AIRSHED PLANNING PROFESSIONALS

# Air Quality Impact Assessment for the Africa Oil South Africa Corp Block 3B/4B Offshore Exploration

Project done for Environmental Impact Management Services (EIMS)


| Report Compiled by: | Project Manager | Project Reviewer |
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# Report Details

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|---|---|
| Project Number | 22EIM11 |
| Status | Rev 0.1 |
| Report Title | Air Quality Impact Assessment for the Africa Oil South Africa Corp Block 3B/4B Offshore Exploration |
| Date | November 2023 |
| Client | Environmental Impact Management Services (EIMS) |
| Prepared by | Gillian Petzer, BEng (Chem.) (University of Pretoria), Pr. Eng. |
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# Revision Record

| **Revision Number** | **Date** | **Reason for Revision** |
|---|---|---|
| Rev 0 | October 2023 | Draft for client review |
| Rev 0.1 | November 2023 | Minor edits, new layout map |

# Abbreviations

| | |
|---|---|
| **AEL** | Atmospheric Emissions Licence |
| **Airshed** | Airshed Planning Professionals (Pty) Ltd |
| **AOI** | Area of interest |
| **AQIA** | Air Quality Impact Assessment |
| **AQSR** | Air Quality Sensitive Receptor |
| **BRE** | Building Research Establishment |
| **CO** | Carbon monoxide |
| **DTU** | Technical University of Denmark |
| **ECMWF** | European Centre for Medium-Range Weather Forecasts |
| **ECSA** | Engineering Council of South African |
| **EIA** | Environmental Impact Assessment |
| **EIMS** | Environmental Impact Management Services |
| **EMEP/EEA** | European Monitoring and Evaluation Programme/European Environment Agency |
| **DFFE** | Department of Forestry, Fisheries and the Environment ( |
| **IFC** | International Finance Corporation |
| **ISC** | Industrial Source Complex |
| **GHG** | Greenhouse gas |
| **GN** | Government Notice |
| **GWA** | Global Wind Atlas |
| **HAZID** | Hazard identification study |
| **HAZOP** | Hazard and operability study |
| **MES** | Minimum Emission Standards |
| **NAAQS** | National Ambient Air Quality Standards (South Africa) |
| **NACA** | National Association for Clean Air |
| **NEMA** | National Environmental Management Act |
| **NEM:AQA** | National Environmental Management: Air Quality Act |
| **$NO_2$** | Nitrogen dioxide |
| **$O_3$** | Ozone |
| **Pb** | Lead |
| **PM** | Particulate matter |
| **$PM_{10}$** | Thoracic particulate matter with an aerodynamic diameter of less than 10 $\mu$m |
| **$PM_{2.5}$** | Inhalable particulate matter with an aerodynamic diameter of less than 2.5 $\mu$m |
| **SA** | South Africa(n) |
| **SCR** | Selective catalytic reduction |
| **$SO_2$** | Sulfur dioxide |
| **TVOC** | Total volatile organic compounds |
| **US EPA** | United States Environmental Protection Agency |

# Executive Summary

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Environmental Impact Management Services (EIMS) to conduct an air quality impact assessment (AQIA) for the Africa Oil South Africa Corp Block3B/4B Offshore Exploration.

With the exploration being offshore, the nearest identified air quality sensitive receptors (AQSRs) include coastal towns along the west coast, with the nearest town being Paternoster and Saldanha Bay (120 km from the closest point).

The total pollutant emissions were estimated using the European Monitoring and Evaluation Programme/European Environment Agency (EMEP/EEA) emission factors. Emissions of nitrogen dioxide ($NO_2$) range between 211 and 216 Tonne per annum (tpa) with fuel combustion being the dominant source. Emissions of carbon monoxide (CO) range between 54 and 76 tpa, with waste gas disposal being the dominant source. Emissions of non-methane volatile organic compounds (NMVOC) range between 17 and 25 tpa, with waste gas disposal being the dominant source. Emissions of particulate matter (PM) and sulfur dioxide ($SO_2$) are low. Greenhouse gases (GHG) were also estimated, and these can be found in the climate change assessment report.

Meteorological scenarios that reflect worst-case atmospheric conditions were selected to perform dispersion simulations. These include calm stable night-time conditions (wind speed of 1.5 m/s) and neutral daytime conditions with a relatively low wind speed of 3 m/s. These atmospheric conditions are more likely to occur during winter winds and in order to impact on the coastline, has to be from westerly wind sector. Based on the wind field for the study area, the wind could blow from this direction approximately 7% of the year.

Screening dispersion modelling using the US EPA SCREEN3 model was used to calculate the maximum concentrations at the closest coastal area, approximately 100 km downwind from the nearest seismic survey location. This model was used with the emission rates calculated using the EMEP/EEA emission factors.

Conservatively all oxides of nitrogen (NOx) was assumed to be $NO_2$. The highest hourly average $NO_2$ concentrations expected at Saldanha Bay (closest receptor at 120 km from a location on the eastern boundary of the Area of Interest) is 12% of the National Ambient Air Quality Standards (NAAQS) limit value. This represents the maximum ground level concentration that would occur under conditions of weak atmospheric dispersion, i.e., low vertical turbulence and calm wind speeds that would otherwise assist with the dilution of air pollutants. Similarly, the highest hourly average $SO_2$ concentration is predicted to be 0.16% of the NAAQS limit value. The extrapolated highest $PM_{2.5}$ daily average concentration is 0.32% of the NAAQS. The predicted highest CO hourly average concentration is only 0.002% of the NAAQS. There are no NAAQS for NMVOCs; however, the highest predicted hourly average NMVOC concentration is still lower than the annual average NAAQS limit value for benzene. **Since the calculated maximum predicted ground level concentrations (under worst-case atmospheric conditions) are considerably lower than the NAAQS limit values, it is expected that the exposure to any significant concentration levels would be infrequent and insignificant when compared with the NAAQS. Such emissions are therefore unlikely to have a direct effect on any receptor or other activity, other than the project vessels themselves.**

The impact of the estimated operational emissions from the proposed project is considered to be **local**, and of **short-term duration** and **low intensity**. The potential impact on the air quality emissions is of **low significance** without further mitigation.

The means to minimise emissions from the Project would be achieved by

- Implement a maintenance plan to ensure all ship engines and boilers receive adequate maintenance to minimise soot and unburnt fuel released to the atmosphere and maximize energy efficiency.

- Ensure no incineration (subject to obtaining an atmospheric emissions license) of waste occurs within the port limits.

However, if incineration of waste material is to be undertaken (within port limits), and the vessel is considered an 'installation' (as per the National Environmental Management: Air Quality Act Minimum Emissions Standards (NEM:AQA MES)) and more than 10 kg waste is incinerated per day, this will require an AEL. The relevant listed activity would be *Category 8.1 - Thermal Treatment of Hazardous and General Waste*.

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# 1 INTRODUCTION

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by Environmental Impact Management Services (EIMS) to conduct an air quality impact assessment (AQIA) for the Africa Oil South Africa Corp Block3B/4B Offshore Exploration.

# 2 DOCUMENT STRUCTURE

This report has been compiled in accordance with the Environmental Impact Assessment (EIA) Regulations, 2017 (Government Notice (GN) 326) as part of the National Environmental Management Act (NEMA) of 1998. A summary of the report structure, and the specific sections that correspond to the applicable regulations, is provided in Table 2-1 below.

**Table 2-1: Report structure (NEMA EIA regulations 2017)**

| Environmental Regulation | Description | Section in Report |
|---|---|---|
| Appendix 6 (1) (a) | Details of -<br>(i) the specialist who prepared the report, and<br>(ii) the expertise of that person to compile a specialist report including curriculum vitae. | Report Details<br>Section 3: Specialist Details<br>Appendix B |
| Appendix 6 (1) (b) | A declaration that the person is independent in a form as may be specified by the competent authority. | Report Details<br>Appendix A |
| Appendix 6 (1) (c) | An indication of the scope of, and the purpose for which, the report was prepared. | Section 4: Terms of Reference |
| Appendix 6 (1) (cA) | An indication of quality and age of base data used. | Section 8: Receiving Environment |
| Appendix 6 (1) (cB) | A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change. | Section 9: Impact on the Receiving Environment |
| Appendix 6 (1) (d) | The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment. | A site investigation was not undertaken. Description of the current land use in the region, simulations undertaken for the current operations and meteorological data used in the study are considered representative of all seasons.<br>Section 9: Impact on the Receiving Environment |
| Appendix 6 (1) (e) | A description of the methodology adopted in preparing the report or carrying out the specialised process. | Section 7: Methodology |
| Appendix 6 (1) (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 9: Impact on the Receiving Environment |
| Appendix 6 (1) (g) | An identification of any areas to be avoided, including buffers. | Section 9: Impact on the Receiving Environment |
| Appendix 6 (1) (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 9: Impact on the Receiving Environment |
| Appendix 6 (1) (i) | A description of any assumptions made and any uncertainties or gaps in knowledge. | Section 12: Assumptions, Uncertainties and Gaps in Knowledge |
| Appendix 6 (1) (j) | A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment. | Section 11: Conclusion |

| Environmental Regulation | Description | Section in Report |
|---|---|---|
| Appendix 6 (1) (k) | Any mitigation measures for inclusion in the EMPr. | Section 11: Conclusion |
| Appendix 6 (1) (l) | Any conditions for inclusion in the environmental authorisation | Section 11: Conclusion |
| Appendix 6 (1) (m) | Any monitoring requirements for inclusion in the EMPr or environmental authorisation. | Section 11: Conclusion |
| Appendix 6 (1) (n) | A reasoned opinion –<br>(i) as to whether the proposed activity, activities or portions thereof should be authorised; regarding the acceptability of the proposed activity or activites; and<br>(ii) if the opinion is that the proposed activity, activites or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan. | Section 11: Conclusion |
| Appendix 6 (1) (o) | A description of any consultation process that was undertaken during the course of carrying out the study. | Not applicable. |
| Appendix 6 (1) (p) | A summary and copies of any comments that were received during any consultation process. | Not applicable. |
| Appendix 6 (1) (q) | Any other information requested by the competent authority. | Not applicable. |

# 3 Specialist Details

**Report author: Gillian Petzer (Pr. Eng., BEng Chemical (University of Pretoria))**

Gillian Petzer started her professional career in Air Quality in 2000 when she joined the Building Research Establishment (BRE) in the United Kingdom after completing her Bachelor's Degree in Chemical Engineering at the University of Pretoria. She joined Airshed Planning Professionals in 2003 and is now a senior consultant at the company.

She has extensive experience on the various components of air quality management including emissions quantification for a range of source types, simulations using a range of dispersion models, impacts assessment and health risk screening assessments. Her project experience range over various countries in Africa, providing her with an inclusive knowledge base of international legislation and requirements pertaining to air quality.

Gillian is also actively involved in the National Association for Clean Air (NACA) and is a member of the Institution of Chemical Engineers (IChemE) and is a registered Professional Engineer with the Engineering Council of South African (ECSA) (registration no. 20170315).

# 4 Terms of Reference

The following tasks, typical of an air quality impact assessment, were included in the scope of work:

- Study of the receiving environment including the identification of air quality-sensitive receptors (AQSRs) and the collection and analysis of local weather data;
- Establishing the legislative and regulatory context, including the consideration of emission limits and ambient air quality standards;
- Quantification of all sources of atmospheric emissions associated with the proposed Project;
- Dispersion simulations and analyses; and
- An air quality impact assessment report.

# 5 Project Description

Block 3B/4B is situated between latitudes 31°S and 33°S (see Figure 5-1) on the continental shelf in water depths ranging from 200 m to 2 000 m. Block 3B/4B is located approximately 120 km west of St Helena Bay and approximately 145 km south-west of Hondeklip Bay off the West Coast of South Africa. The area of primary interest in the north of this block, but this could also cover other areas in future. As part of the process of applying for the Exploration Right, the JV Partners undertook and completed the reprocessing project covering 2 000 km$^2$, which is a subset of the 10 000 km$^2$ BHP/Shell 3D seismic datasets, focussed primarily on the most northern portion of Block 3B/4B. Block 3B/4B covers an area of approximately 11 100 km$^2$, and is adjacent to the Namaqualand and West Coast District Municipalities.

Hydrocarbon deposits occur in reservoirs in sedimentary rock layers. Being lighter than water they accumulate in traps where the sedimentary layers are arched or tilted by folding or faulting of the geological layers. Exploration drilling activities are one of the primary geophysical methods for locating such deposits. The below activities are expected to be undertaken as part of the proposed exploration for oil and gas.

## 5.1 Pre-Drilling Surveys

Pre-drilling surveys may be undertaken prior to drilling in order to confirm baseline conditions at the drill site and to identify and delineate any seabed and sub-seabed geo-hazards that may impact the proposed exploration drilling operations. Pre-drilling surveys may involve sonar surveys, sediment sampling, water sampling and ROV activities.

### *5.1.1 Sonar Surveys*

Pre-drilling sonar surveys may involve multi- and single beam echo sounding and sub-bottom profiling. These surveys would not be limited to a specific time of the year but would be of short duration (around 15 days or shorted per survey) and focused on selected areas of interest within the block. This survey and other anticipated success-based surveys and would take up to four weeks to complete.

### *5.1.2 Echo Sounders*

The majority of hydrographic depth/echo sounders are dual frequency, transmitting a low frequency pulse at the same time as a high frequency pulse. Dual frequency depth/echo sounding has the ability to identify a vegetation layer or a layer of soft mud on top of a layer of rock. The JV Partners are proposing to utilise a single beam echo-sounder with a frequency range of

38 to 200 kHz. In addition, it is proposed to also utilise multibeam echo sounders (70 - 100 kHz range and 200 dB re 1µPa at 1m source level) that are capable of receiving many return “pings”. This system produces a digital terrain model of the seafloor.

#### *5.1.3 Sub-Bottom Profilers*

Sub-bottom profilers are powerful low frequency echo-sounders that provide a profile of the upper layers of the ocean floor. Bottom profilers emit an acoustic pulse at frequencies ranging between 2 and 16 kHz, typically producing sound levels in the order of 200-230 db re 1µPa at 1m.

#### *5.1.4 Piston coring*

Piston coring (or drop coring) is one of the more common methods used to collect seabed geochemical samples. The piston coring rig is comprised of a trigger assembly, the coring weight assembly, core barrels, tip assembly and piston. The core barrels are 6 - 9 m in lengths with a diameter of 10 cm. The recovered cores are visually examined at the surface for indications of hydrocarbons (gas hydrate, gas parting or oil staining) and sub-samples retained for further geochemical analysis in an onshore laboratory.

#### *5.1.5 Box Coring*

Box corers are lowered vertically to the seabed from a survey vessel. At the seabed the instrument is triggered to collect a sample of seabed sediment. The recovered sample is completely enclosed thereby reducing the loss of finer materials during recovery. On recovery, the sample can be processed directly through the large access doors or via complete removal of the box and its associated cutting blade. The JV Partners are proposing to take box core samples (50 cm x 50 cm) at a depth of less than 60 cm.

### 5.2 Well Location and Drilling Programme

The JV Partners are proposing to drill up to five exploration wells within the Area of Interest (AOI) within the Block 3B/4B licence block.

Within Block 3B/4B the AOI for drilling is 9 711.21 km$^2$ in extent and is located offshore roughly between Port Nolloth and Hondeklip Bay, approximately 188 km from the coast at its closest point and 340 km at its furthest, in water depths between 1 000 m and 3 000 m. The expected target drilling depth is not confirmed yet and a notional well depth, below mudline, of 3 570 m is assumed at this stage.

The schedule for drilling the wells is not confirmed yet; however, the earliest anticipated date for commencement of drilling is between first quarter of 2024 (Q1 2024) and third quarter of 2024 (Q3 2024). The expected target drilling depth is not confirmed yet and a notional well depth of 3 570 m below sea floor is assumed at this stage. It is expected that it would take approximately three to four months to complete the physical drilling and testing of each well (excluding mobilisation and demobilisation). The Applicant’s strategy for future drilling is that drilling could be undertaken throughout the year (i.e., not limited to a specific seasonal window period).

## 5.3 Drilling Unit Operations

Various types of drilling technology can be used to drill an exploration well (e.g. barges, jack-up rigs, semi-submersible drilling units (rigs) and drill-ships) depending on, inter alia, the water depth and marine operating conditions experienced at the well site. Based on the anticipated sea conditions, the JV Partners are proposing to utilise a semi-submersible drilling unit or a drillship, both with dynamic positioning system suitable for the deep-water harsh marine environment. The final rig selection will be made depending upon availability and final design specifications.

A semi-submersible drilling unit is essentially a drilling rig located on a floating structure of pontoons. When at the well location, the pontoons are partially flooded (or ballasted), with seawater, to submerge the pontoons to a pre-determined depth below the sea level where wave motion is minimised. This gives stability to the drilling vessel thereby facilitating drilling operations.
A drillship is a fit for purpose built drilling vessel designed to operate in deep water conditions. The drilling "rig" is normally located towards the centre of the ship with support operations from both sides of the ship using fixed cranes. The advantages of a drillship over the majority of semi-submersible units are that a drill-ship has much greater storage capacity and is independently mobile, not requiring any towing and reduced requirement of supply vessels.

## 5.4 Support Vessels

The drilling unit would be supported / serviced by up to two support vessels, which would facilitate equipment, material and waste transfer between the drilling unit and onshore logistics base. A supply vessel will always be on standby near the drilling unit to provide support for firefighting, oil containment / recovery, rescue in the unlikely event of an emergency and supply any additional equipment that may be required. Support vessels can also be used for medical evacuations or transfer of crew if needed.

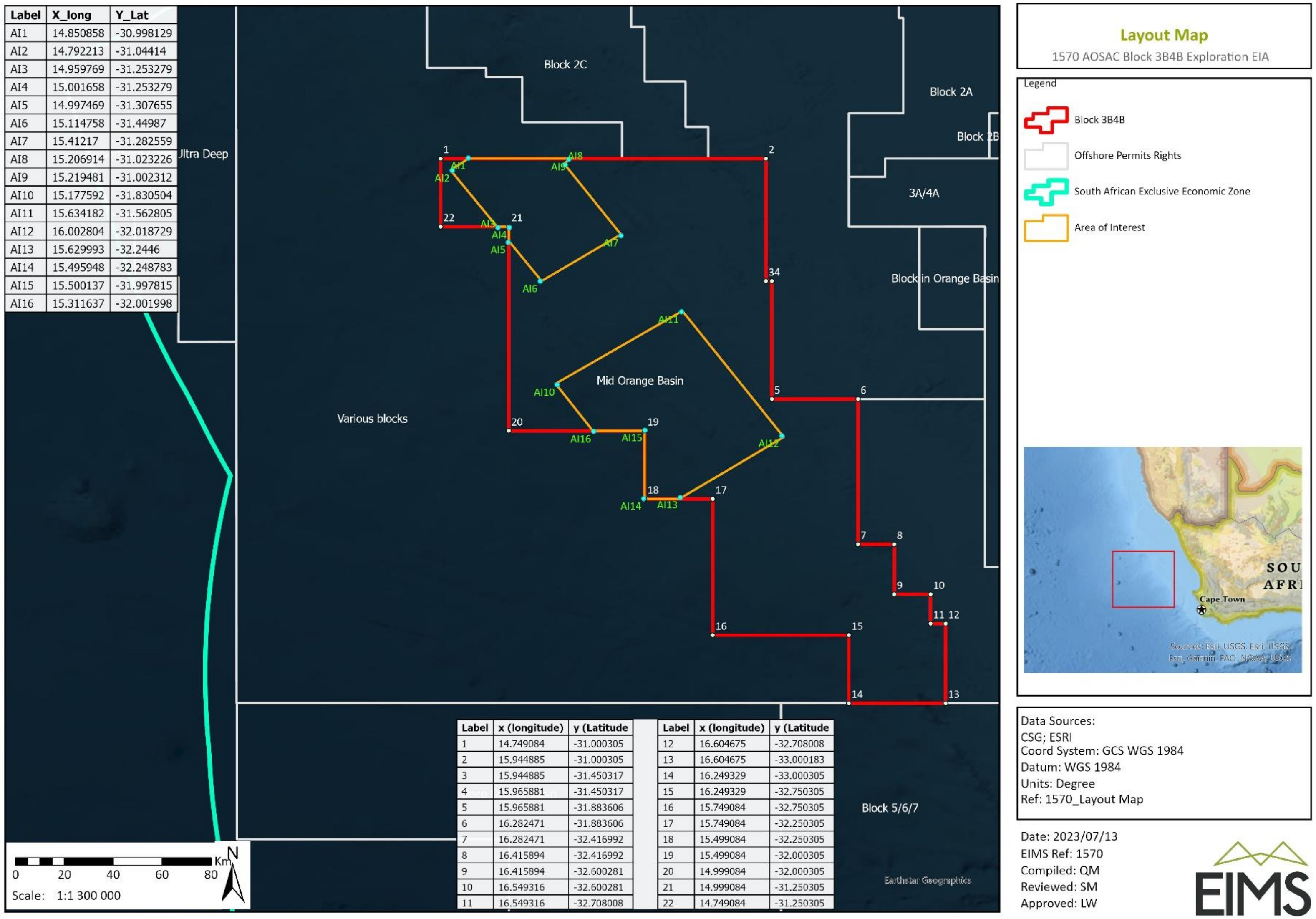
## 5.5 Helicopters

Transportation of personnel to and from the drilling unit would be provided by helicopter from Cape Town airport. It is estimated that there may be at least two flights per week between the drilling unit and the helicopter support base at Cape Town. The helicopters can also be used for medical evacuations from the drilling unit to shore (at day- or night-time), if required.

## 5.6 Onshore Logistics Base

The primary onshore logistics base will most likely be located at the Port of Cape Town (preferred option), but alternatively at the Port of Saldanha.
The shore base would provide for the storage of materials and equipment that would be shipped to the drilling unit and back to storage for onward international freight forwarding. The shore base would also be used for offices, waste management services, bunkering vessels, and stevedoring / customs clearance services.

Refer to Figure 5-1 below for an indication as to where the proposed drilling facilities will be located.




| Label | X_long | Y_Lat |
|---|---|---|
| AI1 | 14.850858 | -30.998129 |
| AI2 | 14.792213 | -31.04414 |
| AI3 | 14.959769 | -31.253279 |
| AI4 | 15.001658 | -31.253279 |
| AI5 | 14.997469 | -31.307655 |
| AI6 | 15.114758 | -31.44987 |
| AI7 | 15.41217 | -31.282559 |
| AI8 | 15.206914 | -31.023226 |
| AI9 | 15.219481 | -31.002312 |
| AI10 | 15.177592 | -31.830504 |
| AI11 | 15.634182 | -31.562805 |
| AI12 | 16.002804 | -32.018729 |
| AI13 | 15.629993 | -32.2446 |
| AI14 | 15.495948 | -32.248783 |
| AI15 | 15.500137 | -31.997815 |
| AI16 | 15.311637 | -32.001998 |

| Label | x (longitude) | y (Latitude |
|---|---|---|
| 1 | 14.749084 | -31.000305 |
| 2 | 15.944885 | -31.000305 |
| 3 | 15.944885 | -31.450317 |
| 4 | 15.965881 | -31.450317 |
| 5 | 15.965881 | -31.883606 |
| 6 | 16.282471 | -31.883606 |
| 7 | 16.282471 | -32.416992 |
| 8 | 16.415894 | -32.416992 |
| 9 | 16.415894 | -32.600281 |
| 10 | 16.549316 | -32.600281 |
| 11 | 16.549316 | -32.708008 |

| Label | x (longitude) | y (Latitude |
|---|---|---|
| 12 | 16.604675 | -32.708008 |
| 13 | 16.604675 | -33.000183 |
| 14 | 16.249329 | -33.000305 |
| 15 | 16.249329 | -32.750305 |
| 16 | 15.749084 | -32.750305 |
| 17 | 15.749084 | -32.250305 |
| 18 | 15.499084 | -32.250305 |
| 19 | 15.499084 | -32.000305 |
| 20 | 14.999084 | -32.000305 |
| 21 | 14.999084 | -31.250305 |
| 22 | 14.749084 | -31.250305 |

## Figure 5-1: Locality map

# 6 LEGISLATIVE AND POLICY FRAMEWORK

Prior to assessing the impact of activities from the offshore exploration on human health and the environment, reference needs to be made to the environmental regulations governing the impact of such operations i.e., ambient air quality standards and emissions standards. Air quality standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality standards indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air standards are given for specific averaging or exposure periods. Emission standards are generally provided for point sources and specify the amount of the pollutant acceptable in an emission stream and are often based on proven efficiencies of air pollution control equipment.

## 6.1 National Ambient Air Quality Standards for Criteria Pollutants

National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for particulate matter less than 10 and 2.5 µm in aerodynamic diameter ($PM_{10}$ and $PM_{2.5}$), sulfur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), ozone ($O_3$), carbon monoxide (CO), lead (Pb) and benzene. The NAAQS were published in the Government Gazette (no. 32816) on 24 December 2009 for $PM_{10}$ and other pollutants (South Africa, 2009). The $PM_{2.5}$ NAAQS were published in 2012 (South Africa, 2012). The relevant NAAQS are listed in Table 6-1.

**Table 6-1: South African NAAQS for relevant criteria pollutants**

| Pollutant | Averaging Period | Limit Value (µg/m³) | Frequency of Exceedance | Compliance Date |
|---|---|---|---|---|
| $NO_2$ | 1 hour | 200 | 88 | Currently enforceable |
| | 1 year | 40 | 0 | Currently enforceable |
| CO | 1 hour | 30 000 | 88 | Currently enforceable |
| | 8 hour | 10 000 | 11 | Currently enforceable |
| $SO_2$ | 1 hour | 350 | 88 | Currently enforceable |
| | 24 hour | 125 | 4 | Currently enforceable |
| | 1 year | 50 | 0 | Currently enforceable |
| $PM_{2.5}$ | 24 hour | 40 | 4 | Currently enforceable |
| | 1 year | 20 | 0 | Currently enforceable |
| $PM_{10}$ | 24 hour | 75 | 4 | Currently enforceable |
| | 1 year | 40 | 0 | Currently enforceable |

## 6.2 Inhalation Health Criteria for Non-criteria Pollutants

There is at present no national assessment criterion for total volatile organic compounds (TVOC). Most reported TVOC-concentrations in non-industrial environments are below 100 µg/m³ and few exceed 250 µg/m³. At these concentration levels only sensory effects are likely to occur, but other health effects cannot be excluded after long-term exposure. The sensory effects include sensory irritation, dryness, weak inflammatory irritation in eyes, nose, air ways and skin. At TVOC concentrations above 250 µg/m³, the likelihood of other types of health effects becomes of greater concern (ECA, 1992). For the purpose of this assessment, use is made of the "comfort" limit proposed for use by Mølhave of 200 µg/m³.

Inhalation criteria for VOCs are summarised in Table 6-2.

**Table 6-2: Chronic inhalation screening criteria for VOCs**

| Pollutant | Averaging Period | Screening criteria (µg/m³) | Source of Data |
|---|---|---|---|
| VOC | Chronic | 200 | ECA |

## 6.3 Atmospheric Emission Licence and other Authorisations

The National Environmental Management: Air Quality Act, 2004 (No. 39 of 2004) (NEM:AQA) regulates all aspects of air quality, including prevention of pollution, providing for national norms and standards. The Minister, in terms of *Section 21* of the NEM:AQA, published a list of activities which result in atmospheric emissions, and which are believed to have significant detrimental effects on the environment, human health and social welfare. Minimum Emission Standards (MES) for these listed activities were originally published on 31 March 2010 (Government Gazette No. 33064) with revisions of the schedule on the 22 November 2013 (Government Gazette No. 37054, (South Africa, 2013)) and 31 October 2018 (Government Gazette No. 42013, (South Africa, 2018)). The proposed exploration operations are not included in the listed activities requiring an Atmospheric Emissions Licence (AEL).

# 7 METHODOLOGY

The approach to, and methodology followed in the completion of tasks as part of the scope of work are discussed.

## 7.1 Emissions Inventory

The establishment of a comprehensive emission inventory formed the basis for the assessment of the air quality impacts from the Project on the receiving environment. In the quantification of emissions, use was made of emission factors which associate the quantity of a pollutant to the activity associated with the release of that pollutant. Emissions were calculated using comprehensive sets of emission factors and equations as published by the European Monitoring and Evaluation Programme/European Environment Agency (EMEP/EEA).

All air emissions from the Project include criteria and non-criteria pollutants such as $SO_2$, $NO_2$, CO, VOC and PM. Greenhouse gases (GHG) were also estimated, and these can be found in the climate change assessment report.

## 7.2 Dispersion Modelling

Air dispersion modelling provides a cost-effective means for assessing the impact of air emission sources, the major focus of which is to determine compliance with the relevant ambient air quality standards. The Department of Forestry, Fisheries and the Environment (DFFE) Regulations Regarding Air Dispersion Modelling were promulgated on 11 July 2014 in Government Gazette No. 37804 (South Africa, 2014) and recommend a suite of dispersion models to be applied for regulatory practices as well as guidance on modelling input requirements, protocols and procedures to be followed. The Code of Practice contained in the Regulations has been applied to the development of this report. The first step in the dispersion modelling exercise requires a clear objective of the modelling exercise and thereby gives clear direction to the choice of the dispersion model most suited for the purpose. Chapter 2 of the Regulations present the typical levels of assessments, technical summaries of the prescribed models (US EPA SCREEN3, AERSCREEN, AERMOD, SCIPUFF, and CALPUFF) and good practice steps to be taken for modelling applications. According to these Regulations, screening level atmospheric dispersion simulations may be completed using the US EPAs SCREEN3 dispersion model. SCREEN3 is a single source Gaussian plume model which provides maximum ground-level concentrations for point, area, flare, and volume sources. The model, however, is limited in that only single emission sources can be simulated per execution. Therefore, the predicted concentrations from each of the individual simulation runs were added to approximate the downwind concentrations of the combined emission sources from the exploration activities. SCREEN3 calculates 1-hour concentration estimates in simple terrain areas and 24-hour concentration estimates in complex terrain. These modelled estimates must be converted to the averaging period of each applicable national ambient air quality standard. The factor to convert from 1-hour to 1-day is 0.4, and from 1-hour to 1-year is 0.08.

Since the well test operations would be relatively far removed from the public it is anticipated that air pollution concentrations may be low enough to be of any health concern. However, the option of predicting worst-case air concentration levels of the pollutants from the activities, and specifically along the coastline where these plumes could potentially reach the public, is included in the scope of works as an option. The United States of America Environmental Protection Agency's (US EPAs) SCREEN3 is the preferred model for estimating air pollutants. Whilst this model does not have the same model capabilities as the more advanced dispersion models of treating the land/sea air mass interface at the coastline, this requirement may not be particularly relevant due to the relatively long distance that the plume would have travelled from the operation (≥45 km), i.e. the vertical dispersion of the elevated plume would've reached ground level at this distance and fumigation effects would be less significant.

SCREEN3 incorporates source related factors and meteorological factors to estimate pollutant concentration from continuous sources. The model assumed that the pollutant does not undergo any chemical reactions, and that no other removal processes (wet or dry deposition) act on the plume during its transportation. SCREEN3 examines a range of stability classes and wind speeds to identify the combination of wind speed and stability that results in the maximum ground level concentrations – the "worst case" meteorological conditions.

Dispersion coefficients are estimated from the Pasquill-Gifford (rural) and McElroy-Pooler (urban) methods based on the Industrial Source Complex (ISC3) formulations. The dispersion coefficients are adjusted to account for the effects of buoyancy induced dispersion. For this assessment, use was made of the rural dispersion coefficients.

SCREEN View is a user-friendly interface for the U.S. EPA screening model, SCREEN3. SCREEN View can model scenarios with simple or complex terrain, with or without building downwash and give results at discrete or automated distances. SCREEN3 is the screening version of the ISC3 model.

### 7.3 Air Quality Management Measures

The findings of the above components will inform recommendations on air quality management measures, including mitigation and monitoring.

# 8 Receiving Environment

## 8.1 Air Quality Sensitive Receptors

With the exploration being offshore, the nearest identified air quality sensitive receptors (AQSRs) include coastal towns along the west coast, with the nearest town being Paternoster and Saldanha Bay (120 km from the closest point). AQSRs generally include places of residence and areas where members of the public may be affected by atmospheric emissions generated by industrial activities.

## 8.2 Atmospheric Dispersion Potential

The atmosphere conditions have traditionally been categorised into six stability classes, as summarised in Table 8-1. Whilst the atmospheric condition over land generally exhibits a strong diurnal variation of atmospheric stabilities, with alternating stable night-time and unstable daytime conditions, the atmospheric condition over the ocean is generally more neutral and stable than unstable. The highest concentrations for low level emission sources would occur during weak wind speeds and stable atmospheric conditions. For elevated releases, unstable conditions can result in high concentrations of poorly diluted emissions close to the point of release. Neutral conditions disperse the plume equally in both the vertical and horizontal planes, whereas stable conditions minimise the plume from mixing vertically, although it can still spread horizontally.

**Table 8-1: Atmospheric stability classes**

| Atmospheric Stability | Pasquill-Gifford Stability Classification | Atmospheric Condition |
|---|---|---|
| Very unstable | A | calm wind, clear skies, hot daytime conditions |
| Moderately unstable | B | clear skies, daytime conditions |
| Unstable | C | moderate wind, slightly overcast daytime conditions |
| Neutral | D | high winds or cloudy days and nights |
| Stable | E | moderate wind, slightly overcast night-time conditions |
| Very stable | F | low winds, clear skies, cold night-time conditions |

In the absence of actual wind observational data for the study area, basic wind statistics were obtained from the Global Wind Atlas (GWA), which has been developed to assist with identifying high-wind areas for wind power generation (DTU, 2023). The current version of the (GWA 3.1) is the product of a partnership between the Department of Wind Energy at the Technical University of Denmark (DTU Wind Energy) and the World Bank Group (consisting of The World Bank and the International Finance Corporation, or IFC). The GWA uses a downscaling process, whereby large-scale atmospheric re-analysis data from the European Centre for Medium-Range Weather Forecasts (ECMWF) is used for the simulation period 2008-2017. The approximately 30-km, coarse gridded ECMWF data is used to feed a smaller spatial scale (mesoscale) model using a grid spacing of 3 km. The result is a set of generalized wind climates that is further applied in a microscale modelling system over the globe. The modelling process is made up of a WAsP[1] calculation of local wind climates for every 250 m at five heights: 10 m, 50 m, 100 m; 150 m and 200 m. On a 250 m grid, there is a local wind climate estimate for every node. The wind information is available for an offshore distance of 200 km.

[1] The WAsP software suite is the industry-standard for wind resource assessment, siting and energy yield calculation for wind turbines and wind farms.

A location approximately 120 km offshore from Paternoster and Saldanha Bay (-32.998°, 16.602°), as shown in Figure 8-1, was selected as a representative area to provide typical wind conditions in the study area. The study area is characterised by strong wind conditions with an annual mean wind speed of 7 m/s. As shown in the annual average wind rose (Figure 8-2) the most prevalent wind direction is from south-southeast (SSE) (35%), followed by winds from the south (S) (20%). Of importance to the current assessment are the conditions leading to impacts of air pollution emissions from the project that may impact on the West coast. The closest shoreline is 120 km from the study area at Paternoster and Saldanha Bay. For a direct impact, the wind must come from a westerly direction. According to the GWA, the probability is about 7% of the year.

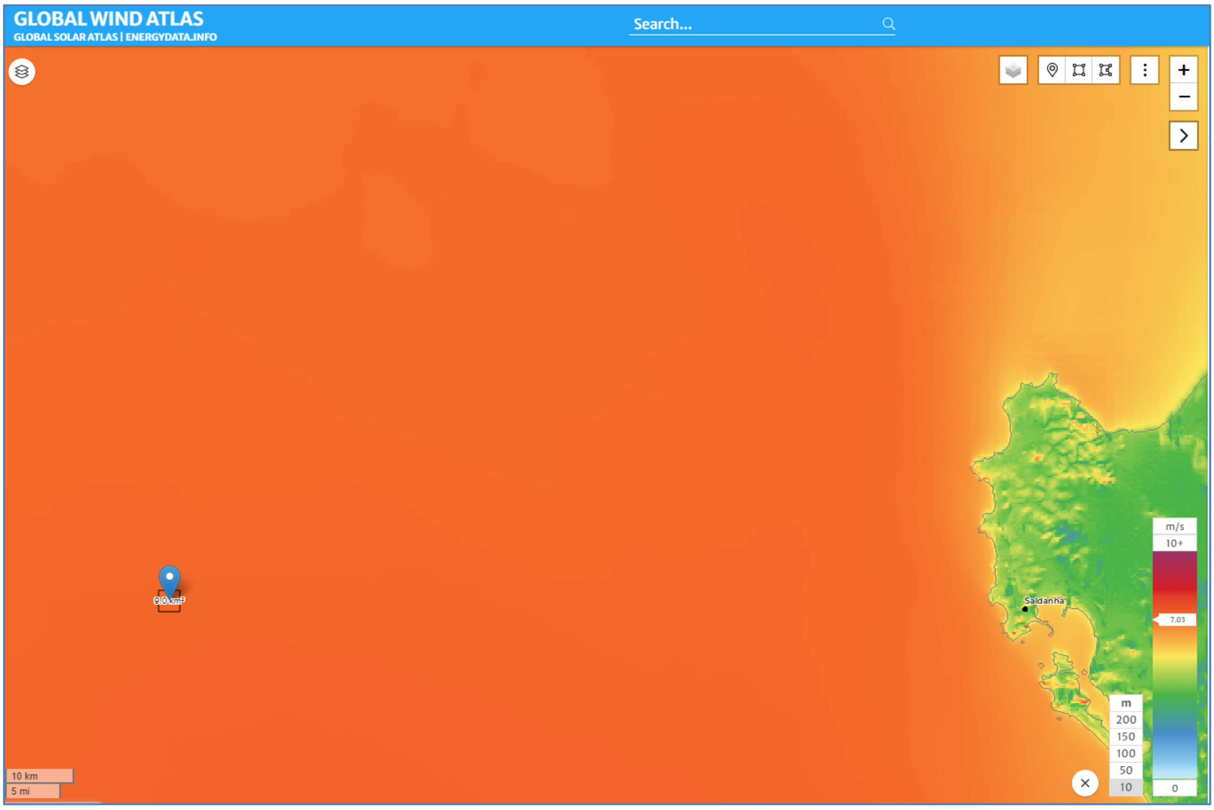



Figure 8-1: Location for selected wind statistics in the Global Wind Atlas (Global Wind Atlas 2022)

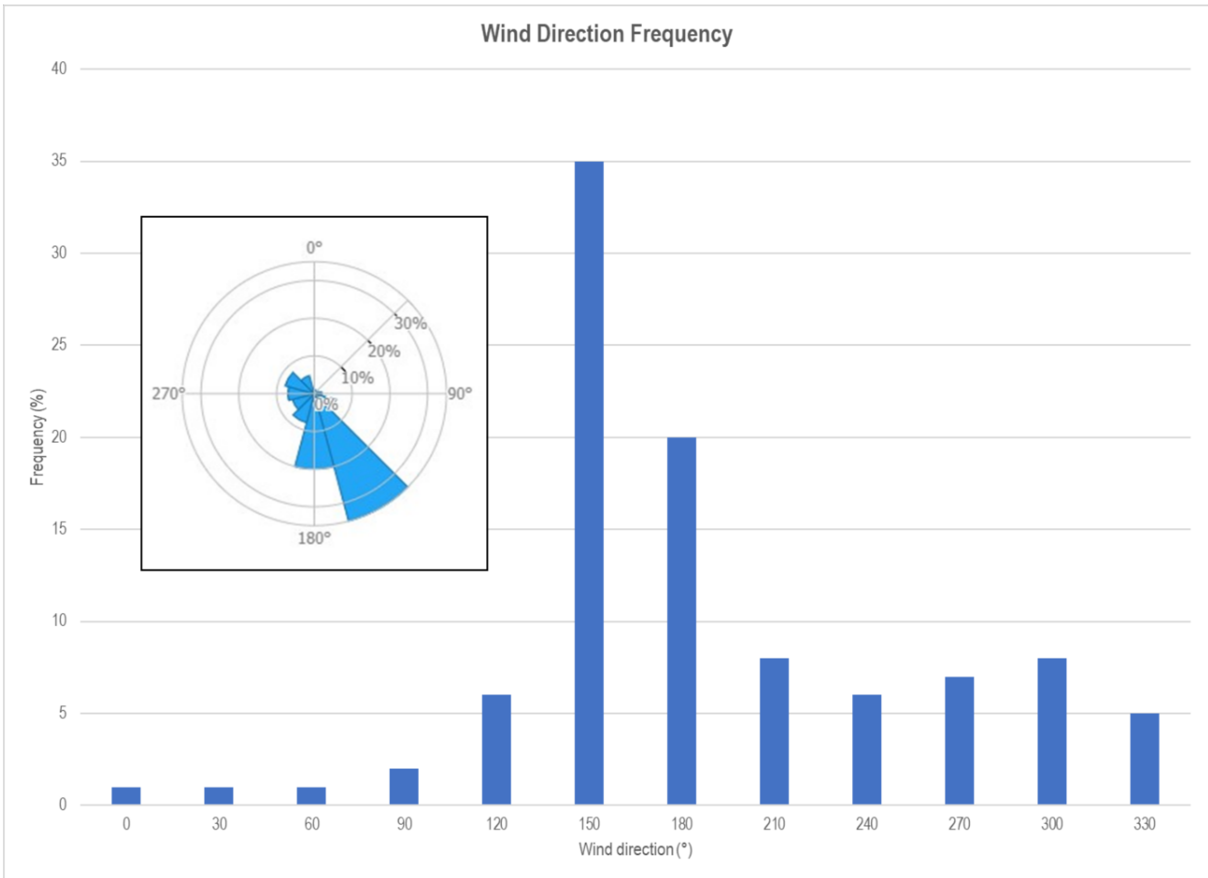



**Figure 8-2: Wind rose using 10-year (2008-2017) hindcast data for the study area (Global Wind Atlas 2022)**

Two atmospheric conditions were included in the dispersion simulations:

- Worst-case meteorological conditions would be during low wind speed and stable atmospheric periods, typically during the night. This meteorological scenario is represented by “F” Pasquill-Gifford class with a wind speed of 1.5 m/s.
- The second meteorological scenario was “D” Pasquill-Gifford class and a wind speed of 3 m/s, a typical daytime condition represented by neutral atmosphere with a more defined wind speed of 3.0 m/s or greater.

As discussed above, the probability of the wind blowing toward the coastline from the Project is estimated to be a maximum of 7% per year. The annual average wind speed is about 7 m/s. Calm wind conditions (≤1.5 m/s) represent the worst case for atmospheric dispersion is expected to occur less than 2% of the year.

# 9 IMPACT ON THE RECEIVING ENVIRONMENT

## 9.1 Atmospheric Emissions

Sources of emission and associated pollutants considered in the emissions inventory included:

- Combustion emissions
- Waste gas disposal emissions
- Process emissions

All emissions were determined through the application of emission factors published by the EMEP/EEA (EMEP/EEA, 2019). A summary of sources quantified, emissions estimation techniques applied, emission factors and source input parameters are summarised in Table 9-1. Estimated annual average emissions, per source group, are presented in Table 9-2 (lower range) and Table 9-3 (upper range).

**Table 9-1: Emission estimation techniques and parameters**

| Source Group | Emission Estimation Technique<br>Emissions factors | Input Parameters |
|---|---|---|
| Combustion | EMEP/EEA Shipping (1.A.3.d)<br>(Ships using marine gas oil)<br>NOx: 72.2 kg/tonne fuel<br>CO: 3.84 kg/tonne fuel<br>NMVOC: 1.75 kg/tonne fuel<br>$SO_2$: 1.82 kg/tonne fuel<br>PM: 1.07 kg/tonne fuel | Drill rig: 65 days/exploration period,<br>22 000 litres/day – 1 430 000 litres/exploration period<br>Platform service vessel: 84 days/exploration period,<br>5 000 litres/day – 420 000 litres/exploration period<br>Anchor handling tug: 74 days/exploration period,<br>20 000 litres/day – 1 480 000 litres/exploration period<br>Assumed a marine gas oil density of 0.84 kg/l (Table A.1, Life Cycle Assessment of Greenhouse Gas and Criteria Air Pollutant Emissions from Conventional and Biobased Marine Fuels) |
| Combustion | EMEP/EEA Civil aviation (1.A.3.a)<br>(Helicopter)<br>NOx: 9.6 kg/tonne fuel<br>CO: 66.4 kg/tonne fuel<br>NMVOC: 5.8 kg/tonne fuel<br>$SO_2$: 0.8 kg/tonne fuel | Helicopter: 16 176 nautical miles (NM)/exploration period,<br>3.75 litres/NM – 82 500 litres/exploration period<br>Assumed average value for the various countries.<br>Assumed a jet kerosene density of 0.794 kg/l (Table D.1, SA Technical guidelines) |
| Waste gas/oil disposal | EMEP/EEA Venting and flaring (1.B.2.c)<br>(Well testing)<br>NOx: 3.7 kg/tonne oil burned<br>CO: 18 kg/tonne oil burned<br>NMVOC: 3.3 kg/tonne oil burned | Burning of oil: range of between 100 to 1000 bbl per day<br>Assumed 10 days per exploration period<br>Assumed a crude oil density of 873.46 kg/m³ (Table 3-8, Compendium of GHG Methodologies for the Natural Gas and Oil Industry 2021) |
| Waste gas/oil disposal | EMEP/EEA Venting and flaring (1.B.2.c)<br>(Flaring in oil and gas extraction)<br>NOx: 1.4 kg/tonne gas burned<br>CO: 6.3 kg/tonne gas burned<br>NMVOC: 1.8 kg/tonne gas burned<br>$SO_2$: 0.013 kg/tonne gas burned | Flaring of gas: 30 MMscfd<br>Assumed 10 days per exploration period<br>Assumed a natural gas density of 0.6728 kg/m³ (Table 3-8, Compendium of GHG Methodologies for the Natural Gas and Oil Industry 2021) |
| Process | EMEP/EEA Oil exploration (1.B.2.a.i)<br>(Oil exploration - offshore facilities)<br>NMVOC: 0.4 kg/tonne oil | Oil: range of between 100 to 1000 bbl per day<br>Assumed 84 days per exploration period |

**Table 9-2: Estimated annual average emission rates (lower range)**

| Source Group | $NO_2$ (tpa) | CO (tpa) | NMVOC (tpa) | $SO_2$ (tpa) | $PM_{10}$ (tpa) |
|---|---|---|---|---|---|
| Combustion | 203 | 15.1 | 5.3 | 5.1 | 3.0 |
| Waste gas/oil disposal | 8 | 38.4 | 10.7 | 0.1 | - |
| Process | - | - | 0.5 | - | - |
| Total Emissions | **211** | **53.5** | **16.5** | **5.2** | **3.0** |

**Table 9-3: Estimated annual average emission rates (upper range)**

| Source Group | $NO_2$ (tpa) | CO (tpa) | NMVOC (tpa) | $SO_2$ (tpa) | $PM_{10}$ (tpa) |
|---|---|---|---|---|---|
| Combustion | 203 | 15.1 | 5.3 | 5.1 | 3.0 |
| Waste gas/oil disposal | 13 | 60.9 | 14.8 | 0.1 | - |
| Process | - | - | 4.7 | - | - |
| Total Emissions | **216** | **76** | **24.8** | **5.2** | **3.0** |

## 9.2 Dispersion modelling of proposed exploration activities

Simulations were undertaken to determine highest hourly pollutant concentrations. Highest daily and annual average ground level concentrations were extrapolated through the application of factors specified in the Regulations Regarding Air Dispersion Modelling. Averaging periods were selected to facilitate the comparison of predicted pollutant concentrations to relevant NAAQS and screening criteria.

Results are presented in tabular form as maximum ground level pollutant concentrations in comparison with assessment criteria.

Simulations are for the incremental concentrations due to the exploration activities. The stack parameters provided in Table 9-4 were assumed for the sources offshore.

**Table 9-4: Stack parameters used in SCREEN3**

| Parameter | Point source |
|---|---|
| Stack height (m) | 10 |
| Stack diameter (m) | 0.5 |
| Stack temperature (K) | 500 |
| Stack velocity (m/s) | 10 |
| Urban/rural | Rural |
| Receptor height (m) | 1.5 |

### 9.2.1 Simulated Ambient $NO_2$ Concentrations

Simulated ambient $NO_2$ concentrations are within the hourly and annual NAAQS at the nearest AQSRs (Table 9-5). The NAAQS may be exceeded from 500 m to 2 km from the source, but this is away from any AQSRs.

**Table 9-5: Simulated $NO_2$ ground level concentrations at the nearest AQSRs**

| AQSR | Simulated SCREEN3 $NO_2$ hourly concentration (µg/m³) | Extrapolated $NO_2$ annual concentration (µg/m³) |
|---|---|---|
| Maximum concentration (419 m) – neutral conditions | **2 065** | **165** |
| Nearest AQSRs (~100 km) – neutral conditions | 1.7 | 0.14 |
| Maximum concentration (2 001 m) – stable conditions | **1 006** | **80** |
| Nearest AQSRs (~100 km) – stable conditions | 23.1 | 1.85 |
| **NAAQS** | **200** | **40** |

### 9.2.2 Simulated Ambient CO Concentrations

Simulated ambient CO concentrations are within the hourly NAAQS at the nearest AQSRs (Table 9-6).

**Table 9-6: Simulated CO ground level concentrations at the nearest AQSRs**

| AQSR | Simulated SCREEN3 CO hourly concentration (µg/m³) |
|---|---|
| Maximum concentration (419 m) – neutral conditions | 727 |
| Nearest AQSRs (~100 km) – neutral conditions | 0.6 |
| Maximum concentration (2 001 m) – stable conditions | 354 |
| Nearest AQSRs (~100 km) – stable conditions | 8.1 |
| **NAAQS** | **30 000** |

### 9.2.3 Simulated Ambient $SO_2$ Concentrations

Simulated ambient $SO_2$ concentrations are within the hourly, daily and annual NAAQS at the nearest AQSRs (Table 9-7).

**Table 9-7: Simulated $SO_2$ ground level concentrations at the nearest AQSRs**

| AQSR | Simulated SCREEN3 $SO_2$ hourly concentration (µg/m³) | Extrapolated $SO_2$ daily concentration (µg/m³) | Extrapolated $SO_2$ annual concentration (µg/m³) |
|---|---|---|---|
| Maximum concentration (419 m) – neutral conditions | 50 | 20 | 4 |
| Nearest AQSRs (~100 km) – neutral conditions | 0.04 | 0.016 | 0.003 |
| Maximum concentration (2 001 m) – stable conditions | 24 | 9.6 | 1.9 |
| Nearest AQSRs (~100 km) – stable conditions | 0.56 | 0.224 | 0.045 |
| **NAAQS** | **350** | **125** | **50** |

### 9.2.4 *Simulated Ambient $PM_{10}$ and $PM_{2.5}$ Concentrations*

All PM was conservatively assumed to be 100 % $PM_{2.5}$. Simulated ambient $PM_{2.5}$ concentrations are within the daily and annual NAAQS at the nearest AQSRs (Table 9-8).

**Table 9-8: Simulated PM ground level concentrations at the nearest AQSRs**

| AQSR | Extrapolated $PM_{2.5}$ daily concentration (µg/m³) | Extrapolated $PM_{2.5}$ annual concentration (µg/m³) |
|---|---|---|
| Maximum concentration (419 m) – neutral conditions | 11.4 | 2.3 |
| Nearest AQSRs (~100 km) – neutral conditions | 0.008 | 0.002 |
| Maximum concentration (2 001 m) – stable conditions | 5.6 | 1.1 |
| Nearest AQSRs (~100 km) – stable conditions | 0.128 | 0.026 |
| **NAAQS** | **40** | **20** |

### 9.2.5 *Simulated Ambient VOC Concentrations*

Simulated ambient VOC concentrations are shown in Table 9-9. Simulated annual average VOC concentrations are well below the ECA guideline of 200 µg/m³ at all of the AQSRs.

**Table 9-9: Simulated VOC ground level concentrations at the nearest AQSRs**

| AQSR | Simulated SCREEN3 VOC hourly concentration (µg/m³) | Extrapolated VOC annual concentration (µg/m³) |
|---|---|---|
| Maximum concentration (419 m) – neutral conditions | 237 | 19 |
| Nearest AQSRs (~100 km) – neutral conditions | 0.2 | 0.02 |
| Maximum concentration (2 001 m) – stable conditions | 116 | 9 |
| Nearest AQSRs (~100 km) – stable conditions | 2.7 | 0.22 |
| **ECA guideline** | **-** | **200** |

**Given the conservative nature of the impact assessment, it can be concluded that emissions from the proposed exploration will not result in exceedances of NAAQS at the closest sensitive receptors.**

## 9.3 Significance of Impact on the Environment

The methodology used for assessing the significance of the impact was obtained from EIMS. The environmental risk is dependent on the consequence and the probability that the impact will occur.

Step 1: Determine the CONSEQUENCE of the impact by using the factors below.

**Table 9-10: Consequence of the impact**

| Score | Source | | | | |
|---|---|---|---|---|---|
| | **Duration of impact** | **Extent** | **Magnitude Intensity** | **Reversibility** | **Nature** |
| -2.25 | Short term<br>2 | Local<br>3 | Low<br>2 | Reversible without significant time and cost<br>2 | Negative<br>-1 |

Step 2: Determine the PROBABILITY of the impact.

**Table 9-11: Probability of the impact**

| Score | Probability |
|---|---|
| 3 | Medium probability |

Step 3 Determine the ENVIRONMENTAL RISK (ER) of the impact by using the values that were obtained above for Probability and Consequence.

**Table 9-12: Environmental risk**

| | | | | | | |
|---|---|---|---|---|---|---|
| Consequence | 5 | 5 | 10 | 15 | 20 | 25 |
| | 4 | 4 | 8 | 12 | 16 | 20 |
| | 3 | 3 | 6 | **9** | 12 | 15 |
| | 2 | 2 | 4 | **6** | 8 | 10 |
| | 1 | 1 | 2 | 3 | 4 | 5 |
| | | 1 | 2 | 3 | 4 | 5 |
| | **Probability** | | | | | |

Applying the criterion given above, the significance for the proposed exploration is given in Table 9-13.

**Table 9-13: Environmental Risk Score**

| Description | ER Score |
|---|---|
| Low (i.e. where this impact is unlikely to be a significant environmental risk) | <9 |

# 10 AIR QUALITY MANAGEMENT PLAN

The principal sources of emissions to air will be exhaust gas emissions produced by the combustion of fuel in engines for vessels and to a minor extent from the helicopter. Flaring could contribute to emissions, however information on flaring is currently uncertain.

## 10.1 Source Specific Recommended Management and Mitigation Measures

### 10.1.1 Navigation by ships

*MARPOL 73/78, Annex VI* outlines international requirements to reduce harmful air emissions from ships. The regulations include emission limits for $SO_2$, NOx and PM. General emission control technologies that have been used on ships include:

- Ultra-Low diesel fuels : PM reduction 5-15%; $SO_2$ reduction up to 99%
- Emission filters : PM reduction efficiencies up to 90%
- Selective catalytic Reduction (SCR) : NOx reduction efficiencies 70%-90%
- Gas scrubbers : $SO_2$ reduction efficiencies 90%-99%
- On-Engine modifications
- Vessel speed reduction

### 10.1.2 Flaring and venting

Associated gas brought to the surface with crude oil during oil production is sometimes disposed of at offshore facilities by venting or flaring. This practice is now widely recognized to be a waste of valuable resources as well as a significant source of GHG emissions. At this stage information on flaring is currently uncertain, however general control measures for flaring of gas given by the World Bank Group can be found in Appendix D. The applicant stated in the RFI in the Info folder that "During testing the gas flaring is normally limited to a max of 30MMscfd gas. Oil will be burnt through the flare boom, rates vary between 100 to 1000 bbl/day but only for a max duration of 4 hours."

# 11 CONCLUSION

## 11.1 Main Findings

NAAQS pollutant emissions are summarised in Table 9-2 and Table 9-3 using the EMEP/EEA emission factors. Emissions of $NO_2$ range between 211 and 216 tpa with fuel combustion being the dominant source. Emissions of CO range between 54 and 76 tpa, with waste gas disposal being the dominant source. Emissions of NMVOC range between 17 and 25 tpa, with waste gas disposal being the dominant source. Emissions of PM and $SO_2$ are low.

Meteorological scenarios that reflect worst-case atmospheric conditions were selected to perform dispersion simulations. These include calm stable night-time conditions (wind speed of 1.5 m/s) and neutral daytime conditions with a relatively low wind speed of 3 m/s. These atmospheric conditions are more likely to occur during winter winds and in order to impact on the coastline, has to be from westerly wind sector. Based on the wind field for the study area, the wind could blow from this direction approximately 7% of the year.

Screening dispersion modelling using the US EPA SCREEN3 model was used to calculate the maximum concentrations at the closest coastal area, approximately 100 km downwind from the nearest seismic survey location. This model was used with the emission rates calculated using the EMEP/EEA emission factors.

Conservatively all NOx was assumed to be $NO_2$. The highest hourly average $NO_2$ concentrations expected at Saldanha Bay (closest receptor at 120 km from a location on the eastern boundary of the Area of Interest) is 12% of the NAAQS limit value. This represents the maximum ground level concentration that would occur under conditions of weak atmospheric dispersion, i.e., low vertical turbulence and calm wind speeds that would otherwise assist with the dilution of air pollutants. Similarly, the highest hourly average $SO_2$ concentration is predicted to be 0.16% of the NAAQS limit value. The extrapolated highest $PM_{2.5}$ daily average concentration is 0.32% of the NAAQS. The predicted highest CO hourly average concentration is only 0.002% of the NAAQS. There are no NAAQS for NMVOCs; however, the highest predicted hourly average NMVOC concentration is still lower than the annual average NAAQS limit value for benzene. **Since the calculated maximum predicted ground level concentrations (under worst-case atmospheric conditions) are considerably lower than the NAAQS limit values, it is expected that the exposure to any significant concentration levels would be infrequent and insignificant with respect to the NAAQS. Such emissions are therefore unlikely to have a direct effect on any receptor or other activity, other than the project vessels themselves.**

The impact of the estimated operational emissions from the proposed project is considered to be **local**, and of **short-term duration** and **low intensity**. The potential impact on the air quality emissions is of **low significance** without further mitigation.

## 11.2 Recommendations

The means to minimise emissions from the Project would be achieved by

- Implement a maintenance plan to ensure all ship engines and boilers receive adequate maintenance to minimise soot and unburnt fuel released to the atmosphere and maximize energy efficiency.
- Ensure no incineration (subject to obtaining an atmospheric emissions license) of waste occurs within the port limits.

However, if incineration of waste material is to be undertaken (within port limits), and the vessel is considered an 'installation' (as per the NEM:AQA MES) and more than 10 kg waste is incinerated per day, this will require an AEL. The relevant listed activity would be *Category 8.1 - Thermal Treatment of Hazardous and General Waste*.

## 12 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

Several assumptions had to be made in the study. These, along with other limitations are listed below and should be noted when interpreting the outcomes of the study:

- The quantification of sources of emission was restricted to project activities provided by the client including drilling, support vessels, etc.
- The fuels assumed to be consumed by these sources was provided by the client.
- As the details of the venting and flaring are not yet certain, it was assumed that flaring may occur for 10 days during the exploration project. The applicant stated in the RFI in the Info folder that "During testing the gas flaring is normally limited to a max of 30MMscfd gas. Oil will be burnt through the flare boom, rates vary between 100 to 1000 bbl/day but only for a max duration of 4 hours."
- No incineration of waste was assumed to occur onboard the vessels.
- Where a range of emission factors were available, the upper range was used in the screening assessment as a worst-case estimate.
- Conservatively all NOx was assumed to be $NO_2$.
- The drill rig was assumed to be a mobile combustion source, however it will be both stationary and mobile.

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# 14 APPENDICES

## APPENDIX A: SPECIALIST DECLARATION FORM

# APPENDIX B: CURRICULUM VITAE OF PROJECT TEAM



# CURRICULUM VITAE

| | |
|---|---|
| **Name** | Gillian Petzer (née Möhle) |
| **Date of Birth** | 1 December 1975 |
| **Nationality** | South African |
| **Employer** | Airshed Planning Professionals (Pty) Ltd |
| **Position** | Principal Consultant and Project Manager |
| **Profession** | Chemical Engineer employed as an Air Quality Assessment Consultant |
| **Years with Firm** | 19 years |

## MEMBERSHIP OF PROFESSIONAL SOCIETIES

- South African Institute of Chemical Engineers, 2003 to present
- Institution of Chemical Engineers (IChemE) - Membership number 99964317
- National Association for Clean Air (NACA), 2003 to present
- Professional Engineer – Registration number 20170315

## EXPERIENCE

Gillian has nineteen years of experience in air quality impact assessment and management. She is an employee of Airshed Planning Professionals (Pty) Ltd and is involved in the compilation of emission inventories, air pollution mitigation and management, and air pollution impact work.

A list of projects competed in various sectors is given below.

*Air Quality Management*

- Richards Bay Air Quality Management Plan
- Tshwane Air Quality Management Plan
- Dust Management Plan for various mines

*Mining Sector*

Lusthof Colliery, South Deep Mine, Kangra, MacWest, Sishen Iron Ore Mine, SA Chrome, Esaase Gold Project (Ghana), Mampon Gold Mine (Ghana), Mittal Newcastle, Navachab (Namibia), Skorpion Zinc mine (Namibia), Debswana Diamond Mines (Botswana). Quarries: Afrisam Pietermaritzburg, AMT operations (Rustenburg and Wonderstone)

*Industrial Sector*

Various Brickworks, Middelburg Ferrochrome, Impala Platinum (Springs), Delta EMD Project, PetroSA, Alfluorco Aluminium Fluoride Project, PPC, Rand Carbide, Vanchem, BCL incinerator, AEL, Namakwa Sands Plant, Liquid Natural Gas Refinery (Equatorial Guinea), Phalaborwa Mining Company, Asphalt plants, Ceramic facilities

*Energy Sector*

Walvis Bay Power Station Project (Namibia), various small power stations (Eritrea, Nigeria, Mauritania, Kenya), Matimba Power Station, Mossel Bay OCGT Power Station, Sese Power Station (Botswana), Geothermal Power Station (Kenya)

*Waste Disposal and Treatment Sector*

Rosslyn and Chloorkop Waste Disposal Sites, Organic waste disposal site

*Transport and Logistics Sector*

Kolomela Iron Ore Railway Line, Guinea Port and Railway Project (Guinea), Grindrod Coal Terminal, VALE Port Project (Mozambique), various fuel depots.

*Ambient Air Quality and Noise Sampling*

- Gravimetric Particulate Matter (PM) and dustfall sampling
- Passive diffusive gaseous pollutant sampling

## SOFTWARE PROFICIENCY

- Atmospheric Dispersion Models: AERMOD, ISC, CALPUFF, ADMS (United Kingdom), CALINE, GASSIM, TANKS
- Graphical Processing: Surfer, ArcGIS (basic proficiency)
- Other: MS Word, MS Excel, MS Outlook

## EDUCATION

- BEng: (Chemical Engineering), 2002, University of Pretoria

## COURSES COMPLETED AND CONFERENCES ATTENDED

- Conference: NACA (October 2003), Attended
- Conference: NACA (October 2005), Attended and presented a paper
- Conference: NACA (October 2007), Attended and presented a paper
- Conference: NACA (October 2008), Attended and presented a poster
- Conference: NACA (October 2009), Attended and presented a paper
- Conference: NACA (October 2012), Attended
- Conference: IUAPPA (October 2013), Attended
- Course: Climate change and carbon management. Presented by Environmental & Sustainability Solutions (July 2014)
- Conference NACA (October 2016), Attended
- Conference NACA (October 2017), Attended
- Process Vessel and Tank Design Course (May 2019), Attended

## COURSES PRESENTED

- National Environmental Management: Air Quality Act and its Implementation (course arranged by the North-West University - NWU)

## COUNTRIES OF WORK EXPERIENCE

South Africa, Namibia, Botswana, Ghana, Eritrea, Mauritania, Mozambique, Kenya, Guinea, Equatorial Guinea and Nigeria

## LANGUAGES

| Language | Proficiency |
|---|---|
| English | Native language |
| Afrikaans | Full professional proficiency |

## REFERENCES

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| Dr Lucian Burger | Director at Airshed Planning Professionals | +27 (82) 491 0385 lucian@airshed.co.za |
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## CERTIFICATION

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications and my experience.

28/04/2022

## Appendix C: Impact Significance Rating Methodology

The impact significance rating methodology, as presented herein and utilised for all EIMS Impact Assessment Projects, is guided by the requirements of the NEMA EIA Regulations 2014 (as amended). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/ likelihood (P) of the impact occurring. The ER is determined for the pre- and post-mitigation scenario. In addition, other factors, including cumulative impacts and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

Determination of Environmental Risk:

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER). The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and Reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{(E + D + M + R) * N}{4}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table C-1 below.

**Table C-1: Criteria for determining impact consequence**

| Aspect | Score | Definition |
|---|---|---|
| Nature | - 1 | Likely to result in a negative/ detrimental impact |
| | +1 | Likely to result in a positive/ beneficial impact |
| Extent | 1 | Activity (i.e. limited to the area applicable to the specific activity) |
| | 2 | Site (i.e. within the development property boundary), |
| | 3 | Local (i.e. the area within 5 km of the site), |
| | 4 | Regional (i.e. extends between 5 and 50 km from the site |
| | 5 | Provincial / National (i.e. extends beyond 50 km from the site) |
| Duration | 1 | Immediate (<1 year) |
| | 2 | Short term (1-5 years), |
| | 3 | Medium term (6-15 years), |
| | 4 | Long term (the impact will cease after the operational life span of the project), |
| | 5 | Permanent (no mitigation measure of natural process will reduce the impact after construction). |
| Magnitude/ Intensity | 1 | Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected), |
| | 2 | Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected), |
| | 3 | Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way), |
| | 4 | High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or |

| Aspect | Score | Definition |
|---|---|---|
| | 5 | Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease). |
| Reversibility | 1 | Impact is reversible without any time and cost. |
| | 2 | Impact is reversible without incurring significant time and cost. |
| | 3 | Impact is reversible only by incurring significant time and cost. |
| | 4 | Impact is reversible only by incurring prohibitively high time and cost. |
| | 5 | Irreversible Impact |

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per Table C-2.

### Table C-2: Probability scoring

| | | |
|---|---|---|
| Probability | 1 | Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%), |
| | 2 | Low probability (there is a possibility that the impact will occur; >25% and <50%), |
| | 3 | Medium probability (the impact may occur; >50% and <75%), |
| | 4 | High probability (it is most likely that the impact will occur- > 75% probability), or |
| | 5 | Definite (the impact will occur), |

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

$$ER = C \times P$$

### Table C-3: Determination of environmental risk

| | | | | | | |
|---|---|---|---|---|---|---|
| Consequence | 5 | 5 | 10 | 15 | 20 | 25 |
| | 4 | 4 | 8 | 12 | 16 | 20 |
| | 3 | 3 | 6 | 9 | 12 | 15 |
| | 2 | 2 | 4 | 6 | 8 | 10 |
| | 1 | 1 | 2 | 3 | 4 | 5 |
| | | 1 | 2 | 3 | 4 | 5 |
| | **Probability** | | | | | |

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table -4.

### Table C-4: Significance classes

| Environmental Risk Score | |
|---|---|
| **Value** | **Description** |
| < 9 | Low (i.e. where this impact is unlikely to be a significant environmental risk), |
| ≥9; <17 | Medium (i.e. where the impact could have a significant environmental risk), |
| ≥ 17 | High (i.e. where the impact will have a significant environmental risk). |

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

Impact Prioritisation:

Further to the assessment criteria presented in the section above, it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

**Table C-5: Criteria for determining prioritisation**

| | | |
|---|---|---|
| **Cumulative Impact (CI)** | Low (1) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change. |
| | Medium (2) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change. |
| | High (3) | Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change. |
| **Irreplaceable loss of resources (LR)** | Low (1) | Where the impact is unlikely to result in irreplaceable loss of resources. |
| | Medium (2) | Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited. |
| | High (3) | Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions). |

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table C-5. The impact priority is therefore determined as follows:

$$Priority = CI + LR$$

The result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (refer to Table C-6).

**Table C-6: Determination of prioritisation factor**

| Priority | Prioritisation Factor |
|---|---|
| 2 | 1 |
| 3 | 1.125 |
| 4 | 1.25 |
| 5 | 1.375 |
| 6 | 1.5 |

In order to determine the final impact significance, the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is an attempt to increase the post mitigation environmental risk rating by a factor of 0.5, if all the priority attributes are high (i.e. if an impact comes out with a high medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance).

**Table C-7: Final environmental significance rating**

| Significance Rating | Description |
|---|---|
| ≥-17 | High negative (i.e. where the impact must have an influence on the decision process to develop in the area). |
| ≥-17, ≤-9 | Medium negative (i.e. where the impact could influence the decision to develop in the area). |
| >-9, <0 | Low negative (i.e. where this impact would not have a direct influence on the decision to develop in the area). |
| 0 | No impact |
| >0, <9 | Low positive (i.e. where this impact would not have a direct influence on the decision to develop in the area). |
| ≥9, ≤17 | Medium positive (i.e. where the impact could influence the decision to develop in the area). |
| >17 | High positive (i.e. where the impact must have an influence on the decision process to develop in the area). |

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

## Appendix D: World Bank Recommendations on Flaring and Venting and Well Testing (World Bank Group, 2015)

Associated gas brought to the surface with crude oil during oil production is sometimes disposed of at offshore facilities by venting or flaring. This practice is now widely recognized to be a waste of valuable resources as well as a significant source of GHG emissions.

However, flaring and venting are important safety measures on offshore oil and gas facilities, helping to ensure that gas and other hydrocarbons are safely disposed of in the event of an emergency, a power or equipment failure, or other facility upset condition. Risk assessment processes (e.g., hazard and operability study (HAZOP), hazard identification study (HAZID), etc.) to estimate the implications of situations of this type should be used in such facilities.

Measures consistent with the Global Gas Flaring and Venting Reduction Voluntary Standard (part of the Global Gas Flaring Reduction Public-Private Partnership) should be adopted when considering venting and flaring options for offshore activities. The standard provides guidance on how to eliminate or achieve reductions in the flaring and venting of natural gas.

Continuous venting of associated gas is not good practice and should be avoided. The associated gas stream should be routed to an efficient flare system, although continuous flaring of gas should be avoided if alternatives are available. Before flaring is adopted, all feasible alternatives for the gas's use should be evaluated to the maximum extent possible and integrated into production design. Alternative options may include gas utilization for on-site energy needs, gas injection for reservoir pressure maintenance, enhanced oil recovery using gas lift, or export of the gas to a neighbouring facility or to market. An assessment of alternatives should be made and adequately documented. If none of the options for the associated gas's use is feasible, measures to minimize flare volumes should be evaluated and flaring should be considered as an interim solution, with the elimination of continuous production associated gas flaring as the preferred goal.

New facilities should be designed, constructed, and operated so as to avoid routine flaring. Cost effective options to reduce flaring from existing or legacy facilities that offer sustainable social benefits (e.g., gas-to-power) should be identified and evaluated in collaboration with host country governments and other stakeholders and with a particular focus on GHG emissions.

If flaring is the only viable solution, continuous improvement of flaring through the implementation of good practices and new technologies should be demonstrated. The following pollution prevention and control measures should be considered for gas flaring:

- Implement source gas reduction measures to the extent possible.
- Use efficient flare tips and optimize the size and number of burning nozzles.
- Maximize flare combustion efficiency by controlling and optimizing flare fuel, air, and stream flow rates to ensure the correct ratio of assist stream to flare stream.
- Minimize flaring from purges and pilots—without compromising safety—through measures including installation of purge gas reduction devices, vapor recovery units, inert purge gas, soft seat valve technology where appropriate, and installation of conservation pilots.
- Minimize risk of pilot blowout by ensuring sufficient exit velocity and providing wind guards.
- Use a reliable pilot ignition system.
- Install high-integrity instrument pressure protection systems, where appropriate, to reduce overpressure events and avoid or reduce flaring situations.
- Minimize liquid carryover and entrainment in the gas flare stream with a suitable liquid separation system.

- Minimize flame lift off and/or flame lick.
- Operate flare to control odor and visible smoke emissions (no visible black smoke). Situate flare at a safe distance from accommodation units.
- Implement burner maintenance and replacement programs to ensure continuous maximum flare efficiency.
- Meter flare gas.

In the event of an emergency or equipment breakdown, or when facility upset conditions arise, excess gas should not be vented but rather should be sent to an efficient flare gas system. Emergency venting may be necessary under specific field conditions where a flare gas system is not available or when flaring of the gas stream is not possible, such as when there is a lack of sufficient hydrocarbon content in the gas stream to support combustion or a lack of sufficient gas pressure to allow it to enter the flare system. Justification for excluding a gas flaring system on offshore facilities should be fully documented before an emergency gas venting facility is considered.

To minimize flaring events as a result of equipment breakdowns and facility upsets, plant reliability should be high (>95 percent) and provisions should be made for equipment sparing and plant turn-down protocols.

Flaring volumes for new facilities should be estimated during the initial commissioning period so that appropriate flaring targets can be developed. The volumes of gas flared for all flaring events should be recorded and reported.

During well testing, flaring of produced hydrocarbons should be avoided, especially in environmentally sensitive areas. Feasible alternatives should be evaluated for the recovery of these test fluids, with the safety of handling volatile hydrocarbons considered, either for transfer to a processing facility or for alternative disposal options. An evaluation of alternatives for produced hydrocarbons should be adequately documented.

If flaring is the sole option available for the disposal of test fluids, only the minimum volume of hydrocarbons required for the test should be flowed and well-test durations should be reduced to the extent practical. An efficient test flare burner head equipped with an appropriate combustion enhancement system should be selected to minimize incomplete combustion, black smoke, and hydrocarbon fallout to the sea. Volumes of hydrocarbons flared should be recorded.