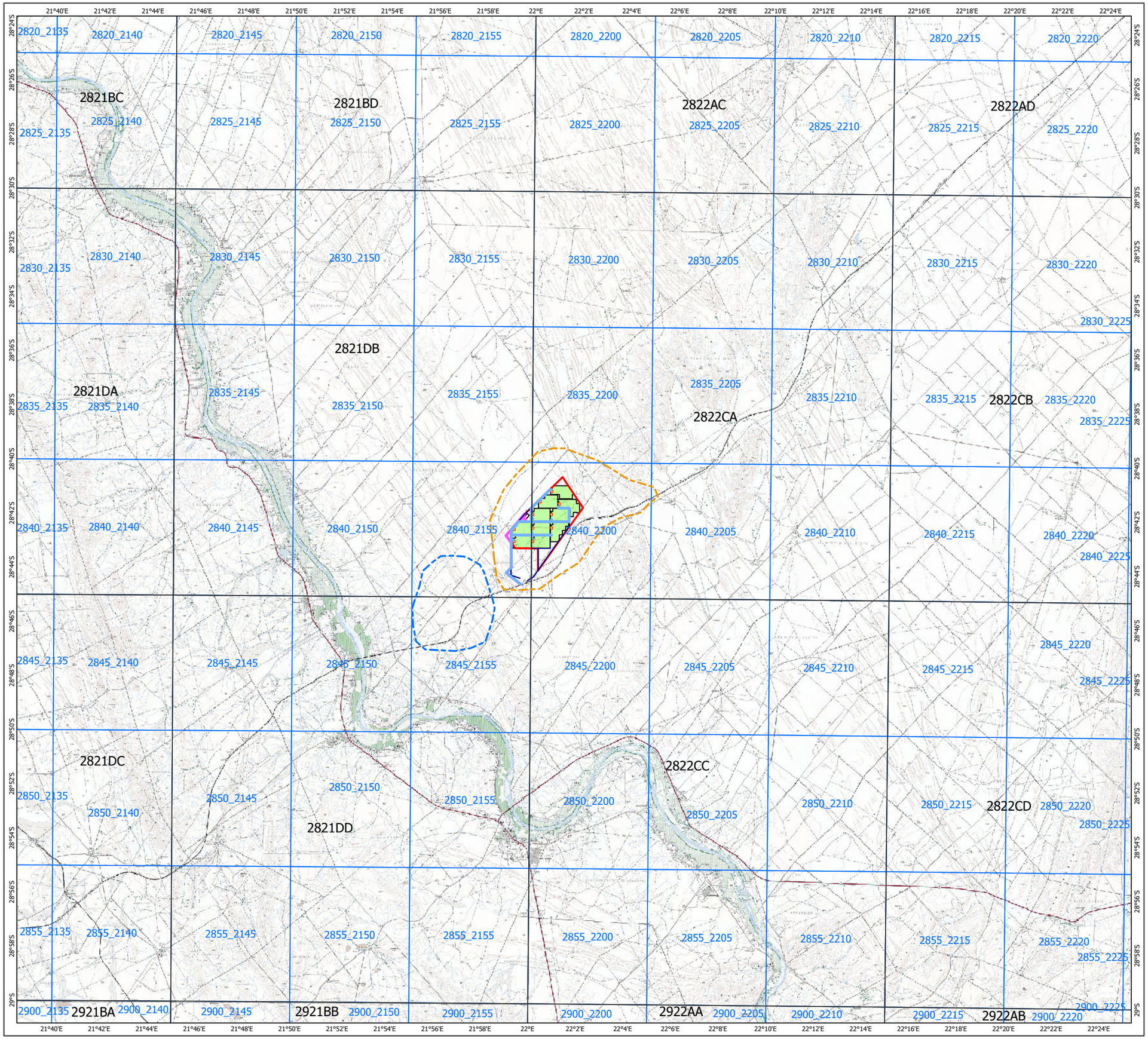
Alphabetical Name	Red Data	Ende-mism*	Arcus 2016	Jeal 2017	SABAP2 Reporting Rate %**										
					2845_2205	2845_2200	2845_2155	2845_2150	2840_2205	2840_2200	2840_2155	2840_2150	2835_2205	2835_2200	2835_2155
Swift, Bradfield's			X					14.3	33.3						
Swift, Common					28.6	25			33.3			20			
Swift, Little			X	X	14.3		66.7	100	33.3	50		40	100		
Swift, White-rumped					57.1	25		42.9	50			20			
Tchagra, Brown-crowned			X	X	57.1	75	33.3	42.9	66.7			20		66.7	
Teal, Cape				X											
Teal, Red-billed				X				28.6							
Tern, Whiskered				X											
Thick-knee, Spotted					28.6				16.7			20			
Thrush, Karoo		x	X				33.3	57.1				60			
Thrush, Short-toed Rock			X	X	14.3				33.3	50					
Tit, Ashy			X		42.9	25	33.3	57.1	100	100	100		100	66.7	
Tit-Babbler, Chestnut-vented			X	X	85.7	75	66.7	85.7	83.3	100	100	20	100	100	100
Tit-Babbler, Layard's		x			28.6	50			100	50					
Turnstone, Ruddy				X											
Vulture, Lappet-faced	EN		X												
Vulture, White-backed	EN												100		
Wagtail, African Pied			X				33.3	42.9							
Wagtail, Cape			X	X			33.3	71.4				80			
Warbler, African Reed								57.1				40			
Warbler, Lesser Swamp								42.9				40			
Warbler, Namaqua		x	X					57.1				60			

Alphabetical Name	Red Data	Ende-mism*	Arcus 2016	Jeal 2017	SABAP2 Reporting Rate %**										
					2845_2205	2845_2200	2845_2155	2845_2150	2840_2205	2840_2200	2840_2155	2840_2150	2835_2205	2835_2200	2835_2155
Warbler, Rufous-eared			X	X	71.4	25	66.7	85.7	33.3	50	100	60		66.7	100
Warbler, Willow								14.3							
Waxbill, Black-faced					28.6		33.3		X					33.3	
Waxbill, Common			X			25	33.3	42.9							
Waxbill, Violet-eared			X	X	14.3									33.3	
Weaver, Sociable			X	X	100	50	100	85.7	100	50	100	60	100	100	100
Weaver, Southern Masked			X	X	14.3	50	100	100	33.3	50	100	80	100	100	
Wheatear, Capped			X		57.1		33.3	14.3	33.3			40			
Wheatear, Mountain			X	X	57.1	50		14.3	100	50				100	
White-eye, Orange River			X			25	100	71.4				80			
Whydah, Pin-tailed							33.3	14.3							
Woodpecker, Cardinal			X					28.6							

SABAP2 data as accessed on 28 November 2019. VU = Vulnerable; NT = Near-threatened. Endemic or near endemic (i.e. ~70% or more of population in RSA) to South Africa (not southern Africa as in field guides) or endemic to South Africa, Lesotho and Swaziland. Taken from BirdLife South Africa Checklist of Birds in South Africa, 2014 **Reporting rates are essentially percentages of the number of times a species was recorded in the pentad, divided by the number of times that pentad was counted. It is important to note that these species were recorded in the entire pentad in each case and may not actually have been recorded on the proposed project area.*

APPENDIX IV: SPECIALIST DESCRIPTION AND CURRICULUM VITAE

Dr Owen Rhys Davies – Owen is a South African Avifauna Specialist and Ecologist who has been involved in avifaunal monitoring activities for renewable energy projects since 2013. He obtained his PhD Zoology (Ornithology) from the Percy FitzPatrick Institute of African Ornithology, a DST-NRF Centre of Excellence at the University of Cape Town. His responsibilities for avifaunal and ecological studies include project management, field surveys and ecological data collection, identification and assessment of environmental impacts, identification of mitigation measures and compilation of specialist reports in accordance with applicable environmental legislation. Owen was involved in the avifaunal pre-construction monitoring for the approved environmental authorisations at the Bokpoort II site and this experience was applied to the assessment of the proposed amendment. Owen is registered as a Professional Natural Scientist ([redacted]with the South African Council for Natural Scientific Professions (SACNASP).



ARCUS

- Control Site
- Broader Project Area
- Quarter Degree Squares
- Pentads

1:250 000 Scale @ A3

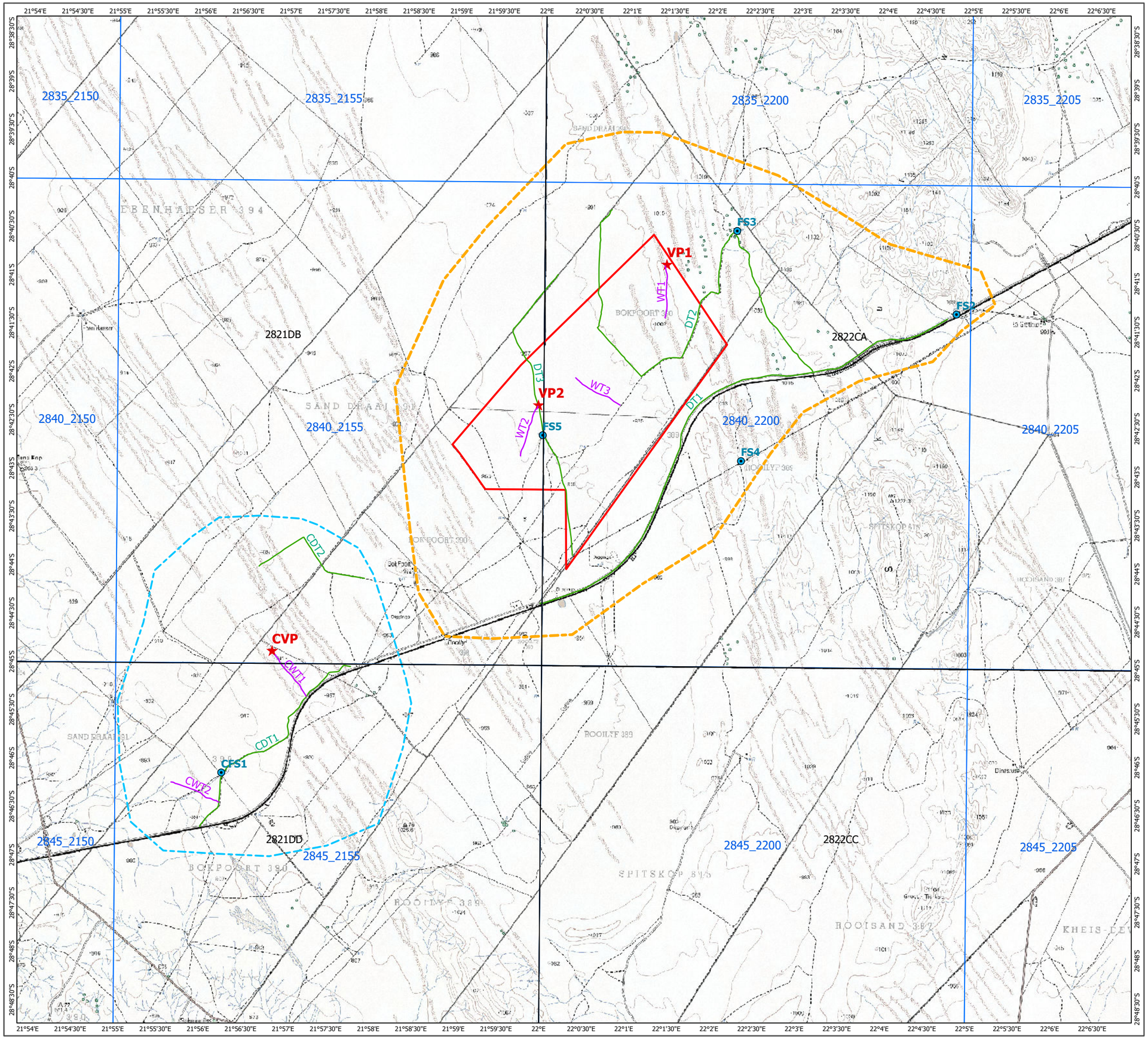
0 5 10 km NORTH

Produced By: OD	Ref: 3570-REP-0001
Checked By: AB	Date: 2019/12/11

Project Site and Control Site Locations
Figure 1

BOKPOORT II SOLAR FARM AVIFAUNAL SPECIALIST AMENDMENT REPORT

C:\Users\Andrew\Documents\Owen Davies\3570 Bokpoort\3570-Bokpoort-Solar-Amendment\3570-Bokpoort-Solar-Amendment.aprx\3570_Bokpoort_Fig_1_Pentads



ARCUS

- Project Site
- Drive Transects
- Focal Sites
- Vantage Points
- Walk Transects
- Broader Project Area
- Control Site
- Pentads
- Quarter Degree Squares

1:70 000 Scale @ A3

0 1 2 km

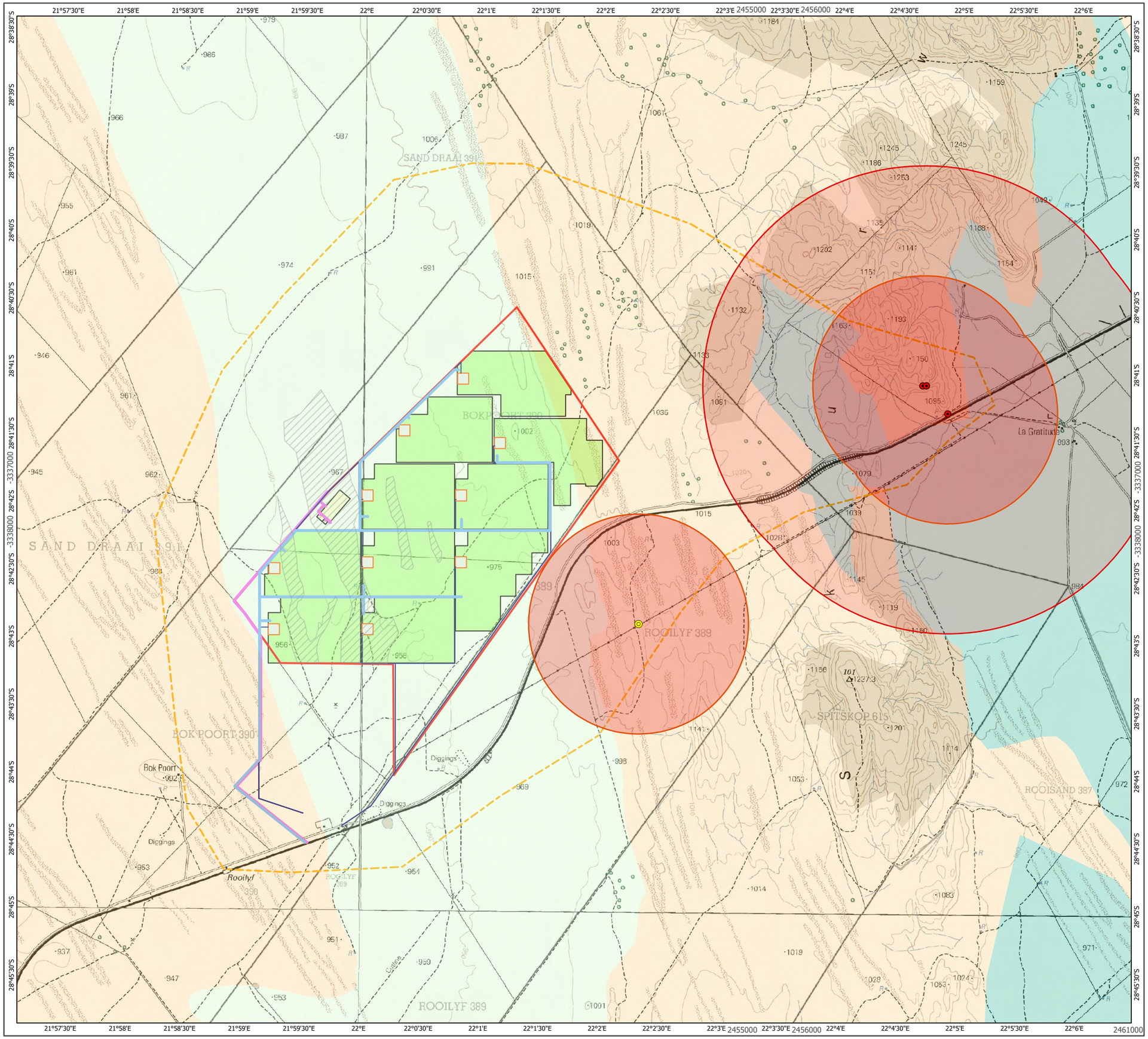
NORTH

Produced By: OD	Ref: 3570.-REP-0002
Checked By: AB	Date: 2019/12/17

Pentads, QDS, and Monitoring Locations
Figure 2

BOKPOORT II SOLAR FARM AVIFAUNAL SPECIALIST AMENDMENT REPORT

C:\Users\Andrew\Documents\Owen Davies\3570 Bokpoort\3570-Bokpoort-Solar-Amendment\3570-Bokpoort-Solar-Amendment.aprx\3570_Bokpoort_Fig_2_Locations



ARCUS

- Verreaux's Eagle Nests
- Martial Eagle Nest (Old)
- 1.5 km Nest Buffer (Very High Sensitivity)
- 3 km Nest Buffer (High Sensitivity)
- Gravel Patches
- Gordonia Duneveld
- Kalahari Karroid Shrubland
- Koranna-Langeberg Mountain Bushveld
- Olifantshoek Plains Thornveld
- Broader Project Area
- Roads
- Overhead Powerlines
- Water Pipeline
- PV Plants
- Project Boundary
- Proposed Substations
- Temporary Contractors Facility

1:50 000 Scale @ A3

0 1 2 km

NORTH

Produced By: OD	Ref: 3570-REP-0005
Checked By: AB	Date: 2020/11/23

Proposed Layout, Vegetation Types and Avifaunal Sensitivity Map
Figure 3

BOKPOORT II SOLAR FARM AVIFAUNAL SPECIALIST AMENDMENT REPORT

S:\GIS\Projects\Older Projects\3570 Bokpoort Solar Amendment\3570-Bokpoort-Solar-Amendment.aprx\3570_Bokpoort_Fig_3_Sensitivity

CURRICULUM VITAE

Dr Owen Davies Pr. Sci. Nat. (Ecology)

Ecologist

[redacted]

Specialisms

- Avifaunal surveys
- Ecological surveys
- Field research
- Data analysis and assessment of ecological data

Summary of Experience

Owen is a Professional Natural Scientist registered with the South African Council for Natural Scientific Professions (SACNASP) and obtained his doctoral degree from the Percy FitzPatrick Institute of African Ornithology, a DST-NRF Centre of Excellence at the University of Cape Town. Owen has been involved in avifaunal monitoring activities for renewable energy projects since 2013. Extensive field research has given Owen experience in the techniques required for conducting biological surveys on a variety of taxa including observations, physical trapping and identification of small terrestrial birds, raptors, bats, small mammals, rodents, snakes, reptiles, scorpions and fish. He is also qualified to conduct observations and acoustic monitoring of marine mammals in the offshore environment. Data collection in a diversity of habitats and ecosystems, combined with formal training in field skills such as off-road driving, enables Owen to conduct ecological surveys across southern Africa. In addition, his skills in data analysis and scientific writing at the PhD level enable him to produce high quality assessments and reports.

Qualifications and Professional Interests

- **University of Cape Town, Percy FitzPatrick Institute of African Ornithology, 2010 to 2015**
  PhD Zoology
- **University of Cape Town, Percy FitzPatrick Institute of African Ornithology, 2008 to 2010**
  MSc Zoology (upgraded to PhD)
- **University of Cape Town, 2007**
  BSc Zoology (Hons)
- **University of Cape Town, 2003 to 2006**
  BSc Zoology
  BSc Botany

Professional History

2015 (July) to present - Avifaunal Specialist, Ecologist, field team leader, Arcus Consultancy Services, Cape Town
2014 to 2015 - Bat monitoring field assistant, Arcus Consultancy Services, Cape Town
2013 to 2015 - Avifaunal observer, Arcus Consultancy Services, Cape Town
2009 to 2013 - Research Assistant (birds) to Dr J. Fuchs (Curator of Birds at the Muséum national d'Histoire naturelle, Paris), throughout South Africa
2007 to 2013 - Research Assistant (birds) to Prof T. M. Crowe (Percy FitzPatrick Institute of African Ornithology, Department of Zoology, University of Cape Town), throughout South Africa
2011 - Research Assistant (birds) to Dr I. Little, Endangered Wildlife Trust, Uganda
2010 - Research Assistant (bats) to Asst. Prof Hassan Salata, Department of Wildlife (South Sudan), Northern Cape
2010 to 2011 - Research Assistant (small mammals) to Dr B. Smit, University of Pretoria, Northern Cape
2010 - Research Assistant to Dr H. Smit-Robinson, Birdlife SA, Western and Northern Cape

CURRICULUM VITAE

Project Experience

- Umsinde Emoyeni WEF (Avifaunal assessment, data analysis and reporting)
- Confidential WEF near Molteno, Northern Cape Province (bird monitoring data analysis and reporting)
- Confidential Grid Connection near De Aar, Northern Cape Province (Avifaunal assessment, Ecological assessment, site-walkthrough, data analysis and reporting)
- Confidential WEF near Yzerfontein, Western Cape Province (Avifaunal assessment, Ecological assessment, site-walkthrough, data analysis and reporting)
- Metsimatala Solar (Field team leader, bird observations, data analysis and reporting in collaboration with specialists)
- Kolkies WEF (Field team leader, bird observations, bat mast commission, data analysis and reporting in collaboration with specialists)
- Karee WEF (Field team leader, bird observations, bat mast commission, data analysis and reporting in collaboration with specialists)
- Gouda WEF (Field team leader, bird observations – post construction)
- Hopefield WEF (Field team leader, bird observations, data analysis and reporting in collaboration with specialists – post construction)
- Spitzkop West WEF (Bird observations, bat mast commission)
- Pofadder WEF (Bat mast commission)
- Cookhouse WEF (Bat mast commission and decommission)
- Komsberg WEF (Field team leader, bird observations, bat mast commission, data analysis and reporting in collaboration with specialists)
- Bokpoort Solar (Avifaunal assessment, bird observations, data analysis and reporting)

Conferences and Seminars

- Biodiversity Southern Africa Conference, Biological Sciences Department, University of Cape Town, 2 to 6 December 2013
- Southern African Society for Systematic Biology (SASSB) Conference 2012: Systematics in the Era of Integrative Biology, Arniston, Western Cape, 16 to 20 July 2012
- The Willi Hennig Society Annual Meeting XXX Conference for Cladistic Research 2011, Sao Jose do Rio Preto, State of Sao Paulo, Brazil, 29 July to 2 August 2011
- Southern African Society for Systematic Biology (SASSB) Conference 2011: Biodiversity Matters!, Rhodes University, Grahamstown, Eastern Cape, 19 to 21 January 2011
- Zoological Society of Southern Africa (ZSSA) 50th Anniversary conference 2009, Natalia Resort, Illovo Beach, Kwa-Zulu Natal South Coast, 21 to 25 July 2009
- Southern African Society for Systematic Biology (SASSB) 10th Anniversary Conference 2009, Natalia Resort, Illovo Beach, Kwa-Zulu Natal South Coast, 25 to 27 July 2009
- Pan-African Ornithological Congress (PAOC 12) South African Conference 2008: Birds and People – Interaction, Utilisation and Conservation, Goudini Spa, Western Cape, 7 to 12 September 2008

Publications

DAVIES, O.R, JUNKER, K, JANSEN, R, CROWE, T.M. & BOOMKER, J. 2008. Age- and sex-based variation in helminth infection of Helmeted Guineafowl (*Numida meleagris*) with comments on Swainson's Spurfowl (*Pternistis swainsonii*) and Orange River Francolin (*Scleroptila levaillantoides*). South African Journal of Wildlife Research 38 (2): 163-170.

JUNKER, K., DAVIES, O.R., JANSEN, R., CROWE, T.M. & BOOMKER, J. 2008. Nematodes of Swainson's Spurfowl *Pternistis swainsonii* and Orange River Francolin *Scleroptila levaillantoides* from the Free State province, South Africa, with a description of *Tetrameres swainsonii*, sp. nov. (Nematoda: Tetrameridae). Journal of Helminthology 82: 365-371.

Appendix C4:
Air Quality and Climate Change

SPECIALIST DECLARATION

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Basic Assessment for the Proposed Development of Internal Combustion Engines (ICE) on the Remaining Extent of Farm Bokpoort 390, Groblershoop, Northern Cape

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	[redacted]
B-BBEE	
Specialist name:	
Specialist Qualifications:	
Professional affiliation/registration:	
Physical address:	
Postal address:	
Postal code:	
Telephone:	
E-mail:	

2. DECLARATION BY THE SPECIALIST

I, **Dr Theresa Leigh Bird**, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

[redacted]

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, **Dr Theresa Leigh Bird**, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

ATMOSPHERIC IMPACT REPORT
(APRIL 2022)

AIRSHED
PLANNING PROFESSIONALS

ATMOSPHERIC IMPACT REPORT:
ACWA Power Project DAO Thermal Power Generation Facility, near Groblershoop, Northern Cape Province

Project done on behalf of **ACWA Power Project DAO (RF) (Pty) Ltd**

Project Compiled by:
T Bird
T Mukota

Reviewed by:
L Burger

Report No: 20ACW02A Revision 3 | **Date:** April 2022

[redacted]

Report Details

Project Name	Atmospheric Impact Report: ACWA Power Project DAO Thermal Power Generation Facility, near Groblershoop, Northern Cape Province
Client	ACWA Power Project DAO (RF) (Pty) Ltd
Report Number	20ACW02A
Report Version	Revision 3
Date	April 2022
Prepared by	**Terri Bird**, (Pr.Sci.Nat), PhD (Wits) Dr (Theresa) Terri Bird holds a PhD from the School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg. The focus of her doctoral research was on the impact of sulfur and nitrogen deposition on the soil and waters of the Mpumalanga Highveld. Since March 2012 she has been employed at Airshed Planning Professionals (Pty) Ltd. In this time, she has been involved in air quality impact assessments for various mining operations (including coal, mineral sand, diamond and platinum mines) as well as coal-fired power station ash disposal facilities. She has been a team member on the development of Air Quality Management Plans, both provincial and for specific industries. Recent projects include assessing the impact of Postponement and/or Exemption of Emission Standards for various Listed Activities.
Assisted by	**Tinashe Mukota**, MEng Env Eng (UP)
Reviewed by	**Lucian Burger**, (Pr.Eng., FSAChE, FIChemE), PhD (Natal), MScEng (Chem) BScEng (Chem)
Notice	Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in all aspects of air quality, ranging from nearby neighbourhood concerns to regional air pollution impacts as well as noise impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003.
Declaration	I, Theresa (Terri) Bird, as authorised representative of Airshed Planning Professionals (Pty) Ltd hereby confirm my independence as a specialist and declare that neither I nor Airshed Planning Professionals (Pty) Ltd have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Airshed Planning Professionals (Pty) Ltd was appointed as air quality specialists in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998); other than fair remuneration for worked performed, specifically in connection with the assessment summarised in this report. I also declare that I have expertise in undertaking the specialist work as required, possessing working knowledge of the acts, regulations and guidelines relating to the application. I further declare that I am able to perform the work relating to the application in an objective manner, even if this result in views and findings that is not favourable to the application; and that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in this report.
Copyright Warning	

Revision Record

Revision Number	Date	Reason for Revision
Draft	16 March 2022	First draft for client review
Revision 1	22 March 2022	Minor text updates
Revision 2	11 April 2022	Map updates (project name); NO_2 simulation updates; VOC simulation updates; text updates
Revision 3	21 April 2022	Text updates; addition of site layouts

Abbreviations

AEL	Atmospheric Emissions Licence
AIR	Atmospheric Impact Report
Airshed	Airshed Planning Professionals (Pty) Ltd
AMS	American Meteorological Society
AQMS	Air Quality Monitoring Stations
AQO	Air Quality Officer
AQSRs	Air Quality Sensitive Receptors
ASTM	American Society of the International Association for Testing and Materials
BESS	Battery energy storage system
CPV	Cancer Potency Values
CALEPA	California Environmental Protection Agency
CLRTAP	Convention on Long Range Trans-boundary Air Pollution
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and Environment
EMP	Environmental Management Programme
GHG	Greenhouse gases
ICE	Internal combustion engine
IPCC	Intergovernmental Panel on Climate Change
IPP Office	Independent Power Producer Office
IRIS	Integrated Risk Information System
MES	(National) Minimum Emission Standard(s) (as defined in Section 21 of the National Environmental Management: Air Quality Act)
NAAQ limit value	National Ambient Air Quality limit value
NAAQS	National Ambient Air Quality Standards (as a combination of the NAAQ Limit and the allowable frequency of exceedance)
NEM:AQA	National Environmental Management: Air Quality Act 2004
NDCR	National Dust Control Regulations
PPA	Power purchase agreement
PV	Photovoltaic
RMIPPPP	Risk Mitigation Independent Power Producer Procurement Programme
UNECE	United Nations Economic Commission for Europe
US EPA	United States (of America) Environmental Protection Agency
UTM	Universal Transverse Mercator
WRF	Weather Research and Forecasting model

Glossary

Air pollution[(a)]	The presence of substances in the atmosphere, particularly those that do not occur naturally
Dispersion[(a)]	The spreading of atmospheric constituents, such as air pollutants
Dust[(a)]	Solid materials suspended in the atmosphere in the form of small irregular particles, many of which are microscopic in size
Frequency of exceedance	Permissible margin of tolerance of the Limit Concentration
Instability[(a)]	A property of the steady state of a system such that certain disturbances or perturbations introduced into the steady state will increase in magnitude, the maximum perturbation amplitude always remaining larger than the initial amplitude
Limit value	Maximum allowable concentration of a pollutant applicable for an applicable averaging period
Mechanical mixing[(a)]	Any mixing process that utilizes the kinetic energy of relative fluid motion
Oxides of nitrogen (NO_x)	The sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide (NO_2)
Particulate matter (PM)	Total particulate matter, that is solid matter contained in the gas stream in the solid state as well as insoluble and soluble solid matter contained in entrained droplets in the gas stream
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5 µm
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10 µm
Stability[(a)]	The characteristic of a system if sufficiently small disturbances have only small effects, either decreasing in amplitude or oscillating periodically; it is asymptotically stable if the effect of small disturbances vanishes for long time periods
Standard	A combination of the Limit Concentration and the allowable frequency of exceedance

Notes:

(a) Definition from American Meteorological Society's glossary of meteorology (AMS, 2014)

Symbols and Units

°C	Degree Celsius
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
g	Gram(s)
g/m²	Grams per square metre
g/s	Grams per second
g/s.m²	Grams per second per square metre
HAP	Hazardous air pollutants
HC	Hydrocarbons
kg	Kilograms
kg/day	Kilograms per day
km	Kilometre
kPa	Kilopascal
kV	Kilo Volt
kW	Kilo Watt
K	Temperature in Kelvin
1 kilogram	1 000 grams
m	Metre
m/s	Metres per second
mamsl	Metres above mean sea level
µg	Microgram(s)
µg/m³	Micrograms per cubic metre
m²	Square metre
m³	Cubic metre
m³/hr	Cubic metre per hour
mg/m².day	Milligram per square metre per day
mg/m³	Milligram per (actual) cubic metre
mg/Nm³	Milligram per normal cubic metre (normalised at 273 K; 101.3 kpa)
MW	Mega Watt
MWh	Mega Watt hour
NO	Nitric oxide
N_2O	Nitrous oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
O_2	Oxygen
O_3	Ozone
ppm	Parts per million
PM	Particulate matter
$PM_{2.5}$	Inhalable particulate matter (aerodynamic diameter less than 2.5 µm)
PM_{10}	Thoracic particulate matter (aerodynamic diameter less than 10 µm)
SO_2	Sulfur dioxide
t/a	Tonnes per annum
TSP	Total suspended particulates
(T)VOCs	(Total) volatile organic compounds

Note:
The spelling of “sulfur” has been standardised to the American spelling throughout the report. "The International Union of Pure and Applied Chemistry, the international professional organisation of chemists that operates under the umbrella of UNESCO, published, in 1990, a list of standard names for all chemical elements. It was decided that element 16 should be spelled “sulfur”. This compromise was to ensure that in future searchable data bases would not be complicated by spelling variants. (IUPAC. Compendium of Chemical Terminology, 2nd ed. (the "Gold Book"). Compiled by A. D. McNaught and A. Wilkinson. Blackwell Scientific Publications, Oxford (1997). XML on-line corrected version: http://goldbook.iupac.org (2006) created by M. Nic, J. Jirat, B. Kosata; updates compiled by A. Jenkins. ISBN 0-9678550-9-8.doi: 10.1351/goldbook)"

EXECUTIVE SUMMARY

ACWA Power Project DAO (RF) (Pty) Ltd. proposes the development a multi-technology hybrid power plant that has a contracted capacity on the output side onto the transmission system of 150 MW, to be located near Groblershoop in the Northern Cape Province**.** The hybrid power plant consists of 326 MW of photovoltaic (PV), battery energy storage system (BESS) of 540-560 MWh and internal combustion engines (ICE) of 49.5 MW. During the operational phase of the project, it is envisaged that the ICE plant will not be required to provide any energy output to the grid. However, from a prudent operating perspective and to ensure that the ICE plant is appropriately maintained, a start-and-stop regime is envisaged to sustain plant integrity. To meet these requirements, the ICE plant will be operated for 2 hours per week during the operational phase of the plant for 20 years. The plant will use diesel delivered to site by tanker truck for thermal generation of electricity in reciprocating engines. The diesel will be stored in containerised storage tanks on-site. The 49.5 MW generating capacity will be divided into five 9.9 MW plants will include reciprocating engines, diesel storage, and ancillary infrastructure.

Criteria atmospheric pollutants emitted during operation of the plant will include sulfur dioxide (SO_2), oxides of nitrogen (NO_X), carbon monoxide (CO), particulate matter, and carbon dioxide (CO_2).

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by ACWA Power Project DAO (RF) (Pty) Ltd to prepare an atmospheric impact report (AIR) for the project, including a greenhouse gas (GHG) assessment. The main objective of the air quality study is to determine air quality related impacts as a result of the proposed generators and fuel storage tanks at the proposed location.

The study area is characterised by terrain elevations in the range 800 and 1 650 metres above mean sea level (mamsl). Simulated Weather Research and Forecasting (WRF) data for the period 2017 to 2019 for the site was used for the assessment and showed the predominance of the north-north-easterly winds with wind speeds greater than 5 m/s, especially during the day. Calm conditions, where the wind speed is less than 1 m/s, occurred approximately 2% of the time.

The main background sources include: open cast mining; construction of solar power; and, various miscellaneous fugitive dust sources. In the absence of any ambient air quality monitoring nearby, the Department of Forestry, Fisheries and Environment (DFFE) Karoo Air Quality Monitoring Station was deemed representative of the site in terms of background ambient air quality. Short-term (hourly and daily) and annual average concentrations of criteria pollutants measured at the monitoring station between April 2018 and October 2020 comply with National Ambient Air Quality Standards (NAAQS). The exception is ozone (O_3) where short term averages exceeded the NAAQS during 2018. Due to the low population density and absence of large industry in the area, the ambient air quality at the site is regarded as good.

Two residences were identified approximately 2.1 km to the southwest and 6 km east of the site boundary. No schools or medical facilities are located within 10 km of the proposed project. The closest residential areas are located outside of a 20 km radius of the proposed project.

The impact of the project on ambient air quality was simulated using the United States Environmental Protection Agency (US EPA) AERMOD modelling suite. Simulated pollutant concentrations were compared against the NAAQS, international exposure guidelines and environmental screening levels for ecosystem impacts. Simulated nuisance dust-fall rates were compared against the National Dust Control Regulations (NDCR) for non-residential and residential areas.

The main findings of the simulated incremental assessment were:

1. Measured ambient air quality based on data from the Karoo monitoring stations managed by the DFFE indicated compliance with hourly, daily and annual compliance with National Ambient Air Quality Standards (NAAQS) for all pollutants assessed across the period assessed.
2. During the construction phase, impacts are likely to be localised and of short duration.
    a. A "**low**" rating was determined for the impact associated with the construction phase of the project.
3. Compliance with hourly, daily, and annual NAAQS under normal operations is likely across the domain and at the receptors for SO_2, particulate matter, (PM_{10} and $PM_{2.5}$), and carbon monoxide (CO).
4. Hourly exceedances of the NO_2 NAAQ limit concentration is likely both on- and off-site, however, the total number of exceedances at the closest receptor is likely to be fewer than those allowed by the NAAQS. Simulated annual average NO_2 concentrations are lower than the NAAQS across the domain.
5. Compliance with the chronic inhalation guidelines for volatile organic compounds (VOCs) and diesel particulate matter (DPM) are likely off-site.
6. The excess cancer risk due to exposure to DPM was calculated to be low (on and near site) and very low at closest receptors and across the remainder of the domain.
7. The United Nations Economic Commission for Europe (UNECE) Convention on Long Range Trans-boundary Air Pollution Limits) critical levels were used to assess the potential for impact of annual SO_2 and NO_2 concentrations on vegetation via various measures of productivity and reproductive success.
    a. Impacts to vegetative productivity are unlikely due to the project across in the domain or at any receptors.
8. The impact of the facility was simulated to be below the NDCR.
    a. However, mitigation measures for control vehicle entrainment dust emissions are recommended along the delivery route.
9. A "**low**" rating was determined for the impact of criteria air pollutants associated with the normal operation of the project (2 hours per week).
10. Cumulative impact of the project and the other sources in the area is likely to exceed the NAAQ limit concentration off site but not at the closest receptor.
    a. A "**low**" rating was determined for the mitigated impact of the project in isolation and in the context of other air pollution sources in the vicinity.
11. Annual greenhouse gas (GHG) emissions for the operational phases of the plant were estimated to represent 0.004% of the published South African National 2015 GHG Inventory, contributing to the Energy sector.
    a. A "**medium**" rating was determined for the GHG emissions associated with the project.

From an air quality perspective, it is the opinion of the specialist that the ACWA Power Project DAO be authorised, on condition that:

- As far as is practical, the reliability tests should be conducted when seasonal conditions allow the best pollutant dispersal (August to November).
- The start-and-stop preventative maintenance operation of the generators occurs during day-time hours only, ideally between 10:00 and 14:00.
- Emissions be monitored annual as per good operating practice;
- Conformance with the other environmental management programme requirements for air quality (Appendix C) are met; and,
- Monitoring at the nearest receptor to be conducted during the reliability tests.

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

NEMA Regulations (2014, as amended) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report.	Report Details (page i)
The expertise of that person to compile a specialist report including curriculum vitae.	Appendix D
A declaration that the person is independent in a form as may be specified by the competent authority.	Report Details (page i) and Annexure B
An indication of the scope of, and the purpose for which, the report was prepared.	Preface (page 1)
An indication of quality and age of base data used.	Sections 5.1.3, and 5.1.5
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change.	Sections 5.1.3, 5.1.4 and 5.1.5 Sections 5.1.6 and 5.1.7 Section 5.1.2.3, 5.1.2.4, and 5.1.2.5 Section 5.2 Section 5.3
The date and season of the site investigation and the relevance of the season to the outcome of the assessment.	Description of the current land use in the region, simulations undertaken for the proposed operations and meteorological data included used in the study are considered representative of all seasons.
A description of the methodology adopted in preparing the report or carrying out the specialised process.	Section 5.1.1
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.	Section 5.1.6
An identification of any areas to be avoided, including buffers.	Not applicable
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	Section 1.3 and 2.2
A description of any assumptions made and any uncertainties or gaps in knowledge.	Preface (page 2)
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment.	Sections 5.1, 5.2, and 5.3
Any mitigation measures for inclusion in the EMPr.	Section 5.4 and Appendix C
Any conditions for inclusion in the environmental authorisation	Section 5.5
Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	Sections 5.4 and Appendix C
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised.	Section 5.5
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan.	Not applicable.
A description of any consultation process that was undertaken during the course of carrying out the study.	Not applicable.
A summary and copies if any comments that were received during any consultation process.	Draft; not yet received.
Any other information requested by the competent authority.	None

PREFACE

Background and Context

ACWA Power Project DAO (RF) (Pty) Ltd (ACWA) proposes the development a multi-technology hybrid power plant that has a contracted capacity on the output side onto the transmission system of 150 MW, to be located near Groblershoop in the Northern Cape Province**.** The hybrid power plant consists of 326 MW of photovoltaic (PV), battery energy storage system (BESS) of 540-560 MWh and internal combustion engines (ICE) of 49.5 MW. Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by ACWA to assess the potential impacts on the atmospheric environment by compiling an Atmospheric Impact Report (AIR) for the ICE power plant (hereafter referred to as 'the project') in support of the environmental authorisation (EA) under the National Environmental Management Act, 1998 (NEMA) addressing the impact significance rating as required by the environmental authorisation process.

During the operational phase of the project, it is envisaged that the ICE plant will not be required to provide any energy output to the grid. However, from a prudent operating perspective and to ensure that the ICE plant is appropriately maintained, a start-and-stop regime is envisaged to sustain plant integrity. To meet these requirements, the ICE plant will be operated for 2 hours per week during the operational phase of the plant for 20 years. The plant will use diesel delivered to site by tanker truck for thermal generation of electricity in reciprocating engines. The diesel will be stored in containerised storage tanks on-site. The five plants will include reciprocating engines, diesel storage, and ancillary infrastructure.

The format of the assessment meets the prescribed format of an AIR, as set out in the Regulations gazetted on 11th of October 2013 (Gazette No. 36904 and amendments in Gazette No. 38633 R284 of 2nd April 2015). The report includes a statement of climate change impacts (Section 5.3).

Terms of Reference for the Atmospheric Impact Report

The Terms of Reference, as a list of tasks, to prepare the AIR and Climate Change Impact Statement will include:

1. A review and identification of legal requirements pertaining to air quality;
2. A desktop study of the receiving atmospheric environment (baseline) including:
    - the identification of air quality sensitive receptors;
    - an analysis of regional climate and site-specific atmospheric dispersion taking into account local meteorology, land-use and topography; and
    - and analysis and assessment of existing (baseline) ambient air quality.
3. The establishment of the facility's emissions inventory;
4. Atmospheric dispersion simulations of the expanded operational phase of the facility;
5. A human health risk and nuisance impact screening assessment based on dispersion simulation results;
6. Compile a Climate Change Impact Statement in line with the Equator Principles IV for Climate Change Risk Assessments, by:
    - Identifying of the Transitional and Physical Risks associated with the project (as per the Task Force on Climate-related Financial Disclosures.
    - Quantifying the greenhouse gas (GHG) emissions during the construction and operation of the project compared to the global and national emission inventories; and compared to international benchmarks for the project.

- Discussing the robustness of the project in terms of forecasted climate change impacts to the area over the lifetime of the project.
- Discussing the vulnerability of communities in the immediate vicinity of the project to climate change.
- Proposing management and mitigation strategies.
- Including this information as a section in the AIR.

7. Preparation of an AIR in the prescribed format.

Management of Uncertainty

The following assumptions, exclusions, and limitations are applicable to the assessment:

1. The AIR is limited to the proposed thermal power generation facility during normal (thermal) operation only. All equipment is provided by the supplier as containerised units and therefore on-site construction activities will be minor and of short duration.
2. The impact of the ICE plant was estimated to operate 2 hours per week for the purposes of preventative maintenance.
    a. All primary (not standby) generators were assumed to run simultaneously during normal operations.
    b. Although continuous emissions were assumed in the dispersion model setup, these were to estimate the worst-case short-term pollutant concentrations.
    c. Simulated annual average pollutant concentrations were weighted based on the operating philosophy of 2 hours per week (104 hours per year).
3. Emergency events were assumed to result in engine unit or plant shut down. No alternative fuel is proposed for use during emergency events. No suboptimal operation of the plant is therefore anticipated under emergency conditions. Health and safety programmes and controls of the plant are to be implemented as per industry best practice, including monitoring, controls and maintenance of fuel handling and storage, as well as general plant operation for the facility lifetime.
4. A reliability test of the facilities was accounted for in the assessment. The requirement of the reliability run is that the power plant must operate at full contracted capacity for the duration of 15 days with some additional starts and stops within that period.
    a. The worst-case impact of the reliability test was simulated using a period when meteorological conditions would be least suitable for pollutant dispersion – typical of the cold days with low wind speeds in winter and if the generators operated continuously for the 15-day period.
5. The parameters of engine exhaust pipe release heights and fuel use were provided by the preferred equipment supplier via ACWA Power Project DAO (RF) (Pty) Ltd.
    a. Engines were assumed to operate at a 75% load, with each engine generating 818 kW during normal operations.
    b. The standby engines would only be engaged 25% of the normal operating hours (used for estimating volatile organic compound (VOC) emissions from standing and working losses from the standby diesel tank only).
    c. Standby engines were not included in the dispersion modelling as they are for redundancy purposes only and will replace one of the main generators only when a generator breaks down.
    d. An initial screening of the default exhaust pipe release height (3.8 m) indicated that non-compliance with the NAAQS would occur at the nearest receptor. It was therefore necessary to simulate all pollutants using a release height of 5.8 m, assuming one standard-length exhaust extension was fitted to all engines prior to commissioning (as indicated would be technically feasible).
6. Building downwash was included for diesel storage tanks as per the Regulations Regarding Air Dispersion Modelling (DEA, 2014).

7. AERMOD simulated oxides of nitrogen (NO_X). Hourly and annual average NO_2 concentrations were calculated from simulated NO_X concentrations using the US EPA Ambient Ratio Method Version 2.
8. It is planned that diesel will be delivered by tanker truck during operational hours of the plant. Fuel delivery activities, will be minimal to support the 2 hour per week preventative maintenance operating of the generators.
9. Diesel storage tank designs were provided by the preferred equipment supplier via ACWA Power Project DAO (RF) (Pty) Ltd. To estimate emissions from the storage tanks, using the American Petroleum Institute Manual of Petroleum Measurement Standards (API MPMS) Chapter 19 methodologies, the following assumptions were made:
    a. The tank for the standby engines would have 25% turnover of the tanks supplying the primary engines.
    b. The safe volume of tanks were 71.6 m³ and 35.6 m³, all ullaged at 0.6 m.
    c. The containerised tanks are horizontal fixed roof tanks with a light grey coating.
    d. The tanks are free venting and uninsulated.
    e. The simulated (Weather Research and Forecasting model) meteorological data was used to calculated atmospheric pressure and solar radiation, as required by the emissions estimation methodology.
10. The sulfur content of the diesel was assumed to be 0.05% (500 ppm).
11. Dispersion model setup included simulated (Weather Research and Forecasting model) meteorological data for the period 2017 to 2019.
12. The baseline air quality was described based on measured air pollutant concentrations (2018 to 2020) based on data from the Karoo monitoring stations owned by the Department of Fisheries, Forestry and Environment (DFFE) and managed by the South African Weather Services (SAWS).
13. Other sources in the domain were not re-quantified.

1 ENTERPRISE DETAILS

1.1 Enterprise Details

The details of the project operations are summarised in Table 1-1. The contact details of the responsible person are provided in Table 1-2.

Table 1-1: Enterprise details

Enterprise Name	ACWA Power Project DAO (RF) Pty Ltd
Trading as	
Type of Enterprise	
Company Registration Number	
Registered Address	
Telephone Number (General)	
Industry Type/Nature of Trade	
Land Use Zoning as per Town Planning Scheme	
Land Use Rights if Outside Town Planning Scheme	

Table 1-2: Contact details of responsible person

Responsible Person	
Telephone Number	
Cell Number	
Fax Number	
Email Address	
After Hours Contact Details	

1.2 Location and Extent of the Plant

Table 1-3: Location and extent of the plant

Physical Address of the Plant	n/a
Description of Site (Where no Street Address)	Remainder of Farm Bokpoort 390 Gordonia Road, approximately 20 km north of Groblershoop in the Northern Cape Province
Coordinates of Approximate Centre of Operations	Latitude: 28.703402° S Longitude: 22.010136° E
Extent	Property: 1 438 ha Total project area, including solar photovoltaics: ~1 410.6 ha Thermal power generation facility and associated infrastructure: 3.6 ha
Elevation Above Sea Level	~982 metres above mean sea level
Province	Northern Cape
Metropolitan/District Municipality	ZF Mgcawu District Municipality
Local Municipality	!Kheis Local Municipality
Designated Priority Area	None

1.3 Description of Surrounding Land Use (within 5 km radius)

The proposed project location is within the !Kheis Local Municipality, approximately 20 km north of Groblershoop on the Orange River. The National Ambient Air Quality Standards (NAAQS) (detailed in Section 5.1.2.3) are based on human exposure to specific criteria pollutants and as such, sensitive receptors were identified where the public is likely to be unwittingly exposed. NAAQS are enforceable outside of the property boundary of the licensed facility. In accordance with the Regulations Regarding Air Dispersion Modelling (DEA, 2014), two residences were identified as AQSRs, located 4.8 km to the southwest and 8.5 km east of the site centre point. These were included in the dispersion model setup as discrete receptors. No schools or medical facilities are located within 10 km of the proposed project. The closest residential areas are located outside of a 20 km radius of the proposed project (Figure 1-1). The predominant land uses in the area are irrigated vineyards for wine production and livestock (mainly sheep) farming.

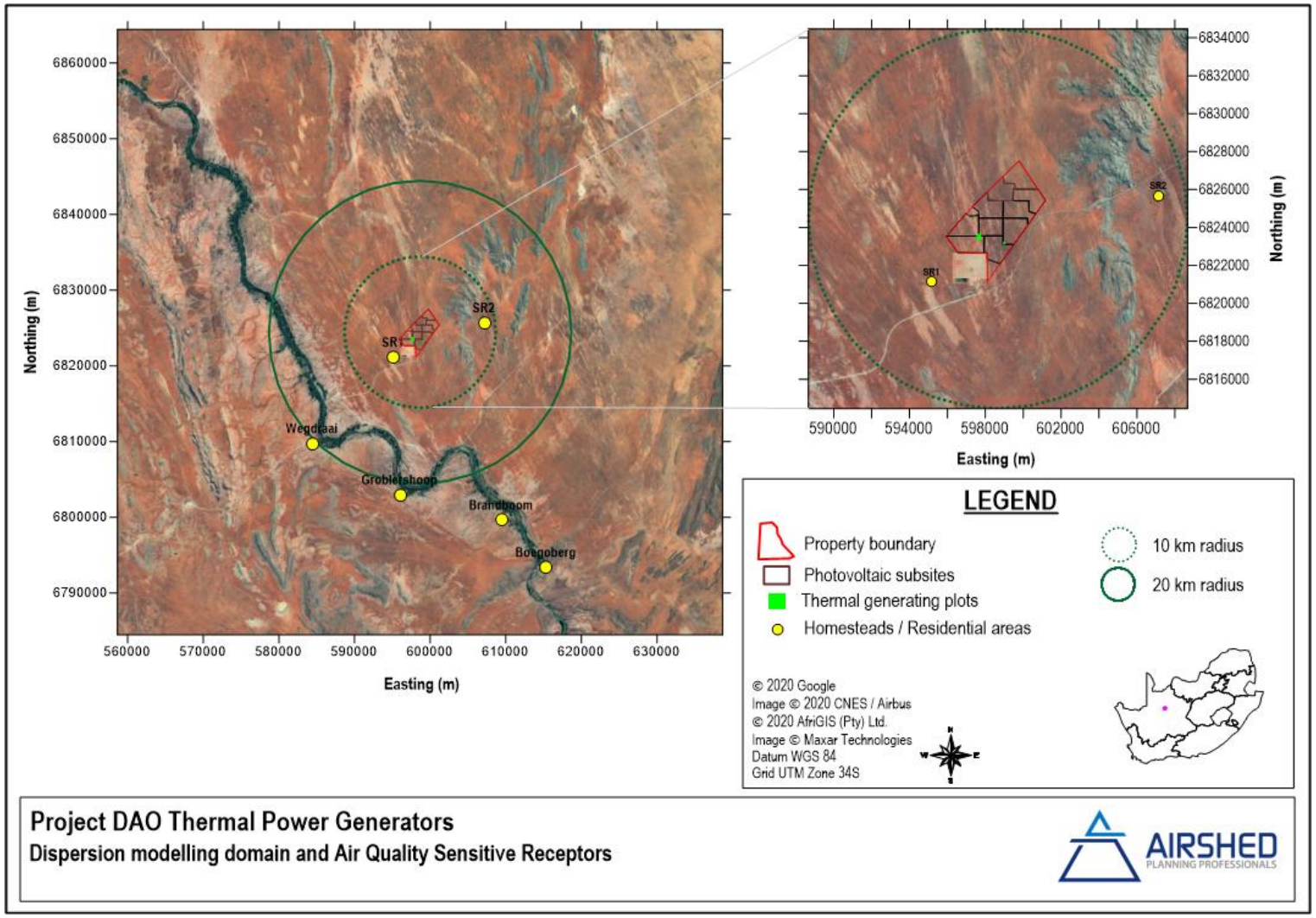

Figure 1-1: Location of the project in relation to the air quality sensitive receptors (AQSRs)

Table 1-4: Distance to the air quality sensitive receptors from the centre point of the proposed facility

Receptor name / details	Distance from proposed site (km)	Direction from proposed site
SR1	4.8	SW
SR2	8.5	E
Wegdraai	20	SW
Groblershoop	21	S
Brandboom	27	SSE
Boegoberg	35	SSE
Upington	80	WNW

1.4 Atmospheric Emission Licence and other Authorisations

The project is a new facility. Based on the process description, equipment design, and operating philosophy (more detail provided in Section 2.2) the ACWA Power Project DAO Thermal Power Generation Facility does not trigger any listed activities. This AIR was prepared in support of the environmental authorisation (EA) under the National Environmental Management Act, 1998 (NEMA) addressing the impact significance of the project – under the proposed operating philosophy – on ambient air quality.

2 NATURE OF THE PROCESS

2.1 Listed Activities

Based on the process description, equipment design, and operating philosophy (more detail provided in Section 2.2) the ACWA Power Project DAO Thermal Power Generation Facility does not trigger any listed activities.

2.2 Process Description

The ACWA Power Project DAO (RF) (Pty) Ltd facility is a multi-technology hybrid power plant that is designed to meet the requirements of the Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP). The plant has a contracted capacity on the output side onto the transmission system of 150 MW. The hybrid power plant consists of 326 MW of photovoltaic (PV), battery energy storage system (BESS) of 540-560 MWh and internal combustion engines (ICE) of 49.5 MW.

The RMIPPPP has a dispatchable period requirement of 16.5 hours per day (05:00 to 21:30). The ACWA Power Project DAO (the project) is dispatched according to needs of the purchaser limited to daily availability declarations. The plant is designed to meet its obligations of dispatch as per its available energy from the renewable components of the plant. In practise, the project can be considered a PV and BESS power plant.

The RMIPPPP has a reliability test run requirement, that must be executed prior to the start of the operating period of the Power Purchase Agreement (PPA). The requirement of the reliability run is that the power plant must operate at full contracted capacity, 150 MW, for the duration of 15 days with some additional starts and stops within that period. Failure to achieve the reliability run, results in the plant being rejected and not achieving the commercial operating date with the risk that the PPA can be terminated.

As the plant is primarily designed for solar renewable energy, ensuring a guaranteed 15-day window at 100% capacity of 150 MW has a low probability. Hence, the design incorporated the ICE component to primarily assist the reliability testing

regime. The reliability run places reliance from an energy input from the ICE over a 24-hour period to compensate for low availability of sunlight during the testing regime. Depending on the specific period of the year (weather conditions of the day and seasonality of the year) of the reliability run, the ICE may run for a full 24-hour period, charging the batteries in those periods that are not dispatchable (between 21:30 and 05:00). The ICE is located within five (5) subplots each containing multiple engines limited to an output capacity of 9.9 MW per subplot. These engines will be operated in accordance to meeting the requirements of the reliability run, and thereafter only to maintain the integrity of the engines as per prudent operator requirements. The design has catered for certain quantity of diesel to be stored at site for the reliability run requirements, with a logistic supply solution to meet additional diesel requirements, should it be required.

During the operational phase of the PPA, it is envisaged that the ICE plant will not be required to provide any energy output to the grid. However, from a prudent operating perspective and to ensure that the ICE plant is appropriately maintained, a start-and-stop regime is envisaged to sustain plant integrity. To meet these requirements, the ICE plant will be operated for 2 hours per week during the operational phase of the plant for 20 years.

ACWA Power Project DAO (RF) (Pty) Ltd places no reliance on energy output from the ICE to meet its contracted capacity obligations in the PPA. The operational philosophy has resulted in zero cost recovery for any diesel that may be used by the ICE.

The proposed thermal power facility subplots are located within the solar PV arrays (Figure 2-1). The infrastructure at each internal combustion engine (ICE) plot is proposed as following:

- ICE 1 (Pedi) – 11 x HTW1260 generators; 2 x 71.6 m³ fuel tanks and 1 x 35.3 m³ fuel tank.
- ICE 2 (Afrikaans) – 11 x HTW1260 generators; 2 x 71.6 m³ fuel tanks and 1 x 35.3 m³ fuel tank.
- ICE 3 (Venda) – 11 x HTW1260 generators; 2 x 71.6 m³ fuel tanks and 1 x 35.3 m³ fuel tank.
- ICE 4 (Ndebele) – 11 x HTW1260 generators; 2 x 71.6 m³ fuel tanks and 1 x 35.3 m³ fuel tank. The combining sub-station for ICE 1 to 4 is also located on this plot. For redundancy, there are also 2 additional HTW1260 generators and an additional 71.6 m³ fuel tank located on this plot which will only be required when other units break down.
- ICE 5 (Sotho) – 12 x HTW1260 generators (and 1 additional HTW1260 generator for redundancy), with 2 x 71.6 m³ fuel tanks and 1 x 35.3 m³ fuel tank.

The total fuel storage volume is 964.1 m³.

From an air quality perspective, the project involves the installation and operation of 56 reciprocating engines (in five blocks of 12) with total installed generating capacity of 49.5 MW. Each engine is proposed to have a 3.8-metre-high exhaust pipe to discharge combustion gases into the atmosphere. An initial screening of the default exhaust pipe height (3.8 m) indicated that non-compliance with the NAAQS would occur at the nearest receptor. It was therefore necessary to simulate all pollutants using a release height of 5.8 m, assuming one standard-length exhaust extension was fitted to all engines prior to commissioning (as indicated would be technically feasible). Provisional site layouts are provided in Figure 2-2 and Figure 2-3.

Primary pollutants from gas engines will be oxides of nitrogen (NO_x), carbon monoxide (CO), and, to a lesser extent, volatile organic compounds (VOCs), and particulate matter (PM). NO_x formation is strongly dependent on the high temperatures developed in the combustor. CO, VOC, PM, and hazardous air pollutants (HAP) are primarily the result of incomplete combustion. SO_2 emissions are directly related to the sulfur content of the fuel (US EPA, 2000) and a 0.05% (500 ppm) sulfur content was assumed for this study. Lower diesel content will reduce SO_2 emissions in the engine exhaust. In addition to the above, VOC emissions will also be released during fuel delivery (from vehicles, off-loading and transfers) and free-venting losses. However, diesel by nature has relatively low volatility which together with equipment service and maintenance as well

as proper safe use of equipment will minimise losses. Air pollutants associated with all phases of the facility are given in Table 2-1.

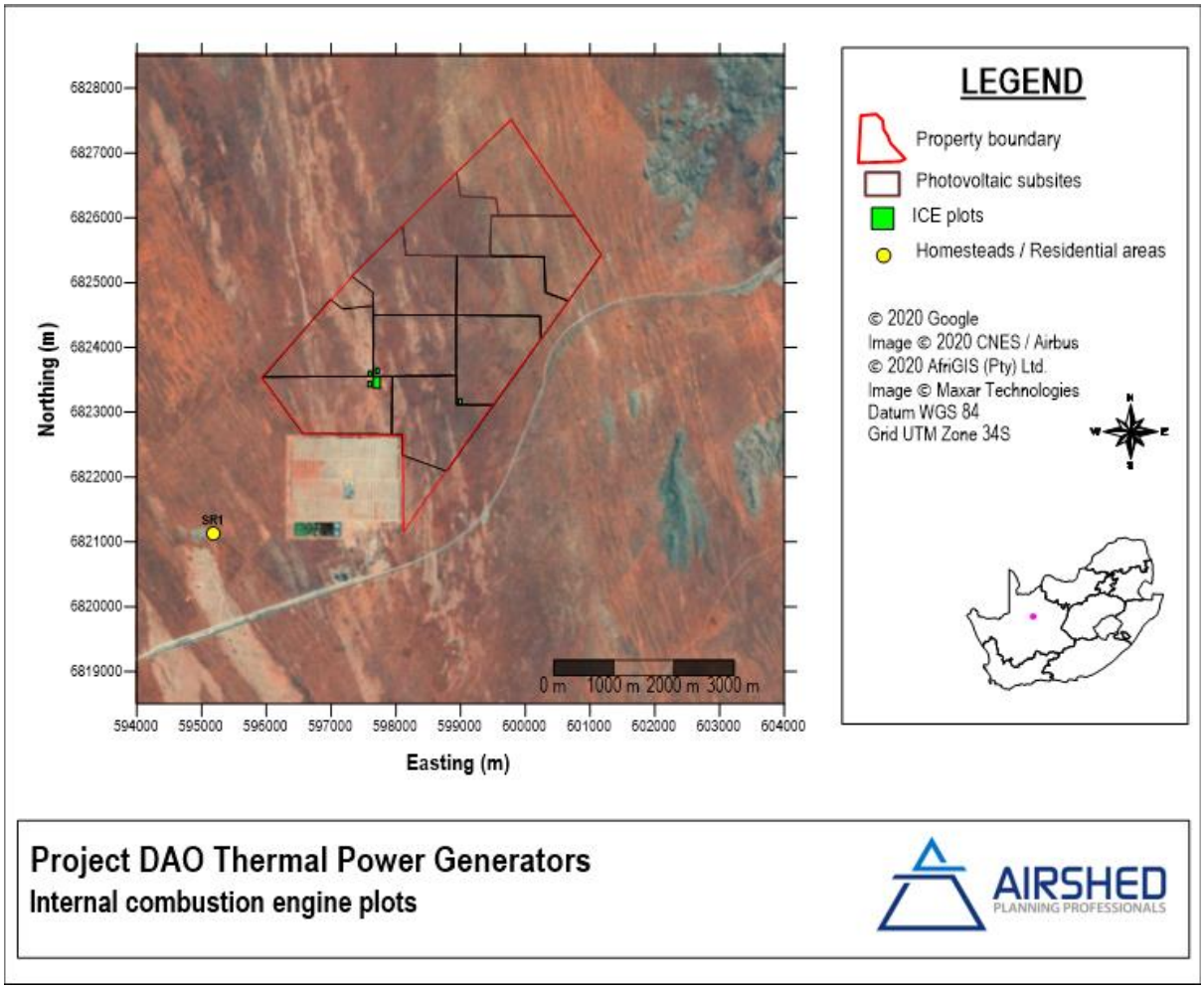

Figure 2-1: Internal combustion engine (ICE) plots

Table 2-1: Identified air quality aspects

Aspect or Project Phase	Expected Atmospheric Sources of Emissions and Associated Pollutants						Rationale
	Source	CO	NO_x	PM[(a)]	SO_2	VOC	
Construction Phase	Fugitive dust from civil and building work such as excavations, piling, foundations, and buildings	n/a	n/a	✓	n/a	n/a	The nature of emissions from construction activities is highly variable in terms of temporal and spatial distribution and is also transient. Daily construction activity detail regarding construction activities and equipment movements was not available and the impact of construction was not included in the study. Since the equipment is containerised and restricted to small areas of 1 ha or smaller, it was assumed that the construction phase would be relatively short and require minor earthwork and surface disruption. Fugitive dust emissions are mostly generated by land-clearing and bulk earthworks.
	Exhaust gases from mobile diesel construction equipment and trucks delivering materials.	✓	✓	✓	✓	✓	
Operational Phase	Exhaust gases from the generator units	✓	✓	✓	✓	✓	The project is designed to operate on diesel, where emissions are expected from the diesel combustion in the generators as well as from diesel handling and storage. Vehicle entrainment and exhaust emissions are likely during diesel delivery.
	Fuel delivery trucks exhaust gases	✓	✓	✓	✓	✓	
	Diesel storage	n/a	n/a	n/a	n/a	✓	
Upset Conditions	Unstable combustion conditions within generator units	✓	✓	✓	✓	✓	Incomplete combustion and unstable combustion temperatures may result in higher than normal PM, CO, NO_x and VOC emissions. SO_2 emissions are directly related to the sulfur content of the fuel and are unlikely to be affected by any upset condition of the power plant operation. Additional VOC emissions because of the diesel leaks may occur. Vehicle entrainment and exhaust emissions are also likely during diesel delivery and will reduce or be absent during shut-down events when fuel is not needed.
	Fuel delivery trucks exhaust gases	✓	✓	✓	✓	✓	
	Diesel leaks	n/a	n/a	n/a	n/a	✓	
Regular Shutdowns	Diesel storage	n/a	n/a	n/a	n/a	✓	During shutdowns there will not be any emissions from the engine units. Emissions (standing losses) from diesel handling, storage, pipework and fittings as per normal operations. Vehicle entrainment and exhaust emissions are also likely during diesel delivery, if required during shutdowns.
	Fuel delivery trucks exhaust gases	✓	✓	✓	✓	✓	
Decommissioning Phase	Fugitive dust from civil work such as rehabilitation and demolition.	n/a	n/a	✓	n/a	n/a	The nature of emissions from decommissioning activities is highly variable in terms of temporal and spatial distribution and is also transient. Detail regarding the extent of decommissioning activities and equipment movements was also not available for inclusion in the study. Fugitive dust emissions are however mostly generated by demolition and rehabilitation activities.
	Exhaust gases from diesel mobile equipment and trucks removing materials.	✓	✓	✓	✓	✓	

Notes:
(a) PM includes PM_{10} and $PM_{2.5}$
(b) n/a – not applicable

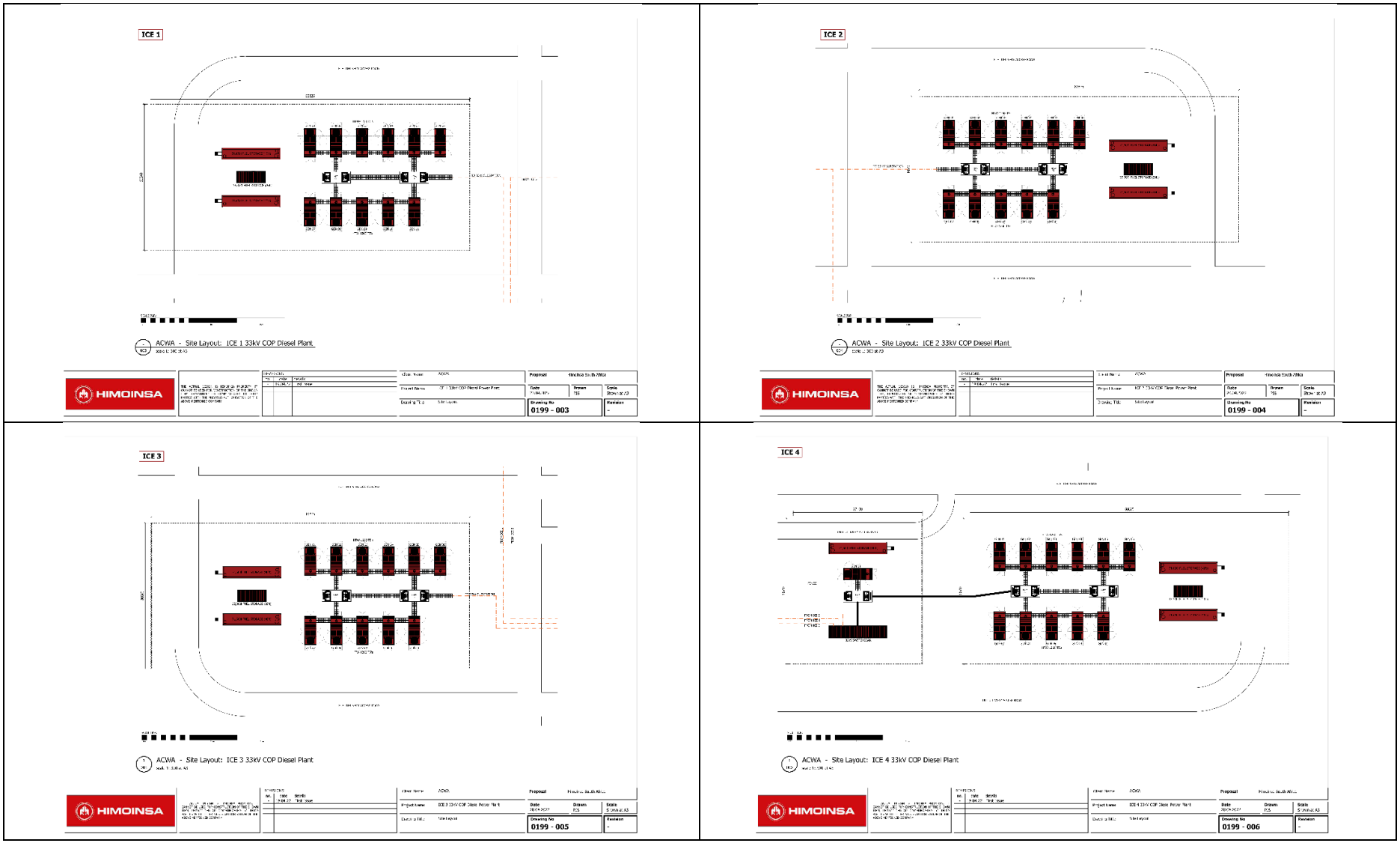

Figure 2-2: Proposed site layout for ICE 1 to ICE4

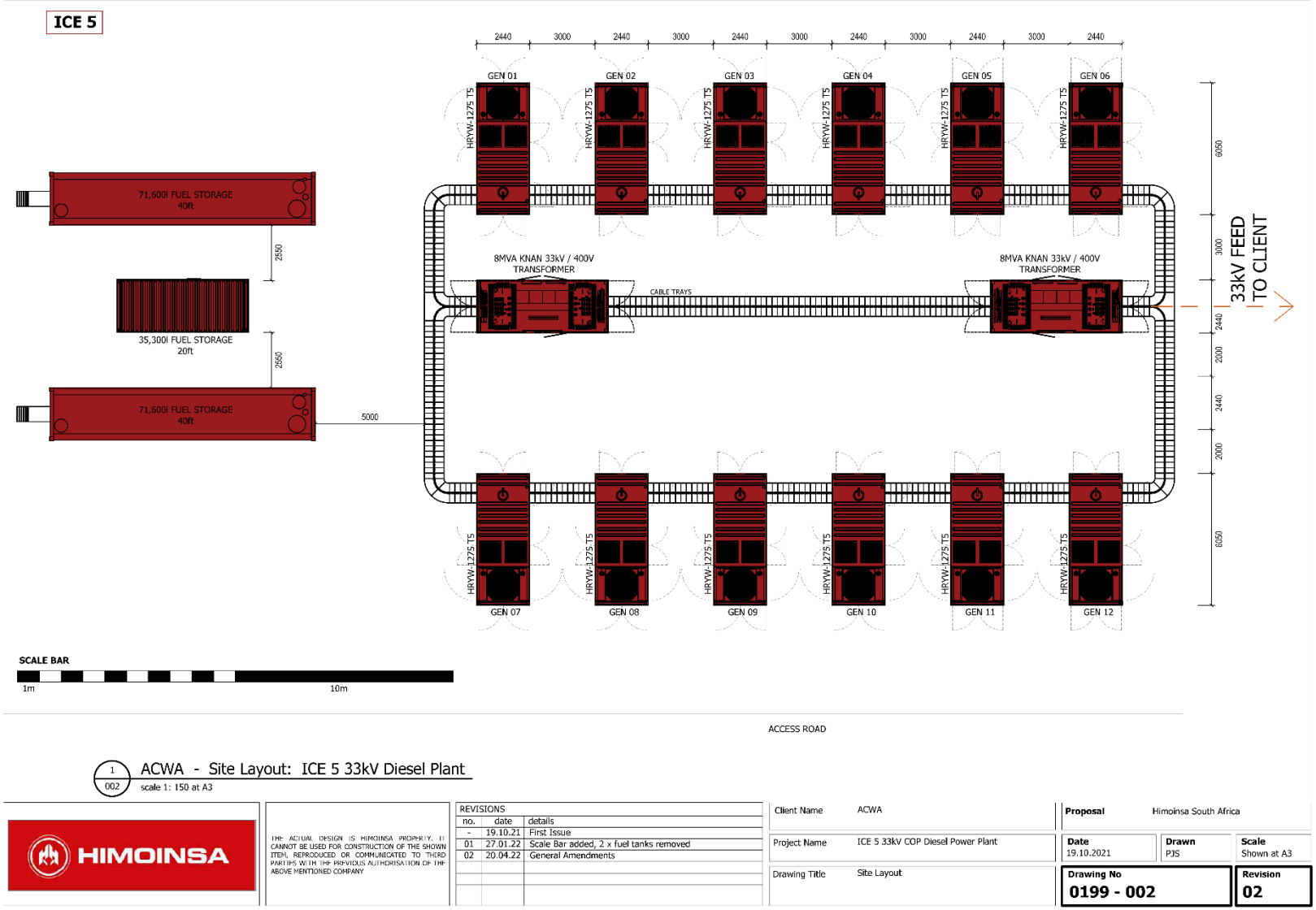

Figure 2-3: Proposed site layout for ICE 5

2.3 Unit Processes

The unit processes for the project are listed in Table 2-2.

Table 2-2: The unit processes for the project

Unit Process	Function of Unit Process	Batch or Continuous Process
Diesel storage	Storage of diesel for use in reciprocating engines	Continuous
Reciprocating engines	Combustion of diesel to generate power (maximum generating capacity per engine - 818 kW)	Routine but Intermittent

3 TECHNICAL INFORMATION

Raw material consumption rates are tabulated in Table 3-1. The project has an installed generation capacity of up to 49.5 MW of electricity supply, with waste streams of combustion off-gases.

3.1 Raw Material Consumption Rates

Table 3-1: Raw materials used

Raw Material Type Alternatives	Design Consumption Rate (Quantity)	Units (quantity/period)
Diesel	1 258.9[a]	m^3/annum

Notes:

(a) Based on 75% load for all 56 engine units, using 201.75 litres/hour, operating 104 hours per year.

3.2 Production Rates

Table 3-2: Production rates

Production Name	Maximum Production Capacity Permitted (Quantity)	Design Production Capacity (Quantity)	Actual Production Capacity (Quantity)	Units (Quantity/Period)
Electricity	49.5	49.5	To be confirmed	MW

Table 3-3: By-products

By-Product Name	Maximum Production Capacity Permitted (Quantity)	Design Production Capacity (Quantity)	Actual Production Capacity (Quantity)	Units (Quantity/Period)
None				

4 ATMOSPHERIC EMISSIONS

The establishment of a comprehensive emissions inventory, for the project, formed the basis for the assessment of air quality impacts from the project operations on the receiving environment. All stack parameters were provided by the applicant.

The following sections describe the location and parameters of the individual sources associated with the project (as per the prescribed format of an AIR - Gazette No. 36904, 2013).

4.1 Point Sources

The thermal power generation facility is planned to have 56 reciprocating engines. An initial screening of the default exhaust pipe height (3.8 m) indicated that non-compliance with the NAAQS would occur at the nearest receptor. It was therefore necessary to simulate all pollutants using a release height of 5.8 m, assuming one standard-length exhaust extension was fitted to all engines prior to commissioning (as indicated would be technically feasible).

The operating cycle of the facility was assumed to be 2 hours per week. Normal operations were assessed using emission rates provided by the preferred equipment suppliers for the same engine models in similar projects and using mass balance calculations for the emission of SO_2 assuming 500 ppm sulfur diesel (details provided in Table 4-1, Table 4-2, and, Table 4-3).

4.2 Fugitive Sources

Fugitive particulate emissions are likely to result from: working and standing losses from the free venting horizontal diesel storage tanks; vehicle exhaust and entrainment emissions during delivery of diesel. Only emissions from diesel working and standing losses were estimated (details provided in Table 4-4, Table 4-5, and Table 4-6). Fuel delivery activities, due to the back-up nature of the thermal power facilities and the combined on-site fuel storage capacity, are likely to be infrequent.

Suitable mitigation measures for minimising particulate entrainment and delivery vehicle exhaust emissions during fuel delivery could include:

- Paving (tarring) or chemical sealants on the fuel deliver access road;
- Dust suppression using water sprays on the access road, if unpaved, and especially shortly before and during delivery activities;
- No vehicle idling during delivery; and,
- Contractual obligation for fuel delivery service to use low emission vehicles (Euro V or better).

4.3 Start-up, Shut down and Emergency Events

According to Section 21 of the NEM:AQA (Government Gazette No. 37054), 'normal operating condition' is defined as any condition that constitutes operation as designed; where, 'upset conditions' are defined as any temporary failure of air pollution control equipment or process equipment or failure of process to operate in a normal or usual manner that leads to an emission standard being exceeded. Section 21 of the NEM:AQA further expands that if normal start-up, maintenance, upset, and shut-down conditions exceed a period of 48 hours, Section 30 of the National Environmental Management Act (Act no. 107 of 1998) shall apply unless otherwise specified by the Licensing Authority. The MES (as per Section 21 of the AQA) (unless otherwise specified) are expressed on a daily average basis, under normal (reference) conditions of 273 K, 101.3kPa, specific oxygen percentage and dry gas.

The proposed project design will facilitate start-up and shut down are likely to represent less than 2% of the operating day, when operating for preventative maintenance (2 hours per week). During these start-up and shut-down periods emissions may be higher than during normal operating conditions, however, the variance from normal operating conditions is dependent on type of start-up (hot, warm, or cold) and the pollutant of concern. For gas-fired power plants, emissions at lower generating loads (for example 50% load) are generally 1.5 to 15 times higher than those at full capacity (Gonzalez-Salazar, Kirsten, & Prchlik, 2018). Shut-down emissions can vary between 1.1 and 9.3 times higher than normal operating conditions (Obaid, Ramadan, Elkamel, & Anderson, 2017).

No emergency events were included in the emissions estimations or simulations. It was assumed that operation beyond normal capacities and emissions would result in engine unit shutdown until normal operations can be restored. The facility will shut down immediately should reserve fuel be insufficient or any unforeseen circumstance indicate that normal operation is not feasible.

A reliability test of the facilities was accounted for in the assessment. The requirement of the reliability run is that the power plant must operate at full contracted capacity for the duration of 15 days with some additional starts and stops within that period. The worst-case impact of the reliability test was simulated using a period when meteorological conditions would be least suitable for pollutant dispersion – typical of the cold days with low wind speeds in winter and if the generators operated continuously for the 15-day period.

Table 4-1: Parameters for point sources of atmospheric pollutant emissions at the project

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Effective Diameter at Stack Tip / Vent Exit (m)	Maximum Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m^3/hr)	Actual Gas Exit Velocity (m/s)
PeGEN01	ICE1 (Pedi) Generator 1	-28.71159	21.99905	5.8	<1	0.304	520	15 480	59.2
PeGEN02	ICE1 (Pedi) Generator 2	-28.71152	21.99905	5.8	<1	0.304	520	15 480	59.2
PeGEN03	ICE1 (Pedi) Generator 3	-28.71146	21.999052	5.8	<1	0.304	520	15 480	59.2
PeGEN04	ICE1 (Pedi) Generator 4	-28.71139	21.99905	5.8	<1	0.304	520	15 480	59.2
PeGEN05	ICE1 (Pedi) Generator 5	-28.71133	21.999051	5.8	<1	0.304	520	15 480	59.2
PeGEN06	ICE1 (Pedi) Generator 6	-28.71127	21.999051	5.8	<1	0.304	520	15 480	59.2
PeGEN07	ICE1 (Pedi) Generator 7	-28.71159	21.999366	5.8	<1	0.304	520	15 480	59.2
PeGEN08	ICE1 (Pedi) Generator 8	-28.71152	21.999365	5.8	<1	0.304	520	15 480	59.2
PeGEN09	ICE1 (Pedi) Generator 9	-28.71146	21.999366	5.8	<1	0.304	520	15 480	59.2
PeGEN10	ICE1 (Pedi) Generator 10	-28.7114	21.999366	5.8	<1	0.304	520	15 480	59.2
PeGEN11	ICE1 (Pedi) Generator 11	-28.71133	21.999367	5.8	<1	0.304	520	15 480	59.2
AfGEN01	ICE2 (Afrikaans) Generator 1	-28.71116	22.000286	5.8	<1	0.304	520	15 480	59.2
AfGEN02	ICE2 (Afrikaans) Generator 2	-28.71109	22.000286	5.8	<1	0.304	520	15 480	59.2
AfGEN03	ICE2 (Afrikaans) Generator 3	-28.71103	22.000287	5.8	<1	0.304	520	15 480	59.2
AfGEN04	ICE2 (Afrikaans) Generator 4	-28.71097	22.000287	5.8	<1	0.304	520	15 480	59.2
AfGEN05	ICE2 (Afrikaans) Generator 5	-28.7109	22.000287	5.8	<1	0.304	520	15 480	59.2
AfGEN06	ICE2 (Afrikaans) Generator 6	-28.71084	22.000288	5.8	<1	0.304	520	15 480	59.2
AfGEN07	ICE2 (Afrikaans) Generator 7	-28.71116	22.000599	5.8	<1	0.304	520	15 480	59.2
AfGEN08	ICE2 (Afrikaans) Generator 8	-28.7111	22.000602	5.8	<1	0.304	520	15 480	59.2
AfGEN09	ICE2 (Afrikaans) Generator 9	-28.71103	22.000602	5.8	<1	0.304	520	15 480	59.2
AfGEN10	ICE2 (Afrikaans) Generator 10	-28.71097	22.000603	5.8	<1	0.304	520	15 480	59.2
AfGEN11	ICE2 (Afrikaans) Generator 11	-28.7109	22.000602	5.8	<1	0.304	520	15 480	59.2
VeGEN01	ICE3 (Venda) Generator 1	-28.71275	21.999046	5.8	<1	0.304	520	15 480	59.2
VeGEN02	ICE3 (Venda) Generator 2	-28.71269	21.999049	5.8	<1	0.304	520	15 480	59.2
VeGEN03	ICE3 (Venda) Generator 3	-28.71263	21.999048	5.8	<1	0.304	520	15 480	59.2
VeGEN04	ICE3 (Venda) Generator 4	-28.71256	21.999047	5.8	<1	0.304	520	15 480	59.2

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Effective Diameter at Stack Tip / Vent Exit (m)	Maximum Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m^3/hr)	Actual Gas Exit Velocity (m/s)
VeGEN06	ICE3 (Venda) Generator 5	-28.7125	21.999047	5.8	<1	0.304	520	15 480	59.2
VeGEN06	ICE3 (Venda) Generator 6	-28.71243	21.999048	5.8	<1	0.304	520	15 480	59.2
VeGEN07	ICE3 (Venda) Generator 7	-28.71276	21.999361	5.8	<1	0.304	520	15 480	59.2
VeGEN08	ICE3 (Venda) Generator 8	-28.71269	21.999361	5.8	<1	0.304	520	15 480	59.2
VeGEN09	ICE3 (Venda) Generator 9	-28.71263	21.999361	5.8	<1	0.304	520	15 480	59.2
VeGEN10	ICE3 (Venda) Generator 10	-28.71256	21.999361	5.8	<1	0.304	520	15 480	59.2
VeGEN11	ICE3 (Venda) Generator 11	-28.7125	21.999361	5.8	<1	0.304	520	15 480	59.2
NdGEN01	ICE4 (Ndebele) Generator 1	-28.71288	22.000177	5.8	<1	0.304	520	15 480	59.2
NdGEN02	ICE4 (Ndebele) Generator 2	-28.71281	22.000171	5.8	<1	0.304	520	15 480	59.2
NdGEN03	ICE4 (Ndebele) Generator 3	-28.71275	22.000174	5.8	<1	0.304	520	15 480	59.2
NdGEN04	ICE4 (Ndebele) Generator 4	-28.71268	22.000174	5.8	<1	0.304	520	15 480	59.2
NdGEN05	ICE4 (Ndebele) Generator 5	-28.71261	22.000176	5.8	<1	0.304	520	15 480	59.2
NdGEN06	ICE4 (Ndebele) Generator 6	-28.71255	22.000177	5.8	<1	0.304	520	15 480	59.2
NdGEN07	ICE4 (Ndebele) Generator 7	-28.71288	22.000543	5.8	<1	0.304	520	15 480	59.2
NdGEN08	ICE4 (Ndebele) Generator 8	-28.71282	22.000542	5.8	<1	0.304	520	15 480	59.2
NdGEN09	ICE4 (Ndebele) Generator 9	-28.71275	22.00054	5.8	<1	0.304	520	15 480	59.2
NdGEN10	ICE4 (Ndebele) Generator 10	-28.71268	22.000543	5.8	<1	0.304	520	15 480	59.2
NdGEN11	ICE4 (Ndebele) Generator 11	-28.71262	22.000543	5.8	<1	0.304	520	15 480	59.2
SoGEN01	ICE5 (Sotho) Generator 1	-28.71513	22.013387	5.8	<1	0.304	520	15 480	59.2
SoGEN02	ICE5 (Sotho) Generator 2	-28.71506	22.013387	5.8	<1	0.304	520	15 480	59.2
SoGEN03	ICE5 (Sotho) Generator 3	-28.71499	22.013385	5.8	<1	0.304	520	15 480	59.2
SoGEN04	ICE5 (Sotho) Generator 4	-28.71491	22.013386	5.8	<1	0.304	520	15 480	59.2
SoGEN05	ICE5 (Sotho) Generator 5	-28.71484	22.013385	5.8	<1	0.304	520	15 480	59.2
SoGEN06	ICE5 (Sotho) Generator 6	-28.71477	22.013384	5.8	<1	0.304	520	15 480	59.2
SoGEN07	ICE5 (Sotho) Generator 7	-28.71512	22.013746	5.8	<1	0.304	520	15 480	59.2
SoGEN08	ICE5 (Sotho) Generator 8	-28.71505	22.013746	5.8	<1	0.304	520	15 480	59.2
SoGEN09	ICE5 (Sotho) Generator 9	-28.71498	22.013747	5.8	<1	0.304	520	15 480	59.2

Point Source code	Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Effective Diameter at Stack Tip / Vent Exit (m)	Maximum Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m^3/hr)	Actual Gas Exit Velocity (m/s)
SoGEN10	ICE5 (Sotho) Generator 10	-28.71491	22.013746	5.8	<1	0.304	520	15 480	59.2
SoGEN11	ICE5 (Sotho) Generator 11	-28.71484	22.013746	5.8	<1	0.304	520	15 480	59.2
SoGEN12	ICE5 (Sotho) Generator 12	-28.71477	22.013744	5.8	<1	0.304	520	15 480	59.2
STDBY1	ICE4 Standby generator 1	-28.711433	22.000351	5.8	<1	0.304	520	15 480	59.2
STDBY2	ICE4 Standby generator 2	-28.711521	22.000350	5.8	<1	0.304	520	15 480	59.2
STDBY3	ICE5 Standby generator 3	-28.714962	22.013538	5.8	<1	0.304	520	15 480	59.2

4.4 Emission Rates during Normal Operating Conditions

Table 4-2: Atmospheric pollutant emission rates for the project

Point Source code	Pollutant Name	Maximum Release Rate				Emissions Hours [b]	Type of Emissions (Continuous / Routine but Intermittent / Emergency Only)
		mg/Nm^3	mg/Am^3 [a]	g/s	Averaging period		
All generator units	Particulates (PM)	51	to be confirmed	0.07	Hourly	2 hours per week	Routine but Intermittent
	Sulfur dioxide (SO_2)	31		0.05	Hourly	2 hours per week	Routine but Intermittent
	Oxides of Nitrogen (NO_X)	1 349		2.0	Hourly	2 hours per week	Routine but Intermittent
	Carbon monoxide (CO)	276		0.41	Hourly	2 hours per week	Routine but Intermittent
	Hydrocarbons[c]	48		0.07	Hourly	2 hours per week	Routine but Intermittent

Note:
(a) Varies depending on actual temperature
(b) Required for preventative maintenance of the engines as per the operating philosophy described in Section 2.2.
(c) Assumed to all be volatile i.e. TVOCs

Table 4-3: Point Source Emission Estimation Information during Normal Operating Conditions

Point Source code	Pollutants	Basis for Emission Rates
All generator units	PM, NO_X, CO, TVOCs	Emission rates (given in g/kWhr) provided by the preferred equipment supplier and original equipment manufacturer for similar projects using the same engine model.
	SO_2	Mass balance calculation assuming 500 ppm (0.05%) sulfur diesel, using fuel consumption rate for 75% load provided by original equipment manufacturer and diesel density 830 kg/m³

Table 4-4: Fugitive source parameters (diesel storage tanks)

Source code	Source name	Source Description	Latitude (decimal degrees) of SW corner	Longitude (decimal degrees) of SW corner	Height of Release Above Ground (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from True North (°)
PeTK1	ICE1 (Pedi) Tank 1	Horizontal fixed roof diesel storage tank (71.6 m³)	-28.71118	21.99912	4	12.192	2.438	0
PeTK2	ICE1 (Pedi) Tank 2	Horizontal fixed roof diesel storage tank (71.6 m³)	-28.71118	21.99921	4	12.192	2.438	0
PeTK3	ICE1 (Pedi) Tank 3	Horizontal fixed roof diesel storage tank (35.3 m³)	-28.71118	21.999298	4	6	2.438	0
AfTK1	ICE2 (Afrikaans) Tank 1	Horizontal fixed roof diesel storage tank (71.6 m³)	-28.71075	22.000356	4	12.192	2.438	0
AfTK2	ICE2 (Afrikaans) Tank 2	Horizontal fixed roof diesel storage tank (71.6 m³)	-28.71075	22.000446	4	12.192	2.438	0
AfTK3	ICE2 (Afrikaans) Tank 3	Horizontal fixed roof diesel storage tank (35.3 m³)	-28.71075	22.000533	4	6	2.438	0
AfTK-STDBY	ICE2 (Afrikaans) Standby Tank	Horizontal fixed roof diesel storage tank (71.6 m³)	-28.71154	22.000243	4	12.192	2.438	0
VeTK1	ICE3 (Venda) Tank 1	Horizontal fixed roof diesel storage tank (71.6 m³)	-28.71282	21.999114	4	12.192	2.438	0
VeTK2	ICE3 (Venda) Tank 2	Horizontal fixed roof diesel storage tank (71.6 m³)	-28.71282	21.999202	4	12.192	2.438	0
VeTK3	ICE3 (Venda) Tank 3	Horizontal fixed roof diesel storage tank (35.3 m³)	-28.71282	21.999293	4	6	2.438	0
NdTK1	ICE4 (Ndebele) Tank 1	Horizontal fixed roof diesel storage tank (71.6 m³)	-28.71295	22.000253	4	12.192	2.438	0
NdTK2	ICE4 (Ndebele) Tank 2	Horizontal fixed roof diesel storage tank (71.6 m³)	-28.71295	22.00036	4	12.192	2.438	0
NdTK3	ICE4 (Ndebele) Tank 3	Horizontal fixed roof diesel storage tank (35.3 m³)	-28.71295	22.000462	4	6	2.438	0
SoTK1	ICE5 (Sotho) Tank 1	Horizontal fixed roof diesel storage tank (71.6 m³)	-28.71523	22.013371	4	12.192	2.438	0
SoTK2	ICE5 (Sotho) Tank 2	Horizontal fixed roof diesel storage tank (71.6 m³)	-28.71523	22.013454	4	12.192	2.438	0
SoTK3	ICE5 (Sotho) Tank 3	Horizontal fixed roof diesel storage tank (35.3 m³)	-28.71523	22.013539	4	6	2.438	0

Table 4-5: Fugitive source emissions (diesel storage tanks)

Source code	Pollutant Name	Maximum Hourly Release Rate (g/s)	Maximum Daily Release Rate (kg/day)	Average Annual Release Rate (kg/a)	Emission Hours (e.g. 07h00 – 17h00)	Type of Emission (Continuous / intermittent)	Wind Dependent (yes/no)
Main storage tanks (71.6 m³)	Hydrocarbons	0.03	2.39	801.9	00:00 – 23:59	Continuous	Yes
Main storage tanks (35.3 m³)	Hydrocarbons	0.01	1.02	343.7	00:00 – 23:59	Continuous	Yes
Standby storage tank (AfTK-STDBY)	Hydrocarbons	0.02	1.86	624.5	00:00 – 23:59	Continuous	Yes

Table 4-6: Fugitive Source Emission Estimation Information

Source code	Basis for Emission Rates
Storage tanks	American Petroleum Institute Manual of Petroleum Measurement Standards (API MPMS) Chapter 19 methodologies. The following assumptions were made: a. The simulated (Weather Research and Forecasting model) meteorological data was used to calculated atmospheric pressure and solar radiation, as required by the emissions estimation methodology. b. The safe volume of tanks was 71.6 m³ and 35.3 m³, ullaged at 0.6 m. c. The containerised tanks are horizontal fixed roof tanks with a light grey coating. d. The tanks are free venting and uninsulated. e. Diesel density of 830 kg/m³ f. Fuel combustion rate in generators running at 75% load using 201.75 litres per hour, operating 104 hours per year. g. The tank for the standby engines would have 25% turnover of the tanks supplying the primary engines.

5 IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

5.1 Analysis of Emissions' Impact on Human Health

5.1.1 Study Methodology

The study methodology may conveniently be divided into a "preparatory phase" and an "execution phase".

The preparatory phase included the flowing basic steps prior to performing the actual dispersion modelling and analyses:

1. Understand Scope of Work
2. Assign Appropriate Specialists
3. Review of Legal Requirements (e.g. dispersion modelling guideline)
4. Prepare a Plan of Study for Peer Review
5. Decide on Dispersion Model

The Regulations Regarding Air Dispersion Modelling (Gazette No 37804 published 11 July 2014) was referenced for the dispersion model selection.

Three Levels of Assessment are defined in the Regulations Regarding Air Dispersion Modelling:

- Level 1: where worst-case air quality impacts are assessed using simpler screening models
- Level 2: for assessment of air quality impacts as part of license application or amendment processes, where impacts are the greatest within a few kilometres downwind (less than 50 km)
- Level 3: require more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situations:
  - where a detailed understanding of air quality impacts, in time and space, is required;
  - where it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types & chemical transformations;
  - when conducting permitting and/or environmental assessment processes for large industrial developments that have considerable social, economic and environmental consequences;
  - when evaluating air quality management approaches involving multi-source, multi-sector contributions from permitted and non-permitted sources in an airshed; or,
  - when assessing contaminants resulting from non-linear processes (e.g. deposition, ground-level O_3, particulate formation, visibility)

The assessment of impact as a result of emissions from the proposed thermal generation plant was considered to fall within the scope of a Level 2 assessment.

The execution phase (i.e. dispersion modelling and analyses) firstly involves gathering specific information in relation to the emission source(s) and site(s) to be assessed. This includes:

- Source information: Emission rate, exit temperature, volume flow, exit velocity, etc.;
- Site information: Site building layout, terrain information, land use data;
- Meteorological data: Wind speed, wind direction, temperature, cloud cover, mixing height;
- Receptor information: Locations using discrete receptors and/or gridded receptors.

The model uses this specific input data to run various algorithms to estimate the dispersion of pollutants between the source and receptor. The model output is in the form of a predicted time-averaged concentration at the receptor. These predicted

concentrations are compared with the relevant ambient air quality standard or guideline. Post-processing can be carried out to produce contour plots that can be prepared for reporting purposes.

The following steps were followed for the execution phase of the assessment:

- Select appropriate meteorological data input;
- Prepare all meteorological model input files;
- Select control options in meteorological model;
- Review emissions inventory and ambient measurements;
- Decide on modelling domain and receptor locations;
- Prepare all dispersion model input files:
    - Control options,
    - Meteorology,
    - Source data,
    - Receptor grid and discrete receptors;
- Review all modelling input data files and fix where necessary;
- Simulate source groups per pollutant and calculate air concentration levels for regular and discrete grid locations for the operational phase of the project;
- Compare against National Ambient Air Quality Standards (NAAQS) and international guidelines;
- Preparation of draft AIR;
- Finalise the AIR.

5.1.1.1 AERMOD Modelling Suite

It was decided to employ the US Environmental Protection Agency's (US EPA) approved regulatory model, AERMOD. The most widely used US EPA model has been the Industrial Source Complex Short Term model (ISCST3). This model is based on a Gaussian plume model. However, this model has been replaced by the new generation AERMET/AERMOD suite of models. AERMOD is a dispersion model, which was developed under the support of the AMS/EPA Regulatory Model Improvement Committee (AERMIC), whose objective has been to include state-of the-art science in regulatory models (Hanna et al., 1999). The AERMOD is a dispersion modelling system with three components, namely: AERMOD (AERMIC Dispersion Model), AERMAP (AERMOD terrain pre-processor), and AERMET (AERMOD meteorological pre-processor).

- AERMOD is an advanced new-generation model. It is designed to predict pollution concentrations from continuous point, flare, area, line, and volume sources (Trinity Consultants, 2004). AERMOD offers new and potentially improved algorithms for plume rise and buoyancy, and the computation of vertical profiles of wind, turbulence and temperature. However, it does retain the single straight-line trajectory limitation of ISCST3 (Hanna et al., 1999). The Breeze AERMOD executable 19191 was used for dispersion modelling.
- AERMET is a meteorological pre-processor for the AERMOD model. Input data can come from hourly cloud cover observations, surface meteorological observations and twice-a-day upper air soundings. Output includes surface meteorological observations and parameters and vertical profiles of several atmospheric parameters. AERMET version 7.9.0.3 was used to process the meteorological data.
- AERMAP is a terrain pre-processor designed to simplify and standardize the input of terrain data for the AERMOD model. Input data includes receptor terrain elevation data. The terrain data may be in the form of digital terrain data. Output includes, for each receptor, location and height scale, which are elevations used for the computation of air flow around hills.

There will always be some error in any geophysical model, but it is desirable to structure the model in such a way to minimise the total error. A model represents the most likely outcome of an ensemble of experimental results. The total uncertainty can be thought of as the sum of three components: the uncertainty due to errors in the model physics; the uncertainty due to data errors; and the uncertainty due to stochastic processes (turbulence) in the atmosphere.

The stochastic uncertainty includes all errors or uncertainties in data such as source variability, observed concentrations, and meteorological data. Even if the field instrument accuracy is excellent, there can still be large uncertainties due to unrepresentative placement of the instrument (or taking of a sample for analysis). Model evaluation studies suggest that the data input error term is often a major contributor to total uncertainty. Even in the best tracer studies, the source emissions are known only with an accuracy of ±5%, which translates directly into a minimum error of that magnitude in the model predictions. It is also well known that wind direction errors are the major cause of poor agreement, especially for relatively short-term predictions (minutes to hourly) and long downwind distances. All the above factors contribute to the inaccuracies not even associated with the mathematical models themselves.

Similar to the ISC model, a disadvantage of the model is that spatial varying wind fields, due to topography or other factors cannot be included. Although the model has been shown to be an improvement on the ISC model, especially short-term predictions, the range of uncertainty of the model predictions is -50% to 200%. The accuracy improves with fairly strong wind speeds and during neutral atmospheric conditions.

Input data types required for the AERMOD model include: meteorological data, source data, and information on the nature of the receptor grid. Each of these data types will be described below and a summary of the model parameterisation is provided in Table 5-1.

Worst-case short-term impacts were simulated assuming continuous operation of the engines. Simulated annual average pollutant concentrations from AERMOD were weighted based on the operating philosophy of 2 hours per week (104 hours per year).

5.1.1.2 Meteorological Requirements

AERMOD requires two specific input files generated by the AERMET pre-processor. In the absence of on-site measured data, Weather Research and Forecasting (WRF) simulated meteorological data for the period 2017 to 2019 were used in the simulations.

5.1.1.3 Topographical Data

The regional-scale study area (50 km radius) is characterised by terrain elevations in the range 800 and 1 650 metres above mean sea level (mamsl) (Figure 5-1). In closer proximity to the project site, elevations vary between 900 to 1150 mamsl with gently undulating terrain with no major topographical features within 10 km of the proposed site. The average slope across the study area is less than 10% and, based on the AERMOD Implementation Guide, terrain with slopes less than 10% should exclude topography in the dispersion simulations (US EPA, 2009). Terrain was therefore excluded from the dispersion modelling simulations.

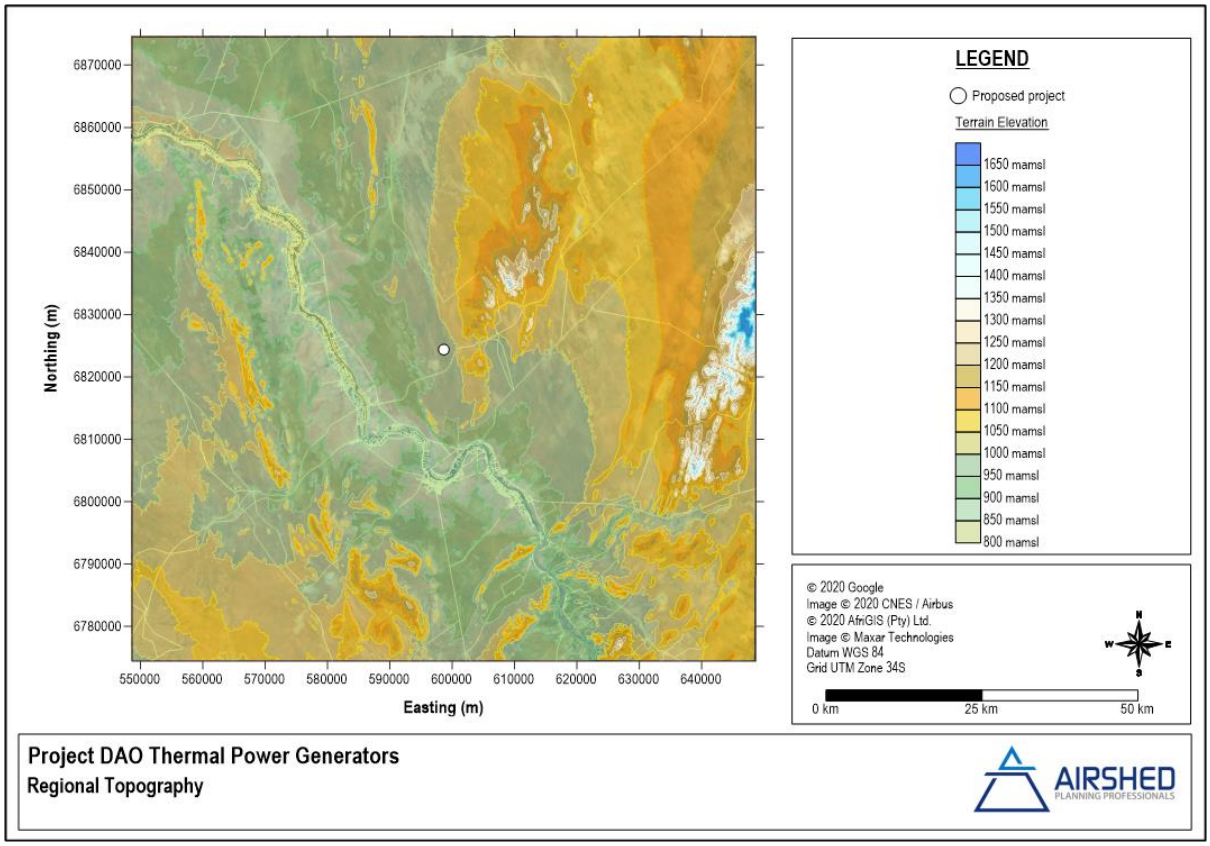

Figure 5-1: Terrain of the proposed project area

5.1.1.4 Receptor Grid

The dispersion of pollutants was modelled for an area covering 20 km (north-south) by 20 km (east-west) with the project at the centre. This area was divided into a grid with a resolution of 250 m (north-south) by 250 m (east-west) (Table 5-1). To assess near-field impacts, a nested 5 650 m by 6 650 m grid with a resolution of 50 m by 50 m was also included (Table 5-1). AERMOD simulates ground-level concentrations for each of the receptor grid points.

Table 5-1: Simulation domain and AERMOD parameter options

Parameter	Simulation domain
Projection	Grid: UTM Zone 34S, Datum: WGS-84
South-western corner of computational domain	588 670 m (Easting); 6 814 456 m (Northing)
Computational domain size	20 x 20 km
Grid resolution	250 m
South-western corner of nested domain	595 669.2 m (Easting); 6 821 032.9 m (Northing)
Nested domain size	5 650 m x 6 650 m
Grid resolution	50 m
Discrete receptors	As per Table 1-4
Model options	Optimise all sources
	Flat terrain
	No depletion
	Flagpole height 1.5 m
Software	Breeze AERMOD by Trinity Consultants VERSION 10.0
Executable	AERMOD_BREEZE_ 21112_64.EXE

5.1.1.5 Nitrogen Dioxide Formation

Of the several species of oxides of nitrogen, only NO_2 is specified in the NAAQS. Since most sources emit varying ratios of these species and these ratios change further in the atmosphere due to chemical reactions, a method for determining the amount of NO_2 in the plume must be selected. Estimation of this conversion normally follows a tiered approach, as discussed in the Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804, published 11 July 2014), which presents a scheme for annual averages:

> Tier 1: Total Conversion Method
>
> *Use any of the appropriate models recommended to estimate the maximum annual average NO_2 concentrations by assuming a total conversion of NO to NO_2. If the maximum NO_x concentrations are less than the NAAQS for NO_2, then no further refinement of the conversion factor is required. If the maximum NO_x concentrations are greater than the NAAQS for NO_2, or if a more "realistic" estimate of NO_2 is desired, proceed to the second-tier level.*
>
> *Tier 2: Ambient Ratio Method (ARM) - Multiply NO_x by a national ratio of NO_2/NO. = 0.80*
>
> *Assume a wide area quasi-equilibrium state and multiply the Tier 1 empirical estimate NO_x by a ratio of NO_2/NO_x = 0.80. The ratio is recommended for South Africa as the conservative ratio based on a review of ambient air quality monitoring data from the country. If representative ambient NO and NO_2 monitoring data is available (for at least one year of monitoring), and the data is considered to represent a quasi-equilibrium condition where further significant changes of the NO/NO_2 ratio is not expected, then the NO/NO_2 ratio based on the monitoring data can be applied to derive NO_2 as an alternative to the national ratio of 0.80.*

The use of a fixed ambient ratio will often over-estimate 1-hour average NO_2 concentrations (API, 2013). Therefore, the US-EPA Tier 2 Ambient Ratio Method Version 2 (ARM2), was selected for this project. The ARM2 option is based on work sponsored by API (API, 2013) to develop a method to adjust simulated NO_X concentrations based on an empirical relationship between ambient NO_X and ambient NO_2 concentrations (US EPA, 2021). This method does not require any additional input data and uses a variable ambient ratio that is a function of the simulated NO_X concentration, based on hourly ambient NO_X monitoring data from approximately 580 stations over the period 2001 to 2010 (API, 2013). The default upper and lower limits on the ambient ratio applied to the simulated NOx concentration are 0.9 and 0.5, respectively (US EPA, 2021) and the defaults were applied to the NO_2 calculations for this study.

5.1.2 Legal Requirements

5.1.2.1 Atmospheric Impact Report

According to the NEM:AQA, an Air Quality Officer (AQO) may require the submission of an AIR in terms of Section 30, if:

- The AQO reasonably suspects that a person has contravened or failed to comply with the AQA or any conditions of an AEL and that detrimental effects on the environment occurred or there was a contribution to the degradation in ambient air quality.
- A review of a provisional AEL or an AEL is undertaken in terms of Section 45 of the AQA.

The format of the Atmospheric Impact Report is stipulated in the Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette No. 36904, Notice Number 747 of 2013 (11 October 2013).

5.1.2.2 Listed Activities and Minimum Emission Standards

The minister, in accordance with the National Environmental Management Air Quality Act (NEM:AQA) (Act No. 39 of 2004), published a list of activities which result in atmospheric emissions and which are believed to have significant detrimental effects on the environment and human health; and, social welfare. The Listed Activities and MES were published on the 31st of March 2010 (Government Gazette No. 33064) and revised MES on 22 November 2013 (Government Gazette No. 37054).

Based on the process description, equipment design, and operating philosophy the ACWA Power Project DAO Thermal Power Generation Facility does not trigger any listed activities.

5.1.2.3 National Ambient Air Quality Standards

Simulated pollutant concentrations were assessed against NAAQS (Table 5-2) as prescribed by South African legislation. Due to the operational life-time of the thermal power facility, the most stringent $PM_{2.5}$ NAAQS were referred to which are enforceable from 1 January 2030.

Table 5-2: National Ambient Air Quality Standards applicable for the assessment of the facility

Pollutant	Averaging Period	Concentration (µg/m³)	Frequency of Exceedance	Compliance Date
Benzene (C_6H_6)	1 year	5	0	Currently enforceable
Carbon Monoxide (CO)	1 hour	30 000	88	Currently enforceable
	8 hour (running average)	10 000	11	Currently enforceable
Nitrogen Dioxide (NO_2)	1 hour	200	88	Currently enforceable
	1 year	40	0	Currently enforceable
Inhalable particulate matter less than 2.5 µm in diameter ($PM_{2.5}$)	24 hours	40	4	Enforceable until 31 December 2029
	24 hours	25	4	1 January 2030
	1 year	20	0	Enforceable until 31 December 2029
	1 year	15	0	1 January 2030
Inhalable particulate matter less than 10 µm in diameter (PM_{10})	24 hours	75	4	Currently enforceable
	1 year	40	0	Currently enforceable
Sulfur Dioxide (SO_2)	10 minutes	500	526	Currently enforceable
	1 hour	350	88	Currently enforceable
	24 hours	125	4	Currently enforceable
	1 year	50	0	Currently enforceable

5.1.2.4 International Health Criteria for Volatile Organic Compounds (VOCs)

VOCs is the name given to a class of several hundred carbon-based chemical compounds that evaporate easily into the air. VOC sources include fuel additives, fuel evaporation, and incomplete combustion. Some VOCs have little or no known direct human health effects, while others are extremely toxic and/or carcinogenic. Very little is known about how various VOCs combine in the atmosphere or in the human body, or what the cumulative impacts of exposure might be.

As the term VOC refers to a group of pollutants, generally guidelines are not available for comparison to determine the health impacts due to exposure to these pollutants. To estimate the probable health impacts a breakdown of the types of pollutants, which dominate in a specific area is required, whereby their respective toxicities can be determined.

Although standards for exposure to VOCs in non-industrial settings do not exist, a number of exposure limits have been recommended. The European Concerted Action Report No. 11, entitled *Guidelines for Ventilation Requirements in Buildings* (European Concerted Action, 1992), lists the following Total VOC (TVOC) concentration ranges as measured with a flame ionisation detector calibrated to toluene. These recommendations are based on Mølhave's toxicological work on mucous membrane irritation (Mølhave, 1990).

Comfort range:	<200 µg/m³
Multifactoral exposure range:	200 to 3 000 µg/m³
Discomfort range:	3 000 to 25 000 µg/m³
Toxic range:	>25 000 µg/m³

The same European report also lists a second method based on Seifert's work (Seifert, 1990). This method established TVOC guidelines based on the ten most prevalent compounds in each of seven chemical classes. The concentrations in each of these classes should be below the maximums listed below.

Alkanes:	100 µg/m³
Aromatic hydrocarbons:	50 µg/m³
Terpenes:	30 µg/m³
Halocarbons:	30 µg/m³
Esters:	20 µg/m³
Aldehydes and ketones (excluding formaldehyde):	20 µg/m³
Other:	50 µg/m³

The VOC concentration is calculated by adding the totals from each class. Seifert gives a target TVOC concentration of 300 µg/m³, which is the sum of the above-listed target concentrations. The author also states that no individual compound concentration should exceed 50% of the guideline for its class or 10% of the TVOC guideline concentration. However, Seifert states that "…the proposed target value is not based on toxicological considerations but – to the author's best judgment."

The 1-year (annual average) inhalation criteria selected for this study is 200 µg/m³ (European Collaborative Action annual average concentration for comfort). It should be noted that this screening criteria is only a guideline and not a legal requirement.

5.1.2.5 Inhalation Health Criteria for Diesel Engine Exhaust

The potential for health impacts associated with non-criteria pollutants emitted from diesel combustion sources and are assessed according to guidelines published by the following institutions:

1. Inhalation reference concentrations published by the US EPA Integrated Risk Information System (IRIS), and,
2. Cancer Potency Values (CPV) published by the California Environmental Protection Agency (CALEPA)

The chronic inhalation criterion and CPV for pollutants considered in the study are summarised in Table 5-3. Increased lifetime cancer risk is conservatively calculated by applying the unit risk factors to predicted long term (annual average) pollutant concentrations.

Table 5-3: Chronic and acute inhalation screening criterion and cancer CPV for pollutants relevant to the project

Pollutant	Chronic Screening Criteria ($\mu g/m^3$)	Inhalation CPV $(\mu g/m^3)^{-1}$
Diesel Exhaust as DPM	5 (US EPA IRIS)	0.000 3 (CAL EPA)

The identification of an acceptable cancer risk level has been debated for many years and it possibly will still continue as societal norms and values change. Some people would easily accept higher risks than others, even if it were not within their own control; others prefer to take very low risks. An acceptable risk is a question of societal acceptance and will therefore vary from society to society. In spite of the difficulty to provide a definitive "acceptable risk level", the estimation of a risk associated with an activity provides the means for a comparison of the activity to other everyday hazards, and therefore allowing risk-management policy decisions. Technical risk assessments seldom set the regulatory agenda because of the different ways in which the non-technical public perceives risks. Consequently, science does not directly provide an answer to the question.

Whilst it is perhaps inappropriate to make a judgment about how much risk should be acceptable, through reviewing acceptable risk levels selected by other well-known organizations, it would appear that the US EPA's application is the most suitable, i.e. *"If the risk to the maximally exposed individual (MEI) is no more than 1 x 10^{-6}, then no further action is required. If not, the MEI risk must be reduced to no more than 1 x 10^{-4}, regardless of feasibility and cost, while protecting as many individuals as possible in the general population against risks exceeding 1 x 10^{-6}"*. Some authorities tend to avoid the specification of a single acceptable risk level. Instead, a "risk-ranking system" is preferred.

For example, the New York State Department of Health produced a qualitative ranking of cancer risk estimates, from very low to very high (Table 5-4). Therefore, if the qualitative descriptor was "low", then the excess lifetime cancer risk from that exposure is in the range of greater than one per million to less than one per ten thousand.

Table 5-4: Excess Lifetime Cancer Risk (as applied by New York State Department of Health)

Risk Ratio	Qualitative Descriptor
Equal to or less than one in a million	Very low
Greater than one in a million to less than one in ten thousand	Low
One in ten thousand to less than one in a thousand	Moderate
One in a thousand to less than one in ten	High
Equal to or greater than one in ten	Very high

5.1.3 Atmospheric Dispersion Potential

Physical and meteorological mechanisms govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the dispersion potential of the site. Parameters useful in describing the dispersion and dilution potential of the site, include: wind speed, wind direction, temperature and rainfall. Since no on-site meteorological data was available, Weather Research and Forecasting (WRF) data for the period 2017 to 2019 was used for the assessment.

5.1.3.1 Surface Wind Field

The wind field for the study area is described with the use of wind roses. Wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind speeds; the yellow area, for example, representing winds in between 5 and 6 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories.

Calm conditions are periods when the wind speed was below 1 m/s. These low values can be due to "meteorological" calm conditions when there is no air movement; or, when there may be wind, but it is below the anemometer starting threshold (AST).

The WRF period wind roses (Figure 5-2) depict the predominance of the north-north-easterly winds with wind speeds greater than 5 m/s, especially during the day. Winds from the north-westerly sector were also predominant during the day, albeit at slightly lower overall wind speed. The night-time wind rose shows a decrease in the northerly and the north-westerly winds and an increase in the easterly and east-south-easterly winds. Night-time was also characterised by an increase in the frequency of calm wind conditions.

Calm conditions were most frequently recorded in summer and most infrequently in winter (Figure 5-3). In summer, west-south-westerly dominance is noted, while in winter north-north-easterly winds were more frequent. Winds in the higher wind speed categories were most common in spring from the north-north-east.

5.1.3.2 Temperature

Air temperature is important, both for determining the effect of plume buoyancy and determining the development of the mixing and inversion layers. The monthly temperature patterns from the WRF data are shown in Figure 5-4 and Table 5-5. Average temperatures ranged between 13.1°C and 25.5°C. The highest temperatures occurred in December and the lowest in July. During the day, temperatures increase to reach maximum at around 15:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 07:00.

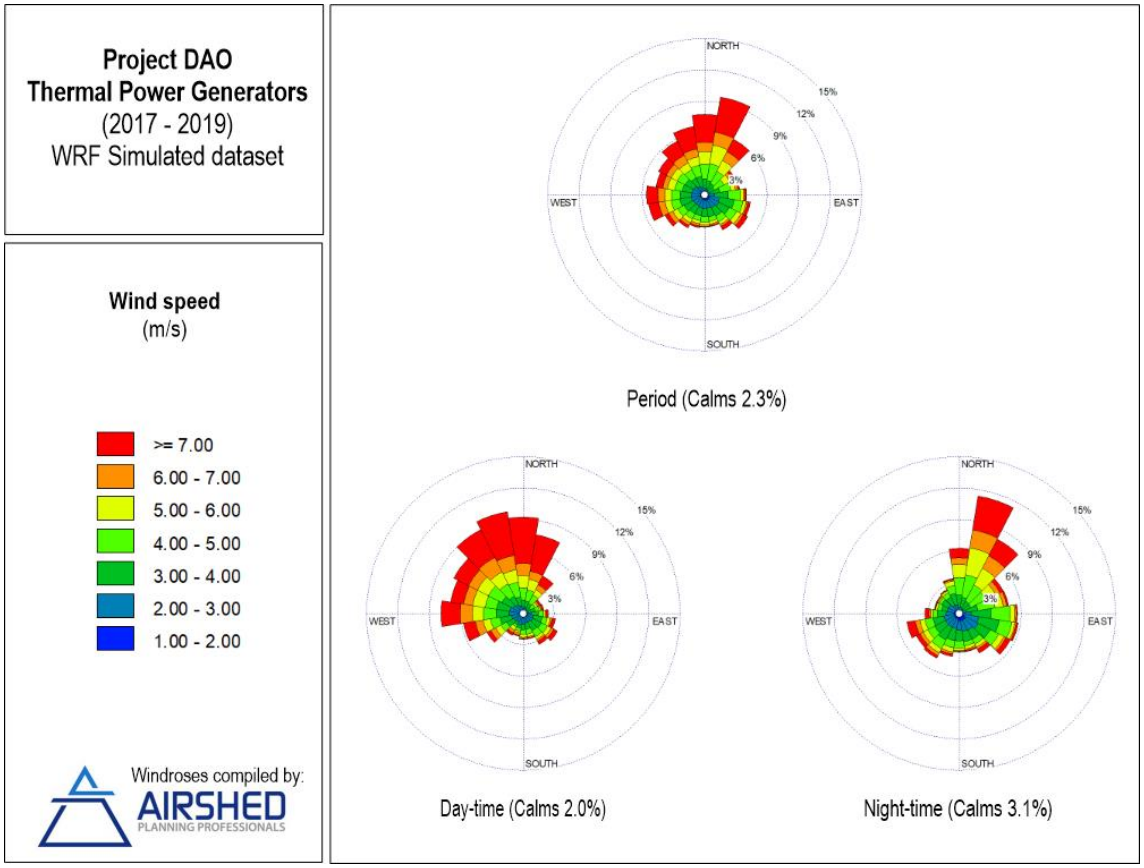

Figure 5-2: Period average, day-time and night-time wind roses (WRF simulated data; 2017 to 2019)

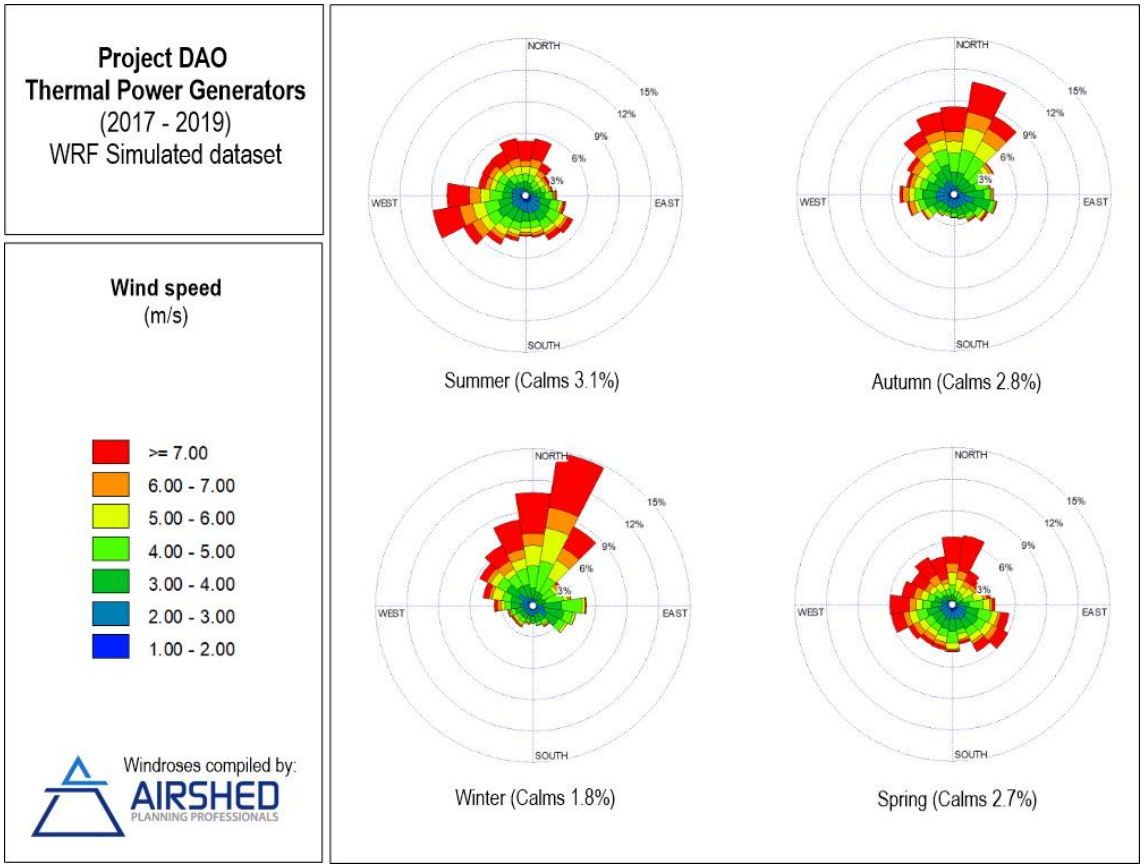

Figure 5-3: Seasonal wind roses (WRF simulated data; 2017 to 2019)

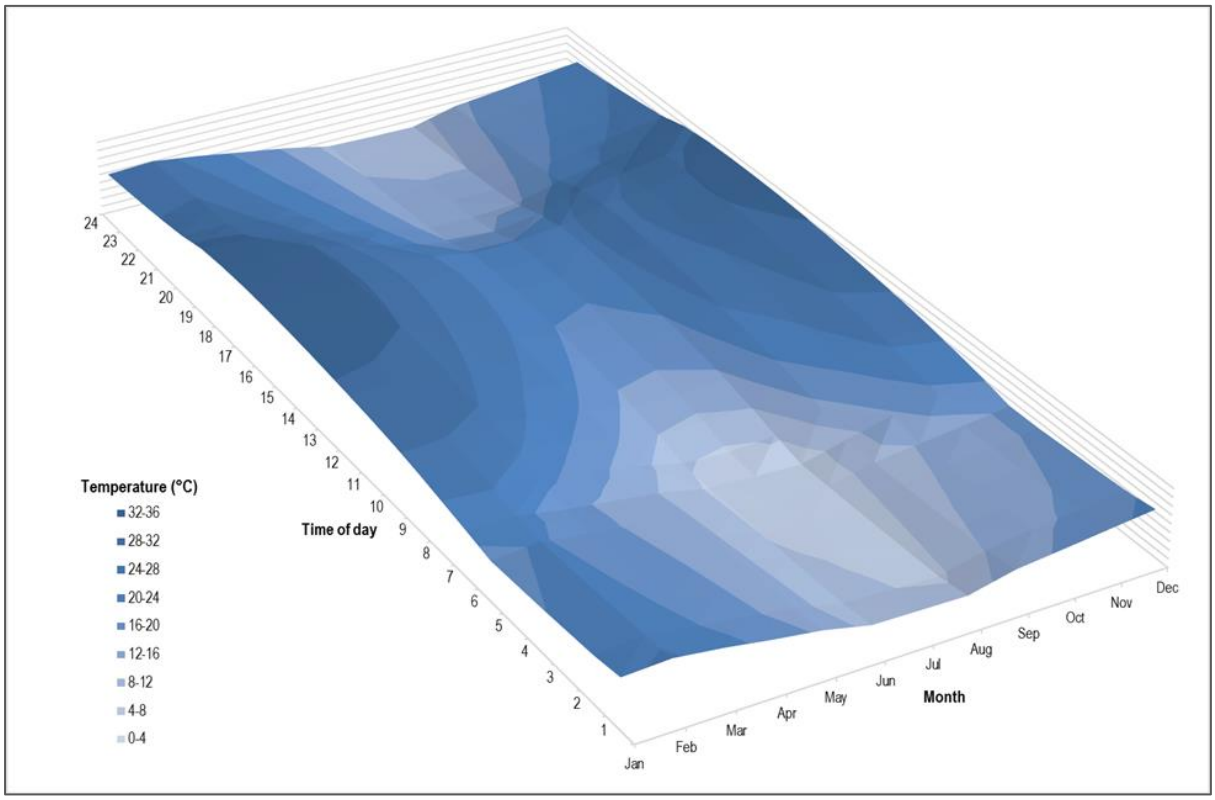

Figure 5-4: Monthly temperature profile (WRF simulated data; 2017 to 2019)

Table 5-5: Monthly temperature summary (2017 - 2019)

Hourly Minimum, Hourly Maximum and Monthly Average Temperatures (°C)												
Statistics	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Minimum	-1.3	-1.8	-2.5	-2.8	-3.1	-3.6	-3.8	-2.5	2.8	4.4	6.4	7.9
Average	17.0	15.2	14.6	14.0	13.5	13.1	14.3	17.0	19.9	22.3	24.0	25.5
Maximum	31.1	28.1	27.0	27.1	27.2	26.7	29.2	32.3	34.2	35.5	36.8	37.6

5.1.3.3 Atmospheric Stability

The atmospheric boundary layer properties are described by two parameters: the boundary layer depth and the Obukhov length.

The Obukhov length (LMo) provides a measure of the importance of buoyancy generated by the heating of the ground and mechanical mixing generated by the frictional effect of the earth's surface. Physically, it can be thought of as representing the depth of the boundary layer within which mechanical mixing is the dominant form of turbulence generation (CERC, 2004). The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. During daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface. Night-times are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds and lower dilution potential.

Diurnal variation in atmospheric stability as described by the inverse Obukhov length and the boundary layer depth is provided in Figure 5-5. The highest concentrations for ground level, or near-ground level, releases from non-wind dependent sources would occur during weak wind speeds and stable (night-time) atmospheric conditions.

For elevated releases, unstable conditions can result in very high concentrations of poorly diluted emissions close to the stack. This is called looping and occurs mostly during daytime hours. Neutral conditions disperse the plume fairly equally in both the vertical and horizontal planes and the plume shape is referred to as coning. Stable conditions prevent the plume from mixing vertically, although it can still spread horizontally and is called fanning (Figure 5-5) (Tiwary & Colls, 2010).

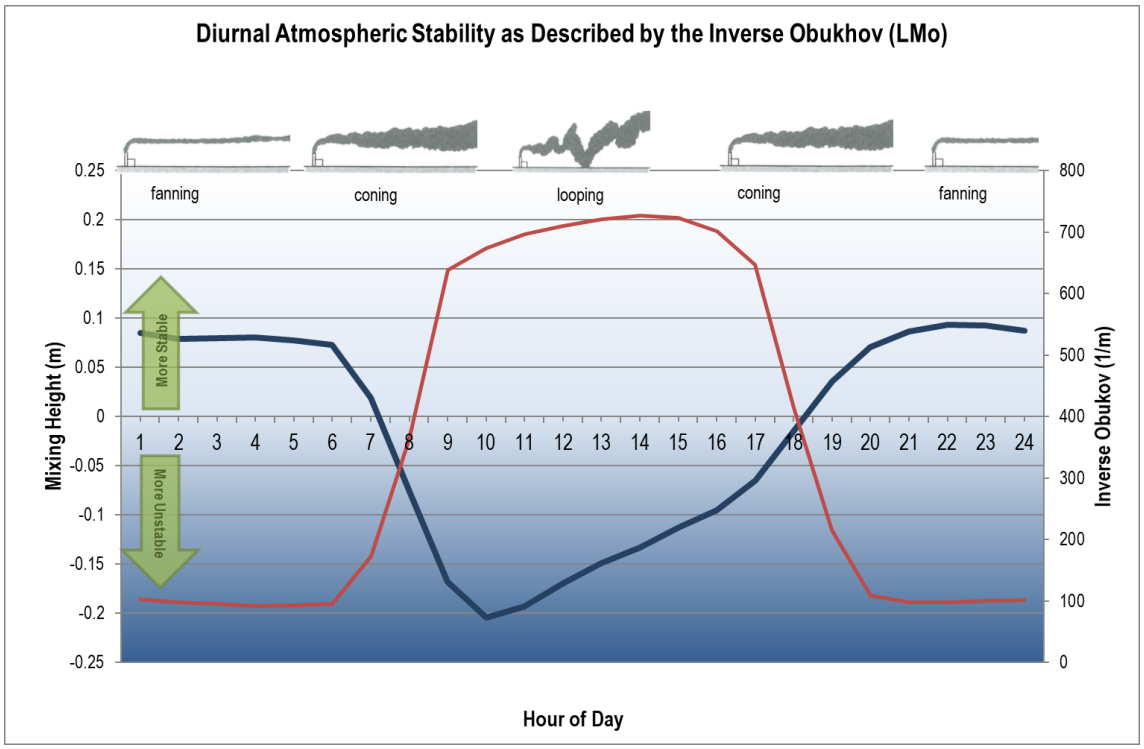

Figure 5-5: Diurnal atmospheric stability (extracted from simulated data at the project site)

5.1.4 Existing Sources of Emissions near the proposed Project Site

A comprehensive emissions inventory for the study area was not available for the basic assessment and the establishment of such an inventory was not within the scope of the current study. Instead, source types present in the area and the pollutants associated with such source types are noted with the aim of identifying pollutants which may be of importance in terms of cumulative impact potentials. Existing pollutant sources in the area surrounding the proposed project are discussed below.

Opencast Mining

Iron ore and manganese mining occurs within the vicinity of the proposed project. Opencast mines are associated with significant dust emissions, sources of which include land clearing, blasting and drilling operations, materials handling, vehicle entrainment, crushing, screening, among others.

Construction of Solar Power Facilities

Solar power facilities awaiting construction within a 60 km radius of the project include two 100 MW Concentrated Solar Thermal (CST) facilities near Upington.

Other Fugitive Dust Sources

Fugitive dust emissions may occur as a result of vehicle entrained dust from local paved and unpaved roads, wind erosion from open areas and dust generated by agricultural activities (e.g. tilling) and mining. The extent of particulate emissions from the main roads will depend on the number of vehicles using the roads, and on the silt loading on the roadways.

5.1.5 Baseline Ambient Air Quality

Measured air quality data from the DFFE Karoo air quality monitoring station (AQMS) was accessed from the South African Air Quality Information System (SAAQIS) for use in this assessment. The station is located near the town of Nieuwoudtville, 575 km to the south-west of the proposed project site. The Karoo station is considered by the DFFE to be a station measuring background levels of pollutants for the country since it is not influenced by typical sources resulting in high pollution loads (for example, industry, domestic fuel burning in high density residential areas, vehicle exhaust emissions in heavy traffic zones). Although the AQMS is located far from the project site, the sources in the vicinity and the climatic zones are similar. The period April 2018 to October 2020 was available from this online database. Data availability for the period varied between 6% and 97%, depending on the pollutant (Table 5-6). The following is noted from the dataset:

- No exceedances of the hourly NAAQS were recorded for SO_2, NO_2, or CO during the period of assessment;
- No exceedances of the daily NAAQS were recorded for SO_2, $PM_{2.5}$, or PM_{10} during the period of assessment;
- Exceedances of the 8-hourly average O_3 NAAQ limit concentration occurred 22 times in 2018 and twice in 2020. The NAAQS allow for 11 exceedances of the 8-hourly O_3 limit concentration per year.
- Compliance with annual NAAQS for all relevant pollutants in 2019 – the only year where data availability was sufficient to assess compliance.

Table 5-6: Summary of the ambient measurements at DFFE Karoo AQMS for the period 2018 – 2020

Karoo Background AQMS						
Period	**Data Availability**	**Hourly**	**Daily**	**Annual Average**	**No of recorded hourly exceedances**	**No of recorded daily exceedances**
		99th Percentile	**99th Percentile**			
SO_2 (ppb)						
Criteria		*134 ppb*	*48 ppb*	*19 ppb*	*88 hours per year*	*4 days per year*
2018[a]	47%	3.16	1.38	1.17	0	0
2019	95%	6.50	6.49	2.44	0	0
2020[b]	52%	5.20	4.76	1.59	0	0
NO_2 (ppb)						
Criteria		*106 ppb*		*21 ppb*	*88 hours per year*	
2018[a]	38%	7.84		1.17	0	
2019	82%	5.08		2.44	0	
2020[b]	48%	5.73		1.59	0	
CO (ppm)						
Criteria		*26 ppm*			*88 hours per year*	
2018[a]	41%	0.27			0	
2019	89%	0.50			0	
2020[b]	43%	2.00			0	

Karoo Background AQMS						
Period	Data Availability	Hourly 99th Percentile	Daily 99th Percentile	Annual Average	No of recorded hourly exceedances	No of recorded daily exceedances
$PM_{2.5}$ (µg/m³)						
Criteria		*n/a*	*40 µg/m³*	*25 µg/m³*	*n/a*	*4 days per year*
2018[(a)]	47%		11.54	1.17		0
2019	97%		16.29	2.44		0
2020[(b)]	30%		8.97	1.59		0
PM_{10} (µg/m³)						
Criteria		*n/a*	*75 µg/m³*	*40 µg/m³*	*n/a*	*4 days per year*
2018[(a)]	47%		17.25	1.17		0
2019	97%		39.53	2.44		0
2020[(b)]	29%		30.10	1.59		0
O_3 (ppb)						
Criteria		*n/a*	*61 ppb*		*n/a*	
2018[(a)]	24%		97.06			22
2019	66%		50.03			0
2020[(b)]	6%		75.23			2

Notes:
(a) Incomplete year (April to December)
(b) Incomplete year (January to October)

Diurnal and seasonal variation plots – generated using openair (Carslaw & Ropkins, 2012; and Carslaw, 2019) - of ambient SO_2, NO_2, CO (Figure 5-6) along with $PM_{2.5}$ and PM_{10} (Figure 5-7) measured at the DFFE Karoo AQMS show the variation of ambient concentrations over daily, weekly and annual cycles (mean with 95% confidence interval). The data have been normalised by dividing by the respective mean values to allow comparison of the shape of diurnal trends for the variables on very different measurement scales (Carslaw, 2019). The pattern shows morning and late evening peak NO_2 concentrations possibly associated with vehicle traffic and domestic fuel burning. CO concentrations show a similar early morning and late afternoon peak possibly associated with vehicle traffic. A slight mid-day peak is evident for SO_2 and is likely associated with the break-up of an elevated inversion layer, in addition to the development of daytime convective conditions causing the plumes from stacks at small industry sources to be brought down to ground level. Particulate fractions (Figure 5-7) show increased concentrations in the late afternoon, possibly associated with domestic fuel burning or wind field patterns where higher wind speeds could result in entrainment of particulate matter from exposed areas. The only pollutant with a discernible seasonal pattern is CO which increases in late winter and spring and is possibly associated with veld fires.

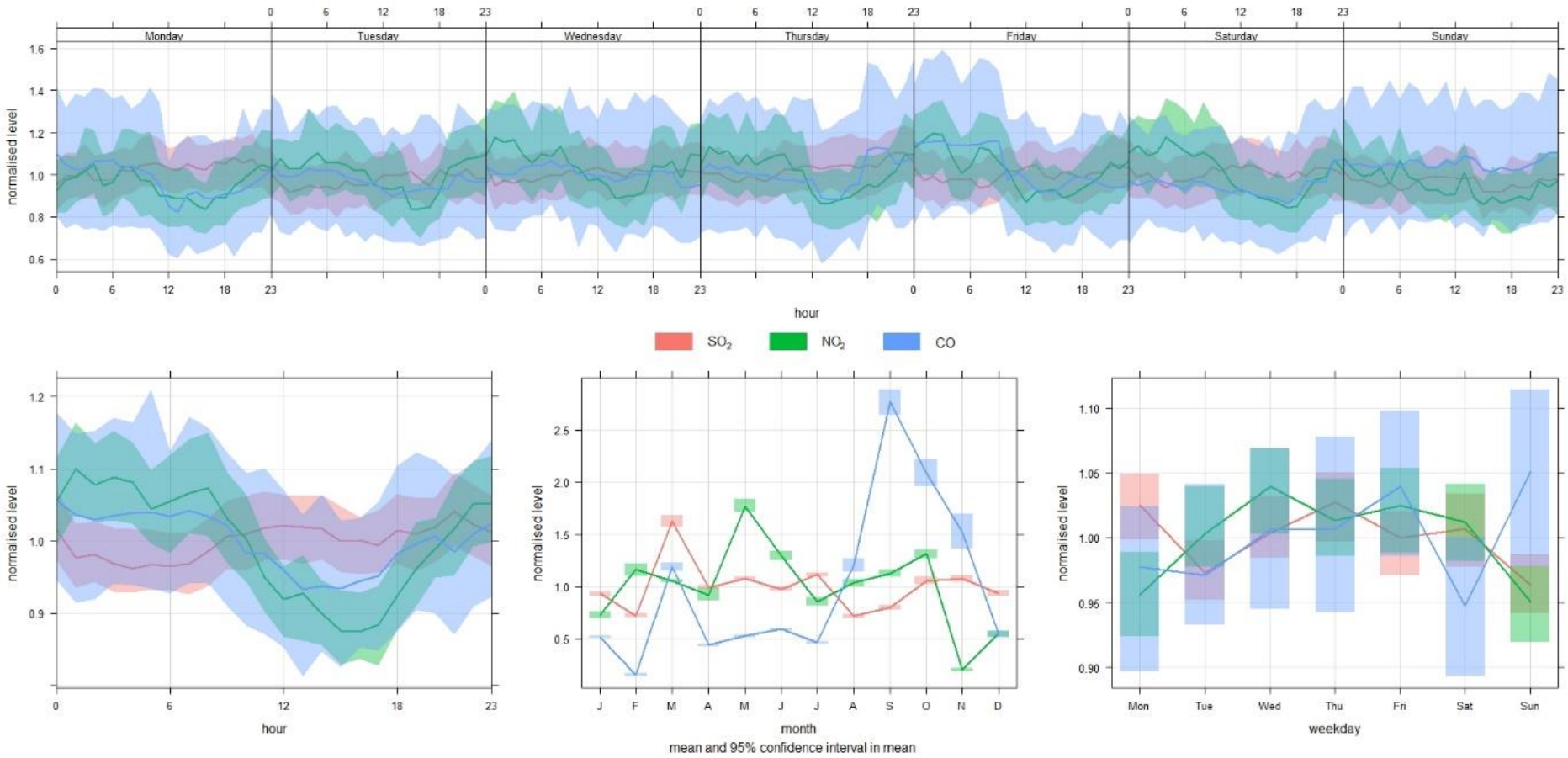

Figure 5-6: Diurnal and seasonal variation plots of observed SO_2, NO_2, and CO at the DFFE Karoo AQMS (shaded area indicates 95th percentile confidence interval)

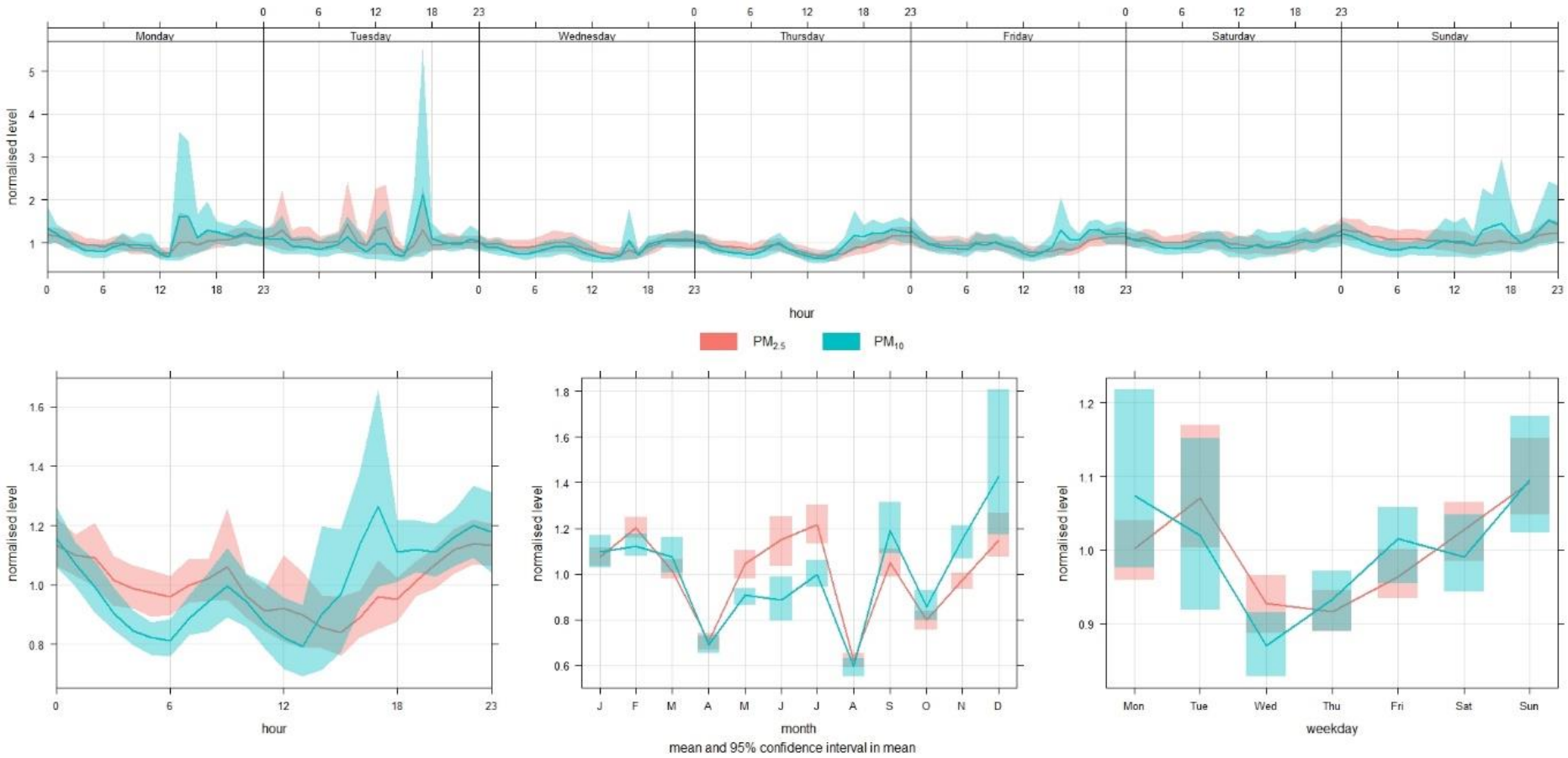

Figure 5-7: Diurnal and seasonal variation plots of observed $PM_{2.5}$ and PM_{10} at the DFFE Karoo AQMS (shaded area indicates 95th percentile confidence interval)

5.1.6 Dispersion Modelling of Project – Incremental Impact of Normal Operations

Impact of the operational phase was simulated using the parameters and emission rates given in Section 4 (Table 4-1, Table 4-2, Table 4-4, and Table 4-5). Short-term (hourly or daily) concentrations were extracted at the 99th percentile, to account for the number of exceedances allowed by the NAAQS.

5.1.6.1 Simulated Incremental SO_2 Impacts

The simulated SO_2 concentrations associated with normal operation of the project were below the hourly (Figure 5-8) and daily (Figure 5-9) National Ambient Air Quality (NAAQ) limit values on- and off-site and at all receptors. Annual concentrations were also simulated to be lower than the respective NAAQS (Figure 5-10).

5.1.6.2 Simulated Incremental NO_2 Impacts

Simulated (worst-case) hourly NO_2 concentrations could exceed the NAAQ limit concentration up to 1.9 km to the south of the project boundary, (Figure 5-11). Simulated hourly average NO_2 concentrations are likely to be near 100 µg/m³ at the nearest receptor (SR1 - Figure 5-11), where the frequency of exceedance of the NAAQ limit was calculated to be at maximum 35 hours per year (data not shown), where 88 hours of exceedance are allowed per year. Simulated annual average NO_2 concentrations are lower than the NAAQS across the domain, with a domain maximum less than 2 µg/m³ (Figure 5-12).

To identify the potential impact of the project on the ambient NO_2 concentrations during the reliability test, all 56 engines were assumed to run simultaneously over the entire meteorological period (2017 to 2019) and NO_2 concentrations at the nearest receptor were simulated. From an air quality perspective, the months of April to July are when dispersion conditions are least favourable and are most likely to result in the most frequent exceedances of the hourly NAAQ limit concentration at the closest sensitive receptor (SR1 - Table 5-7). The months of August to November (as late winter and sprint) provide atmospheric conditions that are more suitable for pollutant dispersal and, therefore, lower pollutant concentrations at the closest sensitive receptor (SR1 - Table 5-7).

Table 5-7: Simulated NO_2 impact at the closest sensitive receptor for continuous operation of the generators during the 15-day reliability test

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hours exceeding 200 µg/m³	3	2	4	10	8	9	5	5	5	4	1	1

5.1.6.3 Simulated Incremental Particulate Matter Impacts

Simulated particulate matter concentrations, in both the PM_{10} and $PM_{2.5}$ fractions, as a result of the project were in below all the respective NAAQS at all receptors and across the entire domain (Figure 5-14 to Figure 5-17).

Simulated annual $PM_{2.5}$ concentrations are below the chronic inhalation criterion for DPM across the domain (Figure 5-17 - where the criterion is 5 µg/m³ and concentrations are lower than 0.1 µg/m³ off-site). Excess life-time cancer risk due to exposure to DPM (see Section 5.1.2.5) were calculated to be "Very low" at the closest receptors (Table 5-8). Across the

domain the risk was calculated to be “Low” within 1.2 km south of the project boundary and “Very low” elsewhere (Figure 5-18).

Table 5-8: Incremental life-time cancer risk at the closet receptor due to exposure to DPM

ID	Annual DPM concentration ($PM_{2.5}$)	Excess life-time cancer risk ratio	Qualitative Descriptor
SR01	0.0012	$3.53X10^{-07}$	Very low
SR02	0.0006	$1.66X10^{-07}$	Very low

5.1.6.4 Simulated Incremental CO Impacts

Simulated hourly CO concentrations as a result of the project are lower than the NAAQ limit values at receptors and across the entire domain (Figure 5-19).

5.1.6.5 Simulated Incremental VOC Impacts

Simulated hourly VOC concentrations across the domain as a result of the project are lower than the international health criteria (200 µg/m³) selected for the project (Figure 5-20). If all VOCs were conservatively assumed to be benzene – which is unlikely given the low benzene contents typical of diesel – off-site concentrations would comply with the annual benzene NAAQS.

5.1.7 Cumulative Impacts

The cumulative impact of the proposed 49.5 MW thermal power generation facility was assessed by adding the off-site maximum simulated concentrations to the measured concentrations at the DFFE Karoo monitoring station (Table 5-9). The proposed facility is likely to make the largest impact on hourly NO_2 concentrations with potential exceedances of the NAAQ limit concentration. Based on Table 5-7, the number of exceedances is likely to be within the frequency allowed by the NAAQS.

Table 5-9: Estimated cumulative impact of the project and existing baseline air pollutant concentrations

Source group	SO_2 (µg/m³)			NO_2 (µg/m³)		PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)	
	Hourly	Daily	Annual	1 hour	Annual	24 hour	Annual	24 hour	Annual
Baseline – Karoo[(a)]	17.0	17.0	6.4	9.6	4.6	39.5	2.4	16.3	2.4
ACWA Project DAO[(b)]	18.7	6.8	0.016	442.0	1.2	5.5	0.013	5.5	0.013
Cumulative	35.8	23.8	6.4	**451.6**	5.8	45.0	2.4	21.8	2.4

Notes:
(a) 2019 used as indicative year since data availability was acceptable and representative of a full year
(b) Conservatively uses off-site maximum simulated concentration

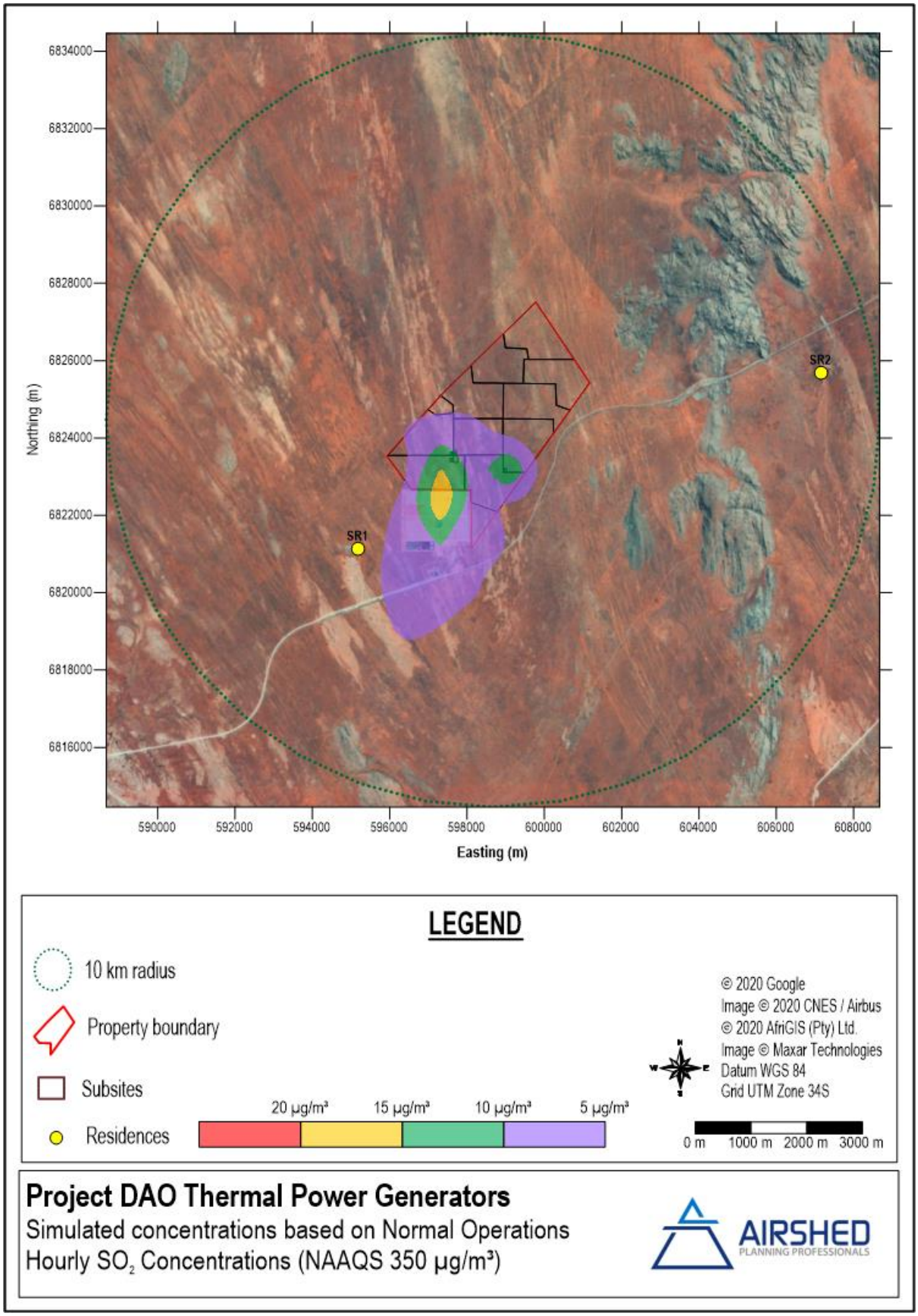

Figure 5-8: Simulated hourly average ambient SO_2 concentrations

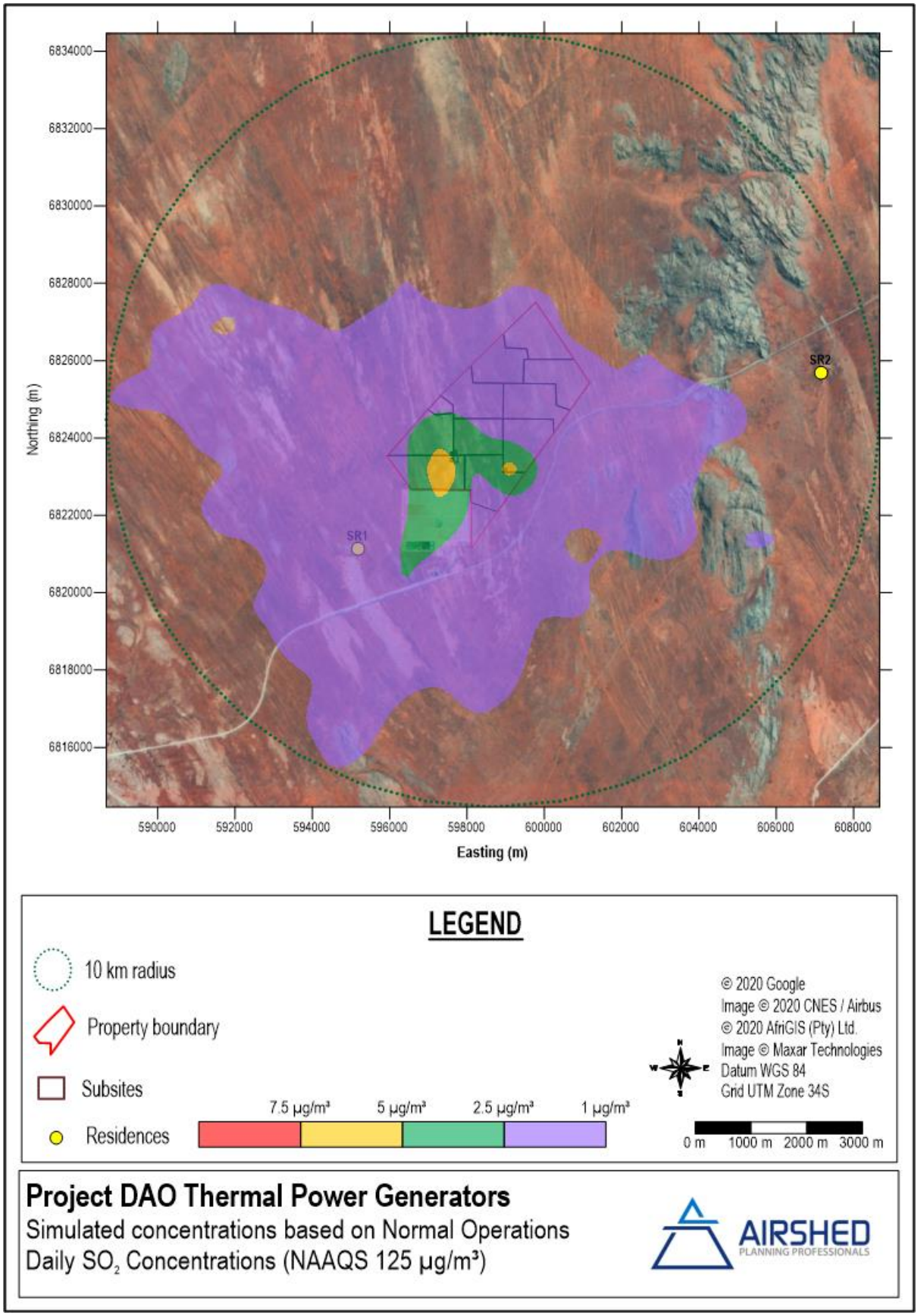

Figure 5-9: Simulated daily average ambient SO_2 concentrations

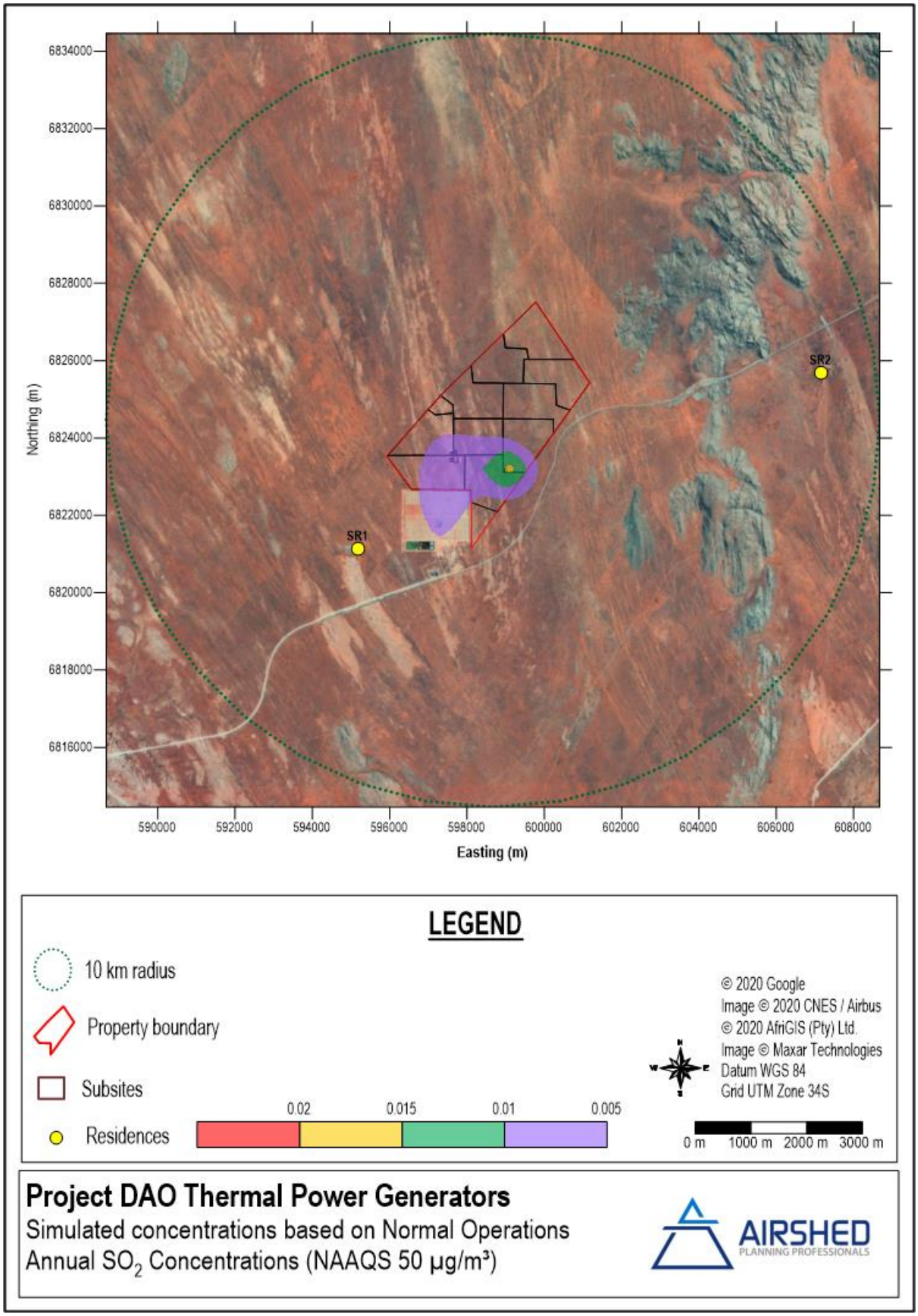

Figure 5-10: Simulated annual average ambient SO_2 concentrations

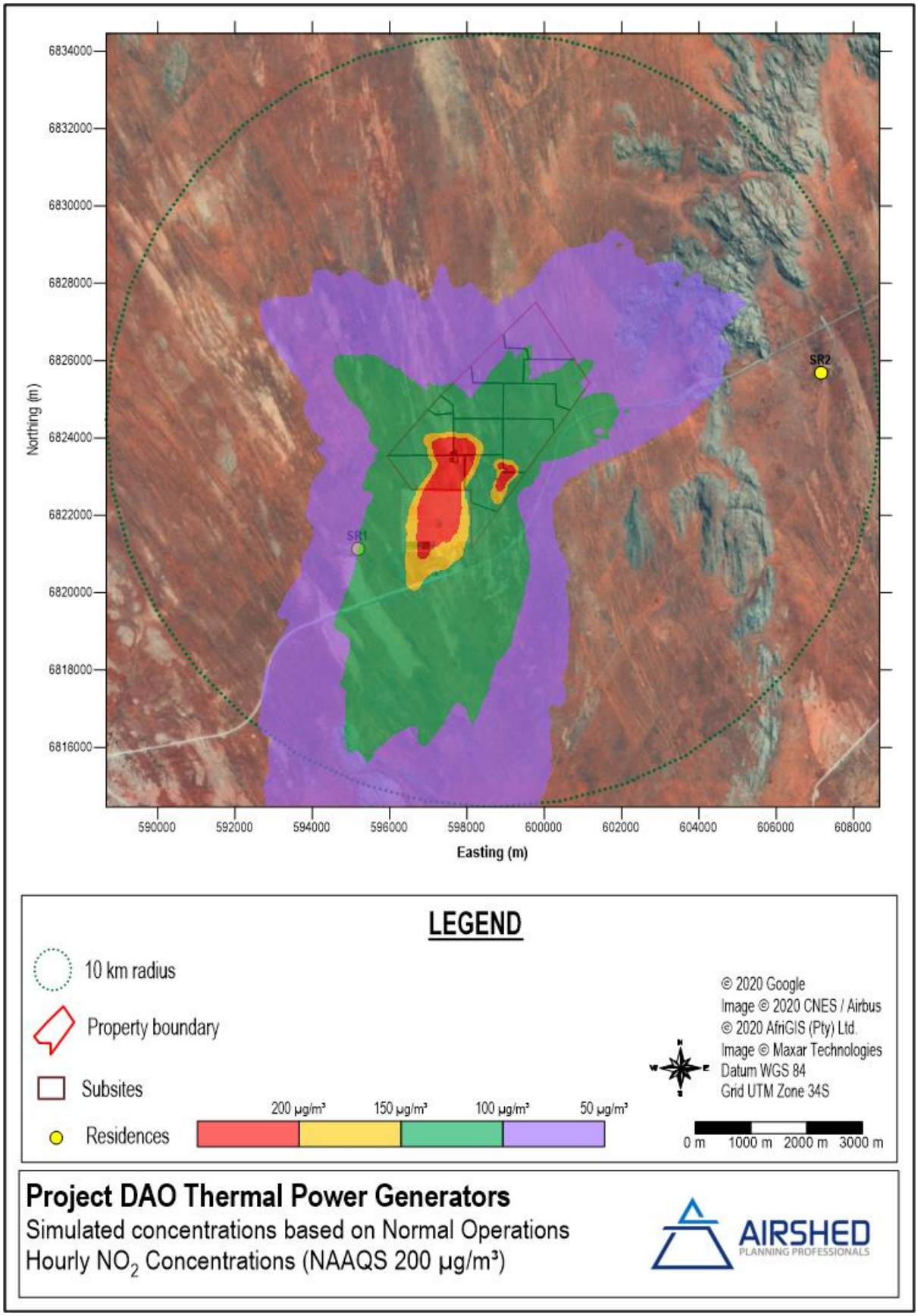

Figure 5-11: Simulated hourly average ambient NO_2 concentrations

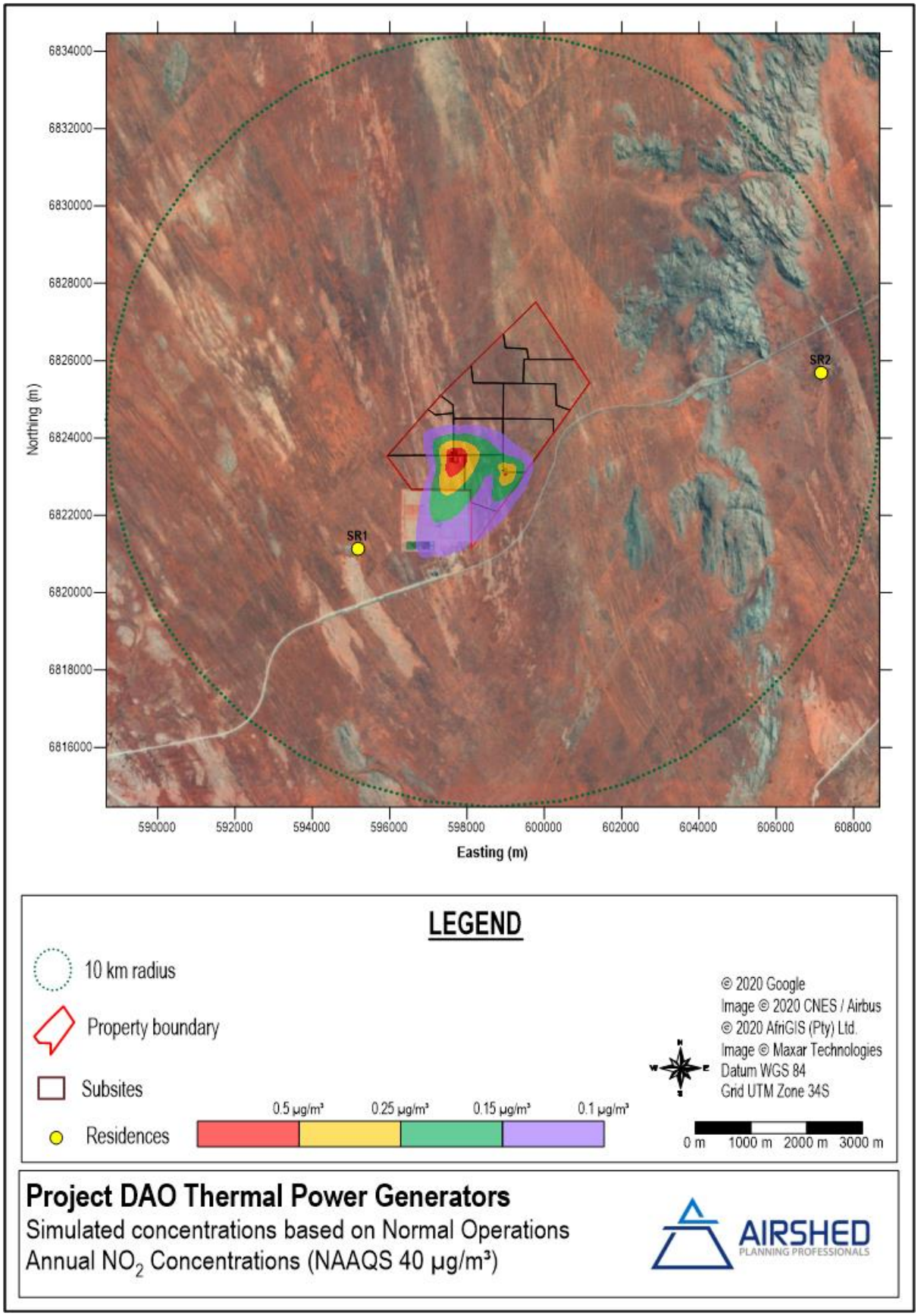

Figure 5-12: Simulated annual average ambient NO_2 concentrations

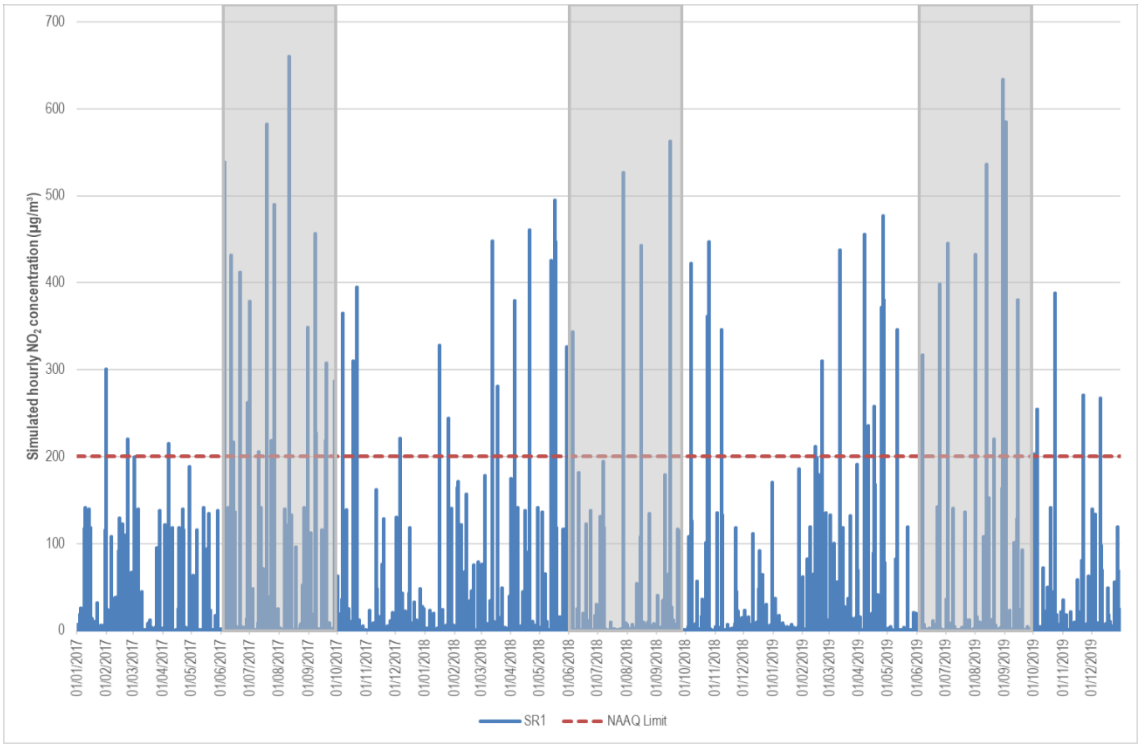

Figure 5-13: Simulated time series of ambient NO_2 concentrations at the closest receptor assuming continuous operation for the purposes of identifying suitable periods for the reliability tests (grey blocks indicate the highest number of exceedances of the NO_2 NAAQ limit concentration)

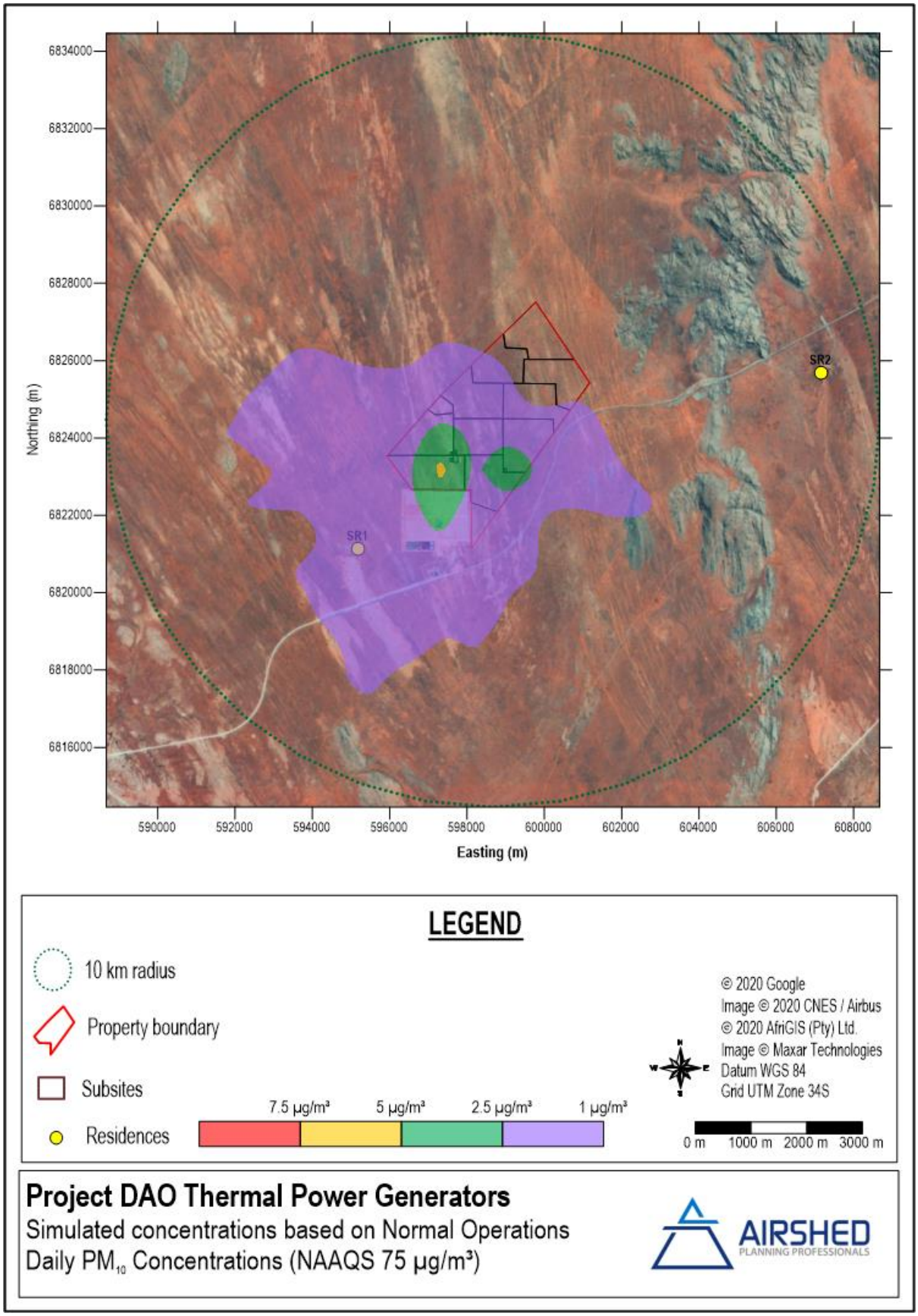

Figure 5-14: Simulated daily average ambient PM_{10} concentrations

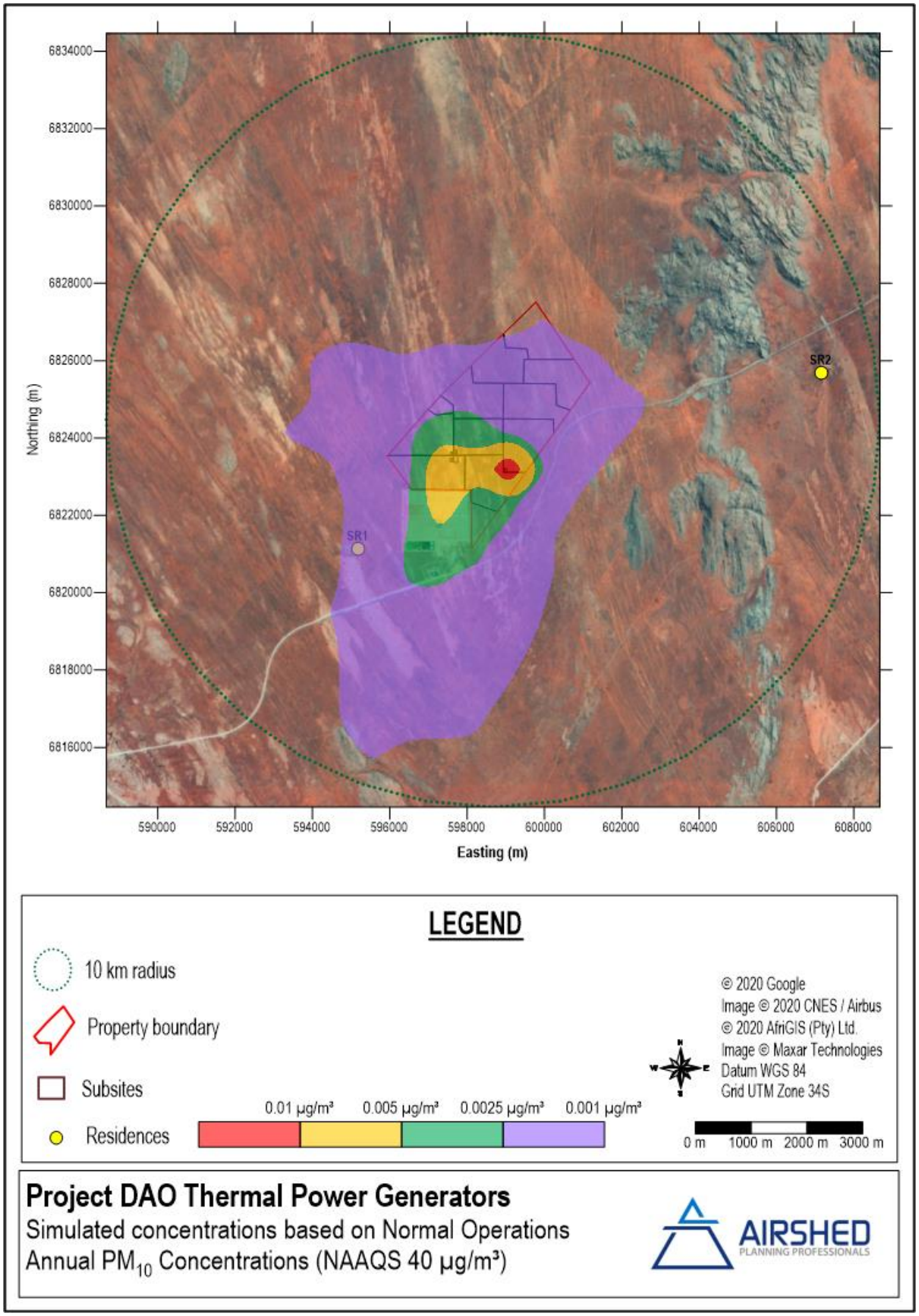

Figure 5-15: Simulated annual average ambient PM_{10} concentrations

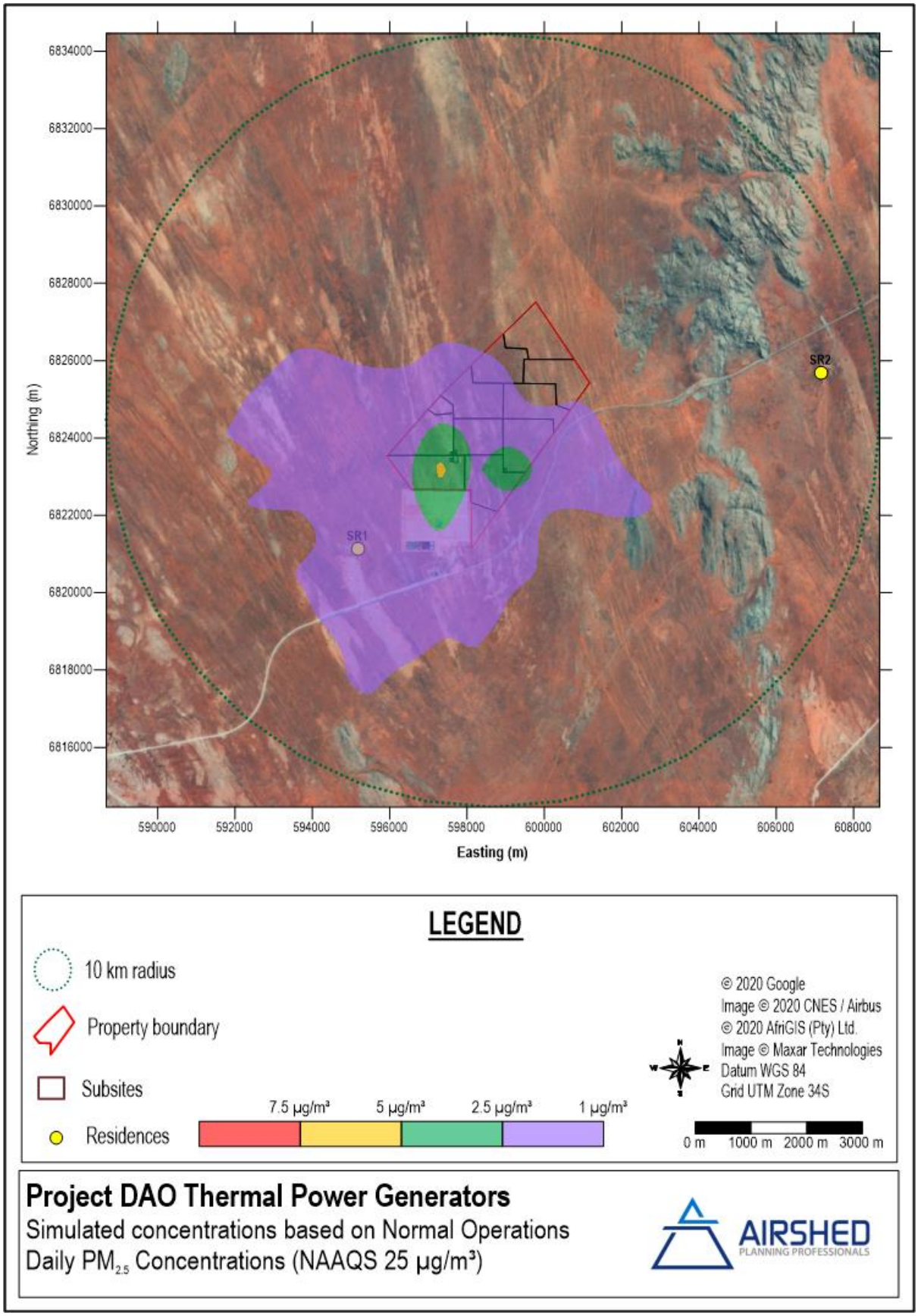

Figure 5-16: Simulated daily average ambient $PM_{2.5}$ concentrations

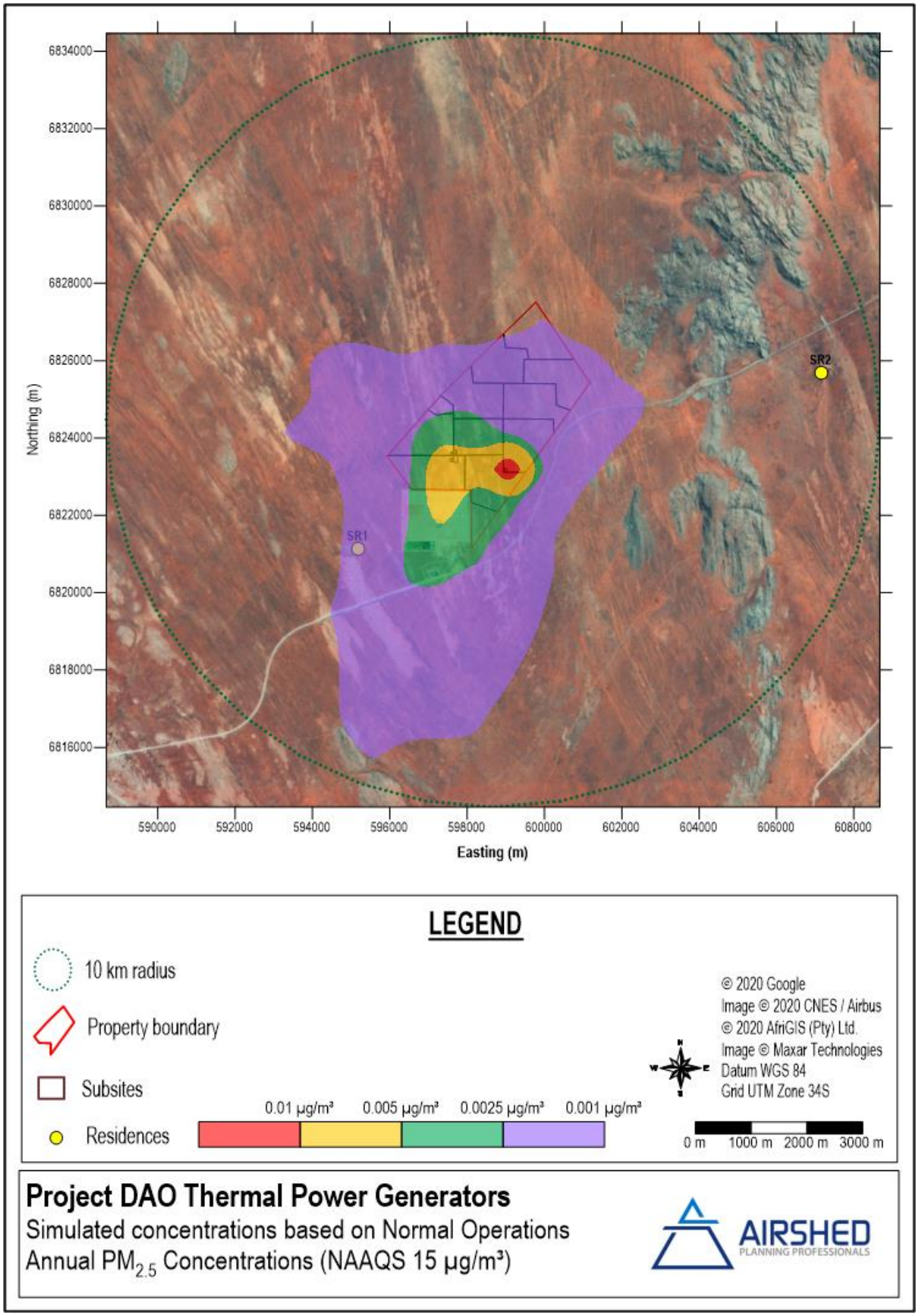

Figure 5-17: Simulated annual average ambient $PM_{2.5}$ concentrations

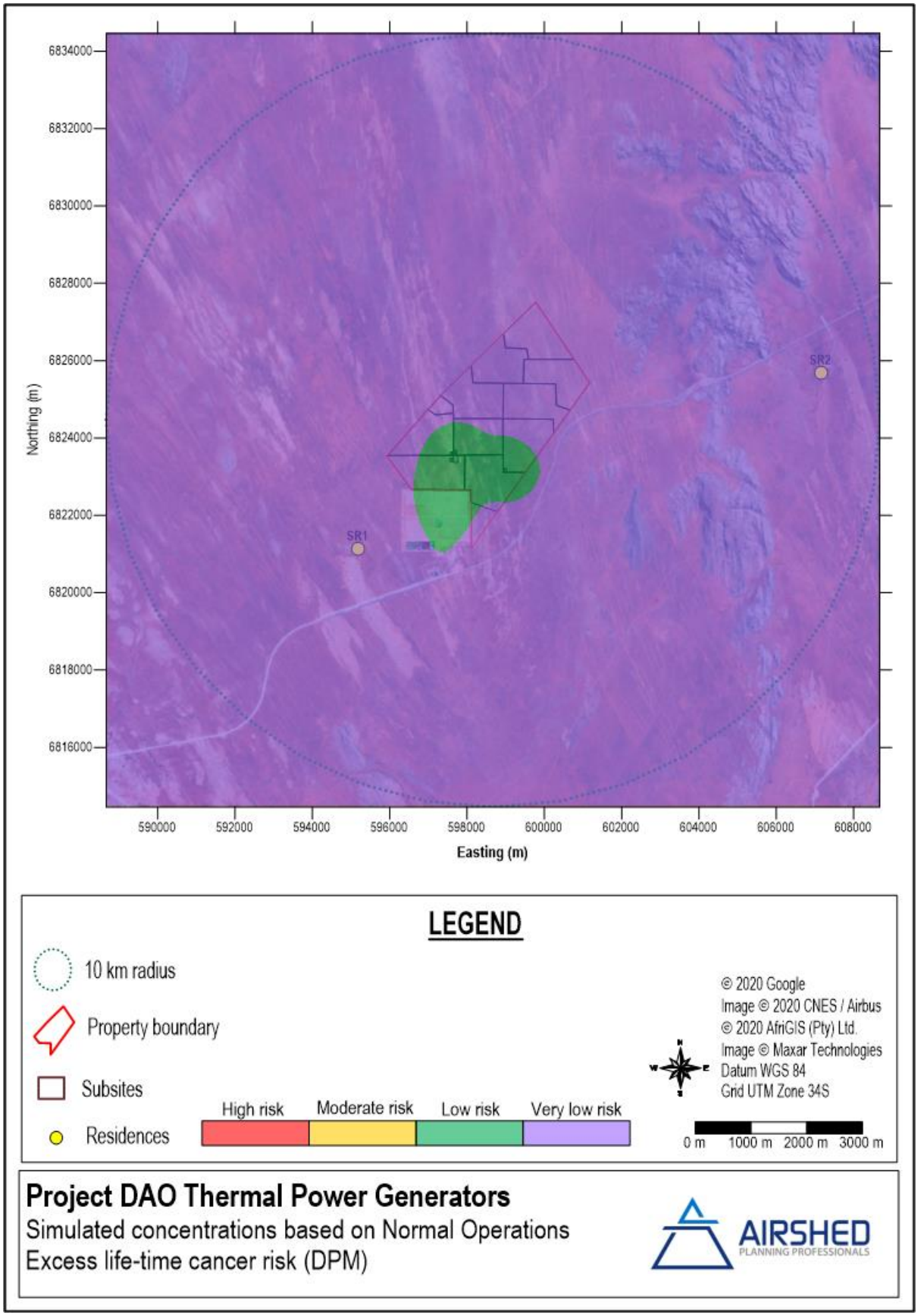

Figure 5-18: Simulated excess life-time cancer risk due to exposure to DPM (based on annual $PM_{2.5}$ concentrations)

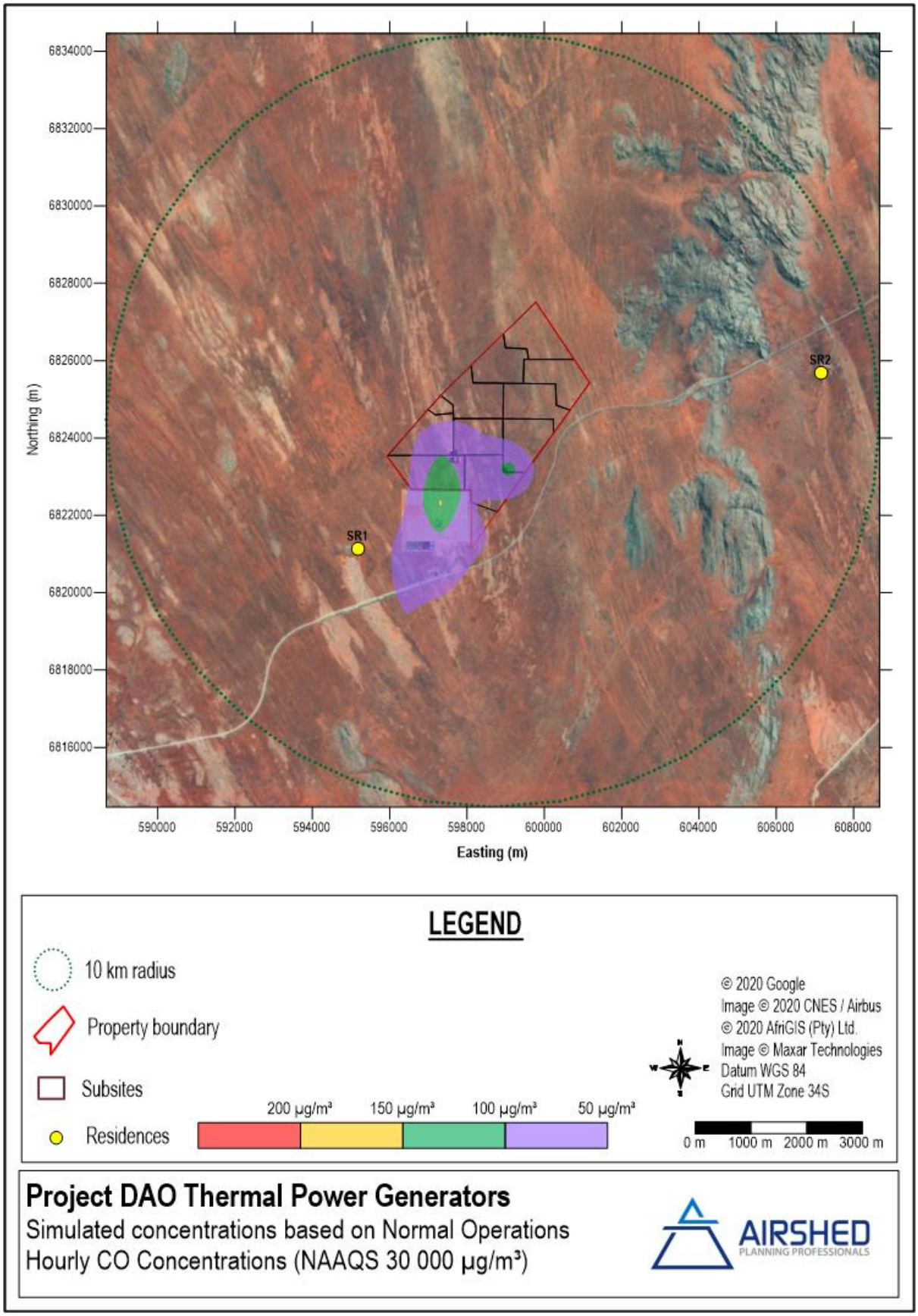

Figure 5-19: Simulated hourly average ambient CO concentrations

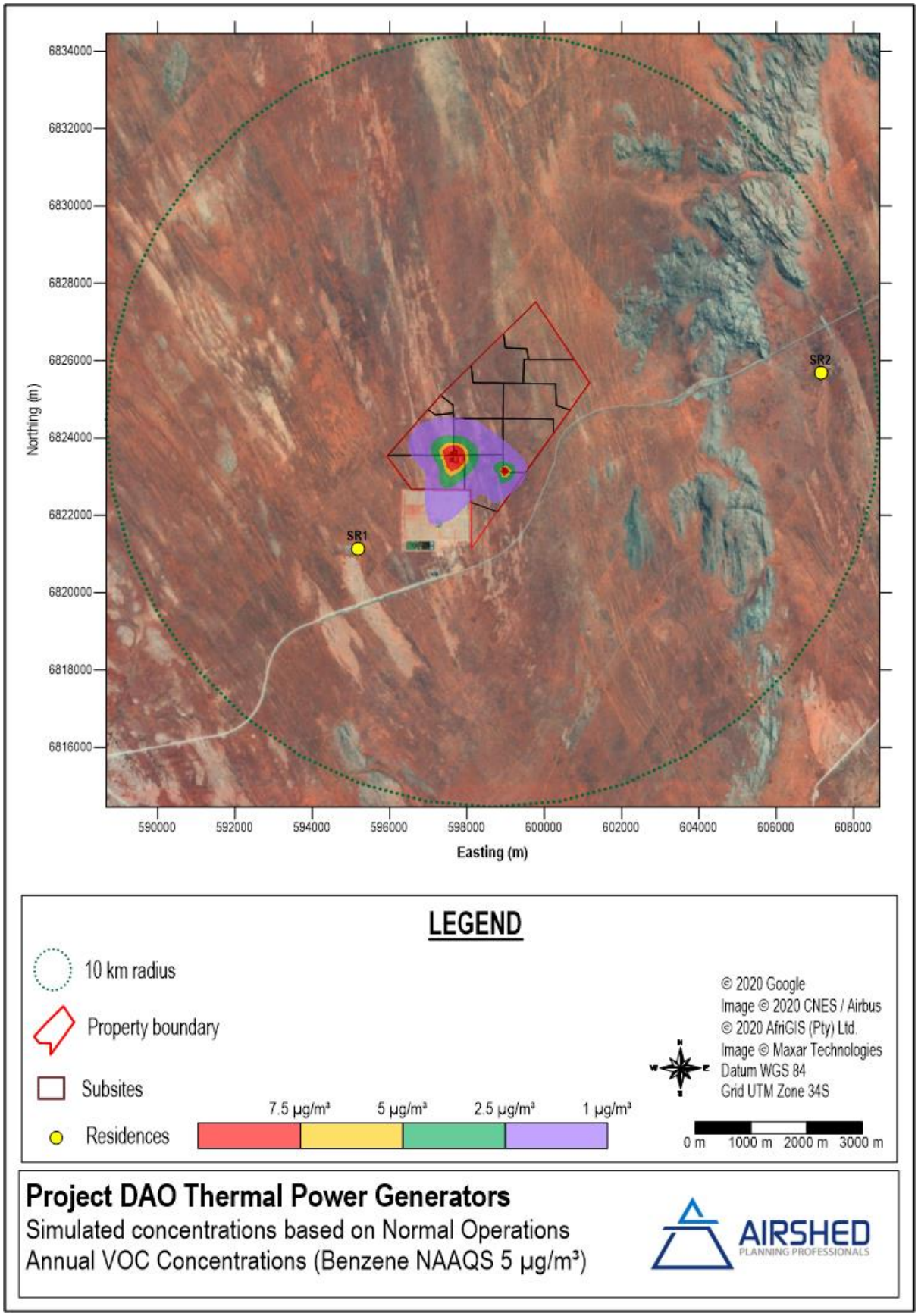

Figure 5-20: Simulated annual average ambient VOC concentrations

5.2 Analysis of Emissions' Impact on the Environment

In the absence of a prescribed methodology (in the Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette No. 36904, Notice Number 747 of 2013; 11 October 2013), the impact of emissions from the facility on the environment was assessed using the pollutant critical levels that may affect vegetative productivity, and nuisance dustfall. The same dispersion modelling approach was used as in the assessment of impact of the facility on human health (described in Section 5.1.1).

5.2.1 Critical Levels for Vegetation

The impact of emissions associated with the project on the surrounding vegetation was assessed by comparing the simulated annual SO_2 and NO_2 concentrations for each of the emission scenarios against the critical levels for vegetation as defined by the United Nations Economic Commission for Europe (UNECE) Convention on Long Range Trans-boundary Air Pollution limits (CLRTAP, 2015) (Table 5-10). The annual concentrations of SO_2 are lower than the critical level affecting cyanobacterial lichen across the domain, where the domain maximum annual average concentrations are less than 0.1 µg/m³ (see Figure 5-10). Domain maximum annual NO_2 concentrations are less than 2 µg/m³ and are therefore not likely to affect vegetation within the domain (see Figure 5-12).

Table 5-10: Critical levels for SO_2 and NO_2 by vegetation type (CLRTAP, 2015)

Pollutant	Vegetation type	Critical Level (µg/m³)	Time Period[(a)]
SO_2	Cyanobacterial lichens	10	Annual average
	Forest ecosystems (including understorey vegetation)	20	Annual average and Half-year mean (winter)
	(Semi-)natural vegetation	20	Annual average and Half-year mean (winter)
	Agricultural crops	30	Annual average and Half-year mean (winter)
NO_2	All	30	Annual average and Half-year mean (winter)
		75	Daily average

Notes:
(a) For the purposes of mapping of critical levels and exceedances CLRTAP recommend using only the annual average, due to increased reliability of mapped and simulated data for the longer period. It is also noted that long-term effects of NO_2 are more significant than short-term effects (CLRTAP, 2015).

5.2.2 Effects of SO_2 and NO_2 on Animals

In addition to potential exposure to outdoor environmental air pollution, animals kept in large-scale husbandry facilities are exposed to, and often diseased by, self-made indoor air pollution that is a function of the conditions under which the animals are reared (Van den Hoven, 2011).

Experimental studies on animals have shown the acute inhalation of SO_2 produces bronchoconstriction, increases respiratory flow resistance, increases mucus production and has been shown to reduce abilities to resist bacterial infection in mice (Costa & Amdur, 1996). Short exposures to low concentrations of SO_2 (~2.6 mg/m³) have been shown to have immediate physiological response without resulting in significant or permanent damage. Short exposures (<30 min) to concentrations of 26 mg/m³ produced significant respiratory changes in cats which were usually completely reversible once exposure had ceased (Corn *et al*., 1972).

Sulfur dioxide can produce mild bronchial constriction, changes in metabolism and irritation of the respiratory tract and eyes in cattle (Blood and Radostits, 1989 as cited in Coppock and Nostrum, 1997). An increase in airway resistance was reported in sensitized sheep after four hours of exposure to 13 mg/m³. Studies report chronic exposure can affect mucus secretions and result in respiratory damage similar to chronic bronchitis. These effects were reported at concentrations above typical ambient concentrations (26-1 053 mg/m³) (Dalhamn, 1956 as cited in Amdur, 1978). Exposure to air pollutants is expected to result in similar adverse effects in wildlife as in laboratory and domestic animals (Newman, 1979).

The simulated annual concentrations of SO_2 associated with the project are very low (<0.1 µg/m³ off-site) and are expected to have a negligible impact on animal health.

The toxicity of NO_2 is related to oxidation processes that form nitric acid with water in the eyes, lungs, mucous membranes and on the skin of animals (MFE, 2004) and result in oxidation of cell membrane lipids and proteins triggering inflammation (Menzel, 1994). Long term exposure to nitrogen oxides increases respiratory infections resulting in lowered resistance to diseases such as pneumonia and influenza (MFE, 2004). An acute association between ambient NO_2 concentrations and dairy cattle mortality was found in Belgium during cold and warm season exposure to NO_2, however, these acute associations did not influence cumulative exposure over a 26-day experimental period (Cox, et al., 2016)The daily average NO_2 concentrations to which for the dairy cattle studied by Cox *et al.* (2016) were exposed ranged between 7.8 and 60 µg/m³ in the warm season and between 21 and 93 µg/m³ in the cold season.

The calculated[1] (data not shown) maximum daily average concentration was lower than 265 µg/m³, while the average simulated daily NO_2 concentration was less than 2 µg/m³ the project is likely to have a low impact on animal health.

5.2.3 Effects of Particulate Matter on Animals

As presented by the Canadian Environmental Protection Agency (CEPA/FPAC Working Group, 1999) experimental studies using animals have not provided convincing evidence of particle toxicity at ambient levels. Acute exposures (4-6 hour single exposures) of laboratory animals to a variety of types of particles, almost always at concentrations well above those occurring in the environment have been shown to cause decreases in lung function, changes in airway defence mechanisms and increased mortality rates.

The epidemiological finding of an association between 24-hour ambient particle levels below 100 µg/m³ and mortality has not been substantiated by animal studies as far as PM_{10} and $PM_{2.5}$ are concerned. With the exception of ultrafine particles (0.1 µm), none of the other particle types and sizes used in animal inhalation studies cause such dramatic acute effects, including high mortality at ambient concentrations. The lowest concentration of $PM_{2.5}$ reported that caused acute death in rats with acute pulmonary inflammation or chronic bronchitis was 250 g/m³ (3 days, 6 hours/day), using continuous exposure to concentrated ambient particles.

The simulated annual concentrations of PM_{10} and $PM_{2.5}$ associated with the project were very low (<0.01 µg/m³ off-site) and are expected to have a negligible incremental impact on animal health.

[1] Using the hourly to daily conversion factor (0.4) recommended in Table 8 of the Regulations Regarding Air Dispersion Modelling (Gazette No 37804 published 11 July 2014)

5.2.4 Nuisance Dustfall

5.2.4.1 National Dust Control Regulations

The National Dust Control Regulations (NDCR) was gazetted on 1 November 2013 (No. 36974). The purpose of the regulations is to prescribe general measures for the control of dust in all areas including residential and light commercial areas. The standard for acceptable dustfall rate is set out in Table 5-11. The method to be used for measuring dustfall rate and the guideline for locating sampling points shall be ASTM D1739: 1970, or equivalent method approved by any internationally recognized body. It is important to note that dustfall is assessed for nuisance impact and not inhalation health impact.

Table 5-11: Acceptable dustfall rates

Restriction Area	Dustfall Rate (mg/m².day; 30-day average)	Permitted Frequency of Exceeding Dustfall Rate
Residential area [(a)]	D<600	Two in a year, not sequential months
Non-residential area [(b)]	600<D<1200	Two in a year, not sequential months

5.2.4.2 Simulated Incremental Nuisance Dustfall Impacts

Simulated operational phase dustfall rates were compared to the acceptable dustfall rates defined by the NDCR (Table 5-11). Daily dustfall rates as a result of the project are likely to be below the NDCR for residential (or non-residential) during normal operations (Figure 5-21 – maximum dustfall rate <20 mg/².day). However, the implementation of dust control measures along the access road (such as sweeping, or wet suppression; screens or berms) is recommended during high traffic periods to minimise the nuisance impacts to local residents.

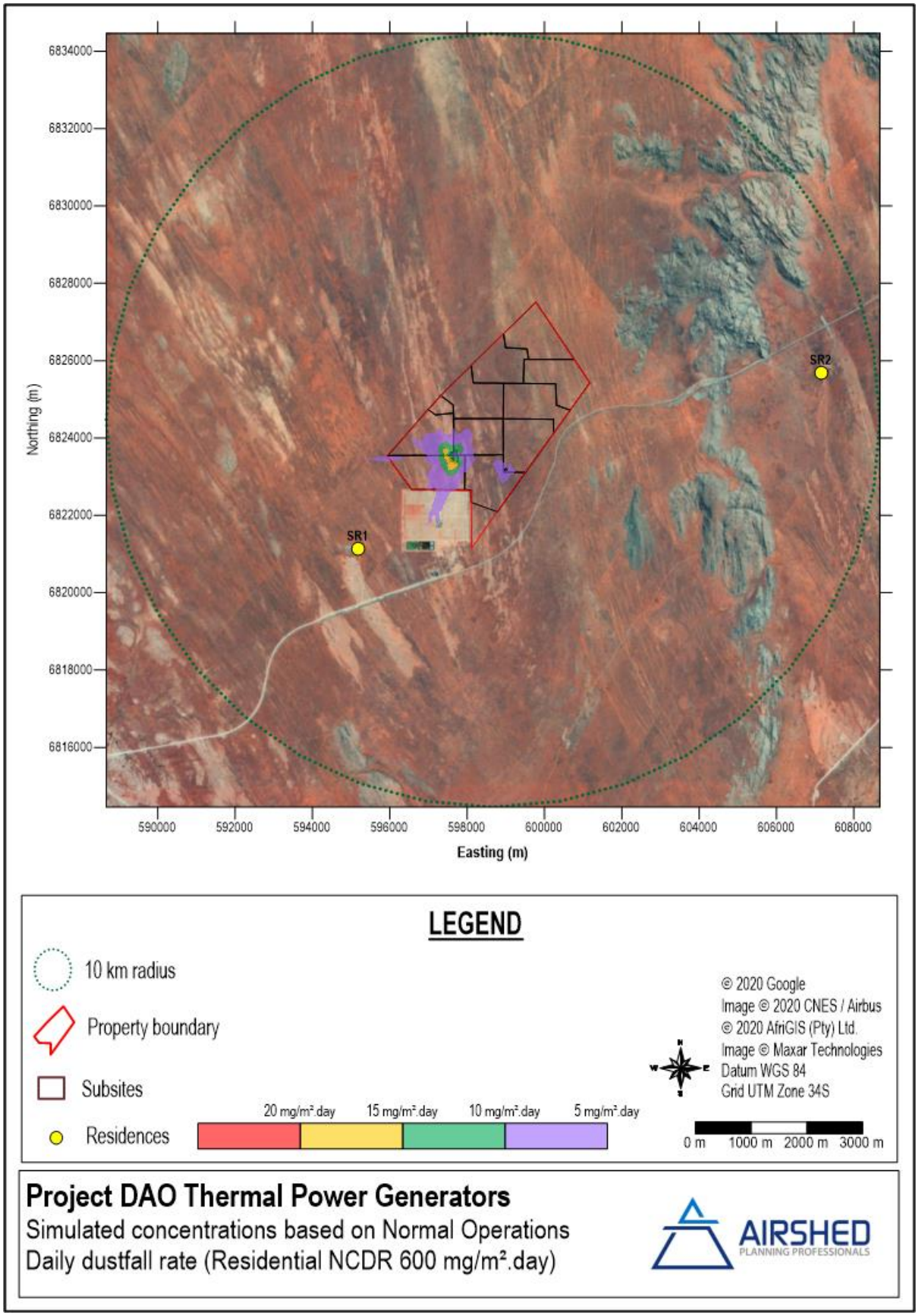

Figure 5-21: Simulated daily dustfall rates

5.2.4.3 *Dust Effects on Vegetation*

Suspended particulate matter can produce a wide variety of effects on the physiology of vegetation that in many cases depend on the chemical composition of the particle. Heavy metals and other toxic particles have been shown to cause damage and death of some species as a result of both the phytotoxicity and the abrasive action during turbulent deposition (Harmens *et al*., 2005). Heavy loads of particle can also result in reduced light transmission to the chloroplasts and the occlusion of stomata (Harmens *et al*., 2005; Naidoo & Chirkoot, 2004; Hirano *et al*., 1995, Ricks and Williams, 1974), decreasing the efficiency of gaseous exchange (Harmens *et al*., 2005; Naidoo and Chirkoot, 2004, Ernst, 1981) and hence water loss (Harmens *et al*., 2005). They may also disrupt other physiological processes such as bud break, pollination and light absorption/reflectance (Harmens *et al*., 2005). The chemical composition of the dust particles can also affect the plant and have indirect effects on the soil pH (Spencer, 2001).

In general, according to the Canadian Environmental Protection Agency (CEPA), air pollution adversely affects plants in one of two ways; either the quantity of output or yield is reduced, or the quality of the product is lowered. The former (invisible) injury results from pollutant impacts on plant physiological or biochemical processes and can lead to significant loss of growth or yield in nutritional quality (for example, protein content). The latter (visible) may take the form of discolouration of the leaf surface caused by internal cellular damage. Such injury can reduce the market value of agricultural crops for which visual appearance is important (for example, lettuce and spinach). Visible injury tends to be associated with acute exposures at high pollutant concentrations, whilst invisible injury is generally a consequence of chronic exposures to moderately elevated pollutant concentrations. However, given the limited information available, specifically the lack of quantitative dose-effect information, it is not possible to define a Reference Level for vegetation and particulate matter (CEPA, 1999).

While there is little direct evidence of what the impact of dust fall on vegetation is under an African context, a review of European studies has shown the potential for reduced growth and photosynthetic activity in Sunflower and Cotton plants exposed to dust fall rates greater than 400 mg/m²/day (Farmer, 1993).

Estimated dust fallout rates due to the project are low (<20 mg/m².day) (Figure 5-21). While dust fallout can have a negative effect on both plant growth and the economic value of crops, the impact is expected to be limited due to the nature of surrounding land use being predominantly small stock farming. Impact of dustfall due to vehicle entrainment can be mitigated (more detail provided in Appendix F).

5.3 Climate Change Impact Statement

5.3.1 Introduction

5.3.1.1 The Greenhouse Effect

Greenhouse gases are "those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine and bromine containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with the greenhouse gases sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) (IPCC, 2007). Human activities since the beginning of the Industrial Revolution (taken as the year 1750) have produced a 40% increase in the atmospheric concentration of carbon dioxide, from 280 ppm in 1750 to 406 ppm in early 2017 (NOAA, 2017). This increase has occurred despite the uptake of a large portion of the emissions by various natural "sinks" involved in the carbon cycle (NOAA, 2017). Anthropogenic CO_2 emissions (i.e., emissions produced by human activities) come from combustion of fossil fuels, principally coal, oil, and natural gas, along with deforestation, soil erosion and animal agriculture (IPCC, 2007).

5.3.1.2 International Agreements

In 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change, (UNFCCC) as a framework for international cooperation to combat climate change by limiting average global temperature increases and the resulting climate change, and coping with impacts that were, by then, inevitable.

By 1995, countries launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol. The Kyoto Protocol legally binds developed country parties to emission reduction targets. The Protocol's first commitment period started in 2008 and ended in 2012. As agreed in Doha in 2012, the second commitment period began on 1 January 2013 and will end in 2020 (UNFCCC, 2017) but due to lack of ratification has not come into force.

The Paris Agreement (2016) builds upon the Convention and – for the first time – brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The central aim of the Paris Agreement is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2.0°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives.

The Paris Agreement requires all Parties to put forward their best efforts through "nationally determined contributions" (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts.

In 2018, Parties will take stock of the collective efforts in relation to progress towards the goal set in the Paris Agreement and to inform the preparation of NDCs. There will also be a global stocktake every five years to assess the collective progress towards achieving the purpose of the Agreement and to inform further individual actions by Parties.

As of October 2020, 189 Parties of the 197 Parties to the UNFCCC Convention, including South Africa, had ratified the Paris agreement. South Africa submitted its intended NDC (INDC) to the UNFCCC on 25 September 2016.

5.3.2 South Africa's Status in terms of Climate Change and Quantification of Greenhouse Gases

5.3.2.1 South African National Climate Change Response Policy 2011

South Africa ratified the UNFCCC in August 1997 and acceded to the Kyoto protocol in 2002, with effect from 2005. However, since South Africa is an Annex 1 country it implies no binding commitment to cap or reduce GHG emissions.

The National Climate Change Response White Paper stated that in responding to climate change, South Africa has two objectives: to manage the inevitable climate change impacts and to contribute to the global effort in stabilising GHG emissions at a level that avoids dangerous anthropogenic interference with the climate system. The White Paper proposes mitigation actions, especially a departure from coal-intensive electricity generation, be implemented in the short- and medium-term to match the GHG trajectory range. Peak GHG emissions are expected between 2020 and 2025 before a decade long plateau period and subsequent reductions in GHG emissions.

The White Paper also highlighted the co-benefit of reducing GHG emissions by improving air quality and reducing respiratory diseases by reducing ambient particulate matter, ozone and SO_2 concentrations to levels in compliance with NAAQS by 2020. In order to achieve these objectives, the Department of Forestry, Fisheries and Environment (DFFE) established a national GHG emissions inventory that reports through SAAQIS.

5.3.2.2 Intended Nationally Determined Contribution

The South African Intended Nationally Determined Contribution (INDC) submission was completed in 2016. This was undertaken to comply with decision 1/CP.19 and 1/CP.20 of the Conference of the Parties to the UNFCC. This document describes South Africa's INDC on adaptation, mitigation and finance and investment necessities to undertake the resolutions.

As part of the adaption portion the following goals have been assembled:

1. Goal 1: Development and implementation of a National Adaptation Strategy. The implementation of this will also result in the implementation of the National Climate Change Response Plan (NCCRP) as per the 2011 policy.
2. Goal 2: In the development of national, sub-national and sector strategy framework, climate concerns must be taken into consideration.
3. Goal 3: An official institutional function for climate change response planning and implementation needs to be assembled.
4. Goal 4: The creation of an early warning, vulnerability and adaptation monitoring system
5. Goal 5: Develop policy regarding vulnerability assessment and adaptation needs.
6. Goal 6: Disclosure of undertakings and costs with regards to past adaptation strategies.

As part of the mitigation portion the following have been, or can be, implemented at National level:

- The approval of 79 (5 243 MW) renewable energy Independent Power Producer (IPP) projects as part of a Renewable Energy Independent Power Producer Procurement Programme (REI4P). An additional 6 300 MW is being deliberated.
- A "Green Climate Fund" has been created to back green economy initiatives. This fund will be increased in the future to sustain and improve successful initiatives.
- It is intended that by 2050 electricity will be decarbonised.
- Carbon Capture and Sequestration (or Carbon Capture and Storage) (CCS).
- To support the use of electric and hybrid electric vehicles.
- Reduction of emissions can be achieved through the use of energy efficient lighting; variable speed drives and efficient motors; energy efficient appliances; solar water heaters; electric and hybrid electric vehicles; solar photovoltaic (PV); wind power; CCS; and advanced bioenergy.

5.3.2.3 Greenhouse Gas Emissions Reporting

Regulations pertaining to GHG reporting using the NAEIS were published on 3 April 2017 (GN 257 in Government Gazette 40762). The South African mandatory reporting guidelines focus on the reporting of Scope 1 emissions only. The three broad scopes for estimating GHG are:

- Scope 1: All direct GHG emissions.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or steam.
- Scope 3: Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities not covered in Scope 2, outsourced activities, waste disposal, etc.

The South African Greenhouse Gas Emission Reporting System (SAGERS) web-based monitoring and reporting system is used to collect GHG information in a standard format for comparison and analyses. The system forms part of the national atmospheric emission inventory component of South African Atmospheric Emission Licensing and Inventory Portal (SAAELIP).

The DFFE is working together with local sectors to develop country specific emissions factors in certain areas; however, in the interim the Intergovernmental Panel on Climate Change's (IPCC) default emission figures may be used to populate the SAAQIS GHG emission factor database. These country specific emission factors will replace some of the default IPCC emission factors. Technical guidelines for GHG emission estimation have been issued.

Also, the Carbon Tax Act (Act 15 of 2019) includes details on the imposition of a tax on the CO_2-e of GHG emissions. Certain production processes indicated in Annexure A of the Declaration of Greenhouse Gases as Priority Pollutants (GN 710 in GG 40966, 21 July 2017) with GHG in excess of 0.1 Mt, measured as CO_2-e, are required to submit a pollution prevention plan to the Minister for approval. The project will be required to report CO_2-e emissions, and be liable for the payment of Carbon Tax, but will not be required to prepare a pollution prevention plan.

5.3.2.4 South African Energy Supply

Coal provides in the order of 70% of the primary energy supply to the SA economy, with more than 90% of the electricity being generated from coal combustion. South Africa is thus regarded as having a carbon-intensive energy economy.

The 1998 White Paper on the Energy Policy of the Republic of South Africa covered both supply and demand of energy for the next decade and made specific provision for independent suppliers of energy to enter the market. No additional capacity ensued during the decade 1998 to 2008, leading to the 'load shedding' of 2008 and the subsequent short-term interventions

to ensure stability of supply. The 2011 Integrated Resource Plan (IRP) (DOE, 2011) provided a planning basis for the period up to 2030 and made provision for the supply of energy (including renewable energy) by independent producers, as well as 9600 MW of nuclear energy over that period. An update of the IRP is in progress at the date of this report but has not been officially adopted; the drafts have attracted considerable criticism regarding the cost and greenhouse gas implications as part of the public participation process, including a report by the CSIR arguing for a much larger use of renewable sources (Wright, et al., 2017).

Seventy-nine renewable energy Independent Power Producer (IPP) projects have been approved and several others are being deliberated as part of a Renewable Energy Independent Power Producer Procurement Programme (REI4P).

5.3.2.5 GHG Inventories

National GHG Emissions Inventory

South Africa is perceived as a global climate change contributor and is undertaking steps to mitigate and adapt to the changing climate. DFFE is categorised as the lead climate change institution and is required to coordinate and manage climate related information such as development of mitigation, monitoring, adaption and evaluation strategies (DEA, nd). This includes the establishment and updating of the National GHG Inventory. The National Greenhouse Gas Improvement Programme (GHGIP) has been initiated; it includes sector specific targets to improve methodology and emission factors used for the different sectors as well as the availability of data.

The 2000 to 2015 National GHG Inventory was prepared using the 2006 IPCC Guidelines (IPCC, 2006). According to the National GHG Inventory (DEA, nd) the 2015 total GHG emissions were estimated at approximately 540.854 million metric tonnes CO_2-e (excluding Forestry and Other Land Use (FOLU)). This was a 23.1% increase from the 2000 total GHG emissions (excluding FOLU). FOLU is estimated to be a net carbon sink which reduces the 2015 GHG emissions to 512.383 million metric tonnes CO_2-e. The assessment (excluding FOLU) showed the main sectors contributing to GHG emissions in 2015 to be the energy industries (solid fuels); road transport; manufacturing industry and construction (solid fuels); and energy industries (liquid fuels). In 2015 the energy industry contributed 79.5% to the total GHG emissions (excluding FOLU), this increased by 17.9% from 2000.

The DFFE is working together with local sectors to develop country specific emissions factors in certain areas; however, in the interim the IPCC default emission figures may be used to populate the SAAQIS GHG emission factor database. The country specific emission factors, when developed, will replace some of the default IPCC emission factors.

GHG Emission Inventory for the Sector

The proposed project would be categorised in the "energy" category for both the global GHG inventory and for the national GHG inventory. According to the "mitigation of climate change" document as part of the IPCC fifth Assessment Report (AR5) (IPCC, 2014) the 2010 global GHG emissions from the "energy" category were approximately 17 Gt CO_2-e; 35% of the total anthropogenic GHG emissions. The World Resources Institute Climate Watch[2] global GHG emissions from the "energy" sector were 36 Gt CO_2-e in 2016 (73% of total anthropogenic GHG emissions). The South African energy section contributed approximately 0.43 Gt CO_2-e to global emissions in 2015.

[2] http://cait.wri.org/ and https://www.climatewatchdata.org/ghg-emissions?breakBy=sector&sectors=energy%2Ctotal-excluding-lucf%2Ctotal-including-lucf

5.3.3 Physical Risks of Climate Change on the Region

In 2017 the South African Weather Service (SAWS) published an updated Climate Change Reference Atlas (CCRA) based on Global Climate Change Models (GCMs) projections (SAWS, 2017). It must be noted that as with all atmospheric models there is the possibility of inaccuracies in the results as a result of the model's physics and accuracy of input data; for this reason, an ensemble of models' projections is used to determine the potential change in near-surface temperatures and rainfall depicted in the CCRA. The projections are for to 30-year periods described as the near future (2036 to 2065) and the far future (2066 to 2095). Projected changes are defined relative to a historical 30-year period (1976 to 2005). The Rossby Centre regional model (RCA4) was used in the predictions for the CCRA which included the input of nine GCMs results. The RCA4 model was used to improve the spatial resolution to 0.44° x 0.44°- the finest resolution GCMs in the ensemble were run at resolutions of 1.4° x 1.4° and 1.8° x 1.2°.

Two trajectories are included based on the four Representative Concentration Pathways (RCPs) discussed in the IPCC's fifth assessment report (AR5) (IPCC, 2013). RCPs are defined by their influence on atmospheric radiative forcing in the year 2100. RCP4.5 represents an addition to the radiation budget of 4.5 W/m^2 as a result of an increase in GHGs. The two RCPs selected were RCP4.5 representing the medium-to-low pathway and RCP8.5 representing the high pathway. RCP4.5 is based on a CO_2 concentration of 560 ppm and RCP8.5 on 950 ppm by 2100. RCP4.5 is based on if current interventions to reduce GHG emissions being sustained (after 2100 the concentration is expected to stabilise or even decrease). RCP8.5 is based on if no interventions to reduce GHG emissions being implemented (after 2100 the concentration is expected to continue to increase).

5.3.3.1 RCP4.5 Trajectory

Based on the median, for the region in which the proposed facility and AQSRs are situated, the annual average near surface temperatures (2 m above ground) are expected to increase by between 1.5°C and 2.0°C for the near future and between 2.5°C and 3.0°C for the far future. The seasonal average temperatures are expected to increase for all seasons, in the same order as the annual average increases, with slightly larger temperature increases in autumn (March to May) and spring (September to November). The total annual rainfall is expected to increase by between 0 mm and 5 mm for the near future and decrease by up to 5 mm in the far future. Seasonal rainfall is expected to increase in summer (December to February) in the near- and far future, while other seasons are likely to show decreases between 5 and 10 mm.

5.3.3.2 RCP8.5 Trajectory

Based on the median, the region in which the proposed facility and AQSRs discussed are situated, the annual average near surface temperatures (2 m above ground) are expected to increase by between 2.0°C and 2.5°C for the near future and between 4.5°C and 5.0°C for the far future. The seasonal average temperatures are expected to increase for all seasons in similar ranges to the annual average temperature, with slightly higher increases in spring, summer, and autumn. The total annual rainfall change is likely to decrease by between 30 and 50 mm, while it is more uncertain for the far future with potential decrease up to 5 mm. Seasonal rainfall changes could see an increase of 5 mm in spring and summer in the near future with decreased up to 10 mm in autumn and winter. In the far future, the seasonal the rainfall changes are similar to the near future, except in summer where increased rainfall could range between 5 and 20 mm.

5.3.3.3 Water Stress and Extreme Events

South Africa is known to be a water stressed country (Kusangaya, Shekede, & Mbengo, 2017), however, the Orange River basin, including Upington and Groblershoop areas, is currently rated with a low risk with low levels of depletion, but low to

medium interannual variability and medium to high seasonal variability, leading to a low to medium drought risk[3]. Climate change, through elevated temperatures, is likely to increase evaporation rates and decrease water volumes available for dryland and irrigated agriculture (Davis-Reddy & Vincent, 2017). Commercial agriculture (irrigated vineyards and stock farming) is the predominant agricultural land-use in the vicinity of Groblershoop.

Extreme weather events affecting southern Africa, including heat waves, flooding due to intensified rainfall due to large storms and drought, have been shown to increase in number since 1980 (Davis-Reddy & Vincent, 2017). Projections indicate (Davis-Reddy & Vincent, 2017):

- with high confidence, that heat wave and warm spell duration are likely to increase while cold extremes are likely to decrease, where up to 80 days above 35°C are projected by the end of the century under the RCP4.5 scenario;
- with medium confidence, that droughts are likely to intensify due to reduced rainfall and/or an increase in evapotranspiration;
- with low confidence, that heavy rainfall events (more than 20 mm per 24 hours) will increase.

5.3.4 Impact Assessment: ACWA Power Project DAO (RF) (Pty) Ltd

5.3.4.1 Methodology

As the emission of greenhouse gases has a global impact, it is not feasible to follow the normal impact assessment methodology where the state of the physical environment after implementation of the project is compared to the condition of the physical environment prior to its implementation. Instead, this report will assess the following:

(i) the GHG emissions during operation of the gas-fired power station compared to the global and South African emission inventory;

(ii) the impact of climate change over the lifetime of the power station taking the robustness of the project into account; and,

(iii) the vulnerability of communities in the immediate vicinity of power station to climate change.

The Carbon Footprint is an indication of the greenhouse gases estimated to be emitted directly and/or indirectly by an organisation, facility or product. It can be estimated from:

$$Carbon\ emissions = Activity\ information * emission\ factor * GWP$$

where

- *Activity information* relates to the activity that causes the emissions
- *Emission factor* refers to the amount of GHG emitted per unit of activity
- *GWP* or global warming potential is the potential of an emitted gas to cause global warming relative to CO_2. This converts the emissions of all GHGs to the equivalent amount of CO_2 or CO_2-e. National GHG reporting guidelines state GWP for CH_4 emissions should have a multiplier of 23; and N_2O emissions should have a multiplier of 296

5.3.4.2 Construction

Carbon Sequestration and Carbon Sink

[3] https://www.wri.org/applications/aqueduct/water-risk-atlas/#/?advanced=false&basemap=hydro&indicator=w_awr_def_tot_cat&lat=30&lng=-80&mapMode=view&month=1&opacity=0.5&ponderation=DEF&predefined=false&projection=absolute&scenario=optimistic&scope=baseline&timeScale=annual&year=baseline&zoom=3

Accounting for the uptake of carbon by plants, soils and water is referred to as *carbon sequestration* and these sources are commonly referred to as *carbon sinks*. Quantifying the rate of carbon sequestration is however not a trivial task requiring detailed information on the geographical location, climate (specifically temperature and humidity) and species dominance (Ravin & Raine, 2007).

Photosynthesis is the main sequestration process in forests and in soils. Carbon is absorbed as fixed carbon into the roots, trunk, branches and leaves, and during the shedding of leaves and limbs, but is emitted – although at a reduced percentage – from foliage and when biomass decays. Several factors also determine the amount of carbon absorbed by trees such as species, size and age. Mature trees, for example, will absorb more carbon than saplings (Ravin & Raine, 2007).

There will be a carbon sink loss due to the vegetation removal for the expansion area. These are considered **Scope 1** carbon emissions.

The regional vegetation types of the site were recently described as a transitional area between the savanna and Nama-Karoo biomes, including the Kalahari Karrod shrubland and Gordonia Duneveld ecological types (Robbeson, 2020). This vegetation type would be considered grassland in the National Greenhouse Gas Emission Inventory. The National Greenhouse Gas Emission Inventory (DEA, nd) assumes a grassland carbon stock of 5.32 tonne C/ha. During construction, approximately 0.5 ha will be denuded for the construction of each generator sets, a total of 5 ha for all generators. Assuming all carbon eventually reports to the atmosphere as CO_2, it is therefore calculated that a total of 19.15 tonnes of CO_2 would be released as a result of clearing vegetation at the site.

Fuel Combustion

GHG emissions from fuel during construction of the project are also considered **Scope 1** emissions. Emissions from these activities were not included in this assessment, however due to the relatively short construction period, they are not likely to make a significant contribution to the project's life-time total emissions.

Electricity use

These emissions are related to purchased energy, heat or steam and can be calculated from the average South African emission factor published annually by Eskom in its integrated report. Electricity use on-site during the construction phase was not estimated but likely to be less than that used annually during the operational life-time of the facility.

5.3.4.3 Operations

For combustion processes, the emission factor is often calculated from a carbon mass balance, where the combustion of each unit mass of carbon in the fuel leads to an equivalent emission of 3.67 mass units of CO_2 (from 44/12, the ratio of molecular weight of CO_2 to that of carbon).

This report considers Scope 1 emissions, which are the emissions directly attributable to the project. Scope 2 emissions, which are the emissions associated with bought-in electricity over the lifetime of the project. Scope 3 emissions, which consider the "embedded" carbon in bought-in materials, are not considered here, in line with the guidelines provided by the International Finance Corporation (IFC, 2012).

Scope 1 Emissions

The Carbon Tax Bill and its supporting technical documents provides default emission factors for Electricity and Heat Production process (specifically combustion of diesel) in kg CO_2/unit energy content, where the density and calorific values of the fuel types are defined in the same document (DEA, 2017).

A summary of the reliability test GHG emissions, based on the fuel use per unit per hour at a 75% load (provided by the preferred equipment supplier), 56 units operating over the reliability test (495 hours) for diesel, is provided in Table 5-12. The total CO_2 (equivalent) emissions from the diesel-fired engines will be approximately 15 530 tonnes per reliability test period.

A summary of the operational GHG emissions, based on the fuel use per unit per hour at a 75% load (provided by the preferred equipment supplier), 56 units operating over an annual operating period of 104 hours for diesel, is provided in Table 5-12. The total CO_2 (equivalent) emissions from the diesel-fired engines will be approximately 3 263 tpa. The lifetime of the project is expected to be 22 years.

Table 5-12: Summary of Scope 1 estimated greenhouse gas emissions for the ICE plant reliability testing and normal operation

Sources	Throughput	Units	Annual Emission (tonnes / year)			Annual Emission (tonnes / year)
			CO_2	CH_4	N_2O	CO_2e [c]
Diesel – reliability test (15 days)[b]						
Stationary Gas Combustion [a]	5 992	m³	15 478	0.63	0.13	15 530
Total reliability test Scope 1 GHG emissions – diesel[d]						
Diesel – normal operation (2 hours per week = 104 hours per year)						
Stationary Gas Combustion [a]	1 259	m³	3 252	0.13	0.03	3 263
Total annual Scope 1 GHG emissions – diesel[d]						

Notes:

a) Emissions calculated using the DEA Technical Guideline TG-2016.1 (DEA, 2017). Emission Factors and Net Calorific Values as per Table D1. Default emission factors for stationary combustion of diesel. Fuel throughput based on 56 units combusting 201.75 litres per hour by each generator set.

b) Conservatively assumes 15-day continuous operation of the generators during dispatchable hours (i.e. 16.5 hours daily).

c) CO_2-e = equivalent CO_2 emissions taking account of the global warming potential of CH_4 and N_2O (as per DEA, 2017).

d) Values rounded up

Scope 2 Emissions

All on-site electricity needs (to power water treatment plant, offices, pumps, and other equipment) will be a parasitic load to the amount of electricity produced. This loss of production capacity has been factored into the total plant generating capacity calculations. Therefore, there will be no Scope 2 GHG Emissions during normal operation of the project.

5.3.4.4 The Project's GHG Impact

Impact on the Sector and on the National Inventory

The annual South African emission rate of GHG is approximately 512.383 million metric tonnes CO_2-e (2015 national emission inventory[4]). The annual CO_2-e emissions from the power station operations using diesel would, at maximum in the first year assuming one 15-day reliability test where the 56 generators operate continuously during dispatchable hours, contribute 0.004% to the South African "energy" sector total and represent a contribution of 0.004% to the National GHG inventory total (based on the published 2015 National GHG Inventory).

Alignment with National Policy

Most of the South African GHG policy is in early phases of implementation where GHG emissions have been reported to DFFE (previously DEA) since 31 March 2018 and the Carbon Tax Bill came into effect on the 1 June 2019. ACWA Power Project DAO (RF) (Pty) Ltd will be required to align GHG reporting with national policy. An annual Carbon Tax environmental levy account will need to be submitted in July of each year after operations commence.

5.3.4.5 Physical Risks of Climate Change on the Project's Operations

Temperature

With the increase in temperature, including heat waves, there is the likelihood of an increase in discomfort, possibility of heat related illness (such as heat exhaustion, heat cramps, and heat stroke). Both these have the potential to negatively affect staff process performance and productivity.

From a process point of view, elevated ambient temperatures (up to 45°C) may slightly reduce the fuel requirements needed to meet the generating capacity required.

Rainfall, Water Stress, and Extreme Events

The rainfall decreases in autumn, winter and spring could result in constrained water supply outside of the summer months. The impact of intense rainfall events on the generator sets cannot be ruled out, where the frequency of intense rainfall events could increase from the long-term baseline. These events could affect generative capacity during intense rainfall (unless fully protected from rain and wind); flooding affecting site access, safe operation of equipment and delivery of fuel; physical damage to infrastructure during high wind speed events associated with intense storms.

5.3.4.6 Transitional Risks and Opportunities of Climate Change on the Project's Operations

The Taskforce for Climate-related Financial Disclosures (TCFD) advocates the disclosure of the financial risks associated with climate change impacts on organisations (TCFD, 2020). These include physical risks resulting in large-scale financial losses caused by storms, droughts, wildfires, and other extreme events (as identified in Sections 5.3.3 and 5.3.4.5, above). The Taskforce also advocates the quantification of transitional risks associated with the adjustment to low carbon economies, such as the rapid loss in the value of assets due to policy changes or consumer preference; and financial risks to the economy through elevated credit spreads, greater precautionary saving and rapid pricing readjustment (TCFD, 2020). Along with risks,

[4] Most recent published inventory reported in the GHG National Inventory Report: South Africa 2000 – 2015 from https://www.environment.gov.za/sites/default/files/reports/GHG-National-Inventory-Report-SouthAfrica-2000-2015.pdf

the Taskforce encourages organisations to identify possible opportunities that could build resilience in economies shifting due to climate change.

Although the full financial risk is out of the scope of the of work, potential transitional risks and opportunities applicable to the project are tabulated below (Table 5-13as summarised from TCFD, 2017).

Table 5-13: Examples of climate-related risks and opportunities and the potential financial impacts (TCFD, 2017)

Type	Climate Related Risk / Opportunity	Potential financial impact	Comments
Risks	Policy and Legal		
	- Increased pricing of GHG emissions	- Increased operating costs (for example higher compliance cost, increased insurance premiums)	Carbon tax bill proposed 2% increase in baseline carbon tax rate until 2022 and thereafter annual inflation-based increases
	- Enhanced emissions reporting obligations	- Write-offs, asset impairment, and early retirement of existing assets due to policy changes	SAGERS online GHG emissions reporting platform in early release stages
	- Mandates on and regulation of existing products and services	- Increased costs and / or reduced demand for products and services resulting from fines and judgements	Country commitment to decarbonise energy supplies by 2050 could influence product demand for gas- generated power. Exceedances of emission standards could result in fines and litigation.
	Technology		
	- Substitution of existing products and services with lower emission options	- Write-offs and early retirement of existing assets - Reduced demand for products and services	Country commitment to decarbonise energy supplies by 2050 could influence product demand for gas- generated power.
	- Costs to transition to lower emissions technology	- Capital investments in technology development - Costs to adopt / deploy new practises and processes	Country commitment to decarbonise energy supplies by 2050 could require deployment of carbon capture, utilisation and storage technology to extend the operational lifespan of the gas to power plant.
	Market		
	- Increased cost of raw materials	- Increased production costs due to changing input prices (for example, water and fuel) and output requirements (for example, wastewater- (brine or turbine wash-water). - Abrupt and unexpected shifts in energy costs - Re-pricing of assets (for example, fossil fuel reserves)	Increased water stress could affect water cost through demand and availability drivers. Proposed diesel supply is via import and therefore could be influenced by international land and security valuations and international market signals.
	Reputation		
	- Shifts in consumer preferences	- Reduced revenue from decreased demand for goods and services - Reduced revenue from decreased production capacity (delayed planning approvals, supply chain interruptions)	Country commitment to decarbonise energy supplies by 2050 could influence product demand for gas- generated power, which could influence consumer choices especially close to the decarbonised target year.
	- Increased stakeholder concern or negative stakeholder feedback	- Reduction in capital availability	Gas to power provides cleaner energy options during transition to decarbonised energy supply therefore capital may be more available than for other fossil fuel technology options. However, it is still based on fossil fuels that may

Type	Climate Related Risk / Opportunity	Potential financial impact	Comments
			have limited role in energy supplies after 2050, and thus have limited long-term funding arrangements.
Opportunities	Resource efficiency		
	- Use of more efficient modes of transport	- Reduced operating costs (through efficient gains and cost reductions)	For example, ensuring fuel-efficient (Euro-V or better) vehicles or compressed natural gas powered vehicles or electric vehicles) to deliver fuel. Switching fuel to natural gas (as liquid or compressed natural gas).
	- Use of more efficient production and distribution processes	- Increased production capacity, resulting in increased revenue	Increased ambient temperatures could increase plant generative capacity and reduce atmospheric emission rates
	- Use of recycling	- Capital costs of alternative water supplies	Investigation of alternative water supplies could open opportunities to recycle or reuse water since water supplies may become constrained by droughts or quality
	Energy source		
	- Use of lower-emission sources of energy	- Reduced operational costs (for example, using lowest cost abatement technologies) - Reduced exposure to future fossil fuel price increases - Reduced exposure to GHG emissions and therefore less sensitivity to changes in cost of carbon	Gas to power provides cleaner energy option compared with other fossil fuel options, such as coal or diesel, which is applicable during transition to decarbonised energy supply.
	- Use of new technologies	- Returns on investment in low-emission technology - Increased capital availability (as more investors favour lower emission producers)	
	- Participation in carbon market		Carbon tax incentives (through sequestration allowances)
	- Shift towards decentralised energy generation	- Reputational benefits resulting in increased demand for goods and services	Direct supply to customers in the region
	Products and services		
	Markets		
	- Access to new markets - Use of public-sector incentives	- Increased revenue through access to new and emerging markets (for example partnerships with governments, development banks)	Opportunity for funding for renewable power generation facilities with transitional fossil fuel for standby.

5.3.4.7 Impact Assessment: Potential Effect of Climate Change on the Community

5.3.4.7.1 Temperature

With the increase in temperature, including heat waves, there is the likelihood of an increase in discomfort and possibility of heat related illness (such as heat exhaustion, heat cramps, and heat stroke). There is also the possibility of increased evaporation which in conjunction with the decrease in rainfall can result in water shortage. This does not only negatively affect the community's water supply but can reduce the crop (vineyard) yields and affect livestock (sheep) resulting in compromised food security.

5.3.4.7.2 Rainfall, Water Stress, and Extreme Events

As discussed above the decrease in rainfall can result in the following effects:

- Reduced water supply of reduced water quality; and,
- A negative impact on food security.

The impact of intense rainfall events on the local communities cannot be ruled out, where the frequency of these event could increase from the long-term baseline. These events could affect road access within the area due to flooding; physical damage to public and private infrastructure through flooding and high wind speeds.

5.3.4.8 Project adaptation and mitigation measures

Climate change management includes both mitigation and adaptation. The main aim of mitigation is to stabilise or reduce GHG concentrations as a result of anthropogenic activities. This is achievable by lessening sources (emissions) and/or enhancing sinks through human intervention. Mitigation measures are typically the focus of the energy, transport and industry sectors (Thambiran & Naidoo, 2017). Adaptation measures focus on the minimising the impact of climate change, especially on vulnerable communities and sectors. Inclusion of the climate change adaptation in business strategic implementation plans is one of the outcomes defined in the Draft National Climate Change Adaptation Strategy (Government Gazette No.42466:644, May 2019).

General

Additional support infrastructure can reduce the climate change impact on the staff and project, for example the improving thermal and electrical efficiency of buildings to reduce electricity consumption, ensuring adequate water supply for staff and reducing on-site water usage as much as possible. A community development program could be initiated to assist communities near the plant that are vulnerable to climate change impacts, such as thermal and electrically efficient buildings (to minimise electricity needs for heating and cooling); energy efficient stoves (to minimise the use of coal and woody biomass); or small scale renewable energy innovations suitable for use in homes.

Scope 1 (technology/sector-specific)

To minimise GHG emissions would require lower fuel use or use alternative lower-carbon fuels. Delivery of fuel to site via alternative low-carbon options (such as rail or compressed natural gas powered vehicles) would reduce the fuel usage by

delivery vehicles. Alternative options for consideration include Carbon Capture and Storage (CCS) or Carbon offsets (for which allowances are contemplated in the Carbon Tax Bill).

CCS is a method of mitigating the contribution of fossil fuel emissions based on capturing CO_2 from large point sources such as power stations and storing it. CCS involves carbon dioxide being concentrated through various options and then permanently stored. The best researched carbon dioxide storage option is geological storage which involves injecting CO_2 directly into underground geological formations. Oil fields, gas fields, saline formations, un-mineable coal seams, and saline-filled basalt formations have been suggested as storage sites. Various physical (e.g. highly impermeable rock) and geochemical trapping mechanisms would prevent the CO_2 from escaping to the surface. The CSIR undertook a study into the potential for CO_2 storage in South Africa (2004). The study concluded that the storage of CO_2 in depleted gas fields, coal mines or gold mines is very limited. Deep saline reservoirs offer the highest potential for the geological storage of CO_2 in South Africa, especially withing the Karoo Super Group sediments of the Vryheid Formation in the north and the Katberg Formation near Burgersdorp/Molteno. However, due to a lack of information about the porosity and permeability of these of reservoirs, significant work is required before CO_2 sequestration into geological formations will be possible (Engelbrecht, Golding, Hietkamp, & Scholes, 2004). The South African CCS Atlas (Cloete, 2010) identified at a theoretical level that South Africa had about 150 Gigatons (Gt) of storage capacity. Less than 2% of this is onshore.

A significant limitation of CCS is its energy penalty. The technology is expected to use between 10 – 40% of the energy produced by a power station to capture the CO_2 (IPCC, 2005). Wide scale adoption of CCS may erase efficiency gains of the last 50 years and increase resource consumption by one third. However, even taking the fuel penalty into account, overall levels of CO_2 abatement remain high, at approximately 80 - 90% compared to a plant without CCS.

Carbon offset options could include investment in REDD+ (Reducing Emissions from Deforestation and forest Degradation) initiatives (Thambiran & Naidoo, 2017). REDD+ initiatives in developing countries incentivise communities to undertake forestry and related activities that can contribute to reducing land-based GHG emissions associated with deforestation and degradation and through sequestration of CO_2 in forests and agroforestry (Thambiran & Naidoo, 2017). REDD+ programmes are also mechanisms for socio-economic development. However, the expansion of the forestry industry in South Africa, will require quantification of the impact of expanded activities on water resources (as highlighted in the Draft National Climate Change Adaptation Strategy (Government Gazette No.42466:644, May 2019).

5.4 Impact Significance Rating

The impact significance of the project is provided below based on the understanding of project during the basic assessment and follows the method provided in Appendix B. The construction and decommissioning phases of the project are expected to have a significance rating of "low" with and without mitigation (Table 5-14). The operational phase is likely to have a "medium" impact on SO_2, CO, particulate matter, and VOCs (Table 5-15); however, if additional mitigation measures are implemented, the significance could be reduced to "low". The operational phase is likely to have a "medium" impact on NO_X; however, if additional mitigation measures are implemented, the significance could be reduced to "low" (Table 5-16). The indirect impact of climate change on the operation and the receptors is expected to have a "medium" significance rating (Table 5-17). A No-go Alternative will not change regional air quality from the baseline.

In conclusion, it is the specialist opinion that the project may be authorised provided that the recommended air quality management measures are implemented to ensure the lowest possible impact on nearby AQSRs and the environment. These conditions to authorisation include:

- the generators would be reciprocating engines with an individual capacity less than 10 MW heat input per unit, based on the lower calorific value of the fuel used, and therefore *will not* require an Atmospheric Emissions License (AEL) for Subcategory 1.5: Reciprocating Engines;
- on-site fuel storage will not exceed 1 000 m³ combined, and therefore *will not* require an Atmospheric Emissions License (AEL) for Subcategory 2.4: Storage and Handling of Petroleum Products;
- minimum stack height on each generator is 5.8 m;
- operation is limited to 2 hours per week;
- typical dust control mitigation measures are applied during the construction period and along the fuel delivery access road, including chemical stabilisation or water suppression, especially during high traffic volumes; and,
- establishment and use of a complaints register during the construction phase of the project.

Table 5-14: Significance rating for construction and decommissioning phases

Nature: The construction (and decommissioning) phase of the generator sets will result in emission of particulate matter, and to a lesser extent, gaseous pollutants. Ambient pollutant concentrations and nuisance dustfall rates will increase during the construction (and decommissioning) periods. Impact is likely to be localised near construction (and demolition) activities. With mitigation, off-site exceedances are not expected.		
	Without mitigation	**With mitigation**
Extent	2 (Local)	1 (Site)
Duration	1 (Very short)	1 (Very short)
Magnitude	2 (Minor)	2 (Minor)
Probability	3 (Probable)	3 (Probable)
Significance	**15**	**12**
	Low	**Low**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Confidence in findings:	Moderate.	
Can impacts be mitigated?	Yes	
Proposed mitigation measures: • Construction phase mitigation measures as per the recommendations made in the Bokpoort 10 x PV solar power plant Air Quality Impact Assessment (Ramsay, 2020). • Establish a complaints register, during construction. • Fence-line monitoring of dustfall in accordance with the NDCR.		

Residual impacts: None.
Cumulative Impacts: There is some risk that the construction activities could contribute to elevated particulate matter concentrations and nuisance dustfall rates off-site during high wind speed events. Cumulative impacts are likely to be limited in duration and frequency.

Table 5-15: Significance rating for operational phase: SO_2, CO, PM_{10}, $PM_{2.5}$, VOCs

Nature:

The operation of the generator sets will result in emissions of SO_2, CO, particulate matter, and VOC emissions. Ambient pollutant concentrations and nuisance dustfall rates will increase during the periods of operation. Off-site exceedances are not expected.

	Without mitigation	With mitigation
Extent	2 (Local)	1 (Site)
Duration	4 (Long term)	4 (Long term)
Magnitude	4 (Low)	2 (Minor)
Probability	3 (Probable)	3 (Probable)
Significance	**30**	**21**
	Medium	**Low**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Confidence in findings:	Moderate.	
Can impacts be mitigated?	Yes	

Proposed mitigation measures:

- Low sulfur fuel, with a maximum of 500 ppm.
- Start-and-stop preventative maintenance operation of the generators is limited to day-time hours only, ideally between 10:00 and 14:00.
- As far as is practical, the reliability tests should be conducted when seasonal conditions allow the best pollutant dispersal (August to November).
- Generator maintenance and repair programme in accordance with the original equipment manufacturer recommendations.
- Continue the use of the complaints register established during construction.
- Fence-line monitoring using passive samplers or low cost-sensors.

Residual impacts:

None.

Cumulative Impacts:

Cumulative effects are likely to be limited to since ambient air quality in the air is considered good and the mitigated impact of the generators is likely to localised impact during operation.

Table 5-16: Significance rating for operational phase: NO_X emissions

Nature:

The operation of the generator sets will result in substantial emissions of NO_X. Ambient pollutant concentrations will increase during the periods of operation. Off-site exceedances are expected although compliance with NAAQS is likely under the operational philosophy.

	Without mitigation	With mitigation
Extent	2 (Local)	2 (Local)
Duration	4 (Long term)	4 (Long term)
Magnitude	4 (Low)	2 (Minor)
Probability	3 (Probable)	3 (Probable)
Significance	**30**	**24**
	Medium	**Low**
Status (positive or negative)	Negative	Negative
Reversibility	High	High

Irreplaceable loss of resources?	No	No
Confidence in findings:	Moderate.	
Can impacts be mitigated?	Yes	
Proposed mitigation measures: • Start-and-stop preventative maintenance operation of the generators is limited to day-time hours only, ideally between 10:00 and 14:00. • As far as is practical, the reliability tests should be conducted when seasonal conditions allow the best pollutant dispersal (August to November). • Generator maintenance and repair programme in accordance with the original equipment manufacturer recommendations. • Continue the use of the complaints register established during construction. • Fence-line monitoring using passive samplers or low cost-sensors. • Based on the operational philosophy additional NO_X mitigation measures would only need investigation if fence-line monitoring indicates regular and sustained exceedances of the NAAQS.		
Residual impacts: None.		
Cumulative Impacts: Cumulative effects are likely to be limited to since ambient air quality in the air is considered good and the mitigated impact of the generators is likely to localised impact during operation.		

Table 5-17: Significance rating for operational phase: Greenhouse gas emissions and Climate Change

Nature: The normal operation of the gas-to-power plant will result in emission of greenhouse gases: CO_2, and to a lesser extent methane and nitrous oxide. Annual GHG emissions from the diesel fuelled facility equate to 0.004% of South Africa's total greenhouse emissions (based on the 2015 emissions inventory) with a total of 15 530 tonnes CO_2-e per year for Scope 1 emissions for the first operational year (including the 15 day reliability test), thereafter reducing to 3 263 tonnes CO_2-e per year for Scope 1 emissions. The impact of the operation on global climate is considered to have a long-term impact on greenhouse gas concentrations.		
	Without mitigation	**With mitigation**
Extent	5 (National)	5 (National)
Duration	4 (Long-term)	4 (Long-term)
Magnitude	2 (Minor)	2 (Minor)
Probability	3 (Probable)	3 (Probable)
Significance	**33**	**33**
	Medium	**Medium**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes, in the long-term	Yes, in the long-term
Confidence in findings:	Moderate.	
Can impacts be mitigated?	To some extent.	
Proposed mitigation measures: • Reduced fuel usage through minimal idle time of stationary diesel delivery and fuel-efficient vehicles. • Local sources of diesel would reduce the Scope 3 emissions (compared with imported diesel).		
Residual impacts: The risk of impact of climate change on the operation, due to historical global emissions, is high even if mitigation measures are effectively applied.		
Cumulative Impacts: Historical global GHG emissions will have an impact on the project and the communities in the !Kheis Local Municipality. The operation of the generators will therefore contribute to projected impacts at a local, national, and global scales (albeit at through a relatively small annual contribution). The impact of global climate change is likely to have a largely permanent impact on the global ecosystem with potential irreplaceable loss of resources. Assuming that the hybrid facility replace generative capacity from other fossil fuel sources, the facility could lower South Africa's GHG emissions from the Energy sector since the ICE plant provides only support to the PV arrays and BESS which provide renewable energy at a lower CO_2-e emission per unit electricity.		

5.5 Main Findings and Conclusions

The findings from the air quality impact assessment are:

1. Measured ambient air quality based on data from the Karoo monitoring stations managed by the DFFE indicated compliance with hourly, daily and annual compliance with National Ambient Air Quality Standards (NAAQS) for all pollutants assessed across the period assessed.
2. During the construction phase, impacts are likely to be localised and of short duration.
    a. A "**low**" rating was determined for the impact associated with the construction phase of the project.
3. Compliance with hourly, daily, and annual NAAQS under normal operations is likely across the domain and at the receptors for SO_2, particulate matter, (PM_{10} and $PM_{2.5}$), and carbon monoxide (CO).
4. Hourly exceedances of the NO_2 NAAQ limit concentration is likely both on- and off-site, however, the total number of exceedances at the closest receptor is likely to be fewer than those allowed by the NAAQS. Simulated annual average NO_2 concentrations are lower than the NAAQS across the domain.
5. Compliance with the chronic inhalation guidelines for volatile organic compounds (VOCs) and diesel particulate matter (DPM) are likely off-site.
6. The excess cancer risk due to exposure to DPM was calculated to be low (on and near site) and very low at closest receptors and across the remainder of the domain.
7. The United Nations Economic Commission for Europe (UNECE) Convention on Long Range Trans-boundary Air Pollution Limits) critical levels were used to assess the potential for impact of annual SO_2 and NO_2 concentrations on vegetation via various measures of productivity and reproductive success.
    a. Impacts to vegetative productivity are unlikely due to the project across in the domain or at any receptors.
8. The impact of the facility was simulated to be below the NDCR.
    a. However, mitigation measures for control vehicle entrainment dust emissions are recommended along the delivery route.
9. A "**low**" rating was determined for the impact of criteria air pollutants associated with the normal operation of the project (2 hours per week).
10. Cumulative impact of the project and the other sources in the area is likely to exceed the NAAQ limit concentration off-site but not at the closest receptor.
    a. A "**low**" rating was determined for the mitigated impact of the project in isolation and in the context of other air pollution sources in the vicinity.
11. Annual greenhouse gas (GHG) emissions for the operational phases of the plant were estimated to represent 0.004% of the published South African National 2015 GHG Inventory, contributing to the Energy sector.
    a. A "**medium**" rating was determined for the GHG emissions associated with the project.

Conclusion

From an air quality perspective, it is the opinion of the specialist that the ACWA Power Project DAO be authorised, on condition that:

- As far as is practical, the reliability tests should be conducted when seasonal conditions allow the best pollutant dispersal (August to November).
- The start-and-stop preventative maintenance operation of the generators occurs during day-time hours only, ideally between 10:00 and 14:00.
- Emissions be monitored annual as per good operating practice.
- Conformance with the other environmental management programme requirements for air quality (Appendix C) are met; and,
- Monitoring at the nearest receptor to be conducted during the reliability tests.

6 COMPLAINTS

The project is a new proposed operation and as such no complaints have been received. As part of the EMP, a complaints register will be in place before commencement of the operations.

7 CURRENT OR PLANNED AIR QUALITY MANAGEMENT INTERVENTIONS

The project is a new proposed operation and as such no air quality management interventions have been implemented and none except for the design mitigation measures are planned at this stage.

8 COMPLIANCE AND ENFORCEMENT HISTORY

The project is a new proposed operation and as such no compliance or enforcement actions have been implemented.

9 ADDITIONAL INFORMATION

The declaration of accuracy of information and the declaration of independence are attached in Annexure A & B respectively. The Environmental Management Programme recommendations for minimising impact on air quality are given in Appendix C.

10 ANNEXURE A

DECLARATION OF ACCURACY OF INFORMATION – APPLICANT

Name of Enterprise: ACWA Power Project DAO (RF) Pty Ltd

Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of section 30 of the Act.

I, Ashley Singh [*duly authorised*], declare that the information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of the National Environmental Management: Air Quality Act (Act No. 39 of 2004).

Signed at Sandton on this 19 day of April 2022

11 ANNEXURE B

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner: Theresa Bird

Senior Air Quality Scientist

CAPACITY OF SIGNATORY

12 REFERENCES

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APPENDIX A: COMPARISON OF STUDY APPROACH WITH THE REGULATIONS PRESCRIBING THE FORMAT OF THE ATMOSPHERIC IMPACT REPORT AND THE REGULATIONS REGARDING AIR DISPERSION MODELLING (GAZETTE NO 37804 PUBLISHED 11 JULY 2014)

The Regulations prescribing the format of the Atmospheric Impact Report (AIR) (Government Gazette No 36094; published 11 October 2013) were referenced for the air dispersion modelling approach used in this study. Table A-1 compares the AIR Regulations with the approach used in Section 5.

The promulgated Regulations regarding Air Dispersion Modelling (Gazette No. 37804, vol. 589; 11 July 2014) were consulted to ensure that the dispersion modelling process used in this assessment agreed with the regulations. Table A-2 compares the Air Dispersion Modelling Regulations with the approach used in Section 5.

Table A-1: Comparison of Regulations for the AIR with study approach

Chapter	Name	AIR regulations requirement	Status in AIR
1	Enterprise details	• Enterprise Details • Location and Extent of the Plant • Atmospheric Emission Licence and other Authorisations	Enterprise details included. Location of plant included. Proposed facility
2	Nature of process	• Listed Activities • Process Description • Unit Processes	All detail included in the regulated format
3	Technical Information	• Raw Materials Used and Production Rates • Appliances and Abatement Equipment Control Technology	Section 3.1 and 3.2. No additional abatement equipment proposed at this stage.

4	Atmospheric Emissions	• Point Source Emissions
		  • Point Source Parameters
		  • Point Source Maximum Emission Rates during Normal Operating Conditions
		• Fugitive Emissions
		• Emergency Incidents
			Emissions from generators provided by equipment supplier (Section 4.1).
			
			Emissions from fugitive sources (diesel storage tanks) was quantified (Section 4.2).
			No emergency events were included in the emissions estimations or simulations. It was assumed that operation beyond normal capacities and emissions would result in engine shutdown until normal operations can be restored.

5	Impact of enterprise on receiving environment		
5.1	Analysis of emissions impact on human health	Must conduct dispersion modelling, must be done in accordance with Regulations; must use NAAQS	Completed as set out by the Regulations.
5.2	Analysis of emissions impact on environment	Must be undertaken at discretion of Air Quality Officer.	Assessment of simulated concentrations against critical levels for vegetation, Nuisance dustfall for the construction and operational phases was quantified and assessed (Section 5.2)
6	Complaints	Details on complaints received for last two years	Not applicable. Proposed facility.
7	Current or planned air quality management interventions	Interventions currently being implemented and scheduled and approved for next 5 years.	Not applicable. Proposed facility with best available technology planned for development.
8	Compliance and enforcement history	Must set out all air quality compliance and enforcement actions undertaken against the enterprise in the last 5 years. Includes directives, compliance notices, interdicts, prosecution, fines	Not applicable. Proposed facility.
9	Additional information		None

Table A-2: Comparison of Regulations regarding the Air Dispersion Modelling with study approach

AIR Regulations	Compliance with Regulations	Comment
Levels of assessment		
• Level 1: where worst-case air quality impacts are assessed using simpler screening models • Level 2: for assessment of air quality impacts as part of license application or amendment processes, where impacts are the greatest within a few kilometres downwind (less than 50 km) • Level 3: requires more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situations: – where a detailed understanding of air quality impacts, in time and space, is required; – where it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types, and chemical transformations; – when conducting permitting and/or environmental assessment process for large industrial developments that have considerable social, economic and environmental consequences; – when evaluating air quality management approaches involving multi-source, multi-sector contributions from permitted and non-permitted sources in an airshed; or, – when assessing contaminants resulting from non-linear processes (e.g., deposition, ground-level ozone (O_3), particulate formation, visibility)	Level 2 assessment using AERMOD	This Gaussian Plume model is well suited to simulate dispersion from multiple sources at low and moderate wind speeds over domains less than 50 km X 50 km.
Model Input		
Source characterisation	Yes	Source characterisation provided in Section 4.
Emission rates: For new or modified existing sources the maximum allowed amount, volume, emission rates and concentration of pollutants that may be discharged to the atmosphere should be used	Yes	Emission rates used for each scenario are provided in Section 4.

AIR Regulations	Compliance with Regulations	Comment
Meteorological data		
Full meteorological conditions are recommended for regulatory applications.	Yes	WRF modelled meteorology (including upper air) (Section 5.1.3 and 5.1.1).
Data period	Yes	3 years (2017 to 2019)
Geographical Information		
Topography and land-use	Yes	The average slope across the study area is less than 10% and, based on the AERMOD Implementation Guide, terrain with slopes less than 10% should excluded topographic in the dispersion simulations (US EPA, 2009). Land-use classification was considered in its influence on surface roughness and albedo during the meteorological pre-processing in AERMET.
Domain and co-ordinate system	Yes	• Dispersion modelling domain: 20 x 20 km • UTM co-ordinate system (WGS84) (Section 5.1.1)
General Modelling Considerations		
Ambient Background Concentrations, including estimating background concentrations in multi-source areas	Yes	Section 5.14 and 5.15
NAAQS analyses for new or modified sources: impact of source modification in terms of ground-level concentrations should be assessed within the context of the background concentrations.	Yes	Model predicted, 99th percentile ground-level concentrations compared against NAAQS (Section 5.1.6 and 5.1.7)
Land-use classification	Yes	Rural (Section 5.1.13)
Surface roughness	Yes	Used from Land-use in the AERMET pre-processing step.
Albedo	Yes	Used from Land-use in the AERMET pre-processing step.
Temporal and spatial resolution		
Receptors and spatial resolutions	Yes	Sections 1.3
Building downwash	Yes	For tanks as per the Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804 Notice R533, 11 July 2014)
Chemical transformations	No	Chemical transformation not possible in AERMOD.
General Reporting Requirements		
Model accuracy and uncertainty	No	
Plan of study	Yes	Section 5.1.1
Air Dispersion Modelling Study Reporting Requirements	Yes	As per the Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette No. 36904, Notice Number 747 of 2013 (11 October 2013) and as per the Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804 Notice R533, 11 July 2014).

AIR Regulations	Compliance with Regulations	Comment
Plotted dispersion contours	Yes	Section 5.1.6 and 5.2

APPENDIX B: IMPACT ASSESSMENT METHODOLOGY

Direct, indirect and cumulative impacts of the issues identified through the EIA process, as well as all other issues identified due to the amendment must be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;
- The **consequences (magnitude)**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S = (E+D+M)P

S = Significance weighting

E = Extent

D = Duration

M = Magnitude

P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

Assessment of impacts must be summarised in the following table format. The rating values as per the above criteria must also be included. The table must be completed and associated ratings for **each** impact identified during the assessment should also be included.

Example of Impact table summarising the significance of impacts (with and without mitigation):

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**		
	Without mitigation	**With mitigation**
Extent	High (3)	Low (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (36)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes
Mitigation: "Mitigation", means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible. Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind.		
Cumulative impacts: "Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities[5].		
Residual Risks: "Residual Risk", means the risk that will remain after all the recommended measures have been undertaken to mitigate the impact associated with the activity (Green Leaves III, 2014).		

[5] Unless otherwise stated, all definitions are from the 2014 EIA Regulations (as amended on 07 April 2017), GNR 326.

APPENDIX C: ENVIRONMENTAL MANAGEMENT PROGRAMME

Environmental Management Programme for the Construction (and decommissioning) Phase(s)

Objective:	Minimise impact on ambient air quality through effective management, mitigation, and monitoring during construction phase
Project component/s	All Thermal Power Generation Facility components including associated infrastructure
Potential Impact	Heavy vehicles and construction equipment can generate dust and fine particulate matter and release air pollutants (NO_2, CO, PM, SO_2) due to movement on-site and movement of materials on-site.
	Construction activities such as vegetation clearing, temporary stockpiles, foundation excavation, and road construction can result in dust and particulate release potentially affecting human health on nearby residents or result in nuisance dustfall and reduced visibility during active construction.
Activity/risk source	The use of heavy vehicle and construction equipment
	Clearing of vegetation and topsoil
	Excavation, grading, and scraping
	Transport and movement of materials, equipment, and materials to site and around site (as required)
	Wind erosion from cleared areas, temporary stockpiles, and unsealed roads
	Combustion of fuel in construction equipment (e.g. generators) and heavy vehicles.
Mitigation: Target/Objective	Minimise potential particulate matter impacts associated with vehicles and construction equipment use
	Minimise potential health and nuisance impacts to communities and adjacent landowners from particulate emissions
	Minimise emissions from combustion engines (stationary or mobile) during the construction phase

Mitigation: Action/control	Responsibility	Timeframe
Establish a complaints register and/or incident reporting system where personnel, communities and adjacent landowners can lodge complaints regarding construction activities. Ideal location would be security post at point of site access.	EO	Prior to construction
Appropriate dust suppression measures on cleared areas, temporary stockpiles, and unsealed roads such as water suppression (using non-potable water if possible), chemical stabilisation, or revegetation (as soon as practically feasible), especially during high wind speed events.	EPC Contractor(s) and EO	During construction
Additional dust control measures (sweeping; screens; berms and/or water suppression - using non-potable water if possible, or chemical suppressants) along access during construction of access road sections and during thermal power generation facility construction.	EPC Contractor(s) and EO	During construction
Use minimum safe drop heights when transferring material on-site	EPC Contractor(s) and EO	During construction
Cover material stockpiles with tarpaulins or story in protected temporary bunkers	EPC Contractor(s) and EO	During construction
Limit cleared area for bulk earthworks to minimum as practically feasible	EPC Contractor(s) and EO	During construction
Heavy vehicles and construction equipment to be road worthy and regularly maintained.	EPC Contractor(s), transportation contractor(s) and EO	During construction
All vehicles leaving site with loose material must have load-bins covered with tarpaulins.	EPC Contractor(s) and EO	During construction

Mitigation: Action/control	Responsibility	Timeframe
All vehicles associated with the construction phase must adhere to the designated speed limits on- and off-site.	EPC Contractor(s), transportation contractor(s) and EO	Duration of contract
Revegetation (as soon as practically feasible)	EPC Contractor(s) and EO	At completion of construction phase (or before if practically feasible)
Investigate inadequate mitigation and control measures if monitoring or complaints potential issues are indicated by non-conformance with performance indicators	EPC Contractor(s) and EO	During construction

Performance Indicator	Appropriate dust suppression measures are implemented during construction phrase. No visible dust plumes from cleared areas and temporary stockpiles during high wind speed events. No visible plumes from roads when in use or during high wind speed events.
	Drivers are aware of potential safety issues and strict enforcement of on-site speed limits when employed and when entering site.
	Vehicle roadworthy certificates and maintenance records for all heavy vehicles are made available prior to construction and updated regularly. No or minimal visible exhaust fumes during normal operation.
Monitoring	Dustfall monitoring at the homesteads along the access road. Measured daily dustfall rates should not exceed the acceptable dustfall standards for residential areas.
	The performance indicators listed above should be met during the construction phase by the responsible parties.
	Any potential or actual issues that could results in non-conformance with the performance indicator must be reported by on-site personnel to the Site Manager immediately.
	An incident reporting system must be used to record non-conformances to the EMPr
	A complaints register must be used to record complaints from the public

Environmental Management Programme for the Operational Phase

Objective:	Minimise impact on ambient air quality through effective management, mitigation, and monitoring during the operational phase.
Project component/s	Gas engines
Potential Impact	The normal operation of the proposed thermal power generation facility will result in emission of gaseous and particulate pollutants including: SO_2, NO_2, PM, CO, and VOCs. Increased ambient concentrations of these pollutants may result in negative human health impacts, and nuisance dustfall.
	The transport of diesel in tanker trucks via road from the distribution depot will result in the emission of gaseous and particulate pollutants including: NOx, CO, PM, SO_2 and VOCs. Increased ambient concentrations of these pollutants may result in negative human health impacts and nuisance dustfall, especially along the access road.
Activity/risk source	Combustion of diesel in engines
	Combustion of diesel in fuel delivery tanker trucks
Mitigation: Target/Objective	Ensure emissions within those typical for the engine model
	Ensure compliance with ambient air quality standards at the property boundary and along delivery access route.
	Ensure compliance with acceptable dustfall standards along delivery access route and at nearest receptor.

Mitigation: Action/control	Responsibility	Timeframe
Establish a complaints register and/or incident reporting system where personnel, communities and adjacent landowners can lodge complaints regarding construction activities. Ideal location would be security post at point of site access.	EO and Plant Manager	Prior to commissioning
Regular maintenance and inspection of engines as per original equipment manufacturer requirements	EO and Plant Manager	During operations
Regular emissions monitoring campaign, by independent contractor, on at least one engine stack per plot.	EO, Contractor and Plant Manager	During operations
Once per year a 7-day ambient monitoring campaign at (minimum) 4 fence-line locations using passive sampling techniques. Monitoring of SO_2, NO_2, CO, and VOCs	EO, Contractor and Plant Manager	During operations
Appropriate dust suppression measures on access road, including regularly sweeping and or wet suppression, to minimise particulate matter build-up along access road.	EO and Plant Manager	During operations
Diesel delivery tanker trucks to be road worthy and regularly maintained. Tanker trucks to comply with Euro V emission limits or better.	Fuel distribution contractor, transportation contractor(s) and EO	Duration of contract
All vehicles associated with the delivery of diesel during the operational phase must adhere to the designated speed limits on- and off-site.	Fuel distribution contractor, transportation contractor(s) and EO	Duration of contract
Investigate inadequate mitigation and control measures if monitoring or complaints potential issues are indicated by non-conformance with performance indicators	EPC Contractor(s) and EO	During operations

Performance Indicator	Appropriate dust suppression measures are implemented during along access road. No visible dust plumes from roads when in use or during high wind speed events.
	Drivers are aware of potential safety issues and strict enforcement of on-site speed limits when employed and when entering site.
	Vehicle roadworthy certificates and maintenance records for tanker trucks are made available prior to construction and updated regularly. No or minimal visible exhaust fumes during normal operation.
	Emission rates within 10% of those quoted by the OEM during normal operation (2 hours per week).
	Compliance with national ambient air quality standards based on passive sampling campaign.
Monitoring	Dustfall monitoring at the homesteads along the access road. Measured daily dustfall rates should not exceed the acceptable dustfall standards for residential areas.
	The performance indicators listed above should be met during the operational phase by the responsible parties.
	Any potential or actual issues that could results in non-conformance with the performance indicator must be reported by on-site personnel to the Site Manager immediately.
	An incident reporting system must be used to record non-conformances to the EMPr
	A complaints register must be used to record complaints from the public
	Annual emissions monitoring campaign, by independent contractor, on engine stacks.
	Once per year a 7-day ambient monitoring campaign at (minimum) 4 fence-line locations using passive sampling techniques. Monitoring of SO_2, NO_2, CO, and VOCs

APPENDIX D: CURRICULUM VITAE OF PROJECT TEAM

CURRICULUM VITAE

Name Theresa (Terri) Leigh Bird

[redacted]

MEMBERSHIP OF PROFESSIONAL SOCIETIES

- National Association for Clean Air (NACA), 2012 to present
- South African Council for Natural Science Professions (Pr.Sci.Nat.), 2016 to present

EXPERIENCE

Projects contributing to Environmental Impact Assessments

Project type	Experience
Mining (including coal, platinum, tin, gold, and rare earth minerals)	▪ At least five proposed open-cast coal mining projects, mostly in South Africa and Botswana ▪ Air quality assessment for the expansion of an underground platinum mine to include a concentrator facility and tailings facility. ▪ Assessment of underground mining of cassiterite (the mineral ore mined for tin) in the Democratic Republic of Congo. The project included the assessment of emissions along a long-distance haul road from the mine to Mombasa for export. ▪ Assessment of open-cast and underground mining of gold-rich ore, including gold plant activities, in order to design an air quality monitoring network. ▪ Three rare earth mineral mining projects included dispersion model runs to assist the radiation specialist assessment of impact of radioactive compounds.

Projects contributing to Environmental Impact Assessments

Project type	Experience
Power Stations	▪ The impact of mine tailings facilities on a proposed mixed use (residential and commercial) development, especially consideration to particulate matter and potential hazardous compounds on the residents of the development. ▪ A project assessing the impact of Namibian coal-fired power station on urban air quality, in the context of many small industrial sources. ▪ The assessment of retrofitting improved particulate emission controls on an existing coal-fired power station on the Mpumalanga Highveld. ▪ The assessment of impact of a floating power plant, fuelled by various potential liquid fuels, docked in a port servicing an industrial development zone. ▪ Professional opinion on the impact of solar power facilities (one concentrated solar power (CSP) and one photovoltaic (PV)) on ambient air quality. ▪ The assessment of three coal-fired power stations in Botswana, including two projects where the assessment assessed the combined impact of an open-cast coal mine and the associated coal-fired power station. ▪ Assessment of gas-to-power facilities using a mix of fuel options and abatement technologies.
Ash disposal facilities for coal-fired power stations	▪ Conducted the assessment of impact of ash disposal facilities coal-fired power stations requiring additional disposal area. Assessment included the estimation of increased life-time cancer risk as a result of exposure to carcinogenic metals in the wind-blown dust from the disposal facilities.
Tyre pyrolysis plant	▪ Assisted on an assessment of a plant that will use waste tyres as raw material to produce machine and vehicle oils.
Mineral alloy plant	▪ Project for a plant that uses multiple listed activities to recovery metals, via thermal processes, to produce ferroalloys that are pressed into briquettes for dispatch to clients.
Domestic waste landfill	▪ Assessing the health and odour impacts of a domestic waste landfill to support residential development plans for the area.
Hazardous waste landfill	▪ Assessing the health and odour impacts of a hazardous waste landfill to support the reduction of the required buffer zone.

Projects contributing to Environmental Impact Assessments

Project type	Experience
Thermal oxidation of industrial waste	▪ The project quantified the impact of an industrial thermal oxidation plant for waste disposal and considered upgrading of new technology to meet more stringent emission standards.
Marine Repair Facility	▪ The project quantified the impact on air quality of a marine vessel repair facility in the context of a busy port which includes an iron-ore transfer yard.
Industrial complexes	▪ Air quality impact of a large industrial special economic zone development (project assistant) ▪ Impact of road traffic on air quality associated with the development of an automated supplier park.

Air Quality Management Plans (AQMP)

Project type	Experience
Priority Area Level AQMP	▪ Involvement included: - baseline assessment of climatic conditions and ambient air quality across the Province; - collation of questionnaires from point-source emission; - point-source emissions inventory database management ▪ Contributor to management plan write-up. ▪ The management intervention strategies proposed in the AQMP were a collaborative effort of the technical project team, which included the client, stakeholders, and consultants.
Provincial Level AQMP	▪ Involvement included: - baseline assessment of climatic conditions and ambient air quality across the Province; - collation of questionnaires from point-source emission; - point-source emissions inventory database management ▪ Assisted with quantification of vehicle emissions and with dispersion modelling of baseline emissions. ▪ Main contributor to management plan write-up. ▪ The management intervention strategies proposed in the AQMP were a collaborative effort of the technical project team, which included the client and consultants.
Metropolitan city level AQMP	▪ Contributed to the emission inventory of industrial sources ▪ Collaborative project with the Council for Scientific Research (CSIR)

Air Quality Management Plans (AQMP)

Project type	Experience
Platinum smelter complex	▪ Fugitive dust emissions from ground-level sources and materials handling were a concern for a platinum smelter complex. The project scope included the identification of all sources; the quantification and ranking of emissions; and proposed management strategies. A risk assessment model was used to assess where the variability of emission sources would constitute a risk if improperly managed.
Diamond mine	▪ The project scope for a Botswana-based diamond mine approaching end-of-life required the assessment of current and future impacts of operations on the ambient air quality; including the development of an air quality management plan and the proposal of an ambient air quality monitoring network, based on the findings of the impact assessment.

Atmospheric Impact Reports (AIR)

Project type	Experience
Coal-to-liquid fuel refineries	▪ Postponement application included four sites with multiple point-sources and modelling iterations for all sources emitting at four different levels for multiple pollutants. ▪ A collaborative project where responsibilities included: model simulations, post-processing and extractions; management of model extractions and management of file transfer for peer review process; graphic summaries results; mapping of results; and, graphic presentation of measured ambient air quality. My contributions to the written report included: report template sections (as per Government Gazette No. 36904: 747); summary of meteorological data used in the assessment; measured ambient air quality; results analysis, interpretation and write-up; and, a literature review of potential impacts of the operations on the environment.
Crude oil refinery	▪ The assessment of impact of petroleum storage tanks storing products of the tar process on the ambient air quality, especially with respect to total volatile organic compounds (TVOCS). ▪ Postponement application included emissions from multiple point-sources, and fugitive emissions from storage tanks; modelling iterations for all sources emitting at two different levels for sulfur dioxide [from point sources] and total volatile organic compounds (TVOCS) [from tanks]. ▪ A collaborative project where I focused on the point-sources, including the model simulations; post-processing and extractions; graphic results summaries; and, graphic presentation of measured

Atmospheric Impact Reports (AIR)

Project type	Experience
	ambient air quality. Contributions to the written report included: report template sections; summary of meteorological data used in the assessment; measured ambient air quality; results analysis, interpretation and write-up.
	▪ Assessment report (prepared as AIR) included emissions from multiple point-sources; modelling iterations for all sources emitting at two different levels for particulate matter and ammonia emissions.
Fertilizer production	▪ A collaborative project where my responsibilities included: model simulation setup, post-processing and extractions; graphic summaries results; mapping of results; and, graphic presentation of measured ambient air quality. My contributions to the written report included: report template sections (as per Government Gazette No. 36904: 747); summary of meteorological data used in the assessment; measured ambient air quality; results analysis, interpretation and write-up.
Platinum smelter	▪ Postponement application included emissions from the smelter furnace and converter; modelling iterations for the sources emitting at two different levels where the pollutant of concern was sulfur dioxide.
Veterinary waste incinerator	▪ New Atmospheric Emissions License (AEL) application for a State Veterinary incinerator. The assessment included calculating emission rates from the incinerator; dispersion modelling; preparation of an AIR (as per Government Gazette No. 36904: 747); and completing the technical sections of the AEL application.
Galvanizing plant	▪ The project assessed the impact of a steel galvanising plant on air quality in a developing industrial development zone. Pollutants of concern included hydrochloric acid (HCl).
Secondary Aluminium Smelter	▪ A project involving the assessment of a secondary aluminium smelter in an already developed urban industrial area
NEMA Section 30	▪ Assessment of air quality impact due to industrial 'upset' events including simulating the off-site impacts for short-term high-emission events.

Ambient air quality monitoring projects

Project type	Comments regarding project details and involvement

Ferrochrome smelter complex	▪ Compiled reports for the dustfall monitoring campaign for a period of 12 months. Results were compared with the relevant legislation and recommendations made for source management as required.
Platinum smelter complex	▪ Project scope required monthly reports of the ambient sulfur dioxide concentrations downwind of a platinum smelter complex, for a 12-month reporting period. Report preparation included: data cleaning and filtering; data analysis, presentation; and report write-up.
Dustfall monitoring	▪ Collate, summarise and report on dustfall rates, and metal content, after laboratory analysis. Projects include: baseline monitoring prior to active coal mining; landfill dustfall monitoring; baseline dustfall monitoring for a residential development.
Ambient air quality monitoring	▪ Using radiello™ passive samplers to assess ambient pollutant concentrations. Projects include: volatile organic compounds around industrial waste water dams; pre-development levels near a medical waste incinerator; pre-development levels near a coal-fired power station; levels near a hazardous landfill; monitoring near an operational natural gas compression plant.
Asbestos monitoring	▪ Air and soil sampling and reporting for asbestos fibres
Petroleum product storage tanks	▪ Calculation of annual (volatile organic compound) emissions from petroleum storage tanks for the purposes of emissions reporting via the National Atmospheric Emission Inventory System.

SOFTWARE PROFICIENCY

- Atmospheric Dispersion Models: AERMOD, CALPUFF, ADMS (United Kingdom), CALINE, GASSIM
- Graphical Processing: Surfer, ArcGIS (basic proficiency)
- R, especially with the package "openair"
- Other: MS Word, MS Excel, MS Outlook

EDUCATION

University of the Witwatersrand

Ph.D. (School of Animal, Plant and Environmental Sciences) (2006 - 2011)	Thesis title: **Some impacts of sulfur and nitrogen deposition on the soils and surface waters of the Highveld grasslands, South Africa.**

M.Sc. (School of Animal, Plant and Environmental Sciences) (1999 – 2001).	Dissertation title: **Some effects of prescribed understory burning on tree growth and nutrient cycling, in *Pinus patula* plantations.**
B.Sc. (Hons) (Botany) (1998)	Project title: **The rate of nitrogen mineralization in plantation soils, in the presence of *Eucalyptus grandis* wood chips.** *Courses*: Wetland ecology, Ecophysiology and Environmental studies.
B.Sc. (1995 – 1997)	Botany III, Geography III, Zoology II.

COURSES COMPLETED AND CONFERENCES ATTENDED

- Paper presented at the International Union of Air Pollution Prevention and Environmental Protection Associations World Clean Air Congress, 2013 in Cape Town, South Africa,29 September - 4th October 2013
  - *Paper entitled*: Nitrogen cycling in grasslands and commercial forestry plantations: the influence of land-use change
  - *Co-authors*: T.L. Bird, M.C. Scholes, Y. Scorgie, G. Kornelius, N.-M. Snyman, J. Blight, and S. Lorentz
- Paper prepared for the National Association for Clean Air (NACA) annual conference, 2012 in Rustenburg, South Africa, 1-2 November 2012, Rustenburg. Annual Conference Proceedings ISBN 978-0-620-53886-2, Electronic Proceedings ISBN 978-0-620-53885-5
  - *Paper entitled*: Developing an Air Quality Management Plan: Lessons from Limpopo
  - *Co-authors*: T. Bird, H. Liebenberg-Enslin*, R. von Gruenewaldt, D. Modisamongwe, P. Thivhafuni, and, T. Mphahlele
- National Association for Clean Air (NACA) annual conference, 2017 in Johannesburg, South Africa, 4-6 October 2017, Rustenburg. Annual Conference Proceedings ISBN 978-0-620-77240-2, Electronic Proceedings ISBN 978-0-620-53885-5
  - *Poster entitled*: Air Pollution in sub-tropical urban and suburban areas: Do trends indicate vegetation as a pollution source?
  - *Co-authors*: T. Bird, G. Petzer, N. von Reiche

COURSES PRESENTED

Training organisation	Details of involvement
National Association for Clean Air (NACA)	▪ Presenting the module regarding the Development of Air Quality Management Plans ▪ Module forms part of a 5-day course presented annually

Centre for Environmental Management (CEM), University of the North-West (Potchefstroom)	▪ Presented two modules: 1. Development of Air Quality Management Plans 2. Air Pollution Meteorology ▪ Modules forms part of a 2-day course presented annually, or at special request

COUNTRIES OF WORK EXPERIENCE

South Africa, Botswana, Mozambique, Democratic Republic of Congo, Namibia, Tanzania

LANGUAGES

Language	Proficiency
English	Full professional proficiency
Afrikaans	Good understanding; fair spoken and written

REFERENCES

[redacted]

Appendix C5:
Noise

SPECIALIST DECLARATION

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Bokpoort CSP PV Plant - Environmental Noise Impact Assessment for Five 9.9MW Generators

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:
B-BBEE

Specialist name:
Specialist Qualifications:
Professional affiliation/registration:
Physical address:
Postal address:
Postal code:
Telephone:
E-mail:

[redacted]

2. DECLARATION BY THE SPECIALIST

I, _____Oliver Knoppersen_____, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

[redacted]

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, ___Oliver Knoppersen_____, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

[redacted]

Date

SUID-AFRIKAANSE POLISIEDIENS
STATION COMMANDER
2021 -11- 21
NORWOOD
SOUTH AFRICAN POLICE SERVICES

ENVIRONMENTAL NOISE IMPACT ASSESSMENT

acoustech
ACOUSTIC ENGINEERING CONSULTANTS

[redacted]

Bokpoort CSP 9.9MW Generator Plants: Environmental Noise Impact Assessment

Prepared for:

ACWA Power Energy Africa (Pty) Ltd

[redacted]

	Remarks	Date	Prepared by	Checked by	Authorised by
Issue 1		02/12/2020	Oliver Knoppersen AMIOA	Oliver Knoppersen AMIOA	Oliver Knoppersen AMIOA
Revision 1	Addition of the Cumulative effects	22/02/2020	Oliver Knoppersen AMIOA	Oliver Knoppersen AMIOA	Oliver Knoppersen AMIOA
Revision 2	7 Generators reduced to 5 generators with a new layout	30/11/2021	Oliver Knoppersen AMIOA	Oliver Knoppersen AMIOA	Oliver Knoppersen AMIOA

Acoustech Consulting (Pty) Ltd REG 2015/098932/07

Directors: J Knoppersen Pr Eng BSc Eng (Wits) GDE (Wits); O Knoppersen AMIOA (IOA)

Associates: W Meyer BSc Eng (Mech) (UKZN)

GREEN BUILDING COUNCIL SOUTH AFRICA MEMBER 2019

Table of Contents

APPENDICES

National Environmental management Act (Act no. 107 of 1998), GN No. 326 of 07 April 2017 Regulations, Appendix 7

Relevant referencing to the Appendix 6 of the National Environmental, Management Act, 1998 (Act No. 107 of 1998) is made below:	
Information requirements	**Reference**
(1) A specialist who prepared the report (a) details of- (i) the specialist who prepared the report; (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	See below (next section) and **Appendix E**.
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	See below (next section).
(c) an indication of the scope of, and the purpose for which, the report was prepared; (cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section **2** Section **6,** Section **7**
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section **6**
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section **5**
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section **7**
(g) an identification of any areas to be avoided, including buffers;	Section **7**
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section **7**
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section **5.4**
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity [including identified alternatives on the environment] or activities;	Section **7**
(k) any mitigation measures for inclusion in the EMPr;	Section **7**
(l) any conditions for inclusion in the environmental authorisation;	Section **7**
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section **7**
(n) a reasoned opinion— (i) As to whether the proposed activity, activities or portions thereof should be authorised; (ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section **7, 8**
(o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section **3.3**
(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto;	Section **3.3**
(q) any other information requested by the competent authority.	None

DETAILS OF SPECIALIST & DECLARATION OF INTEREST

Project Title	Bokpoort CSP PV Plant - Environmental Noise Impact Assessment Report
Contact person	Oliver Knoppersen
Postal address	[redacted]
Telephone	
E-mail	
Professional affiliation(s)	

I, Oliver Knoppersen , declare that –

General declaration:

I act as the independent specialist;

I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;

I declare that there are no circumstances that may compromise my objectivity in performing such work;

I have no, and will not engage in, conflicting interests in the undertaking of the activity;

[redacted]

ABSTRACT AND EXECUTIVE SUMMARY

Acoustech Consulting was appointed by ACWA Power to determine the potential noise impact of the proposed development of five generators of 9.9MW each at the Bokpoort CSP plant in the Groblershoop, Northern Cape. The scope of works of this Environmental Noise Impact Assessment (ENIA) is to determine if the project complies with Government Notice Regulation (GN R) 154 legislation (Government Gazette 13717, 10 January 1992). The methodologies applied in this report comply with the GN 320 of 20 March 2020 requirements.

The ACWA Power is proposing the development and operation of five generators around the proposed extension of the Bokpoort CSP site.

One noise sensitive receptor within proximity of the infrastructure footprint was identified and comprised of the Bokpoort farmstead.

Based on the measurements the following Rating Levels was selected for receptors:

- Rural District Rating for receptors Point B.

The outcome of the assessment indicated that some mitigation options are required during the construction phase and operational phase. Key mitigation options include:

- Construction Phase - The most important mitigation option is to ensure the construction occurs during daytime hours.

- Annual noise measurements programme is recommended initially and then biennially after the initial findings during the operational phase for either of the two options.

With mitigation measures implemented the proposed generator development would comply to GN R154 legislation. In terms of noise assessment, the project does not present a fatal flaw. The project should be authorised in terms of noise, with mitigation measures adhered to.

1. INTRODUCTION

Acoustech Consulting was appointed by ACWA Power to provide a noise impact assessment for five generators of 9.9MW each at the Bokpoort CSP plant in the Groblershoop, Northern Cape. The scope of works of this Environmental Noise Impact Assessment (ENIA) is to determine the baseline noise level measurements at the property boundary and by the closest noise receptor.

The scope of works of this Environmental Noise Impact Assessment (ENIA) is to determine if the project complies with Government Notice Regulation (GN R) 154 legislation (Government Gazette 13717 10 January 1992). The methodologies applied in this report comply with the GN 320 of 20 March 2020 requirements.

The report briefly discusses the ambient noise levels on the measured points in Figure 3-1. It is however a study in terms of guidelines South African National Standards (SANS) 10302:2008 and SANS10103:2008 criteria, the extent of noise levels from the project operations and at the receptors (dwelling, communities, office etc.). Reference is also made in terms of Appendix 6 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) and International Finance Corporation (IFC) guidelines (Table 1.7.1- Noise Level Guidelines).

2. REPORT LAYOUT & TERMS OF REFERENCE (TOR)

The noise impact study comprised an investigation of:

- The measurements of existing noise levels at the noise sensitive areas. The subsequent determination of the baseline setting (SANS 10103:2008 Rating Level) within the area;
- The estimated noise emission from the proposed project, and assessment of the future phases including planning, construction, operational and closure (rehabilitation) noise impacts;
- Mitigation requirements and recommendations where applicable; and
- Conclusions and recommendations as well as statement whether the project should be authorised (in terms of noise)

3. INDICATIVE PROJECT DESCRIPTION

3.1. Project Overview

The site is within one of South Africa's eight renewable energy development zones and has therefore been identified as one of the most suitable areas in the country for renewable energy development, in terms of a number of environmental impacts, economic and infrastructural factors.

Five 9.9MW generator plants are proposed. Locations of the generator plants are indicated in Figure 3-1. The details are given below:

- Generating capacity: 9.9 MW each for five sites.
- Fuel Type: LPG/LNG and Diesel
- Stack height: 50-70m
- Number of engines: 1 for each plot (it is subject to the engine size, various load size available in the market)
- Fuel storage tanks: 5 for each plot
- Fuel volume: 1000 m3 for each plot
- Water requirements: limited water for cooling
- Area size: 1.5 ha
- Designs have not been completed and varies with engine providers. However, the Wartsila Engines are the preferred generators.

The intended periods of operation are as follows:

- 24 hours
- 7 day working week

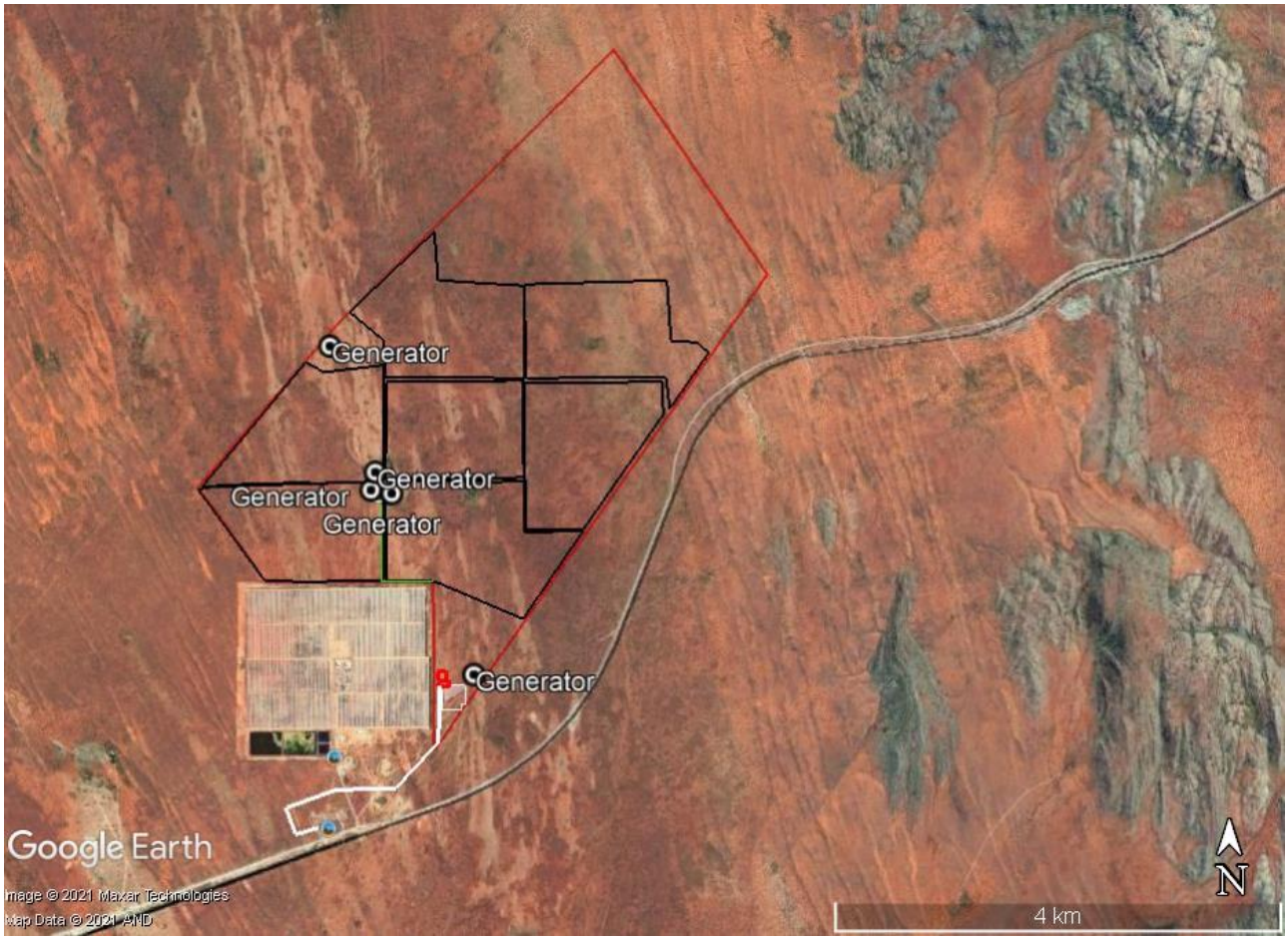


Figure 3-1: Project Layout

3.2. Interested & Affected Parties (I&AP's)

Receptors were identified by means of desktop assessment (up to 2,000m from the project footprint) including information supplied by the project team. Receptor positions are presented in Figure 3-2. Geographic locations of the ambient noise level baseline measurements are further presented in Appendix D.

Only one receptor is within immediate proximity (2000m) of the site footprint were identified. Ambient noise measurements were performed at Point A (proposed development site) and Point B (Bokpoort Farmstead).

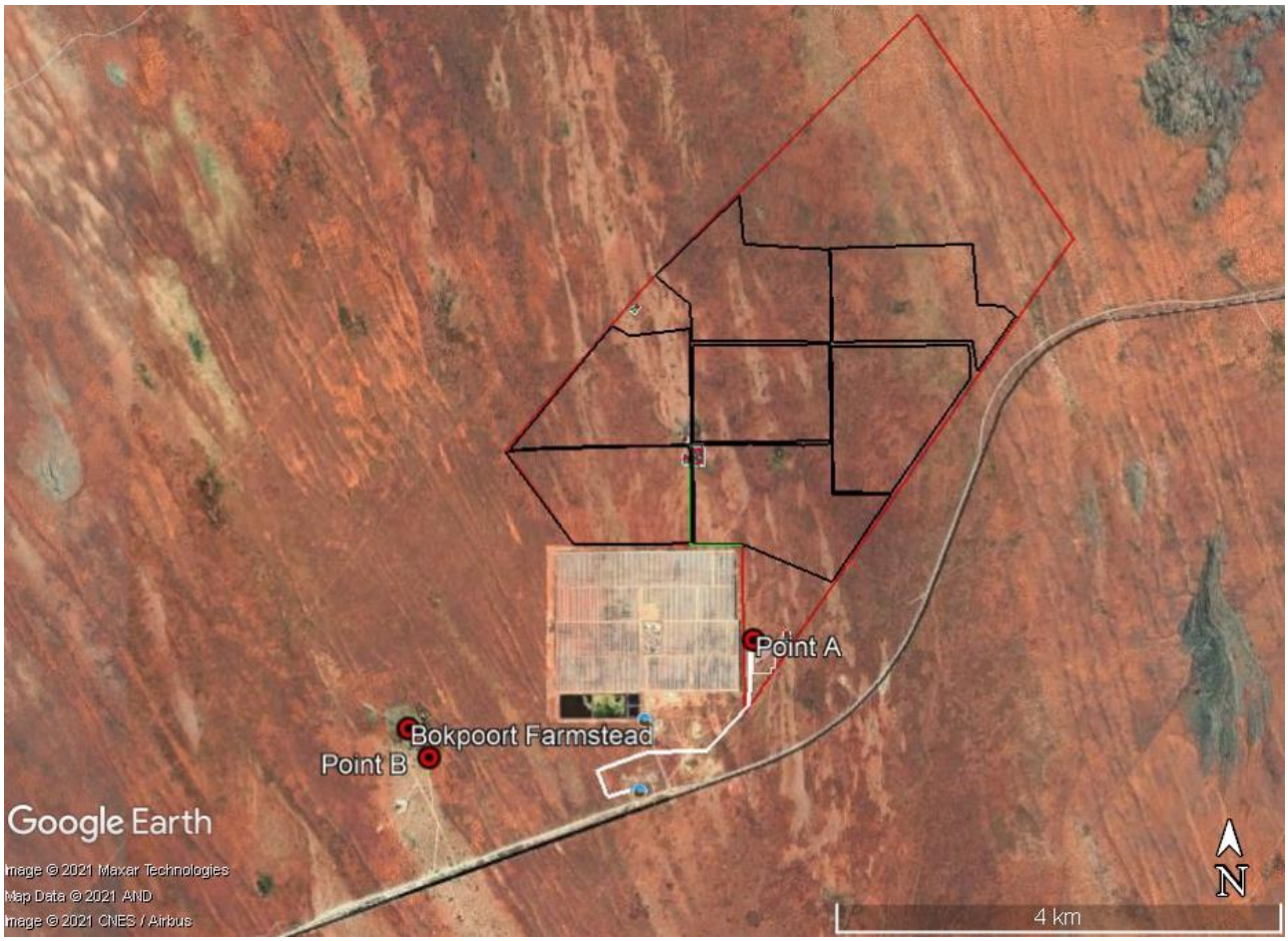


Figure 3-2: Interested and Affected Parties (Noise sensitive establishments).

3.3. Available Information

No online resources were sourced for information regarding previous noise studies conducted within the study area.

Other available information as sources from the client and Wartsila are presented below

Table 3-2 : Comments received- information gathered relating to the project

Source	Comment or Information
Project team	Project layout
Wartsila	Noise Information

4. LEGAL FRAMEWORK

4.1. South African Legislation & Guidelines

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

This act lists noise pollution as a matter which falls under the jurisdiction of local government with assistance from the provincial government.

4.1.2 The Environmental Conservation Act, 1989 (Act No 73 of 1989)

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

4.1.3 The Noise Control Regulations GN R154

No noise control legislation within the Mpumalanga province exists, with reference to the National GN R154 National Noise Control Regulations. The National legislation has set pieces for industrial and controlled areas, residential or business areas. The National noise control legislation defines the following:

Section 1:

- Ambient sound level - means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes, after such meter had been put into operation;
- Disturbing noise - means a noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7-dBA or more;

- Noise nuisance - means any sound which disturbs or impairs or may disturb or impair the convenience or peace of any person.
- Controlled area is as follows –

  c) industrial noise in the vicinity of an industry -

  - (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or
  - (ii) the calculated outdoor equivalent continuous W-weighted sound pressure level at a height of at least 1,2 metres, but not more than 1,4 metres, above the ground for a period of 24 hours, exceeds 61 dBA;

It also should be noted:

Section 7 Exemptions

(1) The provisions of these Regulations shall not apply, if-

(a) the emission of sound is for the purposes of warning people of a dangerous situation; or

(b) the emission of sound takes place during an emergency."

The definition of a disturbing noise (+7 dBA from Rating Level SANS 10103:2008) forms the basis upon which a non-compliance in terms of South African legislation is made.

4.1.4 SANS Guidelines (SABS)

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 4-1,** being the maximum noise level that is acceptable at the boundary of the property for any district. It should be noted that for industries operating in an industrial zone a 24-hour 70 dBA L_{Aleq} is acceptable.

SANS 10328:2008, Methods for environmental noise impact assessments. The document sets out the methodology to compile a comprehensive Environmental Nosie Impact Assessment. Stipulations include methodologies and minimum requirements, as well as various noise sources for investigations.

SANS10210:2004, Calculating and predicting road traffic noise. The document defines the prediction and measurement relating to road traffic noise.

Table 4-1 : Acceptable external noise levels within a district according to SANS 10103:2008

Type of District	Equivalent Continuous Rating Level for Noise ($L_{Req,T}$) (dBA)					
	Outdoors			Indoors with open windows		
	Day-night ($L_{Req,dn}$)	Daytime ($L_{Req,d}$)	Night-time ($L_{Req,n}$)	Day-night ($L_{R,Dn}$)	Daytime ($L_{Req,d}$)	Night-time ($L_{Req,n}$)
a) Rural districts	45	45	35	35	35	25
b) Suburban districts (little road traffic)	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts (with workshops, business premises and main roads)	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

4.1.5 Appendix 6 of the National Environmental, Management Act, 1998 (Act No. 107 of 1998)

The Appendix 6 of the National Environmental, Management Act, 1998 (Act No. 107 of 1998) regulations sets out minimum requirements from the authorities for a specialist to conduct an Environmental Study. The legislation checklist relevant for an ENIA has been compiled and is presented at the start of the document.

The new draft legislation promulgated on the 10th of May 2019 "Procedures to be followed for the assessment and minimum criteria for reporting of identified environmental themes in terms of Section 24(5)(a) and (h) of the National Environmental Management Act, 1998, when applying for environmental authorisation." was applied to this assessment.

5. APPROACH AND METHODS

5.1. Measurement Criterion

The procedures, as detailed in SANS 10328:2008 and SANS10103:2008 have been applied to the noise measurements and assessments made in this report. A summary of the approach to this study is outlined below.

5.1.1 Noise Policy Documents for the Region

No by-laws have been promulgated for Northern Cape Province or for the local or district municipalities.

5.1.2 Field Assessments of the Site

Field assessments in and around the site were undertaken on the 23 – 25 November 2020. This included the identification of the noise sensitive stakeholders, existing noise sources and other baseline noise contributors. Viable and alternative measurement localities at the identified monitoring localities were further investigated to ensure measurements were not influenced by extraneous noise sources (e.g. an air-conditioning condenser unit near measured locality).

5.1.3 Existing Baseline - Noise Measurements

Two baseline measurements (Points A and B) were conducted from the 23rd to the 25th April 2020. The noise measurements were analysed to compile a subjective and objective determination of the Rating levels (L_{Req}) based on the L_{AIeq} measurements.

Two Svantek 979 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 SANAS Calibrated Type 1 01dB sound calibrator. Further details of the sound level meters and their calibration certificates can be found in Appendix D.

$L(A)_{eq}$ values of ambient noise level 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
23/11/2020	31 / 20 Degrees	15 km/h NE
24/11/2020	25 / 18 Degrees	16 km/h NE
25/11/2020	28 / 20 Degrees	13 km/h NE

5.1.4 Estimation of Potential Noise Impacts

The noise impact was determined with reference to legal standards (where applicable) and the specifications and guidelines provided in the SABS standards document (SANS 10103:2008). Significance of impacts can be subjective and legal minimum requirements and 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 level (as described in preceding section) at each receptor locality with each of the following:

- The measured ambient noise levels as described in measurement section above; and
- The identified SANS 10103: 2008 “typical rating levels for noise in districts” based on the measured ambient noise levels.

The extent of potential impacts has taken into consideration the probable community response to increases in sound levels, based on SANS 10103:2008. Important components and nature of the noise, such as impulsiveness and occurrence of pure tones, have also been accounted for by including correction factors as per SANS10103:2008.

5.2. Modelled Scenario

The modelled scenario was designed and based on the layout as supplied by the project team. The significant noise sources were identified, and noise contours developed. The modelled scenario took into consideration the following:

- Corrections for ground conditions (obtained from site observations) and metrological conditions;
- Ground elevation contours;
- Noise modelling based on future predicted noise climate. Sound Power Levels (SPL) will be sourced from the Wartsila noise information and on our SPL Library;
- Noise contour representation will be developed focusing on pre-mitigation and post-mitigation effectiveness (if required).

5.3. Impact Assessment and Management

5.3.1 Introduction

The potential environmental impact of the proposed project was determined by identifying the environmental aspects and then undertaking an environmental risk assessment to determine the potential significant environmental impacts. The impact assessment included all phases of the project, with specific emphasis on construction, operation, and closure with rehabilitation.

5.3.2 Methodology

As per the NEMA EIA Regulations (2017) prescribed requirements, the potential environmental impacts identified for project were evaluated according to severity, duration, extent and significance of the impact, and include the potential occurrence and assessment of cumulative impact. The Risk Assessment Methodology used for the ranking of the impacts is detailed below.

This system derives environmental significance by rating the consequence of the impact on the environment and the likelihood of the impact occurring. Consequence is calculated as the average of the sum of the severity, duration and extent ratings while Likelihood is the average of the frequency of the activity together with the probability of an environmental impact occurring during those frequencies. **Table 5-1** to

Table 5-3 detail the rating assignment process as well as the calculations applied to achieve averages and the over significance.

The methodology was applied to the identified impacts without and with the application of proposed mitigation measures.

5.3.3 Determination of Consequence

Consequence is calculated as the average of the sum of the ratings of severity, duration and extent of the environmental impact.

Table 5-1: Assessment and Rating of Severity, Duration and Extent

Rating/ Description	1	2	3	4	5
Severity	Negligible / non-harmful / minimal deterioration (0 – 20%)	Minor / potentially harmful / measurable deterioration (20 – 40%)	Moderate / harmful / moderate deterioration (40 – 60%)	Significant / very harmful / substantial deterioration (60 – 80%)	Irreversible / permanent / death (80 – 100%)

Rating/ Description	1	2	3	4	5
Duration	Less than 1 month / quickly reversible	Less than 1 year / quickly reversible	More than 1 year / reversible over time	More than 10 years / reversible over time / life of project or facility	Beyond life of project of facility / permanent
Extent	Within immediate area of activity	Surrounding area within project boundary	Beyond project boundary	Regional / provincial	National / international
Consequence	**(Severity + Duration + Extent) / 3**				

5.3.4 Determination of Likelihood

Likelihood considers the frequency of the activity together with the probability of the environmental impact associated with that activity occurring.

Table 5-2: Assessment and Rating of Frequency and Probability

Rating/ Description	1	2	3	4	5
Frequency	Less than once a year	Once in a year	Quarterly	Weekly	**Daily**
Probability	Almost impossible / Never	Unlikely	Probable	Highly likely	**Definite**
Likelihood	**(Frequency + Probability) / 2**				

5.3.5 Environmental Significance

Environmental significance is the product of the consequence and likelihood values:

- **Significance = Consequence X Likelihood**

Table 5-3: Determination of Environmental Significance

Significance	Description
L (1 – 4.9)	Low environmental significance
LM (5 – 9.9)	Low to medium environmental significance
M (10 – 14.99)	Medium environmental significance
MH (15 – 19.9)	Medium to high environmental significance

Significance	Description
H (20 – 25)	High environmental significance. Likely to be a fatal flaw.

5.3.6 Impact Summary Table

Table 7-2 and Table 7-4 provides a summary of the impact assessment based on the above methodology. It further provides detail on the potential impact, the significance rating without mitigation (WoM) measures, proposed mitigation measures, and significant rating with mitigation measures (WM).

5.4. Assumptions and Limitations

5.4.1 Acoustical Measurements

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

- The noise level may change from day to day due to activities within a community (e.g. road traffic fluctuations, see point below) or even at a singular dwelling itself. Dwelling related infrastructure (e.g. air-conditioning units, swimming pool pumps etc.) that has the potential to influence noise levels in terms of dB;
- Seasonal changes have the potential to influence sound levels directly (e.g. rain) or indirectly (influence faunal communication, see point below);
- Faunal communication measurement fluctuations due to seasonal, time of day or night etc. Certain fauna communicates during certain hours e.g. cicada may only audible during night-hours, crepuscular birds are only audible during evening or night hours, crickets may be more audible active as seasons get hotter etc;
- Measurements near mining and industries fluctuates 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 been excessive elevated noise levels (e.g. gas leaks, conveyor pulley roller squeaking, excessive vibrations (and associated noise) from unmaintained dampers on equipment etc;
- Road traffic noise fluctuates due to time of measurement investigation (e.g. peak traffic morning or evening conditions, early morning hours etc.; and
- Metrological conditions can influence noise measurements. These include inversion and diffraction in the temperature layer, change in temperature and humidity etc.

Longer-term measurements (24-hours) were conducted to counter a portion of above-mentioned limitations. The longer-term measurements enabled

measurements to be analysed in terms of LAeq, percentile and octave data. Longer-term measurements are proposed in certain national and international guidelines (or legalisation), namely:

- South African GN R154 Section 1, Controlled Area (LAeq);
- ISO 1996-2:2017, Section 3 Terms and Definitions (LAeq);
- World Health Organisation Night-Time Guidelines for Europe Executive Summary, pg XVII (LNight);
- SANS 10328:2008 & SANS10103:2008 Section 3.20, Reference time interval (LAeq);

6. BASELINE SOUND PRESSURE MEASUREMENTS

Measurement Points are presented in **Figure 3-1**.

6.1. Baseline Noise Measurement Results

The noise survey consisted of the following:

- Baseline Noise Survey:
  - Two long term noise measurements were performed at Point A & B (Proposed Site & Hornbill farmstead).

Equivalent values (Fast setting) are presented in Table 6-1 for Point A and B**.** The detailed noise histograms are shown in Appendix B.

Table 6-1: Rating level – Noise Measurements at Point A and B

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})	**Comparative Rating Level (SANS10103:2008)**
Point A	23/11/2020	45.2 dBA	42.6 dBA	Rural Districts (Daytime = 45 dBA and Night-time = 35dBA)
	24/11/2020	41.5 dBA	39.0 dBA	
Point B	23/11/2020	45,4 dBA	42.9 dBA	Rural Districts (Daytime = 45 dBA and Night-time = 35dBA)
	24/11/2020	45.0 dBA	39.3 dBA	

From the baseline noise survey it was found that the comparative rating level (SANS 10103:2008) for both measurement points were to be considered a rural district. However, Point B is located in an industrial zone which will allow for the noise levels to increase to an industrial district (70 dBA day-time – 60 dBA night-time).

7. NOISE IMPACT ASSESSMENTS

A worst-case controlled scenario was used to help identify potential issues, identify the significance rating and potential noise impacts in terms of legislation.

7.1. Construction

7.1.1 Envisaged Construction Noise Sources

The main activities during construction of the facility are summarised as follows:

- Site preparation, demolition & earthworks
- Generator enclosure construction
- Storage & handling infrastructure and utilities construction
- Delivery, installation and commissioning of plant machinery

The assessment has assumed equipment will be operating at maximum capacity. The main identified noise intensive activities and equipment to be used include piling operations, hydraulic excavators, compactors, cranes, site generators, grinders, air compressors, jack hammers, and construction vehicles including articulated dump trucks, concrete premix trucks, and tractor loader backhoes.

7.1.2 Impact due to construction noise

Typical construction site noise without obstacles emits approximately 112dBA continuous sound power from activities such as steel grinding/ cutting & hammering, piling, earthmoving, and construction vehicles. The maximum continuous time integrated sound pressure levels expected at the noise sensitive site due to the site emissions is summarized in Table 7-1 and a noise contour map is presented in Figure 7-1. The estimated maximum continuous noise levels due to construction are not expected to increase the ambient noise levels in the general surrounding area. The construction activities will be audible up to 500m from site and presents a negligible impact to Point B (Bokpoort Farmstead) during day and night-time hours.

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

Reciever	**Predicted Construction Noise Levels L_{Req} (dBA)**	*Predicted Daytime Excess Ambient Noise Levels* **($\Delta L_{Req,d}$) (dBA)**	*Predicted Night-time Excess Ambient Noise Levels* **($\Delta L_{Req,n}$) (dBA)**
Point B *(Residential)*	25	0	0

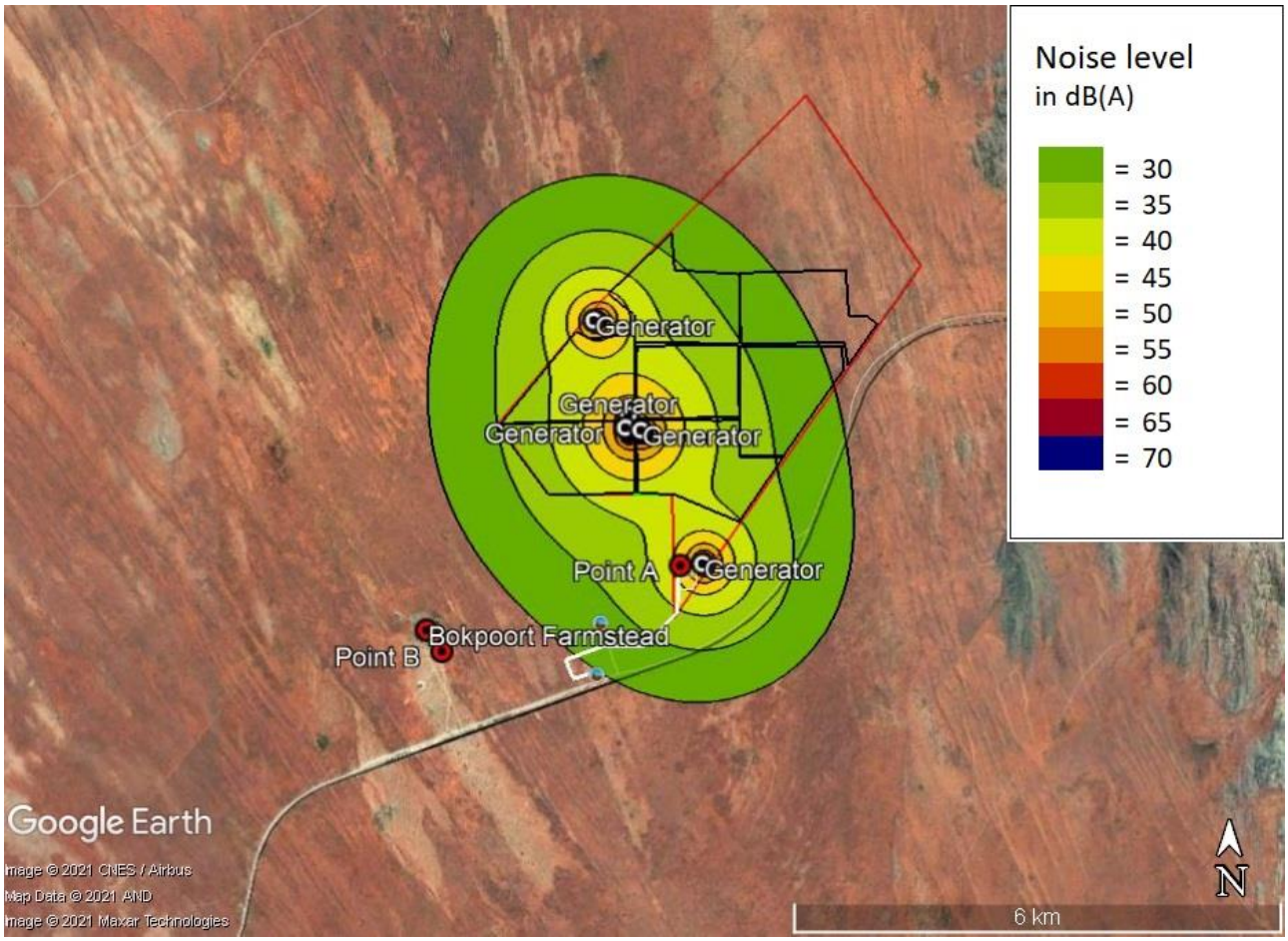


Figure 7-1: Predicted Noise Contour Map of the Construction Phase

7.1.3 Discussion

The continuous typical construction site noise will not exceed the existing baseline noise levels. However, construction activities may still be audible during some periods of the night-time period as the baseline noise levels indicate the noise levels fall below 27 dBA. This will not be considered a noise disturbance as the predicted construction noise level will not exceed 7 dB above the baseline noise levels as defined in the The Environmental Conservation Act, 1989 (Act No 73 of 1989). However, the noise level

exceedance from the predicted construction noise may cause noise nuisance claims doing quiet night-time periods.

The construction phase is temporary and typically completed within two years.

7.1.4 Mitigation Requirements

The construction activities should be limited to daytime (6am-6pm) and Monday to Friday only which will mitigate the possibility of night-time noise nuisance claims from the noise sensitive receptors.

Further mitigation measures for the construction noise sources include:

1. All construction vehicles must be well maintained and in good condition.
2. Construction staff working in areas where the 8-hour ambient noise is equal to or exceeds 85dBA, should be provided with ear protection equipment.
3. Particularly noisy operations must be scheduled appropriately and conducted after notifying sensitive receptors.

7.1.5 Conclusion

Construction noise will not exceed the baseline noise measurements by 7db. However, the construction noise may be audible during night-time periods and may cause noise nuisance claims.

Mitigating measures such as no construction activities during 6pm to 6am, should be implemented to minimise the possibility of noise nuisance complaints from the noise sensitive receptors.

7.1.6 Impact Rating of Construction Noise

The impact rating of the construction noise is given in Table 7-2:

Table 7-2: Environmental Impact Assessment – Construction Phase

Significance Points Quantification														
Site	Impact summary	Before mitigation						After mitigation						
		Consequence			Likelihood		Significance	Consequence			Likelihood		Significance
		Severity	Duration	Extent	Frequency	Probability		Severity	Duration	Extent	Frequency	Probability (Scale)	
Site	**Construction Phase**	1	2	2	2	2	**3.35 Low environmental significance**	1	2	1	1	1	**1.33 Low environmental significance**

7.2. Operational Phase

7.2.1 Expected Operational Noise Sources

The following main noise generating activities were considered for a modelled investigated scenario(s):

- Generator Engine Noise;
- Generator Exhaust Noise; and
- Noise from the Cooling Fans.

The generator noise sources were modelled with the **exclusions** of a generator hall building (with attenuators) and exhaust silencers. Should the assessment indicate that these be required, it will be stated in the noise mitigation section of this report.

7.2.2 Simulated Operational Noise Levels of the Five Generators

Simulated noise levels of the proposed Project's operational phase are illustrated in Figure 7-2 in relation to sensitive receptors. Table 7-3 shows the potential noise levels that may be experienced at the closest noise sensitive site in conjunction with baseline noise levels.

Table 7-3: Simulation of the existing noise levels from the Proposed Generators

Site	**Predicted Noise level at Closest Noise Sensitive Receptor** **dBA**	**Measured Baseline Noise Levels (Day / Night)** **dBA**	**District Rating Level** **(SANS10103:2008)** **Day / Night**
Point B	39	45.0 / 39.3	Rural Districts (45 dBA / 35dBA)
Proposed Site	67	41.5 / 39.3b	Industrial District (70 dBA / 70 dBA)

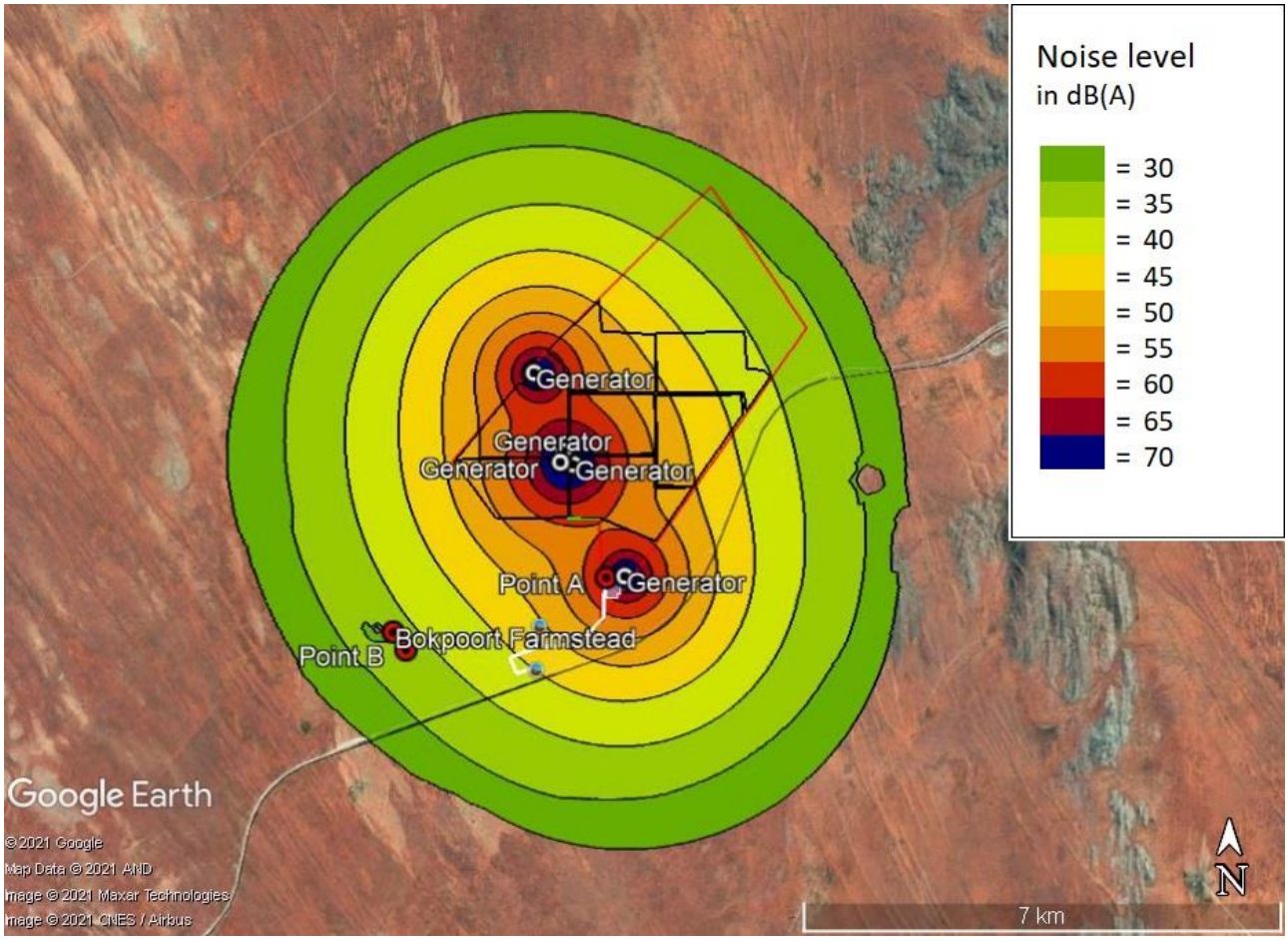


Figure 7-2: Predicted Noise Contour Map of the Operational Phase

7.2.3 Impact due to Operational Noise Levels

The proposed operational noise levels at do not exceed the existing baseline noise levels by 7dB during day or night time and thus does not constitute a noise disturbance. However, the generator noise will be audible during some periods of the day-time and night-time periods as the measured baseline noise levels vary between 20 and 40 dBA which will cause noise nuisance complaints. If noise mitigation is implemented, noise nuisance complaints will be reduced significantly during the day-time and night-time periods.

7.2.4 Mitigation Requirements

In order to reduce the risk of noise nuisance claims at the noise sensitive receptor and to meet the industrial district (60 dBA night-time), a 30 dBA reduction will be required from each generator plant. This will also reduce the noise-controlled areas (areas where hearing protection is required) within the existing and proposed solar plant.

Low frequency airborne noise which can be caused by gas generator exhaust systems can cause damaging vibration in light-weight buildings (both on site and at the noise sensitive receptor) will also need be reduced when the noise mitigation is implemented.

The following noise mitigation measures must be implemented to each 9.9MW generator plant:

1. A generator enclosure must be installed (Engine Hall Building) with a façade (including roof) that meets an airborne sound insulation (DnT,w) of 30 dB.
2. Appropriate inlet and outlet attenuators must be installed in the façade to meet the façade acoustic requirements of (DnT,w) of 30 dB.
3. It is assumed that extract fans will be fitted either on the side of the façade or on the roof. Extract fans are to be fitted with appropriate 2D circular pod attenuators.
4. The exhaust systems must be designed to ensure that low frequency harmonics are not encouraged. The exhaust silencer/s must make use of one or more 35 dB exhaust silencer/s.
5. Noise barriers should be used where cooling fans are located.
6. Noise Monitoring will be required annually around the site boundary as well as the identified noise sensitive receptor. The measured noise levels must be documented and must include the following descriptors: Noise Monitoring will be required biannually around the site boundary as well as the identified noise sensitive receptor, in accordance to 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.

In addition to these mitigation requirements, 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 five generator plants do not negatively affect the noise sensitive receptor as well as the current and proposed infrastructure on the site.

7.2.5 Conclusions

The proposed five generators will not cause a noise disturbance. However, the generator noise may be audible during some period of the daytime and night-time periods. If noise mitigation is used, noise nuisance complaints will be reduced during the daytime and night-time periods.

Mitigating measures should be implemented to minimise the possibility of noise nuisance complaints from the noise sensitive receptors.

7.2.6 Impact Rating of Operational Noise

The impact rating of the construction noise is given in Table 7-4:

Table 7-4: Environmental Impact Assessment – Operational Phase

Significance Points Quantification														
Proposed Site	Impact summary	Before mitigation						After mitigation (No Mitigation Required)						
		Consequence			Likelihood		Significance	Consequence			Likelihood		Significance
		Severity	Duration	Extent	Frequency	Probability		Severity	Duration	Extent	Frequency	Probability (Scale)	
Site	**Operational Phase**	2	4	2	3	4	**9.35 Low to medium environmental significance**	1	4	1	1	2	**4.5 Low environmental significance**

7.3. Closure Phase

The impact will be similar or lower than the busier construction phase (refer to section **7.1**).

7.4. Operational Phase Cumulative Assessment

7.4.1 Expected Operational Noise Sources

Apart from the proposed 9.9MW Generator Plant, there is a proposed 150MW Generator Plant at the Bokpoort CSP site. As for other projects within a 30km radius, several Solar PV and Solar CSP plants are proposed, however the noise levels from these projects are not expected to increase the ambient noise levels in the surrounding areas of the Bokpoort CSP site. Thus, the only expected significant noise sources in the area surrounding the Bokpoort CSP site is the proposed 150MW Generator Plant and the 9.9MW Generator Plant located on the Bokpoort CSP Site.

7.4.2 Simulated Operational Noise Levels

Simulated noise levels of the proposed Project's operational phase with the proposed 150MW Generator Plant at the Bokpoort CSP site, illustrated in **Figure 7-3** in relation to sensitive receptors. **Table 7-5** shows the potential noise levels that may be experienced at the closest noise sensitive site in conjunction with baseline noise levels.

Table 7-5: Simulation of the noise levels from the Proposed Generator Plants

Site	Predicted Noise level at Closest Noise Sensitive Receptor dBA	Measured Baseline Noise Levels (Day / Night) dBA	District Rating Level (SANS10103:2008) Day / Night
Point B	39.5	45.0 / 39.3	Rural Districts (45 dBA / 35dBA)
Proposed Site	70	41.5 / 39.3b	Industrial District (70 dBA / 70 dBA)

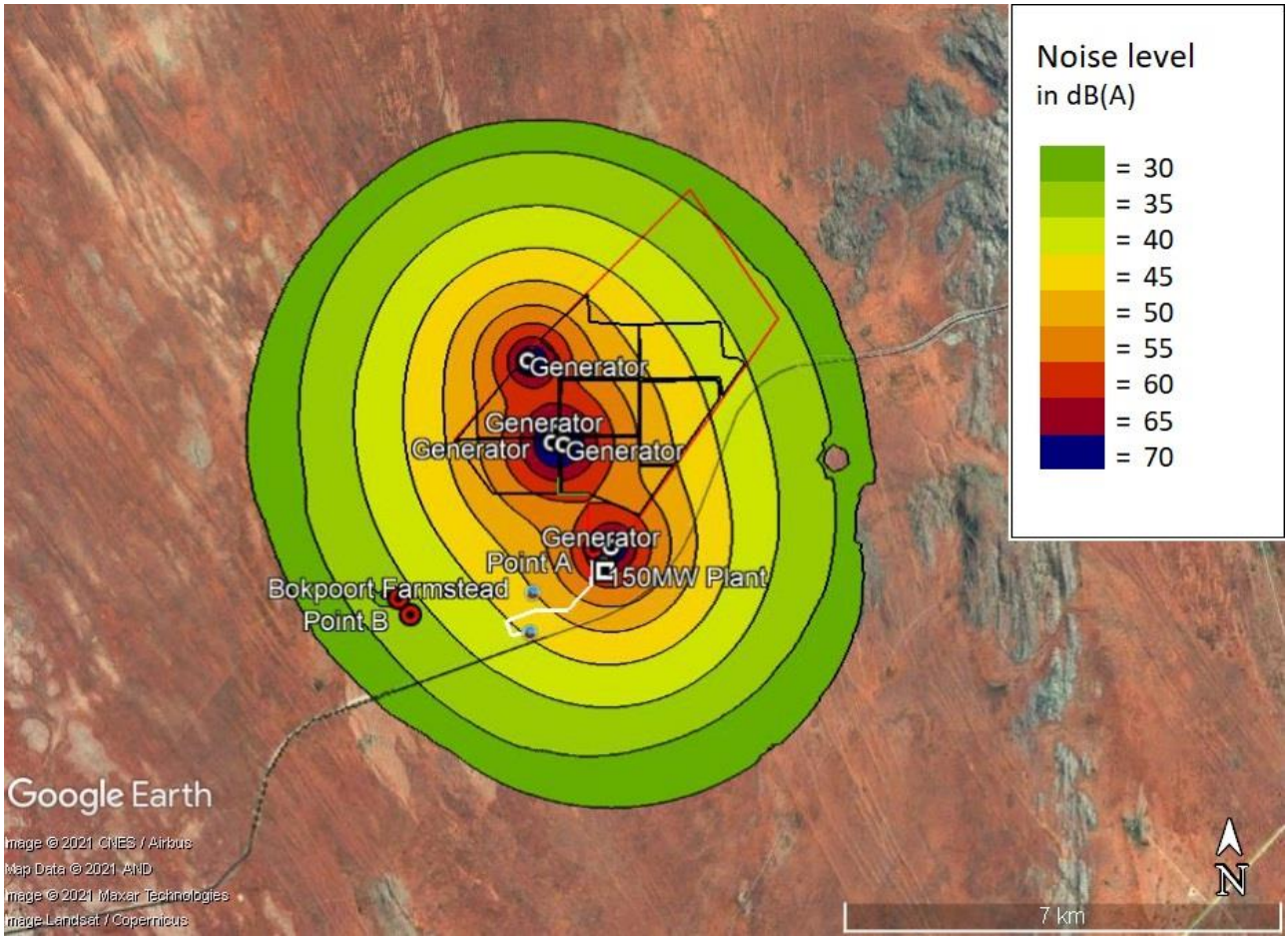


Figure 7-3: Predicted Noise Contour Map of the Cumulative Operational Phase of both Proposed Projects

7.4.3 Impact due to Operational Noise Levels

The proposed operational noise levels at do not exceed the existing baseline noise levels by 7dB during day or night-time and thus does not constitute a noise disturbance. However, the generator noise will be audible during some periods of the daytime and night-time periods as the measured baseline noise levels vary between 20 and 40 dBA which will cause noise nuisance complaints. If noise mitigation is implemented, noise nuisance complaints will be reduced significantly during the daytime and night-time periods.

7.4.4 Conclusions

The cumulative effects of the proposed 9.9MW Generator Plants and proposed 150MW Generator Plant at the Bokpoort CSP site will increase the ambient noise level at the Bokpoort Farmstead but is unlikely to cause a noise disturbance.

A full Noise Impact Assessment will be required to investigate the proposed final design of the 9.9MW Generator Plant.

7.4.5 Impact Rating of Operational Noise

The impact rating of the construction noise is given in **Table 7-6**:

Table 7-6: Environmental Impact Assessment – Operational Phase Cumulative Assessment

Significance Points Quantification							
Proposed Site	Impact summary	Before mitigation					
		Consequence			Likelihood		Significance
		Severity	Duration	Extent	Frequency	Probability	
Site	**Cumulative Operational Phase**	2	4	2	3	4	**9.35 Low to medium environmental significance**

7.5. Closure Phase

The impact will be identical to the construction phase (refer to section **7.1**).

8. NOISE IMPACT ASSESSMENT SUMMARY

A summary of the noise impact assessment for the proposed five 9.9MW Generator plants at the Bokpoort CSP is provided in Table 8.1.

Table 8-1: Summary of the Noise Impact Assessment

Phase	Noise Impact Before Mitigation	Noise Impact After Mitigation
Construction Phase	Low environmental significance- Impact is of a low order and therefore likely to have little real effect. Project can be authorised with low risk of environmental degradation. Mitigation is either easily achieved or little mitigation is required.	Low environmental significance - Zero impact (High Confidence)
Operational Phase	Low to medium environmental significance- Impact is of a low to medium order and therefore likely to have only have a slight effect. Project can be authorised with low to medium risk of environmental degradation. Mitigation can be achieved with design input from a qualified acoustic engineer.	Low environmental significance - Zero impact (High Confidence)
Cumulative Operational Phase	Low to medium environmental significance- Impact is of a low to medium order and therefore likely to have only have a slight effect. Project can be authorised with low to medium risk of environmental degradation. Mitigation can be achieved with design input from a qualified acoustic engineer.	Low environmental significance - Zero impact (High Confidence)
Closure Phase	Low environmental significance- Impact is of a low order and therefore likely to have little real effect. Project can be authorised with low risk of environmental degradation. Mitigation is either easily achieved or little mitigation is required.	Low environmental significance - Zero impact (High Confidence)

The outcome of the assessment indicated that noise mitigation is required during the construction phase and operational phase. Key mitigation options include:

- Construction Phase - The most important mitigation option is to ensure the construction occurs during daytime hours for either of the two sites.
- Mitigation requires engineering input from a qualified acoustic consultant. Further to this annual noise measurements programme is recommended.

With mitigation measures implemented the proposed five 9.9MW Generator Plants would comply to GN R154 legislation. In terms of noise assessment, the project does not present

a fatal flaw. The project should be authorised in terms of noise, with mitigation measures adhered to.

9. REFERENCES

1. Environment Conservation Act, 1989 (Act 73 of 1989).
2. National Environment Management Act (NEMA 2006).
3. Noise Control Regulations (Attached to the Act No 73 of 1989).
4. Occupational Health and Safety Act, 1993.
5. SANS 10328: 2008. 'Methods for environmental noise impact assessments.'
6. SANS 10103:2008. 'The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication.'
7. SANS 10357: 2004. 'The calculation of sound propagation by the Concawe method.'
8. "SoundPLAN, designing a sound environment." URL http://www.soundplan.com/.
9. The Constitution of the Republic of South Africa Act, 1996 (Act No. 108 of 1996).

APPENDIX A

Appendix A: Glossary of Terms & Acronyms

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).
- **Disturbing noise** means a noise level that exceeds the outdoor equivalent continuous rating level of the time period and neighbourhood as given in Table 2 of SANS 10103:2004. For convenience, the latter table is reproduced in this appendix as Table A1.
- **Equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$)** means the value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval, has the same mean-square should pressure as a sound under consideration whose level varies with time.
- **Equivalent continuous rating level ($L_{Req,T}$)** means the equivalent continuous A-weighted sound pressure level during a specified time interval, plus specified adjustments for tonal character and impulsiveness of the sound and the time of day.
- **Equivalent continuous day/night rating level ($L_{R,dn}$)** means the equivalent continuous A-weighted sound pressure level during a reference time interval of 24-hours, plus specified adjustments for tonal character and impulsiveness of the sound and the time of day. (An adjustment of 10dB is added to the night-time rating level).

- **Integrating sound level meter** means a device that integrates a function of the root mean square value of sound pressure over a period of time and indicates the result in dBA.
- **LoP –** means Life of Project.
- **Min.** means minimum.
- **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 climate** is a term used to describe the general character of the environment with regard to sound. As well as the ambient noise level (quantitative aspect), it includes the qualitative aspect and the character of the fluctuating noise component.
- **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 Free State Provinces have promulgated their own regulations and thus sections of the project are governed by the Gauteng Noise Control Regulations and the Noise Control Regulations for the Free State Province.
- **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 nuisance** means any sound which disturbs or impairs or may disturb or impair the convenience or peace of any reasonable person considering the quantitatively measurable such as barking dogs, etc. (compared with disturbing noise which is measurable).
- **Noise-sensitive Development** means and Interested or Affected Party (I&AP), receptor or any other party that has a concern about an activity.
- **Residual sound level** means the ambient noise that remains at a position in a given situation when one or more specific noises are suppressed (compare with *ambient noise).*

Sound exposure level or SEL means the level of sound accumulated over a given time interval or event. Technically the sound exposure level is the level of the time-integrated mean square A-weighted sound for stated time or event, with a reference time of one second.

- **Sound power level** indicates the total acoustic energy that a machine, or piece of equipment, radiates to its environment.

- **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.*
- **SANS 0210** means the latest edition of the South African Bureau of Standards Code of Practice SANS 0210 entitled *Calculating and Predicting Road Traffic Noise.*
- **SANS 10328** means the latest edition of the South African Bureau of Standards Code of Practice SANS 10328 titled *Methods for Environmental Noise Impact Assessments.*
- **SEL** - Sound Exposure Level
- **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.

Appendix B: Noise Measurements Histograms

Appendix B: Baseline Noise Measurement Histograms

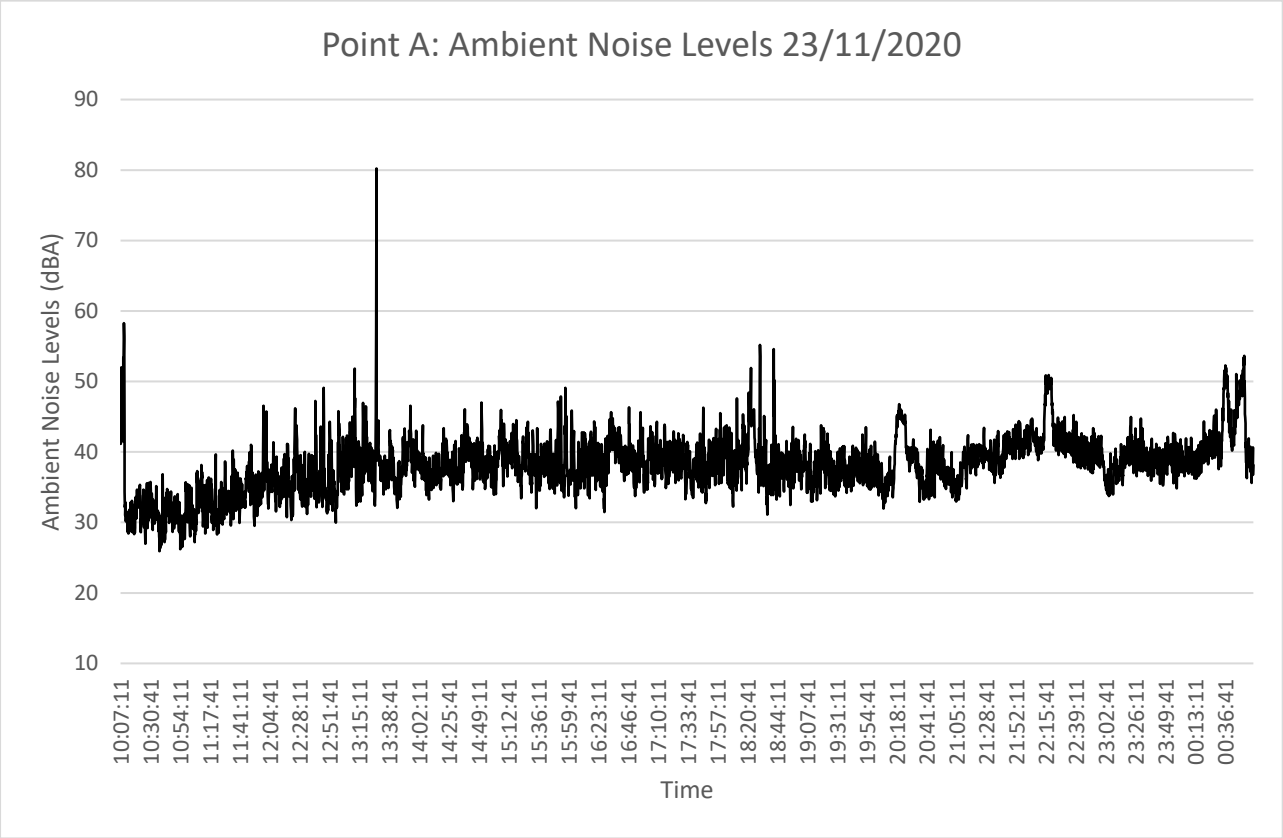


Figure 1: Day Time Ambient Noise Level at Point A of the property boundary on 23 November 2020

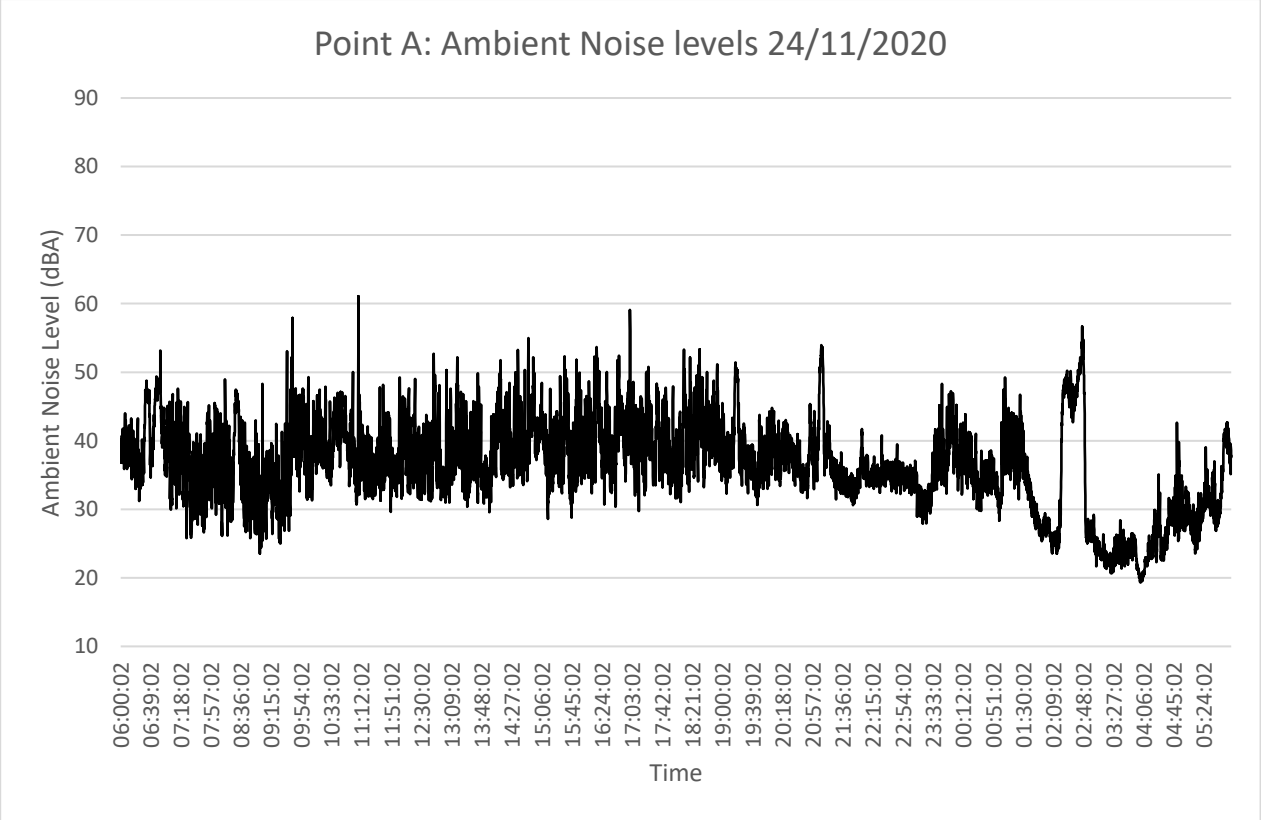


Figure 2: Day time Ambient Noise Level at Point A of the property boundary on 24 November 2020

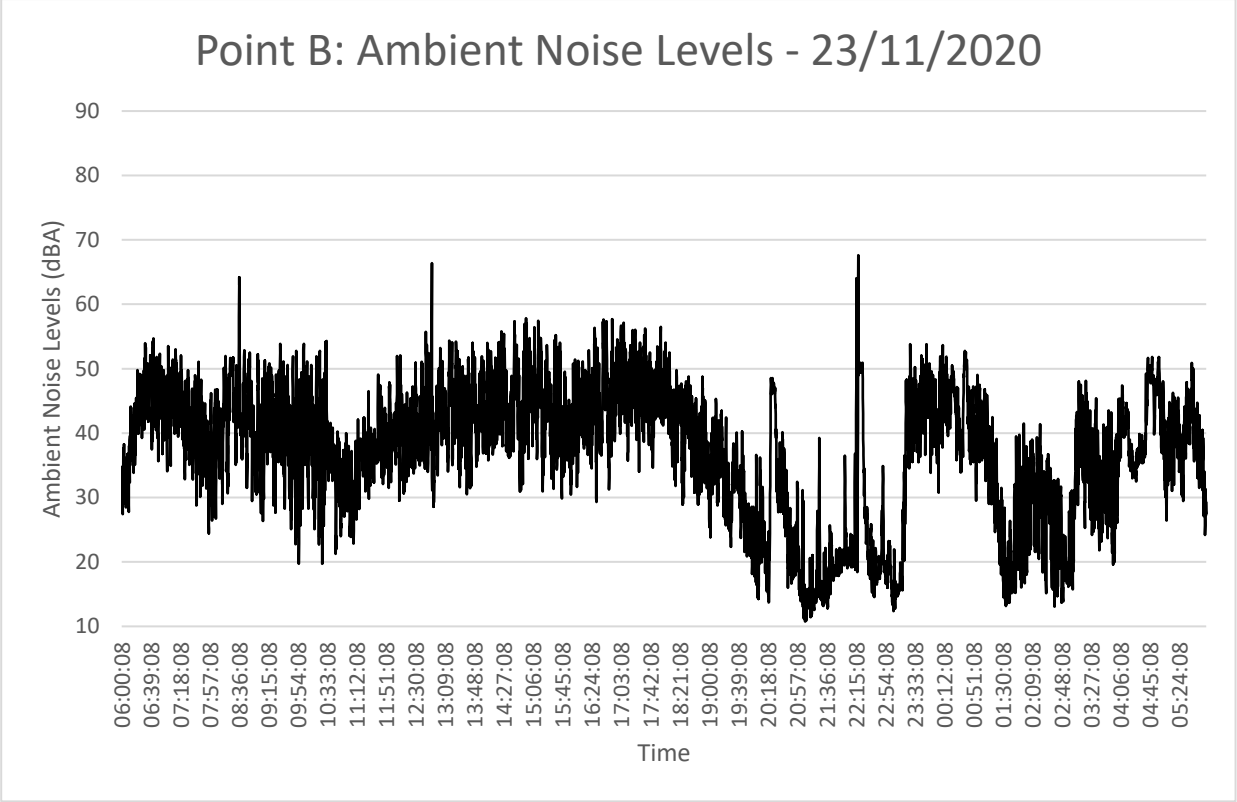


Figure 3: Day time Ambient Noise Level at Point B of the property boundary on 23 November 2020

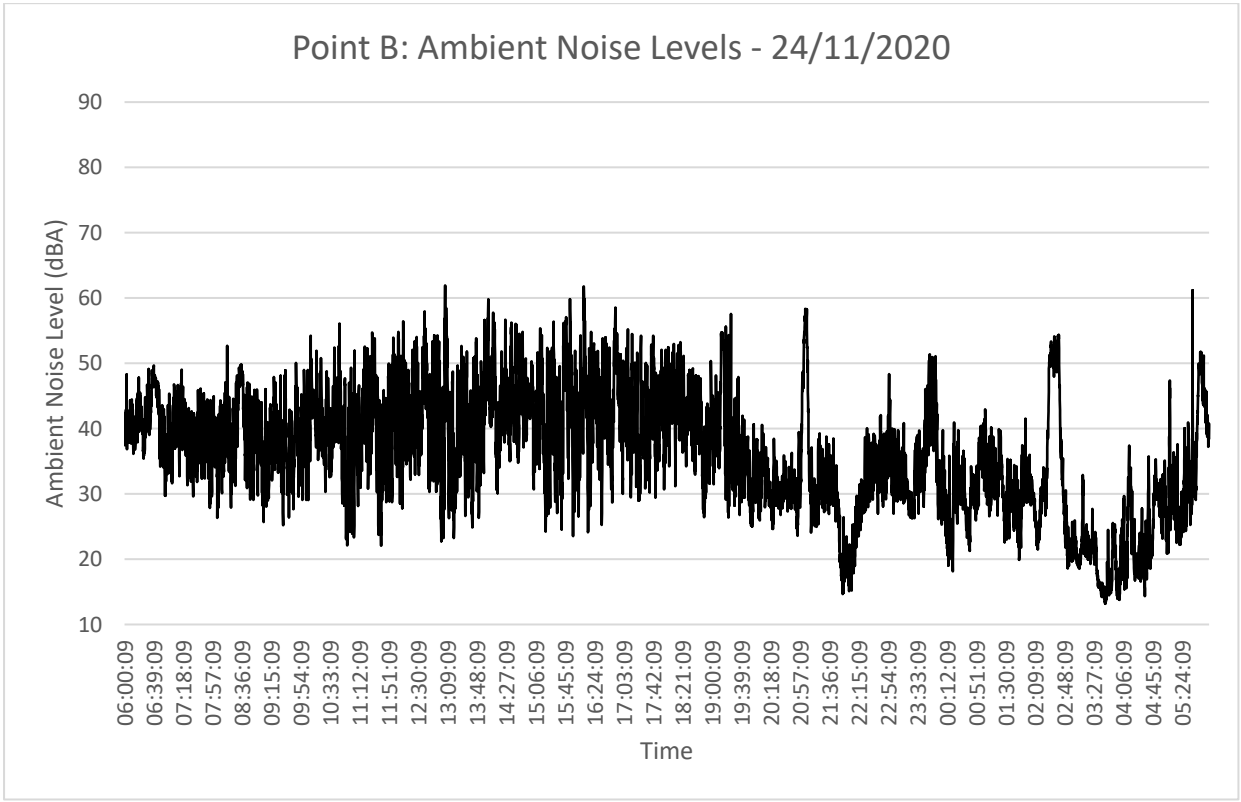


Figure 4: Day time Ambient Noise Level at Point B of the property boundary on 24 November 2020

APPENDIX C

Appendix C: Site Investigation Localities & Equipment/Calibration

Table 9-1: Site investigation localities

Measurement Locality	Latitude	Longitude
Measurements		
Point A (Property Boundary)	28°43'29.81"S	22° 0'16.74"E
Point B (Hornbill Farmstead)	28°44'15.68"S	21°58'29.54"E

Table 9-2: Equipment & Calibration

Equipment	Calibration	Certification number Laboratory (M & N) Acoustic Services
Svantek 979, 46134 (SLM)	09-10 September 2020	2020-AS-0760
Svantek 979, 69437 (SLM)	21-22 August 2020	2020-AS-0686
01dB Calibrator	25 August 2020	2020-AS-0684

APPENDIX D: Wartsila Engine Noise Data

Appendix D: Wartsila Engine Noise Data

W34SG engine sound power levels

Engine sound power levels have been measured according to ISO9614-2 as applicable. Measurement uncertainty is ±2dB

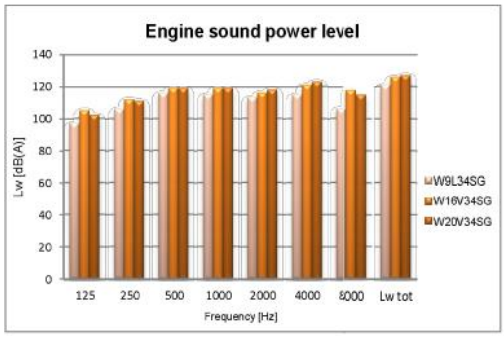


Figure 10. Engine sound power levels

W34SG exhaust sound power levels

The free field sound power spectrum after turbo charger can be seen in Figure 11. Measurement in exhaust duct, actual engine operating conditions. Measurement uncertainty is ±3dB.

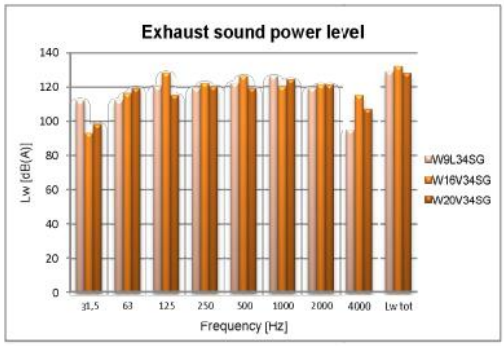


Figure 11. Exhaust sound power level

Typically 35 dB(A) exhaust gas silencers are used in power plants. Figure 12 shows typical transmission loss spectrum for a silencer.

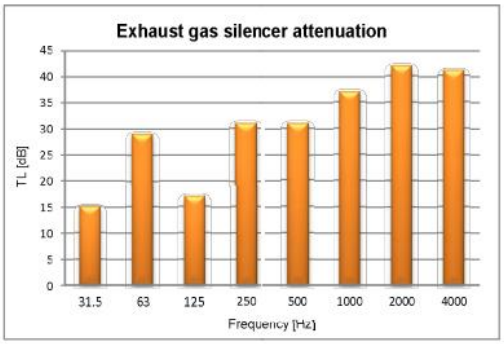


Figure 12. Exhaust gas silencer typical transmission loss

W34SG charge air sound power levels

Free field sound power spectrum after turbo charger can be seen in Figure 13. Measurement uncertainty is ±3dB.

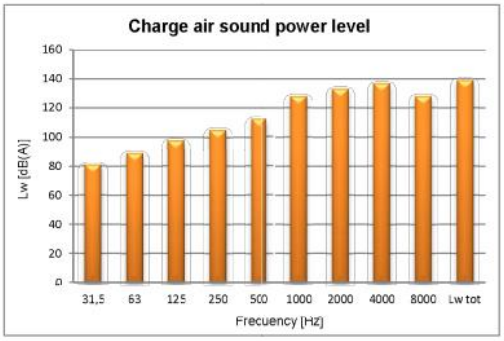
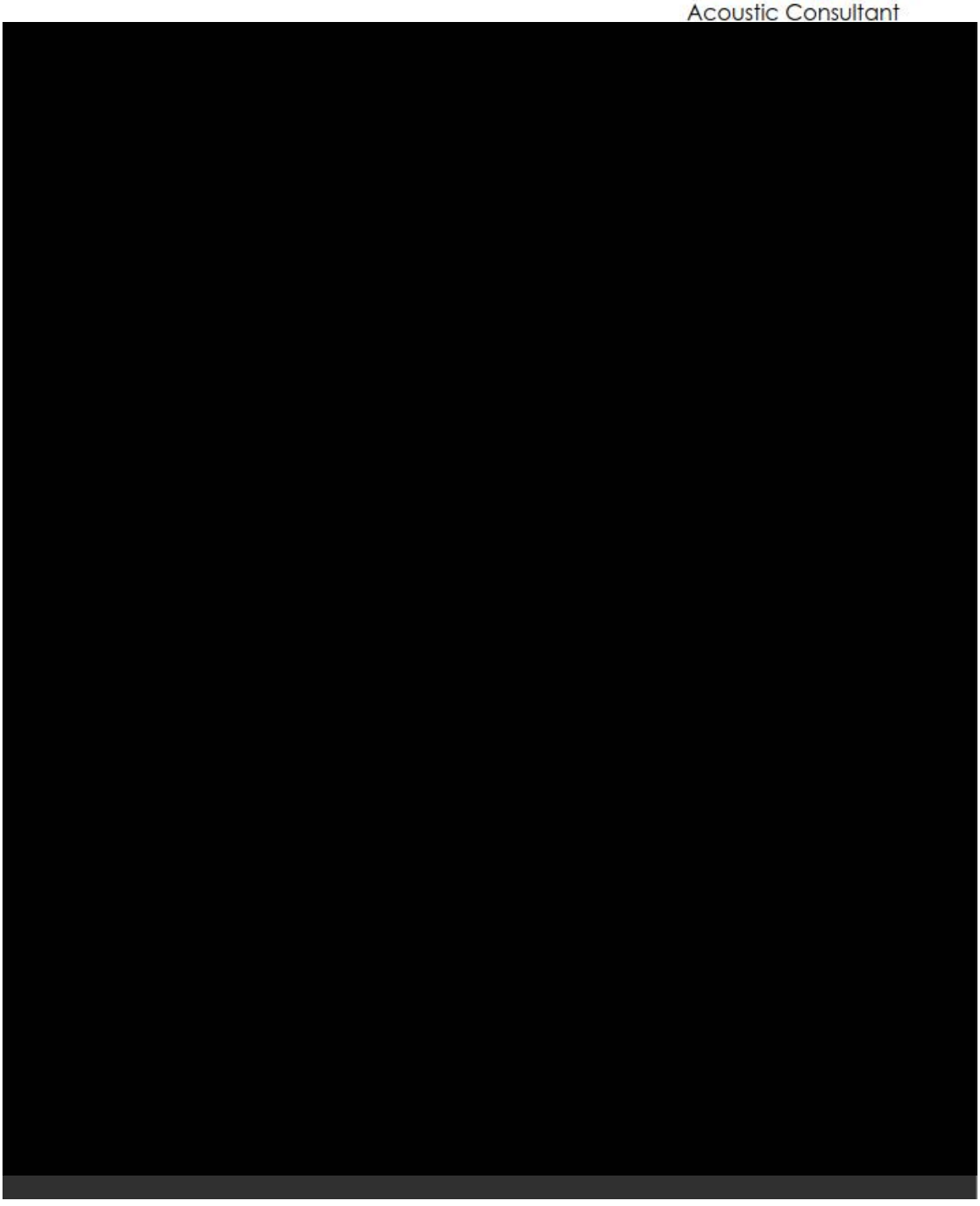


Figure 13. Charge air sound power levels

Typically 35 dB(A) charge air silencers are used in power plants. Figure 14 shows typical transmission loss spectrum for a silencer

APPENDIX E

Appendix E: Curriculum Vitae of Specialist



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

Appendix C6:
Heritage

SPECIALIST DECLARATION

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

The new substation and power line development for Project DAO (formerly Bokpoort Solar Power Photovoltaic (PV) Energy Facility) near Groblershoop, !Kheis Local Municipality, Northern Cape Province

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:
B-BBEE

Specialist name:
Specialist Qualifications:
Professional affiliation/registration:
Physical address:
Postal address:
Postal code:
Telephone:
E-mail:

2. DECLARATION BY THE SPECIALIST

I, J A van Schalkwyk, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, J A van Schalkwyk, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Date

SUID-AFRIKAANSE POLISIEDIENS
SAPS LYTTELTON
2021 -11- 27
COMMUNITY SERVICE CENTRE
SOUTH AFRICAN POLICE SERVICE

COMPLIANCE WITH GN320 AND GN1150

J A van Schalkwyk
[redacted]

11 February 2022

Ms T Ntshingila
ACWA POWER
[Per e-mail: TNtshingila@acwapower.com

To whom it may concern:

COMPLIANCE OF SPECIALIST REPORT WITH REQUIREMENTS GN 320 OF 20 MARCH 2020 AND GN 1150 OF 30 OCTOBER 2020.

I have reviewed my report produced in 2019: Van Schalkwyk, J.A. *Phase 1 Cultural Heritage Impact Assessment: The proposed Bokpoort II PV Solar Power Facilities on the farm Bokpoort 390 near Groblershoop, !Kheis Local Municipality, Northern Cape Province*.

Although the report was completed prior to the gazetting of the protocols referred to above, it is my opinion that the assessment and resultant report is still valid. This is based on the fact that the requirements are inherently contained in the "Minimum Standards for Phase I Heritage Impact Assessments" issued by the South African Heritage Resources Agency as far back as 2016.

We trust you find the above in order. If there are any uncertainties or additional information required, please feel free to contact the undersigned.

Yours sincerely

[redacted]

J A van Schalkwyk (D Litt et Phil)

- Heritage Consultant: ASAPA Registration No.: 164 - Principal Investigator: Iron Age, Colonial Period, Industrial Heritage.

SPECIALIST OPINION – TWO ADDITIONAL INTERNAL COMBUSTION ENGINES (NOVEMBER 2021)

J A van Schalkwyk
Heritage Consultant
[redacted]

29 November 2021

Ms T Ntshingila
ACWA POWER
[Per e-mail: TNtshingila@acwapower.com

To whom it may concern:

SPECIALIST OPINION FOR THE NEW INERNAL COMBUSTION ENGINE (ICE) DEVELOPMENTS ASSOCIATED WITH THE AFRIKAANS AND SOTHO PV PLANT FOR PROJECT DAO (FORMERLY BOKPOORT SOLAR PHOTOVOLTAIC (PV) ENERGY FACILITY) NEAR GROBLERSHOOP, !KHEIS LOCAL MUNICIPALITY, NORTHERN CAPE PROVINCE

In May 2021, ACWA Power Project DAO (RF) Pty Ltd (hereafter ACWA Power) was issued with seven Environmental Authorisations (EAs) for the development of seven individual 9.9MW Internal Combustion Engines (ICE) on the authorised Pedi, Venda, Zulu, Afrikaans, Ndebele, Swati and Sotho Photovoltaic (PV) Plants on the Remaining Extent (RE) of the Farm Bokpoort 390, located 20km north west of the town of Groblershoop within the !Kheis Local Municipality in the ZF Mgcawu District Municipality, Northern Cape Province. PV can only generate electricity when the weather is favourable. In order to address this need, ACWA Power proposed additional infrastructure ICE within their authorised plants to create flexibility and efficiency within the plants which will enable electricity generation during unfavourable weather conditions.

In September 2020, the Department of Mineral Resources and Energy (DMRE) released a request for proposal as part of the Risk Mitigation Independent Power Producer Procurement Programme to reduce the current load shedding periods being experienced by the country. In responding to the request, ACWA Power submitted a bid for a 150MW (export capacity) PV plant that was bid as "Project DAO" and were successful. A condition in the Request for Proposal required Bidders to not tap into the national grid for power and requires that a reliability test be undertaken at a specified generation rate and time.

However, the DMRE informed bidders that these requirements would be relaxed, and ACWA Power decided to lapse four of the seven ICE EAs, the four EAs that have been lapsed are Zulu, Afrikaans, Sotho, and Swati PV Plant ICE. The DMRE has now confirmed that they are not relaxing the reliability run requirements, and as such, ACWA Power now needs two additional ICE infrastructure to meet these requirements. Each of the ICEs will be subject to its own application for Environmental Authorisation.

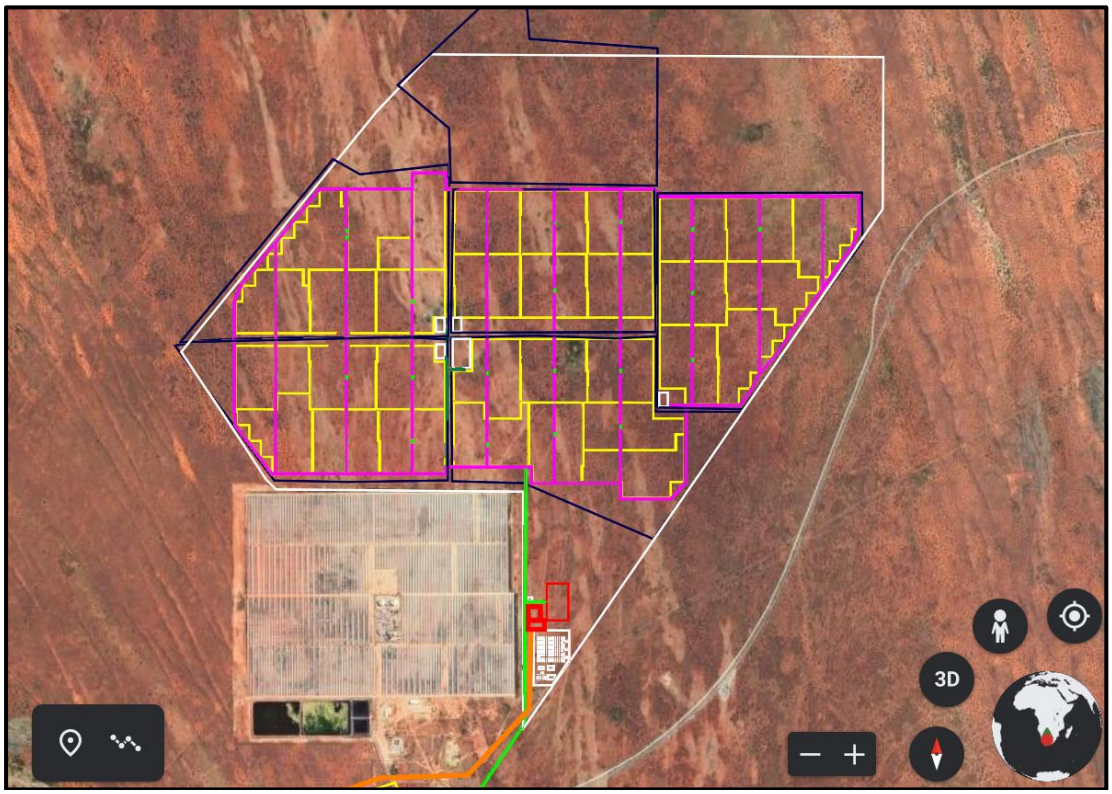
The specifications for each of the ICE associated with the Afrikaans and Sotho PV Plant are provided below:

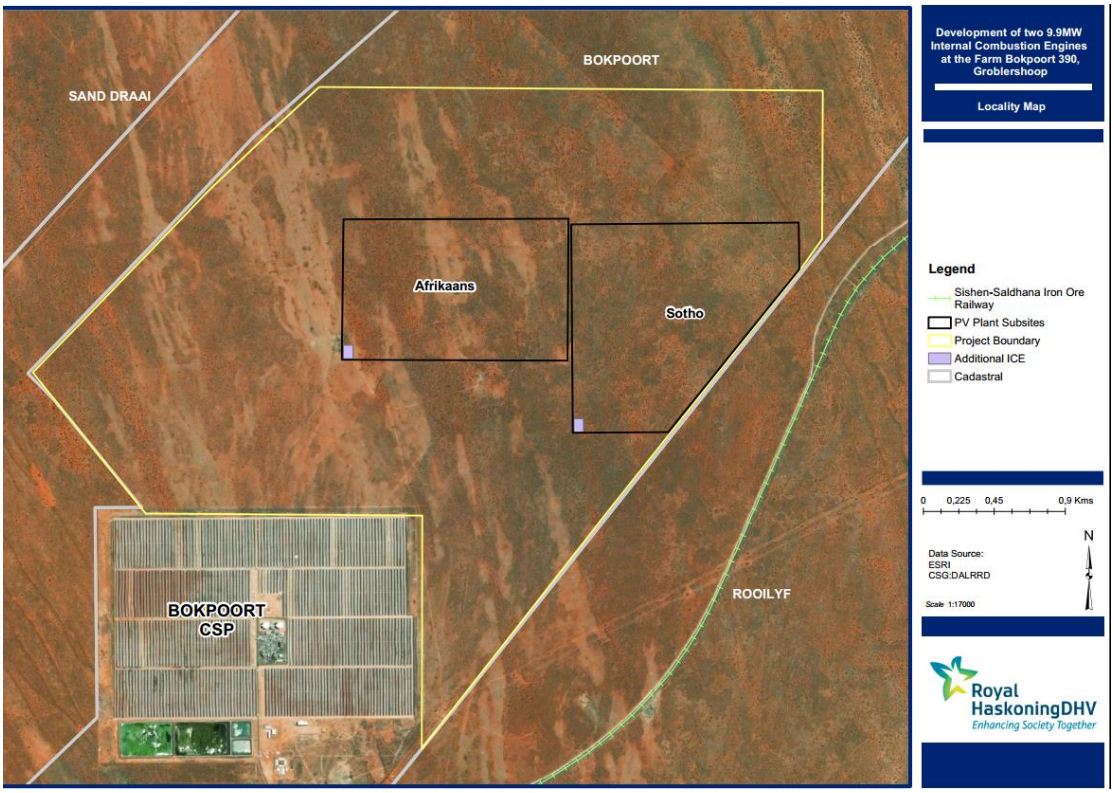
- Generating capacity: 9.9 MW
- Fuel Type: Diesel or Liquified Petroleum Gas (LPG) or Liquified Natural Gas (LNG)
- Stack height: 50 - 70 m
- Number of engines for the ICE: 1 (it is subject to the engine size, various load size available in the market)
- Fuel storage tanks: 5 (subject to the tanks sizing/designing)
- Fuel volume: 500 m3
- Water requirements: limited water for cooling

- Area size: 0.5 ha

Both options would be implemented within the area that has previously been subjected to a full heritage impact assessment and for which environmental authorisation has been granted.

We hereby confirm that the proposed amendments will not result in any additional impacts and will not increase the level or nature of the impact, which was initially assessed and considered when application was made for an EA. The significance ratings will remain unchanged and the proposed mitigation and management measures proposed as part of the EIA process will still suffice.





Location of the proposed new developments within the authorised area

We trust you find the above in order. If there are any uncertainties or additional information required, please feel free to contact the undersigned.

Yours sincerely

[redacted]

J A van Schalkwyk (D Litt et Phil)

- Heritage Consultant: ASAPA Registration No.: 164 - Principal Investigator: Iron Age, Colonial Period, Industrial Heritage.

THE PROPOSED BOKPOORT II PV SOLAR POWER FACILITIES ON THE FARM BOKPOORT 390 NEAR GROBLERSHOOP, !KHEIS LOCAL MUNICIPALITY, NORTHERN CAPE PROVINCE (JANUARY 2020)

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Development of the Bokpoort II PV Solar Power Facilities on the farm Bokpoort, Groblerhoop region, Northern Cape Province

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	Heritage Consultant
B-BBEE	[redacted]
Specialist name:	[redacted]
Specialist Qualifications:	[redacted]
Professional affiliation/registration:	[redacted]
Physical address:	[redacted]
Postal address:	[redacted]
Postal code:	[redacted]
Telephone:	[redacted]
E-mail:	[redacted]

2. DECLARATION BY THE SPECIALIST

I, J A van Schalkwyk, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

[redacted]

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, J A van Schalkwyk, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Date

Phase 1 Cultural Heritage Impact Assessment:

THE PROPOSED BOKPOORT II PV SOLAR POWER FACILITIES ON THE FARM BOKPOORT 390 NEAR GROBLERSHOOP, !KHEIS LOCAL MUNICIPALITY, NORTHERN CAPE PROVINCE

Prepared for:

Royal HaskoningDHV: Mr M Roods

- Address: P O Box 867, Gallo Manor, 2052, Gauteng, Tel: 087 352 1528; E-mail: Malcolm.Roods@rhdhv.com

Prepared by:

J A van Schalkwyk (D Litt et Phil),

- [redacted]
- [redacted]

Report No: 2020/JvS/001

- Status: Final
- Date: January 2020
- Revision No: -
- Date: -

Specialist competency:

Johan A van Schalkwyk, D Litt et Phil, heritage consultant, has been working in the field of heritage management for more than 40 years. Originally based at the National Museum of Cultural History, Pretoria, he has actively done research in the fields of anthropology, archaeology, museology, tourism and impact assessment. This work was done in Limpopo Province, Gauteng, Mpumalanga, North West Province, Eastern Cape Province, Northern Cape Province, Botswana, Zimbabwe, Malawi, Lesotho and Swaziland. Based on this work, he has curated various exhibitions at different museums and has published more than 70 papers, most in scientifically accredited journals. During this period, he has done more than 2000 impact assessments (archaeological, anthropological, historical and social) for various government departments and developers. Projects include environmental management frameworks, roads, pipeline-, and power line developments, dams, mining, water purification works, historical landscapes, refuse dumps and urban developments.

J A van Schalkwyk
Heritage Consultant
January 2020

SPECIALIST DECLARATION

I, J A van Schalkwyk, as the appointed independent specialist, in terms of the 2014 EIA Regulations (as amended), hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 (as amended) and any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist

J A van Schalkwyk
January 2020

EXECUTIVE SUMMARY

Phase 1 Cultural Heritage Impact Assessment:
THE PROPOSED BOKPOORT II PV SOLAR POWER FACILITIES ON THE FARM BOKPOORT 390 NEAR GROBLERSHOOP, !KHEIS LOCAL MUNICIPALITY, NORTHERN CAPE PROVINCE

ACWA Power obtained 3 Environmental Authorisations in 2016 for 2 x 75MW PV facilities as well as a 150MW CSP facility. An EIA study was undertaken for the 75MW CSP plant in Bokpoort, Northern Cape and approved by Department of Environmental Affairs (DEA). In accordance with Section 38 of the National Heritage Resources Act, No. 25 of 1999, a heritage study (Dreyer 2015) was completed and submitted to SAHRA and was subsequently accepted by that authority.

However, ACWA Power Energy Africa (Pty) Ltd (formerly known as ACWA Power Africa Holdings) now proposes to, instead of the 150MW CSP facility, construct 8 x 200 MW PV plants in its place on the same footprint, which was assessed in 2016. Two PV Plants (Xhosa and Ndebele) have already been authorised but are undergoing another Basic Assessment (BA) study for the battery storage energy system (BESS) as well as the capacity increase from 75 to 200MW.

Royal HaskoningDHV (Pty) Ltd was contracted as independent environmental consultant to undertake the EIA process for the proposed construction of the 8 x 200 MW PV plants and the increased capacity and inclusion of BESS in the already authorised 2 PV projects.

In accordance with Section 38 of the NHRA, an independent heritage consultant was appointed by *Royal HaskoningDHV (Pty) Ltd* to conduct a cultural heritage assessment to determine if the construction of the PV plants and associated infrastructure would have an impact on any sites, features or objects of cultural heritage significance.

- As the total area was previously surveyed by Dreyer (2015), the purpose of the current survey was purely to verify his findings, as well as to assess the possible cumulative impact of the development as this was not done previously.

This report describes the methodology used, the limitations encountered, the heritage features that were identified and the recommendations and mitigation measures proposed relevant to this. It should be noted that the implementation of the mitigation measures is subject to SAHRA/PHRA's approval.

The cultural landscape qualities of the region are made up of a pre-colonial element consisting of Stone Age and a much later colonial (farmer) component, which eventually gave rise to an urban component which manifest in a number of small towns and an intensive farming industry.

Identified sites

Stone Age lithics dating to the MSA are found only as low-density surface scatters, which is confirmed by similar findings in the larger region by other researchers (Dreyer 2014, 2015; Morris 2014, 2018; van der Walt 2015; van Schalkwyk 2019). The density of artefacts is less than 1/50m^2.

- The low density of the lithic scatters is, on archaeological grounds, viewed to be of low significance and require no further action.

Impact assessment and proposed mitigation measures

Impact analysis of cultural heritage resources under threat of the proposed development, is based on the present understanding of the development:

- As no sites, features or objects of cultural significance are known to exist in the development area, there would be no impact as a result of the proposed development.

Heritage sites	Significance of impact	Mitigation measures
Bokpoort II Solar Power Plant: Construction Phase		
Without mitigation	n/a	n/a
With mitigation	n/a	n/a
Bokpoort II Solar Power Plant: Operation Phase		
Without mitigation	n/a	n/a
With mitigation	n/a	n/a

Cumulative impact assessment

The cultural heritage profile of the larger region is very limited and consists of isolated findspots of Stone Age (MSA) tools, farmsteads and burial sites. Consequently, the cumulative impact of the proposed development is viewed to be **low**

Site type	**NHRA category**	**Field rating**	**Impact rating: Before/After mitigation**
Archaeological sites/material	Section 35	Generally protected: Low significance – Grade IV-C	Low (16)
			Low (16)
Burial sites and graves	Section 36	Generally protected: Low significance – Grade IV-A	Low (16)
			Low (16)

Legal requirements

The legal requirements related to heritage specifically are specified in Section 3 of this report. For this proposed project, the assessment has determined that no sites, features or objects of heritage significance occur in the study area. If heritage features are identified during construction, as stated in the management recommendation, these finds would have to be assessed by a specialist, after which a decision will be made regarding the application for relevant permits.

Reasoned opinion as to whether the proposed activity should be authorised:

- From a heritage point of view, it is recommended that the proposed development be allowed to continue on acceptance of the proposed mitigation measures and the conditions proposed below.

Conditions for inclusion in the environmental authorisation:

- The Palaeontological Sensitivity Map (SAHRIS) indicate that the study area has a moderate sensitivity of fossil remains to be found and therefore a desktop palaeontological required.
- Should archaeological sites or graves be exposed in other areas during construction work, it must immediately be reported to a heritage practitioner so that an investigation and evaluation of the finds can be made.

J A van Schalkwyk
Heritage Consultant
January 2020

TECHNICAL SUMMARY

Project description	
Description	Development of 10 X 200MW Solar PV facilities
Project name	Bokpoort II Solar Power Plant (each individually identified as Afrikaans; Ndebele; Pedi; Sotho; Swati; Tsonga; Tswana; Venda; Xhosa; Zulu)

Applicant
ACWA Power Green Energy Africa (Pty) Ltd

Environmental assessors
Mr M Roods
Royal HaskoningDHV (Pty) Ltd

Property details						
Province	Northern Cape					
Magisterial district	Gordonia					
Local municipality	!Kheis					
Topo-cadastral map	2821DB, 2822CA					
Farm name	Bokpoort					
Closest town	Groblershoop					
Coordinates	Corner points (approximate)					
	No	Latitude	Longitude	No	Latitude	Longitude
	1	-28.73309	22.00469	2	-28.71962	22.00451
	3	-28.71952	21.98857	4	-28.71189	21.98206
	5	-28.67546	22.02122	6	-28.69420	22.03567

Development criteria in terms of Section 38(1) of the NHR Act	Yes/No
Construction of road, wall, power line, pipeline, canal or other linear form of development or barrier exceeding 300m in length	Yes
Construction of bridge or similar structure exceeding 50m in length	No
Development exceeding 5000 sq m	Yes
Development involving three or more existing erven or subdivisions	No
Development involving three or more erven or divisions that have been consolidated within past five years	No
Rezoning of site exceeding 10 000 sq m	No
Any other development category, public open space, squares, parks, recreation grounds	No

Land use	
Previous land use	Farming
Current land use	Farming

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GLOSSARY OF TERMS AND ABBREVIATIONS

TERMS

Bioturbation: The burrowing by small mammals, insects and termites that disturb archaeological deposits.

Cumulative impacts: "Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities.

Debitage: Stone chips discarded during the manufacture of stone tools.

Factory site: A specialised archaeological site where a specific set of technological activities has taken place – usually used to describe a place where stone tools were made.

Historic Period: Since the arrival of the white settlers - c. AD 1830 - in this part of the country.

Holocene: The most recent time period, which commenced c. 10 000 years ago.

Iron Age (also referred to as **Early Farming Communities**)**:** Period covering the last 1800 years, when new people brought a new way of life to southern Africa. They established settled villages, cultivated domestic crops such as sorghum, millet and beans, and they herded cattle as well as sheep and goats. As they produced their own iron tools, archaeologists call this the Iron Age.

Early Iron Age	AD 200 - AD 900
Middle Iron Age	AD 900 - AD 1300
Later Iron Age	AD 1300 - AD 1830

Midden: The accumulated debris resulting from human occupation of a site.

Mitigation, means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible.

National Estate: The collective heritage assets of the Nation.

Pleistocene: Geological time period of 3 000 000 to 20 000 years ago.

Stone Age: The first and longest part of human history is the Stone Age, which began with the appearance of early humans between 3-2 million years ago. Stone Age people were hunters, gatherers and scavengers who did not live in permanently settled communities. Their stone tools preserve well and are found in most places in South Africa and elsewhere.

Early Stone Age	2 500 000 - 250 000 Before Present
Middle Stone Age	250 000 - 40-25 000 BP
Later Stone Age	40-25 000 - until c. AD 200

Tradition: As used in archaeology, it is a seriated sequence of artefact assemblages, particularly ceramics.

ACRONYMS and ABBREVIATIONS

AD	Anno Domini (the year 0)
ASAPA	Association of Southern African Professional Archaeologists
BC	Before the Birth of Christ (the year 0)
BCE	Before the Common Era (the year 0)
BP	Before Present (calculated from 1950 when radio-carbon dating was established)
CE	Common Era (the year 0)
CRM	Cultural Resources Management
EAP	Environmental Assessment Practitioner
EIA	Early Iron Age
ESA	Early Stone Age
HIA	Heritage Impact Assessment
I & AP's	Interested and Affected Parties
ICOMOS	International Council on Monuments and Sites
LIA	Late Iron Age
LSA	Later Stone Age
MIA	Middle Iron Age
MSA	Middle Stone Age
NASA	National Archives of South Africa
NHRA	National Heritage Resources Act
PHRA	Provincial Heritage Resources Agency
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System

COMPLIANCE WITH APPENDIX 6 OF THE 2014 EIA REGULATIONS (AS AMENDED)

Requirements of Appendix 6 – GN R982	**Addressed in the Specialist Report**
1. (1) A specialist report prepared in terms of these Regulations must contain-	
a) details of-	
i. the specialist who prepared the report; and	Front page
ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Page i Addendum Section 6
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page ii
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1
(cA) an indication of the quality and age of base data used for the specialist report;	Section 4
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 7.3
d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 4.2.2
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 4
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Addendum Section 5; Figure 13
g) an identification of any areas to be avoided, including buffers;	Section 8
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Figure 13 Addendum Section 5
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 2
j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 7
k) any mitigation measures for inclusion in the EMPr;	Section 9 & 10
l) any conditions for inclusion in the environmental authorisation;	Section 10
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 9
n) a reasoned opinion-	
i. whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and	Section 10
ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 8, 9, 10
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Formed part of the original assessment
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Formed part of the original assessment
q) any other information requested by the competent authority.	Formed part of the original assessment
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	-

Phase 1 Cultural Heritage Impact Assessment:
THE PROPOSED BOKPOORT II PV SOLAR POWER FACILITIES ON THE FARM BOKPOORT 390 NEAR GROBLERSHOOP, !KHEIS LOCAL MUNICIPALITY, NORTHERN CAPE PROVINCE

1. INTRODUCTION

1.1 Background

ACWA Power obtained 3 Environmental Authorisations in 2016 for 2 x 75MW PV facilities as well as a 150MW CSP facility. An EIA study was undertaken for the 75MW CSP plant in Bokpoort, Northern Cape and approved by Department of Environmental Affairs (DEA). In accordance with Section 38 of the National Heritage Resources Act, No. 25 of 1999, a heritage study (Dreyer 2015) was completed and submitted to SAHRA and was subsequently accepted by that authority.

However, ACWA Power Energy Africa (Pty) Ltd (formerly ACWA Power Africa Holdings) now proposes to, instead of the 150MW CSP facility, construct 8 x 200 MW PV plants in its place on the same footprint, which was assessed in 2016. Two PV Plants (Xhosa and Ndebele) have already been authorised but are undergoing another Basic Assessment (BA) study for the battery storage energy system (BESS) as well as the capacity increase from 75 to 200MW.

Royal HaskoningDHV (Pty) Ltd was contracted as independent environmental consultant to undertake the EIA process for the proposed construction of the 8 x 200 MW PV plants, and the increased capacity and inclusion of BESS in the already authorised 2 PV projects.

South Africa's heritage resources, also described as the 'national estate', comprise a wide range of sites, features, objects and beliefs. However, according to Section 27(18) of the National Heritage Resources Act (NHRA), No. 25 of 1999, no person may destroy, damage, deface, excavate, alter, remove from its original position, subdivide or change the planning status of any heritage site without a permit issued by the heritage resources authority responsible for the protection of such site.

In accordance with Section 38 of the NHRA, an independent heritage consultant was appointed by *Royal HaskoningDHV (Pty) Ltd* to conduct a cultural heritage assessment to determine if the construction of the 10, 200 MW PV plants and associated infrastructure would have an impact on any sites, features or objects of cultural heritage significance.

- As the total area was previously surveyed by Dreyer (2015), the purpose of the current survey was purely to verify his findings, as well as to assess the possible cumulative impact of the development as this was not done previously.

This report forms part of the Environmental Impact Assessment (EIA) as required by the EIA Regulations in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) as amended and is intended for submission to the South African Heritage Resources Agency (SAHRA).

1.2 Terms and references

The aim of a full HIA investigation is to provide an informed heritage-related opinion about the proposed development by an appropriate heritage specialist. The objectives are to identify heritage resources (involving site inspections, existing heritage data and additional heritage specialists if necessary); assess their significances; assess alternatives in order to promote heritage conservation issues; and to assess the acceptability of the proposed development from a heritage perspective.

The result of this investigation is a heritage impact assessment report indicating the presence/ absence of heritage resources and how to manage them in the context of the proposed development.

Depending on SAHRA's acceptance of this report, the developer will receive permission to proceed with the proposed development, on condition of successful implementation of proposed mitigation measures.

1.2.1 *Scope of work*

The aim of this study is to determine if any sites, features or objects of cultural heritage significance occur within the boundaries of the area where the 8 x 200 MW PV plants and the increased capacity and inclusion of BESS in the already authorised 2 PV projects is to take place. This included:

- Conducting a desk-top investigation of the area;
- A visit to the proposed development site.

The objectives were to:

- Identify possible archaeological, cultural and historic sites within the proposed development areas;
- Identify any potential 'fatal flaws' related to the proposed development;
- Evaluate the potential impacts of construction, operation and maintenance of the proposed development on archaeological, cultural and historical resources;
- Recommend mitigation measures to ameliorate any negative impacts on areas of archaeological, cultural or historical importance;
- Provide guideline measures to manage any impacts that might occur during the construction phase as well as the implementation phase.

1.2.2 *Assumptions and Limitations*

The investigation has been influenced by the following factors:

- It is assumed that the description of the proposed project, provided by the client, is accurate.
- The unpredictability of buried archaeological remains.
- No subsurface investigation (i.e. excavations or sampling) were undertaken, since a permit from SAHRA is required for such activities.
- It is assumed that the public consultation process undertaken as part of the Environmental Impact Assessment (EIA) is sufficient and that it does not have to be repeated as part of the heritage impact assessment.

2. LEGISLATIVE FRAMEWORK

2.1 Background

Heritage Impact Assessments are governed by national legislation and standards and International Best Practise. These include:

- South African Legislation
  - National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA);
  - Mineral and Petroleum Resources Development Act, 2002 (Act No. 22 of 2002) (MPRDA);
  - National Environmental Management Act 1998 (Act No. 107 of 1998) (NEMA); and
  - National Water Act, 1998 (Act No. 36 of 1998) (NWA).
- Standards and Regulations
  - South African Heritage Resources Agency (SAHRA) Minimum Standards;
  - Association of Southern African Professional Archaeologists (ASAPA) Constitution and Code of Ethics;
  - Anthropological Association of Southern Africa Constitution and Code of Ethics.
- International Best Practise and Guidelines
  - ICOMOS Standards (Guidance on Heritage Impact Assessments for Cultural World Heritage Properties); and
  - The UNESCO Convention concerning the Protection of the World Cultural and Natural Heritage (1972).

2.2 Heritage Impact Assessment Studies

South Africa's unique and non-renewable archaeological and palaeontological heritage sites are 'generally' protected in terms of the National Heritage Resources Act (Act No 25 of 1999, Section 35) and may not be disturbed at all without a permit from the relevant heritage resources authority.

The National Heritage Resources Act (Act No. 25 of 1999, Section 38) provides guidelines for Cultural Resources Management and prospective developments:

"38 (1) Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as:

(a) the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;
(b) the construction of a bridge or similar structure exceeding 50m in length;
(c) any development or other activity which will change the character of a site:
(i) exceeding 5 000 m_2 in extent; or
(ii) involving three or more existing erven or subdivisions thereof; or
(iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or
(iv) the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority;
(d) the re-zoning of a site exceeding 10 000 m^2 in extent; or
(e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development."

And:

"38 (3) The responsible heritage resources authority must specify the information to be provided in a report required in terms of subsection (2)(a): Provided that the following must be included:

(a) The identification and mapping of all heritage resources in the area affected;
(b) an assessment of the significance of such resources in terms of the heritage assessment criteria set out in section 6(2) or prescribed under section 7;
(c) an assessment of the impact of the development on such heritage resources;
(d) an evaluation of the impact of the development on heritage resources relative to the sustainable social and economic benefits to be derived from the development;
(e) the results of consultation with communities affected by the proposed development and other interested parties regarding the impact of the development on heritage resources;
(f) if heritage resources will be adversely affected by the proposed development, the consideration of alternatives; and
(g) plans for mitigation of any adverse effects during and after the completion of the proposed development."

3. HERITAGE RESOURCES

3.1 The National Estate

The National Heritage Resources Act (No. 25 of 1999) defines the heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations that must be considered part of the national estate to include:

- places, buildings, structures and equipment of cultural significance;
- places to which oral traditions are attached or which are associated with living heritage;
- historical settlements and townscapes;

- landscapes and natural features of cultural significance;
- geological sites of scientific or cultural importance;
- archaeological and palaeontological sites;
- graves and burial grounds, including-
    - ancestral graves;
    - royal graves and graves of traditional leaders;
    - graves of victims of conflict;
    - graves of individuals designated by the Minister by notice in the Gazette;
    - historical graves and cemeteries; and
    - other human remains which are not covered in terms of the Human Tissue Act, 1983 (Act No. 65 of 1983);
- sites of significance relating to the history of slavery in South Africa;
- movable objects, including-
    - objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
    - objects to which oral traditions are attached or which are associated with living heritage;
    - ethnographic art and objects;
    - military objects;
    - objects of decorative or fine art;
    - objects of scientific or technological interest; and
    - books, records, documents, photographic positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section 1(xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996).

3.2 Cultural significance

In the NHRA, Section 2 (vi), it is stated that ‘‘cultural significance’’ means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance. This is determined in relation to a site or feature’s uniqueness, condition of preservation and research potential.

According to Section 3(3) of the NHRA, a place or object is to be considered part of the national estate if it has cultural significance or other special value because of

- its importance in the community, or pattern of South Africa's history;
- its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
- its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
- its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;
- its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
- its importance in demonstrating a high degree of creative or technical achievement at a particular period;
- its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
- its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa; and
- sites of significance relating to the history of slavery in South Africa.

A matrix (see Section 2 of Addendum) was developed whereby the above criteria were applied for the determination of the significance of each identified site. This allowed some form of control over the application of similar values for similar identified sites.

4. PROJECT DESCRIPTION

4.1 Site location

The proposed development is located on the north-eastern portion of the Remaining Extent of the Farm Bokpoort 390, which is 20 km north-north-west of the town of Groblershoop within the !Kheis Local municipality in the ZF Mgcawu District Municipality, Northern Cape Province (Fig. 1). For more information, see the Technical Summary on p. V above.

The site is within one of South Africa's eight renewable energy development zones and has therefore been identified as one of the most suitable areas in the country for renewable energy development, in terms of a number of environmental impact, economic and infrastructural factors.

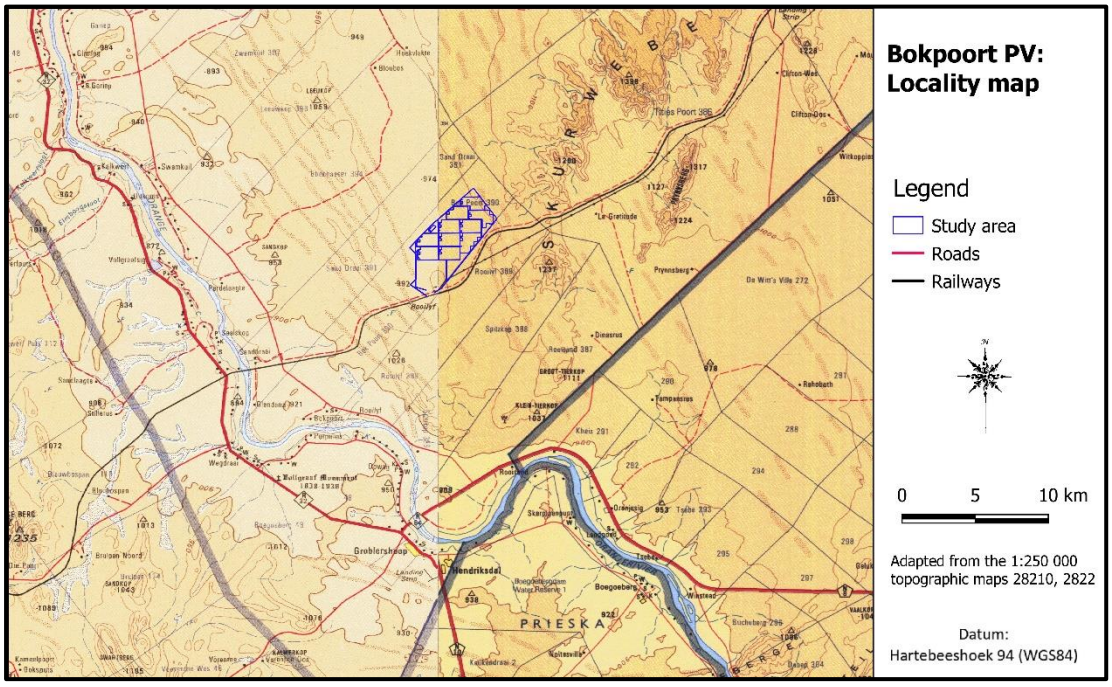


Figure 1. Location of the study area in regional context

4.2 Development proposal

The proposed development is 8 Photovoltaic (PV) Solar Developments of up to 200 Megawatt (MW) each, that will consist of the following infrastructure (Fig. 2):

- Solar PV modules that will be able to deliver up to 200 MW to the Eskom National Grid;
- Inverters that convert direct current (DC) generated by the PV modules into alternating current (AC) to be exported to the electrical grid;
- A transformer that raises the system AC low voltage (LV) to medium voltage (MV). The transformer converts the voltage of the electricity generated by the PV panels to the correct voltage for delivery to Eskom;
- Transformer substation; and
- Instrumentation and Control consisting of hardware and software for remote plant monitoring and operation of the facility.

Associated infrastructure includes:

- Mounting structures for the solar panels;
- Cabling between the structures, to be lain underground where practical;
- A new 132 kV overhead power line which will connect the facility to the national grid via Eskom's existing Garona Substation;
- The powerline will be approximately 5 km in length and will be located within a servitude spanning 15.5m on both sides. The powerline towers will be 35 m high;
- Internal access roads (4 - 6 m wide roads will be constructed but existing roads will be used as far as possible) and fencing.
- Shared infrastructure consisting of buildings, including a workshop area for maintenance, storage (i.e. fuel tanks, etc.), laydown area, parking, warehouse, and offices (previously approved).

Battery energy storage system (applicable to the two authorised PV plants as well):

- Battery Power at Point of Connection: 150MW;
- Area Required: 16ha;
- The BESS will store approximately 4500m^3 of hazardous substance.

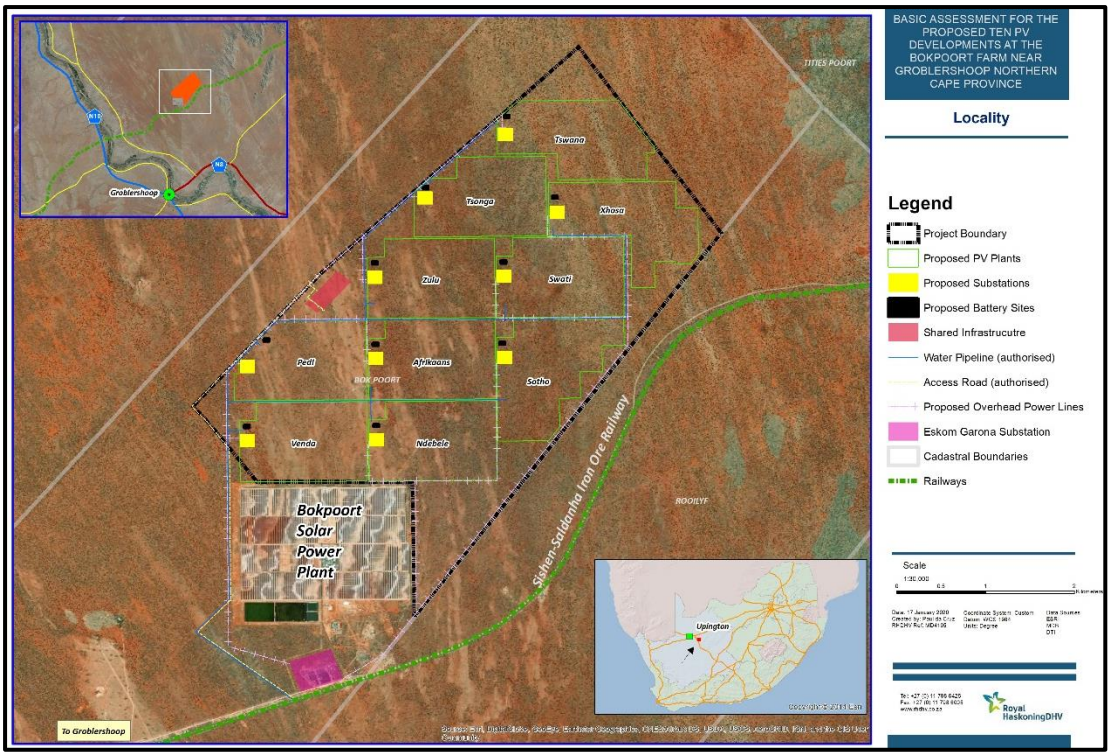


Figure 2. Layout of the project

5. STUDY APPROACH AND METHODOLOGY

5.1 Extent of the Study

This survey and impact assessment cover all facets of cultural heritage located in the study area as presented in Section 4 above and illustrated in Figure 2.

5.2 Methodology

5.2.1 *Pre-feasibility assessment*

5.2.1.1 Survey of the literature
A survey of the relevant literature was conducted with the aim of reviewing the previous research done and determining the potential of the area. In this regard, various anthropological, archaeological and historical sources were consulted – see list of references in Section 11.

- Information on events, sites and features in the larger region were obtained from these sources.

5.2.1.2 Survey of heritage impact assessments (HIAs)
A survey of HIAs done for projects in the region by various heritage consultants was conducted with the aim of determining the heritage potential of the area – see list of references in Section 11.

- Information on sites and features in the larger region were obtained from these sources.

5.2.1.3 Data bases
The *Heritage Atlas Database,* various SAHRA databases, the *Environmental Potential Atlas*, the *Chief Surveyor General* and the *National Archives of South Africa* were consulted.

- Database surveys produced a number of sites located in the larger region of the proposed development.

5.2.1.4 Other sources
Aerial photographs and topocadastral and other maps were also studied - see the list of references below.

- Information of a very general nature were obtained from these sources

The results of the above investigation are presented in Figure 3 below – see list of references in Section 11 – and can be summarised as follows:

- Stone tools, mostly dating to the Middle Stone Age (MSA), occur sporadically across the larger region and is mostly located on hills, outcrops and along drainage channels;
- Historic structures, inclusive of buildings and bridges, occur in a sporadic manner across the larger landscape as well as in urban centres;
- Formal and informal burial sites occur in a number of places in towns and across the countryside.

Based on the above assessment, the probability of cultural heritage sites, features and objects occurring in the study area is deemed to be **very low**.

Table 1: Pre-Feasibility Assessment

Category	Period	Probability	Reference
Natural			
Landscapes		None	
Early hominin	Pliocene – Lower Pleistocene		
	Early hominin	None	
Stone Age	Lower Pleistocene – Holocene		
	Early Stone Age	None	
	Middle Stone Age	Low	Dreyer (2014, 2015); Morris (2012, 2014); van der Walt (2015a, 2015b); van Ryneveld (2007); van Schalkwyk (2011, 2019)
	Later Stone Age	Low	

	Rock Art	None	
Iron age	Holocene		
	Early Iron Age	None	
	Middle Iron Age	None	
	Late Iron Age	None	
Colonial period	Holocene		
	Contact period/Early historic	Possible	Dreyer (2014)
	Recent history	Possible	Van der Walt (2015a); van Schalkwyk (2019)
	Industrial heritage	None	

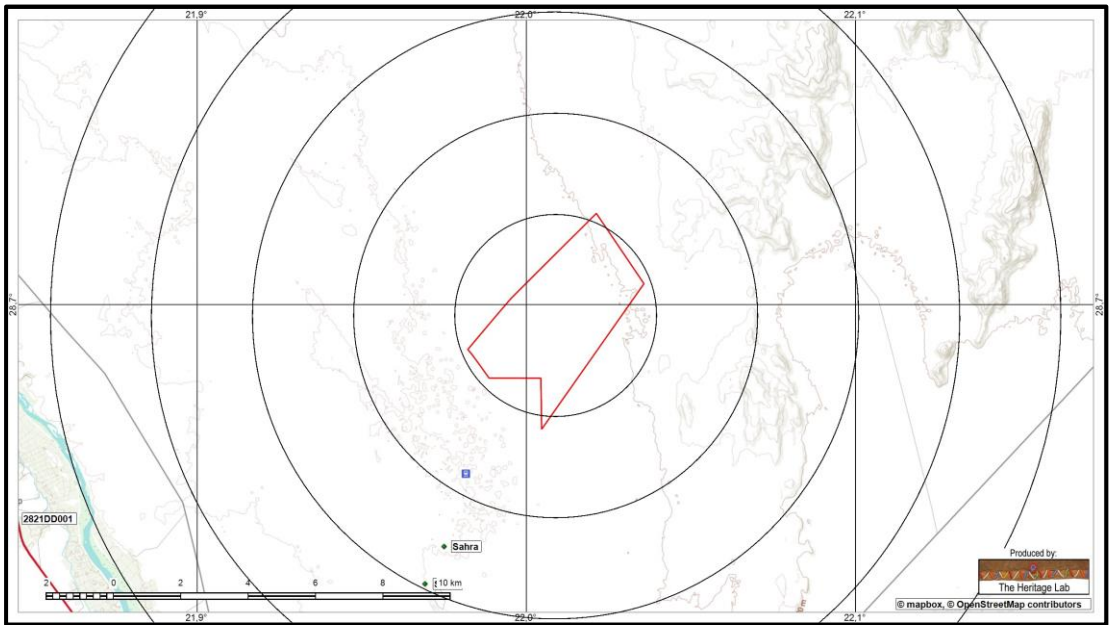


Figure 3. Location of known heritage sites and features in relation to the study area
(Circles spaced at a distance of 2km: heritage sites = coded green dots)

5.2.2 *Field survey*

The field survey was done according to generally accepted archaeological practices, and was aimed at locating all possible sites, objects and structures. The area that had to be investigated was identified by the *Royal HaskoningDHV (Pty) Ltd* by means of maps and .k*ml* files indicating the development area. This was loaded onto an ASUS digital device and used in Google Earth during the field survey to access the areas.

The site was visited on 4 December 2019 and was investigated by using internal tracks to access the sites and then walking a number of transects across it – see Fig. 4 below. During the site visit, archaeological visibility was good due to the prolonged period of drought in the region which prevented the vegetation cover from re-growing (see Fig. 5 below).

- As the total area was previously surveyed by Dreyer (2015), the purpose of this survey was just to confirm his findings. Therefore, only a cursory survey was done, stopping at places that seemed promising, especially to confirm the presence of stone tools.

5.2.3 *Documentation*

All sites, objects and structures that are identified are documented according to the general minimum standards accepted by the archaeological profession. Coordinates of individual localities are determined by means of the *Global Positioning System* (GPS) and plotted on a map. This information is

added to the description in order to facilitate the identification of each locality. Map datum used: Hartebeeshoek 94 (WGS84).

The track log and identified sites were recorded by means of a Garmin Oregon 550 handheld GPS device. Photographic recording was done by means of a Canon EOS 550D digital camera.

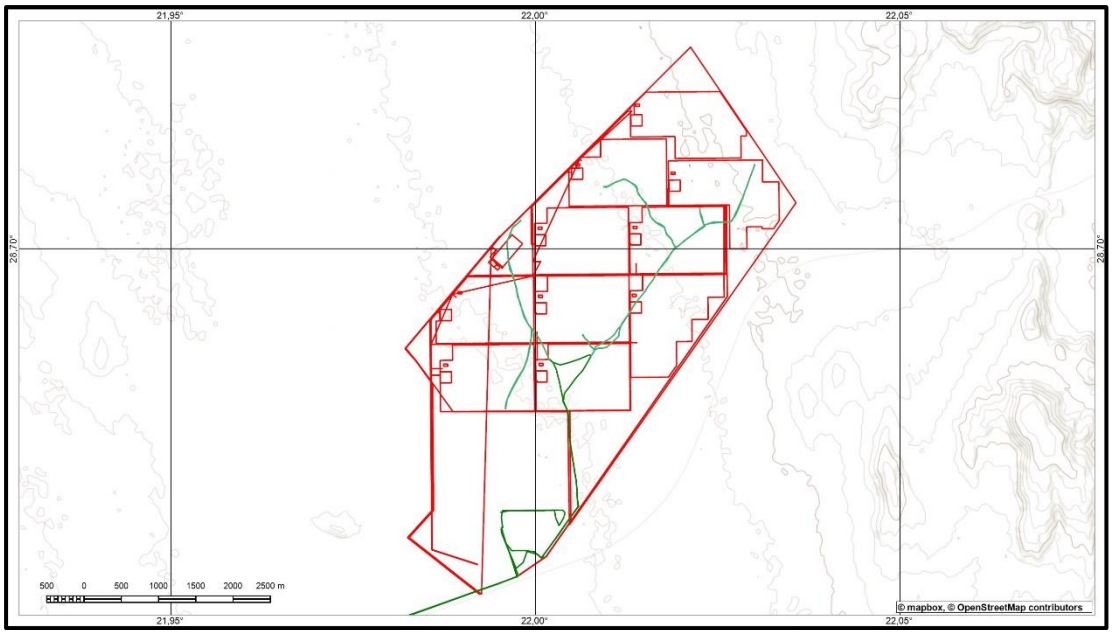


Figure 4. Map indicating the track log of the field survey.

6. DESCRIPTION OF THE AFFECTED ENVIRONMENT

6.1 Natural Environment

The geology of the study area is made up of superficial deposits comprising gravels, clays, sandstone, silcrete, calcrete and aeolian sand. The topography is described as plains and no rivers, outcrops or hills occur in the study area or its immediate vicinity (Fig. 5).

The original vegetation in the study area is classified as Kalahari Karroid Shrubland, part of the Nama-Karoo Biome, which is part of the Bushmanland Bioregion (Muncina & Rutherford 2006) (Fig. 6).

According to Dreyer (2015) the site is characterised by a repeated pattern of alternating red sand dunes, calcrete scatters and quartzite outcrops. The nature of the site varied from Aeolian (Kalahari) dune veld, visible spreads of calcrete and scatters of quartzite sills.

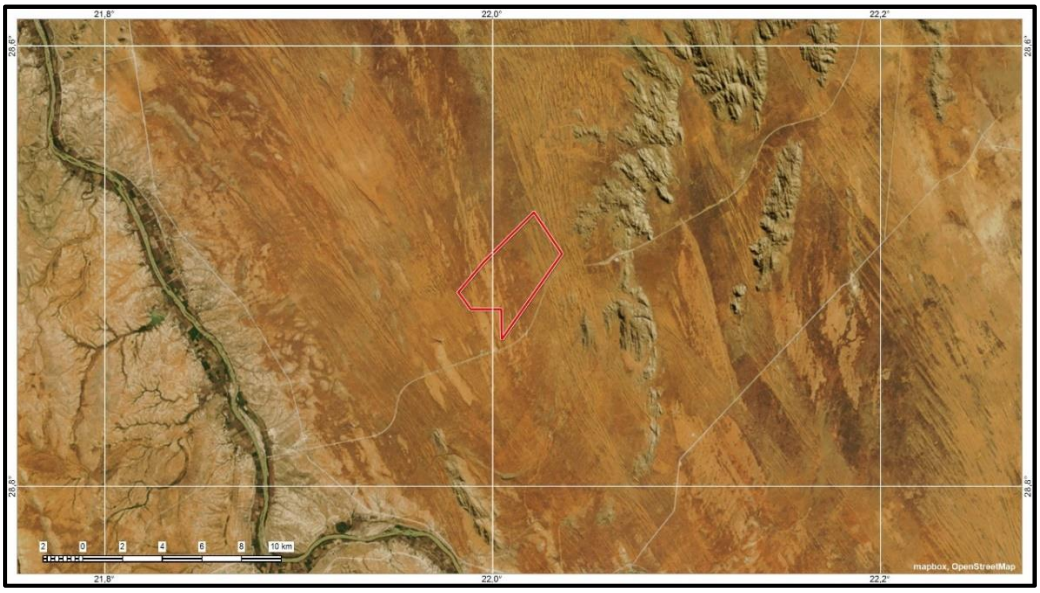


Figure 5. The topography of the larger region

Bushman grass

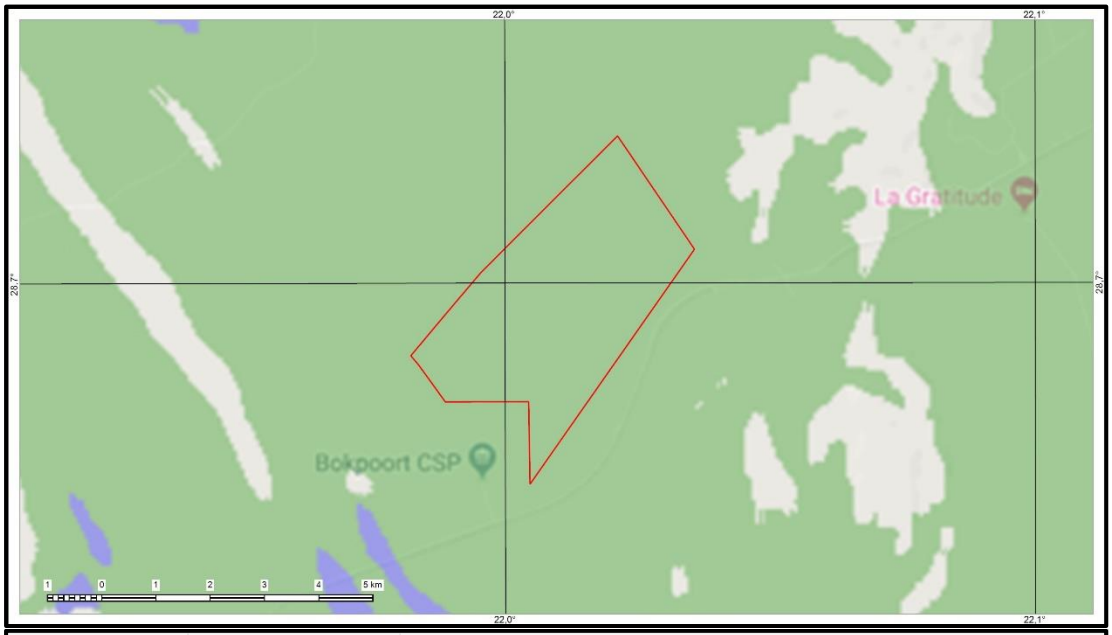
Scrub veldt

Calcrete scatters

Ruins of old dam

Figure 6. Views over the study area

The Palaeontological Sensitivity Map (SAHRIS) indicate that the study area (Fig. 7) has a moderate sensitivity of fossil remains to be found and therefore a desktop palaeontological study is required.



Colour	Sensitivity	Required Action
RED	VERY HIGH	field assessment and protocol for finds is required
ORANGE/YELLOW	HIGH	desktop study is required and based on the outcome of the desktop study, a field assessment is likely
GREEN	MODERATE	desktop study is required
BLUE	LOW	no palaeontological studies are required however a protocol for finds is required
GREY	INSIGNIFICANT/ZERO	no palaeontological studies are required
WHITE/CLEAR	UNKNOWN	these areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

Figure 7. The Palaeontological sensitivity of the study areas

6.2 Cultural Landscape

The aim of this section is to present an overview of the history of the larger region in order to eventually determine the significance of heritage sites identified in the study area, within the context of their historic, aesthetic, scientific and social value, rarity and representativity.

The cultural landscape qualities of the region are made up of a pre-colonial element consisting of Stone Age and a much later colonial (farmer) component, which eventually gave rise to an urban component which manifest in a number of small towns and an intensive farming industry.

6.2.1 *Stone Age*

Surveys in the area has revealed that the archaeological record in the larger region is temporarily confined to the Early and Middle Stone Age, with a smaller occurrence dating to the Later Stone Age. It is spatially concentrated around the rims of pans, the banks of stream and rivers (Morris 2005), but also in the vicinity of raw material resources.

Recently Parsons (2007, 2008) demonstrated that the so-called Swartkop and Doornfontein industries possibly relate to different socio-economies – those of hunter-gatherers and stock keepers. Based on an analysis of material recovered from five sites in the Northern Cape Province, all dating to the last two millennia, she compares variability between assemblages attributed to the Swartkop and Doornfontein industries and identify areas of overlap and difference.

6.2.2 *Iron Age*

Early Iron Age occupation did not take place in the region and seems as if the earliest Bantu-language speakers to have settled in the larger region were those of Tswana-speaking origin (Tlhaping and Tlharo) that settled mostly to the north and a bit to the west of Kuruman. However, they continued spreading westward and by the late 18th century some groups occupied the Langeberg region. With the annexation of the Tswana areas by the British in 1885, the area became known as British Betchuana Land. A number of reserves were set up for these people to stay in. In 1895 the Tswana-speakers rose up in resistance to the British authority as represented by the government of the Cape Colony. They were quickly subjected, and their land was taken away, divided up into farms and given out to white farmers to settle on (Snyman 1986).

In his study on the spread of the Iron Age into the Northern Cape, Humphreys (1976) used not only archaeological evidence, literary sources and eyewitness accounts, but also environmental factors such as rainfall data and vegetation cover. From this he concluded that it was not an environment conducive for keeping large herds of cattle, which was the mainstay of Iron Age communities' economy. He even indicates that the occupation of these people contracted from 1700 south of Postmasburg to just south of Kuruman by 1800, indicating a huge change in environmental factors.

Although some researchers would want to identify isolated, undecorated pieces of pottery found in the vicinity of Douglas as of Late Iron Age origin, this is doubtful as they also do not consider the possibility of it being of Khoi origin. Or, alternatively, of very recent origin, i.e. brought into the region by people working as labourers on the various diamond diggings in the larger region.

6.2.3 *Historic period*

It was only during the last part of the 19th century, early part of the 20th century when population numbers in the region increased. This was the result of intensive irrigation farming that developed along the Orange River.

The town of Upington, originally known as Olijvenhoutsdrift, was founded in 1871 as part of a mission station by the German missionary Rev Schröder. The town was renamed in 1884 after Sir Thomas Upington, who was the Prime Minister of the Cape Colony and who visited the town in 1884.

An irrigation canal was started by Rev Schröder in 1883. It was completed in 1885. By 1884 there were already 77 irrigation farms. Nowadays, it is disputed that Schröder was the original builder of the canal, and it is claimed that he only carried on with an idea that was started by a local inhabitant by the name of Abraham September.

Groblershoop developed as a result of development of the Boegoeberg Dam and water channels in 1929, which gave rise to grapes and wine production. During the Rebellion of 1914, a number of skirmishes were fought in the region.

6.3 Site specific review

Although landscapes with cultural significance are not explicitly described in the NHRA, they are protected under the broad definition of the National Estate (Section 3): Section 3(2)(c) and (d) list "historical settlements and townscapes" and "landscapes and natural features of cultural significance" as part of the National Estate.

The examination of historical maps and aerial photographs help us to reconstruct how the cultural landscape has changed over time as is show how humans have used the land.

As this used to be a very isolated region, little information exists about it. It was only recently when a number of development projects were initiated in the region, that the heritage potential of the region was investigated. Most of these studies focussed on the Stone Age presence in the region, which, by all accounts seems to be very limited (Dreyer 2014, 2015; Morris 2014, 2018; van der Walt 2015; van Schalkwyk 2019) as it presents a very low profile in the landscape.

From the Deed of Transfer no. 1294 (Fig. 8), it can be seen that the farm was first surveyed in December 1892 and then granted to F.W.C Loxton on 14 November 1894.

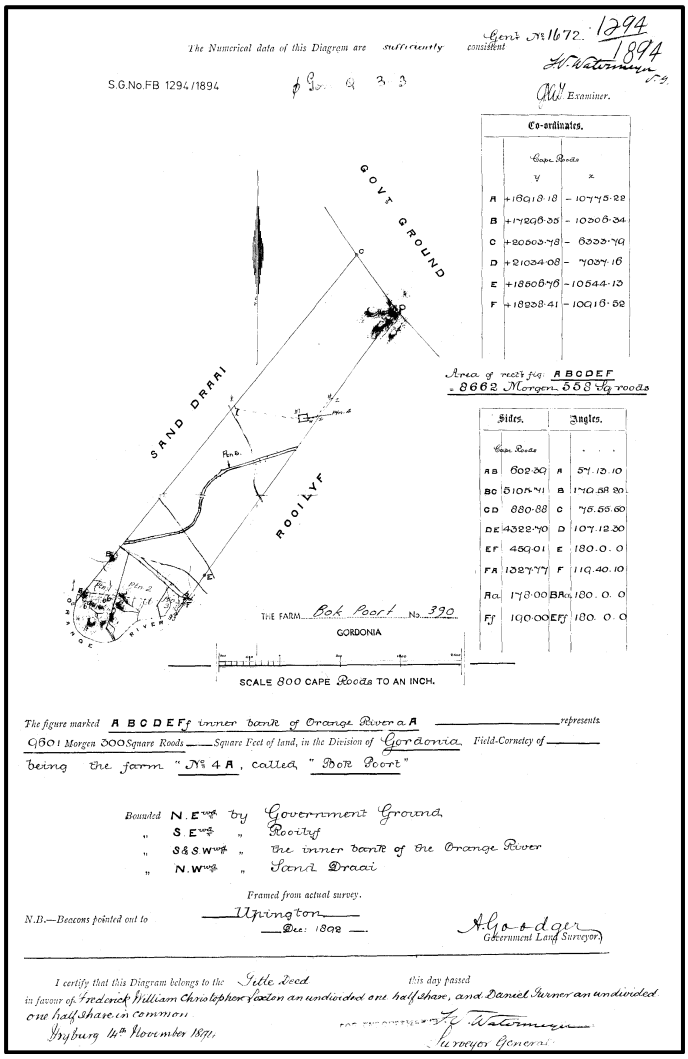


Figure 8. Copy of the original Deed of Transfer for the farm Bokpoort
(Chief Surveyor-General: 10026W01)

One of the older maps of the region (Fig. 9), dating to 1914, shows an area with little development in the interior where the isolated sheep post of vehicle tracks is indicated. Closer to the river and number of presumably farm names are indicated in the vicinity of the Orange River.

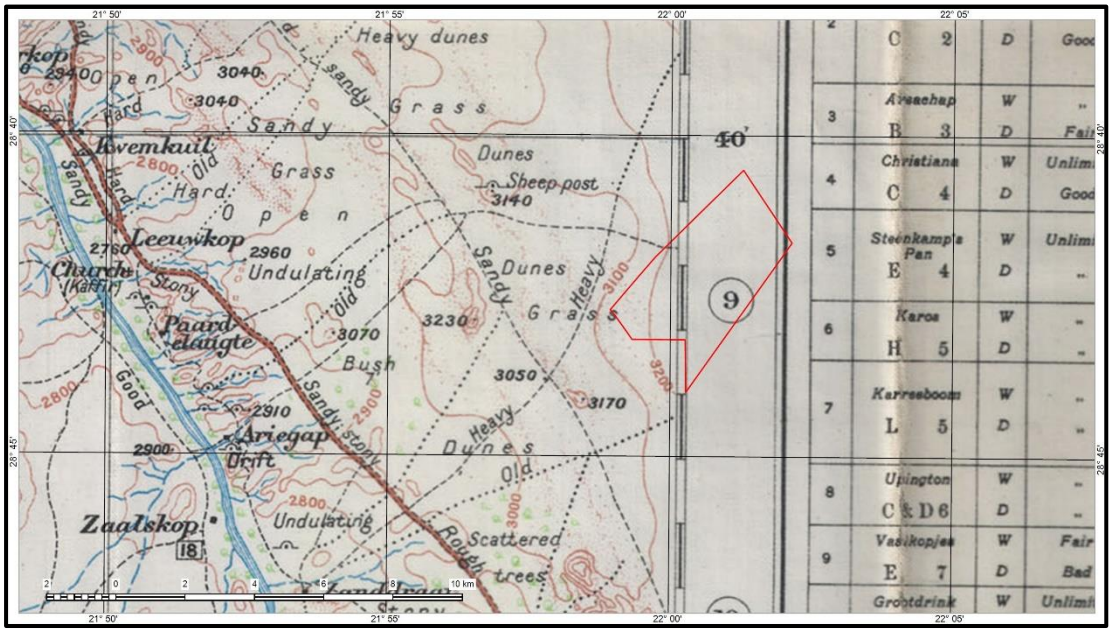


Figure 9. The study areas on the 1914 version of the 1:250 000 topographic map 'Upington'

The official aerial photograph dating to 1964 (Fig. 10) still shows, apart from fence boundaries, a landscape empty of any development. It was only by the middle of the 1970s when the Sishen-Saldanha railway line was opened (1976) and the associated powerlines were constructed, that any development can be seen. This presented on the 1981 version of the 1:50 000 topographic map (11).

However, this lack of development, i.e. built environment, seems to continue as can be seen on the various Google Image aerial photographs (Fig. 12) and it is only with the recent development of the Bokpoort Concentrated Solar Thermal that some built features were added to the region.