ATMOSPHERIC IMPACT REPORT FOR THE PROPOSED KARPOWERSHIP PROJECT AT THE PORT OF RICHARDS BAY

Revised version
10 October 2022

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Report Details

Client:	Karpowership SA Proprietary Ltd
Report title:	Atmospheric Impact Report for the proposed Karpowership Project at the Port of Richards Bay
Project:	uMN701-22
Report number:	uMN141-20
Version:	Final 10 October 2022
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When used in a reference this document should be cited as follows:
uMoya-NILU (2022): Atmospheric Impact Report Atmospheric Impact Report for the proposed Karpowership Project at the Port of Richards Bay, Report No.: uMN141-22, October 2022.

EXECUTIVE SUMMARY

Karpowership SA Proprietary Ltd proposes to locate a Khan Class Powership and a Shark Class Powership in the Port of Richards Bay to supply a contracted 450 MW of power to the National Grid using Liquified Natural Gas (LNG). A Floating Storage and Regasification Unit (FSRU) will store the LNG and convert it to Natural Gas (NG) to supply the Powership. The FSRU will also be in the Port of Richards Bay. The FSRU will be resupplied by an LNG carrier approximately once every 20 to 30 days.

The combustion of gaseous fuel for steam production or electricity in a reciprocating engine with design capacity equal to or greater than 10 MW heat input per unit is a Listed Activity under Category 1: Combustion Installation, and sub-category 1.5: Reciprocating Engines. Minimum Emission Standards (MES) for reciprocating engines using gas are set for NO_X and particulates, but not for SO_2. The MES are shown in Table E1 with the proposed emission concentrations for the Karpowership engines. It appears that emission standards are not prescribed for steam turbines with a capacity of less than 50 MW.

Table E1: Minimum Emission Standards in mg/Nm^3 for Reciprocating Engines (Subcategory 1.5) according to GN 248 248 (DEA, 2010) and its revisions (DEA, 2013c, 2019), compared with emissions for Karpowership

<table>
<tr><th colspan="2">Substance or mixture of substances</th><th>Subcategory 1.5</th><th>Karpowership</th></tr>
<tr><th>Common name</th><th>Chemical symbol</th><th colspan="2">MES under normal conditions of 15% O_2, 273 Kelvin and 101.3 kPa.</th></tr>
<tr><td>Particulate matter</td><td>N/A</td><td>50</td><td>≤10</td></tr>
<tr><td>Oxides of nitrogen[a]</td><td>NO_X</td><td>400</td><td>≤ 50</td></tr>
<tr><td>Sulphur dioxide</td><td>SO_2</td><td>N/A</td><td>max 2</td></tr>
</table>

a: expressed as NO_2

The Karpowership Project at the Port of Richards Bay comprises the Khan and Shark Powership combination, the FSRU and the LNG supply vessel. Each engine has a dedicated stack, or point source. On the Khan Class Powership the 21 stacks are orientated along the vessel from bow to stern. On the Shark Class Powership the 6 stacks are orientated along the deck. LNG supply vessels will restock the FSRU approximately once every 20 to 30 days. For the purposes of this assessment the emissions from the LNG resupply are regarded as fugitive emissions. Emissions result from the ship manoeuvring from the port entrance to the berth, and during the LNG transfer when berthed alongside the FSRU. Total annual emissions resulting from the Karpowership Project are listed in Table E2.

Table E2: Annual emissions from the Karpowership Project in t/a

Source	SO_2	NO_X	PM_{10}
Powership 1 (Khan)	36.7	917.1	183.4
Powership 2 (Shark)	10.5	262.0	52.4
FSRU	7.0	174.7	34.9
LNG vessel	2.6	22.1	0.5
Total	**56.8**	**1376.0**	**271.3**

The CALPUFF dispersion model is used to predict ambient concentrations of SO_2, NO_2 and PM_{10} resulting from the Karpowership Project emissions. Modelling is done according to the modelling regulations and 3-years of hourly surface and upper air meteorological data are used.

The maximum predicted annual SO_2, NO_2 and PM_{10} concentrations and the 99th percentile concentration of the 24-hour and 1-hour predicted concentrations are very low relative to the NAAQS (Table E3).

Table E3: Maximum predicted ambient annual SO_2, NO_2 and PM_{10} concentrations in µg/m^3 and the predicted 99th percentile concentrations for 24-hour and 1-hour averaging periods, with the South African NAAQS

	SO_2		
Description	**Annual**	**24-hour**	**1-hour**
Predicted maximum SO_2	0.07	0.34	0.94
NAAQS	50	125	350
	NO_2		
Predicted maximum NO_2	1.34		18.9
NAAQS	40		200
	PM_{10}		
Predicted maximum PM_{10}	0.33	1.72	
NAAQS	40	75	

The proposed project site is at the Port of Richards Bay. The closest residential area to the proposed site is Arboretum, which is located to the north-east and approximately 3.9 km from the proposed Karpowership Project at the Port of Richards Bay.

Monitoring has shown ambient SO_2 concentrations to be relatively low in the Richards Bay and below the NAAQS. The cumulative effect of the contribution of SO_2 from the Karpowership Project is predicted to be very small and the potential increase in ambient SO_2 concentrations is highly unlikely to result in exceedances of the NAAQS.

The cumulative effect of the contribution of NO_2 from the Karpowership Project is predicted to be very small and the potential increase in ambient NO_2 concentrations is highly unlikely to result in exceedances of the NAAQS.

Monitoring has shown that ambient PM_{10} concentrations are relatively high because of high regional background concentrations from sources such as biomass burning, industrial activity, terrestrial dust and long range atmospheric transport. The cumulative effect of the contribution PM_{10} from the Karpowership Project is predicted to be very small and the potential increase in ambient PM_{10} concentrations is highly unlikely to result in further exceedances of the NAAQS.

Besides the Karpowership Project, it is reasonable to expect that other electricity generation project may operate in Richards Bay in the future. It is therefore relevant to assess the potential cumulative effects of such projects on ambient air quality in Richards Bay together with the Karpowership Project. Three potential project have been identified for the assessment of cumulative impacts, namely the RBGP2 Project, the Nseleni Independent Floating Power Plant and the Richards Bay CCPP. For NO_2 and PM_{10} the significance of the cumulative impact of Karpowership with the other gas-to-power projects is rated as low. For SO_2 the significance of the impact is rated as medium because of predicted exceedances of ambient SO_2 concentrations when diesel is used as an emergency back-up fuel on the Richards Bay CCPP Project.

The NEMA EIA Regulations (DEA, 2014a as amended in 2017) describe the significance of environmental impacts considering the consequence of the impact and the likelihood of the impact occurring. The consequence of an impact is the sum of the severity of the impact, the duration of the impact and spatial scale of the impact. The rating of these parameters is based on the findings of the assessment and professional judgement of specialists. The likelihood of an impact is the sum of the total frequency of the activity causing the impact and the probability of the impact occurring.

With low predicted ambient concentrations for SO_2 and PM_{10} the consequence of impacts is very low. The predicted ambient NO_2 are somewhat higher, but the consequence of the impact is low. The likelihood of occurrence of impacts associated with SO_2, NO_2 and PM_{10} is very low. Therefore, the significance of impacts resulting from the Karpowership Project is predicted to be very low. The consequence and likelihood scores listed in Table E4 for the Karpowership Project with the Project adding to existing ambient concentrations, showing the impact significance.

Table E4: Air quality impact scores

Description	Pollutants	Consequence	Likelihood	Significance	
				Score	Rating
Karpowership Project	SO_2	2	1	**2**	**Very low**
	NO_2	2.7	1	**2.7**	**Very low**
	PM_{10}	2	1	**2**	**Very low**
Cumulative assessment with existing sources	SO_2	2	1	**2**	**Very low**
	NO_2	2.7	1	**2.7**	**Very low**
	PM_{10}	2	1	**2**	**Very low**
Cumulative assessment with other G2P projects	SO_2	3	2	6	**Medium**
	NO_2	3	1	3	**Low**
	PM_{10}	3	1	3	**Low**

Air quality management interventions in the form of the control of emission have been considered in all aspects of design and operation. Further emission reduction interventions are deemed to be unnecessary considering the low impact of the project on air quality.

This atmospheric impact assessment was provided to all Specialists conducting assessments for the proposed Gas to Power Karpowership Project in the Port of Richards Bay. This report was specifically highlighted, for consideration, to the Specialists conducting the following studies: Noise, Socio-Economic Impacts, Tourism and Biodiversity.

From an air quality perspective, it is the reasonable opinion of the authors that the Karpowership Project should be authorised considering the findings of this AIR.

GLOSSARY OF TERMS AND ACRONYMS

AEL	Atmospheric Emission Licence
AIR	Atmospheric Impact Report
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
EIA	Environmental Impact Assessment
FSRU	Floating Storage and Regasification Unit
g/s	Grams per second
kPa	Kilo Pascal
LNG	Liquefied Natural Gas
MES	Minimum Emission Standards
mg/Nm^3	Milligrams per normal cubic meter refers to emission concentration, i.e. mass per volume at normal temperature and pressure, defined as air at $20^{o}C$ (293.15 K) and 1 atm (101.325 kPa)
NAAQS	National Ambient Air Quality Standards
NEM-AQA	National Environment Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
ULM	Umhlatuze Local Municipality
USEPA	United States Environmental Protection Agency
µm	1 µm = Micro meter 1 µm = 10^{-6} m
WHO	World Health Organisation

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1. INTRODUCTION

In response to the Request for Proposals (RFP) for New Generation Capacity under the Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP) issued by the Department of Mineral Resources and Energy (DMRE), Karpowership SA Proprietary Ltd submitted proposals to the DMRE for three gas to power projects, located at the ports of Saldanha Bay (Western Cape), Ngqura (Eastern Cape) and Richards Bay (KZN). In the Port of Richards Bay Karpowership SA Proprietary Ltd proposes to locate a combination of a Khan Class Powership and a Shark Class Powership to generate electricity which will be evacuated through a transmission line to a substation and then to the national grid.

Karpowership SA Proprietary Ltd appointed Triplo4 Sustainable Solutions to facilitate the required environmental authorisation in accordance with the requirements of the National Environmental Management Act (NEMA) (DEA, 2014a) and to undertake the required Environmental Impact Assessment (EIA). Triplo4 Sustainable Solutions appointed uMoya-NILU Consulting (Pty) Ltd to undertake the air quality specialist study and to prepare this Atmospheric Impact Report (AIR) according to the regulations prescribing the format and content of an AIR (DEA, 2013a).

The first AIR was completed in February 2021. The AIR was finalised in April 2021 following the Public Participation Process and stakeholder comment and provided input of the Final EIA Report (EIAr) and Environmental Management Program Report (EMPr) were submitted to the Department Forestry, Fisheries and the Environment (DFFE) by Triplo4 on the 26 April 2021. A site visit was conducted on 30 April 2021 with the DFFE to see the proposed mooring sites.

The DFFE refused the EA application and provided KSA with the Record of Refusal (RoR) on 23 June 2021. On 13 July 2021, Karpowership SA appealed the refusal. On 1 August 2022, the Appeal Authority (the Minister) dismissed the appeal and exercised her powers in terms of Section 43(6) of NEMA. The application was returned to the DFFE to allow the Karpowership SA to address various gaps and defects through a new EIAr and associated Public Participation Process, in order for the application to be considered by the DFFE.

This AIR is an update of the April 2021 report and supports the new EIAr. This AIR is an update of the April 2021 report and supports the new EIAr. The NEMA EIA Regulations of 2014 (as amended) specify the information that must be contain in Specialist Study reports (Appendix 6 (1) of the Regulations). Table A1 in Annexure 1 indicates where this information is included in the AIR.

2. ENTERPRISE DETAILS

2.1 Project overview

The Karpowership Project entails the generation of electricity by two Powerships moored in the Port of Richards Bay, fed with natural gas from a third ship, a Floating Storage &

Regasification Unit (FSRU). The three ships will be moored in the port for the Project's anticipated 20-year lifespan. A Liquefied Natural Gas Carrier (LNGC) will bring in liquified natural gas (LNG) and offload it to the FSRU approximately once every 20 to 30 days, dependent on power demand which is determined by the buyer, ESKOM. The FSRU stores the LNG onboard and converts it into its gaseous form, i.e. Natural Gas upon demand from the Powership, a process known as regassification. Natural gas will be transferred from the FSRU to the Powerships via a subsea gas pipeline.

Electricity will be generated on Powerships by 27 reciprocating engines, each having a heat input in excess of 10MW (design capacity of 18.32 MW each at full capacity). Heat generated by operation of the reciprocating engines is captured and used to generate steam to drive three steam turbines that each have a heat input of circa 15.45 MW. The contracted capacity of 450 MW, which cannot be exceeded under the terms of the RMIPPPP, will be evacuated via a 132kV transmission line from the Richards Bay Port and feed into the national grid. The proposed site in the Port of Richards Bay is shown in Figure 1. A typical Khan Class Powership with 21 reciprocating engines and a Shark Class Powership with 6 reciprocating engines are shown in Figure 2. A typical FSRU is shown in Figure 3.

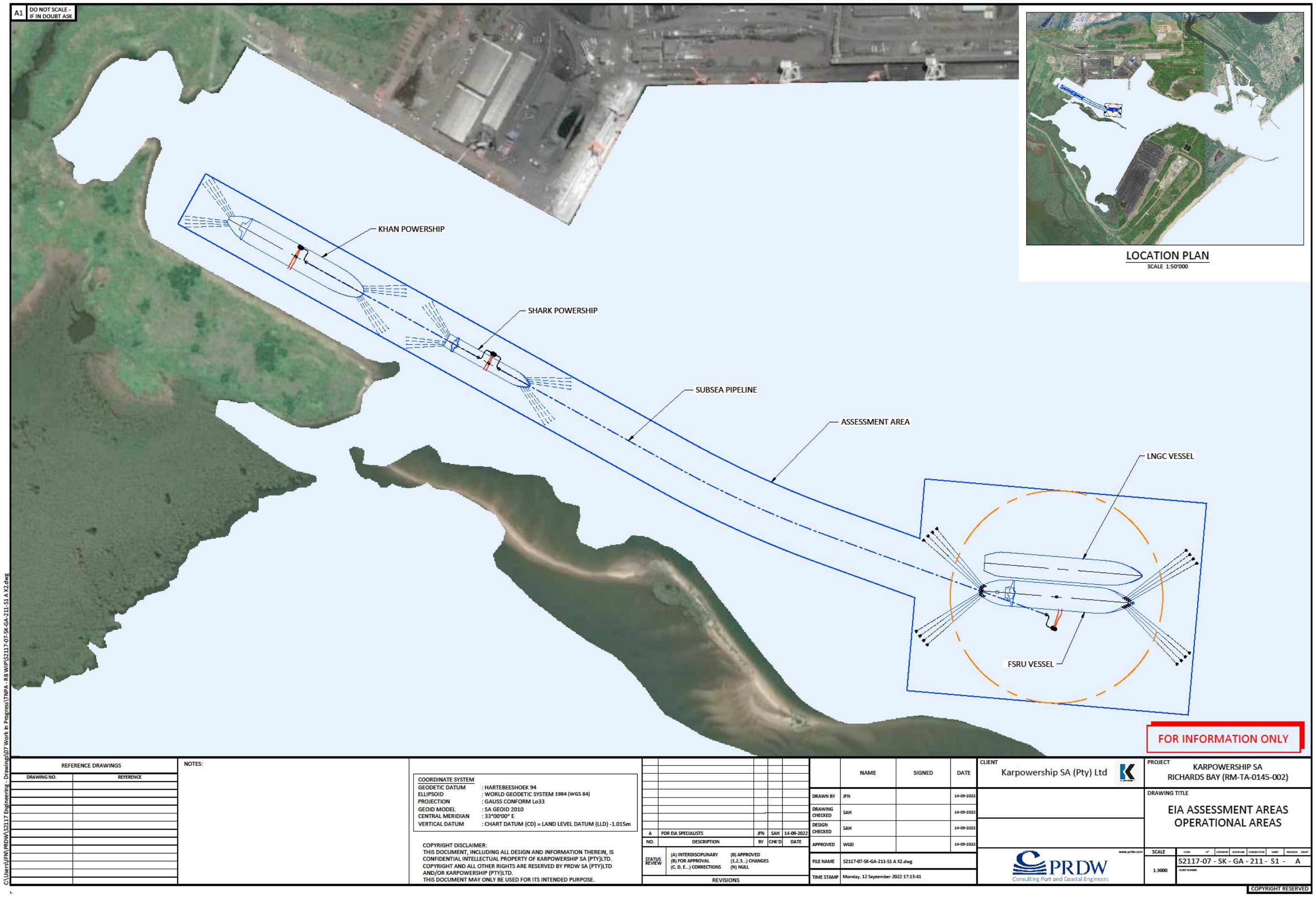

Figure 1: Proposed location for the Karpowership Project in the Port of Richards Bay

Figure 2: Illustration of a Khan Class Powership (top) and a Shark Class Powership (bottom) (www.karpower.com)

Figure 3: FSRU

2.2 Enterprise Details

The enterprise details for the proposed Karpowership SA project are listed in Table 1.

Table 1: Enterprise details

Entity Name:	Karpowership SA Proprietary Limited
Trading as:	Karpowership SA
Type of Enterprise, e.g. Company/Close Corporation/Trust, etc.:	Company
Company/Close Corporation/Trust Registration Number (Registration Numbers if Joint Venture):	2019/537869/07
Registered Address:	54 Wierda Road West, Wierda Valley, Inanda Greens, Building 9, St Andrews, First Floor, Sandton, Gauteng, 2196, South Africa
Postal Address:	Same as registered address
Telephone Number (General):	010 510 3455
Fax Number (General):	No fax
Company Website:	www.karpowership.com
Industry Type/Nature of Trade:	Energy generation
Land Use Zoning as per Town Planning Scheme:	N/A
Land Use Rights if outside Town Planning Scheme:	N/A
Responsible Person:	Curtis Meintjies
Emissions Control Officer:	Curtis Meintjies
Telephone Number:	073 688 6767
Cell Phone Number:	073 688 6767
Fax Number:	No fax
Email Address:	Curtis.Meintjies@karpowership.com
After Hours Contact Details:	Cell phone and email above

2.3 Location and extent of the plant

The Karpowership Project is planned to be at the Port of Richards Bay, situated in the Umhlatuze Local Municipality (ULM), in the KwaZulu-Natal Province. The proposed location for the Karpowership Project in the Port of Richards Bay is shown in Figure 1. Site information is listed in Table 2.

Table 2: Site information

Physical Address of the Licensed Premises:	To be confirmed
Description of Site:	Port of Richards Bay
Property Registration Number (Surveyor-General Code):	N/A
Coordinates (latitude, longitude) **Centre of Operations (Decimal Degrees):**	*Khan Powership:* Latitude: -28.795° Longitude: 32.030° *Shark Powership:* Latitude: -28.797° Longitude: 32.0339585° *FSRU:* Latitude: -28.801° Longitude: 32.045°
Coordinates (UTM) **Centre of Operations (UTM 35S):**	*Khan Powership:* X: 405359.169 Y: 6814376.458 *Shark Powership:* X: 405721.522 Y: 6814175.638 *FSRU:* X: 406790.001 Y: 6813735.712
Extent (km²):	Powerships: 19 000 m^2 FSRU & LNG Carrier: 29 300 m^2
Elevation Above Mean Sea Level (m):	At sea level
Province:	KwaZulu-Natal
District/Metropolitan Municipality:	King Cetshwayo District Municipality
Local Municipality:	Umhlatuze Local Municipality
Designated Priority Area (if applicable):	N/A

2.7 Description of surrounding land use (within 5 km radius)

The proposed project site is at the Port of Richards Bay is shown in Google Map image in Figure 4 with the surround land use.

According to the USEPA, sensitive receptors include, but are not limited to, hospitals, schools, day care facilities, elderly housing and convalescent facilities. These are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides, and other pollutants. Extra care must be taken when dealing with contaminants and pollutants in close proximity to areas recognised as sensitive receptors.

Industrial areas may be classified as receptors, but not necessarily sensitive receptors. Higher pollutant concentrations are normally expected in industrial areas and this is reflected in the NAAQS (e.g. dust fallout limit value of 1 200 mg/m^2/day for industrial areas versus 600 mg/m^2/day for residential areas).
There are no residences at the Port of Richards Bay. The closest residential area to the proposed site is Arboretum, which is located to the north-east of the site and approximately 3.9 km from the proposed Karpowership Project at the Port of Richards Bay. Arboretum is a moderately populated township. It is identified as a sensitive receptor due to the presence of schools, hospitals, crèches, and other similar facilities.

Another residential area, Meerensee, is located to the northeast, more than 5 km from the proposed Karpowership Project site. Other residential areas are located further away from the proposed project site.

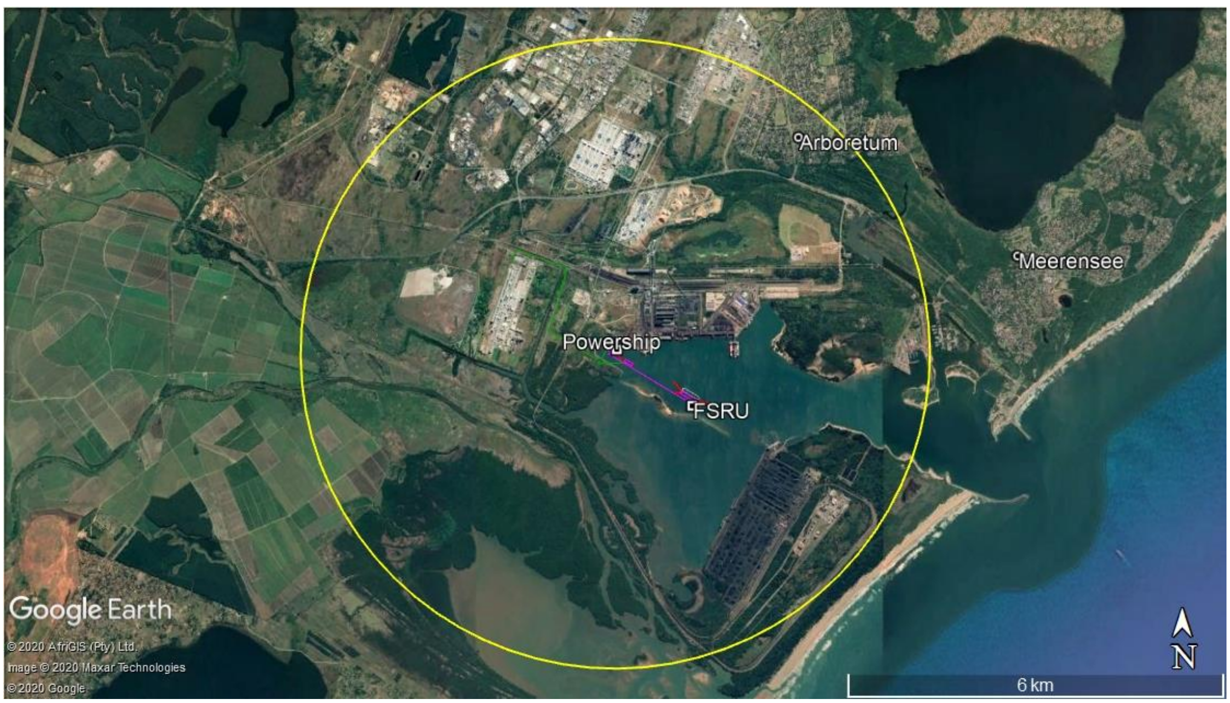

Figure 4: Relative location of the Karpowership Project. The circle indicates a 5 km radius around the site (Google Earth, 2020)

2.5 Emission Control Officer

The Karpowership Emission Control Officer (ECO) is Mr Curtis Meintjies (Mobile: 073 688 6767 and Email: Curtis.Meintjies@karpowership.com).

2.6 Atmospheric Emission License (AEL) and Other Authorisations

An Atmospheric Emissions Licence (AEL) nor any other authorisations have been issued for the proposed Karpowership Project (Table 3).

Table 3: Current authorisations related to air quality

Atmospheric Emission License	Date of Registration Certificate	Listed Activity Subcategory	Category of Listed Activity	Listed Activity Process Description
No record				

2.7 Modelling contractor

The dispersion modelling for this AIR is conducted by:

Company: uMoya-NILU Consulting (Pty) Ltd
Modellers: Dr Mark Zunckel and Atham Raghunandan
Contact details: Tel: 031 262 3265
Cell: 083 690 2728
email: mark@umoya-nilu.co.za or atham@umoya-nilu.co.za

See Annexure 2 for abridged CV's

2.8 Terms of Reference

The application for Environmental Authorisation for the proposed Karpowership Project requires the compilation of an Atmospheric Impact Report (AIR)[1]. To achieve this objective, the Terms of Reference are to:

- Prepare the AIR, including:
  - A description of current state of the receiving atmospheric environment using available monitoring data.
  - Description of the legal environment including regulations under the and the requirements of the Licensing Authority.
  - Development of an emission inventory for the Karpowership Project including emissions from LNG supply vessels.
  - Predictive modelling using the recommended CALPUFF dispersion model according to the modelling guideline[4], to predict ambient concentrations of all

[1] Regulations prescribing the format of an Atmospheric Impact Report, Gov, Gazette No. 36904, Notice No. 747, 11 Oct 2013.

    - relevant substances or mixture of substances resulting from emissions for the proposed project.
    - Assessment of impacts on ambient air quality of the proposed project and the implications for human health considering the predicted ambient concentrations relative to the National Ambient Air Quality Standards (NAAQS), and using EIA criteria for impact significance prescribed Triplo4.
- Submit the draft AIR to Triplo4 and Karpowership SA for review, and then finalisation of the report.

2.9 Assumptions

The following assumptions are relevant to this AIR:

a) No ambient monitoring is done in this assessment, rather available ambient air quality data is used.
b) The assessment of potential human health impacts is based on predicted (modelled) ambient concentrations of SO_2, NO_2, and PM_{10} and the health-based National Ambient Air Quality Standards (NAAQS).

3. NATURE OF THE PROCESS

3.1 Listed Activity or Activities

As a measure to reduce emissions from industrial sources and to improve ambient air quality, Listed Activities and associated Minimum Emission Standards (MES) were initially published in 2010 in Government Notice 248 (DEA, 2010) with the most recent revision applicable in 2019 (Government Notice 867, DEA, 2019).

The proposed Karpowership Project in Port of Richards Bay will use 27 Reciprocating Engines (21 on the Khan Class Powership and 6 on the Shark Class Powership) and three steam turbines to generate and supply up to 450 MW of electricity to the national grid. The following generation units are proposed:

- 21 Wartsila 18V50 reciprocating engines on the Khan Class Powership
- 6 Wartsila 18V50 reciprocating engines on the Shark Class Powership
- 2 Steam Turbines on the Khan Class Powership
- 1 Steam Turbine on the Shark Class Powership

The contracted generation capacity of the engines using gaseous fuel and the steam turbines is 450 MW, but the individual generation units are less than 50 MW. The combustion of gaseous fuel for steam production or electricity in a reciprocating engine with design capacity equal to or greater than 10 MW heat input per unit is the applicable Listed Activity (Table 4).

The heat generated by the engines is used to drive the steam turbines which significantly increases efficiency.

The MES for reciprocating engines using gas as the fuel are shown in Table 5 with the proposed emission concentrations for the Karpowership Project engines. Note that while no emission standard applies for SO_2, there is some sulphur in the LNG hence an SO_2 emission. SO_2 is therefore included in this assessment.

The combustion of gaseous fuel for steam production or electricity generation in a turbine is applied to units with a capacity of more than 50 MW heat input per unit. The regulations for small boilers (DEA, 2013b) apply specifically to boilers with a heat input more than 10 MW, but less than 50 MW. It appears therefore that emission standards are not prescribed for steam turbines with a capacity of less than 50 MW.

Table 4: Details of the Listed Activity for the proposed Karpowership Project according to GN 248 (DEA, 2010) and its revisions (DEA, 2013c, 2019)

Category of Listed Activity	Sub-category of the Listed Activity	Application
Category 1: Combustion Installations	Sub-category 1.5: Liquid and gas fuel stationary engines used for electricity generation	All installations with design capacity equal to or greater than 10 MW heat input per unit, based on the lower calorific value of the fuel use

Table 5: Minimum Emission Standards in mg/Nm^3 for Subcategory 1.5 according to GN 248 248 (DEA, 2010) and its revisions(DEA, 2013c, 2019)

Substance or mixture of substances		MES for sub-category 1.5
Common name	**Chemical symbol**	**MES under normal conditions of 15% O_2, 273 Kelvin and 101.3 kPa**
Particulate matter	N/A	50
Oxides of nitrogen[a]	NO_X	400
Sulphur dioxide	SO_2	N/A

a: expressed as NO_2

3.2 Process Description

3.2.1 *Liquefied natural gas (LNG)*

Natural gas used for energy generation is primarily methane, with low concentrations of other hydrocarbons, water, carbon dioxide, nitrogen, oxygen and some sulphur compounds. Liquefied Natural Gas (LNG) is natural gas which has been cooled below its boiling point of minus 161 °C in a process known as liquefaction. The process of liquefaction involves extracting most of the impurities in raw natural gas. The remaining natural gas is primarily methane with only small amounts of other hydrocarbons and consequently is widely considered a clean fossil fuel.

3.2.2 *Power generation*

The twenty seven (27) Gas Reciprocating Engines are connected in series which provide heat to three steam turbines to generate electricity.

Combustion engines used for electric power generation are internal combustion engines in which an air-fuel mixture is compressed by a piston and ignited within a cylinder. Dual-fuel engines are designed with the ability to burn both liquid and gaseous fuels. When operating in gas mode, the gaseous fuel is premixed with air, injected just after the compression stroke and ignited by a pilot fuel flame. In this process, the pilot fuel flame acts a "spark plug" to ignite the lean gas-air mixture. Dual-fuel DF engines retain the ability to use a backup liquid fuel when gas supply is interrupted. A flow diagram for combustion engines and a typical bank of engines at a power plant is shown in Figure 5.

Electricity will be transferred from the Karpowership Project to a new sub-station via a dedicated power line.

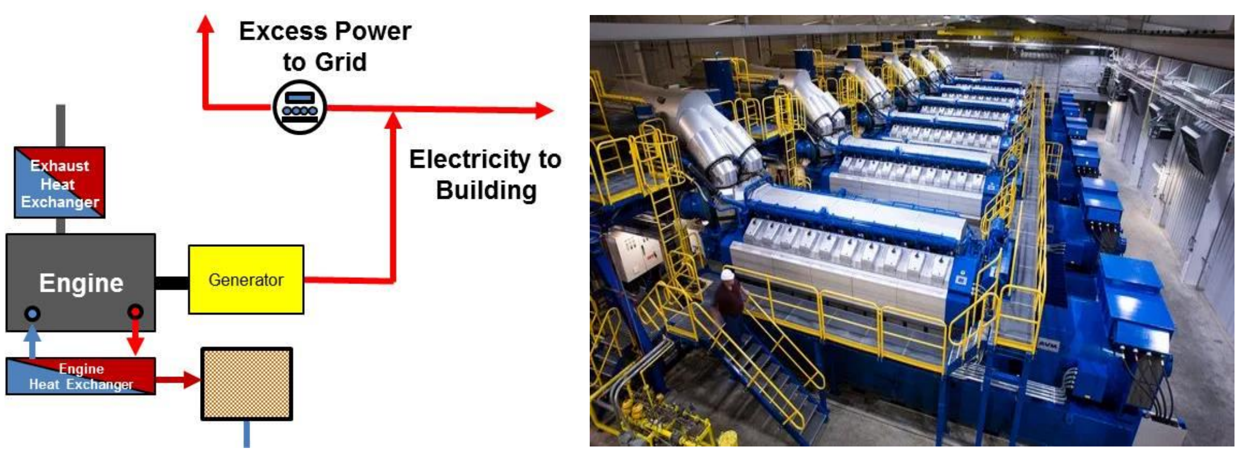

Figure 5: A flow diagram for power generation with engines (left), and a bank of engines connected in series

3.2.3 *Air pollutants resulting from the process*

3.2.3.1 Overview

The quantity and nature of emissions to the atmosphere from LNG combustion depends on the quality of the fuel, fuel consumption, the combustion device, and the air pollution control devices.

The combustion of LNG results in gaseous emissions of sulphur dioxide (SO_2), oxides of nitrogen ($NO + NO_2 = NO_X$), carbon monoxide (CO), and some particulate matter (PM). SO_2 is produced from the combustion of sulphur in the LNG. NO_X is produced from thermal fixation of atmospheric nitrogen in the combustion flame and from oxidation of nitrogen bound in the LNG. The quantity of NO_x produced is directly proportional to the temperature of the flame. The non-combustible portion of the fuel remains as solid waste and emitted as PM.

Carbon dioxide (CO_2) is the main Greenhouse Gas resulting from LNG combustion and is considered in the Carbon Footprint Assessment.

3.2.3.2 National Ambient Air Quality Standards

The effects of air pollutants on human health occur in different ways of ways with short-term, or acute effects, and chronic, or long-term, effects. Different groups of people are affected differently, depending on their level of sensitivity, with the elderly and young children being more susceptible. Factors that link the concentration of an air pollutant to an observed health effect are the concentration and the duration of the exposure to that particular air pollutant.

Criteria pollutants occur ubiquitously in urban and industrial environments. Their effects on human health and the environment are well documented by the World Health Organisation (WHO) (e.g. WHO, 1999; 2003; 2005). South Africa has accordingly established NAAQS for SO_2, NO_2, CO, and respirable particulate matter (PM_{10}), amongst others (DEA, 2009).

The NAAQS consists of a 'limit' value and a permitted frequency of exceedance. The limit value is the fixed concentration level aimed at reducing the harmful effects of a pollutant. The permitted frequency of exceedance represents the acceptable number of exceedances of the limit value expressed as the 99^{th} percentile. Compliance with the ambient standard implies that the frequency of exceedance of the limit value does not exceed the permitted tolerance.

Being a health-based standard, ambient concentrations below the standard imply that air quality poses an acceptable risk to human health, while exposure to ambient concentrations above the standard implies that there is an unacceptable risk to human health. The NAAQS for PM_{10}, NO_X, and SO_2 are presented in Table 6.

Table 6: NAAQS for pollutants relevant to the Karpowership Project.

Pollutant	Averaging period	Limit value ($\mu g/m^3$)	Tolerance
SO_2	1 hour	350	88
	24 hour	125	4
	1 year	50	0
NO_2	1 hour	200	88
	1 year	40	0
PM_{10}	24 hour	75	4
	1 year	40	0

CO_2 is a Greenhouse Gas and ambient air quality standards do not apply. However, it is a priority pollutant (DEA, 2016). Emissions must be accounted for and reported. CO_2 emissions are considered in the Carbon Footprint assessment.

3.2.3.3 Air pollutants and health implications

The path of exposure to air pollutants is inhalation, although some exposure may occur through dermal contact with surfaces where air pollutants settle. The sections below provide a short literature review of the air pollutants from an air quality and human health perspective. Note that the text below is for general background information and is not related directly to the Karpowership Project.

Sulphur dioxide (SO_2)

Dominant sources of SO_2 include fossil fuel combustion from industry and power plants. SO_2 is emitted when coal is burnt for energy. The combustion of fuel oil also results in high SO_2 emissions. Domestic coal or kerosene burning can thus also result in the release of SO_2. Motor vehicles also emit SO_2, in particular diesel vehicles due to the higher sulphur content of diesel fuel. Smelting of mineral ores can also result in the production of SO_2, because metals usually exist as sulphides within the ore.

On inhalation, most SO_2 only penetrates as far as the nose and throat, with minimal amounts reaching the lungs, unless the person is breathing heavily, breathing only through the mouth, or if the concentration of SO_2 is high (CCINFO, 1998). The acute response to SO_2 is rapid, within 10 minutes in people suffering from asthma (WHO, 2005). Effects such as a reduction in lung function, an increase in airway resistance, wheezing and shortness of breath, are enhanced by exercise that increases the volume of air inspired, as it allows SO_2 to penetrate further into the respiratory tract (WHO, 1999). SO_2 reacts with cell moisture in the respiratory system to form sulphuric acid. This can lead to impaired cell function and effects such as coughing, broncho-constriction, exacerbation of asthma and reduced lung function. For example an exposure of 5 to 10 min to 200 to 300 ppb (520 to 780 $\mu g/m^3$) may reduce lung function (measured as Forced Expiratory Volume in the first second (FEV_1)) by more than 15% (US-EPA, 2009). There is however, uncertainty about exposure-response effects below concentrations of 200 ppb (520 $\mu g/m^3$). For SO_2 exposure short-term peak concentrations are therefore important (US-EPA, 2009). Re-analysis of the effects of SO_2 done post-2005 has found evidence suggesting that the departure pont for setting the 10-minute guideline needs an additional uncertainty factor, indicating that the guideline may have to be lowered when it is re-evaluated (WHO, 2013).

Nitrogen dioxide (NO_2)

Nitrogen dioxide (NO_2) and nitric oxide (NO) are formed simultaneously in combustion processes and other high temperature operations such as metallurgical furnaces, blast furnaces, plasma furnaces, and kilns. NO_X is a term commonly used to refer to the combination of NO and NO_2. NO_X can also be released from nitric acid plants and other types of industrial processes involving the generation and/or use of nitric acid. NO_X also forms naturally through de-nitrification by anaerobic bacteria in soils and plants. Lightning is also a source of NO_X.

The route of exposure to NO_2 is inhalation and the seriousness of the effects depend more on the concentration than on the length of exposure. The site of deposition for NO_2 is the distal lung where NO_2 reacts with moisture in the fluids of the respiratory tract to form nitrous and nitric acids. About 80 to 90% of inhaled nitrogen dioxide is absorbed through the lungs (CCINFO, 1998). Nitrogen dioxide (present in the blood as the nitrite ion) oxidises unsaturated membrane lipids and proteins, which then results in the loss of control of cell permeability. Nitrogen dioxide causes decrements in lung function, particularly increased airway resistance. Inflammatory reactions were observed at NO_2 concentrations between 200 and 1000 ppb (380 to 1880 $\mu g/m^3$) when individuals were exposed under controlled conditions for periods that varied between 15 minutes and six hours (WHO, 2013). However, the results had been inconsistent below 1000 ppb but were much more evident at concentrations higher than 1000 ppb (1880 $\mu g/m^3$) (WHO, 2013). Below 1000 ppb healthy individuals did not show inflammatory reactions and for those with respiratory diseases (asthma and chronic obstructive pulmonary disease), inflammation was not induced below 600 ppb, except for one study that reported individuals responded at 260 ppb (500 $\mu g/m^3$) (Hesterberg et al., 2009). A review study (on 50 publications) published in 2009 by Hesterberg et al. focussed on short-term exposure to NO_2 and adverse health effects on humans. The authors came to the conclusion that a short-term exposure standard of not more than 200 ppb would protect all individuals, including sensitive individuals. People with chronic respiratory problems and people who work or exercise outside will be more at risk to NO_2 exposure.

Chronic exposure to NO_2 increases susceptibility to respiratory infections (WHO, 1997). However, a review study of 50 publications found no consistent evidence that short-term exposure below 200 ppb increased susceptibility to viral infections (Hesterberg et al., 2009).

The WHO has reviewed studies published between 2004 and 2011 on adverse health effects after short-term and long-term exposure to NO_2 (WHO, 2013). The health effects from short-term exposure are more evident than from long-term (chronic) exposure, because in many studies a high correlation was found between NO_2 and other pollutants (WHO, 2013). However, some epidemiology studies suggested an association between NO_2 and respiratory mortality and an association with respiratory effects in children, including effects on children's lung function (WHO, 2013).

Particulate Matter

Particulate Matter (PM) is a broad term used to describe the fine particles found in the atmosphere, including soil dust, dirt, soot, smoke, pollen, ash, aerosols and liquid droplets. With PM, it is not just the chemical composition that is important but also the particle size. Particle size has the greatest influence on the behaviour of PM in the atmosphere with smaller particles tending to have longer residence times than larger ones. PM is categorised, according to particle size, into TSP, PM_{10} and $PM_{2.5}$.

Total suspended particulates (TSP) consist of all particles smaller than 100 μm suspended within the air. TSP is useful for understanding nuisance effects of PM, e.g. settling on houses, deposition on and discolouration of buildings, and reduction in visibility.

PM_{10} describes all particulate matter in the atmosphere with a diameter equal to or less than 10 μm. Sometimes referred to simply as coarse particles, they are generally emitted from motor vehicles, factory and utility smokestacks, construction sites, tilled fields, unpaved roads, stone crushing, and burning of wood. Natural sources include sea spray, windblown dust and volcanoes. Coarse particles tend to have relatively short residence times as they settle out rapidly and PM_{10} is generally found relatively close to the source except in strong winds.

$PM_{2.5}$ describes all particulate matter in the atmosphere with a diameter equal to or less than 2.5 μm. They are often called fine particles, and are mostly related to combustion (motor vehicles, smelting, incinerators), rather than mechanical processes as is the case with PM_{10}. $PM_{2.5}$ may be suspended in the atmosphere for long periods and can be transported over large distances. Fine particles can form in the atmosphere in three ways: when particles form from the gas phase, when gas molecules aggregate or cluster together without the aid of an existing surface to form a new particle, or from reactions of gases to form vapours that nucleate to form particles.

Particulate matter may contain both organic and inorganic pollutants. The extent to which particulates are considered harmful depends on their chemical composition and size, e.g. particulates emitted from diesel vehicle exhausts mainly contain unburned fuel oil and hydrocarbons that are known to be carcinogenic. Very fine particulates pose the greatest health risk as they can penetrate deep into the lung, as opposed to larger particles that may be filtered out through the airways' natural mechanisms.

In normal nasal breathing, particles larger than 10 μm are typically removed from the air stream as it passes through the nose and upper respiratory airways, and particles between 3 μm and 10 μm are deposited on the mucociliary escalator in the upper airways. Particles in the range of 1 μm to 2 μm penetrate deeper where deposition in the alveoli of the lung can occur (WHO, 2003). Coarse particles (PM_{10} to $PM_{2.5}$) can accumulate in the respiratory system and aggravate health problems such as asthma. $PM_{2.5}$, which can penetrate deeply into the lungs, are more likely to contribute to the health effects (e.g. premature mortality and hospital admissions (WHO, 2003).

The WHO has reviewed many studies since 2005 to update information on health effects on PM (WHO, 2013). Studies have once again confirmed that PM (not only PM_{10} but fine and ultra-fine PM as well), has short and long-term (both immediate and delayed) adverse health effects such as cardiovascular effects, but new associations with diseases such as atherosclerosis (thickening of artery walls), birth defects and respiratory illness in children have also been found (WHO, 2013). In addition, some studies have suggested a possible link between PM and diabetes and effects on the central nervous system (WHO, 2013). The increase in daily mortality (between 0.4% and 1%) from exposure to PM_{10} was also confirmed in several studies since 2005 (WHO, 2013).

3.3 Unit Processes

The Karpowership Project at the Port of Richards Bay comprises the Powership/Powership combination, the FSRU and the LNG supply vessel. The unit processes that apply are the Powership/Powership combination and the FSRU and are listed in Table 7.

Table 7: Unit processes for the Karpowership Project

Name of the Unit Process	Unit Process Function	Batch or Continuous
Powership Engine 1 to 21: Unit 1 to 21	Heat+electricity generation	Continuous
Powership Engine 1 to 6: Unit 22 to 27	Heat+electricity generation	Continuous
Steam Turbine Generation 1 to 3:	Heat Recovery+Electricity generation	Continuous
FSRU Regasification	Conversion of LNG to NG	Continuous

4. TECHNICAL INFORMATION

4.1 Raw Materials Used

The proposed Karpowership Project uses LNG to generate electricity. The raw materials consumption rate, the production rate and the energy consumption are listed in Table 8 to Table 10 for the contracted capacity (450 MW) for a dispatch period of 16.5 hours per day.
No by-products are produced.

Table 8: Raw material used at the proposed gas to power plant

Material Type	Maximum consumption rate	Units
LNG	1 988 641	MMbtu/month

1 MMbtu = 28.26 m^3

Table 9: Production rate

Product	Maximum production rate	Units
Electricity	226 463	MWh/month

Table 10: Energy sources used

Energy source	Maximum permitted consumption rate	Units
Electricity	5 183	MWh/month

4.2 Appliances and Abatement Equipment Control Technology

LNG is a clean fuel with very low SO_2 and particulate emissions. No emission abatement will be installed for the control of these emissions.

NO_X emissions are controlled to the required concentration at source using selective catalytic reduction (SCR).

Table 11: Appliances and abatement equipment and control technology

Appliance Name	Appliance Type/Description	Appliance Function/Purpose
Selective catalytic reduction		Control of NO_X emissions

5. ATMOSPHERIC EMISSIONS

5.1 Point Source Parameters

Each engine and the steam turbines have a dedicated stack. On the Khan Class Powership the 21 stacks are orientated along the vessel from bow to stern. On the Shark Class Powership the 6 stacks are orientated along the deck. The stack orientation may be seen in Figure 2 and Figure 3.

The Karpowership Project will be located at approximately 28.79° S and 32.03° E in the Port of Richards Bay. Stack parameters are shown in Table 12.

Table 12: Powership, Powership and FSRU stack parameters

Source name	Base elevation (m)	Stack Height (m)	Stack Temperature (°C)	Stack Diameter (m)	Stack Velocity (m/s)	Stack Flowrate (Am^3/hr)	Stack Flowrate (Nm^3/s)
Stack 1-21 - Khan Powership	0	55	359	1.8	25.2	230 832	28
Stack 1-6 - Shark Powership	0	55	359	1.8	25.2	230 832	28
Stack 1- FSRU	0	55	359	1.8	25.2	230 832	28

5.2 Point Source Maximum Emission Rates (Normal Operating Conditions)

Emission rates from the point sources on the Powership and Powership, and the FSRU are presented in Table 13. The total emissions are presented in Table 14.

Table 13: Stack emission rates (t/a)

Source Type	Source number	Source ID	Description	SO_2	NO_X	PM_{10}
Point	1	KhanStk1	Khan Engine Stack1	1.75	43.67	8.73
Point	2	KhanStk2	Khan Engine Stack2	1.75	43.67	8.73
Point	3	KhanStk3	Khan Engine Stack3	1.75	43.67	8.73
Point	4	KhanStk4	Khan Engine Stack4	1.75	43.67	8.73
Point	5	KhanStk5	Khan Engine Stack5	1.75	43.67	8.73
Point	6	KhanStk6	Khan Engine Stack6	1.75	43.67	8.73
Point	7	KhanStk7	Khan Engine Stack7	1.75	43.67	8.73
Point	8	KhanStk8	Khan Engine Stack8	1.75	43.67	8.73
Point	9	KhanStk9	Khan Engine Stack9	1.75	43.67	8.73
Point	10	KhanStk10	Khan Engine Stack10	1.75	43.67	8.73
Point	11	KhanStk11	Khan Engine Stack11	1.75	43.67	8.73
Point	12	KhanStk12	Khan Engine Stack12	1.75	43.67	8.73
Point	13	KhanStk13	Khan Engine Stack13	1.75	43.67	8.73
Point	14	KhanStk14	Khan Engine Stack14	1.75	43.67	8.73
Point	15	KhanStk15	Khan Engine Stack15	1.75	43.67	8.73
Point	16	KhanStk16	Khan Engine Stack16	1.75	43.67	8.73
Point	17	KhanStk17	Khan Engine Stack17	1.75	43.67	8.73
Point	18	KhanStk18	Khan Engine Stack18	1.75	43.67	8.73
Point	19	KhanStk19	Khan Engine Stack19	1.75	43.67	8.73
Point	20	KhanStk20	Khan Engine Stack20	1.75	43.67	8.73
Point	21	KhanStk21	Khan Engine Stack21	1.75	43.67	8.73
Point	22	SharkStk1	Shark Engine Stack1	1.75	43.67	8.73
Point	23	SharkStk2	Shark Engine Stack2	1.75	43.67	8.73
Point	24	SharkStk3	Shark Engine Stack3	1.75	43.67	8.73
Point	25	SharkStk4	Shark Engine Stack4	1.75	43.67	8.73
Point	26	SharkStk5	Shark Engine Stack5	1.75	43.67	8.73
Point	27	SharkStk6	Shark Engine Stack6	1.75	43.67	8.73
Point	28	FSRUStk1	FSRU Stack1	7.0	174.7	34.9

Table 14: Annual emissions from the Khan Powership, Shark Powership and the FSRU (t/a)

Source	SO_2	NO_X	PM_{10}
Powership 1 (Khan)	36.7	917.1	183.4
Powership 2 (Shark)	10.5	262.0	52.4
FSRU	7.0	174.7	34.9

The annual emissions presented above assume that operations are continuous, i.e. 24 hours per day for 365 days. This is a worst-case assumption as operations are likely to be for 16.5 hours per day.

5.3 Point Source Maximum Emission Rates (Start Up, Shut-Down, Upset and Maintenance Conditions)

Internal energy consumption of the Powership is provided by an on-board 0.8 MW natural gas generator which will supply two vessels in Richards Bay.

Planned maintenance is done routinely.

5.4 Fugitive Emissions

An LNG supply vessel will restock the FSRU approximately once every 20 to 30 days. The supply vessel will dock alongside the FSRU during the transfer which will take 1 to 2 days.

For the purposes of this assessment the emissions from the LNG resupply are regarded as fugitive emissions. Emissions from the ship manoeuvring from the port entrance to the berth, and during the LNG transfer are presented in Table 15. Ship manoeuvring assumes main engines while auxiliary engines are assumed during LNG transfer.

Table 15: LNG supply ship emissions (tonnes/annum)

Source number	SO_2	NO_X	PM_{10}
Ship manoeuvring	2.1	18.4	0.4
At berth	0.6	3.7	0.1
Total	2.7	22.1	0.5

5.5 Emergency Incidents

The project is being proposed. Therefore no emergency incidents have occurred.

6. IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

6.1 Baseline conditions

6.1.1 Climate and meteorology

The Richards Bay climate is best described by the South African Weather Bureau (now Service) long-term climate statistics (SAWB, 1992 and 1998). The Richards Bay region has a warm temperate climate and the temperature range is not extreme, although high temperatures can occur during summer. Averages of daily minimum, maximum and mean temperatures, and average monthly rainfall are presented in Figure 6. The average summer maximums exceed 27 °C from December to March, when it is also very humid. Winters are mild with the average minimum temperatures of 14 °C in June and July (SAWS, 1998). The average annual rainfall at Richards Bay is 1 212 mm (SAWB, 1992). The majority of rainfall occurs from late September to March and this period is usually associated with convective summer storms. The winter rainfall is not uncommon and associated with the passage of cold fronts.

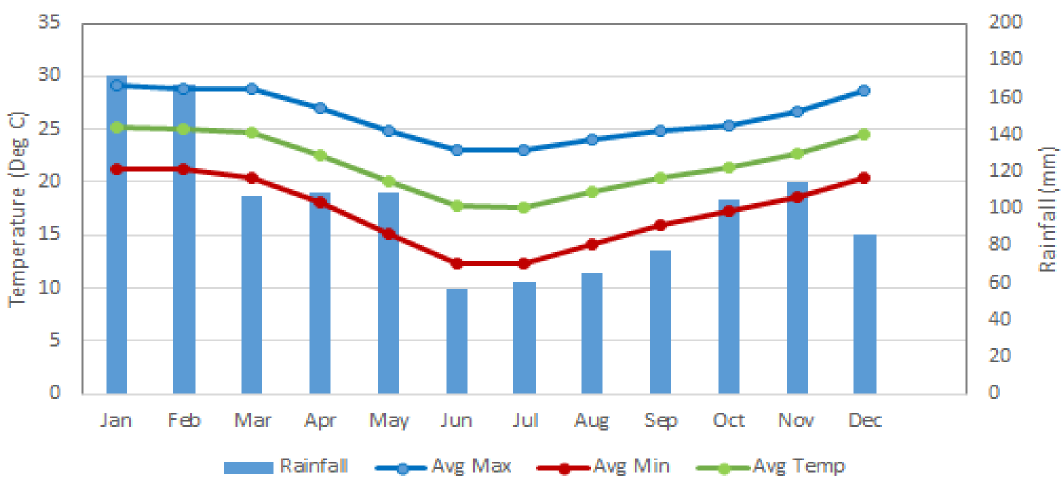

Figure 6: Average monthly maximum, minimum and daily temperature at Richards Bay (SAWB, 1992) and the average monthly rainfall (in mm) (SAWB, 1998)

The South African Weather Services (SAWS) station at the Richards Bay Airport provides a good representation of the prevailing wind direction across the region. The windrose at Richards Bay Airport for the 5-year period 1 January 2010 to 31 December 2014 is shown in Figure 7. Wind roses simultaneously depict the frequency of occurrence of wind from the 16 cardinal wind directions and wind speed classes, for a single site. Wind direction is given as the direction from which the wind blows, i.e., southwesterly winds blow from the southwest. Wind speed is given in meters per second (m/s), and each arc represents a percentage frequency of occurrence (5% in this case).

The predominant winds are associated with the Indian Ocean high pressure system and its seasonal movement relative to Richards Bay, with coastal lows and the passage of frontal systems having some influence. The winds are generally aligned with the coastline and at Richards Bay winds occur predominantly in the sector north to north-northeast and in the sector south to southwest. 32% of all winds occur from the northerly sector. Most of these winds are light to moderate with just 6% exceeding 8.8 m/s. The winds from the south to south-west account for 17% of all winds. While these winds are generally light to moderate, they are strong at time and exceed 11.1 m/s on occasions. These strong winds are usually associated with the passage of deep coastal lows ahead of cold frontal systems.

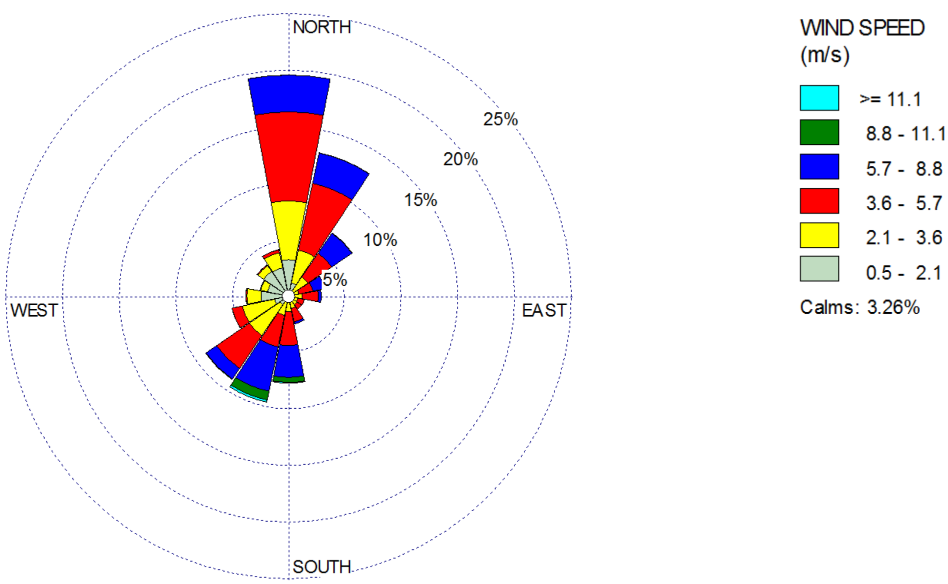

Figure 7: Annual wind rose for Richards Bay Airport, for 2010 to 2014 (SAWB, 1998)

The windrose also indicates mesoscale time land and sea breeze circulation. The land breeze is shown by the light off-shore winds from the west and northwest. These occur mostly at night time in the winter. The sea breeze is also a winter time feature and is shown by the onshore easterly to northeasterly winds. The sea breeze is a daytime feature and is somewhat stronger than the land breeze.

The poorest atmospheric dispersion conditions occur with inversion conditions and calm or light winds. Greater surface cooling in winter is conducive to the formation of surface temperature inversions and a shallow mixing layer, particularly at night. Pollutants that are released into the inversion layer are typically trapped between the surface and the top of the inversion. Under light wind conditions, pollutants will tend to accumulate. It is under these conditions for May to August when the highest ground level concentrations of pollutants may be expected in the area.

6.1.2 Ambient Air Quality

6.1.3.1 Long-term trends

The Richards Bay Clean Air Association (RBCAA, http://www.rbcaa.org.za/) has undertaken ambient air quality monitoring in the area since 2004, measuring SO_2 and PM_{10}. Okello et al (2018) used the RBCAA data to describe air quality in Richards Bay area over the period 2004 to 2017. Findings from this comprehensive analysis are highlighted here.

PM_{10} monitoring data indicates a downward trend at 4 stations (Brakenham, CBD, Esikhaleni and Felixton) (Figure 8). Mtunzini and St. Lucia, the reference sites, had upward trends. The CBD and Brakenham have higher PM_{10} values compared to the other stations. All measurements were within the stipulated NAAQS annual average limit of 50 µg/m^3.

Esikhaleni is a highly populated area with mostly low income households and fewer industries compared to areas around the CBD. The source of PM_{10} are different and are likely to be indoor compared to outdoor. St. Lucia and Mtunzini were the reference site with PM_{10} levels averaging at 20.8 µg/m^3 and 22.3 µg/m^3 respectively. This is deemed a good indication of the background PM_{10} concentration of the whole study area as both sites are relative unaffected by local sources. The background in both cases is above the WHO guideline value indicating the potential contribution of other sources such as pollen and sea salts.

SO_2 measurements in all seven monitoring stations where data was available was within the NAAQS of 50 µg/m^3 (Figure 9). Downward trends were observed in Arboretum, Brakenham, CBD and Felixton. Harbour west had no observable trend. Esikhaleni showed an upward trend although with ambient concentrations well below the annual limit value. Scorpio had the least favourable SO_2 trends attributable to their close vicinity to industry.

Data taken over the long term (1997 to 2017) for SO_2 indicate a slightly upward trend. From 2013 to 2017 however, a significant downward trend is observed. The Scorpio and Harbour West Stations have consistently been above the 20-year average. This can be attributed mostly to emissions from the surrounding industry. The CBD had SO_2 annual average ambient concentration just below the 20-year regional annual average. Measurement from residential areas such as Arboretum, Mtunzini and Esikhaleni showed low concentrations of SO_2.

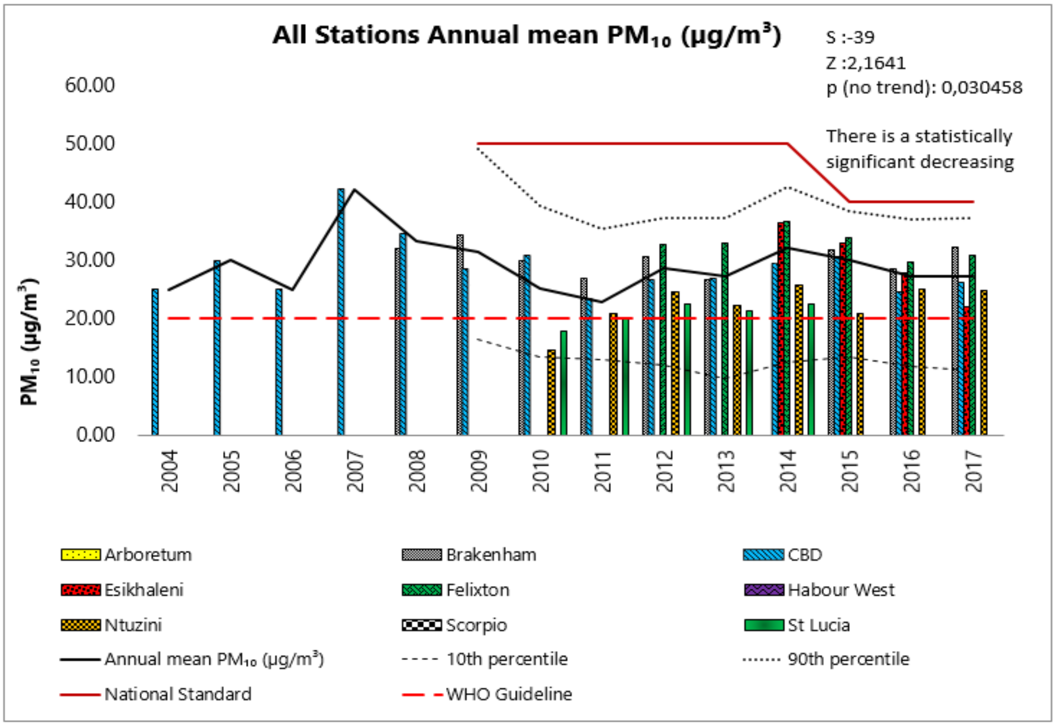

Figure 8: Annual average PM_{10} monitored concentrations (Okello *et al.*, 2018)

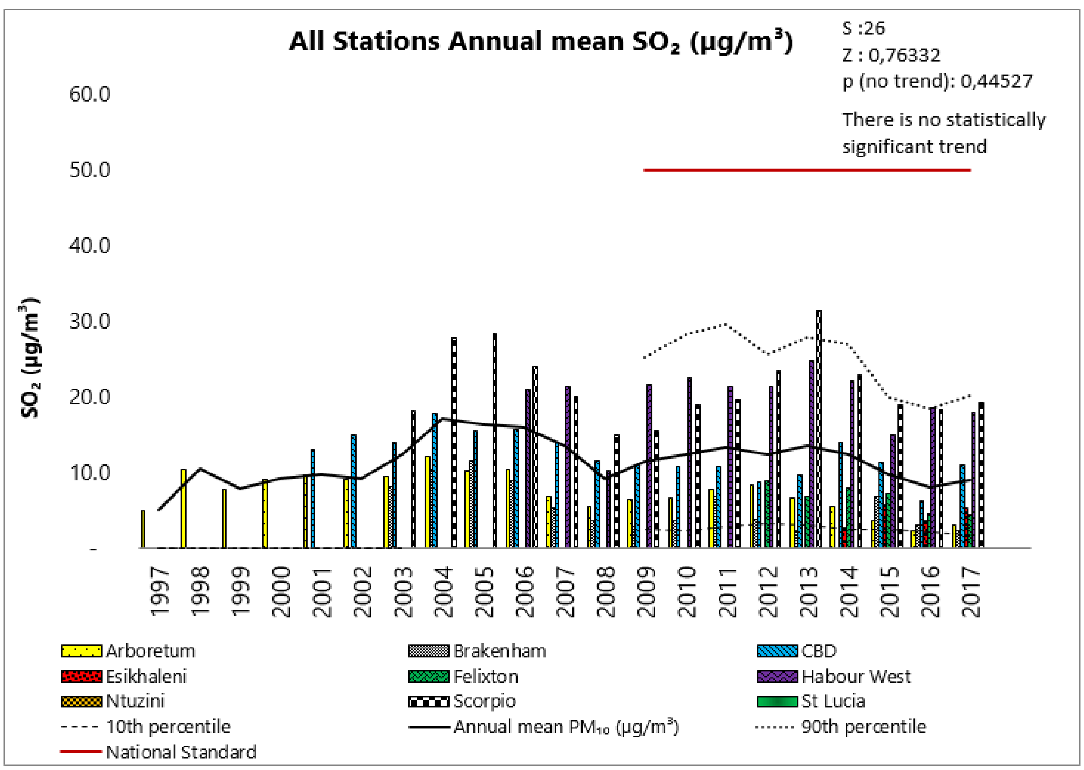

Figure 9: Annual average SO_2 monitored concentrations (Okello *et al.*, 2018)

6.1.3.2 Ambient monitoring data 2019 and 2020

Ambient air quality monitoring is undertaken in Richards Bay by the City of uMhlathuze and the RBCAA (Table 16), measuring SO_2, NO_2 and PM_{10} amongst other parameters. Available hourly data for 2019 and 2020 was downloaded from the South African Air Quality Information System (SAAQIS) (http://saaqis.environment.co.za). The data is summarised here to augment the long-term analysis conducted by Okello et al (2018) in the AIR (uMoya-NILU, 2020).

Table 16: Ambient air quality monitoring stations and pollutants monitored

Station Owner	Monitoring Station	SO_2	NO_2	PM_{10}
City of uMhlathuze	Arboretum	✓	✓	✓
	Brakenham	✓	✓	✓
	eSikhaleni	✓	✓	✓
RBCAA	Arboretum	✓		
	Brakenham	✓		✓
	CBD	✓		✓
	eNseleni	✓		✓
	eSikhaleni	✓		✓
	Felixton	✓		✓
	Harbour West	✓		
	Mtunzini	✓		✓
	Scorpio	✓		✓

Sulphur dioxide (SO_2)

Ambient SO_2 concentrations may be attributed mostly to local industrial sources. The annual average SO_2 concentrations is low relative to the NAAQS of 50 µg/m^3 at all stations in 2019 and 2020 (Table 17). The highest annual average concentrations, albeit below the NAAQS, were measured at Harbour West and Scopio, followed by the CBD and eSikhaleni.

Table 17: Annual average SO_2 concentration in µg/m^3 for 2019 and 2020

Owner	Station	2019	2020
RBCAA	**Arboretum**	5.0	5.6
uMhlathuze	**Arboretum**	8.3	4.8
RBCAA	**Brakenham**	3.4	3.5
uMhlathuze	**Brakenham**	4.1	6.0
RBCAA	**CBD**	11.0	14.1
RBCAA	**eNseleni**	5.2	3.9
RBCAA	**eSikhaleni**	10.6	4.7
uMhlathuze	**eSikhaleni**	10.2	4.6
RBCAA	**Felixton**	7.4	5.6
RBCAA	**Harbour West**	20.2	20.3
RBCAA	**Scopio**	20.5	30.1

In 2019 the 24-hour average SO_2 concentrations complied with the NAAQS at all monitoring stations. There was only one exceedances of the limit value of the NAAQS of 125 μg/m^3 at Harbour West. The average hourly SO_2 concentrations also complied with NAAQS at all monitoring stations. There were exceedances of the limit value of 350 μg/m^3, but these were fewer than the tolerance of 88. They occurred at the CBD (1), eSikhaleni (2) and Scopio (5).

In 2020 the 24-hour average SO_2 concentrations complied with the NAAQS at all monitoring stations except Scopio. At Scopio 11 exceedances of the daily limit value of 125 μg/m^3 occurred, exceeding the tolerance of 4 in a year. The average hourly SO_2 concentrations complied with NAAQS at all monitoring stations, although exceedances of the limit value of 350 μg/m^3 occur, but were fewer than the tolerance of 88 in a year. They occurred at Harbour West (6) and Scopio (75).

The SO_2 data presented here for 2019 and 2020 is generally consistent with the published long-term trends (Okello et al, 2018). Okello et al (2018) reported a statistically significant downward trend across all monitoring stations from 2013 to 2017. The number of exceedances of 24-hour and 1-hour limit value of the NAAQS at Scopio in 2019 and 2020 may however suggest an increasing trend at this monitoring station.

Nitrogen dioxide (NO_2)

Ambient NO_2 concentrations may be attributed mostly to local sources including industrial emissions and traffic. The annual average NO_2 concentrations are very low relative to the NAAQS of 40 μg/m^3 at the three City of uMhlathuze monitoring stations in 2019 and 2020 (Table 18).

Table 18: Annual average NO_2 concentration in μg/m^3 for 2019 to 2020

Station	2019	2020
Arboretum	7.7	7.1
Brakenham	10.1	15.9
eSikhaleni	10.1	8.7

In 2019 the hourly average NO_2 concentrations complied with the NAAQS at all monitoring stations. There were no exceedances of the limit value of 200 μg/m^3.

In 2020 the hourly average NO_2 concentrations complied with the NAAQS at all monitoring stations. There were however exceedances of the limit value of 200 μg/m^3 at Brakenham on 55 occasions, fewer than the permitted tolerance of 88 in a year.

3.3.3 Particulate matter (PM_{10})

PM_{10} is a regional pollutant with a regional background concentration in Richards Bay of more than 20 μg/m^3 (Okello et al, 2018). Ambient PM_{10} concentrations may be attributed mostly to the high regional background with some contribution from local sources. The annual average PM_{10} concentrations are relatively high at most stations, but are consistently below the NAAQS (Table 19). The highest annual average concentrations were measured at Brakenham, eNseleni, eSikhaleni and Felixton.

Table 19: Annual average PM_{10} concentration in µg/m^3 for 2019 and 2020

Owner	Station	2019	2020
uMhlathuze	Arboretum	8.1	1.1
RBCAA	Brakenham	31.6	25.6
uMhlathuze	Brakenham	9.3	5.1
RBCAA	CBD	24.5	13.1
RBCAA	eNseleni	30.9	24.9
RBCAA	eSikhaleni	25.8	23.4
uMhlathuze	eSikhaleni	30.1	15.6
RBCAA	Felixton	30.3	22.5

In 2019 the 24-hour average PM_{10} concentrations complied with the NAAQS at all monitoring stations except eSikhaleni. At eSikhaleni 20 exceedances of the limit value of 75 µg/m^3 were recorded, exceeding the tolerance of 4 per year. Exceedances of the limit value were recorded at Arboretum (1), CBD (1) and eNseleni (1), fewer than the tolerance of 4.

In 2020 the 24-hour average PM_{10} concentrations complied with the NAAQS at all monitoring stations. At eSikhaleni 4 exceedances of the limit value of 75 µg/m^3 were recorded, meeting the permitted tolerance of 4 per year.

The PM_{10} data presented here for 2019 and 2020 is generally consistent with the findings of Okello et al (2018) using long-term data which the CBD and Brakenham experiencing higher concentration than other stations. More recently the high PM_{10} concentrations may be indicative of an increasing contribution from sources in eSikhaleni.

6.1.3.3 Coal dust issue

There was been a significant increase in the number of complaints concerning the deposition of coal dust received by the RBCAA in September 2022 from those in previous months(https://rbcaa.org.za/). In the preceding three months no complaints were received concerning coal dust. However, from 03 to 21 September, 260 of the 268 complaints received from Arboretum, Alton, Birdswood, Veldenvlei, amongst others, concerned coal dust. The source of the coal dust is the coal terminal at the Port of Richards Bay. A recent fire at the Port of Richards Bay resulted in damage to a coal conveyor. The complaints received by the RBCAA in September 2022 precede the fire event.

6.1.3.4 WSP cumulative dispersion modelling

WSP Environment and Energy conducted a dispersion modelling study in Richards Bay to assess the cumulative effects of industrial operations. The report is considered by the RBCAA to be the most comprehensive modelling assessment for sources in Richards Bay. The modelling however has a number of notable shortcomings (pers. comm., Dr Lisa Ramsay, WSP, 31 March 2021). The shortcomings are:

i) The emissions inventory was compiled in 2015 and includes emissions for various industrial sources (point and area sources).
ii) Emissions data was extracted from the various AELs and other reporting (e.g. AQIAs) from 2012 to 2015, depending on applicability.
iii) Some industrial sources were excluded. Other notable exclusions were vehicle emissions and sugarcane burning.
iv) Three years meteorological data was used, 2011 to 2013.
v) The emission profile in Richards Bay has changed since the modelling was done. Some industries have since closed and on 01 April 2020 all Listed Activities had to comply with Minimum Emission Standards (MES) for new plants. Changes in emission as a result of the MES regulations are not captured in the WSP modelling.

The results of the WSP cumulative dispersion modelling are indicative of dispersion and ambient concentrations of SO_2, NO_2 and PM_{10} in 2015. Predicted annual SO_2 and NO_2 concentrations were well below the NAAQS of 50 µg/m^3 and 40 µg/m^3 respectively and the highest concentrations were predicted in the CDB, Alton and Brakenham. Predicted ambient PM_{10} concentrations exceeded the annual NAAQS of 40 µg/m^3 over parts of the Port and adjacent areas and were attribute mainly to coal storage and handling.

The short comings of the cumulative dispersion modelling assessment must be noted. As a result of these it must be emphasised that the findings, while indicative, are not representative of the current airshed.

6.2 Dispersion Modelling

6.2.1 Models used

A Level 3 air quality assessment must be conducted in situations where the purpose of the assessment requires a detailed understanding of the air quality impacts (time and space variation of the concentrations) and when it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types and chemical transformations (DEA, 2014b). A Level 3 assessment may be used in situations where there is a need to evaluate air quality consequences under a permitting or environmental assessment process for large industrial developments that have considerable social, economic and potential environmental consequences. Under these circumstances, the proposed Karpowership project clearly demonstrates the need for a Level 3 assessment.

The CALPUFF suite of models are approved by the US EPA (http://www.src.com/calpuff/calpuff1.htm) and by the DEA for Level 3 assessments (DEA, 2014b). It consists of a meteorological pre-processor, CALMET, the dispersion model, CALPUFF, and the post-processor, CALPOST. It is an appropriate air dispersion model for the purpose of this assessment as it is well suited to simulate dispersion from several sources. It also has capability to simulate dispersion in the atmosphere's complex land-sea interface.

More information about the model can be found in the User's Guide for the CALPUFF Dispersion Model (US EPA, 1995).

The Air Pollution Model (TAPM) (Hurley, 2000; Hurley et al., 2001; Hurley et al., 2002) is used to model surface and upper air metrological data for the study domain. TAPM uses global gridded synoptic-scale meteorological data with observed surface data to simulate surface and upper air meteorology at given locations in the domain, taking the underlying topography and land cover into account. The global gridded data sets that are used are developed from surface and upper air data that are submitted routinely by all meteorological observing stations to the Global Telecommunication System of the World Meteorological Organisation. TAPM has been used successfully in Australia where it was developed (Hurley, 2000; Hurley et al., 2001; Hurley et al., 2002). It is an ideal tool for modelling applications where meteorological data does not adequately meet requirements for dispersion modelling. TAPM modelled output data is therefore used to augment the site-specific surface meteorological data for input to CALPUFF.

6.2.2 TAPM and CALPUFF parameterisation

The TAPM diagnostic meteorological model is used to generate a 3-dimensional temporally and spatially continuous meteorological field for 2017, 2018 and 2019 in hourly increments for the modelling domain.

TAPM is set-up in a nested configuration of three domains, centred on the Port of Richards Bay. The outer domain is 720 km by 720 km at a 24 km grid resolution, the middle domain is 360 km by 360 km at a 12 km grid resolution and the inner domain is 90 km by 90 km at a 3 km grid resolution (Figure 10). The nesting configuration ensures that topographical effects on meteorology are captured and that meteorology is well resolved and characterised across the boundaries of the inner domain. Twenty-seven vertical levels are modelled in each nest from 10 m to 5 000 m, with a finer resolution in the lowest 1 000 m. The subset of the entire TAPM model output in the form of pre-processed gridded surface meteorological data fields is input into the dispersion model.

The 3-dimensional TAPM meteorological output on the inner grid includes hourly wind speed and direction, temperature, relative humidity, total solar radiation, net radiation, sensible heat flux, evaporative heat flux, convective velocity scale, precipitation, mixing height, friction velocity and Obukhov length. The spatially and temporally resolved TAPM surface and upper air meteorological data is used as input to the CALPUFF meteorological pre-processor, CALMET.

The CALPUFF modelling domain covers an area of 1 600 km^2, where the domain extends 40 km (west-east) by 40 km (north-south) (Figure 10). It consists of a uniformly spaced receptor grid with 0.5 km spacing, giving 6 400 grid cells (80 x 80 grid cells).

The topographical and land use for the respective modelling domains is obtained from the dataset accompanying the Commonwealth Scientific and Industrial Research Organisation (CSIRO) The Air Pollution Model (TAPM) modelling package (CSIRO, 2008). This dataset includes global terrain elevation and land use classification data on a longitude/latitude grid at 30-second grid spacing from the US Geological Survey, Earth Resources Observation Systems (EROS) Data Center.

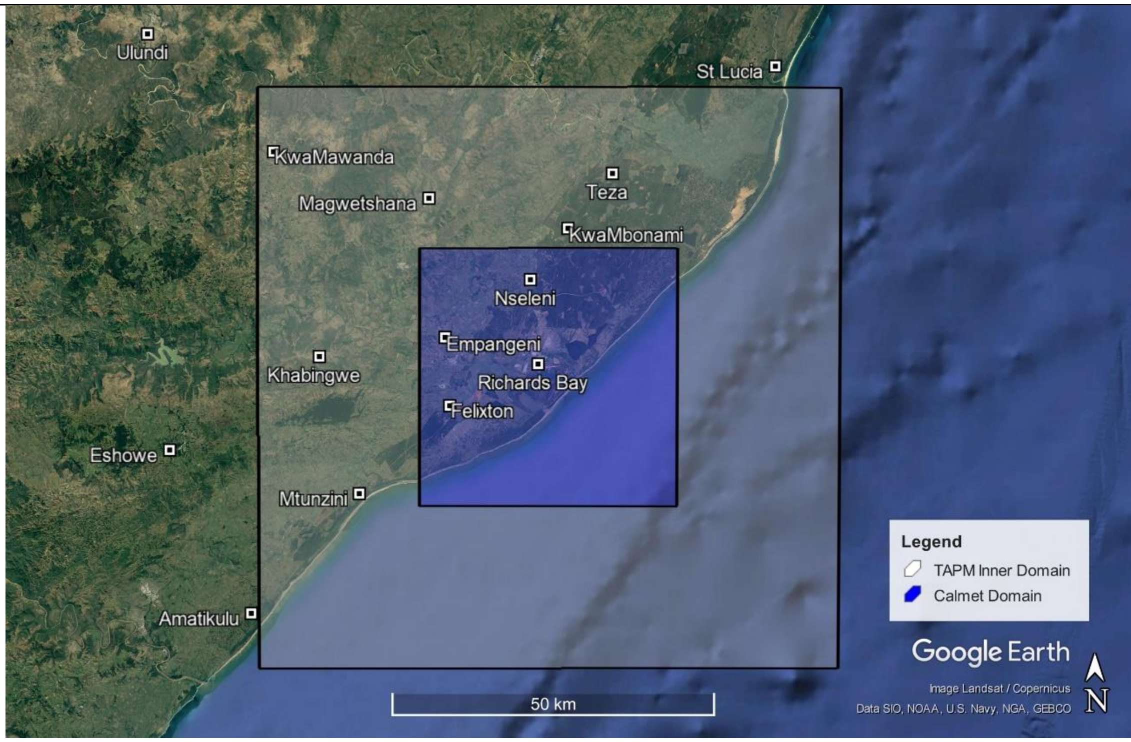

Figure 10: TAPM and CALPUFF modelling

The parameterisation of key variables that will apply in CALMET and CALPUFF are indicated in Table 20 and Table 21 respectively.

Table 20: Parameterisation of key variables for CALMET

Parameter	Model value
12 vertical cell face heights (m)	0, 20, 40, 80, 160, 320, 640, 1000, 1500, 2000, 2500, 3000, 4000
Coriolis parameter (per second)	0.0001
Empirical constants for mixing height equation	Neutral, mechanical: 1.41 Convective: 0.15 Stable: 2400 Overwater, mechanical: 0.12
Minimum potential temperature lapse rate (K/m)	0.001
Depth of layer above convective mixing height through which lapse rate is computed (m)	200
Wind field model	Diagnostic wind module
Surface wind extrapolation	Similarity theory

Parameter	Model value
Restrictions on extrapolation of surface data	No extrapolation as modelled upper air data field is applied
Radius of influence of terrain features (km)	5
Radius of influence of surface stations (km)	Not used as continuous surface data field is applied

Table 21: Parameterisation of key variables for CALPUFF

Parameter	Model value
Chemical transformation	Default NO_2 conversion factor is applied
Wind speed profile	Urban
Calm conditions	Wind speed < 0.5 m/s
Plume rise	Transitional plume rise, stack tip downwash, and partial plume penetration is modelled
Dispersion	CALPUFF used in PUFF mode
Dispersion option	Pasquill-Gifford coefficients are used for rural and McElroy-Pooler coefficients are used for urban
Terrain adjustment method	Partial plume path adjustment

6.2.3 Model accuracy

Air quality models attempt to predict ambient concentrations based on "known" or measured parameters, such as wind speed, temperature profiles, solar radiation and emissions. There are however, variations in the parameters that are not measured, the so-called "unknown" parameters as well as unresolved details of atmospheric turbulent flow. Variations in these "unknown" parameters can result in deviations of the predicted concentrations of the same event, even though the "known" parameters are fixed.

There are also "reducible" uncertainties that result from inaccuracies in the model, errors in input values and errors in the measured concentrations. These might include poor quality or unrepresentative meteorological, geophysical and source emission data, errors in the measured concentrations that are used to compare with model predictions and inadequate model physics and formulation used to predict the concentrations. "Reducible" uncertainties can be controlled or minimised. This is done by using accurate input data, preparing the input files correctly, checking and re-checking for errors, correcting for odd model behaviour, ensuring that the errors in the measured data are minimised and applying appropriate model physics.

Models recommended in the DEA dispersion modelling guideline (DEA, 2014b) have been evaluated using a range of modelling test kits (http://www.epa.gov./scram001). CALPUFF is one of the models that have been evaluated and it is therefore not mandatory to perform any modelling evaluations. Rather the accuracy of the modelling in this assessment is enhanced by every effort to minimise the "reducible" uncertainties in input data and model parameterisation.

6.2.4 Background Concentrations and other sources

A background concentration refers to the portion of the ambient concentration of a pollutant due to sources, both natural and anthropogenic, other than the source being assessed.

In the assessment the annual average ambient concentrations of PM_{10} (Figure 8) and SO_2 (Figure 9) at the RBCAA monitoring stations are used as background concentrations to gauge the potential additive effect of the Karpowership Project emissions in the Richards Bay area.

6.2.5 *Assessment scenarios*

To assess the potential impacts of the Karpowership Project on ambient air quality, the three components of the operation are assessed collectively, i.e. the Powership, the FSRU and the LNG resupply vessels.

6.3 Dispersion Modelling Results

The dispersion modelling results are presented in the following sections for SO_2, NO_2 and PM_{10}. First the maximum predicted ambient concentrations are presented in Section 6.3.1. An explanation of the model output is provided in Section 6.3.2, followed by the dispersion modelling results presented as isopleth maps.

6.3.1 Maximum predicted ambient concentrations

The maximum predicted annual SO_2, NO_2 and PM_{10} concentrations and the 99th percentile of the 24-hour and 1-hour predicted concentrations are listed in Table 22. In all cases the predicted maximum concentrations are very low and are well below the respective NAAQS, also shown in Table 22.

Table 22: Maximum predicted ambient annual SO_2, NO_2 and PM_{10} concentrations in µg/m^3 and the predicted 99th percentile concentrations for 24-hour and 1-hour averaging periods, with the South African NAAQS

	SO_2		
Description	**Annual**	**24-hour**	**1-hour**
Predicted maximum SO_2	0.07	0.34	0.94
NAAQS	50	125	350
	NO_2		
Predicted maximum NO_2	1.3		19.0
NAAQS	40		200

	PM_{10}		
Predicted maximum PM_{10}	0.33	1.7	
NAAQS	40	75	

6.3.2 Isopleth maps

Maps of predicted ambient SO_2, NO_2 and PM_{10} concentrations are presented in the following sections in Figure 11 to Figure 16. The predicted concentrations are shown as isopleths, lines of equal concentration, in μg/m^3 for the respective NAAQS averaging periods. The isopleths are depicted as white lines on the various maps.

The prevailing winds over the Port of Richards Bay largely dictate the dispersion of pollutants from the three components of the Karpowership Project. This is best illustrated by the wind roses at Richards Bay airport (Figure 7).

Dispersion occurs in two predominant sectors from the Karpowership Project. The first is to the sector is south (S) to south-southwest (SW) because of the prevailing northerly to northeasterly winds. The second is the sector north-northeast (NNE) to northeast (NE) because of the southwesterly winds.

6.3.2.1 Sulphur dioxide (SO_2)

The predicted SO_2 concentrations are very low relative to the NAAQS in the modelling domain which includes the Port of Richards Bay and surrounding areas. No exceedances of the NAAQS for SO_2 are predicted. The predicted annual average concentrations are shown in Figure 11, with the 99th percentile of the 24-hour concentrations in Figure 12 and the 99th percentile of the 1-hour concentrations in Figure 13.

In all these cases the area of maximum predicted concentrations occur to the northeast of the Port of Richards Bay over the industrial area, and to the southwest over part of the Port of Richards Bay and naturally vegetated areas. At the point of the predicted maximum, the Karpowership Project will add less than 1 μg/m^3 to the existing annual, 24-hour and 1-hour ambient concentrations.

Current ambient SO_2 concentrations are low relative to the NAAQS (Section 6.1.3). The additive effect to the existing SO_2 concentrations will be less than 1 μg/m^3 throughout the assessment area. The additive effect of the emissions from the Karpowership Project on ambient SO_2 concentrations is therefore predicted to be very small and will not result in exceedances of the NAAQS.

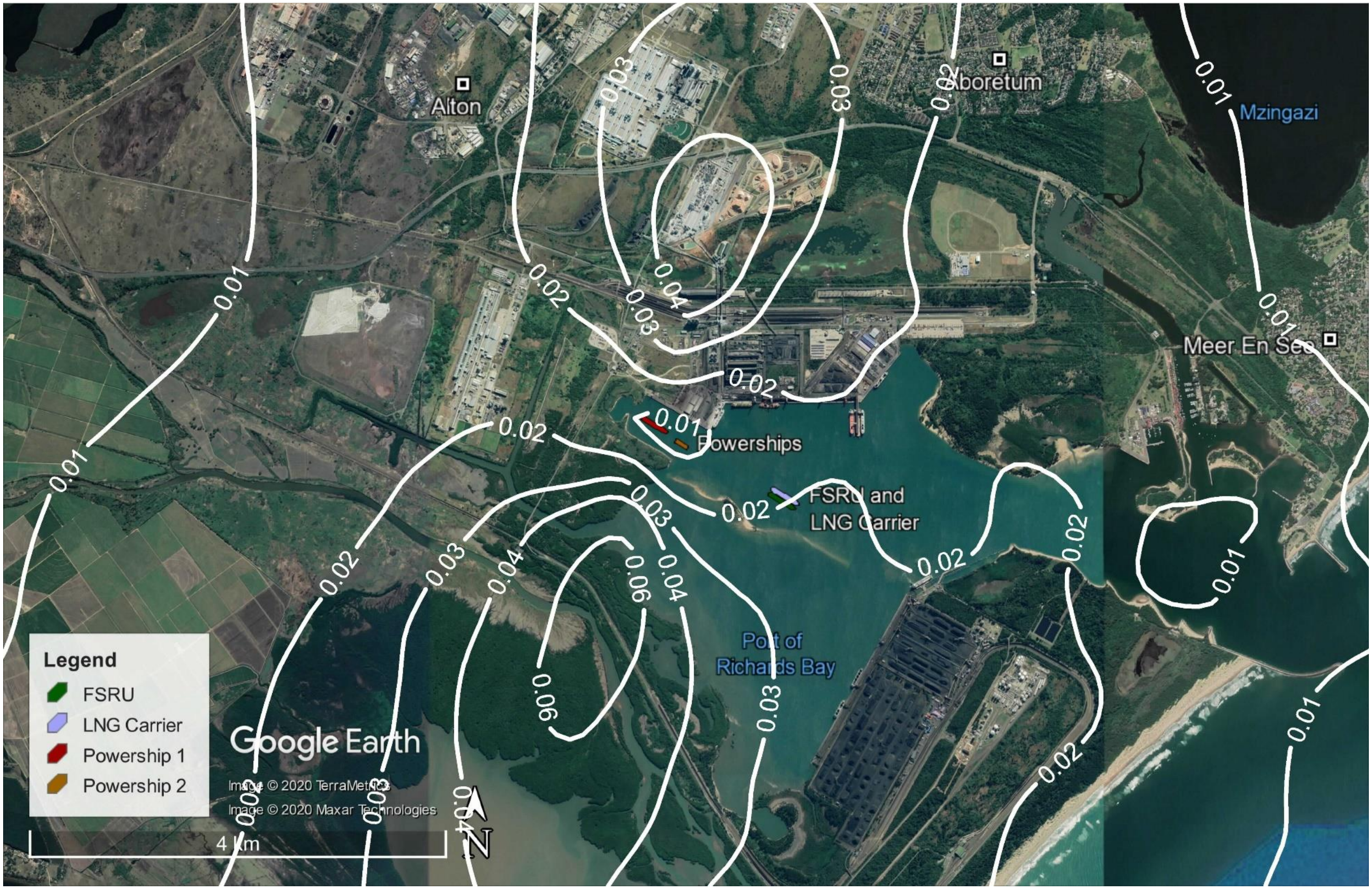

Figure 11: Predicted annual average SO_2 concentrations in µg/m^3 resulting from emissions from the Karpowership Project

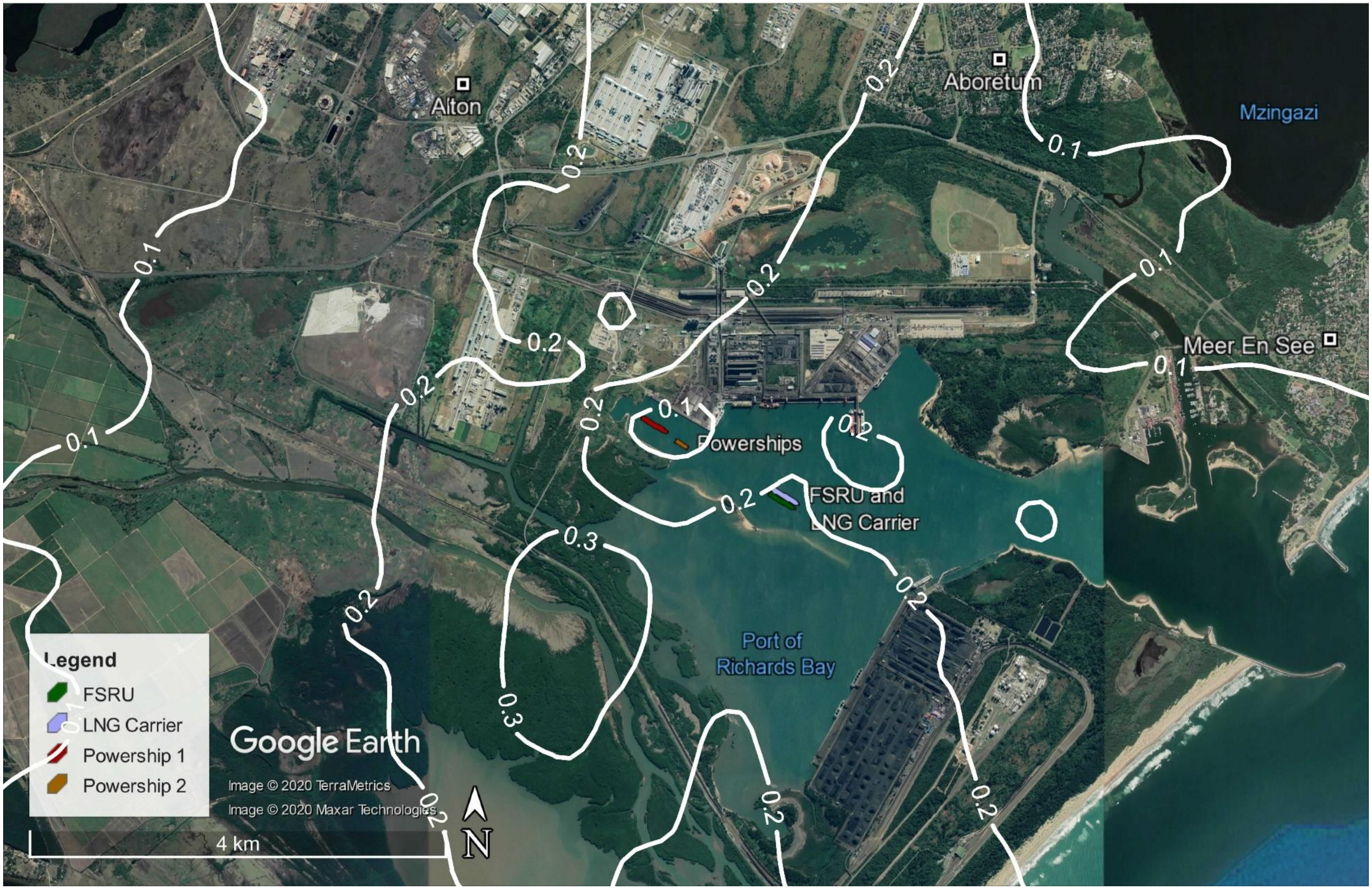

Figure 12: Predicted 99th percentile 24-hour SO_2 concentrations in µg/m^3 resulting from emissions from the Karpowership Project

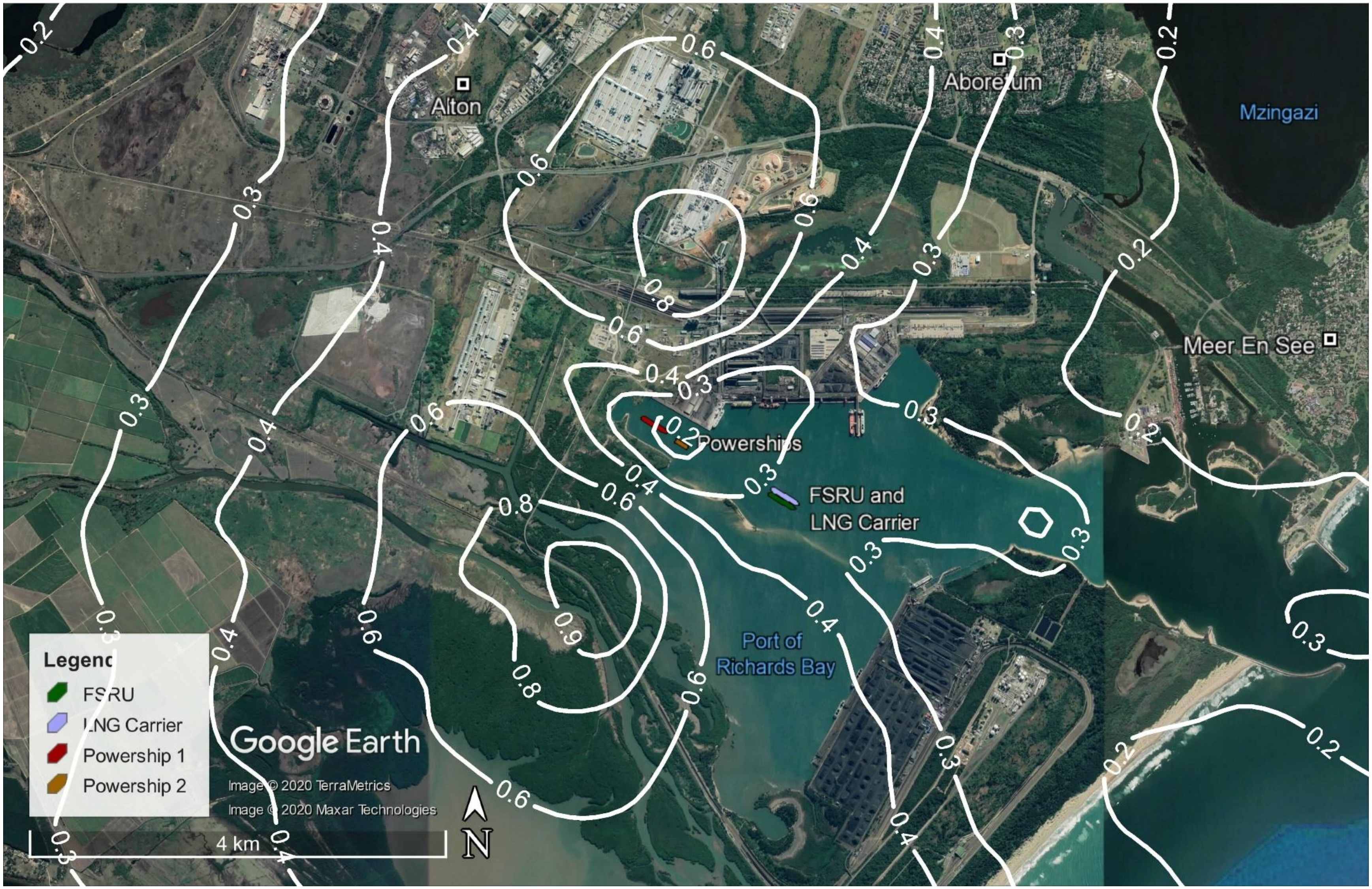

Figure 13: Predicted 99th percentile 1-hour SO_2 concentrations in µg/m³ resulting from emissions from the Karpowership Project

6.3.2.2 Nitrogen dioxide (NO_2)

The predicted NO_2 concentrations are very low relative to the NAAQS throughout the modelling domain which included the Port of Richards Bay and the surrounding areas. There are no predicted exceedances of the NAAQS for NO_2. The predicted annual average concentrations are shown in Figure 14, with the 99th percentile of the 1-hour concentrations in Figure 15.

The highest predicted ambient concentrations occur within 2 km north-northeast of the Karpowership Project over the industrial area, and within 2 km to the south-southwest over parts of the Port of Richards Bay and naturally vegetated areas.

At the point of predicted maximum concentrations 1.3 $\mu g/m^3$ will be added to the existing annual ambient concentrations and a maximum of 19.0 $\mu g/m^3$ will be added to the 1-hour concentrations. The additive effect will be less than this elsewhere in the Port of Richards Bay and the assessment area where predicted ambient concentrations are much lower. The additive effect of the emissions from the Karpowership Project on ambient NO_2 concentrations is small and is unlikely to result in exceedances of the NAAQS.

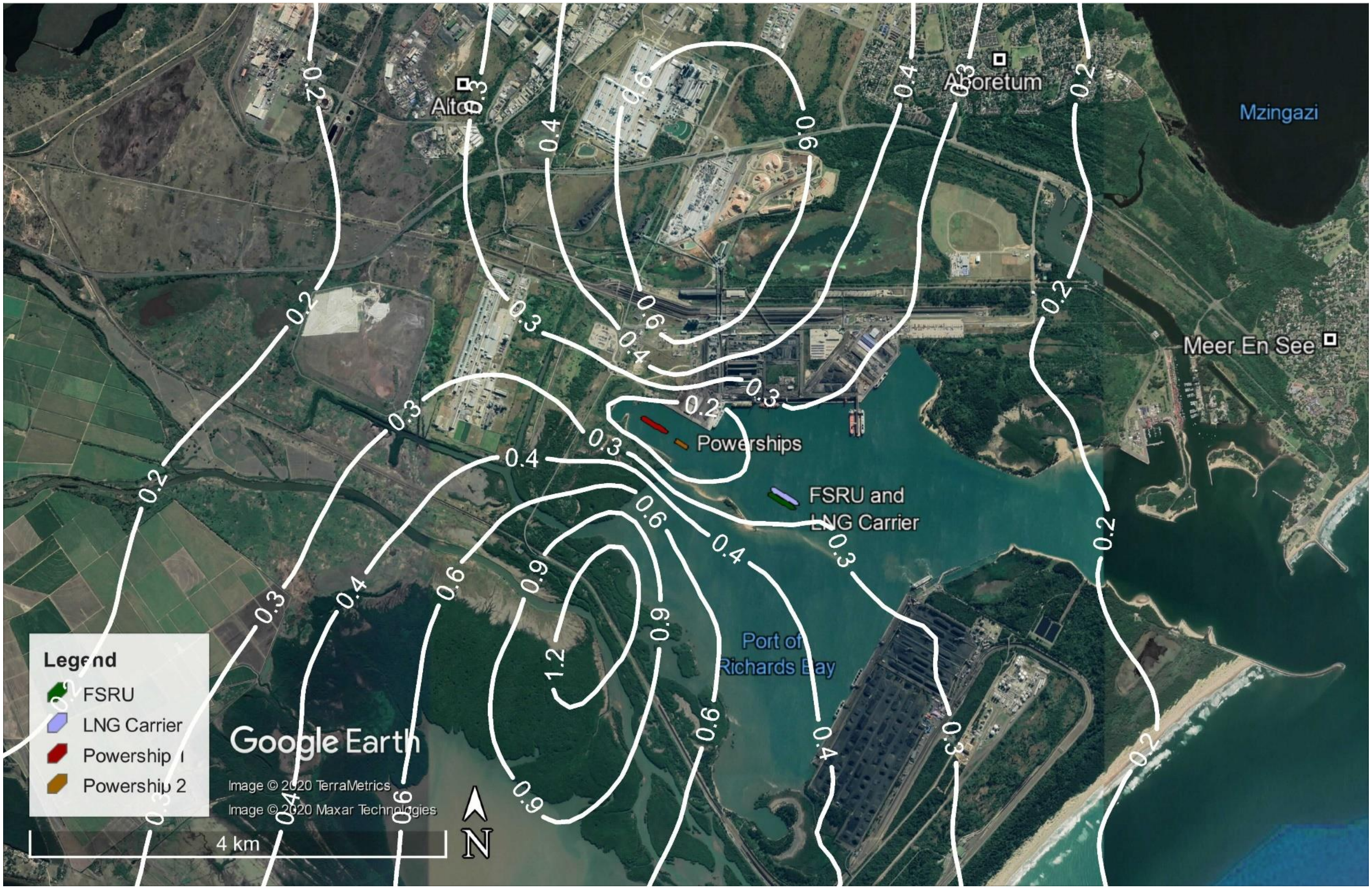

Figure 14: Predicted annual average NO_2 concentrations in µg/m^3 resulting from emissions from the Karpowership Project

Figure 15: Predicted 99th percentile 1-hour NO_2 concentrations in µg/m³ resulting from emissions from the Karpowership Project

6.3.2.3 Particulates (PM_{10})

The predicted PM_{10} concentrations are very low relative to the NAAQS throughout the modelling domain which included the Port of Richards Bay and the surrounding areas. Therefore there are no predicted exceedances of the NAAQS for PM_{10}. The predicted annual average concentrations are shown in Figure 16, with the 99th percentile of the 1-hour concentrations in Figure 17.

The highest predicted ambient concentrations occur within 2 km north-northeast of the Karpowership Project over the Port of Richards Bay and the industrial area, and to the south-southwest over parts of the Port of Richards Bay and natural areas.

Ambient PM_{10} concentrations have been shown to have increased in Richards Bay over the last three years, but these remain well below the NAAQS (Section 6.1.2). At the point of maximum predicted ambient concentrations, the Karpowership Project will add less than 1 $\mu g/m^3$ to the existing annual ambient concentrations and will add a maximum of 1.7 $\mu g/m^3$ to the 24-hour concentrations. The additive effect will be less than this elsewhere in the modelling domain where predicted ambient concentrations are lower. The additive effect of the emissions from the Karpowership Project on ambient PM_{10} concentrations is small and is unlikely to result in exceedances of the NAAQS.

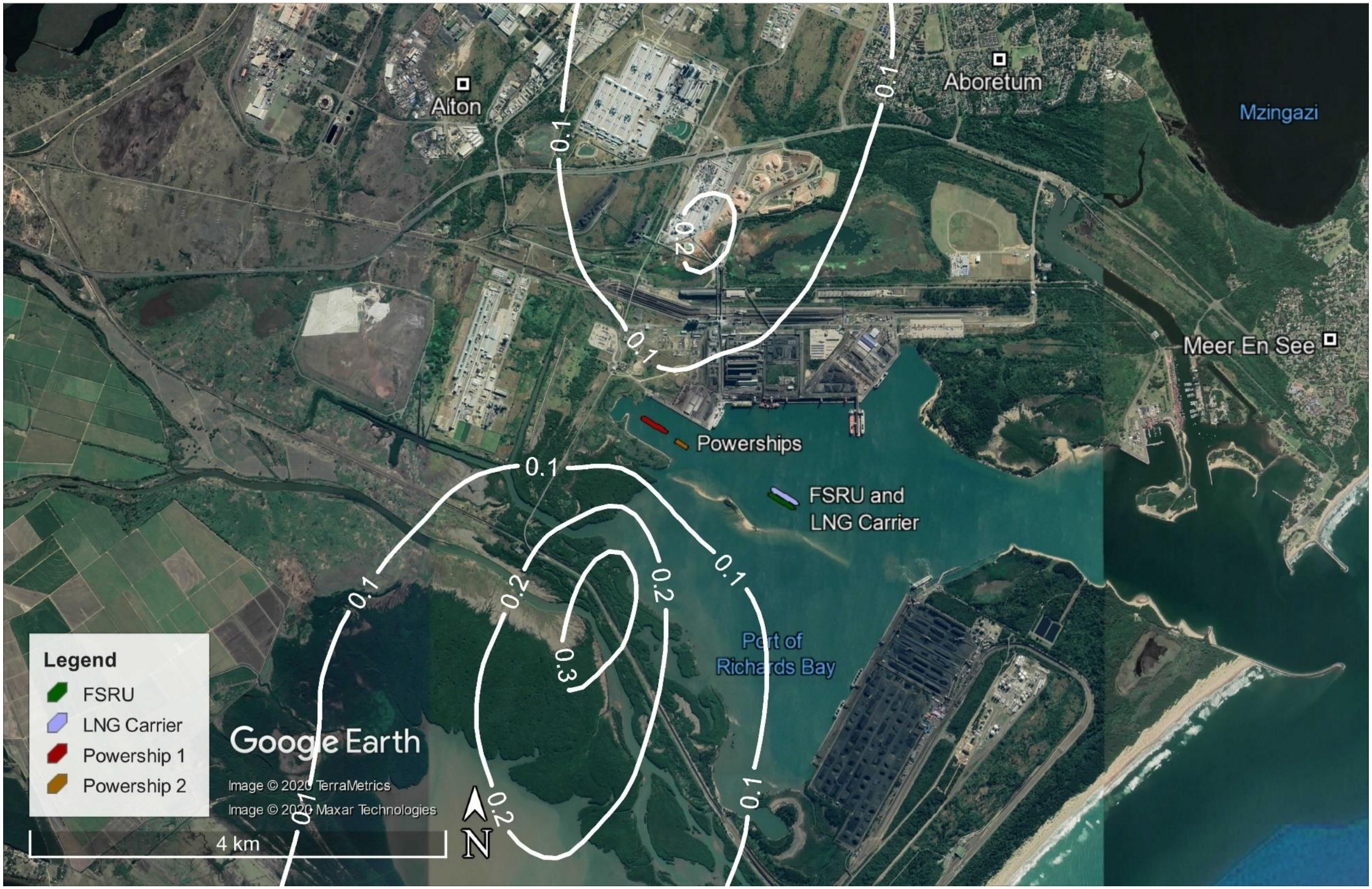

Figure 16: Predicted annual average PM_{10} concentrations in µg/m^3 resulting from emissions from the Karpowership Project

Figure 17: Predicted 99th percentile of the 24-hour PM_{10} concentrations in µg/m³ resulting from emissions from the Karpowership Project

6.4 Impact Assessment

6.4.1 Impact Rating Methodology

The NEMA EIA Regulations (DEA, 2014a) describe the significance of environmental impacts considering the consequence of the impact and the likelihood of the impact occurring.

The consequence of an impact is the sum of the severity of the impact, the duration of the impact and spatial scale of the impact (Table 23). The rating of these parameters is based on the findings of the assessment and professional judgement of specialists. The likelihood of an impact is the sum of the sum of the frequency of the activity causing the impact and the probability of the impact occurring (Table 24).

Table 23: Consequence of impacts (adapted for air quality assessment)

Severity	1 – Insignificant / Non-harmful 2 – Small / Potentially harmful 3 – Significant / Slightly harmful 4 – Great / Harmful 5 – Disastrous / Extremely harmful	-Very low ambient concentrations -Compliance with NAAQS -Exceedances of NAAQS Limit Value -Exceedance of NAAQS -Widescale exceedance of NAAQS
Duration	1 – Up to 1 month 2 – 1 month to 3 months 3 – 3 months to 1 year 4 – 1 to 10 years 5 – Beyond 10 years / Permanent	
Spatial Scale	1 – Immediate, fully contained area 2 – Surrounding area 3 – Within business unit area or responsibility 4 – Within mining boundary area / Beyond BU boundary 5 – Regional, National, International	-Project site -Port of Richards Bay -Port of Richards Bay -Beyond Port of Richards Bay -Beyond NMBMM
Overall Consequence = (Severity + Duration + Extent) / 3		

Table 24: Likelihood of impacts

Frequency of the Activity	1 – Once a year or once / more during operation / LOM 2 – Once / more in 6 months 3 – Once / more a month 4 – Once / more a week 5 – Daily / hourly
Probability of the Incident / Impact	1 – Almost never / almost impossible 2 – Very seldom / highly unlikely 3 – Infrequent / unlikely / seldom 4 – Often / regularly / likely / possible 5 – Daily / highly likely / definitely
Overall Likelihood = (Frequency + Probability) / 2	

The product of the consequence and the likelihood provides the overall significance of the impact which is rated in one of five bands from Very Low to Medium-High (Table 25).

Table 25: Significance of impact

Significance = Consequence X Likelihood	
0 - 2.9	Very Low
3 - 4.9	Low
5 - 6.9	Medium - Low
7 - 8.9	Medium
9 - 10.9	Medium - High

The status of the impact is positive or negative and the confidence in the assigned impact significance rating is rated from Low to High (Table 26).

Table 26: Impact status and confidence classification

Status of impact	
Indication whether the impact is adverse (negative) or beneficial (positive).	+ ve (positive – a 'benefit')
	– ve (negative – a 'cost')
Confidence of assessment	
The degree of confidence in predictions based on available information, specialist judgment and/or specialist knowledge.	Low
	Medium
	High

The reversibility of an impact is defined as the ability of an impact to be changed from a state of affecting aspects to a state of not affecting aspects; and refers to the degree to which an impact can be reversed (Table 27).

Table 27: Reversibility of Impact

	Reversibility	**Score**	**Description**
Reversibility	Completely reversible	1	Will reverse with minimal rehabilitation and negligible residual effects
	Partly reversible	2	Impacts can be reversed through the implementation of mitigation measures
	Irreversible	3	Impacts are permanent and cannot be reversed by the implementation of mitigation measures or rehabilitation is not viable

The irreplaceability of an impact is defined as the amount of resources that can or cannot be replaced; and refers to the degree to which an impact may cause irreplaceable loss of resources (Table 28).

Table 28: Irreplaceability of Impact

Irreplaceability	No loss	No loss of any resources
	Low	Marginal loss of resources
	Medium	Significant loss of resources
	High	Complete loss of resources

6.4.2 *Impact assessment*

6.4.2.1 Karpowership alone and with existing sources

The air quality impact associated with the proposed Karpowership Project is assessed based on the predicted ambient SO_2, NO_2 and PM_{10} concentrations using the methodology described above. The Karpowership Project is assessed *alone* and the *cumulative effect of the project on ambient air quality* in the Port of Richards Bay is assessed.

Impact status

Emissions of SO_2, NO_X and particulates form the sources associated with the Karpowership Project result in an increase in ambient concentration of SO_2, NO_2 and PM_{10}. Exposure to air pollutants through inhalation poses a health risk, regardless of the concentration.

The status of the impact is therefore negative for Karpowership alone and cumulatively with other sources.

Impact confidence

The assessment is based on reliable emissions data, reliable meteorological data and applies the DEA recommended dispersion modelling principles (DEA, 2014b). The assessment team has significant experience and is familiar with the project site and the powership concept.

The confidence in the impact assessment is therefore high for the Karpowership alone and cumulatively with other sources.

Severity

The severity of the impact of the Karpowership Project emissions on ambient air quality is assessed by comparing the predicted SO_2, NO_2 and PM_{10} concentrations with the health-based NAAQS.

The predicted ambient SO_2 concentrations are very low relative to the NAAQS. The maximum predicted concentrations are less than 1% of the limit value of the NAAQS. *The severity of the impact associated with SO_2 is therefore predicted to be insignificant for the Karpowership project alone.*

The predicted ambient NO_2 concentrations are low relative to the NAAQS. The maximum predicted annual concentrations are less than 5% of the NAAQS limit value while the maximum predicted 24-hour concentrations are 16% of the NAAQS. There are no predicted exceedances of the NAAQS. *The severity of the impact associated with NO_2 for the Karpowership Project is therefore predicted to be low for the Karpowership project alone.*

The predicted PM_{10} concentrations are very low, with the maximum concentrations less than 1% of the limit value of the NAAQS. *The severity of the impact associated with PM_{10} is therefore predicted to be insignificant for the Karpowership project alone.*

Monitoring has shown ambient SO_2 concentrations as relatively low in the Richards Bay and below the NAAQS. The additive effect of the contribution of SO_2 from the Karpowership Project is predicted to be very small and the potential increase in ambient SO_2 concentrations is highly unlikely to result in exceedances of the NAAQS. *The severity of the cumulative impact of SO_2 is therefore predicted to be insignificant for the Karpowership project with other sources.*

The additive effect of the contribution of NO_2 from the Karpowership Project is predicted to be very small and the potential increase in ambient NO_2 concentrations is highly unlikely to result in exceedances of the NAAQS. *The severity of the cumulative impact associated with NO_2 is therefore predicted to be low for the Karpowership project with other sources.*

Monitoring has shown that ambient PM_{10} concentrations are relatively high because of high regional background concentrations. The additive effect of the contribution PM_{10} from the Karpowership Project is predicted to be very small and the potential increase in ambient PM_{10} concentrations is highly unlikely to result in further exceedances of the NAAQS. *The severity of the cumulative impact of PM_{10} is therefore predicted to be insignificant for the Karpowership project with other sources.*

Duration

The duration of the impact of the Karpowership Project emissions on ambient air quality depends on the life of the project. The impacts will exist while the project is operational. *It is assumed that this will be more than 10 years.*

The duration will be the same for the cumulative impact, i.e. while the Karpowership Project is in operation.

Spatial scale

The spatial scale of the impact of the Karpowership Project emissions on ambient air quality is assessed by evaluation the spatial extent of predicted SO_2, NO_2 and PM_{10} concentrations.

In all cases the predicted ambient concentrations are low relative to the NAAQS and the highest predicted concentrations occur over the Port of Richards Bay, the industrial area to the northeast and naturally vegetated areas to the southwest. *The spatial scale of the impact* *is limited to the Port of Richards Bay and the immediate surrounding areas for the Karpowership project alone, as well as the cumulative impact with other sources.*

Consequence

Consequence is a function of the severity, duration, and spatial scale. The severity is very low for SO_2 and PM_{10}, and low for NO_2. The duration will be for life of the project, and the spatial scale is limited to the Port of Richards Bay. *The consequence of ambient concentrations of SO_2, NO_2 and PM_{10} resulting from emissions from the Karpowership Project is therefore predicted to be low. The consequence of the addition of to existing ambient concentrations, i.e. the cumulative effect, is also low.*

Frequency

The predicted ambient concentrations of SO_2, NO_2 and PM_{10} are very low. The highest predicted concentrations are well below the respective NAAQS. *Impacts are unlikely to occur and the frequency is therefore predicted to be very low*. *The addition to existing ambient concentrations is unlikely to result in exceedances of the NAAQS. The frequency rating is therefore also low for the cumulative effects.*

Probability

The predicted ambient concentrations of SO_2, NO_2 and PM_{10} are very low. The highest predicted concentrations are well below the respective NAAQS and occur over the Port of Richards Bay. *The probability of impacts occurring is unlikely and is therefore predicted to be almost never for Karpowership alone and cumulative with existing sources.*

Likelihood

Likelihood is a function of frequency and probability. These are both low for SO_2, NO_2 and PM_{10} so the *likelihood of air quality impacts occurring is also low* for Karpowership alone and cumulatively with existing sources.

Reversibility

The predicted ambient concentrations of SO_2, NO_2 and PM_{10} are very low and well below the respective NAAQS. *Air quality impacts occurring in the ambient environment are therefore expected to reverse with minimal rehabilitation and negligible residual effects, and is therefore considered to be completely reversible for Karpowership alone and cumulatively with existing sources.*

Irreplaceability

The predicted ambient concentrations of SO_2, NO_2 and PM_{10} are very low and well below the respective NAAQS. *Air quality impacts occurring in the ambient environment are therefore* *not expected to incur a loss of any resources for Karpowership alone and cumulatively with existing sources.*

Significance

Significance is a function of consequence and likelihood. For SO_2 and PM_{10} the consequence of impacts is very low, and is low for NO_2. With a low likelihood of occurrence of impacts associated with SO_2, NO_2 and PM_{10}, *the significance of any impacts is predicted to be very low* for all three pollutants.

6.4.2.1 Karpowership with other gas-to-power projects

The Department of Mineral Resources and Energy launched the Risk Mitigation Independent Power producers Programme (RMIPPPP) in August 2020 to procure 2 000 MW of new generation from a range of energy technologies. The objective being to fill the short-term supply gap, alleviate the current electricity supply constraints and reduce the extensive use of diesel-based peaking generators.

Besides the Karpowership Project, it is reasonable to expect that other electricity generation project may be procured in Richards Bay as part of the RMIPPPP. It is therefore relevant to assess the potential cumulative effects of these project on ambient air quality in Richards Bay. Three potential project have been identified for the assessment of cumulative impacts (Table 29).

Table 29: Potential electricity generation project in Richards Bay

Project name and description	Project description	Applicant
RBGP2 400MW gas to power project at the RBIDZ 1F	The project includes 6 gas turbines for mid-merit/peaking plant power provision, with 2 steam turbines utilizing the heat from the engineers in a separate steam cycle, as well as 3 fuel tanks of 2 000m³ each for on-site fuel storage.	Richards Bay Gas Power (Pty) Ltd
Nseleni Independent Floating Power Plant in the Port of Richards Bay near the old Bayside complex.	Floating gas powered power station made up of floating Combined Cycle Gas Turbine (CCGT) power plants and associated infrastructure for the evacuation of power from the NIFPP to the National Grid, in the Port of Richards Bay. Four Floating Power Barges generating a nominal 700 MW per barge resulting in 2 800 MW generation capacity.	Nseleni Power Corporation (Pty) Ltd and Anchor Energy (Pty) Ltd
Eskom 3 000 MV CCPP and associated infrastructure on Portion 2 of Erf 11376 and	The facility will operate with natural gas as the main fuel resource and diesel as a back-	Eskom Holdings SoC Limited

Project name and description	Project description	Applicant
Portion 4 of Erf 11376 within the RBIDZ Zone 1D.	up resource. The EAP is Savannah Environmental.	

RBGP2 400 MW gas to power project

Richards Bay Gas Power 2 (Pty) Ltd proposes the establishment of a gas to power plant with a generation capacity up to 400 MW with associated infrastructure Zone 1F in the Richards Bay IDZ. The RBGP2 Project will initially will require liquid fuel such as diesel or Liquefied Petroleum Gas (LPG) and ultimately Liquid Natural Gas (LNG) or Natural Gas (NG). Two operational scenarios were therefore assessed in the AIR (uMoya-NILU, 2016). These were Scenario 1: Power generation using diesel, including stack emissions and fugitive emissions from the diesel storage tanks and Scenario 2: Power generation using LNG via pipeline, including stack emissions only.

Located in the Richards Bay IDZ there are several commercial and residential areas within 5 km of the site. The maximum predicted ambient concentration of SO_2, NO_2 and PM_{10} resulting from emission from the two scenarios occur close to the project site and are very low compared to the respective NAAQS (Table 30).

Table 30: Maximum predicted annual average concentration and the 99th percentile concentration for the 24-hour and 1-hour predictions at the points of maximum ground-level concentration (uMoya-NILU, 2016a)

	SO_2 (µg/m^3)		
	Scenario 1: Diesel	**Scenario 2: LNG**	**NAAQS**
1-hour	7.19	3.43	350
24-hour	3.01	1.43	125
Annual	0.25	0.12	50
	NO_2 (µg/m^3) controlled in brackets		
	Scenario 1: Diesel	**Scenario 2: LNG**	
1-hour	50.15 (13.68)	18.66 (7.58)	200
Annual	1.71 (0.47)	0.64 (0.26)	40
	PM_{10} (µg/m^3)		
	Scenario 1: Diesel	**Scenario 2: LNG**	
24-hour	0.36	0.20	75
Annual	0.03	0.02	40

For Scenario 1 (diesel) and Scenario 2 (LNG) the impact on ambient air quality the significance of the impact of the RBGP2 project on ambient air quality was rated as very low for SO_2 and PM_{10} and low NO_X without and with mitigation**.**

Regarding cumulative impacts, the proposed RBGP2 plant is located in an area where there are many notable sources of SO_2, NO_2 and PM_{10}. Emissions of SO_2, NO_2 and PM_{10} from the combustion of diesel during Phase 1 and LNG during Phase 2 will increase the existing ambient concentrations of these pollutants in the immediate vicinity of the plant. The predicted ambient concentrations of SO_2, NO_2 and PM_{10} are however very low. The contribution to ambient concentrations beyond the immediate vicinity of the proposed gas to power plant is predicted to be small and is highly unlikely to make a significant contribution to the cumulative impacts. It is highly unlikely that they will result in exceedances of the NAAQS. The significance of the cumulative impact is therefore deemed to be a low (Table 32).

Nseleni Independent Floating Power Plant

Nseleni Power Corporation (Pty) Ltd is proposing to establish a floating gas powered power station consisting of floating Combined Cycle Gas Turbine (CCGT) power plants (known as the Nseleni Independent Floating Power Plant (NFIPP)) and associated infrastructure for the evacuation of power from the NIFPP to the National Grid, in the Port of Richards Bay. The EIA is in process and is being led by SE Solutions (2020).

Initially four Floating Power Barges are proposed, 700 MW generated per barge resulting in a combined generation capacity of 2 800 MW. Thereafter, additional barges would be added to increase the combined power generation potential to as much as 8 400 MW. The fuel proposed is LNG. The power plants will be Combined Cycle Gas Turbines (CCGT) providing high generation efficiencies. The gas turbines have low NOx burners and selective catalytic reduction (SCR) to control NOx emissions and three stage filtration to remove respirable Particulate Matter (PM). Power will evacuated to a newly constructed land-based substation and switching yard and from there into the National Grid. Approximately 220 000 tonne of LNG will be delivered monthly to the NIFPP and would be offloaded from supply vessels into Floating Storage Units (FSU) connected to the LNG terminal.

The AIR for the NFIPP has not been completed. Without pre-empting the findings of the AIR, comment can be made on the potential impacts of the NIFPP on air quality. LNG is a clean burning fuel with negligible sulphur and particulates. Emissions of SO_2 and PM_{10} from the combustion of LNG are therefore very low. NO_X emissions will be controlled at source and emissions will comply with the Minimum Emission Standards for gas turbines. Ambient concentrations of SO_2, NO_2 and PM_{10} are therefore likely to be very low. With baseline ambient air quality in Richards Bay generally compliant with the NAAQS, except for PM_{10} at the Scopio monitoring station, it is highly unlikely that the contribution from the NFIPP will result in exceedances on the NAAQS for SO_2, NO_2 and $PM_{10.}$ Basing an opinion from experience with the AIR for Karpowership (uMoya-NILU, 2020a) and AIRs for other gas-to-power project using LNG, the significance in impacts are likely to be very low for SO_2 and PM_{10} and low for NO_2 (uMoya-NILU, 2016b; uMoya-NILU, 2020b) (Table 32).

Richards Bay CCPP

The Richards Bay Combined Cycle Power Plant (CCPP) involves the construction of a gas-fired power station which will supply electrical power to the National Grid. The proposed location is 7 km from the CBD and adjacent to Mondi Richards Bay. It will have an installed capacity of 3 000 MW and use natural gas with diesel as back-up fuel. Electricity generation will be via eight gas turbines and four Heat Recovery Steam Generators (HRSG) with four steam turbines.

The AIR was compiled by Airshed Planning Professionals (Airshed, 2019). Normal operations (gas) and three emergency scenarios when the HSRG and steam turbine are offline were assessed. In Emergency 1 gas is used and the emission is via the by-pass stack, Emergency 2 and Emergency 3 use diesel with emissions via the main stack and the by-pass stack respectively. Emergency events are expected to be less than 88 hours in a year, each less than 8 hours.

For PM_{10} for normal operations and emitting at Minimum Emission Standards no exceedances of the NAAQS were simulated and the predicted ambient concentrations were less than 3 µg/m^3 throughout the modelling domain. The predicted concentrations low for the three emergency scenarios, i.e. less than 2.0 µg/m^3 for Emergency 1, less than 3.6 µg/m^3 for Emergency 2, and less than 2.5 µg/m^3 for Emergency 3. For PM_{10} the significance of the impact was rated as low.

For SO_2 for normal operations and using emission factors for gas turbines for LNG, no exceedances of the NAAQS were simulated and the predicted 1-hour ambient concentrations were less than 0.7 µg/m^3, the predicted 24-hour concentrations were less than 0.21 µg/m^3 and the predicted annual ambient concentrations were less than 0.07 µg/m^3. For Emergency 2 exceedances of the NAAQS of 350 µg/m^3 are predicted up to 9 km from the plant. The predicted maximum SO_2 concentration for Emergency 1 and 3 of 207.4 µg/m^3 and 259.5 µg/m^3 comply with the NAAQS. For SO_2 the significance of the impact was rated as medium as a result of Emergency 2 and using diesel.

For NO_2 for normal operations no exceedances of the NAAQS were predicted. The annual predicted concentrations were less than 23 µg/m^3 and the hourly concentration less than 80 µg/m^3. For Emergency 3 exceedances of the NAAQS of 200 µg/m^3 are predicted up to 3.5 km from the plant. The predicted maximum NO_2 concentration for Emergency 1 and 2 of 25 µg/m^3 and 179.9 µg/m^3 comply with the NAAQS. For NO_2 the significance of the impact was rated as low.

Regarding cumulative impacts, emissions from the CCPP would elevate ambient concentrations and the significance of the cumulative impact was rated as medium for SO_2 and low for NO_2 and PM_{10} (Table 32).

Summary

The cumulative impacts on air quality of the three potential gas-to-power projects and the Karpowership Project may be assessed if it is assumed that the four project operate together. The significance of the impacts resulting from operations of the individual projects are presented in Table 32. The highest rating for an individual project is used to assess the potential cumulative impact of the four gas-to-power projects (Table 31).

For NO_2 and PM_{10} the significance of the cumulative impact of Karpowership with other gas-to-power projects is rated as low. For SO_2 the significance of the impact is rated as medium because of the predicted exceedances of ambient SO_2 concentrations during Emergency 2 simulation using diesel and emitting via the main stack (Airshed, 2019).

Table 31: Significance of project and cumulative impacts

Project	SO_2	NO_2	PM_{10}	Reference
Karpowership	Very low	Very low	Very low	uMoya-NILU (2020a)
RBGP2	Low	Low	Low	uMoya-NILU (2016a)
NIFPP	Very low	Low	Very low	Professional opinion
Richards Bay CCPP	Medium	Low	Low	Airshed (2019)
Cumulative impact	Medium	Low	Low	Highest rating

Table 32: Air quality impact scores

Description	Pollutants	Severity	Duration	Spatial scale	Consequence	Frequency	Probability	Likelihood	Significance	Status	Confidence	Reversibility	Irreplaceability
Karpowership Project	SO_2	1	4	1	2	1	1	1	**2 – Very low**	-ve	High	Completely reversible	No Loss
	NO_2	2	4	2	2.7	1	1	1	**2.7 - Very low**	-ve	High	Completely reversible	No Loss
	PM_{10}	1	4	1	2	1	1	1	**2 – Very low**	-ve	High	Completely reversible	No Loss
Cumulative assessment with existing sources	SO_2	1	4	1	2	1	1	1	**2 – Very low**	-ve	High	Completely reversible	No Loss
	NO_2	2	4	2	2.7	1	1	1	**2.7 – Very low**	-ve	High	Completely reversible	No Loss
	PM_{10}	1	4	1	2	1	1	1	**2 – Very low**	-ve	High	Completely reversible	No Loss
Cumulative assessment with other G2P projects	SO_2	2	4	3	3	1	1	2	**6 – Medium**	**-ve**	Medium	Completely reversible	No Loss
	NO_2	2	4	3	3	1	1	1	**3 – Low**	**-ve**	Medium	Completely reversible	No Loss
	PM_{10}	2	4	3	3	1	1	1	**3 – Low**	**-ve**	Medium	Completely reversible	No Loss

6.5 Analysis of Emissions' Impact on the Environment

This AIR has focused on potential human health impacts. An assessment of the atmospheric impact of the facility on the environment was therefore not undertaken as part of this AIR.

7. COMPLAINTS

Not relevant to this AIR as this is a proposed facility.

8. CURRENT OR PLANNED AIR QUALITY MANAGEMENT INTERVENTIONS

Air quality management interventions in the form of the control of emission have been considered in all aspects of design and operation. Further interventions to reduce emissions are deemed to be unnecessary considering the low impact of the project on air quality.

Routine emission measurements to demonstrate compliance with the Minimum Emission Standards may be stipulated by the Licensing Authority in the Atmospheric Emission License (AEL).

9. COMPLIANCE AND ENFORCEMENT ACTIONS

Not relevant to this AIR as this is a proposed facility.

10. SUMMARY AND CONCLUSION

The Karpowership Project at the Port of Richards Bay comprises the Khan Powership and Shark Powership combination, the FSRU and the LNG supply vessel. Each engine has have a dedicated stack, or point source. On the Khan Class Powership the 21 stacks are orientated along the vessel from bow to stern. On the Shark Class Powership the 6 stacks are orientated along the deck. LNG supply vessels will restock the FSRU approximately once every 20 to 30 days.

The DEA approved CALPUFF dispersion model is used to predict ambient concentrations of SO_2, NO_2 and PM_{10} resulting from the Karpowership Project emissions. Modelling is done according to the DEA modelling regulations and 3-years of hour surface and upper air meteorological data are use.

The maximum predicted annual SO_2, NO_2 and PM_{10} concentrations and the 99^{th} percentile of the 24-hour and 1-hour predicted concentrations are very low and are well below the respective NAAQS. The highest predicted ambient concentrations occur within 2 km over the industrial area northeast of the Port of Richards Bay and south-southwest of the project area over parts of the Port of Richards Bay and naturally vegetated areas.

The contribution from the Karpowership Project will add to the existing ambient concentrations in Richards Bay. The greatest addition will be at the point of maximum with lower concentrations elsewhere. The added effect is small and will not result in exceedances of the NAAQS.

With low predicted ambient concentrations for SO_2 and PM_{10} the consequence of impacts is very low. The predicted ambient NO_2 are somewhat higher, but the consequence of the impact is low. The likelihood of occurrence of impacts associated with SO_2, NO_2 and PM_{10} is very low. Therefore, the significance of impacts resulting from the Karpowership Project is predicted to be very low.

Contribution of the Karpowership Project to the existing ambient concentrations is very small. The cumulative effect of the Karpowership Project with existing sources is likely to be very low.

Air quality management interventions in the form of the control of emission have been considered in all aspects of design and operation. Further interventions to reduce emissions are deemed to be unnecessary considering the low impact of the project on air quality.

This atmospheric impact assessment was provided to all Specialists conducting assessments for the proposed Gas to Power Karpowership Project in the Port of Richards Bay. This report was specifically highlighted, for consideration, to the Specialists conducting the following studies: Noise, Socio-Economic Impacts, Tourism and Biodiversity.

From an air quality perspective, it is the reasonable opinion of the authors that the Karpowership Project should be authorised considering the findings of this AIR.

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12. FORMAL DECLARATIONS

A declaration of the accuracy of the information contained in this Atmospheric Impact Report is included here. A declaration of the independence of the practitioners in the uMoya-NILU consultancy team that compiled this AIR is also included.

DECLARATION OF ACCURACY OF INFORMATION – APPLICANT

Name of Enterprise: uMoya-NILU Consulting (Pty) Ltd

Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the Act

I, Mark Zunckel [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 office is a criminal office in terms of section 51(1)(g) of this Act.

Signed at Durban on this 10th day of October 2022.

SIGNATURE

Managing Director – uMoya-NILU Consulting
CAPACITY OF SIGNATORY

DECLARATION OF INDEPENDENCE – PRACTITIONER

Name of Practitioner: Mark Zunckel

Name of Registered Body: South African Council for Natural Scientific Professionals

Professional Registration Number: 400449/04

Declaration of independence and accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the Act

I, Mark Zunckel declare that I am independent of the applicant. I have the necessary expertise to conduct the assessment required for the report and 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 will disclose to the applicant and the air quality officer 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 air quality officer. The information provided in the 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 office is a criminal office in terms of section 51(1)(g) of this Act.

Signed at Durban on this 10th of Cctober 2022.

____
SIGNATURE

Managing Director – uMoya-NILU Consulting
CAPACITY OF SIGNATORY

ANNEXURE 1: NEMA REGULATION – APPENDIX 6

Specialist Reports as per the NEMA EIA Regulations, 2014 (as amended), must contain the information outlined in According to Appendix 6 (1) of the Regulations. Table A1 indicates where this information is included in the AIR.

Table A1: Prescribed contents of the Specialist Reports (Appendix 6 of the EIA Regulations, 2014)

Relevant section in GNR. 982	**Requirement description**	**Relevant section in this report**
(a) details of—	(i) the specialist who prepared the report; and	Section 2.7
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 2.7 & Annexure 2
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Section 12
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 1, 2.1 & 3.2
(cA)	an indication of the quality and age of base data used for the specialist report;	Section 5 & 6
(cB)	a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 6.1
(d)	the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Site investigation not applicable
(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 & 6.2
(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;	Section 6.3 & 6.4
(g)	an identification of any areas to be avoided, including buffers;	None identified
(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 6.3.2
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge; Note: Uncertainties should be qualified within the report – there will always be uncertainties due to gaps in knowledge should also be qualified – a gap is to record that not all knowledge can be obtained for a study.	Section 2.9
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 6.4
(k)	any mitigation measures for inclusion in the EMPr; Note: We need to include whether these mitigation measures (excluding ongoing monitoring) can be practically implemented prior to commencement or not.	Section 9
(l)	any conditions for inclusion in the environmental authorisation;	Section 9

Relevant section in GNR. 982	Requirement description	Relevant section in this report
(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;	Section 10
	(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; Note: We need to include whether these mitigation measures (excluding ongoing monitoring) can be practically implemented prior to commencement or not.	Section 10
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 1
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Addressed in April 2021 AIR
(q)	any other information requested by the competent authority.	Addressed in April 2021 AIR
(2)	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.	Section 1 & 6.2.1

ANNEXURE 2: CURRICULUM VITAE

MARK ZUNCKEL

Firm	:	uMoya-NILU (Pty) Ltd
Profession	:	Air quality consultant
Specialization	:	Air quality assessment, air quality management planning, air dispersion modelling, boundary layer meteorology, project management
Position in Firm	:	Managing director and senior consultant
Years with Firm	:	Since 1 August 2007
Nationality	:	South African
Year of Birth	:	1959
Language Proficiency	:	English and Afrikaans

EDUCATION AND PROFESSIONAL STATUS

Qualification	Institution	Year
National Diploma (Meteorology)	Technikon Pretoria	1980
BSc (Meteorology)	Univ. of Pretoria	1984
BSc Hons (Meteorology)	Univ. of Pretoria	1988
MSc	Univ. of Natal	1992
PhD	Univ. Witwatersrand	1999

Registered Natural Scientist: South African Society for Natural Scientific Professionals
Ex-Council Member: National Association for Clean Air
Member: National Association for Clean Air

EMPLOYMENT AND EXPERIENCE RECORD

Period	**Organisation details and responsibilities/roles**
1976 – May 1992	*South African Weather Bureau :* Observer, junior forecaster, senior forecast, researcher, assistant director
June 1992 – July 2007	*CSIR:* Consultant and researcher, Research group Leader: Atmospheric Impacts
August 2007 to present	*uMoya-NILU Consulting:* Managing Director and senior air quality consultant

Key and Recent Project Experience:

1996	Project leader & Principal researcher: Atmospheric impact assessment for the proposed Mozal aluminium smelter in Maputo, Mozambique.
1996	Project leader & Principal researcher: Dry sulphur deposition during the Ben MacDhui High Altitude Trace Gas and Transport Experiment (BATTEX) in the Eastern Cape.
1997	Project leader & Principal researcher: Atmospheric impact assessment of the proposed capacity expansion project for Alusaf in Richards Bay.
1997	Project leader & Principal researcher: The Uruguayan ambient air quality project with LATU.

1997	Principal researcher on the Air quality specialist study for the Strategic Environmental Assessment on the industrial and urban hinterland of Richards Bay.
1997	Project leader & Principal researcher: Feasibility study for the implementation of a fog detection system in the Cape Metropolitan area: Meteorological aspects.
2001	Project leader & Principal researcher: Air quality specialist study for the Environmental Impact Assessment for the proposed expansion of the Hillside Aluminium Smelter, Richards Bay.
2001-03	Researcher: The Cross Border air Pollution Impact (CAPIA) project. A 3-year modelling and impacts study in the SADC region.
2002	Project leader & Principal researcher: Air quality assessment specialist study for the proposed Pechiney Smelter at Coega.
2002	Project leader & Principal researcher: Air quality assessment specialist study for the proposed N2 Wild Coast Toll Road.
2002-05	Project leader on the NRF project – development of a dynamic air pollution prediction system
2004	Project leader on the specialist study for expansion at the Natal Portland Cement plant at Simuma, KwaZulu-Natal.
2004-05	Researcher: National Air Quality Management Plan implementation project for Department Environmental Affairs and Tourism.
2005	Researcher in the assessment of air quality impacts associated with the expansion of the Natal Portland Cement plant at Port Shepstone.
2006-07	Project team leader of a multi-national team to develop the National Framework for Air Quality Management for the Department of Environment Affairs and Tourism
2007	Air quality assessment for Mutla Early Production System in Uganda for ERM Southern Africa on behalf of Tullow Oil.
2007-10	Lead consultant on the development of a dust mitigation strategy fro the Bulk Terminal Saldanha and an ambient guideline for Fe_2O_3 dust for Transnet Projects and on-going monitoring.
2008	Lead consultant on the Air quality status quo assessment and scoping for the EIA for the Sonangol Refinery
2008-09	Lead consultant on the development of the air quality management plan for the Western Cape Provincial. Department of Environmental Affairs and Development Planning.
2008-10	Lead consultant on the development of the Highveld Priority Area air quality management plan for the Department of Environmental Affairs and Tourism.
2008	Lead consultant in the development of an odour management and implementation strategy for eThekwini, focussing on Wastewater Treatment Works and odourous industrial sources
2008&10	Lead consultant on the Air Quality Specialist Study for the EIA for the proposed Kalagadi Manganese Smelter at Coega
2008	Lead consultant on the Air Quality Assessment for the Proposed Construction and Operation of a Second Cement Mill at NPC-Cimpor, Simuma near Port Shepstone.
2008	Lead consultant on the Air Quality Specialist Study Report for the New Multi-Purpose Pipeline Project (NMPP) for Transnet Pipelines.
2008	Lead consultant on the Air quality assessment for the proposed UTE Power Plant and RMDZ coal mine at Moatize, Mozambique for Vale.
2008-09	Lead consultant on the Dust source apportionment study for the Coedmore region in Durban for NPC-Cimpor.
2009	Consultant on the Air quality specialist study for the upgrade of the Kwadukuza Landfill, KwaZulu-Natal
2009-10	Lead consultant on the Audit of ambient air quality monitoring programme and air quality training for air quality personnel at PetroSA
2010	Lead consultant on the Qualitative assessment of impact of dust on solar power station at Saldanha Bay

2010	Lead consultant on the Air quality specialist study for the EIA for the Kalagadi Manganese Smelter at Coega
2009-10	Lead consultant on the Air quality specialist study for the Environmental Management Framework for the Port of Richards Bay
2010	Lead consultant on the Air quality status quo assessment and abatement planning at Idwala Carbonates, Port Shepstone
2010	Lead consultant on the Air quality status quo assessment and abatement planning at Sappi Tugela, Mandeni
2010–11	Air quality status quo assessment and revision of the Air Quality Management Plan for City of Johannesburg
2010	Lead consultant on the Air quality status quo assessment and abatement planning at First Quantum Mining's Bwana Mkubwa and Kansanshi mines, Zambia
2010–11	Lead consultant on the Air quality specialist study for the EIA for the Alternative Fuel and Resources Project at Simuma, Port Shepstone
2010–11	Lead consultant on the Air quality specialist study for the EIA for the Coke Oven re-commissioning at ArcelorMittal Newcastle
2010	Qualitative air quality assessment for the EIA for the Mozpel sugar to ethanol project , Mozambique
2011	Development of the South African Air Quality Information System – Phase II The National Emission Inventory
2011	Ambient baseline monitoring for Riversdale's Zambezi Coal Project in Tete, Mozambique
2010-11	Ambient quality baseline assessment for the Ncondeze Coal Project, Tete Mozambique
2011-12	Air quality assessment for the mining and processing facilities at Longmin Platinum in Marikana
2012	Air quality assessment for the proposed LNG and OLNG plants in Mozambique
2012	Modelling study in Abu Dhabi for the transport and deposition of radio nuclides
2012	Air quality assessment for the proposed manganese ore terminal at the Ngqura Port
2012-13	Air quality management plan development for Stellenbosch Municipality
2012-12	Air quality management plan development for the Eastern Cape Province
2013	Air quality specialist for Tullow Oil Waraga-D and Kinsinsi environmental audit in Uganda
2013	Air quality specialist study for the EIA for the Thabametsi IPP station
2013	Air quality management plan for the Ugu District Municipality
2013-14	Air quality specialist study for the application for postponement of the minimum emission standards for 9 Eskom power stations
2014	Air quality specialist study for the application for postponement applications of the minimum emission standards for the Engen Refinery in Merebank, Durban
2014-15	Baseline assessment and AQMP development for the uThungulu District Municipality
2013-15	Baseline assessment, AQMP and Threat Assessment for the Waterberg-Bojanala Priority Area
2014-15	Review of the 2007 AQMP for eThekwini Municipality, including metropolitan emission inventory development for all sectors, i.e. industrial, transport, waste management, biomass burning, residential fuel burning, dispersion modelling and strategy development
2014-14	Dispersion modelling study for Richards Bay Minerals
2015	Air quality assessment for Rainbow Chickens at Hammersdale
2015	Air quality status quo assessment and planning for TNPA ports in South Africa
2016- 7	Lead author of the National State of Air Report for 2005 to 2015, including national emission inventory development for all sectors, i.e. industrial, transport, waste management, biomass burning, residential fuel burning
2016	Air quality assessment for Kanshansi Mine, Solwesi, Zambia

2016	Assessment of air quality impacts associated with activities at the Venetia Mine, Limpopo Province
2016	Assessment of air quality impacts associated with activities at the Komati Anthracite Mine, Mpumalanga Province
2016	Air quality assessment for the proposed Powership Project at the Port of Nacala, Mozambique
2016	Air quality assessment for the proposed Richards Bay Gas to Power Project
2017	Baseline assessment and review of the 2009 AQMP for Gauteng Province, including emission inventory development for all sectors, i.e. industrial, transport, waste management, biomass burning, residential fuel burning, and dispersion modelling
2017	Baseline assessment and air quality management plan for Northern Cape Province
2017	Air quality assessment for the EIA for the Thabametsi Power Station in Limpopo Province
2017	Air quality assessment for the EIA for the proposed Tshivasho Power Station in Limpopo Province
2018	Air quality assessment for the EIA for the proposed Bellmall Thermal Plant in Ekurhuleni
2018	Air quality assessment for the EIA for the proposed Simba Oil mini Refinery in Tororo, Uganda
2018-19	Air dispersion modelling for input to the Atmospheric Reports for the postponement application for 14 Eskom power stations
2019	Air quality impact assessment for the proposed NamPower expansion project in Walvis Bay
2019	Air quality assessment for the mine expansion project at the Akanani Mine
2019	Air quality impact assessment for the proposed power plant at Nacala, Mozambique
2020	AIR for the KarpowershipSA proposal in the Ports of Ngqura, Richards Bay and Saldanha Bay
2020	AIR for the Coega Development Corporation gas-to-power project at 4 sites in the CDC
2020	AIRs for 10 Eskom coal-fired power plants on the Highveld to support their postponement application
2020	AIR for the proposed Azure Power gas-to-power project in the Western Cape
2021	Air quality assessment for the proposed optimisation project at Beeshoek Iron Ore Mine, Postmasburg, Northern Cape
2021	AIR for the proposed Frontier Power Gas-to-Power project at Saldanha Bay, Western Cape
2021	AIR for the 2021 shutdown and start-up at Engen Refinery in Merebank
2021	AIR for the proposed expansion of the Swartkops Ore handling facility in Port Elizabeth, Eastern Cape
2016-21	AEL compliance monitoring for Joseph Grieveson, Durban, including dust fallout monitoring and reporting
2018-21	Dust fallout and HF monitoring and reporting for Hulamin, Richards Bay
2018-21	Dust fallout and H_2S monitoring and reporting for at KwaDukuza Landfill for Dolphin Coast Landfill Management (DCLM)
2019-21	AEL compliance monitoring for Umgeni Iron and Steel Foundry, including dust fallout monitoring and reporting

PUBLICATIONS

Author and co-author of 34 articles in scientific journals, chapters in books and conference proceedings. Author and co-author of more than 300 technical reports and presented 47 papers at local and international conferences.

ATHAM RAGHUNANDAN

Firm	:	uMoya-NILU Consulting (Pty) Ltd
Profession	:	Air Quality Consultant
Specialization	:	Meteorological and Atmospheric Dispersion Modelling, Air Quality Specialist Studies, Project Management, Data Processing, Emission Inventories
Position in Firm	:	Senior Air Quality Consultant
Years with Firm	:	14 years (appointed in 2008)
Nationality	:	South African
Year of Birth	:	1977
Language Proficiency	:	English (mother tongue), Afrikaans (fair)

EDUCATION AND PROFESSIONAL STATUS

Qualification	**Institution**	**Year**
M.A. (Atmospheric Sciences)	University of Natal, Durban	2003
B.A. Hons. (Environmental Sciences)	University of Durban–Westville	2001
B.Paed. (Education)	University of Durban–Westville	2000

Memberships:

- National Association for Clean Air (NACA)
- South African Society for Atmospheric Sciences (SASAS)
- South African Council of Educators (SACE)

EMPLOYMENT AND EXPERIENCE RECORD

Period	Organisation details and responsibilities/roles
Jan 2003 – Oct 2008	CSIR: Consultant/Researcher in Air Quality Group, Research Group Leader – Air Quality Research Group
Nov 2008 – present	uMoya-NILU: Senior Air Quality Consultant

Key and Recent Project Experience:

2003	Baseline air dispersion modelling study for Natal Portland Cement (Pty) Ltd – Simuma Plant, Port Shepstone – *Modelling and Reporting*
2004	Air Quality Screening Study for MOZAL 3 – *Modelling and Reporting*
2005	Air Quality Specialist Study for the Proposed Kudu Combined Cycle Gas Turbine Power Station at Oranjemund, Namibia (Site D) – *Modelling and Reporting*

2005 Air Quality Specialist Study for the Proposed Kudu Combined Cycle Gas Turbine Power Plant at Uubvlei, Namibia – *Modelling and Reporting*

2005 Air Quality Specialist Study for a Proposed Cement Milling, Storage and Packaging Facility and a Second Clinker Kiln at Natal Portland Cement (Pty) Ltd – Simuma Plant, Port Shepstone – *Modelling and Reporting*

2005 Technology Review: Air quality specialist study for the Coega Aluminium Smelter at Coega, Port Elizabeth – *Modelling and Reporting*

2005 Assessment of Development Scenarios for Hillside Aluminium using Sulphur Dioxide (SO_2) as an Ambient Air Quality Indicator – *Modelling and Reporting*

2005 Air Quality Scoping Study for Eskom's Proposed Open Cycle Gas Turbine Power Station at Atlantis – *Modelling and Reporting*

2005 Air Quality Specialist Study for Eskom's Proposed Open Cycle Gas Turbine Power Station at Atlantis, Western Cape – *Modelling and Reporting*

2005 Air Quality Specialist Study for the Proposed Tata Steel Ferrochrome Project at Richards Bay – Alton North Site – *Modelling and Reporting*

2005 Air Quality Audit for the Amathole District Municipality - C*ompilation of detailed emissions inventory*

2006 A Regional Scale Air Dispersion Modelling Study for Northeastern Uruguay – *Modelling and Reporting*

2006 Air Dispersion Modelling Study for Natal Portland Cement (Pty) Ltd for the Proposed AFR Programme at the Simuma Plant, Port Shepstone – *Modelling and Reporting*

2007 Development of an air quality management strategy for particulate matter at the Bulk Terminal Saldanha - *Project Leader and Reporting*

2007 Air Quality and Human Health Specialist Study for the Proposed Coega Integrated LNG to Power Project (CIP) within the Coega Industrial Zone, Port Elizabeth, South Africa - *Project Leader, Modelling and Reporting*

2008 Dispersion Modelling for the Proposed Coega Aluminium Smelter (CAL) at Port Elizabeth - *Project Leader, Modelling and Reporting*

2008 Modelled and Measured Vertical Ozone Profiles over Southern Africa (as part of the Young Researcher Establishment Fund (2005-2008)) - *Project Leader*

2008 Air Quality Specialist Study for the Proposed N2 Wild Coast Toll Highway - *Project Leader, Modelling and Reporting*

2008 Initial Air Quality Impact Assessment for the Proposed Illovo Ethanol Plant in Mali, West Africa - *Project Leader, Modelling and Reporting*

2008 Modelling Mercury Stack Emissions from South African Coal-fired Power Plants – *Modelling and Reporting*

2009 Air Quality Management Plan for the Western Cape Province – Baseline Assessment – *Modelling*

2009 Proposed Exxaro AlloyStream™ Manganese Project in the Coega Industrial Development Zone: Air Quality Impact Assessment – *Modelling and Reporting*

2009 Air Quality Specialist Study for the Kalagadi Manganese Smelter at Coega, Eastern Cape – *Modelling and Reporting*

2009	Qualitative Air Quality Impact Assessment for the Wearne Platkop Quarry – *Modelling and Reporting*
2009	Specialist Air Quality Study for the Vopak Terminal Durban Efficiency Project – *Modelling*
2009	Qualitative Air Quality Impact Assessment for the Proposed ETA STAR Coal Mine at Moatize, Mozambique – *Modelling and Reporting*
2009	Specialist Air Quality Study for the Kwadukuza Landfill Upgrade Project – *Modelling and Reporting*
2010	Ambient dust assessment at Saldanha Bay for the period October 2006 to September 2009 for Transnet Bulk Terminal Saldanha – *Reporting*
2010	Dust Impact Assessment for the Proposed Saldanha Bay Pilot PV plant – *Reporting*
2010	Modelling Particulate Emission Concentration Scenarios for Eskom's Kriel Power Station – *Modelling and Reporting*
2010	Air Quality Dispersion Modelling for MOZAL, Mozambique – *Modelling and Reporting*
2010	Air Quality Management Plan for the Highveld Priority Area – Air Quality Baseline Assessment for the Highveld Priority Area – *Modelling*
2010	Ambient Air Quality Modelling and Monitoring at Sappi, Mandeni – *Modelling and Reporting*
2010	Dust Impact Study at Idwala Carbonates – *Modelling and Reporting*
2010	Air quality specialist study for the EIA for the proposed re-commissioning of an existing coke oven battery at ArcelorMittal South Africa, Newcastle Works – *Modelling*
2010	Air quality specialist study for the proposed storage and utilisation of alternative fuels and resources at NPC-Cimpor's Simuma facility, Port Shepstone, KwaZulu-Natal – *Modelling and Reporting*
2010	Air quality status quo assessment and abatement planning at First Quantum Mining's Bwana Mkubwa and Kansanshi mines, Zambia – *Modelling*
2010	Air quality specialist study for the proposed briquetting plant at the Mafube Colliery – *Modelling and Reporting*
2011	Air quality modelling study for the Copeland reactor at Sappi Stanger – *Modelling and Reporting*
2011	Air quality modelling study for the Copeland reactor at Sappi Tugela – *Modelling and Reporting*
2011	Air quality monitoring and modelling study for the Copeland reactor at Mpact Paper, Piet Retief – *Modelling and Reporting*
2011	Air Quality Study for the Basic Environmental Assessment for the Proposed Biomass Co-Firing Facility at the Arnot Power Station – *Modelling and Reporting*
2011	Assessment of Scenarios for Developing and Implementing a Sulphur Dioxide Emissions Licensing Strategy for Hillside Aluminum – *Modelling and Reporting*

2011-12 Air quality assessment for the mining and processing facilities at Lonmin Platinum in Marikana – *Modelling and Reporting*

2012 Development of an Air Quality Management Plan for Anglo's Mafube Colliery in Mpumalanga – *Modelling and Reporting*

2012 Air quality assessment for the proposed manganese ore terminal at the Ngqura Port – *Modelling and Reporting*

2012 Air Quality Impact Assessment for NPC Cimpor – *Modelling and Reporting*

2013 Air Quality Impact Assessment for Proposed AfriSam Plant in Coega – *Modelling*

2013 Air quality assessment for the Orion Engineered Carbons Co-Gen Plant – *Modelling*

2013 Air quality assessment for the Orion Engineered Carbons - Main Boiler – *Modelling*

2013 Air quality assessment for the EIA for the Sekoko Coal Mine – *Modelling and Reporting*

2013 Air quality specialist study for the EIA for the Thabametsi IPP station – *Modelling and Reporting*

2013 Air quality specialist study for the EIA for the Mamathwane Common User facility – *Modelling and Reporting*

2013-14 Air quality specialist study for the application for postponement of the minimum emission standards for 16 Eskom power stations: Acacia, Arnot, Camden, Duvha, Grootvlei, Hendrina, Kendal, Komati, Kriel, Lethabo, Majuba, Matimba, Matla, Madupi, Tutuka, Port Rex – *Modelling and Reporting*

2014 Air quality specialist study for the application for postponement of the minimum emission standards for the Engen Refinery in Merebank, Durban – *Modelling and Reporting*

2013-14 Baseline assessment and air quality management plan for the Waterberg-Bojanala Priority Area – *Modelling*

2013 Air Quality Specialist Study for the EIA for the Pandora Platinum Mine Joint Venture – *Modelling and Reporting*

2013 Air Quality Specialist Study for the EIA for the Proposed New Tailings Storage Facility (TD8) and Associated Infrastructure at Lonmin's Western Platinum Mine and Eastern Platinum Mine – *Modelling and Reporting*

2015 Waterberg-Bojanala Priority Area Air Quality Management Plan and Threat Assessment – *Modelling*

2015 Air Quality Management Plan for eThekwini Municipality – *Modelling and Reporting*

2015 Air Quality Management Plan for the uThungulu District Municipality – *Modelling and Reporting*

2015 Dispersion Modelling for Richards Bay Minerals – *Modelling and Reporting*

2015 Atmospheric Impact Report in support of Sancryl Chemicals's application for a verification to the existing AEL as a result of the introduction of Ethyl Acrylate and Vinyl Acetate, Prospecton – *Modelling and Reporting*

2016 Dispersion Modelling Study for the City of Johannesburg – *Modelling and Reporting*

2016 Air Quality Specialist Study for the Department of Energy's Emergency Power IPP Project at Richards Bay and Saldanha Bay – *Modelling and Reporting*

2016 Atmospheric Impact Report in support of the EIA for the Proposed Gas to Power Plant in Zone 1F of the Richards Bay IDZ – *Modelling and Reporting*

2016 Atmospheric Impact Report for the EIA for the proposed Tshivhaso Coal-fired Power Plant, Lephalale – *Modelling and Reporting*

2016 TNPA Air Quality Study – Dispersion Modelling for 8 Ports in South Africa: Port of Richards Bay, Durban, East London, Ngqura, Port Elizabeth, Mossel Bay, Cape Town and Saldanha Bay – *Modelling and Reporting*

2016 Atmospheric Impact Report for Durran's Calcination Plant – *Modelling and Reporting*

2016 Air Quality Assessment for the EIA for the Floating Power Plant in Nacala, Mozambique – *Modelling and Reporting*

2016 Ambient Air Quality Assessment for 2016 for Kansanshi Mining Plc – *Modelling and Reporting*

2016 Air Quality Impact Assessment for the EIA for the Proposed Hilli FLNG Project in Cameroon – *Modelling and Reporting*

2016 Kansanshi Smelter and TSF1 Modelling Scenarios for Kansanshi Mining Plc – *Modelling and Reporting*

2016 Air Quality Assessment the Proposed Accommodation Facility at the Venetia Mine in Limpopo – *Modelling and Reporting*

2016 Atmospheric Impact Report in support of the EIA for the Proposed Optimisation of the Process Plant at Nkomati Anthracite Mine – *Modelling and Reporting*

2017 Atmospheric Impact Report in support of the DRDAR Atmospheric Emission License (AEL) application for the proposed replacement and use of an incinerator at their State Veterinary Laboratories located in Grahamstown, Middelburg and Queesntown in the Eastern Cape – *Modelling and Reporting*

2017 Baseline Assessment and Review of the 2009 AQMP for Gauteng Province, including emission inventory development for all sectors, i.e. industrial, transport, waste management, biomass burning, residential fuel burning, and dispersion modelling – *Modelling and Reporting*

2017 Baseline Assessment and Air Quality Management Plan for Northern Cape Province – *Modelling and Reporting*

2017 Atmospheric Impact Report in support of Maloka Machaba Surfacing's application for an Atmospheric Emission License (AEL) for a proposed asphalt plant located in Polokwane – *Modelling and Reporting*

2017 Assessment of modelling scenarios involving an increase in the open area of the cone on the Common Stack for the pretreater, reformer and CHD furnaces at Engen Refinery – *Modelling and Reporting*

2017	Atmospheric Impact Report in support of the Atmospheric Emission License (AEL) application and stack-height assessment for the proposed Thabametsi Power Plant near Lephalale, Limpopo – *Modelling and Reporting*
2017	Dispersion Modelling Study for the Beeshoek Mine, near Postmasburg, Northern Cape – *Modelling and Reporting*
2018	Air quality assessment for the EIA for the proposed Bellmall Thermal Plant in Ekurhuleni – *Modelling and Reporting*
2018	Air quality assessment for the EIA for the proposed Simba Oil mini Refinery in Tororo, Uganda – *Modelling and Reporting*
2018-19	Air dispersion modelling for input to the Atmospheric Reports for the postponement application for 14 Eskom power stations – *Modelling and Reporting*
2019	Air quality impact assessment for the proposed NamPower expansion project in Walvis Bay – *Modelling and Reporting*
2019	Air quality assessment for the mine expansion project at the Akanani Mine – *Modelling and Reporting*
2019	Air quality impact assessment for the proposed power plant at Nacala, Mozambique – *Modelling and Reporting*
2019	Atmospheric Impact Report in Support of the Atmospheric Emission License (AEL) Amendment Application and Basic Assessment for Dow Southern Africa - New Germany – *Modelling and Reporting*
2019	Atmospheric Impact Report in support of Tau-Pele Construction's application for an Atmospheric Emission License (AEL) for a proposed emulsion and asphalt plant located in Indwe, Eastern Cape – *Modelling and Reporting*
2019	Atmospheric Impact Report in Support of the EIA for the Proposed Material Source and Processing Sites Along the N3 Between Durban and Hilton, KwaZulu-Natal: RCL1, RCL9 and Harrison's Quarry – *Modelling and Reporting*
2019	Atmospheric Impact Report in Support of the Atmospheric Emission License (AEL) Amendment Application and Basic Assessment for the Vopak Efficiency (Growth 4) Expansion Project, Durban, South Africa – *Modelling and Reporting*
2020	AIR for the KarpowershipSA proposal in the Ports of Ngqura, Richards Bay and Saldanha Bay – *Modelling and Reporting*
2020	AIR for the Coega Development Corporation gas-to-power project at 4 sites in the CDC – *Modelling and Reporting*
2020	AIRs for 10 Eskom coal-fired power plants on the Highveld to support their postponement application – *Modelling and Reporting*
2020	AIR for the proposed Azura Power gas-to-power project in the Western Cape – *Modelling and Reporting*
2020	Atmospheric Impact Report for the proposed 315 MW LPG Power Plant at Saldanha Bay – *Modelling and Reporting*
2021	Air quality assessment for the proposed optimisation project at Beeshoek Iron Ore Mine, Postmasburg, Northern Cape – *Modelling and Reporting*

2021	Air quality assessment for the proposed expansion at Akanani Mine in Limpopo – *Modelling and Reporting*
2021	AIR for the proposed Frontier Power Gas-to-Power project at Saldanha Bay, Western Cape
2021	AIR for the 2021 shutdown and start-up at Engen Refinery in Merebank – *Modelling and Reporting*
2021	AIR for the proposed expansion of the Swartkops Ore handling facility in Port Elizabeth, Eastern Cape – *Modelling and Reporting*
2021	Atmospheric Impact Report in support of the Proposed 200 MW Engie CB Hybrid Power Project in the Coega Special Economic Zone (SEZ) – *Modelling and Reporting*
2021	Air Quality Impact Assessment for the proposed Mining of TSF-1 at the Stibium Mopani Mine near Gravelotte, Limpopo Province – *Modelling and Reporting*
2021	Addendum to the Atmospheric Impact Report in support of the proposed Mulilo-Total 200 MW Gas-fired Power Station, Coega Special Development Zone, Eastern Cape – *Reporting*
2021	Air Quality Assessment for the EIA for the Tete 1 400 MW Coal-Fired Power Plant, Tete Province, Mozambique – *Modelling and Reporting*
2021	Atmospheric Impact Report in support of Tugela Asphalt's application for an Atmospheric Emission License (AEL) for a proposed asphalt plant located in Mandini, KwaZulu-Natal – *Modelling*
2021	Atmospheric Impact Report for Nkomati Mine – *Modelling and Reporting*
2022	Emission Inventory for Lanxess for 2021 – *Reporting*
2022	Annual Report for Puregas: Atmospheric Emission License - Submission to the City of Ekurhuleni in compliance with the Atmospheric Emission Licence of the facility for the Reporting Period Year 2021 – *Reporting*
2022	Emission Inventory for Puregas for 2021 – *Reporting*
2022	Emission Inventory for Dow Advanced Materials for 2020 – *Reporting*
2022	Atmospheric Impact Report for the Engen Cape Town Terminal – *Modelling and Reporting*

PUBLICATIONS

Author and co-author of 5 articles in scientific journals and conference proceedings. Author and co-author of more than 200 technical reports for external contract clients. Presented 4 papers at local conferences. A full list of publications, conference papers and contract reports is available on request.

YEGESHNI MOODLEY	uMOYA-NILU

Firm	:	uMoya-NILU (Pty) Ltd
Profession	:	Air Quality Consultant
Specialisation	:	Air quality management planning, air quality impact assessment, air dispersion modelling, emission inventories, GHG emission reduction
Position in Firm	:	Senior Consultant
Years with Firm	:	3
Nationality	:	South African
Year of Birth	:	1982
Language Proficiency	:	English

EDUCATION AND PROFESSIONAL STATUS

Qualification	Institution	Year
BSc (Environmental Science, Geography)	Univ. of Natal	2003
BSc Hons (Environmental Science)	Univ. of KwaZulu-Natal	2004
MSc (Environmental Science)	Univ. of KwaZulu-Natal	2007

Member: National Association for Clean Air, past Branch Vice-chairperson
South African Society for Atmospheric Scientists

EMPLOYMENT AND EXPERIENCE RECORD

Period	Organisation details and responsibilities/roles
January 2014 - current	*uMoya-NILU Consulting (Pty) Ltd*, Senior air quality consultant
June 2012 – December 2013	*NPC-Cimpor* Environmental Officer
June 2008 – May 2012	*uMoya-NILU Consulting (Pty) Ltd*, Air quality consultant
February 2004 – May 2008	*University of KwaZulu-Natal* Demonstrator, tutor, research assistant, support administrator, lecturer, research intern (air quality)

Current and Recent Project Experience:

Year	**Description, client, role**
2007	Member of a multi-national team to develop the National Framework
	for Air Quality Management for the Department of Environment
2007/8	Affairs and Tourism
	Development of a proposed strategy to address illegal tyre burning
2008	for the Ethekwini Municipality
2008	Ugu district air quality screening study for the Ugu District
	Municipality
2008	Air quality assessment for the New Multi-Products Pipeline for the
2008-10	NMPP Alliance
	Development of an Odour Management Strategy for Ethekwini
2008-11	Development of the Air Quality Management Plan for the Department
2009-10	of Environmental Affairs and Development Planning, Western Cape

2010	Development of the Air Quality Management Plan for the Highveld Priority Area Development of an Environmental Management Framework for the Umhlatuze Local Municipality, air quality component Review of the City of Joburg's Air Quality Management Plan
2010-11	Air quality management system for Total SA
2011	Air quality management plan for the Alternative Fuel and Resources Project at NPC-Cimpor Simuma Plant, Port Shepstone
2011	Baseline air quality assessment for Zambeze Coal Mine, Tete, Mozambique
2011	Development of SAAQIS Phase 2 for DEA and South African Weather Service
2011	Development of Vehicle Emission Reduction Strategy for DEA
2012	Air quality management system for Total South Africa
2012	Development of Air quality management plan for Mafube Colliery
2014-15	Development of greenhouse gas emission reduction strategy for the Department of Transport
2014-15	Air quality management plan development for the Waterberg-Bojanala Priority Area
2014-15	Air quality management plan development for the eThekwini Metropolitan Municipality
2015-	Development of air quality management system for the Transnet National Ports Authority
2015	Air quality assessment for the EIA for the proposed Karoo uranium project, Western Cape and Eastern Cape Provinces
2016	Carbon budget assessment for Orion Engineered Carbons
2016	Air quality impact assessment for Atlantis LNG power generation facility
2016	Emission inventory for Scott Bader
2016	Air quality impact assessment for Rhino Oil and Gas
2016	Air quality impact assessment for Vopak Growth 4 Project
2017	Air quality chapter for KwaZulu-Natal Environmental Outlook (in process)

Publications*:*
Introduction of local air quality management in South Africa: overview and challenges (Author)
Environmental Science and Policy 17: pp 62-71; Journal; Elsevier Publishing. (Mar 2012)

Presentation at scientific meetings:
Poster presentation at NACA Annual Conference 2006: 'An Assessment of Local Government Capacity to Implement the Air Quality Act'
Presentation at NACA Annual Conference 2009: 'Ambient air quality in the Highveld Priority Area'

Teaching and Training experience:
Lecturing Climatology and Atmospheric Science material to undergraduate students, including lectures, practical exercises, tests and examinations
Supervision of Honours research project in area of air pollution science
Presentation of Training material on Air Pollution Control for CSIR training workshop
Presentation of Training material to government officials in the Highveld Priority Area

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/14/12/16/3/3/2007
Date Received:	02 November 2020

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 Proposed Gas to Power Powership Project at the Port of Richards Bay, Umhlathuze Local Municipality, King Cetshwayo District, Kwazulu-Natal.

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:	uMoya-NILU Consulting (Pty) Ltd			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	2	Percentage Procurement recognition	51
Specialist name:	Dr Mark Zunckel			
Specialist Qualifications:	PhD, MSc, BSc (Hons) (Meteorology), BSc (Meteorology)			
Professional affiliation/registration:	South African Society for Natural Scientific Professionals Reg: 400994/04			
Physical address:	9 Steere Road, Manors, Pinetown 3610			
Postal address:	P O Box 20622 Durban North			
Postal code:	4016	Cell:	083 690 2728	
Telephone:	031 262 3265	Fax:		
E-mail:	mark@umoya-nilu.co.za			

2. DECLARATION BY THE SPECIALIST

I, MARK ZUNCKEL 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.

Signature of the Specialist

uMoya-NILU Consulting (Pty) Ltd

Name of Company:

20 October 2022

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

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

Signature of the Specialist

uMoya-NILU Consulting (Pty) Ltd

Name of Company

20 October 2022

Date

20/10/2022

Signature of the Commissioner of Oaths

Date

20/10/2022

COMMISSIONER OF OATHS
NAMEKA BUYANA
BRANCH MANAGER
41 NEWPORT DRIVE
GLEN ASHLEY
4022 DATE: 20/10/22

GLENASHLEY 1 2022-10-20