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DRAFT ENVIRONMENTAL IMPACT ASSESSMENT REPORT

GREEN METALS REFINING NAMIBIA (PTY) LTD'S PROPOSED MANGANESE REFINERY AND SULPHURIC ACID PLANT PROJECT ON FARM 58, EAST OF WALVIS BAY TOWN

APRIL 2026

Compiled for:
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DOCUMENT CONTROL

Report Title	Draft Environmental Impact Assessment Report Green Metals Refining Namibia (Pty) Ltd's proposed manganese refinery and sulphuric acid plant project on Farm 58 east of Walvis Bay Town
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Specialist input in the EIA Report	Groundwater & Surface Water Study (Sandra Müller, Water Specialist)
	Biodiversity Study (Dr. Antje Burke – EnviroScience)
	Air Quality Baseline Study (Dr. Hanlie Liebenberg-Enslin, Airshed Planning Professionals)
	Climate Change Assessment (Dr. Hanlie Liebenberg-Enslin, Airshed Planning Professionals)
	Noise Study (Nicolette von Reiche, Soundscape Consulting (Pty) Ltd)
	Socio-economic Study (Auriol Ashby)
	Archaeology (Dr. John Kinahan)
	Quantitative risk Assessment (Mike Oberholzer & Gillian Petzer, Riscom (Pty) Ltd)
Final Review	Alexandra Speiser / Werner Petrick
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DISCLAIMER

The views expressed in the document are the objective, independent views of the author. Neither Alexandra Speiser & Werner Petrick nor A. Speiser Environmental Consultants (ASEC) have any business, personal, financial, or other interest in the proposed Project apart from fair remuneration for the work performed. The content of this report is based on the author's best scientific and professional knowledge, specialist input, comments from Interested and/or Affected Parties (IAPs), site visits, information sharing by the client and their Technical Team as well as available information and previously conducted (related) EIAs. Project information contained herein is based on the interpretation of data collected and data provided by the client, accepted in good faith as being accurate and valid.

ASEC reserves the right to modify the report in any way deemed necessary should new, relevant, or previously unavailable or undisclosed information become available that could alter the findings. This report must not be altered or added to without the prior written consent of the author.

EXECUTIVE SUMMARY

INTRODUCTION

Green Metals Refining Ltd (GMR) is a technology-driven midstream refining company specializing in the production of high-purity materials essential for the green energy transition. Leveraging a proven business model, GMR focuses on harnessing existing supply chains and optimizing logistics to deliver low-carbon, battery-grade manganese at competitive costs. GMR is a privately held company registered in the United Kingdom and operates through its wholly owned subsidiary, Green Metals Refining Namibia (Pty) Ltd (GMRN), registered in Namibia.

Green Metals Refining Namibia (Pty) Ltd (GMRN) plans to construct and operate a Manganese Refinery and Sulphuric Acid Plant (and associated infrastructure and activities) ('the proposed project') on Portions 30 to 35 on Farm 58 (east of Walvis Bay town) (see **Map** below). Farm 58 belongs to the Walvis Bay Municipality, and is zoned for heavy industry.

GMRN's proposed Manganese Refinery and Sulphuric Acid Plant Location

Note: The red layout shows the Location of GMRN's proposed Manganese Refinery and Sulphuric Acid Plant. The light blue and red lines show the powerline servitude to the North of the GMRN site. Also shown are the different plots of Farm 58 (e.g. Ptn 2).

This Environmental Impact Assessment (EIA) Report was compiled as part of the EIA process that is being undertaken for the proposed Project and provides the following information:

- Introduction to 'the proposed Project'.
- Relevant environmental legislation and policies.
- The EIA process being followed, i.e., approach and process methodology.
- The motivation for 'the proposed Project' (i.e., need and desirability).
- A description of the proposed project activities, facilities, and associated infrastructure.
- Project alternatives considered.
- A description of the key characteristics of the receiving/baseline environment.
- Findings of specialist studies that were undertaken as part of the EIA process.
- Assessment of potential impacts of the proposed Project activities and associated facilities.
- Management and mitigation measures and design requirements necessary to avoid or reduce potentially significant impacts. (Note: Detailed management and mitigation

measures, design requirements, and monitoring requirements are included in the Environmental Management Plan (EMP) attached as **Appendix A**).

IAPs are invited to comment on this (draft) Environmental Impact Assessment (EIA) Report. The document will be updated to the final EIA Report, considering the comments received. The final EIA Report will be submitted to the Ministry of Industry, Mines and Energy (MIME), as the Competent Authority, for their review and consideration, as well as the Ministry of Environment, Forestry and Tourism (MEFT): Department of Environmental Affairs (DEA). The final report will also be uploaded onto MEFT's online portal. In terms of Section 32 of the Environmental Management Act, 2007 (No. 7 of 2007), the MIME is required to make recommendations on the acceptance or rejection of the report to the MEFT, i.e., the office of the Environmental Commissioner, who will make the final decision on the acceptance of the EIA Report.

Opportunity to comment

IAPs are invited to comment on this draft EIA Report along with all its Appendices (including the Draft EMP), which will be available for a review and comment period from **15th of April 2026** to the **15th of May 2026**. Comments should be sent to ASEC at the address, telephone number, or e-mail address shown below by **no later than 15 May 2026**.

WHO TO CONTACT:

Alexandra Speiser (ASEC)		**Werner Petrick**
Email: amspeiser@yahoo.com	**or**	**Email:** wpetrick@namisun.com
		Telephone: 081 140 5968

Introduction of the proposed GMRN Project

GMRN will source high-quality manganese ore from established mines in South Africa to produce refined, battery-grade manganese products, serving as feedstock for precursor cathode active material (pCAM) manufacturers. The project will be developed within a designated heavy industrial zone. Cathode materials are essential components in the production of lithium-ion batteries (LIBs), which power electric vehicles (EVs) and stationary energy storage systems.

The proposed Project (and associated Application for an Environmental Clearance Certificate (ECC)) entails the following key components:

- Manganese Refinery Facility and associated infrastructure.
- Sulphuric Acid Plant and associated infrastructure.
- Associated waste stream facility, i.e., the Mineral Residue Facility (MRF).

At the time of this assessment, the detailed routing and design of the external power supply and water supply infrastructure are still under development. These components are therefore described only at a conceptual level. Where required, further environmental assessment processes will be undertaken once sufficient design information becomes available. Nonetheless, these project components are briefly outlined in **Section 4** of the full report.

Project Motivation (Need and Desirability)

Business case

Manganese plays a critical role in the battery industry, both in reducing costs and improving performance. In nickel manganese cobalt (NMC) batteries, manganese helps lower production costs, while in lithium manganese iron phosphate (LMFP) batteries, it increases energy density. As a result, manganese is becoming an increasingly important metal in the development of next-generation lithium-ion battery (LIB) technologies.

The demand for high-purity manganese chemicals, such as High-Purity Manganese Sulphate Monohydrate (HPMSM), is being driven by the rapid growth of the electric vehicle (EV) market. This demand is further reinforced by the broader use of manganese across multiple LIB chemistries. Despite its technical advantages, manganese remains a relatively low-cost component in battery production, which makes demand for it less sensitive to price fluctuations—an effect known as inelastic demand.

As EV production scales up, this demand is expected to outpace supply starting around 2026. Forecasts project that by 2032, global demand for high-purity manganese could reach 500 to 800 kilotonnes per year (kt/a) of manganese content, equivalent to 1,500 to 2,400 kt/a of HPMSM.

Currently, over 90% of the world's high-purity manganese supply comes from China, with very few new projects underway outside of China. This creates a looming supply gap that will likely require new producers to come online to meet future global needs. (GMR, EIA - Project Description, 2025)

Motivation for the proposed Project in Namibia (i.e. Walvis Bay)

Namibia was selected by GMRN for its flexibility in sourcing manganese ore from a diverse range of mining operations. Initially, manganese ore will be imported from South Africa. However, if mining operations in Namibia — such as at Otjosondu — resume, the company plans to source ore locally.

GMRN identified Namibia's coastal region as the ideal location for its refinery and supporting infrastructure, based on five key criteria:

- **Proximity to a reliable international port** to reduce import and export costs: Namibia offers two options, namely the Lüderitz and Walvis Bay ports, with the latter having the greatest loading capacity and efficiencies.
- **Access to cost-effective and reliable ore feedstock** road and rail transport routes: GMRN will obtain its supply of manganese ore primarily from the Kalahari Manganese Field, located in the Northern Cape Province of South Africa. A well-established manganese export route to Namibia is already in place, using a combination of world-class road and rail transport links.
- **Reliable and cost-effective transport routes for ore feedstock:** GMRN will source its manganese ore primarily from the Kalahari Manganese Field in South Africa's Northern Cape Province. An established and efficient export corridor to Namibia is already in place, leveraging a combination of world-class road and rail infrastructure.
- **Secure and reliable supply of power and water** at cost-effective rates.
- **Abundant Renewable Energy Potential:** Namibia boasts some of the world's highest levels of direct normal irradiation, making it ideal for solar energy production. The government has outlined a clear strategy to develop an integrated renewable energy system, positioning the country to export both renewable electricity and green hydrogen.

The motivation for Namibia to support the project is economic and strategic in nature. The project has the potential to benefit the country, society, and surrounding communities both directly and indirectly. Direct economic benefits will be derived from wages, taxes, and profits. Indirect economic benefits will be derived from the procurement of goods and services and the increased spending power of employees through the creation of new jobs at the mine.

EIA Team

The Environmental Project team for the EIA process relating to the proposed Project is outlined in the **Table** below.

EIA Project Team and Specialists.

Team	Name	Designation	Task and Roles	Company
Lead EIA Practitioner	Alexandra Speiser	EIA Project Manager	Management of the EIA process and compilation of the Scoping Report, EIA Report and EMP, with input from Specialists.	A. Speiser Environmental Consultants cc
	Werner Petrick	EIA Project Assistant	Report and process review. Co-author/review of the above-mentioned reports. Coordination of the Public participation process.	
Specialists Investigation	Sandra Müller	Groundwater & Surface water Study	Groundwater and surface water assessment	Independent Consultant – Water Specialist
	Hanlie Liebenberg Enslin	Air quality specialist	Air Quality Baseline Study and Assessment, and Climate Change Assessment	Airshed Planning Professionals
	Nicolette von Reiche	Noise specialist	Noise assessment	Soundscape Consulting (Pty) Ltd
	Antje Burke	Biodiversity specialist	Fauna and flora assessment	EnviroScience
	John Kinahan	Archaeologist	Heritage resource assessment	J. Kinahan Archaeologist
	Auriol Ashby	Social specialist	Socio-economic assessment	Independent consultant
	Michael Oberholzer Gillian Petzer	Risk assessment specialist	Quantitative Risk Assessment	RISCOM / Airshed Planning Professionals

Assumptions, Exclusions and Limitations associated with the EIA Process

The assumptions and limitations identified by the EIA Team are outlined below:

- It is assumed that the technical (Project) information provided by GMRN and its Technical Team is accurate.
- There will be no significant changes to the project description or surrounding environment between the completion of the EIA process and implementation of the proposed project that could substantially influence findings and recommendations with respect to mitigation and management, etc. Any changes in the Project of environmental significance may require re-assessment.
- During the EIA Report Phase, the specialists used layouts and project information that were refined as the designs progressed, informed by detailed site surveys, engineering inputs, and other developments.
- The EIA focused on third parties only and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by labour acts, health and safety legislation, policies and standards to be adhered to by GMRN.
- Specialists conducting the various studies and assessments during the impact assessment phase took the limitation into account while evaluating potential impacts. Where relevant, each specialist outlined the specific assumptions and limitations applicable to their respective studies.

A summary of assumptions, exclusions and limitations of each specialist study is provided in the main report (**Section 1.4.5.1** to **Section 1.4.5.7**).

Where data limitations or exclusions apply, a precautionary approach has been adopted in the impact assessment to ensure that potential risks are not underestimated. These limitations have been taken into account when determining impact significance and the need for mitigation.

EIA PROCESS AND METHODOLOGY

The EIA process and corresponding activities that will be undertaken for the proposed GMRN Project are outlined in the sections below. The process being followed is in accordance with the requirements outlined in the EIA Regulations.

Internal Screening Process

The Internal Environmental Screening Study, provided a high-level (qualitative) description of the environmental and social aspects, as well as potential impacts, associated with the site selection for the proposed GMRN Project. This assessment focused on the three preferred sites: Arandis, Swakopmund (approximately 10 km east of Swakopmund within the future planned industrial area), and Farm 58 near Walvis Bay. The initial site selection study was conducted by CREO Engineering Solutions (Pty) Ltd (CREO, 2023),

GMRN considered the findings of the Site Selection and Internal Environmental Screening studies, as well as other relevant criteria, which resulted in the Walvis Bay Farm 58 site being one of the preferred options, offering unique benefits.

Scoping Phase

The purpose of the Scoping Phase was to:

- Communicate the nature of the proposed Project, including the location, description of the activities, infrastructure/facilities, and Project layout to IAPs.

- Provide baseline information and identify environmental and socio-economic aspects and potential impacts associated with the Project.
- Identify the most significant issues for investigation and assessment, and develop the terms of reference for specialist studies to be conducted in the Impact Assessment Phase.

The Scoping Phase involved the following:

- Notifying IAPs of the proposed Project and the steps in the EIA process.
- Creating an opportunity for IAPs to interact with the EIA project team.
- Providing adequate information for IAPs to comment on, to ensure that all key environmental and social issues are identified.

Steps undertaken during the Scoping Phase are summarised below.

Information Collection

ASEC compiled the environmental and social baseline and identified issues related to the proposed GMRN Project by drawing on multiple sources. These included previous studies like the Site Selection Study (CREO, 2023) and the Internal Environmental Screening Study (ASEC, 2024), project details and layouts provided by the GMRN Project Team, and site visits conducted by ASEC and environmental specialists. Input from experts in groundwater, air quality, noise, biodiversity, heritage, and socio-economic aspects further informed the baseline. Additionally, relevant Environmental Impact Assessments (EIAs) from nearby projects and consultations with Interested and Affected Parties (IAPs) and authorities contributed to a comprehensive understanding of the potential impacts and issues.

Scoping Phase Public Participation Process

The objective of the scoping public participation process was to ensure that IAPs were notified about the proposed Project, given a reasonable opportunity to register as interested and/or affected parties on the project database, and to provide comments. Steps undertaken during this phase are summarised in **Section 2.2.2** in the main EIA Report.

- Various (formal) Focus Group Meetings and an Open Public Meeting were held with IAPs, as summarised in the **Table** below.

Summary of Focus Group and Public Meetings conducted.

Date	Time	Type of Metting	Stakeholder	Venue
26 February 2025	8:00	(Informal) Focus Group Meeting (FGM)	Dune 7 operators	Dune 7
	9:30	Focus Group Meeting (FGM)	Walvis Bay International Airport	Walvis Bay International Airport Boardroom
	11:30	FGM	Municipality of Walvis Bay	Walvis Bay Municipality-Boardroom
	14:00	Open Public meeting	Open to the public / any I&AP	Protea Hotel by Marriott Walvis Bay Indongo in Walvis Bay

Date	Time	Type of Metting	Stakeholder	Venue
27 February 2025	12:30	FGM	Clean Energy Developing Committee, O&L	Green Hydrogen Pilot Plant Boardroom
28 February 2025	9:00	FGM	MEFT: DWNP	Stone Valley Environmental Management Facility (Swakop River Plots)
23 April 2025	14:00	FGM	MODVA	Virtual
21 May 2025	8:30	FGM	Dune 7 operators	Dune 7 office in Windhoek

Interested and Affected Parties

The **Table** below provides a broad list of persons, groups of persons or organisations that are included on the Projects IAP database.

Broad list of Stakeholders.

I&AP Grouping	Organisation
Local and regional government	• Erongo Regional Council • Municipality of Swakopmund • Municipality of Walvis Bay

Government Ministries	• Ministry of Environment, Forestry and Tourism (MEFT);
	    ○ DEA;
	    ○ Directorate of Wildlife and National Parks (DWNP);
	• National Heritage Council of Namibia;
	• Ministry of Agriculture, Water and Land Reform (MAWLR);
	• Ministry of Health and Social Services;
	• Ministry of Defence and Veteran Affairs (MODVA);
	• Ministry of Industry, Mines and Energy (MIME).

Government Parastatals	Namibia Civil Aviation Authority (NCAA); Walvis Bay International Airport operated by the Namibia Airports Company (NAC); Namport; Roads Authority;
Mines / Exploration companies	Langer Heinrich Uranium; Swakop Uranium; Orano Mining Namibia; Rössing Uranium; Bannerman Resources; Valencia.
Environmental Foundations / NGOs	Tour and Safari Association of Namibia (TASA).
National Chambers	National Chamber of Environment.
Local Businesses	Neighbouring businesses, including Dune 7 operators, Cleanergy and Ohlthaver & List (O&L) and various other businesses.

I&AP Grouping	Organisation
Media	Newspaper adverts: The Namibian Sun, Die Republikein; Allgemeine Zeitung
Other interested and affected parties	Any other people with an interest in the proposed Project or who may be affected by the proposed Project, including the Topnaar Community, members of the public, etc..

Focus Group meeting with MEFT (DEA)

ASEC and GMRN engaged in various interactions with MEFT (DEA) during the review of the Scoping Report, including follow-ups on its progress. As part of this process, MEFT requested that the Scoping Report be uploaded to their portal, which was completed in October 2025.

On 27 November 2025, GMRN and ASEC met with MEFT (Environmental Commissioner and Head of Assessments) at their office to provide additional information regarding the proposed Project activities. The meeting also provided an opportunity for MEFT to seek further clarifications on the Project and the EIA process, including the submitted Scoping Report, as well as to discuss the expected timeline for MEFT's decision on the report.

The Scoping Report was accepted by MEFT and a letter was issued by the Environmental Commissioner on 18 February 2026, advising to proceed with the detailed impact assessment (see **Appendix C** for a copy of the letter issued by MEFT).

Impact Assessment Phase

The proposed terms of reference for further specialist investigations were developed during the Scoping Phase and presented in the Scoping Report. The Environmental Team, comprising ASEC and various specialists, carried out the tasks outlined in the approved Terms of Reference. They also incorporated the baseline studies conducted during the Scoping Phase into their assessments of the potential impacts the Project may have on the physical, social, and economic environments.

Specialist Studies

The following specialist studies were identified during the Scoping Phase and undertaken as part of the Impact Assessment Phase:

- Biodiversity:

  Biodiversity specialist study for Green Metals Refining. Report for Alex Speiser Environmental Consultant and Green Metals Refining, EnviroScience, Windhoek. Surface Water Assessment. (Burke A, 2025)

- Groundwater Assessment:

  Water specialist report for the EIA of the proposed Green Metals Refining Namibia (Pty) Ltd Manganese Refinery and Sulphuric Acid Plant at Walvis Bay, Erongo Region. (Mueller S, 2025)

- Air Quality Assessment, including a Climate Change Assessment:

  Air Quality Impact Assessment for the proposed Manganese Refinery and Sulphuric Acid Plant, Walvis Bay, Erongo Region. (Airshed Planning Professionals, 2025)

  Climate Change Assessment for the Proposed Manganese Refinery and Sulphuric Acid Plant, Walvis Bay, Erongo Region, Namibia. (Airshed Planning Professionals, 2025)

- Noise Assessment:

Green Metals Refining Namibia (Pty) Ltd Project, Walvis Bay - Environmental noise impact assessment. (Soundscape Consulting (Pty) Ltd, 2025)

- Archaeology / Heritage Resource Assessment:

  Archaeological Assessment of RMG Project Site, Farm 58, Walvis Bay, Namibia. (Kinahan J, 2025)

- Socio-Economic Assessment:

  Socio-economic and Traffic Baseline Studies and Environmental Impact Assessment for a Manganese Refinery and Sulphuric Acid Plant (A. Ashby, 2025)

- Quantitative Risk Assessment:

  Quantitative Risk Assessment of the proposed Green Metals Refining Namibia (Pty) Ltd.'s Manganese Refinery and Sulphuric Acid Plant Project, Walvis Bay. (RISCOM (PTY) LTD, 2025)

Impact Assessment Methodology

The methodology and criteria used to evaluate the significance of the impacts related to the proposed Project are outlined in **Section 7**. This method complies with the EIA Regulations: EMA, 2007 (Government Gazette No. 4878) and was used by all specialists and ASEC to conduct their impact assessments.

EIA Report and Environmental Management Plan

The findings of the specialist studies, including updated baseline descriptions and impact assessments, together with other pertinent information, were integrated into this (Draft) EIA Report and the associated EMP (attached as **Appendix A**). Specialist studies are appended as supporting documentation.

This EIA Report has been prepared in compliance with Section 15(2) of the EIA Regulations 2012. It details all the Project components/activities on the proposed location on Farm 58 for construction, operation and decommissioning. The water pipeline and powerline will be assessed in separate EIAs.

The EMP provides the required design requirements, management and mitigation measures and monitoring requirements (among others) to ensure the potential impacts are avoided, as far as possible, or minimised to acceptable levels.

Completion of the Impact Assessment Phase - including further Public Participation

The following steps are envisaged for the remainder of the Impact Assessment Phase:

1. Notifications to IAPs of the availability of the Draft EIA Report, EMP, and Focus Group/Public Open Day

- The draft EIA Report Executive Summary is distributed to all authorities and I&APs that are registered on the project's public involvement database (**Appendix E1**) via e-mail.
- The draft EIA Report (including the EMP) can be downloaded on the following webpage https://www.asecnam.com/.
- The availability of the report will be advertised in the following newspapers:
  - Republikein
  - Allgemeine Zeitung
  - The Namibian Sun
- A hard copy of the full report, including all Appendices, will be available at the Walvis Bay Library.

- Authorities and I&APs have 30 days to review the EIA Report (including the EMP) to submit comments in writing to ASEC. The comment period ends on the **15 April 2026**.
- An 'Open Day Session' will be held on the **11 May 2026 at the** at the **Protea Hotel by Marriott Walvis Bay Indongo.** The Open Day will run from **15h00 to 18h30**,.

2. Issues and Response Report (IRR)

All comments, questions, and issues raised by the I&APs, during the review period of the EIA Report, either through written (i.e. e-mails) comments received or at the above-mentioned meetings, will be included in an Issues and Response Report (IRR). The IRR will provide responses to each of the comments, questions, and issues raised, referencing relevant sections of the EIA Report, specialists' reports, and the EMP, where applicable. The IRR will be included in the Final EIA Report, as an **Appendix E2**, which will be submitted to the relevant Authorities for their review and decision on the EIA (see below).

3. Final EIA Report and review by MIME and MEFT

After the closure of the comment period, the EIA Report and EMP will be finalised by incorporating all comments received by IAPs, where relevant. An IRR will be appended to the Final EIA Report. The Final EIA Report and EMP will be submitted to MIME for review, who will then forward the report with their comments to MEFT for a decision.

If the Final EIA Report and EMP are approved, MEFT will issue an Environmental Clearance Certificate.

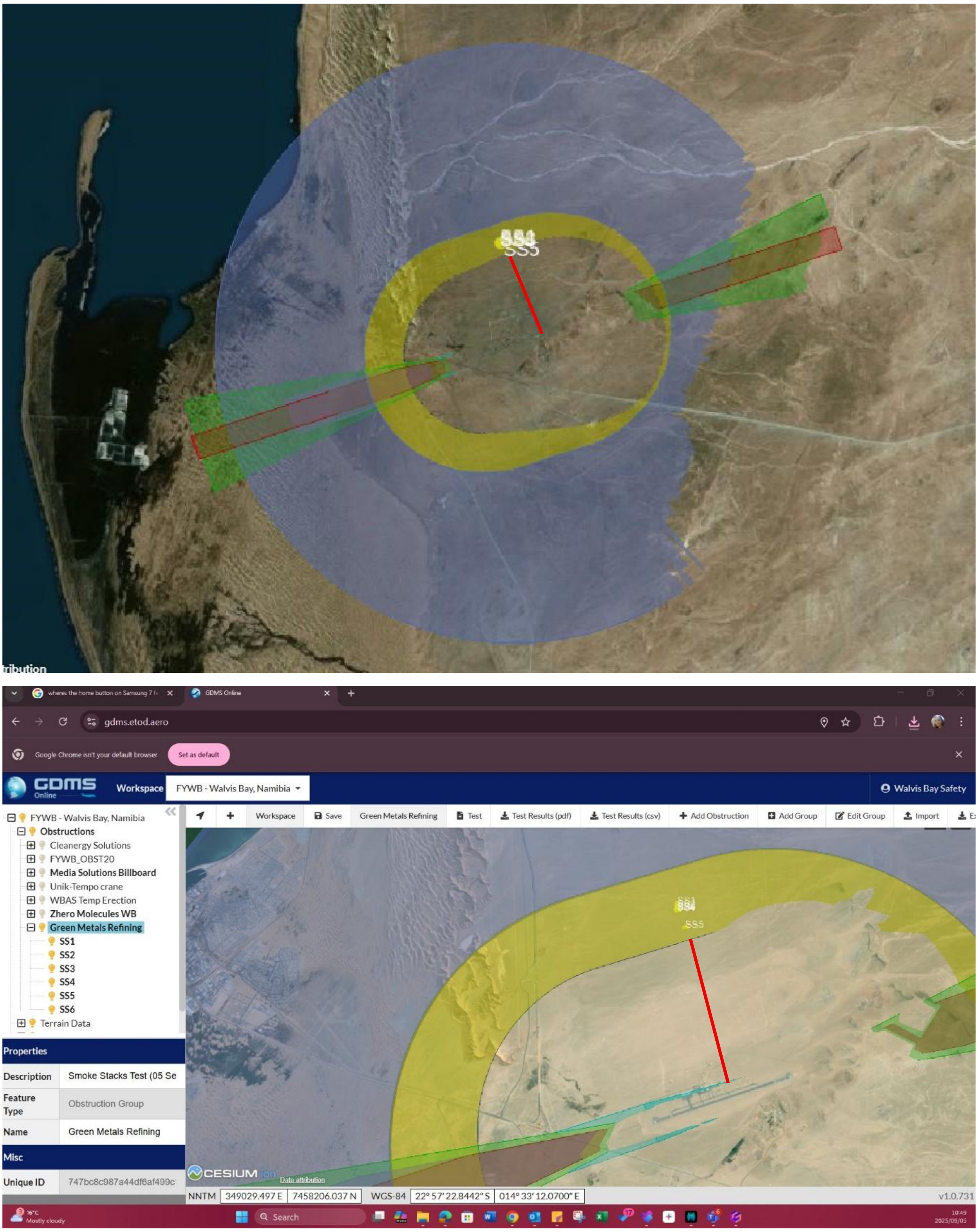
Public Participation during the EIA Phase

During the assessment phase further meetings were held with relevant authorities and are summarised below.

Walvis Bay International Airport - Geographic Data Management System (GDMS)

On 26 February 2025, a focus group meeting was held with Mrs. Samantha Rencs (Chief Safety Officer) from the Walvis Bay International Airport. During this meeting, Mrs. Rencs explained that the airport works with the Geographic Data Management System (GDMS) to calculate any obstacles within a 15km radius around the airport. The airport is responsible for assessing any objects, high-rises, and land use around the airport. Technical information of the Sulphuric Acid Plant and the Manganese Refinery was provided to her by CREO at the beginning of September 2025. The **Figure** below shows the results after Mrs. Rencs ran the GDMS model. **Appendix D** provides the results of the GDMS model. GMRN's infrastructure is well out of the 15km safety radius of the Walvis Bay International Airport.

However, as mentioned in the focus group meeting by Mrs. Rencs, the Namibian Civil Aviation Association (NCAA) requires the Applicant to provide the results to obtain final approval. The NCAA is responsible for intervening if any buildings or construction activities prove to be a threat to the safety of airport operations.



Overlay Screenshot of the GDMS results of infrastructure in relation to the WB International Airport. The red line shows the safety radius for any projects to the Walvis Bay International Airport. (source: Mrs. S. Rencs)

Focus Group meeting with Namibian Civil Aviation Association (NCAA)

On 20 November 2025, a Focus Group meeting was held with the NCAA in Windhoek. This meeting was arranged following the earlier Focus Group meeting with the Walvis Bay International Airport Chief Safety Officer (see Section above), as well as various subsequent discussions between GMRN, ASEC and Mrs. Samantha Rencs, and further correspondence with the NCAA through the Office of the Executive Director.

The objectives of the meeting were to:

- Inform the NCAA of the proposed Project and the EIA process currently underway (including progress to date).
- Share the initial interactions with the Walvis Bay International Airport and their preliminary assessment of the proposed infrastructure near the airport.
- Obtain clarity on any additional requirements from the NCAA that GMRN should consider, both for the EIA process and for compliance beyond the EIA.

The NCAA indicated that the required process entails consultation with the Namibia Airports Company (NAC) regarding the proposed project activities and infrastructure located in proximity to the Walvis Bay Airport. The NAC would provide comments to the NCAA, which would ultimately consider an application for the erection of such infrastructure.

Important considerations highlighted by the NCAA include potential obstacles, smoke emissions, reflective materials, and open water bodies that could attract animals or birds—all of which may affect the safe operation of the airport. Furthermore, the NCAA emphasised the need for an emergency and safety plan to be developed in collaboration with the Namibia Airports Company (Walvis Bay Airport).

Refer to **Appendix E3** for the minutes of the meeting.

Focus Group Meeting with the Ministry of Defence

On 27 November 2025 GMR Namibia met with the Ministry of Defence and Veteran Affairs (MODVA) to introduce the company and provide a status update on the Battery-grade Manganese and Sulphuric Acid Plant Project om Farm 58

The MODVA acknowledged the apparent overlap of the artillery shooting range with Farm 58 and that this needs to be resolved with the Municipality of Walvis Bay. GMR Namibia will facilitate a meeting with the Walvis Bay Municipality CEO to gain clarity on the site location.

Refer to **Appendix E3** for the minutes of the meeting.

LEGAL FRAMEWORK

The Republic of Namibia has five tiers of law and a number of policies relevant to environmental assessment and protection, which include:

- The Constitution
- Statutory law
- Common law
- Customary law
- International law

As the primary source of legislation, the Constitution of the Republic of Namibia (1990) provides for the creation and enforcement of applicable legislation. In this context, and in accordance with its constitution, Namibia has enacted numerous laws aimed at protecting the natural environment and mitigating adverse environmental impacts. The environmental regulations are guided and implemented by the DEA within the MEFT.

In the context of the proposed Project activities, there are several laws and policies currently applicable, including but not limited to:

- The Constitution of the Republic of Namibia of 1990
- Water Resources Management Act 11 of 2013
- National Heritage Act, 2004 (No. 27 of 2004)
- Soil Conservation Act, (amended in 1971, 1973, 1974 & 1977)
- Hazardous Substance Ordinance, No. 14 of 1974
- Nature Conservation Ordinance 14 of 1975 (amended 1990, 1996), Nature Conservation Amendment Act, 2017
- Atmospheric Pollution Prevention Ordinance 11 of 1976
- Petroleum Products and Energy Act, No. 13 of 1990, Petroleum Products and Energy Amendment Act, 2003
- The Wildlife and Protected Areas Management Bill
- Pollution Control and Waste Management Bill (3rd Draft September 2003)
- Labour Act, 2007 (No. 11 of 2007)
- Environmental Management, Act 7 of 2007
- Regulations promulgated in terms of the Environmental Management Act 7 of 2007
- Road Traffic and Transport Act No. 22 of 1999
- Road Traffic and Transport Regulations 2001
- Public and Environmental Health Act No. 1 of 2015
- Regulations made under the Water Resources Management Act, No. 11 of 2013
- Civil Aviation Act, No. 6 of 2016 and the Namibia Civil Aviation Regulations of 2001, as amended in 2018

In addition to national legislation, relevant international agreements and guidelines are considered, including the Convention on Biological Diversity, Basel Convention on Hazardous Wastes, and the IFC Performance Standards.

The applicable legislation, regulations and guidelines for each identified aspect, e.g. groundwater, noise, fauna flora, archaeology, etc.) assessed in the EIA are stated in detail in **Section 3.1** to **Section 3.10** of the main EIA Report.

PROJECT DESCRIPTION

Project Background

GMR aims to bridge the gap between the mining industry and pCAM producers by focusing on the production of high purity battery grade chemicals suitable for the LIB market. Its cornerstone Project in Namibia will support GMR's strategic goal of using feedstock agnostic processing technology to produce battery grade materials from third party manganese ore for the international pCAM market.

GMR's Project in Namibia will establish a first refining facility that uses as its feedstock medium and high-grade manganese ore, mined and supplied by third parties in Southern Africa, to produce both intermediate and final high purity crystalline manganese products. The intermediate products may be sold to the agricultural industry or shipped to downstream facilities close to the off takers for final processing to cater to a variety of LIB cathode types. This will offer the opportunity to establish an early entry into the market, as well as tap into end-market incentive programmes.

GMR will set out to meet their strategic objectives in a series of project phases, as illustrated in the **Table** below.

Project development phases.

Item	Scoping Phase	Prefeasibility Phase	Feasibility Phase
Refinery			
Dates	2Q2024 – 4Q2024	4Q2025 – 2Q2026	3Q2026 – 1Q2027
Outcomes	• Initial metallurgical test work results • Project Scoping Study • Internal environmental screening • Land application	• Metallurgical test work programme results • Residue Management Facility Concept Design • Fieldwork data • Trade-off studies • Residue Management Facility Prefeasibility Design. • Prefeasibility study • Risk register • Pilot plant (not located in Namibia) • Environmental Clearance Certificate	• Metallurgical optimisation results • Residue Management Facility Final Design • Detailed fieldwork analysis • Feasibility study • Off-take expression of interest • Early prequalification
Level of definition	• FEL 1 • AACE Class 5	• FEL 2 • AACE Class 4	• FEL 3 • AACE Class 3
Sulphuric acid plant			
Dates	1Q2025 – 2Q2025	3Q2025 – 4Q2025	1Q2026 – 2Q2026
Outcomes	• Acid Plant scaling study • Project Scoping Study	• Trade-off studies • Utility requirements analysis • Off-take expression of interest	• Technology partner identification • Feasibility Study • Off-take agreements
Level of definition	• FEL 1 • AACE Class 5	• FEL 2	• FEL 3 • AACE Class 3

Notes: FEL – front end loading; AACE Class refers to the Cost Estimate Classification System developed by AACE International (formerly the Association for the Advancement of Cost Engineering). It is used globally to define the level of accuracy, scope, and definition of cost estimates across industries like construction, oil & gas, mining, and manufacturing.

The Project Concept Scoping study phase, completed in November 2024, identified the key elements of the Project that constitute the Project scope of work, which underpins the business plan and a business case with a capital estimate prepared to an AACE International Class 5

(-20%/+50%). The Project Concept Scoping study also identified high-level risks and opportunities that informed the subsequent development phase works programme.

GMR is currently busy with a comprehensive laboratory and fieldwork programme. Data collection, data analysis and interpretation, and options analyses through techno-economic trade-off studies are the mainstay of the prefeasibility phase.

Throughout the EIA process, GMR continued with project development and permitting tasks. Completing these workstreams concurrently allowed GMR's engineers and specialists to identify environmental risk early, design mitigation measures and incorporate them into the overall development scheme as a fundamental feature of the design.

Key Project Components

The key components of the Project include:

- Manganese Refinery Facility.
- Sulphuric Acid Plant.
- Mineral Residue Facility.

Further details regarding the associated activities and supporting infrastructure are provided in the sections that follow.

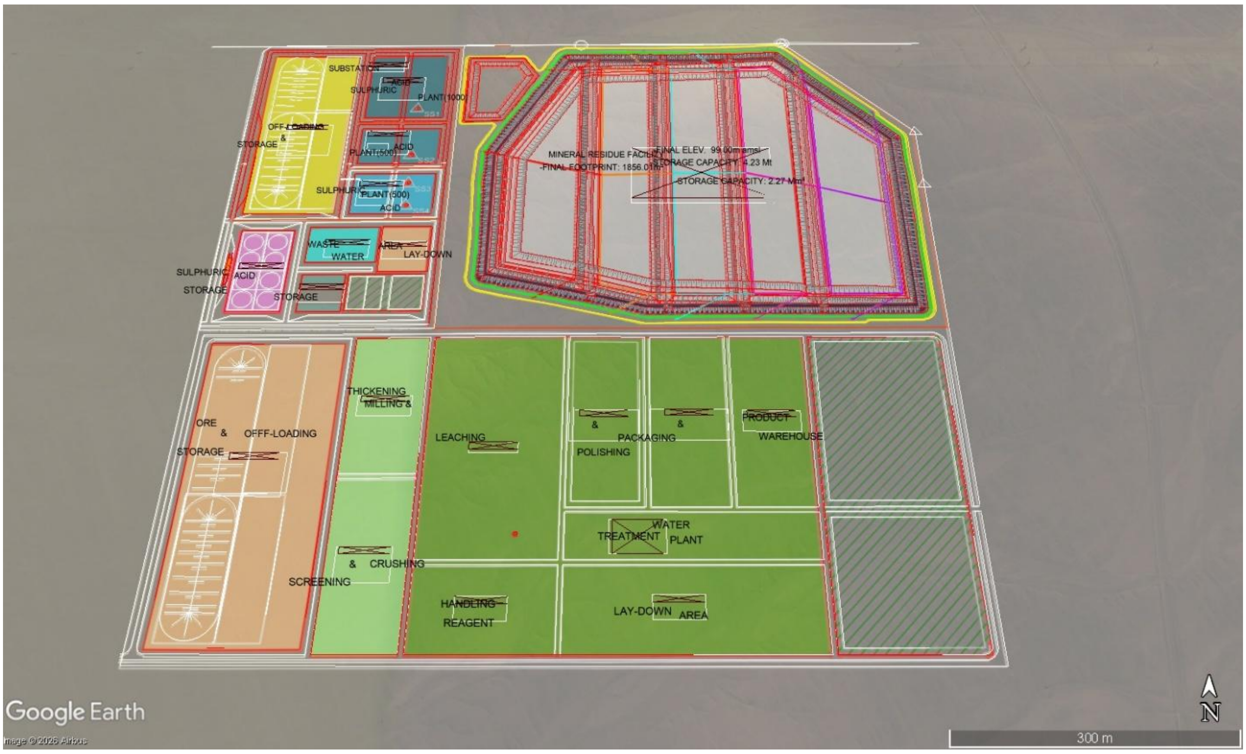
Location and layout

The location was of the Project site is shown in the Introduction Section.

The proposed site layout (see **Figure** below) was designed to accommodate the required facilities and to adhere to the following principles:

- Separate administration and plant operational areas.
- Position non-processing buildings upwind of the stack, acid storage, and dust generating areas.
- Keep delivery traffic away from the plant operational areas, where possible.
- Facilitate light vehicle traffic, forklifts and mobile crane access.
- Limit material transfer distances.

The overall site area will be approximately 950 m × 930 m. The Refinery will be orientated to align with existing road and rail infrastructure and will consider prevailing wind direction.



Site layout (as provided by GMR, 005-00-FS8P14RpGe.kmz). The red dots are the location of the stacks.

Development Phase

GMR does not employ Namibian staff during the Pre-Feasibility Study phase of the project but relies on local engineering and consulting firms to execute the work streams.

At the start of the Feasibility Study phase of the Refinery, GMR, through its subsidiary GMRN, will employ a local team to oversee advanced study and field work, plan and execute environmental and social management, and perform corporate support functions. The team will be based in the Walvis Bay area, making use of existing housing.

Construction Phase

Construction Phase Facilities

The construction phase of the Manganese Refinery Facility and Sulphuric Acid Plant will involve the development of all essential facilities and infrastructure required to support operational readiness. Activities will begin with site preparation and the establishment of contractor laydown areas. Construction will also include the setup of workshops, maintenance areas, stores, wash bays, and laydown zones to facilitate equipment servicing and material handling. A batching plant will be installed for on-site concrete production, along with small fuel handling and storage areas to support machinery and vehicle operations. Office spaces and change houses will be constructed to accommodate administrative and personnel needs.

Essential services such as ablution facilities, comprising chemical toilets or septic systems, will be installed on the site. Specific zones will be designated for the handling and storage of construction materials such as paints, solvents, oils, and greases, alongside dedicated waste management areas to collect and store construction waste. Temporary diesel-fired generators will be deployed to ensure a reliable power supply, while temporary infrastructure for water and power distribution will be established to support all construction activities. Stockpile areas for raw materials will also be established.

At the end of the construction phase, temporary facilities will either be dismantled and removed or, where feasible, incorporated into the final site layout for operational use.

Construction Phase Activities

The construction phase of the proposed Manganese Refinery and Sulphuric Acid Plant (and associated facilities) will encompass the establishment and detailed preparation of the site. Initial activities, including soil stripping, will be undertaken alongside construction works. Where feasible, these materials will be utilised for construction purposes such as road development and site levelling.

Key early-stage activities will include the appointment of contractors and labour forces, followed by clearing, grubbing, and earthmoving. Topsoil will be carefully stripped, stockpiled, and preserved for future rehabilitation efforts, as specified in the EMP (**Appendix A**). Excavations for building foundations and trenches will be carried out, alongside the establishment of contractors' laydown areas and internal access roads to facilitate logistics and mobility on-site.

General construction works shall comprise civil, mechanical, and electrical tasks, including the mixing and placement of concrete, operation and refuelling of construction vehicles, painting, grinding, welding, and the installation of structural and utility infrastructure. Delivery, storage, and handling of materials such as sand, rock, cement, and chemical additives will be critical to supporting these activities.

The construction phase will involve the handling and storage of hazardous materials, including lubricants, paints, welding gases, cement, chemical additives, diesel, and petrol. Equally important will be the responsible management of hazardous waste, such as empty paint containers, contaminated (hydrocarbon) PPE and soil, and redundant concrete. Non-hazardous waste streams, including steel and wood off-cuts, domestic refuse, grinding wheels, and various packaging materials, will also be generated and managed in accordance with applicable regulations and EMP (**Appendix A**). The final waste composition will be determined during the detail design phase of the Refinery and the SAP.

Throughout the construction phase, a strong emphasis will be placed on compliance with environmental, health, and safety standards to minimise risks and ensure the sustainable development of the proposed Project.

Construction Workforce and Housing

During the project execution phase, GMR will initially expand its owner's team to manage construction and later employ the operational team as part of its operational readiness programme.

GMR will employ contractors to construct the Refinery and Sulphuric Acid Plant. The size of the crew will fluctuate over a period of approximately 18 months. This does not include the engineering and procurement team that will likely be based outside Namibia and will visit the site from time to time.

Construction will be done during a 12-hour day shift.

The construction crew will mainly be sourced from Namibia, and where possible, from the Erongo province. As a result, no construction camp will be established on site or in the vicinity, and the crew will make use of locally available housing in Walvis Bay, Swakopmund and Arandis.

Construction Phase Transport System

The final access road from the Clean Energy turn-off to the Project site needs yet to be determine in consultation between GMRN and the WB Municipality.

During the 18-month construction period, structural steel, piping and equipment will be imported through the Walvis Bay port and transported to the site using the T0201 (formerly C14) turning onto the T0202 (highway between Walvis Bay and Swakopmund, formerly D1984 or B2), turning off at the Clean Energy turn-off. Locally sourced materials, likely to be transported to site using route T0202, will include sand, gravel and cement unless they are transported to Walvis Bay by rail and delivered to site via route T0201.

Construction Phase Water Supply and Management

The linear infrastructure associated with water supply will be prioritised in the project execution schedule. Proximity to the main NamWater supply line will facilitate the early construction of a connecting pipeline to provide water to site.

Construction Phase Power Supply

Until the main power connection is made, diesel-fired generators will be used to provide the relatively low construction power requirement on site. These generators will be housed in noise attenuating containers.

Construction Phase Waste Management

During the construction phase, waste will be managed in accordance with the EMP (A**ppendix A**). Standard domestic waste will be separated into recyclable and non-recyclable waste and collected and disposed of at the municipal waste management facility. Hazardous waste will be stored in spillage containment areas and disposed of by specialist contractors. Portable, chemical toilets will be used, the contents of which will be drained and transported to the local sewage works.

Operational Phase

The operational phase description is based on the current preliminary design basis and may be refined during detailed design, subject to regulatory approvals and engineering optimisation.

Preliminary design basis and relevant standards

The Refinery will have the capacity to store substantial amounts of ore from a variety of sources. This facility will mitigate the risk of transport disruptions, spikes in feedstock prices and will allow the operation to select and blend different ore types, to optimise production performance. The operation will track the use and blending of ores in such a way that the final product can be sold with a certificate or passport that indicates the origin of all the major production inputs.

Associated infrastructure, in addition to the Refinery itself, will include an adjacent sulphuric acid plant; rail and road facilities; power, fuel, and water facilities; mineral residue facilities; waste facilities; port facilities associated with handling imported consumables and the export of product; and product marketing facilities in Europe or North America.

The following is a summary of the high-level approach to the design, engineering, and construction of the Refinery:

- Modularity: GMR intends to expand the Refinery's production capacity after the initial phase described in this scoping study. This expansion in scale and any extension of operational capability will be achieved by applying modular design concepts.
- Equipment: where possible, off-the-shelf equipment that is readily available and supported by reputable suppliers will be specified.

- Electrical design: power will be supplied by the local electricity grid that connects to the nearest available switch yard. Where possible, transformers will be standardised, motor control centres (MCCs) prefabricated, and factory acceptance will be tested offsite.
- Civil design: foundations will be raft-type. All process areas will be completely contained using concrete bunds with bund walls of at least 1.2 m above the floor height. Bund floors will be sloped according to the effluent contained: slurry requires a steeper grade than pure liquids. In areas where low pH fluids are handled, the bunded areas will use acid-proof bunds using a special concrete or specialised surface coatings. Spillage is washed into sumps from where it is pumped to the appropriate part of the process.
- Structural design: where possible, equipment packages will be supplied with structural support to limit onsite fabrication. Exposed steel and bunded areas will need specialist surface protection against increased coastal erosion and corrosive spills. On average, 20% more concrete strengthening will be required, 20% more corrosion protection and 10% additional foundation strengthening.
- Platework and piping design: the scale of Phase 1 of the Refinery will offer the opportunity to fabricate many tanks and ancillary platework offsite. Conversely, it is likely that apart from standard flanged pipe lengths, the interconnected piping will be site run.
- Architectural design: generally, the main processing areas will not be enclosed. Where necessary, shading will be provided. Buildings will be prefabricated, light-steel structures with corrugated cladding. Large doors on opposite ends of the buildings will assist with natural ventilation. Stockpiles will either be enclosed or have dust control measures installed.
- Constructability: the scale of the facility lends itself to offsite fabrication and assembly in road transportable subassemblies. It is assumed that there will be no electric overhead travelling (EOT) cranes during construction. All erection and construction will rely on mobile cranes.
- Operational considerations: the absence of EOT cranes will necessitate the use of mobile cranes, telehandlers, and scissor lifts, which will require access and, in some cases, hard stands.

Manganese Refinery Facility

Ore trucks will be offloaded in an enclosure that contains and captures the dust, which is returned to the process via the mill feed conveyor, and transferred to an enclosed ore stockpile facility that makes provision for classification and delineation according to mineralogy.

Stockpiled ore will be extracted and fed to the crushing circuit using enclosed conveyors. Crushing equipment will be small and if enclosing each piece of equipment individually is insufficient, the whole circuit could be enclosed within a building. Where the feedstock is already in a crushed state, material will be transferred to the crushed ore day bins directly, by-passing the crushing circuit completely. The crushed ore day bins are completely enclosed and fitted with mechanical feeders that will extract material in a controlled manner whilst eliminating the escape of dust.

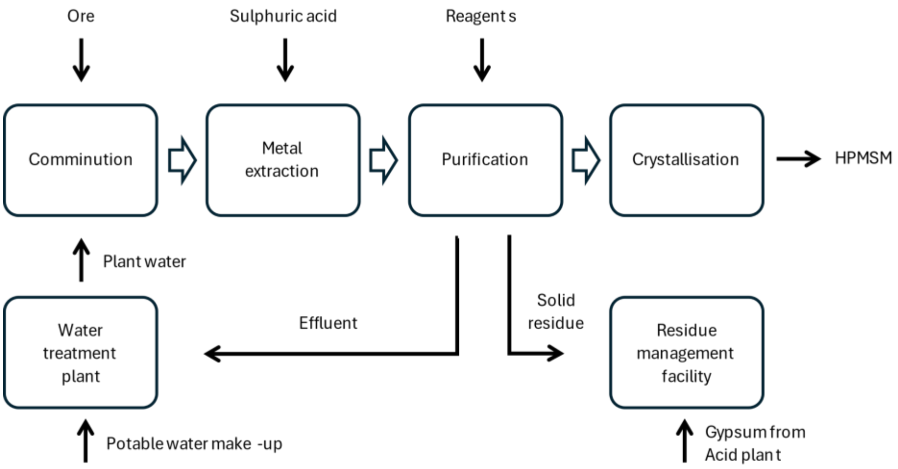
The enclosure design and associated operating procedure as well as any PPE will be designed to protect personnel. From the stockpile it will be extracted using mechanical feeder systems and transferred by enclosed conveyor to the primary crusher feed hopper.

The basic hydrometallurgical process steps to refine diverse types of manganese ore into HPMSM include ore characteristic size reduction, extraction, purification, crystallisation, drying and packaging of the final product. Flowsheet options were developed that met the following objectives:

- achieving the nominated HPMSM product specifications
- applying industry standard unit processes that are proven and simple to operate
- limiting, where possible, the use of dangerous or harmful chemicals
- reducing waste through judicious reagent use and considering the recycling or sale of effluent streams
- minimising capital and operating costs.

The refinery has been designed to treat 100 kt/a of manganese ore at a grade of 46.6% manganese, which is typical of manganese ores shipped to international markets. The estimated overall design recovery of manganese is 88%, which accounts for losses during the various precipitation steps.

The annual target HPMSM production is 127 kt/a. The **Figure** below shows a simplified block flow diagram of the refinery process.



Simplified block flow diagram of the manganese refinery process.

Solid residues are combined and temporarily stored in a bin for collection by truck which will take it to the MRF. Liquid effluent collected at various points in the process is returned to the water treatment plant via the process water tank.

On-site storage for major reagents will be required to mitigate supply chain disruptions and accommodate bulk deliveries. This will also hold true for the sulphuric acid. The **Table** below presents a summary of these requirements.

Major reagents storage requirements.

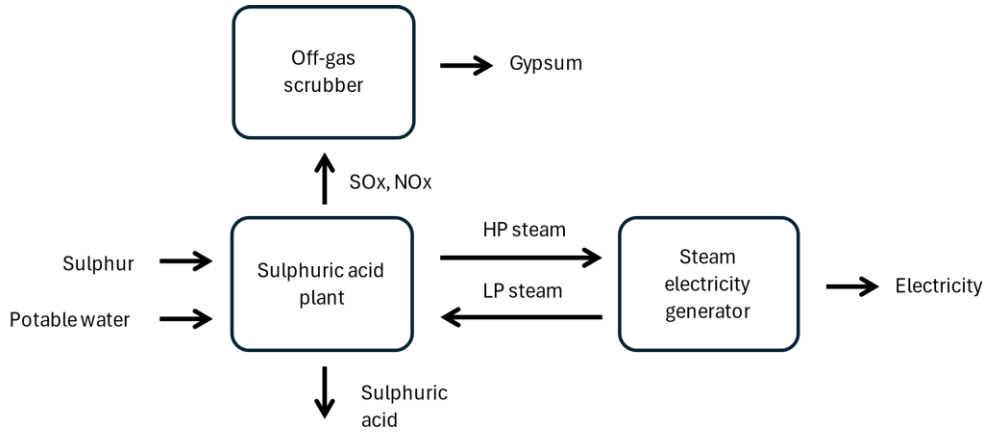
Reagent	Storage type	Properties	Storage capacity
Manganese ore	Covered stockpile	ROM: P80=100mm, 3% moisture Fines: P80=150um, 2% moisture	100,000 t
Sulphuric acid	Steel tanks	98% concentration	4,000 m³
Quicklime	Covered storage		320 t

Reagent	Storage type	Properties	Storage capacity
Sodium carbonate	Covered storage		1,700 t
Flocculant	Covered storage, bulk bags		20 t

Sulphuric Acid Plant

A standard design, modern, modular sulphur burning acid plant will be used to produce 98% pure sulphuric acid (see **Figure** below) for use by the Refinery and for third-party offtake. Sulphur prills will be imported in bulk through Walvis Bay Port (as it currently is) and delivered to site initially by truck and eventually by rail once the infrastructure has been extended into Farm 58.

The sulphur will be stored on site in an enclosed warehouse from where it will be reclaimed and fed into the sulphur burner. Sulphuric acid will be stored in large steel tanks in specially designed bunded areas, from where it will be pumped to the Refinery or transferred into tanker trucks for delivery to customers.



Simplified block flow diagram of the sulphuric acid production process.

Surplus heat from the process in the form of high-pressure steam will be used to generate electricity in a steam turbine plant. Low-pressure steam from the generators will be available to the Refinery for preheating its leach circuit.

The acid production capacity will be developed in stages. These stages do not necessarily correspond to the Refinery development stages.

To receive start-up acid and store acid to bridge acid plant downtime, large acid tanks will be installed. These will be mild steel, closed-topped tanks built in bunded areas specifically prepared to handle an acid spillage. The bunded area will have a displaced volume of the greater of 110% of the largest tank or 25% of the total tank storage capacity. The facility will be expanded in stages.

Stack emissions from the sulphuric acid plant are provided in the **Table** below and the locations of the stacks (SS1 to SS5) are shown in the **Figure** showing the Site Layout.

Stack emissions.

Project Phase and area	**Stack number**	**Height**	**Diameter**	**Flowrate**	**SO_2 (24h)**	**SO_3/H_2SO_4 (24h)**
	Unit	**m**	**mm**	**Nm^3/min**	**ppm**	**ppm**
Phase 3 (SAP)	SS1	50	1,300	720	<300	<30
Phase 2 (SAP)	SS2	42	1,300	720	<300	<30
Phase 1 (SAP)	SS3	40	1,430	870	<300	<30
Phase 1 (SAP)	SS4	40	1,650	1150	<300	<30
Complete final Refinery requirements	SS5	30	550	70	<300	

Power Supply

It is assumed that power will be supplied by Erongo Red or NamPower. GMRN is currently in discussion with them. The powerline feeding the proposed project will be assessed in a separate EIA.

Water Supply and Management

The national water utility company, Namibia Water Corporation (NamWater), has indicated that up to 350 m^3/h of spare capacity is available for the Project. This will be supplied from the local water supply network, which is fed by the Kuiseb River alluvial aquifer, the Omdel scheme, and the Orano Desalination Plant. The network supplies both Swakopmund and Walvis Bay via a water pipeline running along the dual carriageway approximately 4.3 km from Farm 58. The water pressure at the tie-in point will be approximately 80 m, sufficient to transfer the water to site without the need for a booster pump station.

Water is used extensively in the refining processes, but the vast majority is recovered, treated and recycled. A high-level water balance comprises the following components:

- Inflows: moisture in the ore, potable and raw water make-up, water associated with sulphuric acid, and
- Outflows: residue moisture, residue water of crystallisation, water treatment brine, product moisture and water of crystallisation, and evaporation.

The net make-up water requirement is estimated to be 50 m^3/h for a 100,000t/a ore production rate, including an allowance of 10% for general plant use and domestic requirements. Water from various parts of the refinery will be collected and returned to the water treatment plant along with the make-up water required to replace the water associated with the product, locked in the tailings stream and through evaporation.

Five types of water will be used in the Refinery:

- Potable water: Drinkable water provided by the local utility company. This will be the make-up water quality for the Refinery.
- Fire water: Water stored and used for fire suppression. Although this may start as potable water, the more relaxed requirement for clean storage means it will not be potable.

- Process water: All water that has been in contact with the process will be returned to the water treatment plant for treatment and distribution.
- Plant water: Water that will be treated for general use in the process to remove suspended solids and neutralise the pH.
- Reverse osmosis (RO) water: Treated water from which all dissolved solids are removed using reverse osmosis. Reverse osmosis water will be used in the base metal ion exchange, manganese precipitation, manganese redissolution and crystallisation unit processes.

Stormwater Management

A stormwater management plan will include runoff catchment from the MRF, including diversion features such as berms and channels to direct storm run-off away from built infrastructure. Any water that comes into contact with the infrastructure will be captured (in bunded areas for instance) and pumped to the stormwater pond from where it will be recovered to the water treatment area to offset NamWater demand.

Run-off generated from precipitation on the MRF embankment slopes will be actively managed to prevent uncontrolled flow, which can lead to surface erosion and gully formation. This will be achieved through a combination of slope benching and toe paddocks. The constructed benching on the MRF slopes will serve to break up the flow path of water, reducing flow velocity and facilitating infiltration. Each bench will be graded inwards to collect run-off and direct it towards designated drop structures. At the toe of the embankment, perimeter paddock drains will be constructed to capture all collected run-off from the benches and any overland flow from the immediate surrounding area. These paddock drains are designed to safely convey the water without causing erosion. All collected run-off from the MRF slopes and toe paddocks will be diverted into the clarification pond via a dedicated, lined solution trench. This ensures that all contact water is contained within the facility's water management circuit. This water will then be recycled for use in processing, thereby minimising freshwater make-up requirements and ensuring that there is no uncontrolled release from the MRF.

Waste Management

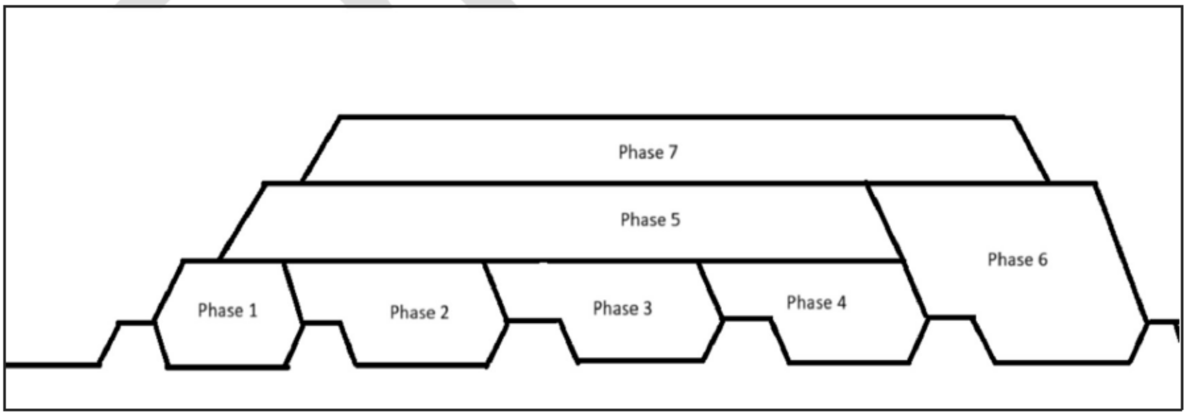
Different waste will be generated during operation; each is briefly discussed below.

MRF Design

Information in the following section describing the MRF design has been sourced form Knight Piesold (2025).

The MRF is developed in a phased approach to assist in the deferral of Capex, and for the longevity of infrastructure that would otherwise remain exposed while the footprint is developed. The **Figure** below shows the proposed phase development cross-section for the GMR MRF.

Mineral residue will be stacked under wet conditions and compacted when wet.



MRF phased development during operation.

Surface Water Run-off form the MRF

Uncontrolled flow, which can lead to surface erosion and gully formation, from precipitation on the MRF embankment slopes will be actively managed through a combination of slope benching and toe paddocks.

Benching: The constructed benching on the MRF slopes will serve to break up the flow path of water, reducing flow velocity and facilitating infiltration. Each bench will be graded inwards to collect run-off and direct it towards designated drop structures.

Toe Paddocks: At the toe of the embankment, perimeter paddock drains will be constructed to capture all collected run-off from the benches and any overland flow from the immediate surrounding area.

These paddock drains are designed to safely convey the water without causing erosion. All collected run-off from the MRF slopes and toe paddocks will be diverted into the PCD via a dedicated, lined solution trench. This ensures that all contact water is contained within the facility's water management circuit. This water will then be recycled for use in processing, thereby minimising freshwater make-up requirements and ensuring that there is no uncontrolled release from the MRF.

Solid waste

The types of waste that will be generated by the proposed Project include: hazardous industrial waste (such as packaging for hazardous materials, used oil, lubricants), general industrial waste (such as scrap metal and building rubble), medical waste (such as swabs, bandages) from the staff medical station, and domestic waste (such as packaging, canteen waste and office waste).

These wastes will be temporarily handled and stored on site before being removed for recycling by suppliers, reuse by scrap dealers or final disposal at permitted waste disposal facilities.

A registered Waste Management Company will be contracted to remove all hazardous waste from the mine.

Liquid Effluent / Wastewater

The selection of the most appropriate sewage treatment and effluent discharge method mainly depends on the number of persons to be employed on site. GMRN estimates that 100-500 workers will be on site during the various construction phases and 300 during operation. These numbers exceed the capacity of simple sewage disposal systems like conservancy tanks or septic tanks. Different option of sewage and effluent discharge methods are currently investigated, these are:

- Conservancy tanks that are regularly pumped out by a contractor who takes the raw sewage to the municipal treatment plant.
- Depending on the ground conditions, it may be possible to use septic tanks with French drains. Septic tanks must be constructed according to DWA specifications.
- A containerised plant based on trickling filter technology would be a suitable option. Such a plant is easy to operate; the only advanced mechanical equipment being submersible pumps and actuated valves.
- If a sufficiently large area is available, one could consider wastewater ponds. These normally comprise of an anaerobic pond, a facultative pond and a maturation pond. Sewage effluent is treated by naturally occurring processes under the influence of sunlight, wind, algae and microorganisms.
- A further, probably more long-term option would be a sewage treatment plant set up by the Municipality of Walvis Bay for all the occupants of Farm 58.

Operating times and Maintenance

The Sulphuric Acid Plant will operate 24 hours per day, 7 days a week, throughout the year with a maintenance shutdown for a month every second year, while the Manganese Refinery Facility will operate 24 hours per day, 7 days a week, for 350 days per annum.

Workforce

The MRF and SAP will be staffed mostly from in-country resources. Certain key technical positions may be filled at first from other parts of the world until such time as local resources can be trained to take over. Apart from the crushing area in the Refinery, which will operate on a 12-hour day shift only, both plants will operate on three 8-hour shifts.

Three assignment categories have been identified:

- Managers: senior staff who work conventional working hours and do not require leave relief.
- Dayshift: staff who work on day shift only. These are typically supervising, administrative or maintenance personnel.
- Shift: most of the workforce will be working a three-shift pattern, and allowance will be made for leave relief.

Sustainability measures

The following initial sustainability measures will be included:

- The use of surplus energy from the sulphur burning process to generate high pressure steam from which electricity is generated for use in the Refinery and to provide base load to the local grid (**Note:** This probably will trigger a separate ECC application). Low pressure steam from the generators will be used for the preheating of process slurry in the extraction process, displacing heat generated using grid power or hydrocarbons.
- The crystallisation technology uses vapour recompression technology which is 50% more efficient than evaporation alone.
- Trucks used to deliver reagents are used to export the product on the return leg, if technical feasible (**Note:** special trucks will be needed to transport different goods).
- Supplier contracts will obligate to take back used containers to reduce waste on-site.

- Both the Refinery and SAP will be completely contained to avoid any environmental contamination.
- Where possible, local labour will be employed. When skills are imported it will be done as part of a skills transfer programme.

Project Decommission

At the conclusion of processing operations at the Manganese Refinery and Sulphuric Acid Plant, decommissioning and rehabilitation are expected to be undertaken in a structured and phased manner, in accordance with applicable Namibian legislation in force at the time, the company's management systems, and stakeholder expectations. Planning will be undertaken throughout the life of the Project, so that the final scope is informed by operational monitoring results, evolving standards, and any updated land-use planning for Farm 58 and the wider industrial area. Progressive rehabilitation is expected to remain an important principle, where practicable, as areas may become redundant or could be taken out of service during operations.

ALTERNATIVES

Choosing Namibia's Central Coastal Region

Namibia was selected for its flexibility in sourcing manganese ore from a wide range of mining operations. Initially, ore will be imported from South Africa, with a future opportunity to transition to local supply should operations, such as Otjosondu, resume. GMRN selected the coastal region of Namibia for its refinery based on access to major ports (Walvis Bay and Lüderitz), efficient transport links, reliable utilities, and strong renewable energy potential. The project offers significant economic and strategic benefits for Namibia through job creation, local procurement, taxes, and infrastructure development.

Farm 58 Site

As referenced in **Section 2.1**, CREO Engineering Solutions (Pty) Ltd undertook a comprehensive Site Selection Study (C0823_GMR_Site Selection Study_V1.2) during 2023. The study initially investigated 17 potential sites and provided an overview of the project, a summary of the potential locations, the selection criteria applied, and a ranked site preference.

Many of the towns and areas considered currently have limited or no utility services available to support the proposed project, necessitating significant upgrades or extensions to existing infrastructure. Conversely, locations near existing infrastructure tend to be less industrially zoned, posing different challenges. The Site Selection Study (CREO, 2023) emphasised that Lüderitz harbour currently lacks the infrastructure required for the offloading and storage of sulphuric acid. In contrast, Walvis Bay harbour is equipped with existing facilities (i.e. servicing Rössing Uranium) and will soon see the addition of a new acid handling terminal developed by Cooperative Bulk Handling Terminal (Pty) Ltd, a wholly owned subsidiary of Bannerman Investments Namibia (Pty) Ltd, part of the Bannerman Energy Ltd Group of Companies.

General Project Information Alternative Infrastructure Layout Options and Design Considerations

Based on the modular design of the refinery and acid plant, there are numerous alternatives for relevance to layout options that were considered. In the EIA report, the relevant alternatives will be elaborated on with a justification/explanation as to why the final layout was completed as per the layout maps included in the EIA process.

Water requirement: If the GMRN project does not require potable water quality, a small reverse osmosis plant could easily treat grey water to an acceptable standard at a much lower cost than seawater desalination.

MRF design and operation: The concept design of the MRF considered conventional thickened tailings stored in a lined facility with supernatant water returned using floating pumps or a penstock. Owing to the scarcity of water, high evaporation rates and the need to retain liquor in the process, this concept was rejected.

Residue management and water treatment considerations: The initial limiting of residue dewatering to conventional thickening of the residue slimes was cost effective but owing to the colloidal nature of the precipitates would not dewater sufficiently to allow dry stacking. Pressure filtration of the mineral residue in the process plant before disposal on the MRF allows the operation to produce a drier residue and to retain maximum water for reuse in the plant. The retention of process water in the plant allows for better water management, a high recycle coefficient and a minimisation of standing water.

Fugitive dust management: Initial air quality modelling by Airshed indicated fugitive dust levels that were higher than expected. GMRN updated the Refinery and MRF infrastructure to minimise these dust levels. The operational changes include using a grader rather than a bulldozer, limiting the MRF operating hours to four hours per day (resulting in an almost seven-fold reduction in emissions), enclosing ore off-loading with the necessary dust extraction and suppression technology and a truck wash. Crushing and screening (and associated off-loading and loading) initially included a small conventional three stage closed circuit with conventional dust handling equipment. Following the Airshed modelling GMRN specified fully enclosed crushers, conveyors, transfer points and screens. Revised air quality modelling shows a significant improvement in fugitive dust levels following these interventions.

The 'No Project' Option

The assessment of this option requires a comparison between the options of proceeding with the project and not proceeding with the project. The assessment of this option requires input from the investigations described in **Section 7** of the main EIA Report so that the full extent of environmental, social and economic considerations can be taken into account.

If the project does not go-ahead all positive impacts stated in **Section 7** will not materialise. On the other hand, all negative impacts will not occur.

Although, the project area is located in an area zoned for heavy industry, the management of the MRF, as shown in **Section 7.2.3** (Air Quality Assessment), is of highest importance to prevent and/or reduce any manganese dust. These needs to be carefully addressed from the beginning of the design of the MRF.

DESCRIPTION OF THE CURRENT / RECEIVING ENVIRONMENT

Baseline studies, incorporating input from relevant specialists, are critical to any EIA for a project of this nature and scale. These studies provide essential information that underpins the impact assessment (see **Section 7** of the main EIA Report) and serves as the foundation for future monitoring and potential adaptive management (see EMP in **Appendix A**), further research, and decision-making. At the outset of the Scoping Phase, several specialist studies were commissioned for the Project, with work commencing in early 2025. These studies, along with additional investigations identified during the Scoping Process, were undertaken or expanded as needed to inform the Impact Assessment Phase, which started in August 2025. The specialists contributed to the sections below, as follows:

- Groundwater and Surface Water Study: Sandra Müller, independent water consultant

- Air Quality and Climate Change Study: Airshed Planning Professionals
- Noise Study: Soundscape Consulting (Pty) Ltd
- Biodiversity Study: EnviroScience
- Archaeology / Heritage Study: John Kinahan, independent archaeologist
- Socio-Economic and Traffic Study: Auriol Ashby, independent consultant
- Risk Assessment Study: RISCOM

Regional Climate

The area lies within the area receiving fog, which forms when moist air that has been cooled over the Benguela current is blown onshore (Pallett, 1995). Along the coast, the air remains humid throughout the year as a result of moist air feeding off the Atlantic. Even at 14h00 in winter, average humidity values drop only to 60% or 70%, while they are generally above 80% at other times (Mendelsohn *et al.*, 2002). Walvis Bay area receives, on average >125 fog days per year (Molloy & Reinikainen, 2003). Episodic dust storms associated with strong easterly winds occur during the autumn and winter months, giving rise to dust emissions from natural and anthropogenic sources under conditions of high wind speeds (Ministry of Mines and Energy, 2010).

As a whole, the various climate related aspects influence the potential for environmental impacts:

- Rainfall and (to a certain extend) fog influence erosion, evaporation, surface water flow, groundwater infiltration, vegetation growth, rehabilitation planning and dust suppression.
- Temperature influences air dispersion through impacts on atmospheric stability and mixing layers, vegetation growth and evaporation.
- Wind influences erosion, the dispersion of potential air pollutants and evaporation.

Topography, Soils, Hydrology and Hydrogeology

Topography and Soils

The dominant landform in the central Namib Desert, where the GMRN Project is proposed, is a feature-less gravel plain with a network of shallow washes. The site lies at around 95 m above mean sea level east of the coastal dune belt, about 20 km from the Atlantic Ocean, and almost halfway between the Swakop River and the Kuiseb River. The plains slope gently from east to west.

Soils at the proposed project site are mostly shallow petric gypsisols and petric calcisols on the plains with arenosols in the washes (Atlas of Namibia Team, 2022). Soils play a critical role in providing habitat for plants, wildlife, insects and micro-organisms, as well as ecosystem services, such as water storage and carbon sequestration. As the soils do not retain water well and the nutrient and organic matter levels are generally low, vegetation cover, in general, is sparse. The terrain is composed of well-developed desert pavement, where wind and occasional runoff have washed away finer sediments over time, leaving behind gravel and rock fragments across the surface.

Hydrology

The project site lies between the Swakop River and Kuiseb River basins in the much smaller catchment area of the endorheic Tumas River. The dune belt has covered the mouth of this river system, but seepages on the western side of the dunes indicate that groundwater still flows toward the sea. South of the Tumas River are several small, shallow ephemeral drainage lines that cross Farm 58 from the east and terminate against the road in the west.

Surface water resources include rivers, drainage lines (washes), pans and dams. The proposed project activities and infrastructure could potentially alter the surface water drainage or result in the contamination of the surface water through seepage or hazardous material spills.

Hydrogeology

Groundwater resources are limited and deep, necessitating reliance on desalinated water. No boreholes exist in the wider vicinity of the project area and thus no data are available.

Groundwater is a valuable resource in a desert such as the Namib. Activities such as the handling and storage of hazardous materials could pollute potentially existing groundwater to the extent that it loses its value as an ecosystem driver.

Biodiversity

The project area is located on the gravel plains of the Central Namib Desert. The central Namib is characterised by low rainfall (annual mean approximately 10 mm, https://weatherandclimate.com), but regular fog can surpass rainfall in the coastal area (Eckardt et al. 2013). Temperatures are moderate (annual mean 17 – 23ºC, https://weatherandclimate.com), and conditions are generally windy in this coastal area (a detailed weather summary is presented in **Section 6.1**). The vegetation in the project area is very sparse shrubland, classified regionally as *Arthraerua leubnitziae* – *Salsola nollothensis* unit (Hachfeld & Jürgens 2000).

The project area is wedged between the dune belt and the Rooikop outcrops, and bordered by the Walvis Bay airport to the south. This area is by no means pristine, as it was used as a training ground for South Africa's military base at Rooikop before Namibia's independence in 1990. Although this is more than 30 years in the past, signs of these activities are still present in the form of graded roads and numerous tracks criss-crossing the area, many of which are still visible today. Some tracks have, however, partly recovered.

Nevertheless, the project area is surrounded by habitats of conservation importance such as the dune belt to the west, which harbours Namib endemic reptile and invertebrate fauna, and the plains and washes to the south draining into the Kuiseb River. These support lichens as well as Namib endemic flora and fauna (Walvis Bay Municipality 2008).

In this context, gravel plains in the broader study area support the recently described Bill's sand lizard *Pedioplanis branchi* (Childers et al. 2021), which could potentially occur in the project area and is a Namibian endemic. It is also worth noting that the central Namib harbours a number of endemic invertebrates such as spiders, sun spiders, scorpions and beetles (Irish 2007), many associated with gravel plain habitats.

Flora

The perennial flora (shrubs) is overall extremely sparse (< 0.1 % canopy cover) and consists of two species, the Namib endemic pencil bush, i.e. *Arthraerua leubnitziae* and the salt-tolerant shrub *Salsola nollothensis*. These are found in drainage lines, locally with a higher concentration of shrubs where they could reach 1% canopy cover. *Salsola nollothensis* is the dominant species and reaches up to 30 cm height. Sand accumulates around these shrubs.

Salsola (Caroxylon) nollothensis is neither rare nor endangered and forms large hummocks along the southern African west-coast from the northern Cape to Angola.

The pencil bush *Arthraerua leubnitziae* is restricted to the Namib fog belt, but occurs from the Kuiseb River to the northern Namib and into Angola. Although this is a Namib endemic plant it is often the dominant plant within its distribution range and is thus not rare.

Large amounts of seedlings of succulent herbs were observed throughout the project area. During the survey period four species emerged: *Aizoon galenioides. Mesembryanthemum hypertrophicum (*or *M. cryptanthum), Psilocaulon salicornioides* (or *Brownanthus kuntzei)* and *Zygophyllum simplex*. In seedling stage, *Psilocaulon salicornioides* and *Brownanthus kuntzei* cannot be distinguished and both possibilities are therefore mentioned. The two *Mesembryanthemum* species can only be distinguished with certainty when in flower, which was not the case. The small herb *Myxopappus hereroensis* emerged in drainage lines in May. The Namib endemic grass, *Stipagrostis namibensis,* could also be identified during the last site visit in May.

Aizoon galenioides and *Zygophyllum simplex* were abundant and grow on the plains and in washes, while *Myxopappus* sp. was only found occasionally in washes. *Stipagrostis namibensis* grows occasionally on plains and in washes where sand has accumulated and is very localised.

The majority of the plant species found on the project site are endemic to the Namib. *Aizoon galenioides* has an even more limited range and only grows in the central Namib desert.

Lichens

Lichens (a life form composed of two organisms: algae and fungi, living in mutual support of each other) attached to rocks, stones, soil surface and plants are present on the plains where these have not been disturbed by vehicle tracks. Although present throughout the project area, the lichens are widely scattered and patchily distributed, not forming a continuous cover as found in the Namib Desert lichen fields to the north. Yet, taken cumulative they contribute a sizable portion of the biomass to this desert ecosystem, serving as a food source for small animals and contributing to inserting nutrients into the ecosystem.

Fauna

The one-day site visit does not provide a comprehensive or representative account of available wildlife, but observations are nevertheless mentioned here. A lark species, 2 black-backed jackals, a dead snake and several darkling beetles of the species *Cauricara eburnea* were observed 1 April 2025Figure 31. Signs of animal activity were several invertebrate burrows and spider nests among plants. This indicates that the project area is not devoid of fauna.

The darkling beetle *Cauricara eburnea* is endemic to the central Namib but occurs widely on the Namib's quartz gravel plains, often where these are associated with lichens. Once the seedlings of the annuals have developed further, particularly if these make it to flowering, a lot more invertebrate activity is expected. This, in turn, will attract small mammals, reptiles and birds.

The project area is sufficiently far removed from the coast and there is no open water nearby to attract coastal and wetland birds. Birds expected in this area therefore are those typical of the Namib plains, such as larks, chats and crows with occasional raptors passing over. However, the Namib endemic Gray's Lark, *Ammomanopsis grayi*, could be present and possibly nesting on these plains.

Air Quality

Sources identified as possibly impacting on air quality in the region include, but are not limited to:

- Fugitive emissions from mining operations.
- Vehicle tailpipe emissions from national and main roads.
- Various miscellaneous fugitive dust sources (wind erosion of open areas, vehicle-entrainment of dust along paved and unpaved roads).

Ambient Air Quality within the Region

As part of the baseline assessment, an ambient air quality sampling campaign (i.e. Passive gaseous sampling and Particulate Sampling was conducted to run over a period of one month (two 14-day campaigns) at four sites (i.e. GMR01, GMR02, GMR03 and GMR04) to take PM_{10} and $PM_{2.5}$ samples, as well as SOx, NOx and VOCs.

The sampled concentrations were very low, with most of the SO_2 below the detection limit. The maximum sampled NO_2 concentration of 5.55 µg/m³ is 14% of the annual AQO, where the maximum SO_2 concentration is 2% of the AQO. Due to the low concentrations over the two 14-day campaigns there is no need to extrapolate these to annual averages, which will be even lower.

Physical Risks of Climate Change on the Region

Project specific information together with local and internationally published emission factors were used to calculate Scope 1 (direct), Scope 2 (indirect) and Scope 3 (indirect) greenhouse gases (GHG) emissions for the proposed project. Locally published literature was referred to, to understand the projected changes to climate for the area.

The physical risks of climate change on the study area (based on the World Bank Group Climate Risk Country Profile for Namibia (2021) can be summarised as follows:

- Climate:
  - Temperature: Based on the median, the annual average near surface temperatures at the GMR site are expected to increase by 2.0°C for the near future (2040-2059) and by 3.75°C for the far future (2080-2099).
  - Rainfall: The total annual rainfall change at the GMR site is likely to decrease by up to -25 mm for the near future (2040-2059), while it is more uncertain for the far future (2080-2099) with potential decrease of up to -50 mm (2080-2099).
- Hazards assuming the low mitigation climate situation:
  - Wildfires: The risk of wildfires is High, with the increased risk due to combination of lower rainfall and higher temperature which would increase aridity.
  - Drought: The risk of water scarcity is High, with communities mostly at risk from floods, drought, and disease outbreaks with drought regarded as the most devastating hazard for Namibia.
  - Floods: At the GMR site, the risk for river floods is Medium, but High for urban floods.

Based on information provided, the project is likely to result in an estimated total of 1 104 tCO_2e (direct – Scope 1) and 20 498 tCO_2e (indirect – Scope 2) GHG emissions per annum. This was calculated to represent 0.084% of the estimated 2022 Namibian annual GHG budget.

Scope 3 GHG emissions totalled 3 864 622 tCO_2e per annum, of which 'Upstream transportation and distribution' contributes 76% and 'Downstream transportation and distribution' 24%

Noise

There are no permanent residential structures within approximately 4 km of Project infrastructure. The closest residences are the Rooikop Army Base located directly southeast of Walvis Bay International Airport and about 4.5 km south-southeast of the Project.

Dune 7, a well-known tourist attraction and recreational site, is considered a sensitive receptor.

There are other industrial, commercial, and quarrying activities in the surrounding area, but these are not expected to be sensitive to project-related noise.

A noise survey was conducted for day and night time end of February 2025 at two sites – on the Project site and at Dune 7 during day- and night-time. Measurements showed that existing noise levels are **low** and typical of rural or undeveloped areas:

• **Daytime:** 42 to 45 dBA

• **Night-time:** 29 to 33 dBA

These baseline levels are well below international guideline values, indicating a **quiet acoustic environment** with sound influenced mainly by distant road traffic and occasional air movement.

The more significant noise sources during construction include: earthmoving equipment, materials handling equipment, stationary equipment, impact equipment.

During the operational phase, the Project will include several noise generating activities and/or equipment, including: vibrating equipment including crushers, screens, feed hoppers etc., motor driven equipment incl. pumps, fans, compressors, conveyors, agitators etc., hydraulically and aerodynamically generated noise from pipes and ducts, steam turbine, cooling and heating systems, transformers and switchgear i.e., electrical equipment such as transformers and switchgear can generate humming sounds due to electromagnetic fields, venting and blowdown system, transport related noise via road or rail, auxiliary system: Other auxiliary systems, such as emergency diesel generators, fire pumps, and air conditioning units for control rooms and other critical areas etc.

Archaeology

The field survey comprised a general assessment of Farm 58 and a detailed assessment of the project site. Farm 58 includes a well-defined linear infrastructure corridor along its western margin. The corridor contains the railway, a highway (Hifikipunye Pohamba), several powerlines and a number of unsurfaced roads. Adjacent to Farm 58 in the southeast is the Walvis Bay International Airport. There are in addition several small developments such as the Hydrogen Academy and a number of abandoned developments as well as large areas of surface disturbance comprising dense networks of off-road tracks, borrow pits and refuse dumps. In all, Fram 58 may be considered a brownfield site. However, the natural features of Farm 58 are to some extent still visible. No significant sites were found during the survey.

The field survey of Farm 58 and focussing on the project site yielded no evidence of archaeological or palaeontological remains as defined by the National Heritage Act (27 of 2004). On the basis of this survey the project site is not considered to be archaeologically sensitive. It is recommended that the project should be granted consent to proceed under the National Heritage Act. The project proponent will however adopt the Chance Finds Procedure (this will be part of the construction EMP).

Socio-Economic Affected Environment

Walvis Bay is the third largest town in Namibia with 102,704 people counted at the 2023 census, having grown from a population of 62,000 in 2011 which is an average annual growth rate of 4.2%. This is slightly higher than the overall national urban growth rate of 4.1%.

Unfortunately, the Namibia Statistics Agency (NSA) has not yet published the latest 2023 census constituency data sets. The latest detailed information on Walvis Bay is based on the work done for the Walvis Bay Integrated Urban Spatial Development Framework (IUSDF) by Urban Dynamics Africa and approved by the Walvis Bay Council in 2014 (UDA, 2013).

In 2011, the population of Walvis Bay is distributed in suburbs that reflect income inequalities: high-income areas (6% of the total population), middle-income areas (16%), low-income areas including back yard shacks (78%) (UDA, 2013).

The following impacts have been identified for the construction and operations phases:

1. Positive direct, indirect and induced economic impacts.
2. The project will generate new jobs and skills development opportunities.
3. The housing shortage at the coast is dire with very little supply and high demand from shacks to mansions; this has driven up rents and house prices. Any project which entices more people to the coastal towns will add additional pressure on the limited housing stock.

Transport Routes and Traffic Overview

The roads to be used by project-related vehicles have had a series of name changes as clarified below:

i. The road section from Walvis Bay Traffic Circle to the Swakopmund Interchange was changed from C14 to MR36 & MR44 to **TR 2/1** (T0201 formally M0036 on the maps below). The road construction is scheduled to be completed in June 2027[1].

ii. The dual carriageway behind the dunes between Swakopmund and Walvis Bay, previously labelled the D1984, C34, A2, MR44 is now called the **Dr Hifikepunye Pohamba Freeway**.

iii. The B2 connecting Walvis Bay to the B1 at Okahandja is now named **T2/2** by the Roads Authority (also known as T0202) and links the Port of Walvis Bay to the rest of Namibia and the Southern African Development Community's (SADC) landlocked neighbouring countries via the Trans-Kalahari, Trans-Caprivi, and Trans-Cunene Corridors.

iv. The coastal road between Walvis Bay and Swakopmund is now called **M54**, previously called B2, M0054 and T0201.

During the proposed construction of the refinery and acid plant, it is anticipated that structural steel, piping and equipment will be imported through the Port of Walvis Bay and transported to site using the route marked T2/1 (formerly C14). Locally sourced materials for construction such as sand, gravel and cement and those for operations – lime and limestone - are likely to be transported to site using the Dr Hifikepunye Pohamba Freeway unless they are transported to Walvis Bay by rail and delivered to site via route T2/1 (C14).

It is anticipated that all project personnel will travel to and from the site to either Walvis Bay, along the T2/1 (C14), or to Swakopmund along the Dr Hifikepunye Pohamba Freeway and on to Arandis on the B2. Service vehicles are more likely to come from Walvis Bay, but some may be based in Swakopmund.

The access road to the Project site has yet to be determine. The alignment of the access road needs to be stipulated by the Municipality of Walvis Bay as other erven are sited on Farm 58.

Visual / Sense of Place, Land use, Surrounding Built Environment and Sensitive Receptors

One of the major attractions to tourists visiting the NNNP and Dorob National Park and surroundings is the scenic beauty of the area. This is predominantly based on the absence of

[1] Pers Com Mr B. Sikanda (Project Engineer at Roads Authority of Namibia) by email on 31/3/2025.

human activities and structures in most parts of the parks, coupled with the sense of remoteness.

The project area is located outside the Dorob National Park (bordering the Dorob National Park), wedged between the dune belt and the Rooikop outcrops, and bordered by the Walvis Bay airport to the south. Farm 58 and specifically the proposed Project area is not regarded as pristine, as it was used as a training ground for South Africa's military base at Rooikop before Namibia's independence in 1990. Although this is more than 30 years in the past, signs of these activities are still present in the form of graded roads and numerous tracks criss-crossing the area, many of which are still visible today. Some tracks have, however, partly recovered.

There are no communities living in the immediate vicinity of the project area. The nearest receptors are:

- Walvis Bay International Airport, situated approximately 4.5 km to the south of the proposed Project.
- Green Hydrogen Pilot Plant – approximately 3.5 km to the south-west of the proposed Project.
- Dune 7, a tourist attraction, but no permanent community – approximately 5.5 km to the south-west the proposed Project. This includes Dune 7 Adventures and Dune 7 Concession which was awarded in 2023 to Sandwich Dune Tours and Safari.
- Walvis Bays Town – the closest residents are approximately 10 km from the proposed Project.
- Informal settlements are located on Farm 37 and 33, approximately 8.5 km
- Rooikop Army Base southeast of the Walvis Bay International Airport
- The Topnaar Nama nomadic community – along the Kuiseb River between 30 to 40 km from the proposed Project.

Other infrastructure in the area include:

- Dr. Hifikepunye Pohamba Freeway (D1984) that links Swakopmund to Walvis Bay and other road networks, as described in **Section 6.10** of the main EIA Report.
- Railway line.
- A powerline at the northern boundary of the proposed Project.
- Water supply pipelines.
- Various unnamed gravel tracks.

Changes to the current topography through the development of the Project components may impact the visual aspects. Furthermore, lighting might cause impacts ("glow") at night.

Aeronautical Baseline in the Region

The Walvis Bay Airport is located ~4.5 km south of the proposed Project area. The runway is aligned approximately perpendicular to the proposed Project, therefore aircraft departing and approaching the airport is unlikely to fly directly over the Project Site and the proposed infrastructure.

The Namibia Airports Company and the NCAA have communicated the following general safety considerations to be considered:

- Physical obstacles and height restrictions.

- Wildlife attractants (open water bodies, waste, vegetation).
- Fire, explosions, and emergency-response interactions.
- Air-quality and plume-dispersion risks.
- Visual disturbances and glare.
- Lighting and navigational interference.
- Electromagnetic interference (EMI).
- Construction-phase crane operations.

On 26 February 2025, a focus group meeting was held with Mrs. Samantha Rencs (Chief Safety Officer) from the Walvis Bay International Airport. During this meeting, Mrs. Rencs explained that the airport works with the Geographic Data Management System (GDMS) to calculate any obstacles within a 15km radius around the airport. The airport is responsible for assessing any objects, high-rises, and land use around the airport. Technical information of the Sulphuric Acid Plant and the Manganese Refinery was provided to her by CREO at the beginning of September 2025. The GDMS model results shows that GMRN's infrastructure is well out of the 15km safety radius of the Walvis Bay International Airport.

ASSESSMENT OF POTENTIAL IMPACTS

Potential environmental impacts were identified by ASEC and the team of environmental specialists in consultation with I&APs, regulatory authorities and GMRN. With reference to **Section 2.3.1** of the main EIA Report, the terms of reference for further specialist investigations were developed as a result of the Scoping Phase and presented in the Scoping Report (ASEC, 2025), which has been approved by MEFT (refer to **Appendix C** for a copy of the approval letter by MEFT).

This Section provides an assessment of the key impacts that the Project may have on the physical, social and economic environment, referring to the various specialist studies undertaken.

The impacts are discussed under issue headings in the various sections and considered in a cumulative manner where relevant, such that the impacts of the proposed Project are seen in the context of the baseline conditions described in section above. The assessment must therefore be read in conjunction with the section above and **Section 6** of the main EIA Report.

Surface Water and Groundwater

1. <u>Alteration of drainage pattern and stormwater runoff</u>

The project site occupies a gently dipping gravel plain covered with sheetwash deposits that are likely to soak up all but the most intense rainfall without creating much surface runoff. As described in **Section 6.2.4** of the main EIA Report there are only indistinct, shallow washes in the project area. Refinery infrastructure is thus unlikely to interfere with the existing drainage pattern or obstruct surface water runoff.

2. <u>Water pollution</u>

Surface and groundwater pollution from Mineral Residue Facilities, general waste management and sewage or hydrocarbon spills is one of the main environmental risks experienced at industrial sites. It requires continuous management and awareness training. Waste types at the project will include domestic waste, general and hazardous industrial waste and medical waste. Hydrocarbons such as diesel and oil will be present in vehicles and storage tanks on site.

General and hazardous waste will be sorted and transported off-site to appropriate recycling or landfill facilities. Prior to removal, it will be stored on site in suitable containers to prevent littering and contamination of the environment. Mineral waste (dry ore processing residues with <15% moisture content, gypsum from the acid plant and brine from the water treatment plant) will be stored on site as shown in the site layout plan.

As mentioned earlier, it is not certain if there are any appreciable volumes of groundwater at Farm 58, and if there is water, it will almost certainly be saline, i.e. not complying with the Namibian water quality standards and unfit for human consumption or stock watering. The international principle of highest beneficial use, which states that the water quality should be preserved to remain fit for the highest purpose to which it is currently being put, should be applied in this case.

Mitigation measures

- Two monitoring boreholes to be drilled, one upstream and one downstream of the mineral residue facility, to determine the background water quality before the start of operation and from then on, GMRN should regularly (e.g. annually) analyse groundwater samples to detect any pollution from seepage.
- Avoid spills during the transfer of waste materials to the mineral residue facility (refer to the section on waste management for spill control measures).
- Store hydrocarbons in bunded areas able to accommodate 110% of the largest container or tank, equip parked vehicles and generators with spill trays.
- Train employees in the importance of waste management and spill emergency response to avoid littering and to clean up spills immediately.

Recommended monitoring

Carry out regular inspections to detect spills and improper waste management.

3. Sewage disposal

The disposal of untreated effluents from ablution facilities at the office, refinery and acid plant could cause soil and water pollution and expose employees and wildlife to infectious diseases. The company is considering chemical toilets during the construction phase, which would introduce an off-site impact related to the effect of chemicals on the functioning of the Walvis Bay municipal sewage works and the treated effluent evaporation ponds – known as the 'bird sanctuary' – an important fauna habitat. During operation, the treated effluent will be re-used in the process.

Mitigation measures

- Design an appropriate sewage system for the number of people working on site.
- If using chemical toilets or conservancy tanks take the effluent to the Walvis Bay sewage plant for treatment.
- Carefully consider the method of discharging or reusing treated effluent from a containerised treatment plant, if such a plant is chosen.
- Apply for a wastewater treatment and reuse licence from the Ministry of Agriculture, Fisheries, Water & Land Reform (MAFWLR) and comply with its conditions.

Recommended monitoring

- Monitor the treated effluent quality as required by the MAFWLR licence.

4. Water Consumption

GMRN's water demand for the refinery and acid plant will range from 150 000 m^3/a initially to 600 000 m^3/a at full capacity. Although NamWater has confirmed that enough spare capacity was available, the condition of the supply network restricts the volume of water that can be pumped from Swakopmund to Walvis Bay. Currently, the wellfields in the Kuiseb River that supply Walvis Bay are probably used at maximum capacity, and NamWater is supplementing the groundwater supply with desalinated seawater from the EDP. The availability of groundwater is limited by the dry climate and the fact that groundwater recharge only takes place in years with exceptionally good rainfall.

Significant volumes of desalinated water can only be pumped to Walvis Bay once the old pipeline from Swakopmund has been replaced – a process that has been proceeding in small stages for several years and hampered by budget constraints. Once the replacement has been completed, there will be more than enough water to supply the project, while the initial lower water demand can most likely be met from the Kuiseb groundwater resources.

Mitigation measures

An important mitigation measure – upgrading the NamWater Central Namib Scheme – is outside of GMRN's control, but still listed here as an important prerequisite for the successful implementation of the project. The second mitigation measure is wastewater treatment and reuse to reduce the freshwater demand.

GMRN to ensure a water supply agreement with NamWater is in place before Construction commences.

A separate EIA for the infrastructure associated with the bulk water-supply infrastructure to the proposed Project site does not form part of this EIA application or report. GMRN will initiate this application process as soon as an agreement has been finalised with NamWater regarding the required infrastructure, connections and related arrangements.

Monitoring recommendations

Install flow meters and monitor the water consumption during the construction and operation of the project.

4. <u>Cumulative Impacts</u>

The project's water consumption could have a cumulative impact on the water availability for other users. In the unmitigated case, the additional strain on the Kuiseb water supply scheme could possibly cause water shortages affecting other water users at Walvis Bay. Provided that NamWater's supply system is fully upgraded by the planned start of production, the probability that the project will negatively affect the regional water supply will, however, be low.

Biodiversity

1. <u>Loss of vegetation, lichens and associated biota due to clearing of vegetation</u>

The construction of infrastructure requires the clearing of vegetation, not only for the footprint of the buildings and structures to be erected, but also for temporary lay-down areas, parking areas and areas where machinery needs to move. It is expected that the entire project site will be affected. The project site is only sparsely vegetated with perennial plants largely confined to washes. However, the good rains in the project area in March 2025 resulted in a flush of annual vegetation on the plains and in drainage lines, showing that this area is by no means barren and supports narrow-range, endemic plants. This is despite disturbances in the past when the land was used as a military training ground. The required clearing presents a loss of vegetation and lichen biomass, which provides an important habitat and food source for animals.

Where there is presently no vegetation to be cleared, the surface will be compacted and/or sealed by the infrastructure to be built. This alters the soil structure, which may not allow the re-establishment of plants and lichens after the buildings and structures have been demolished and removed at closure.

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Minimise ground disturbance.
- Rehabilitate all areas necessary for construction only immediately and test different methods of facilitating natural recovery (e.g. lay-down, parking and movement areas).

Monitoring recommendations

- The testing of rehabilitation methods will require monitoring of the test sites.
- Develop a protocol to restore lichen cover (e.g. topsoil removal before construction and storage for rehabilitation).

2. Change of habitat and water flow

The placement of infrastructure will locally alter the flow conditions of the drainage lines in the development areas. Water flow will either be blocked or rerouted. This will likely affect the downstream plant populations. The rains in March 2025 illustrated that even these shallow washes can flow during rains. Rains also generate sheetwash, which is water running freely on the surface. Any disruption of natural flows will likely diminish the water received by plants further downstream, but can also create catchments for water where water flows are blocked by structures. The creation of catchment areas is not necessarily a negative impact, but it does present a change in habitat.

The vegetation on site captures airborne sand and silt, which accumulates beneath the plants' canopies. Those sand-trapping services will now be replaced by infrastructure. This may not necessarily be a negative impact on biodiversity, but the changed sand accumulation and erosion alter the habitats and ecological processes. This does not only affect biodiversity, but could also affect the operations.

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Maintain surface drainage channels for water flow during operation, where possible.
- Where water flow needs to be rerouted, consider the effect on downstream ecosystems.
- Re-establish natural flow conditions as far as possible at closure.

Monitoring recommendations

- Monitor the changes in water flow and sand transport created by the infrastructure.

3. Introduction of invasive alien plants and animals

The movement of machinery and materials and the alteration of natural habitats could result in introducing invasive alien plants such as *Argemone* sp., *Datura* sp., *Nicotiana glauca, Prosopis* sp. and *Ricinus communis.* This is particularly a concern if material/machinery which has been in touch with infested areas moves onto site.

Artificial water sources such as the clarification pond, reservoirs and pipelines are likely a nucleus for the establishment of invasive alien plants.

The project site is close to a national park and bringing pets such as dogs and cats on site will affect the local fauna. Although close to Walvis Bay, the area supports populations of reptiles, invertebrates and birds that would be affected by cats' and dogs' hunting behaviour.

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Bring no material from alien-infested sites on site; i.e. check sites for invasive aliens before loading; if invasive aliens cannot be avoided, treat material with relevant herbicide and spray tyres and underbody of machinery and vehicles.
- Prohibit pets on site.

Monitoring recommendations

- Monitor sites where disturbance and/or additional water could potentially lead to the establishment of invasive alien plants.

4. <u>Effect of dust and airborne pollutants on vegetation and lichens</u>

Dust along unpaved roads affect metabolic processes of vegetation in the direct vicinity of the dust plumes. Dust can clog stomata (the plant's breathing pores) and result in a reduced capacity for gas exchange and thus ultimately photosynthesis. This impact will be mostly during construction, but could remain at a lower level if areas where vehicles and machinery move are not paved and where the raw material is handled. If no mitigation measures are implemented, then dust plumes could go beyond the project footprint. This includes dust containing manganese, which could also affect areas outside the project footprint (Airshed 2025b).

Emissions from the sulphuric acid plant release additional chemicals into the air. The modelling of the SO_2 emissions indicated that annual average SO_2 ground level concentrations are raised beyond acceptable human health standards within the project footprint (Airshed 2025). However, projected, elevated SO_2 concentrations go beyond the project footprint, and these could potentially impact ecosystems in the surrounding. Sulphur eruptions in the Atlantic Ocean are a natural, sporadic occurrence in this coastal area (Ohde et al. 2007), and plants and lichens may have adapted to elevated sulphur levels. In fact, these eruptions are necessary to the development of gypsum in the soil, which is an important factor to explain the distribution of the Namib's lichen fields (Lalley et al. 2006).

The mineral residue facility (MRF), which will remain at the site after decommissioning, has the potential to provide a source of dust which did not exist before the project was developed. This impact would occur during operation and after closure. It would be permanent if no mitigation measures are implemented.

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Refer to management and mitigation measures provided in **Section 7.2.3**.
- Use dust suppression measures at all dust sources.
- Ensure sulphuric acid plant is equipped with appropriate filters for emissions to reduce air pollution to an internationally acceptable standard.
- Plan for appropriate cover on top of MRF.

Monitoring recommendations

- Monitor dust impact on vegetation and lichens.

5. <u>Change of natural lighting conditions at night</u>

Lights at night will attract night-active animals such as flying invertebrates and small mammals, for example, rodents, hares and jackals. This could also affect birds migrating at night, such as flamingos and pelicans.

Insects flying into the light would be killed, while the same could happen to mammals blinded by vehicle and machinery traffic on roads, resulting in collisions.

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Use down-lighting and low impact lighting (by selecting appropriate light fittings), avoid tall lights on the periphery, and use motion sensors where possible. Down-lighting shall be from non-UV lights where possible, as the light emitted at one wavelength will attract fewer insects. This will reduce the likelihood of attracting insects and their predators (i.e. herpetofauna).
- Avoid white light as far as possible.
- Confine lighting to the areas to be illuminated (i.e. downwards towards ground) and avoid illuminating the sky.

6. <u>Domestic waste and open water attracting animals</u>

Readily available domestic waste attracts scavenging animals such as jackals and crows. They will be drawn to areas where they could be killed by moving machinery and vehicles. Interaction with humans could result in changed behaviour and the animal losing the ability to fend for themselves in nature. There is also a possibility that diseases are spread by wild animals, if they are in close contact with humans.

The clarification pond associated with the RMF may attract birds. The water could contain traces of chemicals and may not be of an adequate standard as a safe drinking water source for wildlife.

Note: the attraction of animals to site could further lead to aeronautical safety risks. These are assessed in the aeronautical section.

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Develop a waste management strategy/management plan that avoids exposing domestic waste to animals (closed temporary waste containers, regular removal to managed landfill)
- Cover all waste storage areas.
- Prohibit feeding of wild animals.

Monitoring recommendations

- Test the water quality of clarification ponds and if unsafe for wildlife, place bird deflectors and/or fence off.
- Monitoring of animals coming to site and if increase apply adaptive management

7. <u>Spillage of chemicals and hydrocarbons polluting soil</u>

Chemicals used for processing and hydrocarbons necessary for machinery and vehicles will have to be handled on-site. Spillage of these onto the ground surface will pollute the soil and, depending on the material spilt, make it unsuitable for plants to re-establish.

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Provide adequate bunding wherever chemicals and hydrocarbons are stored to contain potential, accidental spills.
- Develop protocols for accidental spillages for each potential pollutant and have the necessary clean-up materials readily available on site.
- Drip trays shall be positioned under stationary vehicles and plant machinery that are not actively moving around the plant, to collect hydrocarbon spills.

- If extensive spills have occurred, the area must be rehabilitated appropriately. This will require consultation with an ecologist and soil scientist specialising in the rehabilitation of polluted habitats. This will further decrease the magnitude of the anticipated impacts arising from accidental spills.

Monitoring recommendations

- Monitor treated soil pollution levels until appropriate standards are reached.

Air Quality

The establishment of an emission inventory formed the basis for the assessment of the impacts from of the proposed operation activities on the receiving environment. An emissions inventory comprises the identification of sources of emission, and the quantification of each source's contribution to ambient air pollution concentrations. Dispersion simulations use the emissions together with the source parameters and meteorological data to determine the impacts on the surrounding environment, including closest receptors (i.e. third parties).

<u>Dispersion Modelling Results</u>

Dispersion modelling was undertaken to determine highest daily and annual average ground level concentrations (GLCs). Averaging periods were selected to facilitate the comparison of predicted pollutant concentrations to relevant ambient air quality and inhalation health criteria as well as dustfall regulations.

Pollutants with the potential to result in human health impacts which are assessed in this study include $PM_{2.5}$, PM_{10}, Mn, SO_2 and SO_3. Dustfall is assessed for its nuisance potential. Results are primarily provided in form of isopleths to present areas of exceedance of assessment criteria.

It should also be noted that ambient air quality criteria apply to areas where the Occupational Health and Safety regulations do not apply, thus outside the property or lease area. Ambient air quality criteria are therefore not occupational health indicators but applicable to areas where the public has access i.e. off-site. Two scenarios were modelled – Scenario 1 with no mitigation and Scenario 2 with mitigation.

<u>*PM_{10}*</u>

- PM_{10} daily GLC for Scenario 1, with no mitigation applied to the activities, exceed the AQO (WHO IT-3 and SA NAAQS) for approximately 1 km to the east and along the access road to site (assumed that the road from the Green Hydrogen Pilot Plant will be extended to the Project site). With additional mitigation measures in place (Scenario 2), PM_{10} daily GLCs exceed the AQO (WHO IT-3 and SA NAAQS) only for small area to the northeast.
- PM_{10} annual GLC, for Scenario 1, exceed the AQO (WHO IT-3 and SA NAAQS) for approximately 100 m along the fenceline on the east and south. When mitigation measures are applied, there are no off-site exceedances.

<u>*$PM_{2.5}$*</u>

- $PM_{2.5}$ daily GLC for Scenario 1, with design mitigation applied to the activities, exceed the AQO (WHO IT-3 and SA NAAQS) for approximately 500 m on the northeastern side of Erf GMR, and southwestern and western side. With design and additional mitigation measures in place (Scenario 2), $PM_{2.5}$ daily GLCs exceedance footprint reduces to about 200 m.
- $PM_{2.5}$ annual GLC, for Scenario 1, exceed the AQO (WHO IT-3 and SA NAAQS) only along the GMR boundary. When mitigation measures are applied there are no off-site exceedances.

Manganese

Manganese (Mn) emissions within the PM_{10} fraction were modelled to assess potential health impacts. Based on the estimated Mn content in the material, the impacts exceed the WHO limit for up to 3 km to the southwest and ~1.5 km to the northeast, but not at any sensitive receptors for Scenario 1. The impact area reduces significantly with mitigation measures in place (Scenario 2), exceeding up to about ~1 km from the site.

SO_2

The simulated highest hourly, daily and annual average SO_2 GLCs are low, with no exceedances of the respective AQOs off-site and no plots are included. The highest off-site GLCs are 85 µg/m³ for the highest hourly, 22 µg/m³ for the highest daily and 7.5 µg/m³ for the annual average.

SO_3

The simulated highest 8-hour average and annual average SO_3 GLCs result in no exceedances of the AQO off-site. The highest annual average GLC is 0.9 µg/m³.

Dustfall

Maximum daily dustfall rates for Scenario 1 only exceed the AQO limit (SA NDCR and Botswana industrial limit of 1 200 mg/m²/day) at the boundary on the east and south, with Scenario 2 not exceeding the AQO limit outside the GMR site boundary.

Cumulative Assessment

Background concentrations for SO_2, NO_2 and particulate matter are available from the sampling campaign conducted. Measured SO_2 concentrations at the proposed GMRN site were very low, and mostly below detection. The highest PM_{10} and $PM_{2.5}$ concentrations recorded over 30-days were 84 µg/m^3 and 39 µg/m^3, respectively, and when extrapolated to annual averages are 15 µg/m^3 and 7 µg/m^3, respectively.

- SO_2: Based on the low modelled SO_2 concentrations and the low measured concentrations, the cumulative impact from SO_2 is expected to be well below the AQO.
- SO_3: There are no other sources of SO_3 in the vicinity of the GMRN site, and the modelled results indicated low off-site concentrations. The cumulative impacts from SO_3 are expected to be low.
- PM_{10}: Cumulative impacts from PM_{10} (with design mitigation only) are expected to be high, resulting in exceedances of the daily and annual AQOs on a regional level. The area of impact will reduce with additional mitigation in place, but likely still exceeding the AQOs cumulatively due to the high baseline concentrations.
- $PM_{2.5}$: The cumulative impacts from $PM_{2.5}$ will be on a smaller scale but expected to exceed the AQOs on a local scale, both with design mitigation and additional mitigation where the latter will impact a smaller domain.
- Mn: There are no other sources of Mn and hence the cumulative impacts are likely to be the same as the residual impacts.
- Dustfall: Dustfall impacts will be localised and likely to have the same residual impacts as cumulative impacts.

Mitigation measures

The main objective of the proposed air quality management measures for the project is to ensure that operations result in ambient air concentrations (specifically PM_{10} and $PM_{2.5}$) and dustfall rates that are within the selected AQOs (**Section 3.6.6** of the main EIA Report) outside the Project site boundary. To define site specific management objectives, the main sources of pollution need to be identified. Once the main sources have been identified, target control efficiencies for each source can be defined to minimise dust emissions and ensure acceptable cumulative ground level concentrations.

The ranking of sources serves to confirm the current understanding of the significance of specific sources, and to evaluate the emission reduction potentials required for each. Sources ranking can be established on:

- Emissions ranking: based on the comprehensive emissions inventory established for the operations (**Section 7.2.3.2** of the main EIA Report); and
- Impact ranking; based on the simulated pollutant GLCs (**Section 7.2.3.3** of the main EIA Report).

Sources ranked on emission contribution for Scenario 1 (no mitigation measures) and Scenario 2 (mitigation measures).

Sources of Emission	Scenario 1 (no mitigation)			Scenario 2 (mitigation)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Material Handling	4	4	4	4	4	4
Crushing	1	2	2	1	3	2
Roads - unpaved	5	5	5	5	5	5
Roads - paved	3	3	3	2	2	3
Wind Erosion	2	1	1	3	1	1

The main contributing fugitive emission sources can be summarised as follows:

- For both Scenario 1 and 2, crushing is the main source of TSP, with wind erosion the main source of PM_{10} and $PM_{2.5}$ emissions with no mitigation (Scenario 1) and with mitigation in place (Scenario 2).
- Wind erosion is the second highest contributor to TSP and crushing to PM_{10} and $PM_{2.5}$ emissions for both Scenario 1, with on-site roads the second highest contributor to TSP and PM_{10} and crushing to $PM_{2.5}$.
- The third most significant source of TSP, PM_{10} and $PM_{2.5}$ emissions is the on-site roads with no mitigation in place (Scenario1). For Scenario 2, the third most significant sources are wind erosion for TSP, crushing for PM_{10} and roads for $PM_{2.5}$.
- The main contributing source of Mn emissions is wind erosion (Scenario 1) and crushing (Scenario 2).

Using PM_{10} GLCs as an indicator of off-site impacts[2], vehicle-entrained dust from on-site roads is the main source, followed by wind erosion, then crushing circuit and lastly materials handling.

For construction the main contributing sources would likely be dust generation from scraping and grading (land clearing) and vehicle-entrained dust on-site, with drilling and digging and vehicle entrainment the main sources of dust generation during the site construction.

[2] PM_{10} is the only pollutant resulting in H- nature and intensity, with the highest significance although moderate (Table 4-10 in Appendix F).

Decommissioning activities likely to result in dust impacts are the demolition and removal of infrastructure, rehabilitation of surroundings, and vehicle entrainment on unpaved road surfaces during rehabilitation. Once that is done, vehicle activity associated with the mining operations should cease.

Point source ranking is discussed below. SS4 is the main contributor of both SO_2 and SO_3 emissions, followed by SS3.

Compared to the SA emission limits as provided in **Section 3.6.6** of the main EIA Report, only the refinery SO_2 emissions are within the limits with both SO_2 and SO_3 from the SAP exceeding the emission limits.

Point source emissions compared to emission limits.

Stack ID	Notes	Emissions (mg/Nm³)		Emission limit (mg/Nm³)	
		SO_2	SO_3	SO_2	SO_3
SS1	SAP Stage 3	786	98	350	25
SS2	SAP Stage 2	786	98	350	25
SS3	SAP Stage 1	786	98	350	25
SS4	SAP Stage 1	786	98	350	25
SS5	Refinery	786	-	1 000	-

Based on modelled impacts, SO_2 is well below the AQOs off-site for all averaging periods whereas SO_3, is just within the boundary.

Proposed Mitigation Measures and/or Target Control Efficiencies

The main unmitigated sources resulting in off-site impacts are onsite roads and windblown dust. The material properties (particle size distribution and moisture content) for the MRF were based on manganese mining operations and may differ from the process at GMR. Although the mineral residue will have high moisture content, and be compacted on the MRF, it is not known how it will behave once dried out. Mitigation measures for the onsite roads and the MRF should thus also be considered.

Detailed mitigation measures are stated in the main EIA Report and the EMP in **Appendix A**. These include dust minimisation during construction and decommissioning, mitigation measures to minimise Mn dust, various key performance indicators, source monitoring (especially for emissions from the stacks), ambient air quality monitoring.

Climate Change Assessment

The project was undertaken in accordance with the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard (WRI & WBCSD, 2004), which provides two approaches. This includes the assessment of GHGs based on: (1) the organisational boundaries and (2) operational boundaries. For the calculation of GHG footprint for GMRN operations, the operational boundary approach was selected.

To help delineate direct and indirect emission sources, improve transparency, and provide utility for different types of organisations and different types of climate policies and business goals, three “scopes” (Scope 1 - direct GHG emissions, Scope 2 electricity / indirect GHG emissions and Scope 3 other indirect GHG emissions) are defined for GHG accounting and reporting purposes.

GHG emissions were quantified for the Operational phase only, with data and assumptions used in estimating GHG emissions provided by GMR.

The emission factors used for the assessment were mainly sourced from the:

- IPCC guidelines (IPCC, 2006), and
- UK Government GHG Conversion Factors for Company Reporting developed by Department for Energy Security & Net Zero (DESNZ, 2025).

The annual GHG emissions for Scope 1 and 2 from the operational phase of the project due to diesel combustion will contribute 3.9% from mobile equipment and 1.2% from stationary sources (1.2%) with the largest contribution to the total project GHG emissions from Municipal electricity use (94.9%).

Annual GHG emissions for Scope 3 is dominated by 'Upstream transportation and distribution' contributing 76% and to a lesser extent 'Upstream transportation and distribution' at 24%. The other three categories contribute 0.01%.

Scope 1 GHG emissions for the project operations is 1 104 tCO_2e per annum, with Scope 2 at 20 498 tCO_2e per annum. For comparison, international reporting considers a small facility as producing 10 000 tCO_2e per annum, medium at 25 000 tCO_2e per annum and large at 100 000 tCO_2e per annum (for Scope 1 and 2 emissions).

The cumulative impacts of the project emissions will add 0.084% tot the 2022 National GHG inventory total, which can be regarded as a low.

Project Mitigation and Adaptation Measures

To minimise project specific GHG (Scope 1) emissions would require lower fuel use or use alternative lower-carbon fuels, where possible or switching to renewable energy for stationary sources. Effective rehabilitation of above-ground and soil-based carbon stocks could be an effective carbon sink during rehabilitation.

From an adaptation perspective, additional support infrastructure can reduce the climate change impact on the employees. For example, improving the thermal and electrical efficiency of buildings to reduce electricity consumption for air conditioning, ensuring adequate water supply for staff drinking water, amending summer operating hours to avoid the hottest part of the day and potential health and safety impacts for employees, and having shaded green rest areas for employees during their shift breaks.

Noise

Potentially sensitive receptors in terms of noise typically include places of residence and permanent community locations such as schools, hospitals and places of worship but can also include commercial and industrial facilities. There are currently no permanent residential areas within a 4km radius.

<u>Construction</u>

During site development, construction activities (which will include site clearing, ground excavation and earthworks, distribution and compaction of materials, concrete works, metal works, piling, transport etc.) will be highly variable in intensity, location, duration, and time of day, even over a 24-hour cycle. It is, however, generally **assumed that construction activities would be limited to daytime working hours**, typically from 07:00 to 18:00.

<u>Operation</u>

From the process and operations overview, it is clear that during the operational phase, the Project will include a multitude of noise generating activities and/or equipment, e.g. crushers, screens, feed hoppers, steam turbine, etc..

Key findings:

- The assessment indicates that the project will not result in any exceedance of the desired noise levels at sensitive receptors.
- Predicted noise increases at these receptors are less than 3 dBA, which is below the threshold of perceptibility.
- The night-time impact area extends up to 1.9 km, primarily due to lower residual (baseline) noise levels rather than higher project emissions.
- Receptors at Dune 7 and Dune 7 Adventures are affected mainly by road transport activities, not by the Refinery or SAP operations.
- These locations are not inhabited at night, further reducing the potential for disturbance.
- No noise impacts are predicted at residential receptors in Rooikop.

Mitigation measures

- General noise management measures (GIIP):
- Equipment selection, modification, and use
- Maintenance and operational controls
- Community engagement and complaints management

Monitoring recommendations

In the absence of noise-sensitive receptors within the Project's predicted noise impact area, monitoring should be undertaken along the Project boundary, where levels are required to remain below 70 dBA. The spread of noise and potential effects at distant receptors can be inferred from boundary measurements by the appointed acoustic specialist. Additional monitoring should be carried out in response to community complaints or when significant operational changes occur.

Archaeology

The field survey of Farm 58 focusing on the Green Metals Refining Namibia (Pty) Ltd (GMR Namibia) project site yielded no evidence of archaeological or palaeontological remains as defined by the National Heritage Act (27 of 2004). On the basis of this specialist study, the project site is not considered to be archaeologically sensitive and no assessment was carried out.

However, the **Chance Finds Procedure**, included in the EMP must be applied during construction.

Assessment of Socio-economic Impacts

The main objective of the impact assessment is to identify the significance of potential impacts that can be avoided and/or mitigated and to identify beneficial positive impacts which could be enhanced, during the construction, operation and decommissioning and rehabilitation phases of the Project on the receiving socio-economic environment. A quantitative impact assessment is used, as far as possible.

1. <u>Economic Impact</u>

Construction: Importing and building the refining infrastructure will promote local procurement and will generate import taxes from components such as the crystalliser unit. Wages of contractors and inputs up and down the supply chain generate further economic activities.

Operations: Refining manganese ore, manufacturing sulphuric acid and exporting the final battery-grade manganese chemicals. Surplus sulphuric acid may become available for the local market. These create wages for employees and generate taxes. Inputs up and down the supply chain generate further economic inputs.

Enhancement measures

1. The Project and its contractors should purchase Namibian-made goods and services whenever possible, or if not available, from businesses within the South African Development Community.
2. The Project and its contractors should implement procurement policies which promote the use of small and medium enterprises (SMEs), owned and/or managed by previously disadvantaged Namibians.
3. GMRN should engage with government and other stakeholders to promote and facilitate the expansion of the manufacturing sector in Namibia.

Monitoring recommendations

- At the project's Development Phase, GMRN should identify indicators which will monitor its economic contributions to the local, regional and national economy.
- The Project should hold stakeholder meetings at least annually, as part of its stakeholder engagement plans, to monitor its economic and social contributions.

2. <u>Job Creation and Skills Development</u>

The Project will create new jobs in the construction and operations phases and will provide opportunities for Namibians to gain skills.

At the start of the Feasibility Study phase of the Refinery, GMR, through its subsidiary GMRN, will employ a local team of five to oversee advanced study and field work, plan and execute environmental and social management, and perform corporate support functions.

During all project phases jobs will be created and skills transferred.

3. <u>Housing</u>

Construction: Mostly single, construction workers will require short-term housing. Jobseekers will seek basic housing in the informal settlements and backyard shacks.

Operation: Single workers will seek longer term accommodation in the rental and possibly ownership market. Workers with families will require larger accommodation units & some school places. Newly arrived, unsuccessful jobseekers will seek basic housing in the informal settlements/backyard shacks.

If other large employers come to the coastal towns, further pressure will be put on the limited decent housing stock, which will cause rents and house prices to rise further.

Mitigation Measures

1. GMRN must consider the need to construct a construction camp, at least for low and semi-skilled workers, to ensure they have adequate housing and can sleep well to avoid workplace incidents and accidents.
2. GMRN must recruit from existing local residents to help reduce in-migration and avoid increasing the housing demand.
3. GMRN must identify and train local residents for available jobs for construction and operations, to minimise in-migration.
4. GMRN must collaborate with the local municipalities to ensure land is available for servicing and the construction of housing.
5. GMRN to collaborate with local banks and developers to create a package which facilitates workers to build and own their own homes in Walvis Bay, Swakopmund and Arandis.

Monitoring

GMRN will report annually on its stakeholder dialogue to improve the housing stock.

4. Increase in traffic

Construction: Transporting infrastructural materials to Farm 58.

Operation: Transporting inputs and outputs along the routes between Project site - Walvis Bay and regionally; personnel operating the Project.

Decommissioning: Transport required to de-construct and remove surface infrastructure.

Monitoring recommendations

- Number of project-related traffic accidents.
- Any complaints received regarding traffic issues should be recorded together with action taken to prevent impacts from being repeated.

Cumulative impacts

As the refinery and sulphuric acid plant expands, the risk of traffic accidents will increase.

Roads Authority has planned the upgrades of the Dr Hifikepunye Pohamba Freeway (A2) and the T2/1 (C14) to accommodate the expansion of heavy industries on Farm 58 and other areas east of Walvis Bay.

Visual / Sense of Place

Negative visual impacts are expected as a result of the visual intrusion by the proposed infrastructure, specifically when viewed from the surrounding tourist routes along the T0202 between Swakopmund and Walvis Bay and from Dune 7. Furthermore, passengers flying in and out of the Walvis Bay Airport will also see the proposed project infrastructure, particularly during take-off and landing. Large infrastructure components, i.e. stacks, and the MRF would be the most visual aspects of the Project. The MRF will remain post decommissioning. Night lighting from the manganese refinery and sulphuric acid plant could also impact on the sense of place around the area.

The more significant activities and infrastructure are therefore associated with the operational, decommissioning and closure phases.

Mitigation measures

The following mitigation measure can reduce the visual impact:

- Land disturbance will be limited to what is necessary.
- Shaping of the MRF that will remain after closure by avoiding harsh and angular structures and shaping the structures to blend with the surrounding landscape.
- Limit visual intrusion by dust.
- Littering will be prevented.
- Minimise the number of light fixtures to the bare minimum required, including security lighting.
- Install light fixtures that provide precisely directed illumination to reduce light "spillage" beyond the immediate surroundings of the Project area.
- Avoid high pole top security lighting along the periphery of the site and use only lights that are activated on illegal entry to the site, where relevant.
- Visually monitor the light pollution, and install improved lighting measures if required.

Safety risk and potential impacts to third parties and infrastructure

Risk calculations are not precise. Accuracy of predictions is determined by the quality of base data and expert judgments.

This risk assessment included the consequence of fires and toxic releases of the proposed facility. A number of well-known sources of incident data were consulted and applied to determine the likelihood of an incident to occur.

The risk assessment was performed with the assumption that the site would be maintained to an acceptable level and that all statutory regulations would be applied. It was also assumed that the detailed engineering designs would be done by competent people and would be correct specified for the intended duty.

It is the responsibility of the owners and their contractors to ensure that all engineering designs would have been completed by competent persons and that all pieces of equipment would have been installed correctly.

A number of incident scenarios were simulated, taking into account the prevailing meteorological conditions, and described in the report.

Plant and Associated Equipment

Hazardous substances associated with the facility would include: sulphur, sulphur dioxide, sulphur trioxide and diesel.

The risk of 1×10^{-6} fatalities per person per year isopleth found to extend beyond the site boundary but did not reach any residential areas or the Walvis Bay Airport.

Impacts onto Neighbouring Properties, Residential Areas and MHIs

A large release of sulphur dioxide could extend a considerable downward distance impacting the commercial and residential areas of Walvis Bay. However, potential fatalities will be limited to the industrial area and will not impact on residential areas or the airport.

No residential area or vulnerable institutions would be seriously impacted with the construction and operation of the proposed GMRN facility.

Mitigation

Mitigation would include emergency response arrangements and systems, such as alarms and shutdown systems to allow for personnel to muster in case of emergency, as well as fire-fighting systems and cooperation with emergency responders. Preventive measures would include maintenance procedures to prevent the occurrence of a catastrophic loss of containment from corrosion, fire and gas detection and firewater systems to prevent escalation and strict control of ignition sources and other measures. Mitigation measures should include design controls to limit wildlife attractants, effective waste and water management. Ongoing coordination with the Namibia Airports Company and relevant aviation authorities is also required.

Residual Risks

Even with mitigation, there may be residual risk of occurrence due to failures in protection systems and break-down in procedures and documented systems.

No cumulative impact is anticipated as the proposed plant is located in a remote area with no other industrial activity nearby.

Aeronautical

A number of potential impacts have been identified, such as –

1. Impacts to aviation - relating to additional obstacles

2. Impacts to aviation - relating to additional obstacles

Mitigation measures

Key measures include the following:

- As early as possible GMRN must liaise with the NCAA and the Namibia Airports Company (Strategic Business Unit: Operations Walvis Bay International Airport), to share information on the final design, i.e. layout and height of structures (including the stacks) for the proposed Project. GMRN to confirm any specific requirements from the above-mentioned parties as part of their detail design stage.
- Submit application forms: FSS-AGA-FORM-032 (permanent structures) and / or FSS-AGA-FORM-033 (temporary structures), as may be required, prior to the erection of the structure(s). Hereafter, the applications are then evaluated, and a response is provided to the applicant by the NCAA.
- Adhere to the design specifications for the infrastructure (specifically the stack heights), as per communication shared with the NCAA and the Namibia Airports Company.
- No additional structures to be installed on top of the tall structures other than those required and approved by the NCAA and the Namibia Airports Company, e.g. visual aids denoting obstacles.
- The high infrastructure – specifically the stacks - must be suitably marked and or illuminated to indicate the presence of the object, as per approval with conditions from the NCAA and / or the Namibia Airports Company (Strategic Business Unit: Operations Walvis Bay International Airport.
- GMRN to share information on the “as build” (i.e. final design) layout and height of stacks to relevant Companies operating scenic flights, from Swakopmund / Walvis Bay Airport (in consultation with the NCAA), before construction of the stacks commence.

3. Impacts to aviation - relating to additional glare from infrastructure, lights and emissions or dust clouds / smoke from stacks

Mitigation measures

- During design ensure that the best available technology is applied to avoid or minimise any potential visual emissions.
- Install aviation warning lights on the tallest structures if required by the Civil Aviation Authority.
- Maintain regular consultation with the Namibia Airports Company regarding construction and operational activities.
- As part of permit application, GMRN should prepare:
    - Glint & glare modelling report (sun-path analysis, seasonal variation)
    - Lighting impact assessment (intensity, direction, shielding)
    - ATC sightline assessment (if applicable)
    - Mitigation plan with engineering and operational controls
    - Site layout showing all reflective/glare-producing elements
- Use matte or non-reflective finishes on all tall structures to minimize sunlight reflections.
- Orient any reflective surfaces away from runway approach and departure paths, as far as possible.
- Shield high-intensity lights and / or direct downwards and ensure lighting design complies with aviation standards to avoid pilot distraction, where relevant.
- Conduct regular inspections to ensure structures remain compliant with OLS and glare mitigation measures.
- Report any incident or near-miss related to aviation to the airport authorities promptly.

- Review mitigation measures periodically and update the EMP based on operational experience and regulatory changes.

4. Impacts to aviation - relating to Wildlife attractants (open water bodies, waste).

Mitigation measures

- Cover all water ponds with bird balls.
- Develop waste management strategy/management plan that avoids exposing domestic waste to animals (closed temporary waste containers, regular removal to managed landfill)
- Cover all waste storage areas.
- Prohibit feeding of wild animals.

Monitoring recommendations

- Monitor animals and birds visiting the Project area during both construction and operations phase. Should there be in increase in the number of animals (not due to natural reasons), further mitigation needs to be planned and developed.
- Ongoing consultation with the Namibia Airports Company.

Summary of all environmental aspects / potential impacts and assessment ratings

The Table below provides a summary of the environmental aspects / potential impacts associated with the proposed Project and the assessment ratings, in the unmitigated and mitigated scenarios.

Summary of the environmental and social aspects/potential impacts associated with the proposed Project and significance ratings, in the unmitigated and mitigated scenarios.

Environmental component	Environmental issues (i.e. environmental and social aspects/potential impacts	Assessment Significance Rating	
		Unmitigated	Mitigated
Surface Water and Groundwater	Impacts on alteration of drainage pattern and stormwater runoff	L	L
	Impacts from surface water pollution from mineral waste facilities	M	L
	Impacts from sewage disposal	M	L
	Impacts from Water consumption	M	L
Biodiversity	**Impacts on Flora and fauna:**		
	• Loss of vegetation, lichens and associated biota due to clearing of vegetation	H	M
	• Change of habitat and water flow	M	M
	• Introduction of invasive alien plants and animals	M	L
	• Effect of dust and airborne pollutants on vegetation and lichens	M - H	M
	• Change of natural lighting conditions at night	M	L
	• Domestic waste and open water attracting animals	M	L
	• Spillage of chemicals and hydrocarbons polluting soil	M	L
Air Quality	**Air pollution - Residual impact summary:**		
	***Construction phase*:**		
	• PM_{10} and $PM_{2.5}$ impacts	M	L
	• Dustfall impacts	M	L

Environmental component	Environmental issues (i.e. environmental and social aspects/potential impacts	Assessment Significance Rating	
		Unmitigated	**Mitigated**
	Operational phase:		
	• PM_{10} and $PM_{2.5}$ impacts	**H**	**M**
	• Mn impacts	**H**	**M**
	• SO_2 impacts	**M**	**M**
	• SO_3 impacts	**M**	**M**
	• Dustfall impacts	**M**	**M**
	Decommissioning phase:		
	• PM_{10} and $PM_{2.5}$ impacts	**M**	**L**
	• Dustfall impacts	**M**	**L**
	Air pollution - Cumulative impact summary:		
	***Construction phase*:**		
	• PM_{10} and $PM_{2.5}$ impacts	**M**	**M**
	• Dustfall impacts	**M**	**L**
	Operational phase:		
	• PM_{10} and $PM_{2.5}$ impacts	**H**	**M**
	• Mn impacts	**H**	**M**
	• SO_2 impacts	**M**	**M**
	• SO_3 impacts	**M**	**M**

Environmental component	Environmental issues (i.e. environmental and social aspects/potential impacts	Assessment Significance Rating	
		Unmitigated	Mitigated
	• Dustfall impacts	M	M
	Decommissioning phase:		
	• PM_{10} and $PM_{2.5}$ impacts	M	M
	• Dustfall impacts	M	L
Climate Change	Operational phase		
	• Combined GHG emissions for project operations	VL	VL
	• Cumulative impacts	L	L
Noise	Cumulative environmental noise impacts associated with the construction phase	L	L
	Maximum' cumulative environmental noise impacts associated with the operational phase	L	L
Socio-economic	All levels of the economy	H+	VH+
	Job Creation	H+	VH+
	Skills Development	VH+	VH++
	Housing	M	L
Traffic	Traffic accidents (Mn transport route excluded)	H	L
Visual / Sense of Place	Visual impacts associated with the project	H	M
Safety risk and potential	Fire at sulphur store leading to combustion, toxic sulphur dioxide dispersion	L	L

Environmental component	Environmental issues (i.e. environmental and social aspects/potential impacts	Assessment Significance Rating	
		Unmitigated	Mitigated
impacts to third parties and infrastructure			
Aeronautical	Impacts to aviation - relating to additional obstacles	**M - H**	**L**
	Impacts to aviation - relating to additional glare from infrastructure, lights and emissions or dust clouds from stacks	**M**	**L**
	Impacts to aviation - relating to Wildlife attractants (open water bodies, waste)	**M - H**	**L**

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

The actions required to effectively implement design requirements, management and mitigation measures and monitoring requirements are detailed in the EMP (**Appendix A**). These actions are required to avoid / minimise the negative impacts and enhance positive impacts relating to the activities and infrastructure associated with the proposed GMRN Project, as assessed in the previous section.

The EMP gives the environmental commitments, which will be implemented by GMRN.

GMRN developed a Environmental and Social Policy, to which all employees, contractors and sub-contractors must adhere to.

At the current planning and design stage of the Project, GMRN recognises its responsibility to manage environmental and social risks and impacts in a systematic and proportionate manner, consistent with applicable Namibian legislation and Good International Industry Practice. In line with the principles of IFC Performance Standard 1, the Company adopts a risk-based and phased approach to environmental and social management that is appropriate to the stage of project development.

ENVIRONMENTAL IMPACT STATEMENT AND CONCLUSION

It is ASEC's opinion that the environmental aspects and potential impacts relating to the proposed Project have been successfully identified and assessed as part of this EIA process. Relevant management and mitigation measures and monitoring requirements have been provided to avoid/minimise key environmental and social impacts and enhance positive social impacts, where relevant. These measures are included in the EMP (**Appendix A**) and will become legally binding if MEFT provides a positive decision on the Application for the proposed Project.

The socio-economic benefits of the project outweigh any potential negative impacts of the socio-economic aspects assessed. The increased risk of traffic accidents due to project-related traffic can be mitigated to acceptable levels.

Impacts identified with the biophysical environment can be avoided due to design or appropriate mitigated. It is important that these measures stated in the EMP are adhered to and implement during all phases of the Project.

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APPENDICES

ACRONYMS

AQG	Air Quality Guidelines
AQMP	Air Quality Management Plan
AQO	Air Quality Objectives
ASEC	A. Speiser Environmental Consultants
ATC	Arandis Town Council
ATSDR	US Federal Agency for Toxic Substances and Disease Registry
CALEPA	Californian Office of Environmental Health Hazard Assessment
CCPP	calcium carbonate precipitation potential
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMSP	Central Marine Spatial Plan
CO	Carbon monoxide
COSDEC	Community Skills Development Centre
CoM	Chamber of Mines
CREO	CREO Engineering Solutions (Pty) Ltd
BID	Background Information Document
dBA	dBA or dB (A) is an expression of the relative loudness of sounds as perceived by the human ear.
DEA	Department of Environmental Affairs
DNP	Dorob National Park
DWNP	Directorate of Wildlife and National Parks
DRC	Democratic Resettlement Community
EAP	Environmental Assessment Practitioner
EAPAN	Environmental Assessment Professionals Association of Namibia
EC	European Community
ECC	Environmental Clearance Certificate
ECN	Engineering Council of Namibia
EDP	Erongo Desalination Plant
EIA	Environmental Impact Assessment
EHS	Environmental, Health and Safety
EMP	Environmental Management Plan
EOT	electric overhead travelling
EPA	Environmental Protection Agency
EQOS	Environmental Quality Objectives
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental Management Plan
EV	electric vehicle
GBV	Gender based violence
GDMS	Geographic Data Management System

GDP	Gross Domestic Product
GIIP	Good International Industry Practice
GMRN	Green Metals Refining Namibia (Pty) Ltd
GRN	Government of the Republic of Namibia
HDPE	High-density polyethylene
HPMSM	High-purity manganese sulphate monohydrate
HPP	Harambee Prosperity Plan II
IAP	Interested and Affected Parties
IFC	International Finance Corporation
IPPR	Institute for Public Policy Research
IRIS	Integrated Risk Information System
IT	Interim target
KMF	Kalahari Manganese Field
LFP	lithium iron phosphate
LIB	lithium-ion battery
LSA	Local Study Areas)
MAFWLR	Ministry of Agriculture, Fisheries, Water and Land Reform
MCCS	motor control centres
MJLR	Ministry of Justice and Labour Relations
MURD	Ministry of Urban and Rural Development
MIME	Ministry of Industry, Mines and Energy
MEFT	Ministry of Environment, Forestry and Environment
MFSGM	Ministry of Finance and Social Grants Management
MODVA	Ministry of Defence and Veteran Affairs
MoEAC	Ministry of Education, Arts and Culture
MoHSS	Ministry of Health and Social Services
MRF	Mineral Residue Facility
N_2	Nitrogen
NAAQS	National Ambient Air Quality Standards
NCAA	Namibia Civil Aviation Authority
NDCR	National Dust Control Regulations
NDP	National Development Plan
NEMAQA	South African National Environmental Management Air Quality Act
NDP6	Sith National Development Plan
NIMT	Namibia Institute of Mining and Technology
NLG	Noise level Guidelines
NMC	Nickel-manganese-cobalt
NO_2	Nitrogen dioxide
NPC	National Planning Commission
NSA	Namibia Statistics Agency
NUST	Namibia University of Science and Technology
NO_2	Nitrogen dioxide

NOX	Oxides of nitrogen
O_3	Ozone
OTS	off-the-shelf
pCAM	Precursor cathode active material is a powder-like substance containing critical components such as nickel, cobalt, manganese, or other chemical elements. As the name suggests, it is the precursor material to cathode active material (CAM), which is one of the main components of lithium-ion batteries. The battery recycling technology is rapidly evolving, yet the United States and other countries are struggling to keep up with a closed-loop battery supply chain. (https://www.greenli-ion.com/)
PFS	Pre-Feasibility Study
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5μ
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10μ
ppm	Parts per million
PPRTV	Provisional Peer Reviewed Toxicity Values
RSA	Regional Study Areas
RELS	Reference exposure levels
RfC	reference concentrations
RO	Reverse osmosis
RUL	Rössing Uranium Limited
SA	South African
SADC	Southern African Development Community
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessment
SAIEA	Southern African Institute of Environmental Assessment
SEMP	Strategic Environmental Management Plan
SO_2	Sulphur dioxide
SO_3	Sulphur trioxide
TCEQ	Texas Commission on Environmental Quality
TDS	total dissolved solids
TSP	Total suspended particulates
UN	United Nations
UNAM	University of Namibia
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency
WB	Walvis Bay
WBG	World Bank Group
WHO	World Health Organisation
WRF	Weather Research and Forecasting

UNITS

°C	degree Celsius
cm/s	centimetres per second
g	gram
g/s/m²	grams per second per metre squared
kg	kilogram
km	kilometre
km/hr	kilometres per hour
µm	micrometre
m	metres
m²	metres squared
m³	cubic metre
mg/L	milligrams per litre
mm	millimetre
mg/m²/day	milligram per metre squared per day
Mg	Megagram (or one metric ton)
m/s	metres per second
Pa	pascal
tpa	tons per annum
tph	tons per hour
µg/m³	microgram per cubic metre
%	percent

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APRIL 2026

DRAFT ENVIRONMENTAL IMPACT ASSESSMENT REPORT

GREEN METALS REFINING NAMIBIA (PTY) LTD'S PROPOSED MANGANESE REFINERY AND SULPHURIC ACID PLANT PROJECT ON FARM 58 EAST OF WALVIS BAY TOWN

1. INTRODUCTION

This Section describes the report purpose, briefly describes the project background, provides the project motivation, summarises legislative requirements, provides information on the EIA Team, explains the report structure, summarises assumptions and limitations of the study, and explains how Interested and/or Affected Parties (IAPs) can comment.

1.1 Purpose of the Scoping Report

Green Metals Refining Namibia (Pty) Ltd (GMRN) plans to construct and operate a Manganese Refinery and Sulphuric Acid Plant (and associated infrastructure and activities) ('the proposed project') on Portions 30 to 35 on Farm 58 (east of Walvis Bay town). Farm 58 belongs to the Walvis Bay Municipality, and is zoned for heavy industry. This Environmental Impact Assessment (EIA) Report was compiled as part of the EIA process that is being undertaken for the proposed Project and provides the following information:

- Introduction to 'the proposed Project'.
- Relevant environmental legislation and policies.
- The EIA process being followed, i.e., approach and process methodology.
- The motivation for 'the proposed Project' (i.e., need and desirability).
- A description of the proposed project activities, facilities, and associated infrastructure.
- Project alternatives considered.
- A description of the key characteristics of the receiving/baseline environment.
- Findings of specialist studies that were undertaken as part of the EIA process.
- Assessment of potential impacts of the proposed Project activities and associated facilities.
- Management and mitigation measures and design requirements necessary to avoid or reduce potentially significant impacts. (Note: Detailed management and mitigation measures, design requirements, and monitoring requirements are included in the Environmental Management Plan (EMP) attached as **Appendix A**).

IAPs are invited to comment on this (draft) Environmental Impact Assessment (EIA) Report (see **Section 1.4.3**). The document will be updated to the final EIA Report, considering the comments received. The final EIA Report will be submitted to the Ministry of Industry, Mines and Energy (MIME), as the Competent Authority, for their review and consideration, as well as the Ministry of Environment, Forestry and Tourism (MEFT): Department of Environmental Affairs (DEA). The final report will also be uploaded onto MEFT's online portal. In terms of Section 32 of the Environmental Management Act, 2007 (No. 7 of 2007), the MIME is required to make recommendations on the acceptance or rejection of the report to the MEFT, i.e., the office of the Environmental Commissioner, who will make the final decision on the acceptance of the EIA Report.

A copy will also be sent to the Municipality of Walvis Bay, as the owner of Farm 58, for their review and consideration.

1.1.1 Structure of this EIA Report

The content of this EIA Report is outlined in **Table 1** below and includes various sections and appendices.

Table 1: EIA Report content.

Section	Contents
Executive Summary	Provides a non-technical (executive) summary of the EIA Report.
Section 1	**Introduction** Describes the report purpose, briefly describes the project background, provides the project motivation, summarises legislative requirements, provides information on the EIA Team, explains the report structure, summarises assumptions and limitations of the study, and explains how IAPs can comment.
Section 2	**EIA Process and methodology** Outlines the approach and methodology for the EIA process, the public participation process undertaken in the Scoping phase, and further consultation planned.
Section 3	**Legal framework** Provides an overview of relevant Namibian policies and applicable Namibian legislation and key international conventions/treaties applicable to the proposed project.
Section 4	**Project description** Presents an overview of GMRN's proposed Manganese Refinery Project, including related activities and infrastructure, across the construction, operations, decommissioning, and decommissioning phases. It outlines the conceptual layout of the facility, processing infrastructure, and associated activities, which will be further developed and detailed in the forthcoming EIA Report.
Section 5	**Alternatives** Summarises the various project alternatives evaluated by GMRN, along with additional alternatives to be considered during the EIA.

Section	Contents
Section 6	**Description of the current/receiving environment** Describes the existing biophysical and social environment that could potentially be affected by the proposed Project, using currently available information. The link to potential environmental and socio-economic impacts is also explained for the various receptors/aspects.
Section 7	**Assessment of potential impacts** Describes and assesses the significance of potential impacts associated with the proposed Manganese Refinery Project for the unmitigated and mitigated scenarios, and summarises key management and mitigation measures and design requirements necessary to avoid or reduce potentially significant impacts.
Section 8	**Environmental and Social Management Plan**
Section 9	**Environmental Impact Statement and Conclusions**
Section 10	**References** Provides a list of the references used in compiling this report.
Appendices	**Various Appendices are attached to this report.**

1.2 Introduction of the proposed GMRN Project

GMRN will source high-quality manganese ore from established mines in South Africa to produce refined, battery-grade manganese products, serving as feedstock for precursor cathode active material (pCAM) manufacturers. The project will be developed within a designated heavy industrial zone. Cathode materials are essential components in the production of lithium-ion batteries (LIBs), which power electric vehicles (EVs) and stationary energy storage systems. **Figure 1** illustrates the location of the proposed project site, situated on Portions 30 to 35 of Farm 58, east of the town of Walvis Bay.

The proposed Project (and associated Application for an Environmental Clearance Certificate (ECC)) entails the following key components:

- Manganese Refinery Facility and associated infrastructure.
- Sulphuric Acid Plant and associated infrastructure.
- Associated waste stream facility, i.e., the Mineral Residue Facility (MRF).

At the time of this assessment, the detailed routing and design of the external power supply and water supply infrastructure are still under development. These components are therefore described only at a conceptual level. Where required, further environmental assessment processes will be undertaken once sufficient design information becomes available. Nonetheless, these project components are briefly outlined in **Section 4**.

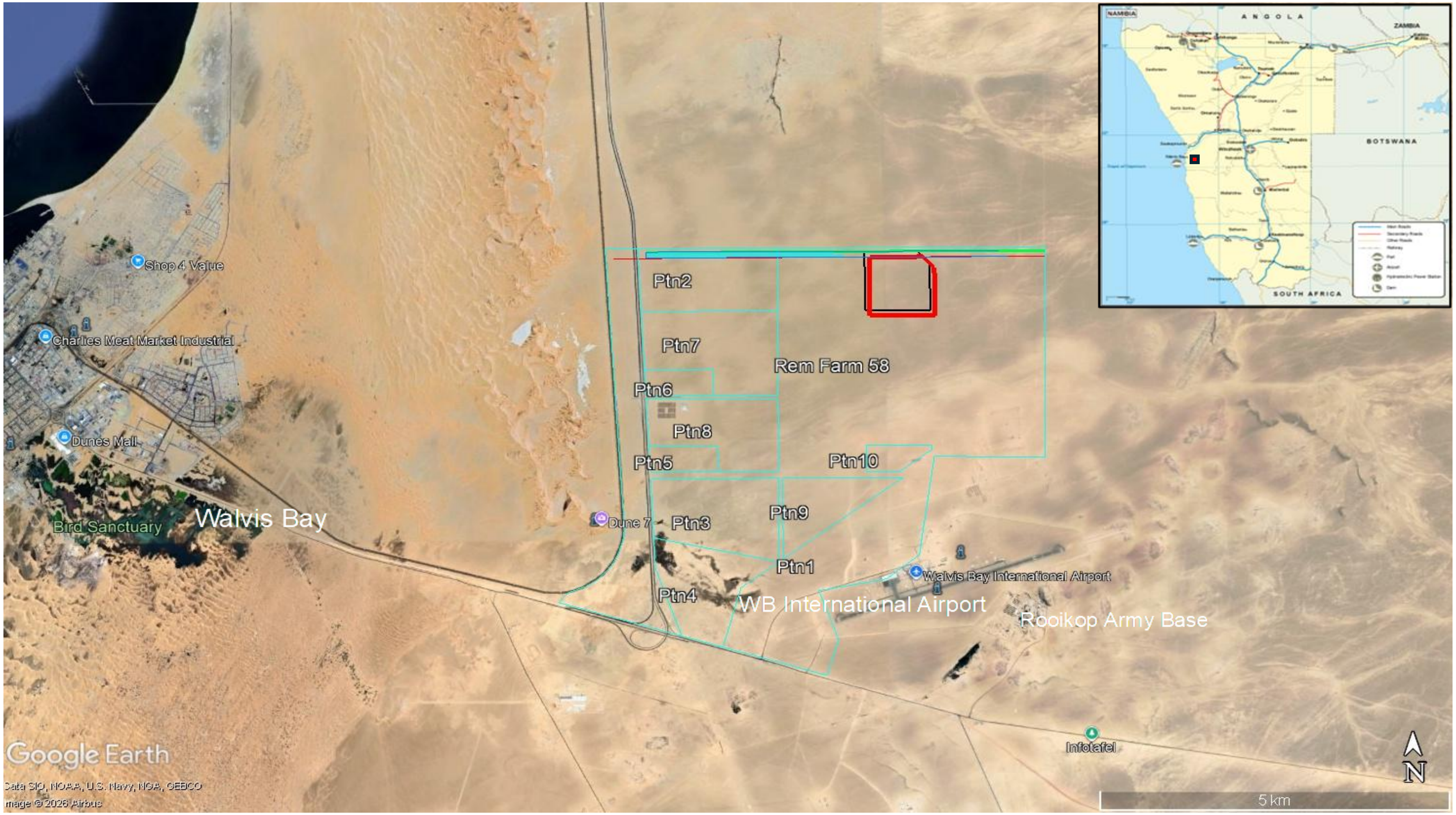

Figure 1: GMRN's proposed Manganese Refinery and Sulphuric Acid Plant Location

Note: The red layout shows the Location of GMRN's proposed Manganese Refinery and Sulphuric Acid Plant. The light blue and red lines show the powerline servitude to the North of the GMRN site. Also shown are the different plots of Farm 58 (e.g. Ptn 2).

1.3 Project Motivation (Need and Desirability)

1.3.1 Business case

Manganese plays a critical role in the battery industry, both in reducing costs and improving performance. In nickel manganese cobalt (NMC) batteries, manganese helps lower production costs, while in manganese iron phosphate (LMFP)batteries, it increases energy density. As a result, manganese is becoming an increasingly important metal in the development of next-generation lithium-ion battery (LIB) technologies.

The demand for high-purity manganese chemicals, such as High-Purity Manganese Sulphate Monohydrate (HPMSM), is being driven by the rapid growth of the electric vehicle (EV) market. This demand is further reinforced by the broader use of manganese across multiple LIB chemistries. Despite its technical advantages, manganese remains a relatively low-cost component in battery production, which makes demand for it less sensitive to price fluctuations—an effect known as inelastic demand.

As EV production scales up, this demand is expected to outpace supply starting around 2026. Forecasts project that by 2032, global demand for high-purity manganese could reach 500 to 800 kilotonnes per year (kt/a) of manganese content, equivalent to 1,500 to 2,400 kt/a of HPMSM.

Currently, over 90% of the world’s high-purity manganese supply comes from China, with very few new projects underway outside of China. This creates a looming supply gap that will likely require new producers to come online to meet future global needs. (GMR, EIA - Project Description, 2025)

1.3.2 Motivation for the proposed Project in Namibia (i.e. Walvis Bay)

Namibia was selected by GMRN for its flexibility in sourcing manganese ore from a diverse range of mining operations. Initially, manganese ore will be imported from South Africa. However, if mining operations in Namibia — such as at Otjosondu — resume, the company plans to source ore locally.

GMRN identified Namibia’s coastal region as the ideal location for its refinery and supporting infrastructure, based on five key criteria:

- **Proximity to a reliable international port** to reduce import and export costs: Namibia offers two options, namely the Lüderitz and Walvis Bay ports, with the latter having the greatest loading capacity and efficiencies.
- **Access to cost-effective and reliable ore feedstock** road and rail transport routes: GMRN will obtain its supply of manganese ore primarily from the Kalahari Manganese Field, located in the Northern Cape Province of South Africa. A well-established manganese export route to Namibia is already in place, using a combination of world-class road and rail transport links.
- **Reliable and cost-effective transport routes for ore feedstock:** GMRN will source its manganese ore primarily from the Kalahari Manganese Field in South Africa’s Northern Cape Province. An established and efficient export corridor to Namibia is already in place, leveraging a combination of world-class road and rail infrastructure.
- **Secure and reliable supply of power and water** at cost-effective rates.
- **Abundant Renewable Energy Potential:** Namibia boasts some of the world's highest levels of direct normal irradiation, making it ideal for solar energy production. The government has outlined a clear strategy to develop an integrated renewable energy system, positioning the country to export both renewable electricity and green hydrogen.

Also refer to **Section 2.1** for information about a Site Selection Study conducted by GMRN.

The motivation for Namibia to support the project is economic and strategic in nature. The project has the potential to benefit the country, society, and surrounding communities both directly and indirectly. Direct economic benefits will be derived from wages, taxes, and profits. Indirect economic benefits will be derived from the procurement of goods and services and the increased spending power of employees through the creation of new jobs at the mine. **Section 7.3.1** to **7.3.3** provide further details on the assessment of potential socio-economic benefits from the proposed Project.

1.4 Introduction to the EIA Process

Before the development of the proposed Project can commence, GMRN must obtain an ECC issued by the MEFT: DEA. Furthermore, the transfer of Portions 30 to 35 on Farm 58 from the Municipality of Walvis Bay to GMRN is contingent upon securing the ECC.

EIA applications are governed by the MEFT under the Environmental Management Act, 7 of 2007, published on 27 December 2007 (Government Gazette No. 3966). The EIA Regulations, issued under the Environmental Management Act (Government Gazette No. 4878), came into effect in January 2012. Together, the Environmental Management Act and the 2012 EIA Regulations regulate activities listed in Government Notice (GN) No. 29. These listed activities may not commence without first obtaining an ECC from the MEFT (DEA). A flowchart illustrating the regulated EIA application (i.e., scoping and assessment phases) process is presented in **Figure 2**.

The proposed Project triggers several of these listed activities, as detailed in **Section 1.4.1**. Additionally, as noted in **Section 1.2**, GMRN will undertake separate EIAs and ECC applications for the construction of a water supply pipeline and a powerline at a later stage.

A. Speiser Environmental Consultants (ASEC) has been appointed by GMRN as the independent Environmental Assessment Practitioner to undertake the EIA process. The process began with the Screening Stage, which was completed in July 2024, and has since progressed to the Application Stage. The Scoping Phase has been completed, and the project is currently in the Impact Assessment Phase. Once the Impact Assessment Phase—including the review of the Draft EIA Report and EMP by IAPs—is complete, the process will proceed to the final review and decision stage by the relevant authorities.

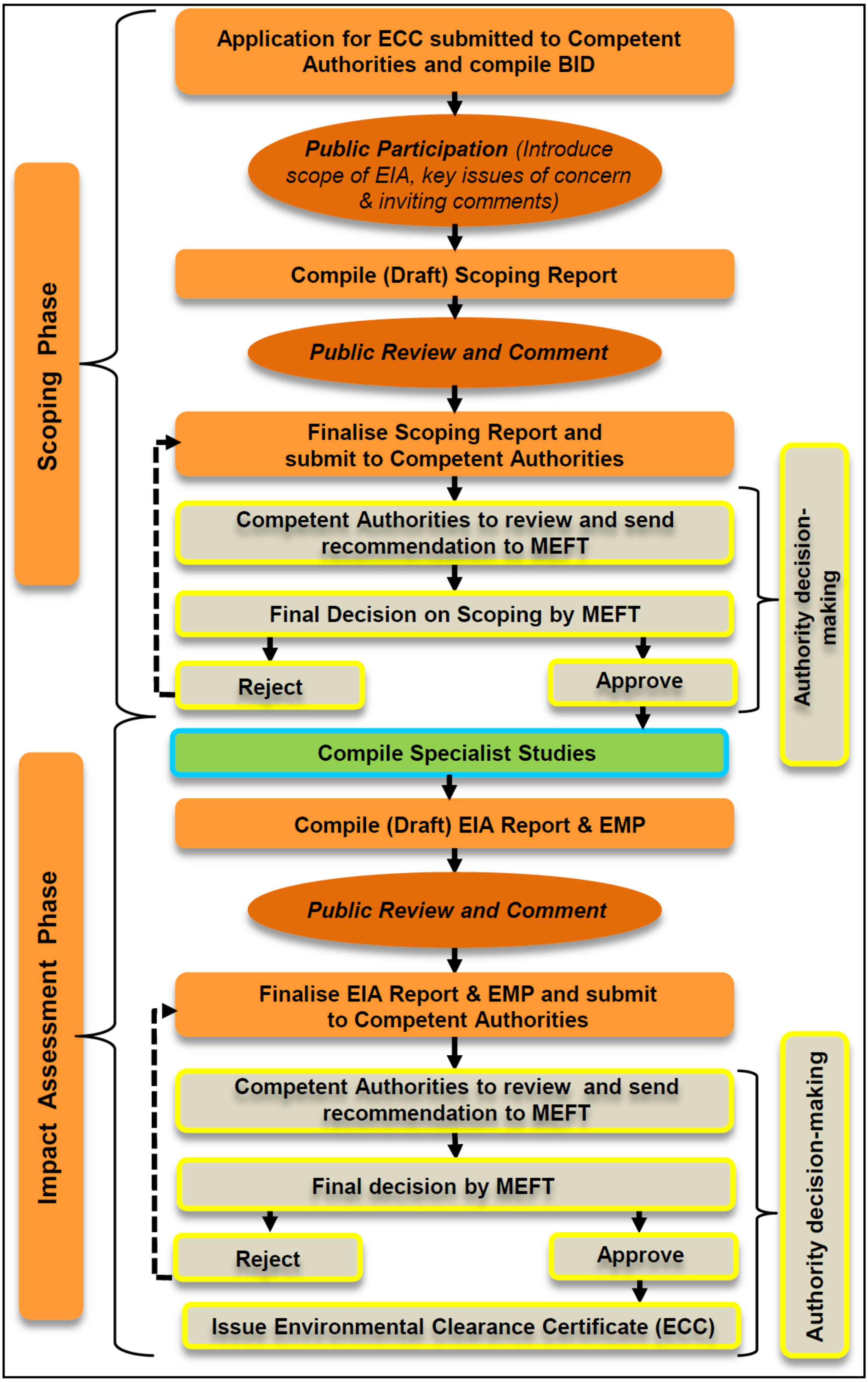

Figure 2: EIA (Application) Process for the proposed GMRN Project.

1.4.1 Applicable listed Activities

Table 2 lists the activities identified in the above-mentioned EIA Regulations that apply to the proposed Project:

Table 2: Listed activities triggered by the proposed project.

Listed activity	Project component
Waste management, treatment, handling, and disposal activities	
2.1 The construction of facilities for waste sites, treatment of waste, and disposal of waste. 2.2 Any activity entailing a scheduled process referred to in the Atmospheric Pollution Prevention Ordinance, 1976. 2.3 The import, processing, use, recycling, temporary storage, transit or export of waste.	• An MRF will be constructed on site. • The possible use of fossil fuel generators for power supply will generate emissions. The proposed processing and beneficiation might also be listed in future under the Atmospheric Pollution Prevention Ordinance. • Waste would be generated by the proposed Project. Hazardous and general waste will be managed and stored on site and finally disposed of at an authorised waste management facility.
Water resource development	
8.6 Construction of industrial and domestic wastewater treatment plants and related pipeline systems.	• A wastewater treatment plant will be constructed and operated on site.
Hazardous substance treatment, handling, and storage	
9.1 The manufacturing, storage, handling or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974. 9.2 Any process or activity which requires a permit, licence or other form of authorisation, or the modification of or changes to existing facilities for any process or activity which requires an amendment of an existing permit, licence or authorisation or which requires a new permit, licence or authorisation in terms of a law governing the generation or release of emissions, pollution, effluent or waste. 9.3 The bulk transportation of dangerous goods using pipelines, funiculars or conveyors with a throughput capacity of 50 tons or 50 cubic meters or more per day. 9.4 The storage and handling of dangerous goods, including petrol, diesel, liquid petroleum gas or paraffin, in containers with a combined capacity of more than 30 cubic meters at any one location.	• Various hazardous substances will be needed in the Manganese Refinery and Sulphuric Acid Plant.
Infrastructure	
10.2 The route determination of roads and design of associated physical infrastructure where –	• A new access road will be constructed to the site.

Listed activity	Project component
(b) the road reserve is wider than 30 meters.	

1.4.2 Objectives of the EIA Process

The overall objectives of the EIA process are to:

- Provide information about the proposed Project, including its activities, facilities, and infrastructure.
- Describe the existing (i.e. baseline / current) environmental and social conditions of the Project area and surroundings.
- Ensure meaningful opportunities for IAPs to participate throughout the EIA process, including both the Scoping and Impact Assessment phases.
- Identify and evaluate feasible alternatives to the proposed Project.
- In consultation with IAPs, identify the environmental (including social) aspects, as well as potential positive and negative impacts across all project phases, i.e. construction, operation and decommissioning.
- Assess the significance of these potential impacts.
- Recommend appropriate measures to avoid, minimise, or mitigate negative impacts to acceptable levels and develop monitoring requirements.

1.4.3 Opportunity to Comment on the Draft EIA Report

IAPs are invited to comment on this draft EIA Report along with all its Appendices (including the Draft EMP), which will be available for a review and comment period from **15th of April 2026** to **15th of May 2026**. Comments should be sent to ASEC at the address, telephone number, or e-mail address shown below by **no later than 15th of May 2026**.

WHO TO CONTACT:

Alexandra Speiser (ASEC)		**Werner Petrick**
Email: amspeiser@yahoo.com	**or**	**Email:** wpetrick@namisun.com
		Telephone: 081 140 5968

1.4.4 EIA Team

Founded in 2003, ASEC is a Namibian company with extensive experience in conducting environmental and socio-economic assessments for projects across a wide range of sectors throughout Namibia.

The primary aims of ASEC are to promote and ensure implementation of the three pillars of sustainable development (social, biophysical, and economic) while providing efficient, cost-effective solutions that take current best practices into account at the planning, strategic, and operational levels.

The project team comprises Ms Alex Speiser (Project Manager) and Mr Werner Petrick (Project Assistant). Ms Speiser is a member of the Chamber of Mines of Namibia, the Chamber of Environment of Namibia and Environmental Assessment Professionals of Namibia (EAPAN).

Mr Petrick has more than twenty-six (26) years of relevant experience in environmental management, conducting/managing EIAs, compiling EMPs, and implementing EMPs and Environmental Management Systems. Mr Petrick is certified as a lead Environmental Assessment Practitioner and Reviewer under the Environmental Assessment Professionals Association of Namibia (EAPAN) and is on the Executive Committee of EAPAN.

The relevant curriculum vitae for Ms Speiser and Mr Petrick are attached in **Appendix B**.

The Environmental Project team for the EIA process relating to the proposed Project is outlined in **Table 3**.

Table 3: EIA Project Team and Specialists.

Team	Name	Designation	Task and Roles	Company
Lead EIA Practitioner	Alexandra Speiser	EIA Project Manager	Management of the EIA process and compilation of the Scoping Report, EIA Report and EMP, with input from Specialists.	A. Speiser Environmental Consultants cc
	Werner Petrick	EIA Project Assistant	Report and process review. Co-author/review of the above-mentioned reports. Coordination of the Public participation process.	
Specialists Investigation	Sandra Müller	Groundwater & Surface water Study	Groundwater and surface water assessment	Independent Consultant – Water Specialist
	Hanlie Liebenberg Enslin	Air quality specialist	Air Quality Baseline Study and Assessment, and Climate Change Assessment	Airshed Planning Professionals
	Nicolette von Reiche	Noise specialist	Noise assessment	Soundscape Consulting (Pty) Ltd
	Antje Burke	Biodiversity specialist	Fauna and flora assessment	EnviroScience
	John Kinahan	Archaeologist	Heritage resource assessment	J. Kinahan Archaeologist
	Auriol Ashby	Social specialist	Socio-economic assessment	Independent consultant
	Michael Oberholzer Gillian Petzer	Risk assessment specialist	Quantitative Risk Assessment	RISCOM / Airshed Planning Professionals

1.4.5 Assumptions, Exclusions and Limitations associated with the EIA Process

The assumptions and limitations identified by the EIA Team are outlined below:

- It is assumed that the technical (Project) information provided by GMRN and its Technical Team is accurate.
- There will be no significant changes to the project description or surrounding environment between the completion of the EIA process and implementation of the proposed project that could substantially influence findings and recommendations with respect to mitigation and management, etc. Any changes in the Project of environmental significance may require re-assessment.
- During the EIA Report Phase, the specialists used layouts and project information that were refined as the designs progressed, informed by detailed site surveys, engineering inputs, and other developments.
- The EIA focused on third parties only and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by labour acts, health and safety legislation, policies and standards to be adhered to by GMRN.
- Specialists conducting the various studies and assessments during the impact assessment phase took the limitation into account while evaluating potential impacts. Where relevant, each specialist outlined the specific assumptions and limitations applicable to their respective studies.

A summary of assumptions, exclusions and limitations of each specialist study is provided in the sections below.

1.4.5.1 Air Quality Specialist Study

The main assumptions, exclusions and limitations are summarised below:

- Meteorological and ambient data:
  - Meteorological data from the Walvis Bay Airport weather station for the period 2024 was provided courtesy of Namibia Airports Company (NAC) for use in the assessment. The weather station is located 4.5 km south-southeast of the Project site and regarded representative of the site conditions.
  - A one-month passive air quality sampling campaign including particulate matter (PM) and sulphur dioxide (SO_2) and oxides of nitrogen (NO_x). These ambient concentrations provide an indication of the baseline levels but cannot be used to determine cumulative impacts as variability in concentrations have not been considered.
  - A general description of the air quality within the greater Erongo Region was obtained from the Air Quality Management Plan (AQMP) conducted as part of the Strategic Environmental Management Plan (SEMP).
- Emissions:
  - The quantification of sources of emission was restricted to the Project activities only. Although other background sources were identified, such as emissions from roads and other industrial processes and quarries, these could not be quantified and did not form part of the scope of work.
  - Emissions were based on the process description and refinery layout plan as provided and were quantified for one operational year representing the final Stage 3 operations.

- Since it is a proposed facility, no site-specific particle size fraction data for the MRF was available and use was made of information obtained from existing manganese facilities previously studied.
- The Mn content in the ore grade was given as 46.6% and this was assumed to be the fraction in the dust content from materials handling (off-loading of ore) and crushing and screening. The design recovery of Mn was given as 88%, and it was assumed that the remaining 12% would end up in the mineral residue and on the MRF.
- Routine emissions for the proposed operations were simulated. Upset conditions were not accounted for.
- Although some mitigation is accounted for in the plant design, such as the off-loading of ore in an enclosure that contains and captures dust, and that the crushing equipment will be individually enclosed, the unmitigated scenario assumed no mitigation in place, with only the mitigated scenario accounting for both design mitigation (already accounted for in the plant design) and additional proposed mitigation measures.

1.4.5.2 Climate Change Study

The following were excluded from the inventory:

- GHG emissions could not be quantified for the Construction phase due to insufficient information on fuel consumption by stationary and mobile equipment, raw materials used for construction (i.e. concrete, steel, bricks, etc.), and contractors commuting. The CO_2e contribution from the Construction phase to CO_2e from the life of the project is likely small.
- Embodied emissions in equipment used and transport of equipment to the project site.
- Scope 3 categories not regarded as applicable to the project, including:
  - Upstream emissions:
    - *Purchased Goods and Services*: Emissions from the production of the goods and services a company buys.
    - *Capital Goods*: Emissions from the production of physical assets like buildings and machinery used by the company.
    - *Upstream Leased Assets*: Emissions from leased assets.
  - Downstream emissions:
    - *Processing of Sold Products*: Emissions from the processing of the company's sold products by other entities.
    - *Use of Sold Products*: Emissions from the use of the company's sold products by customers.
    - End-of-Life Treatment of Sold Products: Emissions from the treatment and disposal of sold products after their use.
    - *Downstream Leased Assets*: Emissions from leased assets by the company's customers.
    - *Franchises*: Emissions from franchises associated with the reporting company.
    - *Investments*: Emissions from investments made by the company.

- Scope 3 categories which didn't have enough information available:
  - Upstream emissions:
    - *Waste Generated in Operations:* Emissions from the disposal and treatment of waste created in a company's operations.
    - *Business Travel*: Emissions from employee business trips
    - *Employee Commuting*: Emissions from employees travelling to and from work in vehicles (only accounted for commuting by bus).

1.4.5.3 Water Specialist Study

The following limitations and assumptions apply to the study:

- The GMRN project description made available to the specialists did not include all the relevant data on the project's water consumption.
- No boreholes were available on or near the project site to determine the depth of the water table or the water quality.
- The compilation of a numerical groundwater model to assess the potential for groundwater contamination was not possible without having any hydrogeological information as input, e.g. borehole data within the closer Project vicinity. No boreholes were advanced as part of this scope of work.

1.4.5.4 Biodiversity Study

The following assumptions were made:

- The infrastructure will be developed within the confines of the spatial scope provided by the project team. This also includes roads to the various infrastructure components within the planned complex.
- Water pipelines and power lines outside the project area are not included in this assessment as the routes are not yet known.
- Access to the project area to be developed will follow existing roads/tracks.
- No additional natural areas will be required outside the project area depicted above; for example, for quarries for limestone, borrow pits for building material or similar activities that affect undisturbed land. For the purpose of this assessment, the area surrounding the project site is considered undisturbed, except for the borrow-pit areas south of the river.
- The selected sewage treatment is a closed installation of sufficient capacity to cater for the effluent generated during construction and operation.
- The impact of the combined effect of climate change and the project on biodiversity cannot be assessed in detail, but a paragraph at the end of this Section is dedicated to this aspect.
- The impact assessment assumes that all mitigation measures proposed are implemented and are effective. The assessment with mitigation measures is provisional as the effectiveness of the measures will only be known after implementation.

1.4.5.5 Socio-economic Study

none

1.4.5.6 Traffic Study

The transport of the manganese ore from outside Namibia to the Dr Hifikepunye Pohamba Freeway is not part of this ESIA. The access road to the Project site has yet to be determined. **The alignment of the access road needs to be stipulated by the Municipality of Walvis Bay as other erven are sited on Farm 58.** At the moment it is assumed that access will be created continuing from the road to the Green Hydrogen Pilot Plant site.

Mitigation measures to reduce traffic impacts, e.g. accidents, are stated in the EMP (**Appendix A**) and need to be implemented and adhered to by the contractor transport companies.

1.4.5.7 Risk Assessment Study

The risk assessment was based on the conceptual designs of the facility, excluding the details still to be determined from the detailed designs. Furthermore, EIAs are intended to suggest mitigation which may alter the design and layout of the project. It is thus understood that detailed designs would be required to complete the project for construction.

RISCOM used the information provided and made engineering assumptions as described in the document for the purposes of compiling this quantitative risk assessment. The accuracy of the document would be limited to the available documents presented for the completion of this report. However, the inventory of hazardous goods of the facility is not expected to increase from the amounts stated in this document, and despite the potential of an improved site layout, we expect the maximum impacts to be representative.

With the detailed designs, we expect additional mitigation, which should reduce the risks as recommended.

The greatest impact on accuracy would be omissions from the design presented, changes to the process, substitution of hazards goods (typically), as required by the equipment supplier or the increase of hazardous goods inventory. These would be evaluated prior to construction.

NOTE: Where data limitations or exclusions apply, a precautionary approach has been adopted in the impact assessment to ensure that potential risks are not underestimated. These limitations have been taken into account when determining impact significance and the need for mitigation.

2 EIA PROCESS AND METHODOLOGY

This Section outlines the approach and methodology for the EIA process, the public participation process undertaken in the Scoping phase, and further consultation planned as part of the Impact Assessment Phase.

The EIA process and corresponding activities that will be undertaken for the proposed GMRN Project are outlined in the sections below. The process being followed is in accordance with the requirements outlined in the EIA Regulations (see **Section 1.4**).

2.1 Internal Screening Process

In addition to the regulated EIA application process, a Site Selection Study and an Internal Environmental Screening Study were conducted between 2023 and 2024. These studies evaluated three alternative sites for the project's development. Based on the findings of these studies and other relevant criteria, GMRN determined that the Walvis Bay site was one of the preferred options, offering unique benefits. ASEC completed the Scoping Phase of the EIA (Application) process (see **Section 2.2**) and is currently engaged in the Impact Assessment Phase (see **Section 2.3**) for the proposed project, which is located at Farm 58 (see **Section 1.2**).

The Internal Environmental Screening Study provided a high-level (qualitative) description of the environmental and social aspects, as well as potential impacts, associated with the site selection for the proposed GMRN Project. This assessment focused on the three preferred sites: Arandis, Swakopmund (approximately 10 km east of Swakopmund within the future planned industrial area), and Farm 58 near Walvis Bay. The initial site selection study was conducted by CREO Engineering Solutions (Pty) Ltd (CREO, 2023),

GMRN considered the findings of the Site Selection and Internal Environmental Screening studies, as well as other relevant criteria, which resulted in the Walvis Bay Farm 58 site being one of the preferred options, offering unique benefits.

2.2 Scoping Phase

The purpose of the Scoping Phase was to:

- Communicate the nature of the proposed Project, including the location, description of the activities, infrastructure/facilities, and Project layout to IAPs.
- Provide baseline information and identify environmental and socio-economic aspects and potential impacts associated with the Project.
- Identify the most significant issues for investigation and assessment, and develop the terms of reference for specialist studies to be conducted in the Impact Assessment Phase.

The Scoping Phase involved the following:

- Notifying IAPs of the proposed Project and the steps in the EIA process.
- Creating an opportunity for IAPs to interact with the EIA project team.
- Providing adequate information for IAPs to comment on, to ensure that all key environmental and social issues are identified.

Steps undertaken during the Scoping Phase are summarised below.

2.2.1 Information Collection

ASEC compiled the environmental and social baseline and identified issues related to the proposed GMRN Project by drawing on multiple sources. These included previous studies like the Site Selection Study (CREO, 2023) and the Internal Environmental Screening Study (ASEC, 2024), project details and layouts provided by the GMRN Project Team, and site visits conducted by ASEC and environmental specialists. Input from experts in groundwater, air quality, noise, biodiversity, heritage, and socio-economic aspects further informed the baseline. Additionally, relevant Environmental Impact Assessments (EIAs) from nearby projects and consultations with Interested and Affected Parties (IAPs) and authorities contributed to a comprehensive understanding of the potential impacts and issues.

2.2.2 Scoping Phase Public Participation Process

The objective of the scoping public participation process was to ensure that IAPs were notified about the proposed Project, given a reasonable opportunity to register as interested and/or affected parties on the project database, and to provide comments. Steps undertaken during this phase are summarised below.

Notification to MEFT:DEA (December 2024)

- ASEC notified MEFT (DEA) of the proposed Project and EIA process through the online registration (i.e. on the MEFT online registration system/portal) and the uploading of a background information document (BID).
- The Scoping Report was submitted to MIME and reviewed. Comments from MIME were provided to MEFT(DEA) in August 2025.

I&AP identification (throughout the process)

- Possible IAPs were identified and contact details obtained through meetings with certain key stakeholders, telephone calls, and using databases from other EIAs conducted in the region.
- ASEC developed an I&AP database with input from GMRN. This database is updated as and when required (i.e. on request from additional IAPs who wish to register), throughout the EIA process. A copy of the most recent I&AP database is attached in **Appendix E1**.

I&AP Registration and comments period and distribution of Background Information Document (BID) (February to March 2025)

- Copies of the BID were distributed via email to relevant authorities and IAPs on the IAP database, and copies were made available on request to ASEC.
- The purpose of the BID was to inform IAPs and authorities about the proposed Project activities, the EIA process and Project Schedule, possible environmental and social impacts, and ways in which IAPs could provide input to ASEC.
- The initial I&AP registration and BID review and comment period was from 17 February to 3 March 2025.

E-mail notifications and site notices (February 2025)

- E-mails were sent to all IAPs on the database. Site notices were placed to notify IAPs of the proposed GMRN Project, the EIA process being followed and who to contact for further information requirements. The details of the public open meeting were also published.

Walvis Bay Municipality social media platforms

On requested from ASEC, the Walvis Bay Municipality's Public Relations Department published the notification (as distributed by ASEC) on their social media platforms to reach various organisations and individuals in the Municipal area – informing them of the proposed

GMRN Project, the EIA process being following, details of the public open meeting, as well as who to contact for further information requirements.

Newspaper Advertisements (February 2025)

- Block advertisements were placed in the Market Watch as part of the following newspapers:
    - The Namibian Sun (17 and 24 February 2025).
    - Die Republikein (17 and 24 February 2025).
    - Allgemeine Zeitung (17 and 24 February 2025).

Focus Group Meetings, telephone discussions and open public meeting (February 2025)

- ASEC contacted various key stakeholders telephonically to confirm their e-mail addresses, to share the relevant information and/or to arrange for Focus Group meetings. Also, to obtain further input regarding IAPs to be added to the I&AP database.
- Informal information sharing discussions were undertaken telephonically during the above-mentioned discussions.
- As part of the e-mail notifications and newspaper adverts, ASEC invited IAPs to attend the Open Public meeting.
- Various (formal) Focus Group Meetings and an Open Public Meeting were held with IAPs, as summarised in **Table 4**.
- The same PowerPoint presentation was given at each of the meetings listed in **Table 5**.

Table 4: Summary of Focus Group and Public Meetings conducted.

Date	Time	Type of Metting	Stakeholder	Venue
26 February 2025	8:00	(Informal) Focus Group Meeting (FGM)	Dune 7 operators	Dune 7
	9:30	Focus Group Meeting (FGM)	Walvis Bay International Airport	Walvis Bay International Airport Boardroom
	11:30	FGM	Municipality of Walvis Bay	Walvis Bay Municipality-Boardroom
	14:00	Open Public meeting	Open to the public / any I&AP	Protea Hotel by Marriott Walvis Bay Indongo in Walvis Bay
27 February 2025	12:30	FGM	Clean Energy Developing Committee, O&L	Green Hydrogen Pilot Plant Boardroom
28 February 2025	9:00	FGM	MEFT: DWNP	Stone Valley Environmental Management Facility (Swakop River Plots)
23 April 2025	14:00	FGM	MODVA	Virtual

Date	Time	Type of Metting	Stakeholder	Venue
21 May 2025	8:30	FGM	Dune 7 operators	Dune 7 office in Windhoek

Review of draft Scoping Report by IAPs and relevant authorities (May 2025)

- An email notification was sent to all IAPs on the database to inform them about the availability of the EIA Scoping Report for review and to inform them where the report could be found. The full Scoping Report was attached to the e-mail.
- A hard copy and electronic (soft) copy of the Scoping Report (including all Appendices) were made available for review at the Walvis Bay Public Library from 13 to 27 May 2025.
- During this time, a focus group meeting between GMRN and Dune 7 Operators was held. The Topnaar Community (representative) was telephonically informed that the draft Scoping Report was sent to him and that a focus group meeting was been offered.
- Authorities and IAPs had the opportunity to review the report and submit comments in writing to ASEC. The closing date for comments was 27 May 2025.

2.2.2.1 Interested and Affected Parties

Table 5 provides a broad list of persons, groups of persons or organisations that are included on the Projects IAP database.

Table 5: Broad list of Stakeholders.

I&AP Grouping	Organisation
Local and regional government	• Erongo Regional Council • Municipality of Swakopmund • Municipality of Walvis Bay

Government Ministries	• Ministry of Environment, Forestry and Tourism (MEFT);
	  ○ DEA;
	  ○ Directorate of Wildlife and National Parks (DWNP)
	• National Heritage Council of Namibia;
	• Ministry of Agriculture, Water and Land Reform (MAWLR);
	• Ministry of Health and Social Services;
	• Ministry of Defence and Veteran Affairs (MODVA),
	• Ministry of Industry, Mines and Energy (MIME).

Government Parastatals	*Namibia Civil Aviation Authority (NCAA)*; Walvis Bay International Airport operated by the Namibia Airports Company (NAC); Namport; Roads Authority;
Mines / Exploration companies	Langer Heinrich Uranium; Swakop Uranium; Orano Mining Namibia; Rössing Uranium; Bannerman Resources; Valencia.
Environmental Foundations / NGOs	Tour and Safari Association of Namibia (TASA).
National Chambers	National Chamber of Environment.

I&AP Grouping	Organisation
Local Businesses	Neighbouring businesses, including Dune 7 operators, Cleanergy and Ohlthaver & List (O&L) and various other businesses.
Media	Newspaper adverts: The Namibian Sun, Die Republikein; Allgemeine Zeitung
Other interested and affected parties	Any other people with an interest in the proposed Project or who may be affected by the proposed Project, including the Topnaar Community, members of the public, etc..

* Organisations or Ministries in Italics still need to be consulted

The full list of stakeholders for the GMRN Project EIA process is included in Appendix B of the Scoping Report (ASEC, 2025).

2.2.2.2 Summary of Comments and Issues raised during Scoping

The key comments and issues raised by IAPs regarding the Project during the Scoping Phase include the following:

Issues relating to Farm 58 and zonation:

- Current status/zonation of the land.
- Farm 58 belonged to NamPort in the past and was exchanged with the WB municipality for land closer to the Port for the expansion.
- WB municipality needs more land to the North of Farm 58 and applied to MEFT to obtain more land east of the double carriageway behind the dunes.
- Farm 58 is not part of the Dorob National Park.
- Purchase or rental agreement of GMRN with Walvis Bay Municipality.

Water Supply:

- Water requirements (i.e. volume).
- Where will the water supply be sourced for the proposed Project.

Power supply:

- Electricity requirements.
- The sulphuric acid plant will produce energy, which can be fed into the NamPower grid.

Waste management:

- Type, volume, management, and disposal of the various hazardous waste streams generated by the proposed activities.
- The general management and disposal of waste from the proposed activities.
- Storage of the mineral residue.

Air quality (dust):

- Impacts of Dust on Third Parties and operations from all activities at the proposed Project site, and also during transportation of Manganese.

Aviation Safety:

- Infrastructure (height) and related activities affecting aviation (e.g., Walvis Bay Airport).
- Open water sources attract bird life, which could affect the WB International Airport.

Safety aspects, possible risks and Emergency Response:

- Activities that could affect third parties and their operations.

- Fire hazards of fine Manganese dust.
- The need for the development of Emergency Response Plans. (Industrial Emergency Plans need to be streamlined between land users).
- All hazardous materials must be listed.
- Synergy between industry and community.

Traffic:

- Traffic-related aspects in and out of the port.
- Consideration of transport options.

2.2.3 Compilation and approval of the Final Scoping Report

The Final Scoping Report was prepared in compliance with Section 8 of the EIA Regulations (2012) and was informed by all comments received during the public participation process described in **Section 2.2.2**.

ASEC (and the appointed Environmental Specialists) considered all the comments received from IAPs and Regulatory Authorities after the closing date for comments. Where relevant, the report was updated. A copy of the final Scoping Report, including authority and IAP review comments, was delivered to MIME and MEFT for their review and recommendation on 06 June 2025.

2.2.3.1 Focus Group meeting with MEFT (DEA)

ASEC and GMRN engaged in various interactions with MEFT (DEA) during the review of the Scoping Report, including follow-ups on its progress. As part of this process, MEFT requested that the Scoping Report be uploaded to their portal, which was completed in October 2025.

On 27 November 2025, GMRN and ASEC met with MEFT (Environmental Commissioner and Head of Assessments) at their office to provide additional information regarding the proposed Project activities. The meeting also provided an opportunity for MEFT to seek further clarifications on the Project and the EIA process, including the submitted Scoping Report, as well as to discuss the expected timeline for MEFT's decision on the report.

The Scoping Report was accepted by MEFT and a letter was issued by the Environmental Commissioner on 16 February 2026, advising to proceed with the detailed impact assessment (see **Appendix C** for a copy of the letter issued by MEFT).

2.3 Impact Assessment Phase

The proposed terms of reference for further specialist investigations were developed during the Scoping Phase and presented in the Scoping Report. The Environmental Team, comprising ASEC and various specialists (see **Table 3**), carried out the tasks outlined in the approved Terms of Reference. They also incorporated the baseline studies conducted during the Scoping Phase into their assessments of the potential impacts the Project may have on the physical, social, and economic environments.

2.3.1 Specialist Studies

The following specialist studies were identified during the Scoping Phase and undertaken as part of the Impact Assessment Phase:

- Biodiversity:

  Biodiversity specialist study for Green Metals Refining. Report for Alex Speiser Environmental Consultant and Green Metals Refining, EnviroScience, Windhoek. Surface Water Assessment. (Burke A, 2025)

- Groundwater Assessment:

  Water specialist report for the EIA of the proposed Green Metals Refining Namibia (Pty) Ltd Manganese Refinery and Sulphuric Acid Plant at Walvis Bay, Erongo Region. (Mueller S, 2025)

- Air Quality Assessment, including a Climate Change Assessment:

  Air Quality Impact Assessment for the proposed Manganese Refinery and Sulphuric Acid Plant, Walvis Bay, Erongo Region. (Airshed Planning Professionals, 2025)

  Climate Change Assessment for the Proposed Manganese Refinery and Sulphuric Acid Plant, Walvis Bay, Erongo Region, Namibia. (Airshed Planning Professionals, 2025)

- Noise Assessment:

  Green Metals Refining Namibia (Pty) Ltd Project, Walvis Bay - Environmental noise impact assessment. (Soundscape Consulting (Pty) Ltd, 2025)

- Archaeology / Heritage Resource Assessment:

  Archaeological Assessment of RMG Project Site, Farm 58, Walvis Bay, Namibia. (Kinahan J, 2025)

- Socio-Economic Assessment:

  Socio-economic and Traffic Baseline Studies and Environmental Impact Assessment for a Manganese Refinery and Sulphuric Acid Plant (A. Ashby, 2025)

- Quantitative Risk Assessment:

  Quantitative Risk Assessment of the proposed Green Metals Refining Namibia (Pty) Ltd.'s Manganese Refinery and Sulphuric Acid Plant Project, Walvis Bay. (RISCOM (PTY) LTD, 2025)

2.3.2 Impact Assessment Methodology

The methodology and criteria used to evaluate the significance of the impacts related to the proposed Project are outlined in **Section 7**. This method complies with the EIA Regulations: EMA, 2007 (Government Gazette No. 4878) and was used by all specialists and ASEC to conduct their impact assessments.

2.3.3 EIA Report and Environmental Management Plan

The findings of the specialist studies, including updated baseline descriptions and impact assessments, together with other pertinent information, were integrated into this (Draft) EIA Report and the associated EMP (attached as **Appendix A**). Specialist studies are appended as supporting documentation.

This EIA Report has been prepared in compliance with Section 15(2) of the EIA Regulations 2012 (see **Table 6**). It details all the Project components/activities on the proposed location on Farm 58 for construction, operation and decommissioning. The water pipeline and powerline will be assessed in separate EIAs.

The EMP provides the required design requirements, management and mitigation measures and monitoring requirements (among others) to ensure the potential impacts are avoided, as far as possible, or minimised to acceptable levels.

Table 6: EIA Report requirements stipulated in the EIA Regulations.

EIA Report requirements in terms of the EIA regulations	Reference in report
(a) the curriculum vitae of the EAP who prepared the report;	Appendix B
(b) a detailed description of the proposed listed activity;	Section 4
(c) a description of the environment that may be affected by the activity and the manner in which the physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity	Sections 6 and 7
(d) a description of the need and desirability of the proposed listed activity and identified potential alternatives to the proposed listed activity, including advantages and disadvantages that the proposed activity or alternatives may have on the environment and the community that may be affected by the activity;	Sections 1.3 and 5
(e) an indication of the methodology used in determining the significance of potential effects;	Section 7.1
(f) a description and comparative assessment of all alternatives identified during the assessment process	Section 5
(g) a description of all environmental issues that were identified during the assessment process, an assessment of the significance of each issue and an indication of the extent to which the issue could be addressed by the adoption of mitigation measures;	Sections 6 and 7 Appendix A
(h) an assessment of each identified potentially significant effect, including – (aa) cumulative effects; (bb) the nature of the effects; (cc) the extent and duration of the effects; (dd) the probability of the effects occurring; (ee) the degree to which the effects can be reversed; (ff) the degree to which the effects may cause irreplaceable loss of resources; (gg) the degree to which the effects can be mitigated;	Section 7 Appendix A
(i) a description of any assumptions, uncertainties and gaps in knowledge;	Section 1.4.5 and Appendices F to M
(j) an opinion as to whether the proposed listed activity must or may not be authorized, and if the opinion is that it must be authorized, any conditions that must be made in respect of that authorization;	Section 9
(k) a non-technical summary of the information.	Executive Summary

2.3.4 *Completion of the Impact Assessment Phase - including further Public Participation*

The following steps are envisaged for the remainder of the Impact Assessment Phase:

1. **Notifications to IAPs of the availability of the Draft EIA Report, EMP, and Focus Group/Public Open Day**

   - The EIA Report Executive Summary will be distributed to all authorities and I&APs that are registered on the project's public involvement database (**Appendix E1**) via e-mail.
   - Electronic copies of the full report will be available on request to ASEC.
   - The availability of the report will be advertised in the following newspapers:
     - Republikein
     - Allgemeine Zeitung
     - The Namibian Sun
   - Hard copies of the full report, including all Appendices, will be available at the Walvis Bay Library.
   - Authorities and I&APs have 30 days (15th April to 15th May 2026) to review the EIA Report and EMPs and submit comments in writing to ASEC. The **comment period ends on the 15th May 2025**.
   - An 'Open Day Session' will be held on **11th May 2026** at the **Protea Hotel by Marriott Walvis Bay Indongo** in Walvis Bay. The Open Day will run from **15h00 to 18h30**.

2. **Issues and Response Report (IRR)**

All comments, questions, and issues raised by the I&APs, during the review period of the EIA Report, either through written (i.e. e-mails) comments received or at the above-mentioned meetings, will be included in an Issues and Response Report (IRR). The IRR will provide responses to each of the comments, questions, and issues raised, referencing relevant sections of the EIA Report, specialists' reports, and the EMP, where applicable. The IRR will be included in the Final EIA Report, as an **Appendix E2**, which will be submitted to the relevant Authorities for their review and decision on the EIA (see below).

3. **Final EIA Report and review by MIME and MEFT**

After the closure of the comment period, the EIA Report and EMP will be finalised by incorporating all comments received by IAPs, where relevant. An IRR will be appended to the Final EIA Report. The Final EIA Report and EMP will be submitted to MIME for review, who will then forward the report with their comments to MEFT for a decision.

If the Final EIA Report and EMP are approved, MEFT will issue an Environmental Clearance Certificate.

2.4 Public Participation during the EIA Phase

During the assessment phase further meetings were held with relevant authorities and are summarised below.

2.4.1 *Walvis Bay International Airport - Geographic Data Management System (GDMS)*

On 26 February 2025, a focus group meeting was held with Mrs. Samantha Rencs (Chief Safety Officer) from the Walvis Bay International Airport. During this meeting, Mrs. Rencs explained that the airport works with the Geographic Data Management System (GDMS) to calculate any obstacles within a 15km radius around the airport. The airport is responsible for assessing any objects, high-rises, and land use around the airport. Technical information of the Sulphuric Acid Plant and the Manganese Refinery was provided to her by CREO at the beginning of September 2025. **Figure 3** shows the results after Mrs. Rencs ran the GDMS model. **Appendix D** provides the results of the GDMS model. GMRN's infrastructure is well out of the 15km safety radius of the Walvis Bay International Airport.

However, as mentioned in the focus group meeting by Mrs. Rencs, the Namibian Civil Aviation Association (NCAA) requires the Applicant to provide the results to obtain final approval. The NCAA is responsible for intervening if any buildings or construction activities prove to be a threat to the safety of airport operations.

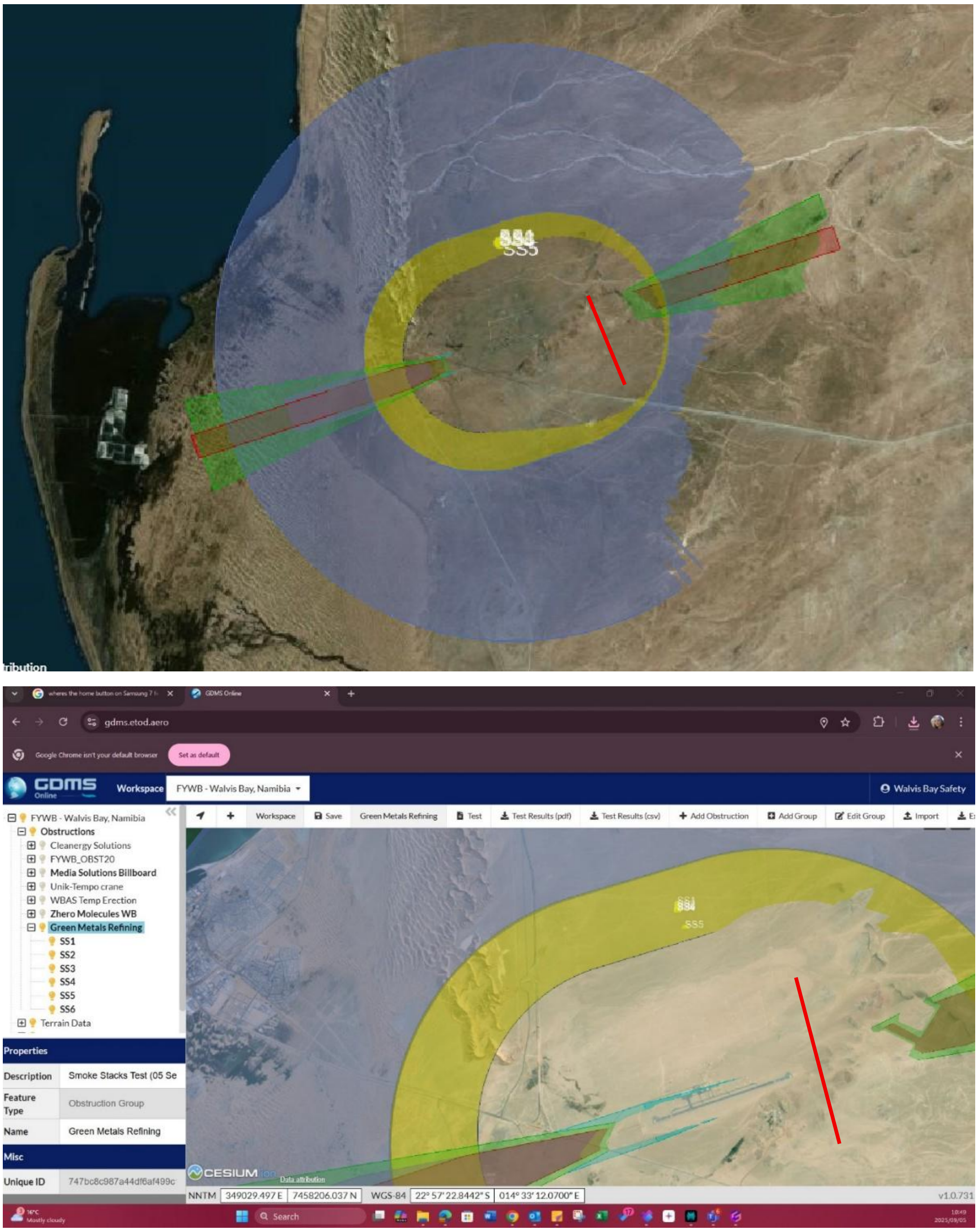

Figure 3: Overlay Screenshot of the GDMS results of infrastructure in relation to the WB International Airport. The red line shows the safety radius for any projects to the Walvis Bay International Airport. (source: Mrs. S. Rencs)

2.4.2 Focus Group meeting with Namibian Civil Aviation Association (NCAA)

On 20 November 2025, a Focus Group meeting was held with the NCAA in Windhoek. This meeting was arranged following the earlier Focus Group meeting with the Walvis Bay International Airport Chief Safety Officer (see **Section 2.4.1**), as well as various subsequent discussions between GMRN, ASEC and Mrs. Samantha Rencs, and further correspondence with the NCAA through the Office of the Executive Director.

The objectives of the meeting were to:

- Inform the NCAA of the proposed Project and the EIA process currently underway (including progress to date).
- Share the initial interactions with the Walvis Bay International Airport and their preliminary assessment of the proposed infrastructure near the airport.
- Obtain clarity on any additional requirements from the NCAA that GMRN should consider, both for the EIA process and for compliance beyond the EIA.

The NCAA indicated that the required process entails consultation with the Namibia Airports Company (NAC) regarding the proposed project activities and infrastructure located in proximity to the Walvis Bay Airport. The NAC would provide comments to the NCAA, which would ultimately consider an application for the erection of such infrastructure.

Important considerations highlighted by the NCAA include potential obstacles, smoke emissions, reflective materials, and open water bodies that could attract animals or birds—all of which may affect the safe operation of the airport. Furthermore, the NCAA emphasised the need for an emergency and safety plan to be developed in collaboration with the Namibia Airports Company (Walvis Bay Airport).

Refer to **Appendix E3** for the minutes of the meeting.

2.4.3 Focus Group Meeting with the Ministry of Defence

On 27 November 2025 GMR Namibia met with the Ministry of Defence and Veteran Affairs (MODVA) to introduce the company and provide a status update on the Battery-grade Manganese and Sulphuric Acid Plant Project om Farm 58

The MODVA acknowledged the apparent overlap of the artillery shooting range with Farm 58 and that this needs to be resolved with the Municipality of Walvis Bay. GMR Namibia will facilitate a meeting with the Walvis Bay Municipality CEO to gain clarity on the site location.

Refer to **Appendix E3** for the minutes of the meeting.

2.4.5 Open Day in Walvis Bay

This section will be included after the Open Day has been held.

3 LEGAL FRAMEWORK

This Section outlines the key environmental legislative requirements. It provides an overview of relevant Namibian legislation and policy and summarises the Namibian administrative framework. It also describes the key international treaties, industry standards, and guidelines applicable to the proposed Project.

The Republic of Namibia has five tiers of law and a number of policies relevant to environmental assessment and protection, which include:

- The Constitution
- Statutory law
- Common law
- Customary law
- International law

As the primary source of legislation, the Constitution of the Republic of Namibia (1990) provides for the creation and enforcement of applicable legislation. In this context, and in accordance with its constitution, Namibia has enacted numerous laws aimed at protecting the natural environment and mitigating adverse environmental impacts.

As outlined in **Section 1.4**, the EIA regulations are administered and enforced by the DEA within the MEFT.

In the context of the proposed Project activities, several laws and policies are currently applicable. Key legislation and policies are summarised below, and key relevant National Acts, Policies, Plans, as well as International Conventions and Protocols, are listed in **Section 3.1** to **Section 3.3** below.

The EIA Policy (1995) is enforced through the Environmental Management Act, 7 of 2007 and the EIA Regulations. Within this legal framework, certain identified activities may not commence without an environmental clearance issued by MEFT (see **Section 1.4.1**).

3.1 Summary of Applicable Acts

There are several laws and policies currently applicable to the proposed project activities (i.e. transport of ore, processing and associated activities and facilities) (see **Table 7**).

Table 7: List of Laws Applicable to the EIA.

Name of Act	Natural Resource Use (energy & water)	Emissions to air (fumes, dust & odours)	Emissions to land (non-hazardous & hazardous)	Emissions to water / sea	Noise	Visual	Traffic	Impact on Land use	Impact on biodiversity	Impact on Archaeology	Socio-economic	3rd Party Safety & Health	Other
The Constitution of the Republic of Namibia of 1990	X	X	X	X	X	X	X	X	X	X	X	X	
Water Resources Management Act 11 of 2013	X			X							X		
National Heritage Act, 2004 (No. 27 of 2004)										X			
Soil Conservation Act (amended in 1971, 1973, 1974 & 1977)	X			X				X					
Hazardous Substance Ordinance, No. 14 of 1974		X	X	X								X	X
Nature Conservation Ordinance 14 of 1975 (amended 1990, 1996) Nature Conservation Amendment Act, 2017	X			X					X	X			
Atmospheric Pollution Prevention Ordinance 11 of 1976		X										X	
Petroleum Products and Energy Act, No. 13 of 1990 Petroleum Products and Energy Amendment Act, 2003		X	X	X					X			X	X
The Wildlife and Protected Areas Management Bill									X				

Name of Act	Natural Resource Use (energy & water)	Emissions to air (fumes, dust & odours)	Emissions to land (non-hazardous & hazardous)	Emissions to water / sea	Noise	Visual	Traffic	Impact on Land use	Impact on biodiversity	Impact on Archaeology	Socio-economic	3rd Party Safety & Health	Other
Pollution Control and Waste Management Bill (3rd Draft September 2003)		X	X	X	X								
Labour Act, 2007 (No. 11 of 2007)											X		
Environmental Management, Act 7 of 2007	X	X	X	X	X	X	X	X	X	X	X	X	
Regulations promulgated in terms of the Environmental Management Act 7 of 2007	X	X	X	X	X	X	X	X	X	X	X	X	X
Road Traffic and Transport Act No. 22 of 1999							X					X	
Road Traffic and Transport Regulations 2001							X					X	
Public and Environmental Health Act No. 1 of 2015												X	
Regulations made under the Water Resources Management Act, No. 11 of 2013	X			X							X		
Civil Aviation Act, No. 6 of 2016 and the Namibia Civil Aviation Regulations of 2001, as amended in 2018												X	

3.2 National Policies and Plans

Namibia’s policies provide the framework for the applicable legislation. Whilst policies do not often carry the same legal recognition as official statutes, they are used to provide support for legal interpretation. Relevant policies and plans currently in force include:

- Environmental Assessment Policy for Sustainable Development and Environmental Conservation (1995) (commonly referred to as the EIA Policy).
- Namibia’s Environmental Assessment Policy for Sustainable Development and Environmental Conservation (1995).
- White Paper on the Energy Policy, 1998.
- Namibia Vision 2030.
- National Development Plan, 201/2018 – 2021/2022, guided by Vision 2030.
- Policy for the Conservation of Biotic Diversity and Habitat Protection, 1994.
- Namibia’s Second National Biodiversity Strategy and Action Plan (NBSAP2) (2013-2022).
- SADC: Protocol on Energy.
- National Environmental Health Policy (2002).
- National Waste Management Policy (2010).
- The National Climate Change Policy of Namibia (September 2010).
- National Rangeland Management Policy and Strategy of 2012
- New Equitable Economic Empowerment Framework (NEEEF) Policy (2011).

3.3 International Treaties and Protocols

The Namibian Government has ratified the following international treaties and protocols:

- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973 Amendment to Article XI of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, Bonn, 1979.
- United Nations Framework Convention on Climate Change (UNFCCC), 1992.
    - Kyoto Protocol to the UN Framework Convention on Climate Change, 1997.
    - *Doha Amendment to the Kyoto Protocol to the United Nations Framework Convention on Climate Change, 2012.
    - Paris Agreement, 2015.
- Vienna Convention for the Protection of the Ozone Layer, 1985.
    - Montreal Protocol on Substances that Deplete the Ozone Layer, 1987:
        - Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted by the Second Meeting of the Parties at London on 29 June 1990 (London Amendment).
        - Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted by the Fourth Meeting of the Parties at Copenhagen on 25 November 1992 (Copenhagen Amendment).
        - Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted by the Ninth Meeting of the Parties at Montreal on 17 September 1997 (Montreal Amendment).
        - Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted by the Eleventh Meeting of the Parties at Beijing on 3 December 1999 (Beijing Amendment).

    - Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted by the Twenty-Eighth Meeting of the Parties at Kigali from 10 to 15 October 2016 (Kigali Amendment).
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention), 1989 Amendment to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 1995.
- Convention on Biological Diversity (1992).
- World Heritage Convention (1972).
- Convention to Combat Desertification (1994).
- Stockholm Convention on Persistent Organic Pollutants (2001).
- Paris Agreement (2016)

3.4 Strategic Environmental Assessments in the Region

3.4.1 Coastal SEAs

Two Namibian coastal Strategic Environmental Assessments (SEAs) were undertaken between 2006 and 2008, i.e. one for the northern regions of Kunene and Erongo and another for the southern regions of Karas and Hardap. These draw on international experience and were undertaken at a time of mounting pressure in the production sector within Namibia. As an initiative of the Namibian Government through MEFT, the two SEAs aim to inform political and technical decision-makers at local, regional, and national levels. The 2008 "SEA for the coastal areas of the Erongo and Kunene Regions" compiled by the Namibian Coast Conservation & Management Project (NACOMA) aimed to ensure informed decisions on issues related to biodiversity conservation, land use planning and socio-economic development planning in the Kunene and Erongo coastal regions.

A Rapid SEA was undertaken in 2022 (BCC, 2022). The aim of this rapid SEA was to assess the proposed measures of the Central Marine Spatial Plan (CMSP) against a range of socio-economic and biophysical criteria. This would help ensure that sustainable development is integrated into the emerging plan and equip the government with an improved basis for considering and adopting the plan. The Rapid SEA assessed the zonation and the regulations pertaining to each zone of the CMSP, against sustainability criteria relating to the main aims of the marine spatial planning process, namely (BCC, 2022):

- Ecosystem health.
- Social and economic benefits.
- Research and monitoring.
- Spatial governance.

In 2023, a Draft CMSP was published.

Regarding ports (i.e. Walvis Bay port and related activities), the SEA summarised the following:

- With Walvis Bay being the primary national port, this is a significant contribution toward national planning priorities. Unfortunately, this comes with an increased risk of pollution and the associated potential negative impacts on biodiversity in the nearby Ramsar site. However, the lack of data and understanding of thresholds makes this potential risk difficult to define. Diligent and continuous intersectoral coordination is key if this trade-off is to be sustainable (SAIEA, 2022).

3.4.2 Uranium Rush SEA

In 2009, as fuel prices for civil nuclear reactors surged and triggered a global boom in uranium exploration and mining, Namibia's uranium industry recommended that the government undertake a Strategic Environmental Assessment (SEA) of the rapidly expanding Namibian uranium province. The Ministry of Mines and Energy's Geological Survey of Namibia subsequently led this assessment, providing not only a strategic vision but also fostering a culture of cooperation among the uranium mining sector, government, and the public.

The SEA resulted in the development of the Strategic Environmental Management Plan (SEMP), an overarching framework designed to address the cumulative impacts of existing and future developments. Since 2011, the SEMP has guided the joint efforts of government and industry to manage the impact of uranium mining on the central Namib.

The SEMP is structured around 12 Environmental Quality Objectives (EQOs), each defining a specific goal, providing context, setting performance standards, and establishing key indicators for ongoing monitoring. The themes covered include socio-economic development, employment, infrastructure, water resources, air quality, public health, tourism impacts, ecological integrity, education, governance, cultural heritage and future planning, as well as mine closure and land rehabilitation.

Each EQO is evaluated based on indicators categorised as "met," "in progress," "not met," or "exceeded." From the outset, the Namibian Uranium Institute has played an active role in compiling the annual SEMP reports.

3.5 Noise Regulations and Guidelines

All references in this section can be found in the Noise Specialist report in **Appendix K** and are not repeated in the main EIA report.

Environmental noise guidelines and/or standards are important tools for impact management as they form the link between the source of noise and the receiver.

To the author's knowledge, national standards for environmental noise have not yet been set by Namibian authorities. Excessive noise that infringes on the rights of others is, however, identified as a health nuisance in the Public and Environmental Health Act No. 1 of 2015 (Namibia, 2015) to protect individuals and communities from such risks.

In the absence of national guidelines and/or standards, reference is made instead to guideline values for noise levels measured outdoors set by the World Health Organisation (WHO) Guidelines for Community Noise (Berglund, Lindvall, Schwela, & WHO, 1999). These were adopted by the World Bank (WB) International Finance Corporation (IFC) in their General EHS Guidelines of 2007.

Noise level Guidelines (NLG) adopted in this study are presented in **Table 8** and should not exceed the levels presented, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site (IFC, 2007).

Table 8: IFC Noise Level Guidelines.

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

Notes:

(a) L_{Aeq} is the A-weighted (a frequency weighting to better reflect the human ear), equivalent continuous sound pressure level during a stated time interval, expressed in decibels (dB), at a given point in space.

The most recent comprehensive update of the WHO Guidelines for Community Noise is the 2018 Environmental Noise Guidelines for the European Region (WHO, 2018). The 2018 guidelines provide evidence-based recommendations for protecting human health from exposure to environmental noise sources, including road traffic, railway traffic, aircraft, wind turbines, and leisure noise (e.g., live music, nightclubs). These guidelines introduce more stringent noise limits compared to the 1999 version, reflecting new research on the health impacts of noise.

Guidelines for road and rail traffic, which may be applicable to the Project, are presented in **Table 9**. These are for exposure at the most exposed façade representative of a noise-sensitive receiver, outdoors (WHO, 2018).

Table 9: 2018 Environmental Noise Guidelines for the European Region for road and rail traffic.

Source	L_{den}[a] (dBA)	L_{night}[b] (dBA)
Road traffic noise	Less than (<) 53 dBA	< 45 dBA
Railway noise	< 54 dBA	< 44 dBA

Notes:

(a) The L_{den} indicator can be calculated as the A-weighted average sound pressure level, measured/calculated over a 24-hour period, with a 10 dB penalty added to the average level in the night (23:00–07:00 or 22:00–06:00), a 5 dB penalty added to the evening (19:00–23:00 or 18:00–22:00) and no penalty added to the daytime period (07:00–19:00 or 06:00–18:00). The penalties are introduced to indicate people's extra sensitivity to noise during the evening and night.

(b) The L_{night} indicator is the A-weighted average sound pressure level, measured/calculated over an eight-hour period during nighttime, usually between 23:00 and 07:00.

3.6 Air Quality Regulations and Guidelines

All references in this section can be found in the Noise Specialist report in **Appendix F** and are not repeated in the main EIA report.

Air quality guidelines and 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. Air quality guidelines and standards are based on benchmark concentrations that typically indicate safe daily exposure levels for most of the population, including the very young and the elderly, throughout an individual's lifetime. Benchmark concentrations could therefore be based on health effects, such as those caused by SO_2, or carcinogenic consequences, such as those associated with benzene.

Air quality guidelines and standards are typically established for specific averaging or exposure periods and are evaluated based on the observed air concentration expressed as a fraction of a benchmark concentration. A standard, as opposed to a benchmark concentration only, is a set of instructions which includes a limit value and may contain a set of conditions to meet this limit value. Standards are typically associated with a legal requirement as implemented by the country's relevant authority; however, organisations such as the World Bank Group (WBG), the International Finance Corporation (IFC) and private companies also issue standards for internal compliance. The benchmark concentrations issued by the World Health Organisation (WHO), on the other hand, are not standards, but rather guidelines that may be considered for use as limit values in standards.

A common condition included in a standard is the allowable frequency of exceedances of the limit value. The frequency of exceedances recognises the potential for unexpected meteorological conditions coupled with emission variations that may result in outlier air concentrations. It would typically be based on the 99^{th} percentile.

Standards are normally issued for criteria pollutants, i.e. those most commonly emitted by industry, including SO_2, NO_2, CO, PM_{10} and $PM_{2.5}$, but may also include secondary pollutants such as O_3. Some countries include other pollutants, specifically when these are problematic emissions.

In addition to ambient air quality standards or guidelines, emission limits aim to control the amount of pollution from a point source[3]. Emissions to air should be avoided or controlled according to Good International Industry Practice (GIIP) applicable to the specific industry sector (IFC, 2007a).

Namibia does not have air quality guidelines or limits, and reference is usually made to international ambient air quality guidelines and standards. The WHO is widely referenced, as well as countries in the region that have air quality standards. As part of the Air Quality Management Plan (AQMP) developed for the Strategic Environmental Management Plan (SEMP) update, ambient guidelines for PM_{10} and $PM_{2.5}$ were determined to provide the necessary performance indicators for mines and industries within the Erongo Region. These guidelines are applicable to all mining operations in Namibia, as they were adopted as Air Quality Objectives in the Best Practice Guide for the Mining Sector in Namibia (see **Section 2.1.1**).

3.6.1 Namibian Legislation

The Atmospheric Pollution Prevention Ordinance (No. 11 of 1976) deals with the following:

- Part I : Appointment and powers of officers;
- Part II : Control of noxious or offensive gases;
- Part III : Atmospheric pollution by smoke;
- Part IV : Dust control;
- Part V : Pollution of the atmosphere by gases emitted by vehicles;
- Part IV : General provisions; and
- Schedule 2: Scheduled processes.

The Ordinance does not include any ambient air standards with which to comply, but opacity guidelines for smoke are provided under Part III. It is implied that the Director[4] provides air quality guidelines for consideration during the issuing of Registration Certificates, where Registration Certificates may be issued for “Scheduled Processes” which are processes resulting in noxious or offensive gases and typically pertain to point source emissions. To our knowledge, no Registration Certificates have been issued in Namibia. However, an Environmental Clearance Certificate is required for any activity entailing a scheduled process as referred to in the Atmospheric Pollution Prevention Ordinance, 1976.

Additionally, the Ordinance categorises a range of pollutants as noxious and offensive gases; however, it does not provide ambient air quality guidelines, standards, or emission limits for Namibia.

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[3] Point sources are discrete, stationary, identifiable sources of emissions that release pollutants to the atmosphere (IFC, 2007).

[4] *Director* means the Director of Health Services of the Administration, and, where applicable, includes any person who, in terms of any authority granted to him under section 2(2) or (3) of the Ordinance.

Part II of the Ordinance pertains to the regulation of noxious or offensive gases. The Executive Committee may declare any area a *controlled area* in terms of this Ordinance by notice in the Official Gazette. Any scheduled process carried out in a *controlled area* must have a current registration certificate authorising that person to carry out that process on those premises.

The published Public and Environmental Health Act 1 of 2015 provides "a framework for a structured uniform public and environmental health system in Namibia; and to provide for incidental matters". The act identifies health nuisances, such as chimneys sending out smoke in quantities that can be offensive, injurious, or dangerous to health and liable to be dealt with.

A Best Practice Guide for the Mining Sector in Namibia was published in July 2020 (NCE, 2020). The document serves as a guiding framework during all mining phases to effectively assess aspects such as environmental and social impacts. Although the proposed operations do not include mining, the best practice guidelines are regarded as applicable to all processing operations.

The report lists air quality as an environmental risk. It provides examples of sources and activities that result in particulate and gaseous emissions, and offers guidance on the management and control of these source activities. Aspects relevant to the Project can be summarised as follows:

- Section 3 of the Best Practice Guide for the Mining Sector in Namibia provides requirements for Baseline Studies where air quality is listed as one of the most important aspects, where background conditions of dust, gaseous and nuisance emissions, and in some cases fumes and odours are required. Dust and gaseous emissions require immediate monitoring, as well as the establishment of a network of meteorological measuring points. Dust requires the monitoring of particulate matter (PM), in PM_{10}–format, but the monitoring program may require simultaneous measurement of TSP or $PM_{2.5}$ as well.
- Applicable ambient air quality guidelines are listed in Section 3 of the report. It states that Namibia does not have ambient air quality standards or guidelines and references published by the WBG, the WHO, and the European Community (EC). The South African (SA) National Ambient Air Quality Standards (NAAQS) are also referenced.
- Recommendations in Section 3 of the Best Practice Guide for the Mining Sector in Namibia include: Dust Management Plans for all operational sites (mines, exploration sites and quarries); annual reporting of dust fall levels and PM_{10} concentrations to the authorities; dust suppression at construction sites (as well as annual reporting on dust mitigation measures); update and improvement of the current emissions inventory; establishing a monitoring regime to enhance source apportionment of PM concentrations and sodium content; and continuation with PM_{10} and meteorological monitoring.
- Section 4 of the Best Practice Guide for the Mining Sector in Namibia indicates that once mines are operational, an air quality management plan is essential for dealing with issues that can potentially have an adverse impact on operations. In addition to dust, an air quality plan must also incorporate the management of emissions (the release of pollutants and particulates) and fumes. All mines must, as a minimum requirement of an air quality management plan, manage dust.
- Requirements for air quality monitoring during the operational phase are provided.
- The report also provides guidance on closure and maintenance, where the management and monitoring of erosion are essential aspects.

3.6.2 International Criteria

Typically, when no local ambient air quality criteria exist, or are in the process of being developed, international criteria are referenced. This serves to provide an indication of the severity of the potential impacts from proposed activities. The most widely referenced international air quality criteria are those published by the WBG, the WHO, and the European Community (EC). The South African (SA) National Ambient Air Quality Standards (NAAQS) are also referenced since it is regarded as representative indicators for Namibia due to the similar environmental and socio-economic characteristics between the two countries.

3.6.2.1 WHO Air Quality Guidelines

Air Quality Guidelines (AQG) were published by the WHO in 1987 and revised in 1997. Since the completion of the second edition of the AQG for Europe, which included new research from low-and middle-income countries where air pollution levels are at their highest, the WHO has undertaken to review the accumulated scientific evidence and to consider its implications for its AQG. The result of this work is documented in *'Air Quality Guidelines – Global Update 2005'* in the form of revised guideline values for selected criteria air pollutants, which are applicable across all WHO regions (WHO, 2005). The ITs and WHO AQG were updated recently (WHO, 2021) following a much stronger body of evidence that shows how air pollution affects various aspects of health at even lower concentrations than previously understood.

Given that air pollution levels in developing countries frequently far exceed the recommended WHO AQG, interim target (IT) levels were included in the updates. These are more lenient than the WHO AQG with the purpose to promote steady progress towards meeting the WHO AQG (WHO, 2005) (WHO, 2021). There are two to four interim targets, depending on the pollutant, starting at WHO interim target-1 (IT-1) as the most lenient and IT-3 or IT-4 as more stringent targets before reaching the AQG. The 24-hour SA NAAQS are, for instance, in line with IT-1 for SO_2 and IT-3 for PM_{10} and IT-4 for $PM_{2.5}$. It should be noted that the WHO permits a frequency of exceedance of 1% per year (3 to 4 days per year) for 24-hour average PM_{10} and $PM_{2.5}$ concentrations. These are provided in **Table 10** for pollutants considered in this study.

3.6.2.2 South Africa National Ambient Air Quality Standards

National Ambient Air Quality Standards (NAAQS) for South Africa (SA) were determined based on international best practice for SO_2, NO_2, $PM_{2.5}$, PM_{10}, O_3, CO, lead (Pb) and benzene. These standards were published in the Government Gazette on 24 December 2009, and included a margin of tolerance (i.e. frequency of exceedance) and implementation timelines linked to it. SA NAAQS for $PM_{2.5}$ were published on 29 July 2012. As mentioned previously, SA NAAQS closely follow WHO interim targets, which are targets for developing countries, for $PM_{2.5}$, PM_{10} and SO_2. The SA NAAQS for ambient NO_2 concentrations is equivalent to the WHO AQG. The SA NAAQS referred to in this study are also given in **Table 11**.

Table 10: International Assessment Criteria for Criteria Pollutants.

Pollutant	Averaging Period	WHO Guideline Value (µg/m³) (i)	South Africa NAAQS (µg/m³)
Carbon monoxide (CO)	24-hour 1-hour	7 000 (IT 1) 4 000 (AQ level)	 30 000
Sulphur Dioxide (SO_2)	1-year 24-hour 1-hour 10-minute	- 125 (IT1) 50 (IT2) (a) 40 (AQ level) - -	50 125 (b) 350 (c) 500 (d)

Pollutant	Averaging Period	WHO Guideline Value (µg/m³) (i)	South Africa NAAQS (µg/m³)
Nitrogen Dioxide (NO_2)	1-year 24-hour 1-hour	40 (IT1) 30 (IT2) 20 (IT3) 10 (AQ level) 120 (IT1) 50 (IT2) 25 (AQ level)	40 200 (c)
Particulate Matter (PM_{10})	1-year 24-hour	70 (IT1) 50 (IT2) 30 (IT3) 20 (IT4) 15(AQ level) 150 (IT1) 100 (IT2) 75 (IT3) 50 (IT4) 45 (AQ level)	40 (e) (b) 75 (e)
Particulate Matter ($PM_{2.5}$)	1-year 24-hour	35 (IT1) 25 (IT2) 15 (IT3) 10 (IT4) 5 (AQ level) 75 (IT1) 50 (IT2) 37.5 (IT3) 25 (IT4) 15 (AQ level)	25 (f) 20 (g) 15 (h) 65 (f) 40 (g) 25 (h)

Notes:

(a) Intermediate goal based on controlling motor vehicle emissions; industrial emissions and/or emissions from power production. This would be a reasonable and feasible goal to be achieved within a few years for some developing countries and lead to significant health improvement.
(b) 4 permissible frequencies of exceedance per year
(c) 88 permissible frequencies of exceedance per year
(d) 526 permissible frequencies of exceedance per year
(e) Applicable from 1 January 2015.
(f) Applicable immediately to 31 December 2015.
(g) Applicable 1 January 2016 to 31 December 2029.
(h) Applicable 1 January 2030.
(i) WHO (2021) for 24-hour averages 99th percentile (i.e., 3-4 exceedance days per year).

3.6.2.3 Dustfall Limits

Air quality standards are not defined by all countries for dust deposition, although some countries may refer to annual average dust fall thresholds above which a 'loss of amenity' may occur. In the southern African context, widespread dust deposition impacts occur due to windblown dust from mining operations, other fugitive dust sources and natural sources.

South Africa published the National Dust Control Regulations (NDCR) on 1 November 2013 (Government Gazette (GG) 36974), with an updated NDCR gazetted on 8 March 2024, (GG 50272). The purpose of the regulations is to prescribe general measures for controlling dust in all areas, including residential and non-residential areas. Similarly, Botswana published dust deposition evaluation criteria (BOS 498:2013). According to these limits, an enterprise may submit a request to the authorities to operate within Band 3 (the action band) for a limited period, provided that this is essential for the practical operation of the enterprise and provided that the best available control technology is applied for the duration. No margin of tolerance will be granted for operations that result in dustfall rates in the Band 4 (alert band). This four-band scale is presented in **Table 11**.

Table 11: Bands of dustfall rates.

Band Number	Band Description	30 Day Average Dustfall Rate (mg/m^2-day)	Comment
1	Residential	Dustfall rate < 600	Permissible for residential and light commercial
2	Industrial	600 < Dustfall rate < 1 200	Permissible for heavy commercial and industrial
3	Action	1 200 < Dustfall rate < 2 400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	2 400 < Dustfall rate	Immediate action and remediation required following the first exceedance. Incident report to be submitted to relevant authority.

3.6.2.4 Inhalation Health Criteria for Non-criteria Pollutants

There are no Namibian standards or limits for SO_3 or Manganese (Mn) concentrations, and reference is made to international health criteria. Such criteria include:

a) WHO guideline values for non-carcinogens and unit risk factor guidelines for carcinogens,
b) Chronic and sub-chronic inhalation reference concentrations (RfC), Provisional Peer Reviewed Toxicity Values (PPRTV) and cancer unit risk factors published by the United States Environmental Protection Agency (US EPA) in its Integrated Risk Information System (IRIS),
c) Acute, sub-acute and chronic effect screening levels published by the Texas Commission on Environmental Quality (TCEQ),
d) Reference exposure levels (RELs) published by the Californian Office of Environmental Health Hazard Assessment (CALEPA), and
e) Minimal risk levels issued by the US Federal Agency for Toxic Substances and Disease Registry (ATSDR).

Risk Assessment Information System[5] was referred for health-effect screening levels above which negative health effects may occur (**Table 12**). It should be noted that the limits are based on the respirable dust fraction (i.e. PM_{10}).

Table 12: Most stringent health-effect screening levels identified.

<table>
<tr><th>Compound</th><th>Source</th><th>Acute (24-hr) exposure (a) (µg/m³)</th><th>Chronic exposure (b) (µg/m³)</th></tr>
<tr><td rowspan="5">Mn</td><td>WHO</td><td>-</td><td>0.15 (c)</td></tr>
<tr><td>IRIS</td><td>-</td><td>0.05 (d)</td></tr>
<tr><td>ATSDR</td><td>-</td><td>0.30 (g)</td></tr>
<tr><td>MDH</td><td>-</td><td>0.10 (f)</td></tr>
<tr><td rowspan="2">CALEPA</td><td>-</td><td>0.09 (h)</td></tr>
<tr><td>SO_3</td><td>120 (h)</td><td>1.00 (h)</td></tr>
</table>

Notes:

(a) Acute REL is an 8-hour average.

(b) Typically, applicable to annual average concentrations.

(c) WHO Guidelines for air quality: compounds with non-carcinogenic health endpoints. The guideline value was derived by dividing by a factor of 4.2 to adjust for continuous exposure and an uncertainty factor of 50. The adjustment for continuous exposure was considered sufficient to account for long-term exposure based on knowledge of the half-time of manganese in the brain (WHO, 2000).

(d) The IRIS is a human health assessment program that evaluates quantitative and qualitative risk information on effects that may result from exposure to environmental contaminants. IRIS was initially developed for EPA staff in response to a growing demand for consistent information on substances for use in risk assessments, decision-making, and regulatory activities.

(e) The ATSDR minimal risk levels (MRLs) were developed as an initial response to The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Final, Draft and Addendum values are presented on the RAIS.
(f) MDH Manganese Chronic Non-Cancer Risk Assessment Advice ($RAA_{Chronic}$) is based on the most recent substantive evaluation that included external peer review of the ATSDR (2012), (MDH, 2025).
(g) The OEHHA Office of Environmental Health Hazard Assessment's Acute and Chronic Reference Exposure Levels (RELS).
(h) REL provided for sulfuric acid.

3.6.5 International Conventions

The technical reference documents published in the IFC Environmental, Health and Safety (EHS) Guidelines provide general and industry-specific examples of GIIP. The General EHS Guidelines are designed to be used together with the relevant Industry Sector EHS Guidelines (IFC, 2007).

The IFC EHS Guidelines provide a general approach to air quality management for a facility, including the following:

- Identifying possible risks and hazards associated with the project as early on as possible and understanding the magnitude of the risks, based on:
  - the nature of the project activities; and,
  - the potential consequences to workers, communities, or the environment if these hazards are not adequately managed or controlled.
- Preparing project- or activity-specific plans and procedures incorporating technical recommendations relevant to the project or facility;

[5] https://rais.ornl.gov/tools/profile.php

- Prioritising the risk management strategies to achieve an overall reduction of risk to human health and the environment, focusing on the prevention of irreversible and/or significant impacts;
- When impact avoidance is not feasible, implementing engineering and management controls to reduce or minimise the possibility and magnitude of undesired consequences; and,
- Continuously improving performance through a combination of ongoing monitoring of facility performance and effective accountability.

Significant impacts on air quality should be prevented or minimised by ensuring that:

- Emissions to air do not result in pollutant concentrations exceeding the relevant ambient air quality guidelines or standards. These guidelines or standards can be national guidelines or standards, or in their absence, WHO AQG or any other internationally recognised sources.
- Emissions do not contribute significantly to the relevant ambient air quality guidelines or standards. It is recommended that 25% of the applicable air quality standards be allowed to enable future development in a given airshed. Thus, any new development should not result in ground-level concentrations exceeding 25% of the guideline value.
- The EHS recognises the use of dispersion models to assess potential ground-level concentrations. The models used should be internationally recognised or comparable.

3.6.3.1 Degraded Airsheds or Ecological Sensitive Areas

The IFC provides further guidance on projects located in degraded airsheds (IFC, 2007), i.e., areas where the national/ WHO/ other recognised international Air Quality Guidelines are significantly exceeded or where the project is located next to areas regarded as ecologically sensitive, such as national parks. The project is not located in an ecologically sensitive area, and the airshed is not regarded as degraded.

3.6.3.2 Fugitive Source Emissions

According to the IFC (IFC, 2007), fugitive source emissions refer to emissions that are distributed spatially over a wide area and confined to a specific discharge point. These sources have the potential to result in more significant ground-level impacts per unit release than point sources. It is therefore necessary to assess this through ambient quality assessment and monitoring practices.

3.6.6 Emission Limits

An ambient standard is a never-exceed level for a pollutant in the ambient environment, whereas emission limits are never-exceed levels applied directly to the quantities of emissions coming from pollution sources.

Processes at GMR which may be subject to emission limits are the refinery and sulphuric acid plant (SAP).

The Namibian Atmospheric Pollution Prevention Ordinance (No. 11 of 1976) lists Sulphuric Acid Manufacture as Scheduled Process no. 1. This applies to the manufacturing of sulphuric acid. There is, however, no emission guidelines associated with the Scheduled Processes.

3.6.6.1 IFC Emission Guidelines and Standards

The IFC EHS guidelines refer to projects, which generate emissions to the air at any stage of the project life cycle. The purpose of the guidelines is to minimise the impact on human health, safety and the environment from emissions to air. The IFC have guidelines on air emissions for Nickel, Copper, Lead, Zinc and Aluminium Smelting and Refining, but not for manganese (IFC, 2007a).

3.6.6.2 South Africa Minimum Emission Standards

The South African National Environmental Management Air Quality Act (NEMAQA) (Act No. 39 of 2004) published a list of activities which result in atmospheric emissions, and which is believed to have significant detrimental effects on the environment and human health and social welfare. The Listed Activities and Minimum National Emission Standards were published on 22nd November 2013 (Government Gazette, 2013).

The refining process has a dryer, which is similar to SA Listed Activity 4.1: Drying and Calcining, which applies to drying and calcining of mineral solids including ore with a capacity of more than 100 tons/month. Applicable emission limits for are listed in **Table 13**. All emission limit values are for standard conditions at a temperature of 298.15 K (25°C), and a pressure of 101.3 kPa.

Table 13: SA Minimum Emission Standards for Drying and Calcining.

Pollutant	Unit	Stack emission limits under normal conditions of 273 K and 101.3 kPa
Particulate matter	mg/Nm^3	50
SO_2	mg/Nm^3	1 000
NOx (expressed as NO_2)	mg/Nm^3	500

Production of Acids is a Listed Activity in South Africa (Subcategory 7.2) and is subject to the following description:

- The production, bulk handling and or use in manufacturing of hydrofluoric, hydrochloric, nitric and sulphuric acid (including oleum) in concentration exceeding 10%.
- Processes in which oxides of sulphur are emitted through the production of acid sulphites of alkalis or alkaline earths or through the production of liquid sulphur or sulphurous acid.
- Secondary production of hydrochloric acid through regeneration.

This is applicable to all installations producing, handling and or using more than 100 tons per annum of any of the above-listed compounds. GMR will be exceeding this limit. Minimum emission standards (MES) to produce acids applicable to several pollutants are listed in **Table 14**. The emission limits are for New Plant status, applicable to all facilities operational after 1 April 2010.

Table 14: SA Minimum Emission Standards for Production of Acids.

Pollutant	Unit	Stack emission limits under normal conditions of 273 K and 101.3 kPa
F as HF (a)	mg/Nm^3	5
HCl (b)	mg/Nm^3	15
HCl (c)	mg/Nm^3	30
SO_2	mg/Nm^3	350
SO_3 (d)	mg/Nm^3	25
NOx (expressed as NO_2)	mg/Nm^3	350

Notes:

(a) Total fluoride measured as Hydrogen Fluoride (from processes in which HF is evolved)
(b) Hydrogen chloride (from primary production of hydrochloric acid)
(c) Hydrogen chloride (from secondary production of hydrochloric acid)
(d) Sulphuric acid mist and sulphur trioxide expressed as SO_3 (from processes in which SO_3 is evolved).

3.6.7 Recommended Guidelines and Objectives

The IFC references the WHO guidelines but indicates that any other internationally recognised criteria can be used, such as the United States (US) Environmental Protection Agency (EPA) or the EC. It was, however, found that merely adopting the WHO guidelines would result in exceedances of these guidelines in many areas due to the country's arid environment, particularly in Namibia. The WHO states that these AQG and interim targets should be used to guide standard-setting processes and aim to achieve the lowest concentrations possible, considering local constraints, capabilities, and public health priorities. These guidelines are also aimed at urban environments within developed countries (WHO, 2005). For this reason, the South African NAAQS are also referenced, as they were developed after a thorough review of all international criteria and selected based on the socio-economic and ecological conditions of the country.

In the absence of guidelines on ambient air concentrations for Namibia, reference is made to the Air Quality Objectives (AQO). These objectives are based on the WHO interim targets and SA NAAQS. The criteria were selected on the following basis:

- The WHO IT3 was selected for particulates since these limits are in line with the SA NAAQS, and the latter are regarded as feasible limits for the arid environment of Namibia.
- Even though $PM_{2.5}$ emissions are mainly associated with combustion sources and are mainly a concern in urban environments, it is regarded good practice to include as health screening criteria given the acute adverse health effects associated with this fine fraction. Also, studies found that desert dust with an aerodynamic diameter 2.5 µm causes premature mortality.
- For SO_2, there is no IT3, and the IT2 was selected since the WHO states: "This would be a reasonable and feasible goal for some developing countries (it could be achieved within a few years) which would lead to significant health improvements that, in turn, would justify further improvements (such as aiming for the AQG value)".
- The WHO provides no interim targets for NOx. The AQGs are in line with the South African NAAQSs and therefore regarded as achievable limits.
- The Botswana and South African criteria for dust fallout are the same, and with limited international criteria for dust fallout, these were regarded applicable.
- The IRIS chronic manganese value is far more stringent because it is based on an older and extremely conservative 1993 RfC derived from sensitive neurobehavioral endpoints using large uncertainty factors, while WHO, ATSDR, and MDH use more recent datasets and updated dose-response models that produce higher, less conservative limits. The WHO is a global authority with strong peer-review and broad public health mandate, and thus the WHO chronic limit is regarded applicable to this study.

The proposed AQO as set out in **Table 15,** are intended to be used as an indicator during the impact assessment.

Table 15: Proposed Air Quality Objectives for the project.

Pollutant	Averaging Period	Criteria (µg/m³)	Reference
SO_2	1-hour average	350 µg/m³ (a)	EC Limit & SA Standard (no WHO guideline)
	24-hour average	125 µg/m³ (b)	WHO IT1, SA Standard, Botswana and EC Limit

Pollutant	Averaging Period	Criteria (µg/m³)	Reference
	Annual average	50 µg/m³	SA Standard (no WHO guideline)
NO_2	1-hour average	200 µg/m³ (a)	WHO AQG & EC Limit & SA Standard
	Annual average	40 µg/m³	WHO AQG & EC Limit & SA Standard
SO_3	Annual average	1 µg/m³	CALEPA
Particulate matter (PM_{10})	24-hour average	75 µg/m³ (b)	WHO IT3 & SA NAAQS (as per SEMP AQMP)
	Annual average	40 µg/m³	SA NAAQS (as per SEMP AQMP)
Particulate matter ($PM_{2.5}$)	24-hour average	37.5 µg/m³ (b)	WHO IT (as per SEMP AQMP)
	Annual average	15 µg/m³	WHO IT3 & SA NAAQS (as per SEMP AQMP)
Mn	Annual average	1.5 µg/m³	WHO non-carcinogenic health endpoint
Dustfall	30-day average	600 mg/m²/day (c)	SA NDCR & Botswana residential limit
		1 200 mg/m²/day (c)	SA NDCR & Botswana industrial limit
		2 400 mg/m²/day	Botswana Alert Threshold

Notes:

(a) Not to be exceeded more than 88 hours per year (SA)

(b) Not to be exceeded more than 3 times per year or 2 consecutive months

(c) Not to be exceeded more than 3 times per year or 2 consecutive months

3.7 Climate Change Legislation

All references in this section can be found in the Noise Specialist report in **Appendix J** and are not repeated in the main EIA report.

3.7.1 International Agreements

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

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

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

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

The Paris Agreement is founded on the idea of countries improving their climate change strategies in 5-year cycles. The Paris Agreement requires all Parties to put forward their best efforts through "nationally determined contributions" (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts.

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

As of October 2022, 194 Parties of the 197 Parties to the UNFCCC Convention, including Namibia, had ratified the Paris Agreement. Namibia submitted a revised version of its first NDC to the UNFCCC in July 2021 and a second update in April 2023.

3.7.2 Namibia's Climate Change Response

Climate change has been identified as a critical threat to sustainable development and the general welfare of society in Namibia. Namibia has the most arid climate of all southern African countries, and its economy is exposed to difficult and harsh conditions, with water accessibility a serious problem. A large proportion of the Namibian people are reliant on the natural environment for their livelihood (i.e. it is a natural resource-based economy), and the existing fragility of the environment (viz. the arid climate and variability in climatic patterns, as well as a limited adaptive capacity of the population due to poverty and high divergence of income levels) makes Namibia one of the most vulnerable countries to climatic change impacts (Hanns Seidel Foundation, 2015). Namibia has recognised the threat posed by climate change and has put an appropriate policy framework in place to deal with this threat. The key milestones in Namibia's response to climate change are outlined in **Table 16**.

Table 16: Key milestones in Namibia's response to climate change (Source: Hanns Seidel Foundation, 2015, as amended with more recent information).

Year	Report	Description
1995	United Nations Framework Convention on Climate Change (UNFCCC)	In 1995 Namibia ratified the UNFCCC, with the ultimate objective of the Convention being the stabilisation of greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system.
2001	National Climate Change Committee (NCCC)	Namibia established the NCCC in 2001 with the main function of advising and making recommendations to government on climate change including how to meet its obligations to the UNFCCC. The NCCC is hosted by the DEA in the Ministry of Environment and Tourism (MET). The NCCC is comprised of

Year	Report	Description
		representatives from various government ministries, NGOs, parastatals and the private sector.
2011	National Climate Change Policy (NCCP)	Namibia's NCCP takes a cross-sectoral approach and elaborates on climate change adaptation and mitigation in Namibia. The policy outlines a coherent, transparent and inclusive framework on climate risk management in accordance with Namibia's national development agenda, legal framework, and in recognition of environmental constraints and vulnerability. The policy launched the NCC Strategy and Action Plan after a long process of stakeholder consultation and reviews.
2012	Disaster Risk Management (DRM) Act	Aimed to provide for the establishment of institutions for disaster risk management in Namibia. A DRM plan is in place to cover amongst others drought and flood events from climate change. The DRM Act also provides for the establishment of institutions for disaster risk management in Namibia; to provide for an integrated and coordinated disaster management approach that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery.
2014	National Climate Change Strategy and Action Plan, 2013-2020 (NCCSAP)	The NCCSAP lays out the guiding principles responsive to climate change that is effective, efficient and practical. It further identifies priority action areas for adaptation and mitigation. The Strategy and Action Plan introduce various funding mechanisms, as well as Government funding (e.g. Adaptation Fund, Green Climate Fund), and other existing funding mechanisms such as those of the Global Environmental Facility (GEF), as well as support through various institutions, for the strategy to come to fruition.
2015	Nationally Determined Contribution (NDC)	The Republic of Namibia submitted its climate action plan (NDC) to the UN Framework Convention on Climate Change (UNFCCC) in September 2015, ahead of the 2015 Paris Agreement. It was converted to a Nationally Determined Contribution (NDC) in 2016.
2016	Paris Agreement on Climate Change	In April 2016 the president of the Republic of Namibia signed the Paris Agreement and followed that up in September 2016 by ratifying the Agreement.
2021	Revised version of its First NDC	Did not include Information to facilitate Clarity, Transparency and Understanding (ICTU) to be in line with Decision 4/CMA.1 and the major updates in its GHG inventory.
2023	First NDC second update	Covers the period 2021 to 2030, to inform the global stocktake more accurately on its efforts to implement the Convention. The urgent adaptation actions to enable the country to build its resilience and meet the sustainable development goals within its low emissions development strategy have also been included.

3.7.3 Nationally Determined Contribution

Namibia's updated NDC outlines climate change mitigation and adaptation strategies, emphasising gender responsiveness and socioeconomic resilience (MET, 2023).

3.7.3.1 Background

Namibia submitted its revised Second NDC in April 2023, addressing omissions in clarity and transparency from the First NDC dated July 2021. The updated version covers the period 2021 to 2030 and includes urgent adaptation actions. It aims to inform the global stocktake on Namibia's climate commitments.

3.7.3.2 Salient Features of Namibia

Namibia is an arid country with a population of nearly 2.6 million over 825 000 square km. The economy is highly dependent on natural resources, making it vulnerable to climate change impacts. Women are disproportionately affected by climate-related shocks due to socio-economic marginalisation. Namibia's Gini index was 59.1 in 2015, indicating high inequality.

3.7.3.3 Namibia's Emissions Business Usual Scenario

Namibia is projected to remain a net carbon sink, with a share of global emissions at 0.00026%. The GHG inventory shows an increase in net sink capacity from -85.823 Mt CO_2e in 2010 to -104.206 Mt CO_2e in 2016. The Business as Usual (BAU) scenario projects a net sink capacity of -90.713 Mt CO_2e by 2030. **Figure 4** shows the base year versus Business as Usual (BAU) emissions scenario

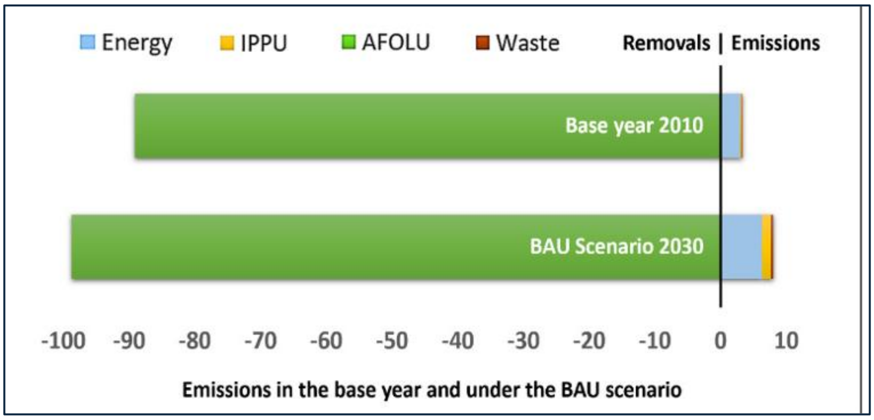


Figure 4: Base year versus Business as Usual (BAU) emissions scenario.

3.7.3.4 Mitigation

As part of the Paris Agreement, Namibia is committed to reducing its emissions and increasing its removals. Mitigation targets are shown in **Figure 5**:

- Namibia targets a reduction of 7.669 Mt CO_2e and an increase in removals by 4.233 Mt CO_2e.
- Total mitigation potential is 11.902 Mt CO_2e, enhancing sink capacity to -102.615 Mt CO_2e.
- The total cost for implementing mitigation measures is approximately 9 052 million USD.
- The Energy and Agriculture, Forestry, and Other Land Use (AFOLU) sectors will be the main contributors with 30% and 67% of the national mitigation potential in 2030.

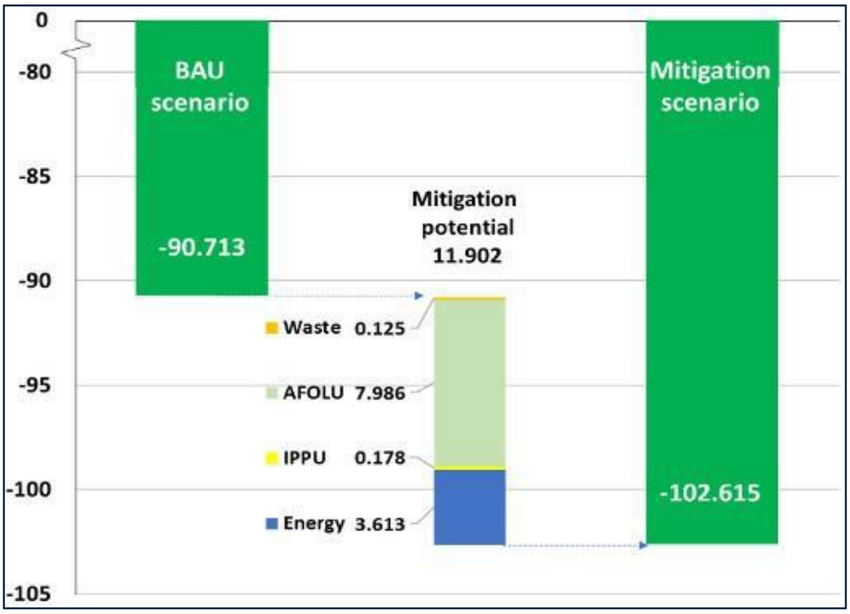


Figure 5: Namibia's BAU and mitigation scenario potential.

3.7.3.5 Adaptation

Namibia is in the process of preparing a National Adaptation Plan informed by vulnerability assessments completed and in line with the First Adaptation framework, which was submitted to the UNFCCC. Some points to note include:

- The country faces erratic rainfall patterns, prolonged droughts, and floods, impacting livelihoods.
- Total cost for adaptation measures is estimated at 6,013 million USD, with 10% unconditional support.
- Identified co-benefits resulting from adaptation actions are:
- CO_2 sequestration through the development of urban green corridors and agroforestry.
- Improving soil carbon through conservation agriculture combined with the use of compost and biochar.
- Improving soil carbon in land restored through the removal of encroaching bush for biodiversity conservation and food security.
- Carbon capture through enhanced vegetation during the establishment and restoration of a riparian buffer.
- Reduction of CH_4 emissions through water recycling for reuse or recharging of aquifers.
- Establishment of firebreaks to reduce GHG emissions.

3.7.3.6 Equity Fairness Ambition

Namibia's NDC is considered equitable and ambitious, aligning with national development strategies. The country voluntarily pursues emission reductions despite being a net sink. The updated NDC addresses additional gases and emitting categories.

3.7.3.7 Measurement Reporting Verification

A functional Measurement, Reporting and Verification (MRV) system is essential for tracking and reporting on NDC implementation. The system will ensure compliance with the Enhanced Transparency Framework under the Paris Agreement. It will capture data on environmental, social, and economic benefits aligned with SDGs.

3.7.3.8 Gender Mainstreaming

Climate change impacts are gender-differentiated, affecting women and marginalised groups disproportionately. The National Gender Policy provides a framework for gender-responsive climate actions. The focus is on integrating women's needs into climate change planning and actions.

3.7.3.9 Implementation Plan Strategy

Namibia's NDC Implementation Strategy Action Plan (NDC-ISAP) covers 2023-2030. The plan consolidates key information for managing and tracking implementation across sectors. Total estimated costs for all NDC measures is 15 065 million USD, with 90% conditional on international support.

3.7.3.10 Greenhouse Gas Emissions Reporting

Namibia has made progress in developing a measuring, reporting, and verification system and action will be taken in future to strengthen it and make it fully operational as soon as possible. Namibia also intends to establish a carbon register to record the outcome of all development activities linked with emission reductions and removals (WBG, 2021).

3.7.4 GHG Inventories

3.7.4.1 National GHG Emissions Inventory

Namibia has completed its First National Inventory Document (NID1) in December 2024, covering the period 1990-2022 (MET, 2024). Namibia has further developed its GHG Inventory Management System within the wider MRV system for emissions. User-friendly tools for collecting data for the inventory have been produced within the framework of the Capacity Building Initiative for Transparency (CBIT) project. Additionally, Namibia has developed and launched its quality assurance/quality control (QA/QC) plan.

The 2022 National GHG Inventory was prepared using the Intergovernmental Panel on Climate Change (IPCC) fifth assessment report (ARC5) (IPCC, 2013). For the period 1990 to 2022, Namibia remained a net sink with removals exceeding emissions. Although emissions increase slightly at 11% over the 32-year period, net removals increase by 36%, resulting in total emissions staying stable at slightly above 20 000 kt CO_2e as shown in **Figure 6**.

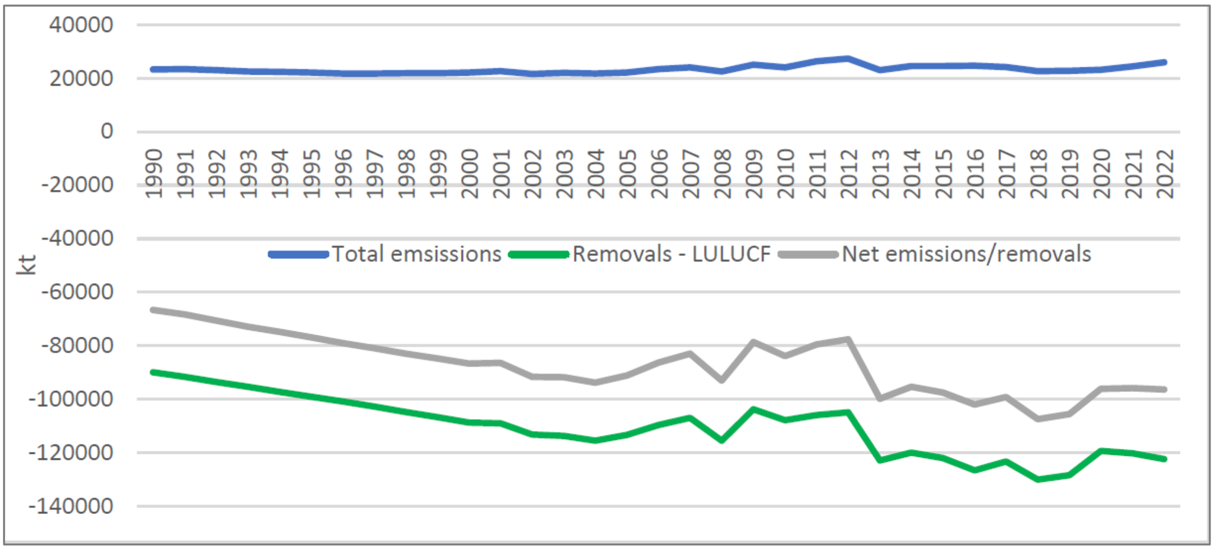


Figure 6: Trend of national emissions (kt CO2e), removals and the resultant net removals.

The highest emitting sector remained Land Use, Land Use Change and Forestry (LULUCF) followed by Agriculture, Energy, Waste and Industrial Production and Product Use (IPPU). In 2022, the LULUCF sector was responsible for significant removals of 122 411 kt CO_2e. Between 1990 and 2022, gross emissions decreased by 19% in the LULUCF sector due to 122 411 kt CO_2e removals, but with increases for Agriculture (42%), Energy (258%), Waste (89%) and IPPU (6 324%). These trends are shown in **Figure 7**.

As shown in **Figure 8**, there was a slight increase of 36% in CO_2 emissions, with a decrease of 14% in CH_4 emissions and a 12% reduction in N_2O emissions. HFCs and SF6 emissions remained negligible. The reported 2022 CO_2 emissions are 15 469 kt, with CH_4 at 275 kt and N_2O at 10 kt, which totals at 25 819 kt.

According to the World Resources Institute – CAIT Climate Data Explorer (http://cait.wri.org/) the total 2022 national emissions were 24 120 kt of CO_2e, representing 0.04% of global emissions.

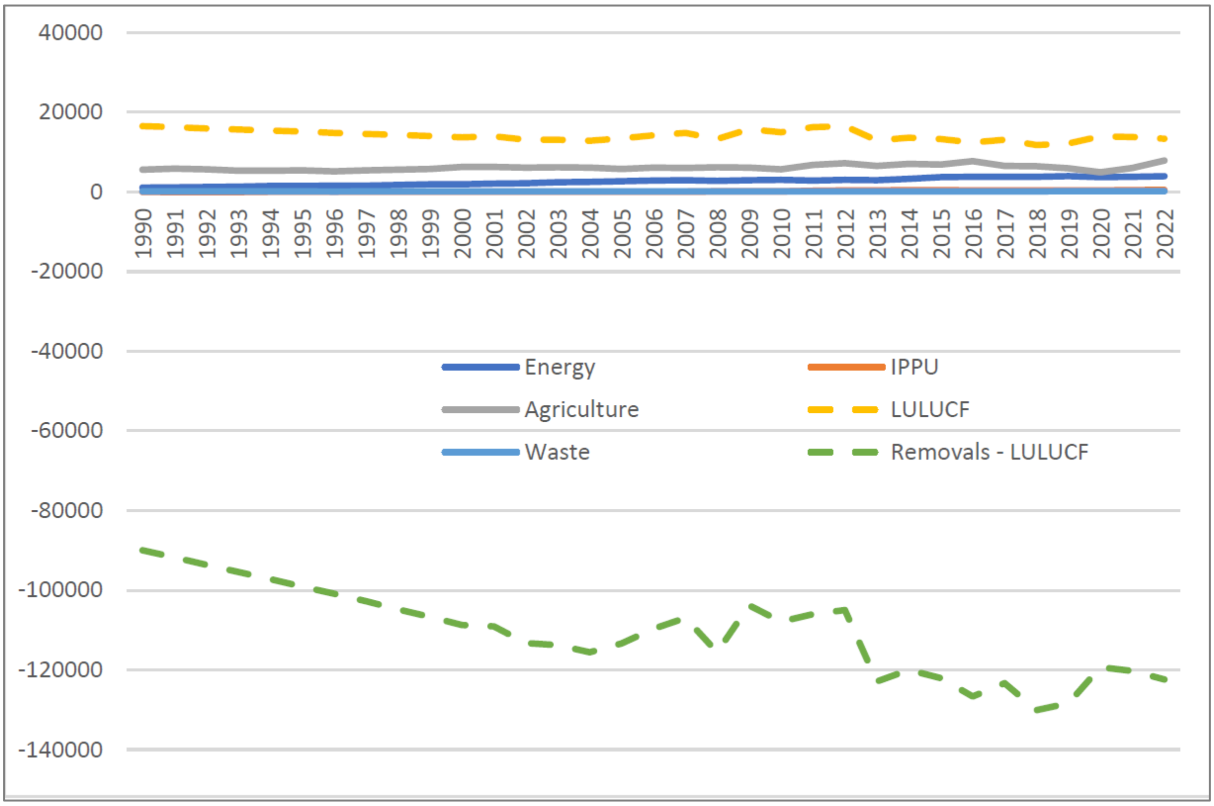


Figure 7: Trend of aggregated gross emissions (kt CO2e) by sector.

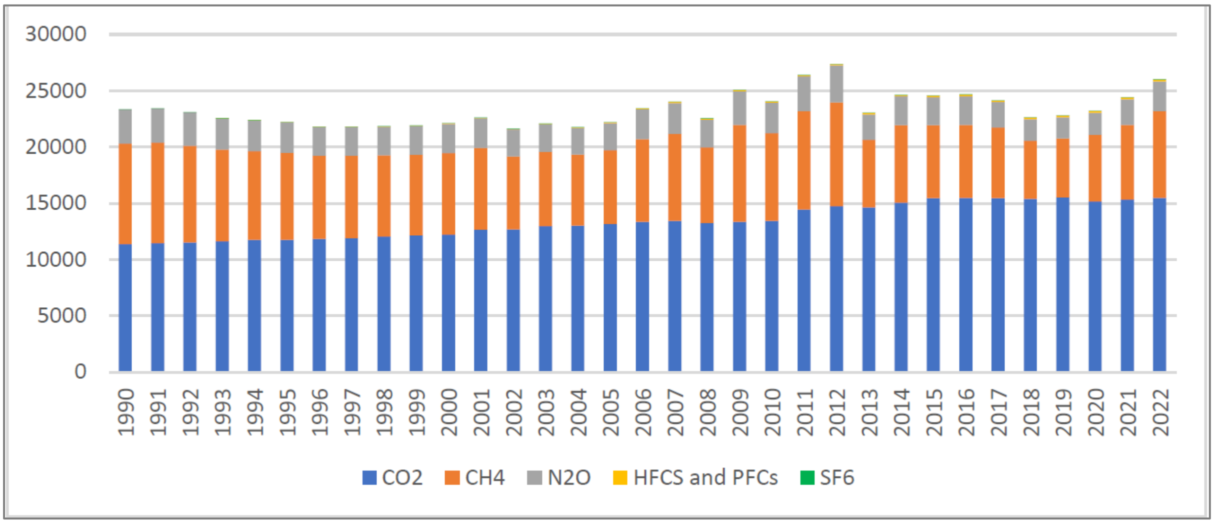


Figure 8: National aggregated emissions (kt CO2e) trends by gas.

3.7.4.2 GHG Emission Inventory for the Sector

The proposed project would be categorised in the industrial category for both the global GHG inventory and the national GHG inventory. Industrial production is not well developed in Namibia with only a few sub-categories from 5 categories accounting for the emissions, of which mineral processing is not one. According to the World Resources Institute – CAIT Climate Data Explorer the 2022 GHG emissions from the industry category were approximately 1 110 kt CO_2e, which accounts for approximately 4.98% of the total Namibian GHG emissions.

3.8 Relevant Social and Economic Legislation

All references in this section can be found in the Noise Specialist report in **Appendix M** and are not repeated in the main EIA report.

Table 17 below provides a summary of relevant social legislation that is applicable to the proposed project.

Table 17: Applicable Socio-economic Namibian Legislation.

Sector	Law	Key Provisions and relevance to the Project
Labour	*Labour Act, 2007 (No. 11 of 2007) and its amendment: No. 2 of 2012*	These Acts stipulate, amongst other things, sound labour relations, employment equity, fair employment practices, training, minimum basic conditions of service, workplace health and safety and retrenchment. Compliance is enforced and monitored by the Ministry of Justice and Labour Relations (MJLR) through the office of the Labour Commissioner.
	Social Security Act, 1994 (No. 34 of 1994, as amended	
	Employees Compensation Act, 1995 (No. 5 of 1995)	
	Occupational Health and Safety Regulations 156 of 1997	These Regulations establish health and safety regulations for the workplace.
	Affirmative Action (Employment) Act, 1998 (No. 29 of 1998)	This Act aims to achieve equal opportunity in employment by redressing, through appropriate affirmative action plans, the conditions of disadvantage in employment experienced by persons in designated groups arising from past discriminatory laws and practices.
Economic	*Anticorruption Act 8 of 2003*	The company will need to demonstrate measures taken to prevent corruption, including reviewing practices, systems, and procedures that may be prone to or conducive to corrupt practices. This will involve advising and educating its employees and other stakeholders on the evils and dangers of corruption, as well as ways to prevent it.

Sources: Various Government Gazettes

The Sixth National Development Plan NDP6) is the last medium-term development plan that aligns with Namibia's Vision 2030 and the UN 2030 Agenda. It I covers the fiscal years from 2025/26 to 2030/31.

It has three development goals: wealth creation, improved equality and employment creation. Similar to NDP5 it will consist of four development pillars which encompass the principle of sustainable development:

- Pillar #1 Economic Growth, Transformation and Resilience
- Pillar #2 Human Development and Community Resilience
- Pillar #3 Environmental Sustainability and

- Pillar #4 Effective Governance and Public Service Delivery (NPC, 2025).

This project is in line with the GRN's goals and its policies to lever "economic opportunities for investment, innovation, and diversification through value addition, development of manufactured and high-end complex products, and facilitation of trade both domestically and internationally." (NPC, 2025).

3.9 The Water Resources Management Act, No. 11 of 2013

All references in this section can be found in the Noise Specialist report in **Appendix H** and are not repeated in the main EIA report.

The Water Resources Management Act, No. 11 of 2013, provides for the management, protection, development, use and conservation of water resources; for the regulation and monitoring of water services and incidental matters.

The commencement of the 2013 Water Act and its associated Regulations was gazetted in June 2023. The Regulations made under the Act set water quality standards for drinking water and treated wastewater. The following licences are now required before the start of any of the associated activities:

- Borehole drilling (any type of borehole for any purpose)
- Groundwater abstraction and use
- Construction and operation of a water treatment plant (including sewage systems)
- Wastewater (effluent) discharge, treatment or reuse
- Obstruction of water courses

The latter point is not well defined in the Act, but it most probably only refers to rivers that contain surface water or groundwater. Licence application forms are available on the Ministry of Agriculture, Fisheries, Water & Land Reform website.

3.10 The Civil Aviation Act, No. 6 of 2016

The Namibian Civil Aviation Authority (NCAA) is responsible for regulating the safety and security of civil aviation operations in Namibia.

Compliance with the following requirements of the Civil Aviation Act, No. 6 of 2016 and the Namibia Civil Aviation Regulations of 2001, as amended in 2018, is implied:

Part 91 (General Operating and Flight Rules) prohibits any activity that creates a hazard to aircraft operations, including visual interference. This includes:

- Activities that impair pilot visibility.
- Objects or lighting that create distractions.
- Any installation that interferes with safe flight operations.

Part 139.01.13 of the Namibia Civil Aviation Regulations (NAMCARs) of 2001, as amended in 2018, and the Namibia Civil Aviation Technical Standards (NAMCATs) – Aerodromes and Heliports, stipulate the requirements for lights that may endanger the safety of aircraft.

Part 139.01.33 (Obstacle Evaluation & Control) of the above-mentioned Regulations relates to obstacle evaluation, which includes any object that may:

- Interfere with aircraft operations.
- Affect visibility.
- Create confusion with aeronautical lighting.

Part 139.01.34 requires a person who intends to carry out land use activities in the vicinity of aerodromes which are likely to impact the operational safety of the aerodrome and the safety of the surrounding communities must, during the planning for such land use activities, consult with the Executive Director and operator of the aerodrome or the operator's personnel.

As far as glint and glare is concerned, Part 139.12.7 states:

"1. General

1.1 Lights which may endanger the safety of aircraft

1.1.1 A non-aeronautical ground light near an aerodrome which might endanger the safety of aircraft must be extinguished, screened or otherwise modified so as to eliminate the source of danger. Compliance Note. See also NAMCARs Part 139.01.13.

- *The assessment should then be submitted to the NCAA for review.*
- *Although, the NCAA has not yet domesticated the technical guidance material for glint and glare assessments, industry best practice is to be adhered to."*

Subparts 11 of the Namibia Civil Aviation Regulations (NAMCARs) of 2001, as amended in 2018, and the NAMCATs – Aerodromes and Heliports, stipulate the requirements for obstacle surface limitations (139.11.2) and for objects outside obstacle limitation surfaces (139.11.6).

The following are the requirements for the erection of obstacles:

Erection of obstacles

(1) 139.11.2 A person may not cause or permit the erection or growth of an obstacle at, or in the vicinity of, an aerodrome, where the obstacle may prevent an aircraft operation from being conducted safely or the aerodrome from being usable.

(2) The erection of buildings or other objects in the navigable airspace or in the vicinity of an aerodrome or navigation aid must be in accordance with standards prescribed in Document NAMCATs - Aerodromes and Heliports.

(3) *A person may not cause or permit any object, including new or extension of existing objects to penetrate the obstacle limitation surface, established in accordance with regulation 139.11.3, without the written permission of the Executive Director.*

Subsequently, the above-stated regulations are further supplemented in the NAMCATs - Aerodromes and Heliports, as follows:

(1) The erection or growth of an obstacle at or in the vicinity of an aerodrome, must not be permitted where the obstacle may prevent an aircraft operation from being conducted safely or the aerodrome from being usable.

(2) Buildings or other objects which will constitute an obstruction or potential hazard to aircraft moving in the navigable air space in the vicinity of an aerodrome, or navigation aid, or which will adversely affect the performance of the radio navigation or instrument landing systems, may not be erected or allowed to come into existence without the prior written approval of the Executive Director and if erected in the absence of approval are liable to forced removal without right of compensation.

(3*) No building or object higher than 45 meters above the aerodrome elevation, or in the case of a water aerodrome, the normal level of the water, maybe erected within a distance of 15 kilometers measured from the aerodrome reference point without the written approval of the Executive Director*.

(4) A person must not cause or permit any object, to penetrate the obstacle limitation surface, without the written permission of the Executive Director, where the object may cause an increase in an obstacle clearance altitude or the height for an instrument approach procedure or of any associated visual circling procedure.

(5) The object referred to in sub-regulation (4) includes a new object or an extension of an existing object above the obstacle limitation surface.

(6) In the event of a conflict of interest between land-use authorities and air space users, air safety must be regarded as predominant and not to be compromised by land development projects or other obstacles.

Hence,

- An entity with the interests of erecting structures with the features mentioned in the requirements of the regulatory and technical standard, must seek approval from the Executive Director, prior to the erection of the structures.
- The interested party must complete for evaluation the following application forms; FSS-AGA-FORM-032 (permanent structures) and / or FSS-AGA-FORM-033 (temporary structures), as may be required, prior to the erection of the structure(s). Hereafter, the applications are then evaluated, and a response is provided to the applicant by the NCAA.

4 PROJECT DESCRIPTION

This Section presents an overview of GMRN's proposed Manganese Refinery Project, including related activities and infrastructure, across the construction, operations and decommissioning. It outlines the layout of the facility, processing infrastructure, and associated activities, which will be further developed and detailed in the forthcoming EIA Report.

4.1 General Project Information

4.1.1 Company Overview

Green Metals Refining Ltd (GMR) is a technology-driven midstream refining company specialising in the production of high-purity materials essential for the green energy transition. Leveraging a proven business model, GMR focuses on harnessing existing supply chains and optimising logistics to deliver low-carbon, battery-grade manganese at competitive costs. GMR is a privately held company registered in the United Kingdom and operates through its wholly owned subsidiary, Green Metals Refining Namibia (Pty) Ltd (GMRN), registered in Namibia.

GMR's strategy and business model centre on securing high-quality manganese ore from established mines in South Africa's nearby Kalahari Manganese Field (KMF) and, in the future, from mining operations in Namibia — such as at Otjosondu once operation resume. The company refines this ore into battery-grade manganese chemicals, serving as critical feedstock for precursor cathode active material (pCAM) manufacturers. As a merchant of industrial chemicals, GMR does not engage in mining operations. Its initial focus is the production of high-purity manganese sulphate monohydrate (HPMSM).

4.1.2 Project Background

GMR aims to bridge the gap between the mining industry and pCAM producers by focusing on the production of high purity battery grade chemicals suitable for the LIB market. Its cornerstone Project in Namibia will support GMR's strategic goal of using feedstock agnostic processing technology to produce battery grade materials from third party manganese ore for the international pCAM market.

GMR's Project in Namibia will establish a first refining facility that uses as its feedstock medium and high-grade manganese ore, mined and supplied by third parties in Southern Africa, to produce both intermediate and final high purity crystalline manganese products. The intermediate products may be sold to the agricultural industry or shipped to downstream facilities close to the off takers for final processing to cater to a variety of LIB cathode types. This will offer the opportunity to establish an early entry into the market, as well as tap into end-market incentive programmes.

GMR will set out to meet their strategic objectives in a series of project phases, as illustrated in **Table 18**.

Table 18: Project development phases.

Item	Scoping Phase	Prefeasibility Phase	Feasibility Phase
Refinery			
Dates	2Q2024 – 4Q2024	4Q2025 – 2Q2026	3Q2026 – 1Q2027
Outcomes	• Initial metallurgical	• Metallurgical test work programme	• Metallurgical optimisation

Item	Scoping Phase	Prefeasibility Phase	Feasibility Phase
	test work results • Project Scoping Study • Internal environmental screening • Land application	results • Residue Management Facility Concept Design • Fieldwork data • Trade-off studies • Residue Management Facility Prefeasibility Design. • Prefeasibility study • Risk register • Pilot plant (not located in Namibia) • Environmental Clearance Certificate	results • Residue Management Facility Final Design • Detailed fieldwork analysis • Feasibility study • Off-take expression of interest • Early prequalification
Level of definition	• FEL 1 • AACE Class 5	• FEL 2 • AACE Class 4	• FEL 3 • AACE Class 3
Sulphuric acid plant			
Dates	1Q2025 – 2Q2025	3Q2025 – 4Q2025	1Q2026 – 2Q2026
Outcomes	• Acid Plant scaling study • Project Scoping Study	• Trade-off studies • Utility requirements analysis • Off-take expression of interest	• Technology partner identification • Feasibility Study • Off-take agreements
Level of definition	• FEL 1 • AACE Class 5	• FEL 2	• FEL 3 • AACE Class 3

Notes: FEL – front end loading; AACE Class refers to the Cost Estimate Classification System developed by AACE International (formerly the Association for the Advancement of Cost Engineering). It is used globally to define the level of accuracy, scope, and definition of cost estimates across industries like construction, oil & gas, mining, and manufacturing.

The Project Concept Scoping study phase, completed in November 2024, identified the key elements of the Project that constitute the Project scope of work, which underpins the business plan and a business case with a capital estimate prepared to an AACE International Class 5 (-20%/+50%). The Project Concept Scoping study also identified high-level risks and opportunities that informed the subsequent development phase works programme.

GMR is currently busy with a comprehensive laboratory and fieldwork programme. Data collection, data analysis and interpretation, and options analyses through techno-economic trade-off studies are the mainstay of the prefeasibility phase.

Throughout the EIA process, GMR continued with project development and permitting tasks. Completing these workstreams concurrently allowed GMR's engineers and specialists to identify environmental risk early, design mitigation measures and incorporate them into the overall development scheme as a fundamental feature of the design.

4.1.2.1 Key Project Components

As outlined in **Section 1.2**, the key components of the Project include:

- Manganese Refinery Facility.
- Sulphuric Acid Plant.
- MRF.

Further details regarding the associated activities and supporting infrastructure are provided in the sections that follow.

4.1.3 Project development schedule

Key project development milestones are summarised in **Table 19**. Note that the Pilot Plant will not be located in Namibia.

Table 19: Project execution milestones.

Milestone	Refinery	SAP
Scoping study complete	Q4 2024	Q2 2025
Prefeasibility study complete	Q4 2026	-
Feasibility study complete	Q3 2027	Q4 2026
Value engineering completed	Q4 2027	Q4 2026
FID	Q2 2028	Q4 2026
Execution kick-off	Q2 2028	Q1 2027
Basic engineering completed	Q4 2028	Q2 2027
Detailed engineering completed	Q2 2029	Q3 2027
Construction and commissioning completed	Q1 2030	Q4 2028

Table 20 provides the timeline for the Refinery and Sulphuric Acid Plant (SAP) expansion:

Table 20: Project execution milestones.

Milestone	2027	2028	2029	2030	2031	2032	2033
Refinery [Ore kt/a]	-			Stage 1 +25 kt/a	Stage 2 +25kt/a		Stage 3 +50 kt/a
SAP [Acid t/d]	-	Stage 1 +500 t/d	-	Stage 2 +500 t/d	-	Stage 3 +1,000 t/d	

4.1.4 Location and layout

Refer to **Figure 1** (**Section 1.2**) for the location of the proposed project site, situated on Portions 30 to 35 of Farm 58, east of the town of Walvis Bay.

The proposed site layout (**Figure 9**) was designed to accommodate the required facilities and to adhere to the following principles:

- Separate administration and plant operational areas.
- Position non-processing buildings upwind of the stack, acid storage, and dust generating areas.
- Keep delivery traffic away from the plant operational areas, where possible.
- Facilitate light vehicle traffic, forklifts and mobile crane access.
- Limit material transfer distances.

The overall site area will be approximately 950 m × 930 m. The Refinery will be orientated to align with existing road and rail infrastructure and will consider prevailing wind direction.

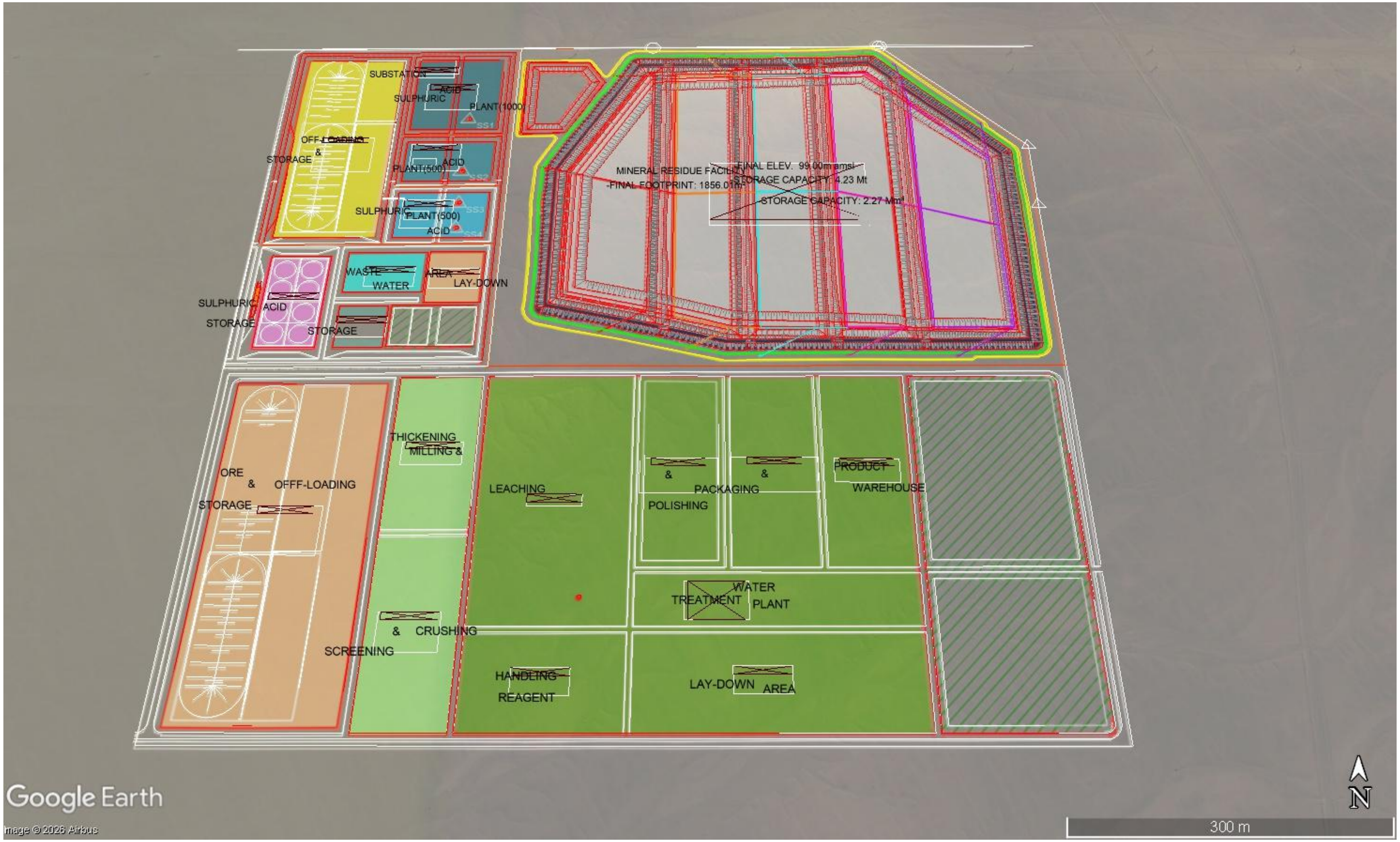


Figure 9: Site layout (as provided by GMR, 005-00-FS8P14RpGe.kmz). The red dots are the location of the stacks.

4.2 Development Phase

GMR does not employ Namibian staff during the Pre-Feasibility Study phase of the project but relies on local engineering and consulting firms to execute the work streams.

At the start of the Feasibility Study phase of the Refinery, GMR, through its subsidiary GMRN, will employ a local team to oversee advanced study and field work, plan and execute environmental and social management, and perform corporate support functions. **Table 21** lists the team for the Feasibility Study. The team will be based in the Walvis Bay area, making use of existing housing.

Table 21: Owner's team during late-stage study phase.

Skill level	Paterson band	Quantity	Employment
Programming	E2	1	Permanent
	E1	1	Permanent
Interpretive	D3	2	Permanent
Skilled	C1	1	Permanent
Total Refinery		5	

Note: It is anticipated that all employees will be Namibians.

Labour classification and rates are in accordance with the "Paterson band" scale, a salary grading system widely used in Southern Africa. The system classifies jobs into bands ranging from A to F based on the level and complexity of decision-making required. Band F represents the most senior tier in an organisation and is equivalent to GMR's corporate level. Each band is divided into up to four sub-categories denoted by a number after the band.

- A - Defined decisions, unskilled workers
- B - Automatic decisions, semi-skilled workers
- C - Routine decisions, skilled workers
- D - Interpretive decisions, middle management
- E - Programming decisions, senior management
- F - Policy-making decisions, top management

4.3 Construction Phase

4.3.1 Construction Phase Facilities

The construction phase of the Manganese Refinery Facility and Sulphuric Acid Plant will involve the development of all essential facilities and infrastructure required to support operational readiness. Activities will begin with site preparation and the establishment of contractor laydown areas. Construction will also include the setup of workshops, maintenance areas, stores, wash bays, and laydown zones to facilitate equipment servicing and material handling. A batching plant will be installed for on-site concrete production, along with small fuel handling and storage areas to support machinery and vehicle operations. Office spaces and change houses will be constructed to accommodate administrative and personnel needs.

Essential services such as ablution facilities, comprising chemical toilets or septic systems, will be installed on the site. Specific zones will be designated for the handling and storage of construction materials such as paints, solvents, oils, and greases, alongside dedicated waste management areas to collect and store construction waste. Temporary diesel-fired generators will be deployed to ensure a reliable power supply, while temporary infrastructure for water and power distribution will be established to support all construction activities (see **Section 4.3.5** and **4.3.6** for further details). Stockpile areas for raw materials will also be established.

At the end of the construction phase, temporary facilities will either be dismantled and removed or, where feasible, incorporated into the final site layout for operational use.

4.3.2 Construction Phase Activities

The construction phase of the proposed Manganese Refinery and Sulphuric Acid Plant (and associated facilities) will encompass the establishment and detailed preparation of the site. Initial activities, including soil stripping, will be undertaken alongside construction works. Where feasible, these materials will be utilised for construction purposes such as road development and site levelling.

Key early-stage activities will include the appointment of contractors and labour forces, followed by clearing, grubbing, and earthmoving. Topsoil will be carefully stripped, stockpiled, and preserved for future rehabilitation efforts, as specified in the EMP (**Appendix A**). Excavations for building foundations and trenches will be carried out, alongside the establishment of contractors' laydown areas and internal access roads to facilitate logistics and mobility on-site.

General construction works shall comprise civil, mechanical, and electrical tasks, including the mixing and placement of concrete, operation and refuelling of construction vehicles, painting, grinding, welding, and the installation of structural and utility infrastructure. Delivery, storage, and handling of materials such as sand, rock, cement, and chemical additives will be critical to supporting these activities.

The construction phase will involve the handling and storage of hazardous materials, including lubricants, paints, welding gases, cement, chemical additives, diesel, and petrol. Equally important will be the responsible management of hazardous waste, such as empty paint containers, contaminated (hydrocarbon) PPE and soil, and redundant concrete. Non-hazardous waste streams, including steel and wood off-cuts, domestic refuse, grinding wheels, and various packaging materials, will also be generated and managed in accordance with applicable regulations and EMP (**Appendix A**). The final waste composition will be determined during the detail design phase of the Refinery and the SAP.

Throughout the construction phase, a strong emphasis will be placed on compliance with environmental, health, and safety standards to minimise risks and ensure the sustainable development of the proposed Project.

Internal combustion engines will require oil changes at a frequence proportional to their running time. It is estimated that up to 10,760 litres of hydrocarbon waste will be produced per year. This will be disposed as set out the EMP (see **Appendix A**).

Typically, a person produces 150 l/day of wastewater (including toilets, showers, laundry, cleaning, cooking and drinking). Based on **Table 22**, this amounts to 20 m³ per day for operational staff will peak at 100 m³ per day during construction. This will report to the municipal sewage works.

Brine effluents from the Refinery will be used for dust suppression on the MRF.

An estimate of the domestic waste production is shown in **Table 22**. This will be disposed of as set out the EMP (see **Appendix A**).

Table 22: Domestic waste generation.

Major area	On Duty/day	Monthly equivalent personnel	Food and drink	Packaging	Textiles	Total (kg/mo)	Total (t/a)
			7.3 kg/p/month	7	1		
Refinery	97	2,910	21,243	20,370	2,910	44,523	534
SAP	34	1,020	7,446	7,140	1,020	15,606	187
Total	131	3,930	28,689	27,510	3,930	60,129	722

Source:

1. UK Statistics on Waste, Department for Environment, Food & Rural Affairs (DEFRA),2023,https://www.gov.uk/government/statistics/uk-statistics-on-waste
2. Biodegradable Municipal Waste to Landfill, DEFRA (England),2023,https://www.gov.uk/government/statistics/local-authority-collected-waste-management-annual-results
3. Household Waste Composition, WRAP UK,2022,https://wrap.org.uk/resources/guide/household-waste-composition
4. Municipal Waste Management in Germany, European Environment Agency (EEA),2023,https://www.eea.europa.eu/themes/waste/waste-management
5. Japan Waste Management Data, Ministry of the Environment, Japan,2023,https://www.env.go.jp/en/recycle/statistics/index.html
6. US Municipal Solid Waste Facts and Figures, US Environmental Protection Agency (EPA),2023,https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling

4.3.3 Construction Workforce and Housing

During the project execution phase, GMR will initially expand its owner's team to manage construction and later employ the operational team as part of its operational readiness programme.

Table 23 lists the GMR team during construction.

Table 23: Owner's team during construction phase.

Skill level	Paterson band	Quantity (up to)	Employment
Programming	E2	1	Permanent
	E1	1	Contractor
Interpretive	D3	4	Permanent
	D2	3	Permanent
	D1	6	Permanent
Skilled	C2	4	Permanent
	C1	3	Permanent
Semi-skilled	B1	8	Permanent
Unskilled	A1	4	Permanent
Total Refinery	-	**36**	-

Note: It is anticipated that all employees will be Namibians if skills are available.

GMR will employ contractors to construct the Refinery and Sulphuric Acid Plant. The size of the crew will fluctuate over a period of approximately 18 months, as reflected in **Table 24**. This does not include the engineering and procurement team that will likely be based outside Namibia and will visit the site from time to time.

Table 24: Construction team.

Skill level	Quantity (up to)	Employment
Skilled	20 – 75	Contractor
Unskilled	75 – 430	Contractor
Total	**100 - 500**	

Note: It is anticipated that all employees will be Namibians if skills are available.

Construction will be done during a 12-hour day shift.

The construction crew will mainly be sourced from Namibia, and where possible, from the Erongo province. As a result, no construction camp will be established on site or in the vicinity, and the crew will make use of locally available housing in Walvis Bay, Swakopmund and Arandis.

4.3.4 Construction Phase Transport System

The final access road from the Clean Energy turn-off to the Project site needs yet to be determine in consultation between GMRN and the WB Municipality.

During the 18-month construction period, structural steel, piping and equipment will be imported through the Walvis Bay port and transported to the site using the T0201 (formerly C14) turning onto the T0202 (highway between Walvis Bay and Swakopmund, formerly D1984 or B2), turning off at the Clean Energy turn-off. Locally sourced materials, likely to be transported to site using route T0202, will include sand, gravel and cement unless they are transported to Walvis Bay by rail and delivered to site via route T0201. **Table 25** presents an estimate of the number of truck loads during construction.

Table 25: Total truck movement during construction.

Road	20t truck / month	30t truck / month	60t truck / month
T0201 (C14)	200	100	-
T0202 (D1984 / B2)	121	44	-

4.3.5 Construction Phase Water Supply and Management

The linear infrastructure associated with water supply will be prioritised in the project execution schedule. Proximity to the main NamWater supply line will facilitate the early construction of a connecting pipeline to provide water to site.

4.3.6 Construction Phase Power Supply

Until the main power connection is made, diesel-fired generators will be used to provide the relatively low construction power requirement on site. These generators will be housed in noise attenuating containers.

4.3.7 Construction Phase Waste Management

During the construction phase, waste will be managed in accordance with the EMP (A**ppendix A**). Standard domestic waste will be separated into recyclable and non-recyclable waste and collected and disposed of at the municipal waste management facility. Hazardous waste will be stored in spillage containment areas and disposed of by specialist contractors. Portable, chemical toilets will be used, the contents of which will be drained and transported to the local sewage works.

4.4 Operational Phase

The operational phase description is based on the current preliminary design basis and may be refined during detailed design, subject to regulatory approvals and engineering optimisation.

4.4.1 Preliminary design basis and relevant standards

The Refinery will have the capacity to store substantial amounts of ore from a variety of sources. This facility will mitigate the risk of transport disruptions, spikes in feedstock prices and will allow the operation to select and blend different ore types, to optimise production performance. The operation will track the use and blending of ores in such a way that the final product can be sold with a certificate or passport that indicates the origin of all the major production inputs.

Associated infrastructure, in addition to the Refinery itself, will include an adjacent sulphuric acid plant; rail and road facilities; power, fuel, and water facilities; mineral residue facilities; waste facilities; port facilities associated with handling imported consumables and the export of product; and product marketing facilities in Europe or North America.

The following is a summary of the high-level approach to the design, engineering, and construction of the Refinery:

- Modularity: GMR intends to expand the Refinery's production capacity after the initial phase described in this scoping study. This expansion in scale and any extension of operational capability will be achieved by applying modular design concepts.
- Equipment: where possible, off-the-shelf equipment that is readily available and supported by reputable suppliers will be specified.
- Electrical design: power will be supplied by the local electricity grid that connects to the nearest available switch yard. Where possible, transformers will be standardised, motor control centres (MCCs) prefabricated, and factory acceptance will be tested offsite.
- Civil design: foundations will be raft-type. All process areas will be completely contained using concrete bunds with bund walls of at least 1.2 m above the floor height. Bund floors will be sloped according to the effluent contained: slurry requires a steeper grade than pure liquids. In areas where low pH fluids are handled, the bunded areas will use acid-proof bunds using a special concrete or specialised surface coatings. Spillage is washed into sumps from where it is pumped to the appropriate part of the process.
- Structural design: where possible, equipment packages will be supplied with structural support to limit onsite fabrication. Exposed steel and bunded areas will need specialist surface protection against increased coastal erosion and corrosive spills. On average, 20% more concrete strengthening will be required, 20% more corrosion protection and 10% additional foundation strengthening.

- Platework and piping design: the scale of Phase 1 of the Refinery will offer the opportunity to fabricate many tanks and ancillary platework offsite. Conversely, it is likely that apart from standard flanged pipe lengths, the interconnected piping will be site run.
- Architectural design: generally, the main processing areas will not be enclosed. Where necessary, shading will be provided. Buildings will be prefabricated, light-steel structures with corrugated cladding. Large doors on opposite ends of the buildings will assist with natural ventilation. Stockpiles will either be enclosed or have dust control measures installed.
- Constructability: the scale of the facility lends itself to offsite fabrication and assembly in road transportable subassemblies. It is assumed that there will be no electric overhead travelling (EOT) cranes during construction. All erection and construction will rely on mobile cranes.
- Operational considerations: the absence of EOT cranes will necessitate the use of mobile cranes, telehandlers, and scissor lifts, which will require access and, in some cases, hard stands.

4.4.2 Site Layout / Surface Infrastructure (Figure 4 needs to be clearer where what is, text very small.)

The Manganese Refinery Facility and associated facilities will be in a compact arrangement near Walvis Bay.

Table 26 provides a summary of the facilities on site to support the Manganese Refinery Facility and Sulphuric Acid Plant operations.

Table 26: Summary description of the buildings on site.

Building	Description
Control room	An elevated, prefabricated, air-conditioned building housing the central control and monitoring computers will be positioned inside the main processing area footprint, such that it provides a view of the operation.
Main site office	A prefabricated building adjacent to the control room that houses the offices of the production superintendent and supervisors.
Crushing site office	Prefabricated building adjacent to the crushing plant that houses a satellite control desk for the crushing plant.
MCC	Prefabricated, air-conditioned buildings that contain the switchgear, including variable speed drives, to safely start and stop electric drives. Provision is made for cables to leave the building, often at the bottom, by elevating the building slightly. MCCs will likely have a stepdown transformer outside.
Laboratory	A prefabricated, air-conditioned building with wet and dry rooms and a storeroom that will contain glassware, consumables and samples. The laboratory will require an extraction system, both three-phase and single-phase power, and instrument air.
Workshop	Fully clad, light steel structure with concrete floor, large roller doors and a light EOT crane for mechanical, electrical and vehicle repairs. Integral to the building will be a small stores and tool shed as well as an office for the superintendent and maintenance planners. The workshop will be located inside a fenced area that includes an outside laydown area.
Stores	Fully clad, light steel structure with concrete floor, large roller doors and a light EOT crane. Provision will be made for racks and laydown areas to store spare parts, equipment and materials. The workshop will be located inside a fenced area that includes an outside laydown and storage area. Hydrocarbons will be stored in a secure, covered lean-to structure.
Administration offices	A prefabricated, air-conditioned building that includes the following features: • five individual offices • two open plan workspaces, each with 10 desks • small kitchen area • washrooms • storeroom • two, ten-person meeting rooms • parking
Change house	Prefabricated building with both male and female changing facilities that include locker rooms, showers, and washrooms.
Bus stop	A shaded bus stop with sufficient turning space.

4.4.3 Manganese Refinery Facility

GMR will procure manganese ore on the open market from various sources in Southern Africa and trucked by a certified independent transport company from the KMF (notionally Upington) to Walvis Bay Farm 58. Ore trucks will be offloaded in an enclosure that contains and captures the dust, which is returned to the process via the mill feed conveyor, and transferred to an enclosed ore stockpile facility that makes provision for classification and delineation according to mineralogy.

Stockpiled ore will be extracted and fed to the crushing circuit using enclosed conveyors. Crushing equipment will be small and if enclosing each piece of equipment individually is insufficient, the whole circuit could be enclosed within a building. Where the feedstock is already in a crushed state, material will be transferred to the crushed ore day bins directly, by-passing the crushing circuit completely. The crushed ore day bins are completely enclosed and fitted with mechanical feeders that will extract material in a controlled manner whilst eliminating the escape of dust.

The enclosure design and associated operating procedure as well as any PPE will be designed to protect personnel. From the stockpile it will be extracted using mechanical feeder systems and transferred by enclosed conveyor to the primary crusher feed hopper.

The basic hydrometallurgical process steps to refine diverse types of manganese ore into HPMSM include ore characteristic size reduction, extraction, purification, crystallisation, drying and packaging of the final product. Flowsheet options were developed that met the following objectives:

- achieving the nominated HPMSM product specifications
- applying industry standard unit processes that are proven and simple to operate
- limiting, where possible, the use of dangerous or harmful chemicals
- reducing waste through judicious reagent use and considering the recycling or sale of effluent streams
- minimising capital and operating costs.

The Refinery is a continuous operation downstream of the crushing plant, which is run intermittently during the day to maintain minimum levels in the crushed ore bin that feeds the mill.

Extraction characteristics of typical manganese ore samples with representative grades between 30% and 47% manganese from Southern Africa indicated that excellent manganese extraction rates between 94% and 98% can be achieved using a reductive sulphuric acid leach process. The resultant leach solution analysis and the range of impurities present provided a good basis to consider subsequent impurity removal processes.

The selected process was designed downstream of extraction, with the cost of supply and local or regional availability of reagents, the requirement to treat ore from a variety of sources, and the need to meet a high-purity product specification in mind. The aim is for the refinery to be as simple and low cost as possible to construct, operate, and maintain.

The refinery has been designed to treat 100 kt/a of manganese ore at a grade of 46.6% manganese, which is typical of manganese ores shipped to international markets. The estimated overall design recovery of manganese is 88%, which accounts for losses during the various precipitation steps.

The annual target HPMSM production is 127 kt/a. **Figure 10** shows a simplified block flow diagram of the refinery process.

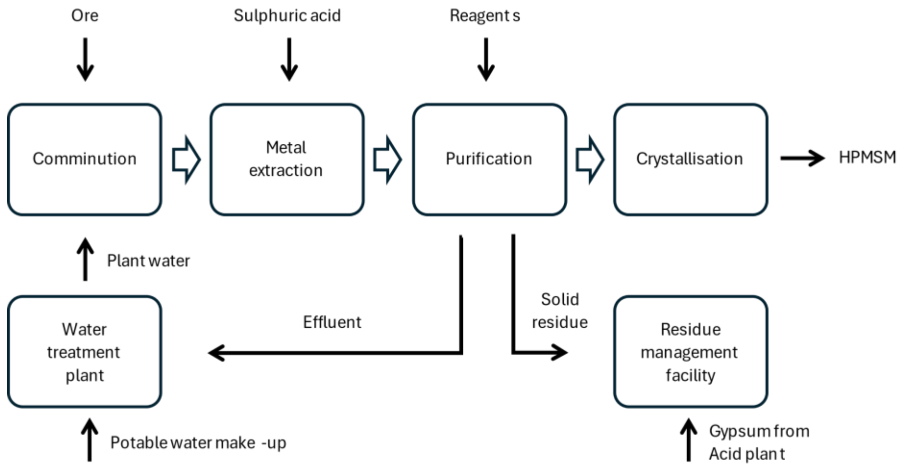


Figure 10: Simplified block flow diagram of the manganese refinery process.

Comminution will comprise conventional off-the-shelf (OTS) equipment including jaw crushers, cone crushers, vibrating screens and feeders, conveyors and ball mills. Dust suppression will be achieved by either enclosing each piece of equipment or by enclosing the whole operation with a building.

Metal extraction is achieved in specially designed tank reactors that include agitators to suspend the slurry mixture, heating jackets to increase and maintain the temperature of this slurry and extraction hoods to capture and direct any off-gas to scrubbers. Fluids are either pumped or transferred by gravity from one unit process to the next. Liquids and solids will be separated using OTS technology such as thickeners and pressure filters. Effective phase separation is important for an efficient process and to recover as much water within the plant for recycling.

Purification is achieved in steps, each consisting of a series of bespoke agitated tank reactors where conditions can be controlled through the judicious addition of reagents followed by a separation of the newly formed solids from the remaining liquid. As in metal extraction, the separation is achieved using conventional OTS equipment such as thickeners and pressure filters. Similarly, effective phase separation is essential for an efficient process and to recover as much water within the plant for recycling. Solids are typically moved using belt conveyors and liquids and mixtures using pumps.

Crystallisation is a controlled evaporation of the water phase from the concentrated manganese sulphate solution to produce a wet final HPMSM, which is dried and packaged in 1 t bulk bags, stored in a warehouse. The crystalliser unit is vendor-supplied package typically consisting of steel towers, steam boilers, pumps, blowers and fans.

Solid residues are combined and temporarily stored in a bin for collection by truck which will take it to the MRF. Liquid effluent collected at various points in the process is returned to the water treatment plant via the process water tank.

The various unit processes will manifest as a conventional heavy industrial chemical facility. Services will be distributed on main arteries in the form of main pipe and cable racks that feed the local distribution of water, reagents, steam, compressed air, power, and control communications. Spillage will be contained in bunded areas that will be demarcated with consideration of how the process fluids could be returned to the process. Production and consumption rates are presented in

Table 27.

Table 27: Refinery design consumption and production rates (t/a).

Stage	1	2	3
Plant ore capacity	25,000	50,000	100,000
Raw materials			
Sulphuric acid	46,250	92,500	185,000
Caustic soda	5,000	10,000	20,000
Soda ash light	21,250	42,500	85,000
Flocculent	250	500	1,000
Limestone	1,250	2,500	5,000
Quick lime	3,750	7,500	15,000
Water	100,000	200,000	400,000
Products and by-products			
HPMSM	30,000	60,000	120,000
Mineral residue	26,000	54,000	108,000

On-site storage for major reagents will be required to mitigate supply chain disruptions and accommodate bulk deliveries. This will also hold true for the sulphuric acid. **Table** 28 presents a summary of these requirements.

Table 28: Major reagents storage requirements.

Reagent	Storage type	Properties	Storage capacity
Manganese ore	Covered stockpile	ROM: P80=100mm, 3% moisture Fines: P80=150um, 2% moisture	100,000 t
Sulphuric acid	Steel tanks	98% concentration	4,000 m³
Quicklime	Covered storage		320 t
Sodium carbonate	Covered storage		1,700 t
Flocculant	Covered storage, bulk bags		20 t

4.4.4 Sulphuric Acid Plant

A standard design, modern, modular sulphur burning acid plant will be used to produce 98% pure sulphuric acid (see **Figure 11**) for use by the Refinery and for third-party offtake. Sulphur prills will be imported in bulk through Walvis Bay Port (as it currently is) and delivered to site initially by truck and eventually by rail once the infrastructure has been extended into Farm 58.

The sulphur will be stored on site in an enclosed warehouse from where it will be reclaimed and fed into the sulphur burner. Sulphuric acid will be stored in large steel tanks in specially designed bunded areas, from where it will be pumped to the Refinery or transferred into tanker trucks for delivery to customers.

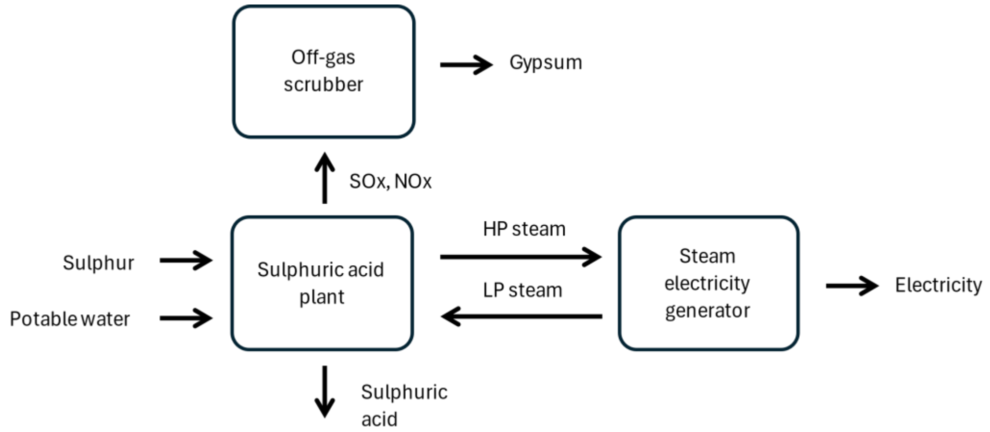


Figure 11: Simplified block flow diagram of the sulphuric acid production process.

Surplus heat from the process in the form of high-pressure steam will be used to generate electricity in a steam turbine plant. Low-pressure steam from the generators will be available to the Refinery for preheating its leach circuit.

The acid production capacity will be developed in stages (see **Table 29**). These stages do not necessarily correspond to the Refinery development stages.

Table 29: Sulphuric acid plant design consumption and production rates (t/a).

Stage	1	2	3
Raw materials			
Sulphur	57,000	144,000	228,000
Water	186,000	372,000	744,000
Products and by products			
Sulphuric acid	175,000	350,000	700,000

To receive start-up acid and store acid to bridge acid plant downtime, large acid tanks will be installed. These will be mild steel, closed-topped tanks built in bunded areas specifically prepared to handle an acid spillage. The bunded area will have a displaced volume of the greater of 110% of the largest tank or 25% of the total tank storage capacity. The facility will be expanded in stages (see **Table 30**).

Table 30: Sulphuric acid storage.

Item	Unit	Stage 1	Stage 2	Stage 3
Sulphuric acid storage	m^3	2x 6,140	4x 6,140	6x 6,140

Stack emissions from the sulphuric acid plant are provided in **Table 31** and the locations of the stacks (SS1 to SS5) are shown in **Figure 8**.

Table 31: Stack emissions.

Project Phase and area	Stack number	Height	Diameter	Flowrate	SO_2 (24h)	SO_3/H_2SO_4 (24h)
	Unit	m	mm	Nm^3/min	ppm	ppm
Phase 3 (SAP)	SS1	50	1,300	720	<300	<30

Project Phase and area	Stack number	Height	Diameter	Flowrate	SO_2 (24h)	SO_3/H_2SO_4 (24h)
	Unit	m	mm	Nm^3/min	ppm	ppm
Phase 2 (SAP)	SS2	42	1,300	720	<300	<30
Phase 1 (SAP)	SS3	40	1,430	870	<300	<30
Phase 1 (SAP)	SS4	40	1,650	1150	<300	<30
Complete final Refinery requirements	SS5	30	550	70	<300	

4.4.5 Power Supply

It is assumed that power will be supplied by Erongo Red or NamPower. GMRN is currently in discussion with them. The powerline feeding the proposed project will be assessed in a separate EIA. **Table 32** and **Table 33** provide the power supply parameters and the power demand of the refinery and sulphuric acid plant.

Table 32: Manganese Refinery power supply parameters (50 Hz).

Parameter	Unit	Value
Main substation supply voltage	kV	132
Main substation delivery voltage	kV	11
Main switch room supply voltage	kV	11
Main switch room delivery voltage	kV	3.3
Low voltage	V	400

Table 33: Refinery and Acid plant power demand.

Parameter	Unit	Value
Installed power	MW	2.1
Load factor	-	0.9
Absorbed power	MW	12
Power factor	-	0.9
Reactive power	MVA	13

4.4.6 Water Supply and Management

The national water utility company, Namibia Water Corporation (NamWater), has indicated that up to 350 m^3/h of spare capacity is available for the Project. This will be supplied from the local water supply network, which is fed by the Kuiseb River alluvial aquifer, the Omdel scheme, and the Orano Desalination Plant. The network supplies both Swakopmund and Walvis Bay via a water pipeline running along the dual carriageway approximately 4.3 km from Farm 58 (**Figure 12**). The water pressure at the tie-in point will be approximately 80 m, sufficient to transfer the water to site without the need for a booster pump station.

The Omdel scheme is a bulk water supply scheme in the Erongo province that consists of the Omdel Dam, the Omdel Aquifer with its boreholes, two collector pipelines bringing water from the boreholes to the collector reservoir and the pipeline between this reservoir and the terminal reservoir at Swakopmund Base Station. The Omdel Dam is situated 36 km northeast of Henties Bay, and the Omdel Aquifer is located along the lower Omaruru riverbed.

The Orano Desalination Plant was constructed between 2008 and 2010 by Orano Mining Namibia, which was previously known as Areva Resources Namibia. The desalination plant was established to supply water to Orano's Trekkopje Uranium Mine, which was never built. At the time this plant was commissioned, it was the largest reverse osmosis desalination plant in Southern Africa. The plant operator, Nafasi Water (based in Gauteng, South Africa) sells the potable water to NamWater, which distributes it throughout the Erongo Region.

Source: Google Earth, Site-selection Report (Appendix A)

Figure 12: Existing and proposed water infrastructure near Walvis Bay.

Please note that the water pipeline will be assessed in a separate EIA.

Water is used extensively in the refining processes, but the vast majority is recovered, treated and recycled. A high-level water balance comprises the following components:

- Inflows: moisture in the ore, potable and raw water make-up, water associated with sulphuric acid, and
- Outflows: residue moisture, residue water of crystallisation, water treatment brine, product moisture and water of crystallisation, and evaporation.

The net make-up water requirement is estimated to be 50 m^3/h for a 100,000t/a ore production rate, including an allowance of 10% for general plant use and domestic requirements (see **Table 34**). Water from various parts of the refinery will be collected and returned to the water treatment plant along with the make-up water required to replace the water associated with the product, locked in the tailings stream and through evaporation.

Five types of water will be used in the Refinery:

- <u>Potable water:</u> Drinkable water provided by the local utility company. This will be the make-up water quality for the Refinery.

- Fire water: Water stored and used for fire suppression. Although this may start as potable water, the more relaxed requirement for clean storage means it will not be potable.
- Process water: All water that has been in contact with the process will be returned to the water treatment plant for treatment and distribution.
- Plant water: Water that will be treated for general use in the process to remove suspended solids and neutralise the pH.
- Reverse osmosis (RO) water: Treated water from which all dissolved solids are removed using reverse osmosis. Reverse osmosis water will be used in the base metal ion exchange, manganese precipitation, manganese redissolution and crystallisation unit processes.

The freshwater consumption in cubic metres per annum (m^3/a) for the refinery and acid plant at various project stages is shown in **Table 34**, though the stages of the acid plant do not necessarily correspond to the refinery development stages. Water will circulate as steam within the acid plant and the associated steam-driven power plant, there will be no liquid effluent from the acid plant. The table also shows the planned water storage capacity that will be provided in closed tanks, as no open water is allowed within 8 km of an airport.

Table 34: Estimated water consumption (m3/a).

Development stage	**1**	**2**	**3**
Refinery consumption	100 000	200 000	400 000
Acid plant consumption	50 000	100 000	200 000
Total consumption	**150 000**	**300 000**	**600 000**
Water storage capacity	1200	1200	1900

The water treatment plant will be a vendor package that utilises standard technologies, including clarifiers, dissolved air flotation, reverse osmosis, and ion exchange, to produce either plant, fire, or reverse osmosis water.

Water storage on site for the different stage is shown in **Table 35**.

Table 35: Water storage (m^3).

Stage	**1**	**2**	**3**
Plant ore capacity	25,000	50,000	100,000
Potable water	400	400	800
Fire water	100	100	100
Process water	200	200	400
Plant water	400	400	400
RO water	100	100	200

Water storage on site will smooth out water demand to the average demand.

NamWater's' committed supply is an informal assurance until a network study is completed. This will be negotiated after the current engineering phase.

4.4.7 Stormwater Management

A stormwater management plan will include runoff catchment from the MRF, including diversion features such as berms and channels to direct storm run-off away from built infrastructure. Any water that comes into contact with the infrastructure will be captured (in bunded areas for instance) and pumped to the stormwater pond from where it will be recovered to the water treatment area to offset NamWater demand.

Run-off generated from precipitation on the MRF embankment slopes will be actively managed to prevent uncontrolled flow, which can lead to surface erosion and gully formation. This will be achieved through a combination of slope benching and toe paddocks. The constructed benching on the MRF slopes will serve to break up the flow path of water, reducing flow velocity and facilitating infiltration. Each bench will be graded inwards to collect run-off and direct it towards designated drop structures. At the toe of the embankment, perimeter paddock drains will be constructed to capture all collected run-off from the benches and any overland flow from the immediate surrounding area. These paddock drains are designed to safely convey the water without causing erosion. All collected run-off from the MRF slopes and toe paddocks will be diverted into the clarification pond via a dedicated, lined solution trench. This ensures that all contact water is contained within the facility's water management circuit. This water will then be recycled for use in processing, thereby minimising freshwater make-up requirements and ensuring that there is no uncontrolled release from the MRF.

4.4.8 Waste Management

Different waste will be generated during operation; each is briefly discussed below.

4.3.8.1 Mineral Residue Facility (MRF)

The waste streams (see **Table 36**) from the Refinery will consist of undigested minerals, precipitates, and water treatment brine. To recover both the water and the manganese in solution, the waste products will be thoroughly dewatered.

Table 36: Residue disposal.

Description	Units	Residues	Effluent
Constituent	-	solids	solution
Mass flowrate	t/h	13.8	72.7
Solids content	% w/w	75	0.0
Aluminium	ppm	4,621	-
Calcium	ppm	245,248	609
Iron	ppm	76,426	-
Manganese	ppm	52,036	1,598
Silicon	ppm	24,403	14
Sodium	ppm	-	79,262

The MRF will comprise a filtered tailings storage area and a clarification pond. The tailings storage area of the MRF will consist of an HDPE-lined pad surrounded by a rock-fill perimeter berm. A clarification pond will be excavated below the original ground level to a depth of approximately 3 m, and the associated perimeter containment dam will be limited to a height of approximately 9 m above original ground level. The clarification pond will be fully lined with the seepage collection sump at the downstream end of the contained area. Due to the limited height, the perimeter containment dam will be constructed of rock fill lined with HDPE. Neither internal filters nor a clay core will be constructed within the containment dam section. The construction should limit the carbonate content of the construction rock.

Tailings will be delivered to the storage site in form of dry cake with a moisture content of up to 15%, using a single articulated 20 t dump truck. Tailings will be loaded from the stockpile outside the plant onto the truck using a dedicated backhoe loader. Once deposited, tailings will be spread in nominally compacted by a D7 dozer. Dozer traffic over previously deposited tailings will aid the process of compaction and negate the requirement for specific compaction equipment.

A detailed monitoring system will be developed including monitoring boreholes, leachate detection, and seepage management systems to demonstrate compliance with IFC and Namibian waste management standards.

4.3.8.1.1 MRF Design

Information in the following section describing the MRF design has been sourced form Knight Piesold (2025).

The MRF is developed in a phased approach to assist in the deferral of Capex, and for the longevity of infrastructure that would otherwise remain exposed while the footprint is developed. **Figure 13** shows the proposed phase development cross-section for the GMR MRF.

Mineral residue will be stacked under wet conditions and compacted when wet.

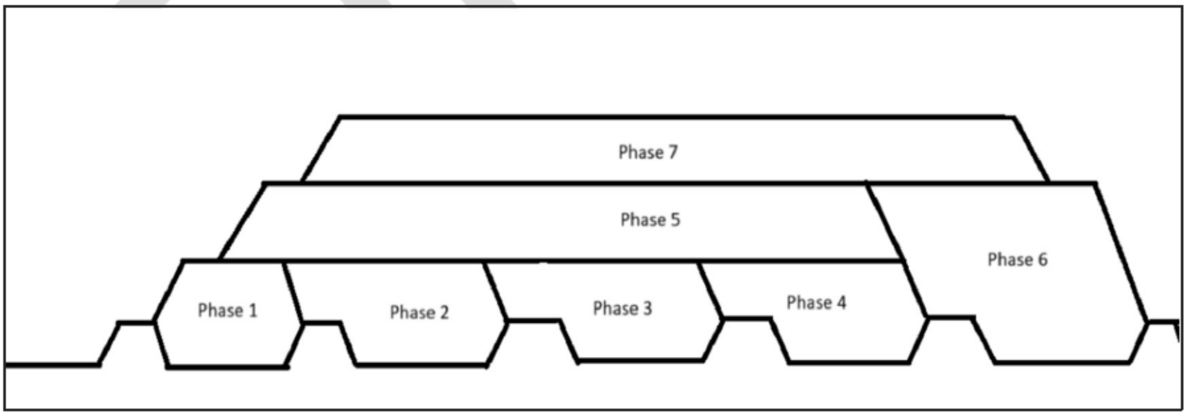


Figure 13: MRF phased development during operation.

The physical geometry of the proposed MRF is summarised in **Table 37**.

Table 37: Summary of the MRF Final Geometry (Knight Piesold, 2025).

Property	Value
Starter Embankment Height	3 m above NGL
Starter Embankment Crest Width	6 m
Starter Embankment Upstream and Downstream Slopes	1V:2H
TMF Final Design Elevation	99 mamsl
Final TMF Side Slope	1V:4H
Tailings Bench Height	4 m
Bench step-in widths	4 m
Outer Wall Slopes	1V:3H

4.3.8.2.2 Storage Capacity and Filling Schedule

The filling schedule for the MRF expansion under 300 tons per day (tpd) feed scenario over the projected over the 25 years LOM. The different phases are briefly described below (Knieght Piesold, 2025).

- **Phases 1** to **4** are the initial phases where the TMF is constructed from ground level to an initial height of 91 mamsl. For these 4 phases, a total combined capacity of approximately 803 000 m^3 (1.5 Mt) will be provided.

- **Phase 1** has an initial filling time of 4 years at the current projected LOM deposition rate of 108,799 tpa. In total the first four phases have a combined storage filling of 13 years.
- **Phase 5** provides approximately 9.5 years of storage deposition with approximately 590,000 m^3 (1,103,300 tonnes).
- **Phase 6** and **7** take a total of approximately 14 years with a total capacity of approximately 880,000 m^3 (1,645,600 tonnes).
- Overall, a total of approximately 2.3 million m^3 can be stored on the facility which can cater for projected LOM tonnages with additional capacity still available for deposition.
- The TMF will have a maximum height of 15 m above the ground surface.

4.3.8.2.3 Surface Water Run-off form the MRF

Uncontrolled flow, which can lead to surface erosion and gully formation, from precipitation on the MRF embankment slopes will be actively managed through a combination of slope benching and toe paddocks.

Benching: The constructed benching on the MRF slopes will serve to break up the flow path of water, reducing flow velocity and facilitating infiltration. Each bench will be graded inwards to collect run-off and direct it towards designated drop structures.

Toe Paddocks: At the toe of the embankment, perimeter paddock drains will be constructed to capture all collected run-off from the benches and any overland flow from the immediate surrounding area.

These paddock drains are designed to safely convey the water without causing erosion. All collected run-off from the MRF slopes and toe paddocks will be diverted into the PCD via a dedicated, lined solution trench. This ensures that all contact water is contained within the facility's water management circuit. This water will then be recycled for use in processing, thereby minimising freshwater make-up requirements and ensuring that there is no uncontrolled release from the MRF.

4.3.8.2 Solid waste

The types of waste that will be generated by the proposed Project include: hazardous industrial waste (such as packaging for hazardous materials, used oil, lubricants), general industrial waste (such as scrap metal and building rubble), medical waste (such as swabs, bandages) from the staff medical station, and domestic waste (such as packaging, canteen waste and office waste).

These wastes will be temporarily handled and stored on site before being removed for recycling by suppliers, reuse by scrap dealers or final disposal at permitted waste disposal facilities.

A registered Waste Management Company will be contracted to remove all hazardous waste from the mine.

4.3.8.3 Liquid Effluent / Wastewater

The selection of the most appropriate sewage treatment and effluent discharge method mainly depends on the number of persons to be employed on site. GMRN estimates that 100-500 workers will be on site during the various construction phases and 300 during operation. These numbers exceed the capacity of simple sewage disposal systems like conservancy tanks or septic tanks. These options are briefly described below for completeness.

The easiest option at the start of the project would be conservancy tanks that are regularly pumped out by a contractor who takes the raw sewage to the municipal treatment plant. The number of plastic tanks would be adjusted to accommodate the workforce, up to a maximum of approximately 30-40 people. At higher numbers, the trips required to empty the tanks may become too frequent and expensive.

Depending on the ground conditions, it may be possible to use septic tanks with French drains for approximately the same number of workers. Septic tanks must be constructed according to

DWA specifications. French drains will only function properly if the treated effluent can freely soak into the soil, i.e. if the sand layer is thick and permeable enough, so that water will not pond on the surface, emitting smells and attracting flies etc. A site investigation with trenching would be needed to determine if this option is feasible.

For more than 30 people or for a more permanent solution, a containerised plant based on trickling filter technology would be a suitable option. Such a plant is easy to operate; the only advanced mechanical equipment being submersible pumps and actuated valves. Once commissioned, no further process control is required. The plants can handle fluctuating loads related to both flow volumes and biological loading of the raw sewage. This is important if the majority of employees are only present during the day and not much effluent is generated at night. Provided that no disinfecting cleaners that kill the microorganisms on the trickling filters are discharged into the sewage system, the final effluent should meet the Namibian water quality general standard for disposal into the environment.

If a sufficiently large area is available, one could consider wastewater ponds. These normally comprise of an anaerobic pond, a facultative pond and a maturation pond. Sewage effluent is treated by naturally occurring processes under the influence of sunlight, wind, algae and microorganisms. The disadvantage is that evaporation losses will significantly reduce the volume of water that is available for reuse.

A further, probably more long-term option would be a sewage treatment plant set up by the Municipality of Walvis Bay for all the occupants of Farm 58. Seeing that the municipality is the landowner, it should be their responsibility to provide sewage, as well as waste removal, services. This may however only happen once all the land has been allocated. Considering the town's budget constraints, this is, however, unlikely to materialise.

4.4.9 Transport System

Transport and logistics outside the site area will be contracted to a third party.

Typical equipment on site is presented in **Table 38**. All vehicles will run on diesel and be refuelled on site from a central storage tank bowser.

Table 38: Total truck movement during construction.

Mobile equipment	Qty
Mobile crane	2
FEL	4
Dozer	1
Water tanker truck	1
10t truck	1
5t truck	1
Light vehicles	5
Ambulance	1
Fire truck	1

During the 18-month construction period, structural steel, piping and equipment will be imported through the NamPort and transported to site using route C14. Locally sourced materials, likely to be transported to site using route A2, will include sand, gravel and cement unless they are transported to Walvis Bay by rail and delivered to site via route C14. **Table 39** presents an estimate of the number of truck loads during construction.

Table 39: Total truck movement during construction

Road	20t truck	30t truck	60t truck
C14	200	100	-
A2	121	44	-

Lime and limestone will be trucked using the B2 unless it is transported to Walvis Bay by rail and delivered to site via route C14. **Table** 40**40** summarises truck movements per week during the operations for both the initial 25 kt/a and final 100 kt/a production capacities.

Table 40: Average weekly truck movements during operations (25-100 kt/a plant capacity).

Road	20t truck	30t truck	60t truck
C14 – import NamPort	1 - 4	81 - 123[1]	-
C14 – product export NamPort	-	20-80[2]	-
B2 – deliveries to site	2 - 8	4 - 16	9 - 36
B2 – acid deliveries to third parties	-	87 - 115	-

Note:
[1] During start-up, once every two years, acid will be imported through the port leading to a temporary increase in traffic
[2] Product will be exported using the return legs of the delivery trucks

Most personnel will be transported from Walvis Bay, Arandis and Swakopmund to site by 60-seater bus (see **Table 41**).

Table 41: Average bus trips per shift during operations (25-100 kt/a plant capacity).

Road	Shifts	Busses/shift
C14 from Walvis Bay	3	1
B2 from Arandis and Swakopmund	3	1

4.4.10 Operating times and Maintenance

The Sulphuric Acid Plant will operate 24 hours per day, 7 days a week, throughout the year with a maintenance shutdown for a month every second year, while the Manganese Refinery Facility will operate 24 hours per day, 7 days a week, for 350 days per annum. **Table 42** shows the operating times and scheduled maintenance.

Table 42: Operating time.

Element	Unit	Value
Calendar time	d/a	365
	h/a	8,760
Crushing		
Planned downtime – night shift	h/a	4,080
Planned downtime – planned maintenance	h/a	600
Planned operating time	h/a	4,080
Availability	-	0.76
Available time	h/a	3,117
Grinding and hydrometallurgical plant		
Planned downtime – night shift	h/a	0
Planned downtime – maintenance	h/a	468

Element	Unit	Value
Planned operating time	h/a	8,292
Availability	-	0.95
Available time	h/a	7,884
SAP		
Planned downtime – night shift	h/a	0
Planned downtime – maintenance	h/a	468
Planned operating time	h/a	8,292
Availability	-	0.95
Available time	h/a	7,884
Annual shutdown (every second year)	wk	4

4.4.11 Workforce

The MRF and SAP will be staffed mostly from in-country resources. Certain key technical positions may be filled at first from other parts of the world until such time as local resources can be trained to take over. Apart from the crushing area in the Refinery, which will operate on a 12-hour day shift only, both plants will operate on three 8-hour shifts.

Three assignment categories have been identified:

- Managers: senior staff who work conventional working hours and do not require leave relief.
- Dayshift: staff who work on day shift only. These are typically supervising, administrative or maintenance personnel.
- Shift: most of the workforce will be working a three-shift pattern, and allowance will be made for leave relief.

Table 43 presents a summary of the staffing plan.

Table 43: Summary of MRF and SAP operational staff.

Major area	Skill level	Paterson code	On Duty				Employed			
			Manager	Day shift	Shift	Total	Manager	Dau shift	Shift	Total
MRF	Programming	E2	1	-	-	**1**	15	-	-	**1**
	Interpretive	D3	5	-	-	**5**		-	-	**5**
		D2	5	2	-	**7**	5	4	-	**9**
	Skilled	C2	8	5	6	**19**	8	10	24	**42**
		C1	4	7	10	**21**	4	14	40	**58**
		D1	3	2	-	**5**	3	4	-	**7**
	Semi-skilled	B1	-	-	3	**3**	-	-	12	**12**
		B2	3	-	12	**15**	3	-	48	**51**
	Unskilled	A1	4	2	15	**21**	4	4	60	**68**
	Total MRF		**33**	**18**	**46**	**97**	**33**	**36**	**184**	**253**
SAP	Interpretive	D3	1	-	-	**1**	1	-	-	**1**

Major area	Skill level	Paterson code	On Duty				Employed			
			Manager	Day shift	Shift	Total	Manager	Dau shift	Shift	Total
		D2	-	2	-	**2**	-	2	-	**2**
		D1	-	-	1	**1**	-	-	4	**4**
	Skilled	C3	-	3	4	**7**	-	3	4	**7**
		C2	-	12	-	**12**	-	14	-	**14**
		C1	-	3	8	**11**	-	3	32	**35**
	Semi-skilled	B2	-	-	-	**-**	-	-	-	**-**
	Unskilled	A1	-	-	-	**-**	-	-	-	**-**
	Total SAP		1	20	13	**34**	1	22	40	**63**

Source: GMRN: NPNB-I-MEM-002-00-F58Project Information received 15/7/2025

Note: Labour classification and rates are in accordance with the Paterson band scale, see **Section 4.2**.

4.4.12 Sustainability measures

The following initial sustainability measures will be included:

- The use of surplus energy from the sulphur burning process to generate high pressure steam from which electricity is generated for use in the Refinery and to provide base load to the local grid (**Note:** This probably will trigger a separate ECC application). Low pressure steam from the generators will be used for the preheating of process slurry in the extraction process, displacing heat generated using grid power or hydrocarbons.
- The crystallisation technology uses vapour recompression technology which is 50% more efficient than evaporation alone.
- Trucks used to deliver reagents are used to export the product on the return leg, if technical feasible (**Note:** special trucks will be needed to transport different goods).
- Supplier contracts will obligate to take back used containers to reduce waste on-site.
- Both the Refinery and SAP will be completely contained to avoid any environmental contamination.
- Where possible, local labour will be employed. When skills are imported it will be done as part of a skills transfer programme.

4.5 Project Decommission

At the conclusion of processing operations at the Manganese Refinery and Sulphuric Acid Plant, decommissioning and rehabilitation are expected to be undertaken in a structured and phased manner, in accordance with applicable Namibian legislation in force at the time, the company's management systems, and stakeholder expectations. Planning will be undertaken throughout the life of the Project, so that the final scope is informed by operational monitoring results, evolving standards, and any updated land-use planning for Farm 58 and the wider industrial area. Progressive rehabilitation is expected to remain an important principle, where practicable, as areas may become redundant or could be taken out of service during operations. This approach supports ongoing refinement of rehabilitation methods and performance criteria, taking account of what proves effective under local climatic and soil conditions.

Conceptually, decommissioning activities are expected to reverse the construction sequence, with an emphasis on risk reduction, infrastructure removal, management of residues and contaminated materials, and restoration of disturbed areas. The objective is to leave the site physically and chemically stable, environmentally safe, and suitable for an agreed post-closure land use consistent with the industrial zoning of Farm 58.

In practice, the final decommissioning scope is likely to be confirmed through a dedicated planning process closer to the end of operations. That process typically includes confirmation of decommissioning objectives, an updated inventory of infrastructure and hazardous materials, a waste and materials management approach (including opportunities for reuse and recycling), and a rehabilitation and monitoring programme with measurable completion criteria.

4.5.1 Site Infrastructure

All infrastructure associated with processing operations, including mechanical equipment, tanks, pipelines, and ancillary structures, is expected to be assessed for decontamination requirements, practical dismantling, and end-of-life pathways, such as reuse, recycling, or disposal at appropriately authorised facilities. Decommissioning is typically undertaken using a risk based approach, with priority given to removal or making safe of hazardous materials and residual process chemicals, followed by demolition and removal of structures no longer required. Where progressive decommissioning occurs during operations, this can reduce the final closure workload and provide operational learning on decontamination methods, waste classification, and rehabilitation performance.

4.5.2 Process Plants and Associated Facilities

The decommissioning of the Manganese Refinery, the Sulphuric Acid Plant, and associated buildings (such as offices, workshops, warehouses, and laboratories) is expected to follow an orderly sequence that begins with plant shutdown, the isolation of services, and the removal of chemicals, reagents, fuels, and wastes from process systems. Structures and equipment would then be cleaned or decontaminated to defined acceptance levels suitable for dismantling, transport, recycling, or disposal. Where process areas have a potential to affect soil or groundwater, confirmatory assessment and verification sampling may be appropriate to demonstrate that residual contamination is suitably managed, and to inform any targeted remediation that might be required. The level of demolition, removal, and remediation can vary depending on the final objectives and the feasibility of repurposing certain assets within the industrial area; the overall intent would be for remaining structures not to create ongoing safety or environmental risk.

4.5.3 Access Roads, Utilities, and Services

Redundant roads, pipelines and service corridors are expected to be decommissioned and rehabilitated to avoid unnecessary long-term disturbance and to reduce the potential for erosion, dust generation, and altered drainage. The extent of removal is likely to be informed by practical considerations, including whether specific routes serve ongoing functions for Farm 58, whether they are required for post-decommissioning monitoring access, and whether the Municipality or other stakeholders identify continued use in the broader industrial layout of Farm 58.

4.5.4 MRF

The MRF is expected to be closed in a manner that prioritises long-term physical stability and environmental protection, recognising that residue facilities often remain the most persistent closure feature. Closure concepts would mirror the typical approach for similar facilities in a mining context. Typically, this would include progressive filling and consolidation, management of free water and seepage / supernatant, surface water controls to limit ingress and manage clean water run-off, and final shaping to promote stable drainage. The approach referenced at this stage includes dewatering, stabilisation and capping with inert material, followed by placement of suitable growth medium where available and appropriate for this arid environment, with landforms designed to minimise erosion and avoid ponding. The final MRF closure design and performance requirements would usually be confirmed closer to the closure thereof, informed by residue characteristics, operational performance, monitoring results, and the relevant regulatory expectations for residue storage facilities. Post-closure monitoring and maintenance are typically required for a defined period to confirm that the landform performs as intended and that any seepage or water quality risks remain within acceptable limits.

5 ALTERNATIVES

This Section summarises the various project alternatives evaluated by GMRN, along with additional alternatives to be considered during the EIA.

5.1 Choosing Namibia's Central Coastal Region

With reference to **Section 1.3.2**, Namibia was selected for its flexibility in sourcing manganese ore from a wide range of mining operations. Initially, ore will be imported from South Africa, with a future opportunity to transition to local supply should operations, such as Otjosondu, resume. GMRN selected the coastal region of Namibia for its refinery based on access to major ports (Walvis Bay and Lüderitz), efficient transport links, reliable utilities, and strong renewable energy potential. The project offers significant economic and strategic benefits for Namibia through job creation, local procurement, taxes, and infrastructure development.

Also refer to **Section 2.1** for information about a Site Selection Study conducted by GMRN.

The motivation for Namibia to support the project is economic and strategic in nature. The project has the potential to benefit the country, society, and surrounding communities both directly and indirectly. Direct economic benefits will be derived from wages, taxes, and profits. Indirect economic benefits will be derived from the procurement of goods and services and the increased spending power of employees through the creation of new jobs at the mine. **Section 7.3.1** to **7.3.3** provide further details on the assessment of potential socio-economic benefits from the proposed Project.

5.2 Farm 58 Site

As referenced in **Section 2.1**, CREO Engineering Solutions (Pty) Ltd undertook a comprehensive Site Selection Study (C0823_GMR_Site Selection Study_V1.2) during 2023. The study initially investigated 17 potential sites and provided an overview of the project, a summary of the potential locations, the selection criteria applied, and a ranked site preference.

Many of the towns and areas considered currently have limited or no utility services available to support the proposed project, necessitating significant upgrades or extensions to existing infrastructure. Conversely, locations near existing infrastructure tend to be less industrially zoned, posing different challenges. The Site Selection Study (CREO, 2023) emphasised that Lüderitz harbour currently lacks the infrastructure required for the offloading and storage of sulphuric acid. In contrast, Walvis Bay harbour is equipped with existing facilities (i.e. servicing Rössing Uranium) and will soon see the addition of a new acid handling terminal developed by Cooperative Bulk Handling Terminal (Pty) Ltd, a wholly owned subsidiary of Bannerman Investments Namibia (Pty) Ltd, part of the Bannerman Energy Ltd Group of Companies.

Nevertheless, several factors led to the elimination of Lüderitz from further consideration, including:

- Lack of proximity to essential utility infrastructure.
- Limited industrial development.
- Concerns over the reliability of the railway connection, which is frequently obstructed by desert sands.
- A remote location compared to the more centrally situated Port of Walvis Bay.

Based on the evaluation criteria outlined in the Site Selection Study (CREO, 2023), the sites best meeting the project requirements are:

- Karibib.

- Kranzberg.
- Arandis.
- Swakopmund.
- Walvis Bay A – Farm 58.
- Walvis Bay B – Town.

Following this assessment, Green Metals Refining Ltd. (GMR) shortlisted three sites for the proposed construction of a manganese refinery and sulphuric acid plant:

- Arandis.
- Swakopmund (approximately 10 km east of the town, within the planned future industrial area).
- Farm 58 near Walvis Bay.

Land applications for these three locations were subsequently submitted to the relevant authorities for concurrent consideration.

In 2024, ASEC conducted an Environmental and Social Screening Study (Environmental and Social Screening Report, July 2024) to further inform the site selection process.

GMRN considered the findings of the Site Selection and Internal Environmental Screening studies, as well as other relevant criteria, which resulted in the Walvis Bay Farm 58 site being one of the preferred options. GMRN determined that the Walvis Bay site was one of the preferred options, offering unique benefits.

5.3 General Project Information Alternative Infrastructure Layout Options and Design Considerations

Based on the modular design of the refinery and acid plant, there are numerous alternatives for relevance to layout options that were considered. In the EIA report, the relevant alternatives will be elaborated on with a justification/explanation as to why the final layout was completed as per the layout maps included in the EIA process.

Water requirement: If the GMRN project does not require potable water quality, a small reverse osmosis plant could easily treat grey water to an acceptable standard at a much lower cost than seawater desalination.

MRF design and operation: The concept design of the MRF considered conventional thickened tailings stored in a lined facility with supernatant water returned using floating pumps or a penstock. Owing to the scarcity of water, high evaporation rates and the need to retain liquor in the process, this concept was rejected.

Residue management and water treatment considerations: The initial limiting of residue dewatering to conventional thickening of the residue slimes was cost effective but owing to the colloidal nature of the precipitates would not dewater sufficiently to allow dry stacking. Pressure filtration of the mineral residue in the process plant before disposal on the MRF allows the operation to produce a drier residue and to retain maximum water for reuse in the plant. The retention of process water in the plant allows for better water management, a high recycle coefficient and a minimisation of standing water.

Fugitive dust management: Initial air quality modelling by Airshed indicated fugitive dust levels that were higher than expected. GMRN updated the Refinery and MRF infrastructure to minimise these dust levels. The operational changes include using a grader rather than a bulldozer, limiting the MRF operating hours to four hours per day (resulting in an almost seven-fold reduction in emissions), enclosing ore off-loading with the necessary dust extraction and suppression technology and a truck wash. Crushing and screening (and associated off-loading and loading) initially included a small conventional three stage closed circuit with conventional dust handling equipment. Following the Airshed modelling GMRN specified fully enclosed crushers, conveyors, transfer points and screens. Revised air quality modelling shows a significant improvement in fugitive dust levels following these interventions.

5.4 The 'No Project' Option

The assessment of this option requires a comparison between the options of proceeding with the project and not proceeding with the project. The assessment of this option requires input from the investigations described in **Section 7** so that the full extent of environmental, social and economic considerations can be taken into account.

If the project does not go-ahead all positive impacts stated in **Section 7** will not materialise. On the other hand, all negative impacts will not occur.

Although, the project area is located in an area zoned for heavy industry, the management of the MRF, as shown in **Section 7.2.3** (Air Quality Assessment), is of highest importance to prevent and/or reduce any manganese dust. These needs to be carefully addressed from the beginning of the design of the MRF.

6 DESCRIPTION OF THE CURRENT / RECEIVING ENVIRONMENT

This Section describes the existing biophysical and social environment that could potentially be affected by the proposed Project, using currently available information. The link to potential environmental and socio-economic impacts, which are assessed in section 7, are also explained for the various receptors/aspects.

Baseline studies, incorporating input from relevant specialists, are critical to any EIA for a project of this nature and scale. These studies provide essential information that underpins the impact assessment (see **Section 7**) and serves as the foundation for future monitoring and potential adaptive management (see EMP in **Appendix A**), further research, and decision-making. At the outset of the Scoping Phase, several specialist studies were commissioned for the Project, with work commencing in early 2025. These studies, along with additional investigations identified during the Scoping Process, were undertaken or expanded as needed to inform the Impact Assessment Phase, which started in August 2025.

For the Impact Assessment Phase, the Environmental Team (see **Section 1.4.4**, **Table 3**) updated their baseline studies to improve the knowledge base of the current/receiving environment, relating to the proposed Project area and surroundings.

Table 3 in **Section 1.4.4** provides an overview of the specialists engaged in the Project. The specialists contributed to the sections below, as follows:

- Groundwater and Surface Water Study: Sandra Müller, independent water consultant
- Air Quality and Climate Change Study: Airshed Planning Professionals
- Noise Study: Soundscape Consulting (Pty) Ltd
- Biodiversity Study: EnviroScience
- Archaeology / Heritage Study: John Kinahan, independent archaeologist
- Socio-Economic and Traffic Study: Auriol Ashby, independent consultant
- Risk Assessment Study: RISCOM

References in **Section 6** and **7** are included in the respective Specialist Reports (see **Appendices F – M**) and are not repeated in the EIA reference list.

The spatial scope of the EIA is defined as the area over which changes to the environment could occur as a result of the various phases of the project. The study areas are referred to as the Local Study Areas (LSA) and Regional Study Areas (RSA). The spatial scope for the various specialist disciplines to be considered in the EIA is provided in **Table 44**.

Table 44: Spatial Scope of Environmental and Social Aspects.

Environmental and Social Component	Spatial Scope
Air quality (and climate)	Dust and emission are not limited to the site due to the regional climate and wind regimes. These were modelled as part of the assessment phase.
Archaeology and cultural heritage	The footprint of the Project site.
Biodiversity	The footprint of the project site with a buffer zone (the width depends on habitat sensitivity, ranges and migration routes) during construction and operation.
Groundwater	No abstraction will occur on site due to the assumed depth and quality of the ground water. However,

Environmental and Social Component	Spatial Scope
	monitoring boreholes will be established to ensure that no pollution enters the groundwater, which could extend beyond the site boundaries.
Hydrology	The footprint of the Project site and downstream drainages, i.e. beyond the site boundaries, during construction and operation.
Noise	The study area will be identified in relation to the sources and levels of noise to verify the spatial scope. No close sensitive noise receptors are in the vicinity of the proposed Project site.
Soil and land-use	Project footprint and adjacent areas.
Socio-economic	Directly and indirectly affected communities were verified during baseline studies; indirectly affected communities include those along transport routes.
Safety risks to third parties	Site and nearest receptors

6.1 Regional Climate

The proposed Project is located in the Erongo Region on the west coast of Namibia. The climate in the project area is arid and falls into southern Africa's summer-rainfall region.

The area lies within the area receiving fog, which forms when moist air that has been cooled over the Benguela current is blown onshore (Pallett, 1995). Along the coast, the air remains humid throughout the year as a result of moist air feeding off the Atlantic. Even at 14h00 in winter, average humidity values drop only to 60% or 70%, while they are generally above 80% at other times (Mendelsohn *et al.*, 2002). Walvis Bay area receives, on average >125 fog days per year (Molloy & Reinikainen, 2003). Episodic dust storms associated with strong easterly winds occur during the autumn and winter months, giving rise to dust emissions from natural and anthropogenic sources under conditions of high wind speeds (Ministry of Mines and Energy, 2010).

As a weather station still needs to be installed on site, meteorological data from the Walvis Bay Airport for one-year period (year 2024) was utilised which includes wind speed (km/hr), wind direction (degrees), temperature (°C), humidity (%), barometric pressure (Pa) and rainfall (mm).

The section below relating to climate was compiled by Airshed and RISCOM (Air Quality Specialist Study and Quantitative Risk Assessment Study), see **Appendix F** and **Appendix G**) and references in this section can be found in the respective appendices.

6.1.1 Surface Wind Fields

The wind direction and the variability in wind direction, determines the general path that air pollutants will follow, and the extent of crosswind spreading. Wind roses comprise 16 spokes, which represent the directions from which winds blew during the period. The colours used in the wind roses below, reflect the different categories of wind speeds; the red area, for example, represents winds higher than 10 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred refers to periods during which the wind speed was below 1 m/s.

Period, daytime and night-time wind roses for the study area, based on meteorological data from the Walvis Bay Airport for one-year period: 2024 are depicted in **Figure 14**.

The predominant wind direction for the study area is from the south-southwest and west-southwest to west, and north-northeast, with little wind from the south to southeast. The strongest winds, although infrequent, are from the east. During the day, the wind field is dominated by westerly to northerly winds, with more frequent west-southwesterly and north-northeastly winds during the night. Calm conditions (i.e., wind speeds of less than 1 m/s) occurred for 6.24% of the period.

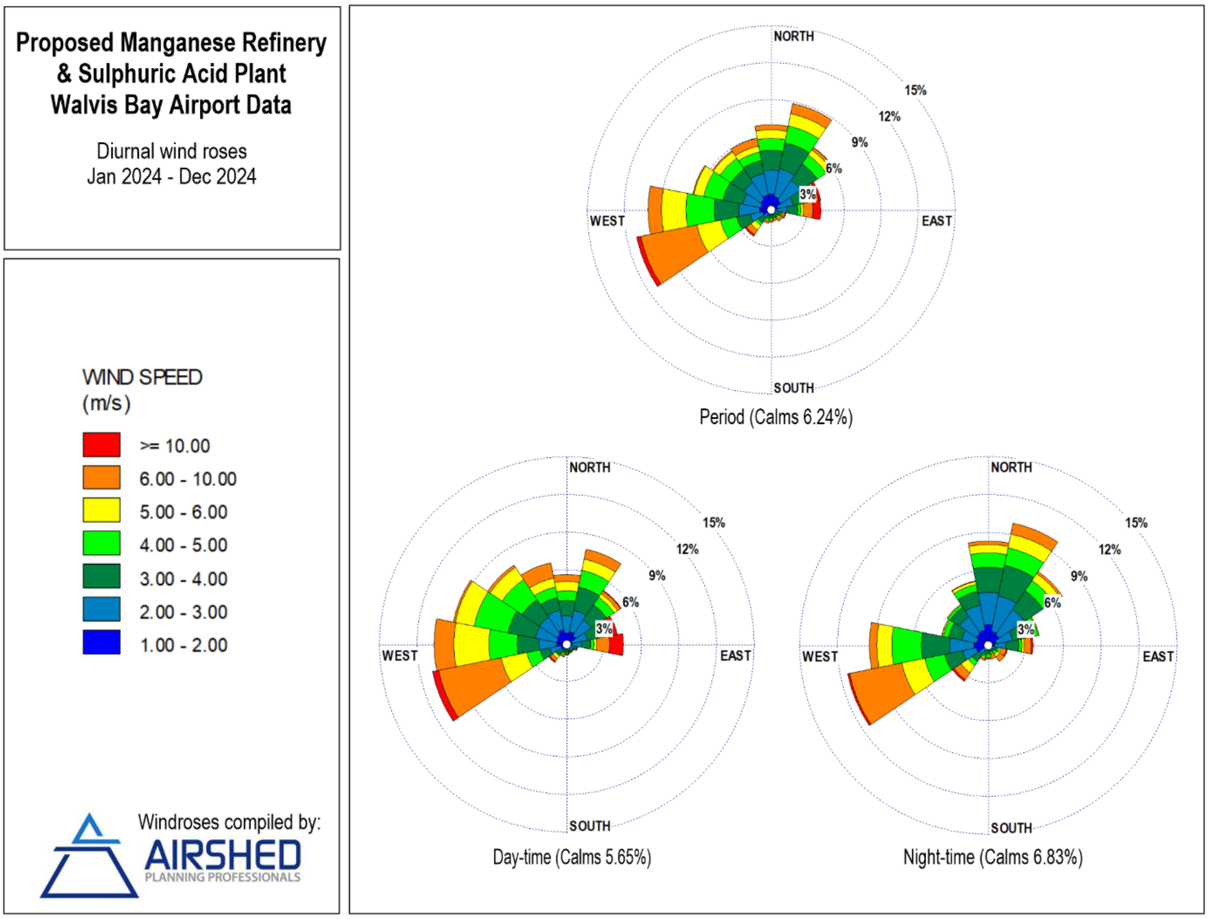


Figure 14: Period, day- and night-time wind roses (Walvis Bay Airport: January to December 2024).

Seasonal variability in the wind field is shown in **Figure 15**. Summer and spring have similar wind patterns with frequent winds from the north-north-east to west-southwest, where in springtime the west-southwesterly flow increases. During the autumn months, westerly and easterly winds increase, with the winter months being dominated by strong east winds with decreased flow from the other prevailing sectors. These strong easterly winds are referred to as “East Winds”[6], typically associated with high temperatures and speeds.

[6] These are typically characterized as wind speeds >10m/s, with wind direction between 45-135 degrees and humidity <20% for longer than 30-minutes, or temperatures >30°C, or both.

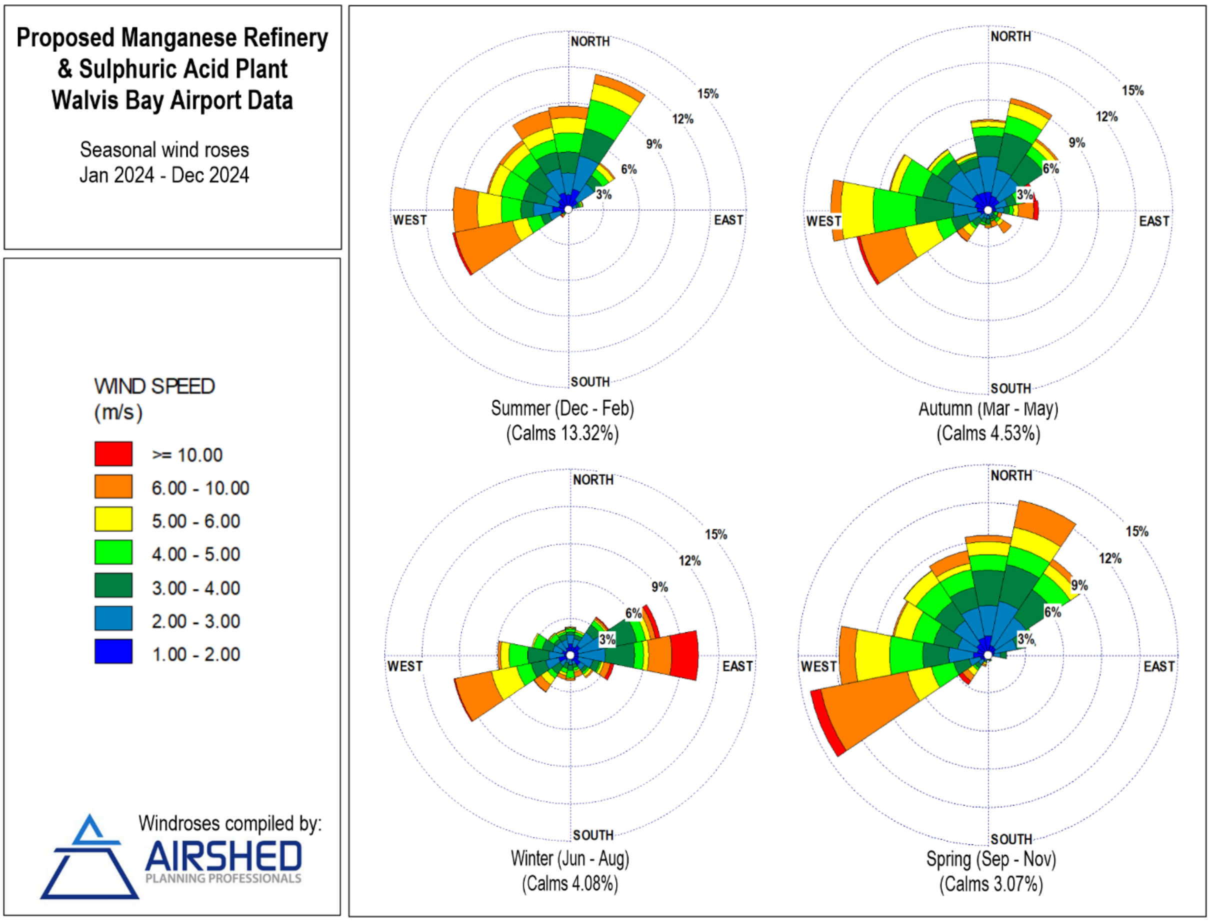


Figure 15: Seasonal wind roses (Walvis Bay Airport: January to December 2024).

According to the Beaufort wind force scale (https://www.metoffice.gov.uk/guide/weather/marine/beaufort-scale), wind speeds between 6-8 m/s equate to a moderate breeze, with wind speeds between 14-17 m/s near gale force winds. Based on the Walvis Bay Airport data for the period 2024, wind speeds fell mostly in the 2-4 m/s category (33.5%), with winds higher than 5 m/s occurring for 21.2% of the time (**Figure 15**). The maximum wind speed over the period was 16 m/s and the average wind speed was 3.6 m/s. Calm conditions (wind speeds <1 m/s) occurred for 6.2% of the time (**Figure 16**). The likelihood for wind erosion to occur from open and exposed surfaces, with loose fine material, was estimated when the wind speed exceeds 10 m/s (Liebenberg-Enslin, et al., 2019), whereas the estimated wind speed threshold for platinum tailings is 8 m/s (Liebenberg-Enslin, 2014). Wind speeds exceeding 8 m/s occurred for 4.3% over the period.

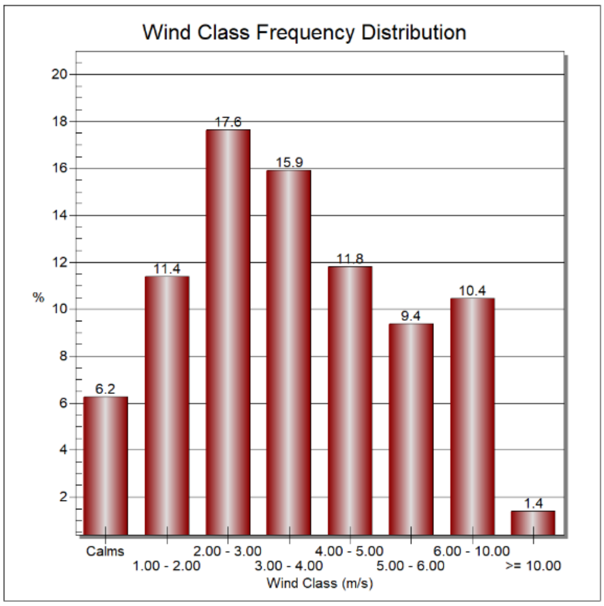
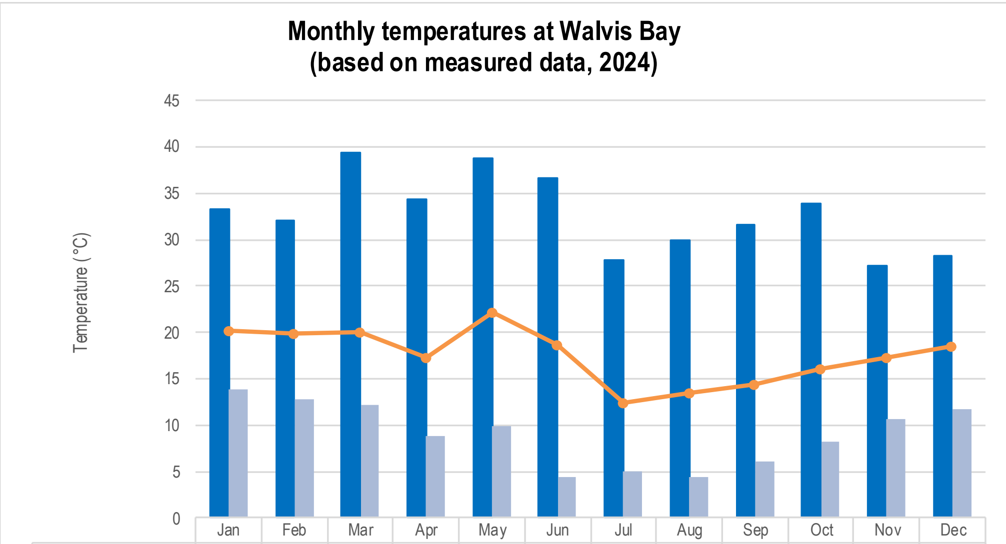


Figure 16: Wind speed categories (Walvis Bay Airport: January to December 2024).

6.1.2 Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the emission plume and the ambient air, the higher the plume can rise), and for determining the development of the mixing and inversion layers.

Monthly mean, maximum and minimum temperatures are given in **Figure 17**, and diurnal temperature variability is presented in **Figure 18**. Average monthly temperatures ranged between 13.4°C and 22.2°C, with the lowest temperature recorded in June (4.4°C) and the highest of 39.4°C in March. During the day, temperatures increase to reach a maximum at about 15:00 to 16:00 in the late afternoon. Ambient air temperature decreases to reach a minimum between 06:00 and 07:00.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max of Temp	33.3	32.2	39.4	34.4	38.9	36.7	27.8	30.0	31.7	33.9	27.2	28.3
Min of Temp	13.9	12.8	12.2	8.9	10.0	4.4	5.0	4.4	6.1	8.3	10.7	11.7
Average of Temp	20.2	20.0	20.1	17.3	22.2	18.6	12.5	13.4	14.4	16.0	17.3	18.4

Figure 17: Monthly temperatures summary (Walvis Bay Airport: January to December 2024).

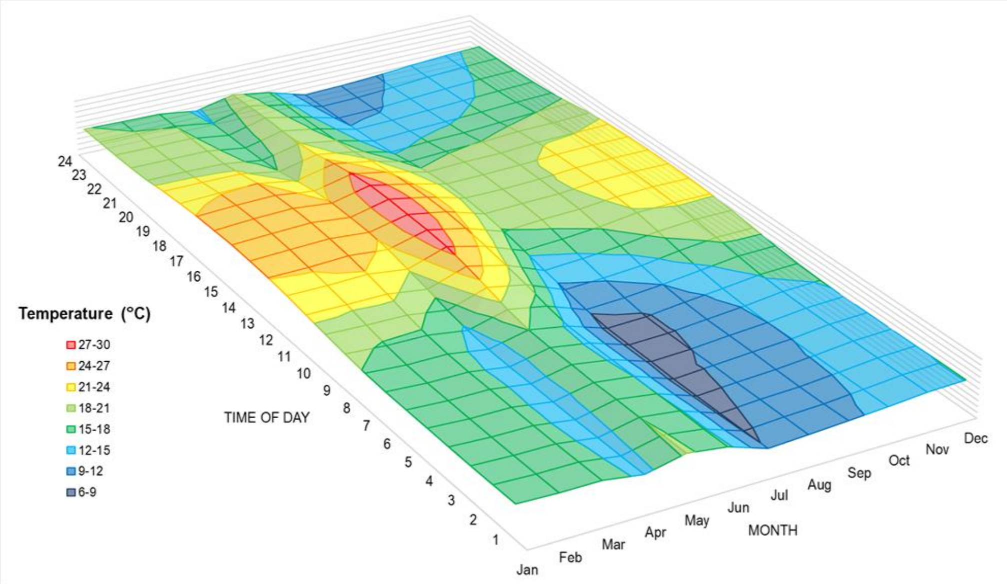


Figure 18: Diurnal temperature profile (Walvis Bay Airport: January to December 2024).

6.1.3 Atmospheric Stability

Atmospheric stability is frequently categorised into one of six stability classes. These are briefly described in **Table 45**. The atmospheric stability, in combination with the wind speed, is important in determining the extent of a pollutant from a release.

Table 45: Classification scheme for atmospheric stability.

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

Diurnal variation in atmospheric stability, as calculated from measured data, and described by the inverse Obukhov length and the boundary layer depth, is provided in **Figure 19**. The highest concentrations for ground level, or near-ground level releases from non-wind dependent sources would occur during weak wind speeds and stable (night-time) atmospheric conditions. For elevated releases, unstable conditions can result in very high concentrations of poorly diluted emissions close to the stack. This is called looping and occurs mostly during daytime hours. Neutral conditions disperse the plume equally in both the vertical and horizontal planes, and the plume shape is referred to as coning. Stable conditions prevent the plume from mixing vertically, although it can still spread horizontally and is called fanning (Tiwary & Colls, 2010). For ground level releases such as fugitive dust, the highest ground level concentrations will occur during stable night-time conditions.

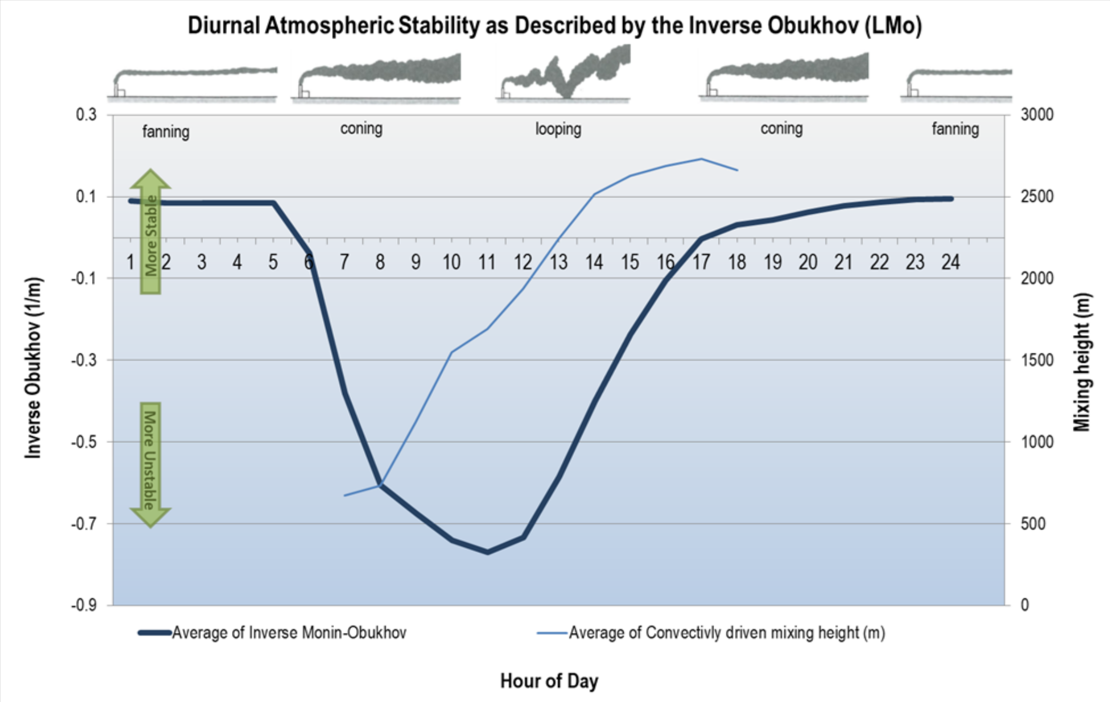


Figure 19: The diurnal atmospheric stability for the site (Walvis Bay Airport: January to December 2024).

6.1.4 Precipitation

The long-term rainfall and relative humidity recorded at the Walvis Bay International Airport was obtained from Climate Data for the period from 1991 to 2021, as given in **Table 46**.

Walvis Bay is considered to have a desert climate with very little rainfall. At Walvis Bay International Airport there is an average annual rainfall of 33 mm. A total of 28 mm has been received in March 2025 (pers. Comm., Antje Burke).

Table 46: Long-term rainfall and relative humidity at the Walvis Bay International Airport.

Month	Average Monthly Rainfall (mm)	Average Relative Humidity Monthly Average (%)
January	6	82
February	6	81
March	5	78
April	3	71
May	1	65
June	1	57
July	1	54
August	1	67
September	2	74
October	2	76
November	2	78
December	3	80
Year	**33**	**72**

6.1.5 Link to Impacts

As a whole, the various climate related aspects influence the potential for environmental impacts. Specific issues are listed below:

- Rainfall and (to a certain extent) fog influence erosion, evaporation, surface water flow, groundwater infiltration, vegetation growth, rehabilitation planning and dust suppression.
- Temperature influences air dispersion through impacts on atmospheric stability and mixing layers, vegetation growth and evaporation.
- Wind influences erosion, the dispersion of potential air pollutants and evaporation.

6.2 Topography, Soils, Hydrology, Stormwater Management, Hydrogeology and Water Resources

The sections below were compiled by the water specialist and the full report is attached in **Appendix H**. References stated in this section can be found in **Appendix H**.

6.2.1 Topography and Soils

The dominant landform in the central Namib Desert, where the GMRN Project is proposed, is a feature-less gravel plain with a network of shallow washes. The site lies at around 95 m above mean sea level east of the coastal dune belt, about 20 km from the Atlantic Ocean, and almost halfway between the Swakop River and the Kuiseb River. The plains slope gently from east to west.

Soils at the proposed project site are mostly shallow petric gypsisols and petric calcisols on the plains with arenosols in the washes (Atlas of Namibia Team, 2022). Soils play a critical role in providing habitat for plants, wildlife, insects and micro-organisms, as well as ecosystem services, such as water storage and carbon sequestration. As the soils do not retain water well and the nutrient and organic matter levels are generally low, vegetation cover, in general, is sparse. The terrain is composed of well-developed desert pavement, where wind and occasional runoff have washed away finer sediments over time, leaving behind gravel and rock fragments across the surface.

6.2.1.1 Link to Impacts

Project infrastructure may change the topography in terms of surface water drainage, visual aspects, and the safety of both people and animals. Furthermore, terrain features affect the way noise is propagated and air pollution is dispersed.

6.2.2 Hydrology

The project site lies between the Swakop River and Kuiseb River basins in the relatively small catchment area of the endorheic Tumas River (**Figure 20**). The dune belt has covered the mouth of this river, but seepages on the western side of the dunes indicate that groundwater still flows toward the sea.

South of the Tumas River are several small, shallow ephemeral drainage lines that cross Farm 58 from the east and terminate against the road in the west. The two largest are the wash on the northern border of the GMRN site, catchment C2 in **Figure 21** and C9 in the south-eastern corner of the site. All the other washes have very small catchment areas, as shown on the more detailed map in **Figure 22**.

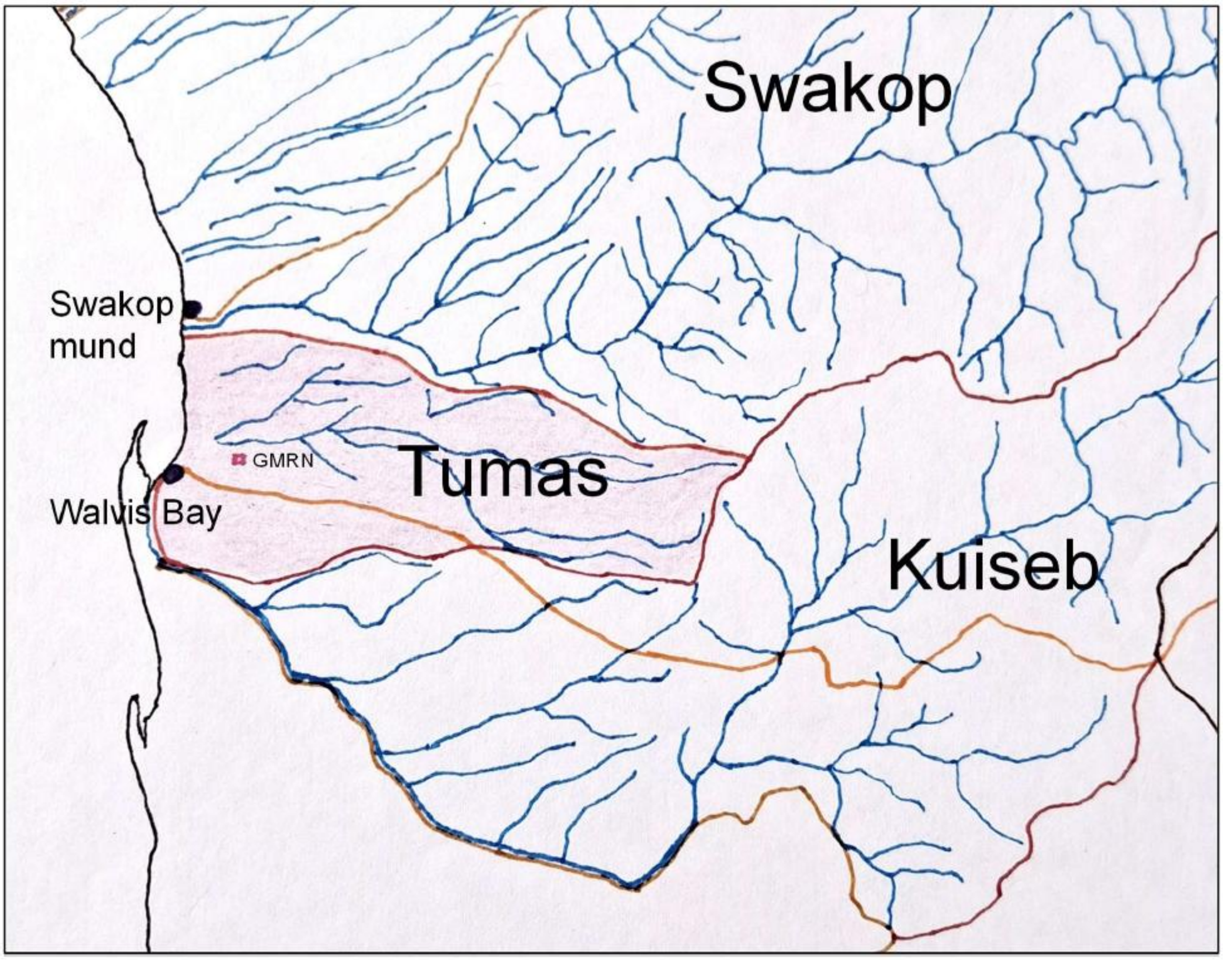


Figure 20: Regional catchment areas.

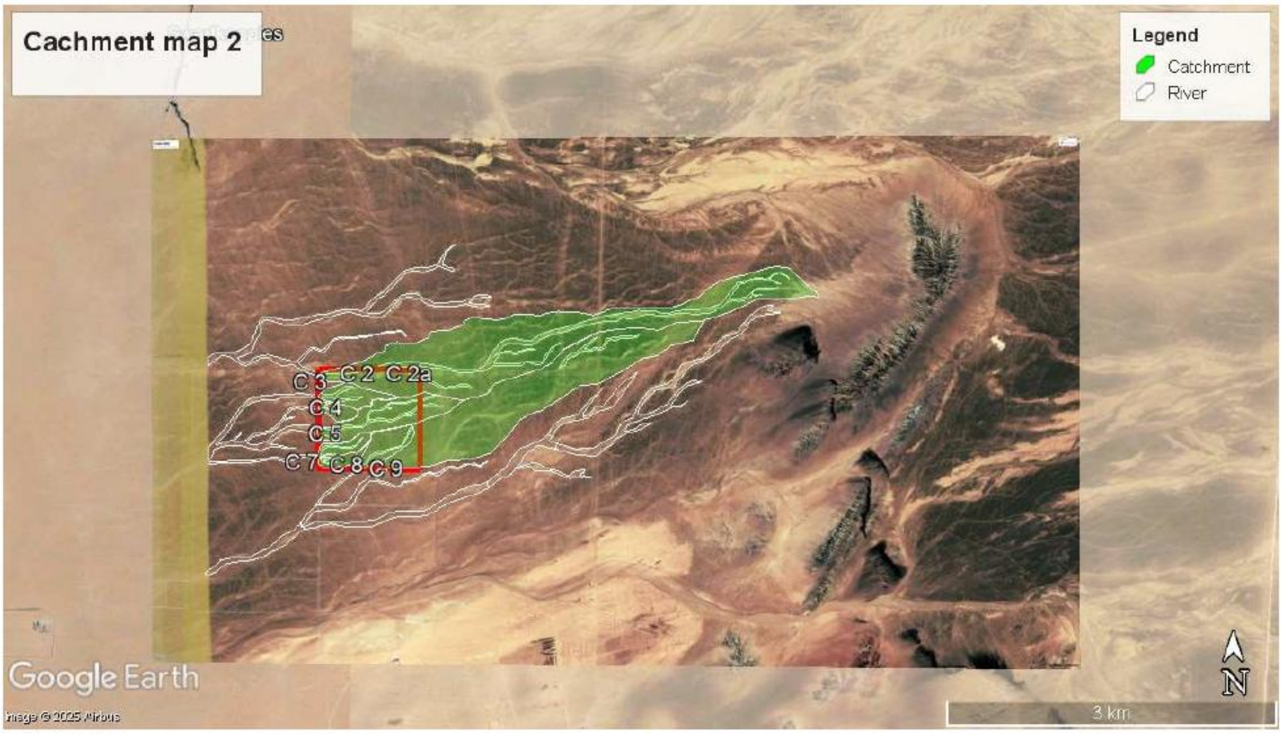


Figure 21: Catchment map of the project area.

Figure 22: Catchments and washes crossing the project area.

In the absence of well-defined stream beds on the flat gravel plains sheetwash will accumulate in the sandy depressions that readily soak up rainwater. The silty and sandy soils with gypsum crusts are less permeable and will produce more runoff.

The catchment areas are too small to carry out a meaningful maximum probable flood assessment, which produces more reliable results for areas over 100 km^2. **Table** 47**47** shows the calculated maximum runoff for rainfall events of 30 mm and 40 mm, provided that the ground is already wet (saturated) from previous rains so that no infiltration losses occur. If the ground is dry, most of the rain will be soaked up without producing much runoff and will evaporate later.

This has been observed after the rainfall event on 19 March 2025, when 28 mm were measured in Walvis Bay (pers. comm. A Burke).

Table 47: Catchment areas and estimated maximum runoff.

	Rainfall	30 mm	40 mm
Catchment	**Area m^2**	**Runoff m^3**	**Runoff m^3**
C2	1,560,000	46,800	62,400
C2a	90,000	2,700	3,600
C3	97,000	2,910	3,880
C4	40,000	1,200	1,600
C5	290,000	8,700	11,600
C6	61,000	1,830	2,440
C7	39,000	1,170	1,560
C8	110,000	3,300	4,400
C9	1,110,000	33,300	44,400

The maximum runoff along the northern border from catchments C2 and C2a would thus be 50,000 to 66,000 m^3, while 33,000-44,000 m^3 from catchment C9 could flow across the south-eastern corner of the site. Catchment C5 in the middle of the site could produce 8,700-11,600 m^3 of runoff; all the other volumes are probably too small to cause any flood damage.

Though infiltrating rain could form groundwater in fractured or weathered bedrock, it is more likely that most of it will evaporate from the wet ground. Empirical values for the western part of Namibia suggest that 10% of the average annual precipitation forms runoff and only 1% forms groundwater.

6.2.2.1 Link to Impacts

Surface water resources include rivers, drainage lines (washes), pans and dams. The proposed project activities and infrastructure could potentially alter the surface water drainage or result in the contamination of the surface water through seepage or hazardous material spills.

Ephemeral rivers and washes are normally dry but occasionally flow after heavy rainfall events. The calculation of flood runoff volumes is important for the design of flood control measures for the protection of key infrastructure. The recommended approach allows clean water to flow in the natural environment, while preventing any contaminated runoff from leaving the site.

6.2.3 Hydrogeology

The hydrogeological map of Namibia shows that the Tumas River has formed a wide, sediment-filled palaeochannel that contains saline groundwater north of the project site (Christelis, G & W Struckmeier, 2001) (**Figure** 23**23**). The brown hatching on the map indicates saline water, while the circles signify sand and gravel alluvium. Drilling at the Tumas uranium project to the east has shown that the channel can be more than 50 m deep, while the groundwater salinity varies from fresh to hypersaline (SLR, 2024).

A hydrocensus carried out for this study was based on the Ministry of Agriculture, Water and Land Reform's groundwater database (MAWLD, 2024), which did not show any existing boreholes in the project area or its immediate surroundings (**Figure 24**).

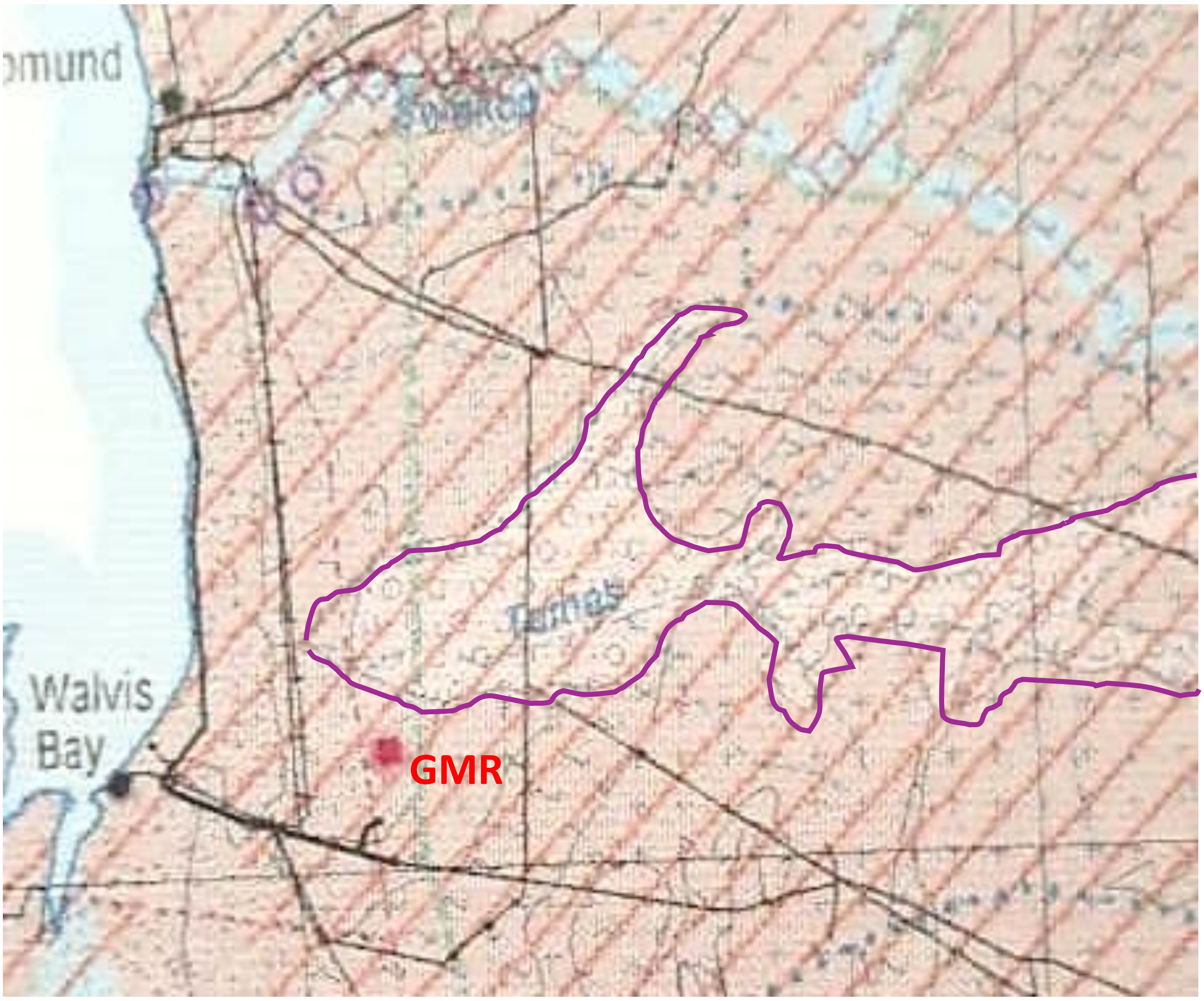


Figure 23: Hydrogeological map of the project area (the purple line indicates the Tumas River, that formed a wide, sediment-filled palaeochannel).

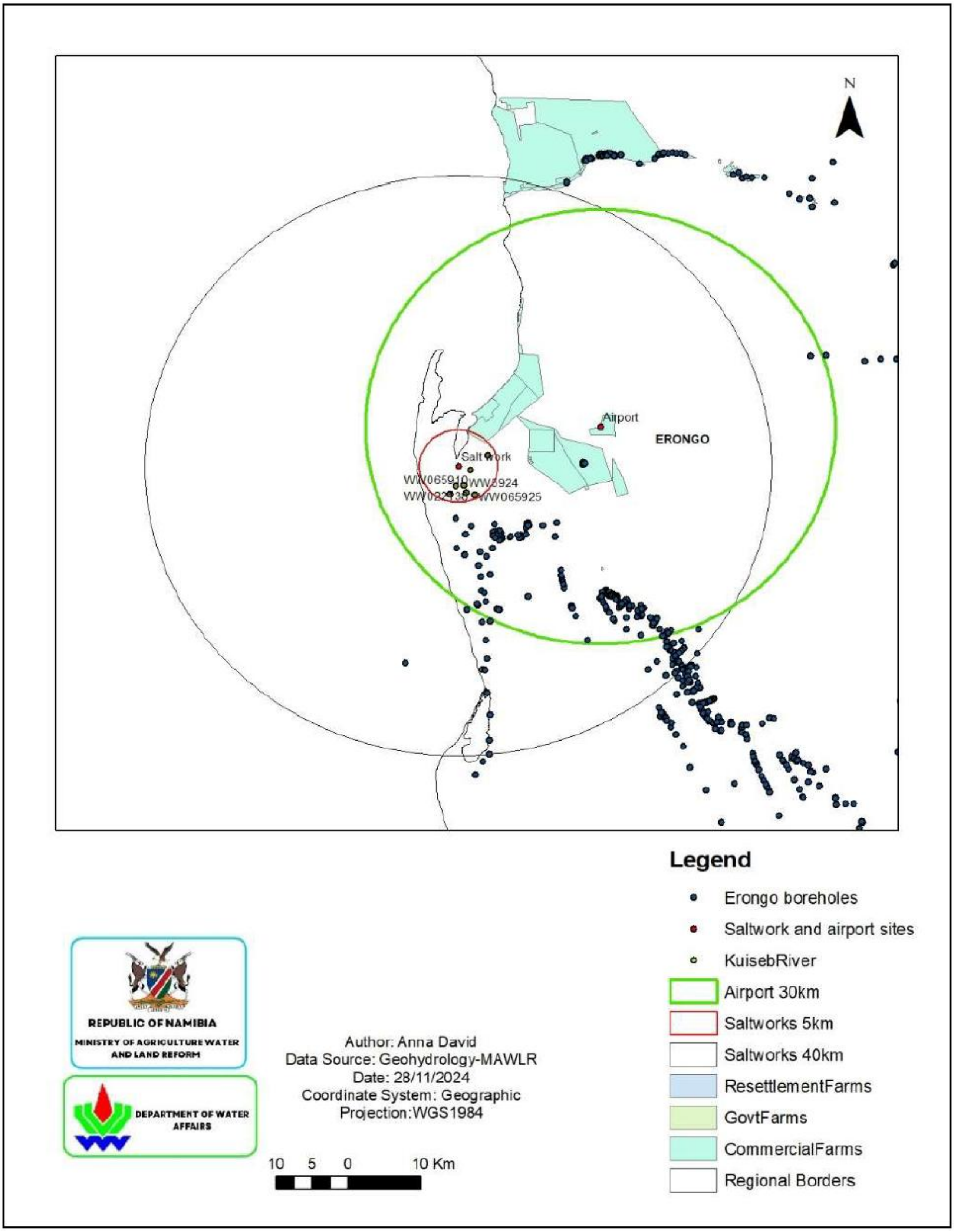


Figure 24: Boreholes within 30 km of the project site.

Most of the boreholes within a 30-km radius around Farm 58 are situated in the alluvial aquifers of the Kuiseb Delta, a completely different environment from the predominant bedrock on Farm 58. Three boreholes south-southwest of the airport were drilled in 2024 at a planned waste handling site for the company NamWaste (see red circle in **Figure 24**). Information from the MAWLR groundwater database in **Table 48** shows that they were all dry at 60 m depth. This could not be confirmed by new measurements because the borehole caps were locked.

Table 48: Data of the closest boreholes.

BH number	Longitude	Latitude	Date drilled	Depth	Water level	Yield
WW207356	14.6193	23.0240	11/07/2024	60 m	0	0
WW207357	14.6215	23.0233	12/07/2024	60 m	0	0
WW207348	14.6200	23.0224	08/07/2024	60 m	0	0

The drill chips laid out next to boreholes WW207356, WW207357 and WW207348 indicate that they were drilled in weathered and fresh granite. The granite exposed in nearby quarries is not very fractured and acts as an aquitard. During the site visit in March 2025, one quarry still contained water from recent rainfall, and one could see that it was previously filled to a level of about 2 m above the bottom.

No information could thus be found to confirm the presence or absence of groundwater in the project area or the depth to the water table. Damara granites and metasediments typically have extremely low permeability and storage capacity, while the arid climate severely limits groundwater recharge. According to the Hydrogeological Map of Namibia, groundwater in bedrock aquifers along the coast is expected to be saline with elevated levels of dissolved salts, predominantly chloride and sodium, which render it unsuitable for human consumption.

To summarise, if any groundwater should be present at the GMRN site, it will be of limited quantity and saline quality. There is a low risk that the project will pollute an aquifer that may be of beneficial use to people or the ecology. Unfortunately, this also means that no groundwater is available as an alternative, cheaper supply source to the refinery.

6.2.3.1 Link to Impacts

Groundwater is a valuable resource in a desert such as the Namib. Activities such as the handling and storage of hazardous materials could pollute potentially existing groundwater to the extent that it loses its value as an ecosystem driver.

6.2.4 Water Resources

The Namibian Water Corporation (NamWater) operates a water supply scheme in the Kuiseb River, consisting of wellfields at Swartbank, Rooibank and Dorob South (**Figure 25**), approximately 12 km south-west of the proposed Project area. The scheme mainly supplies Walvis Bay, Namport, Langstrand and the International Airport, but water can also be pumped to Swakopmund in a pipeline that runs parallel to the MR44 road and to a limited extent in the opposite direction from Swakopmund to Walvis Bay.

The Central Namib scheme's capacity of up to 12 million cubic metres per annum (Mm^3/a) is insufficient to meet the region's water demand and needs to be supplemented with desalinated seawater (ILF, 2020). As reported in various newspaper articles, NamWater in cooperation with Swakop Uranium, is planning to build a desalination plant at Wlotzkasbaken in the near future.

In the meantime, NamWater has been purchasing water from Orano Mining Namibia's Erongo Desalination Plant (EDP) north of Wlotzkasbaken since 2013 (**Figure 25**). The EDP was built in 2010 to supply the Trekkopje uranium mine, which is not yet in operation. The pipeline to Trekkopje has been connected to NamWater's pipeline from the Omdel wellfield near Henties Bay to Swakopmund. The condition of this pipeline dating from the mid-1970s somewhat constrains the present supply capacity but NamWater is steadily replacing the corroded sections.

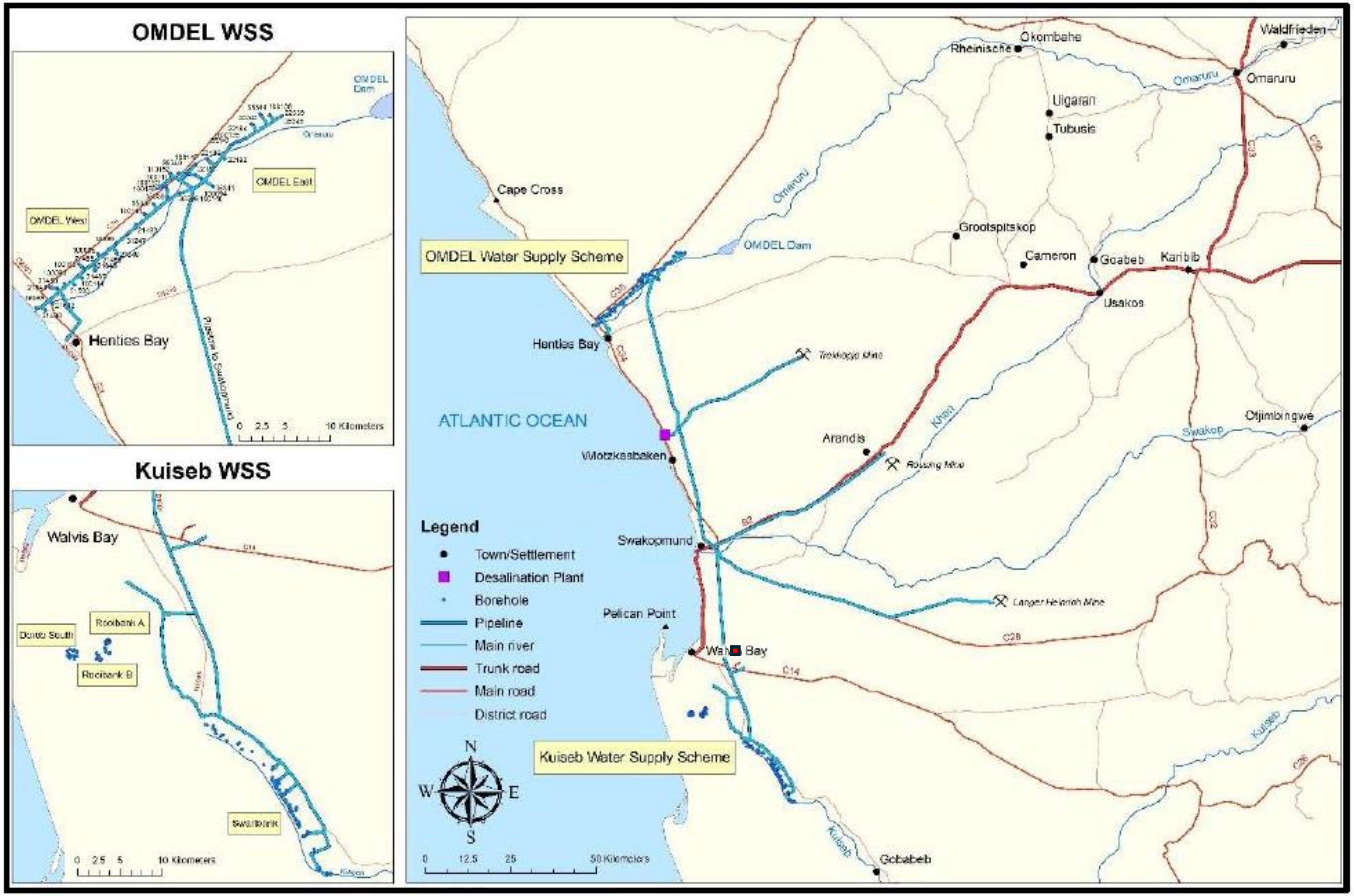


Figure 25: NamWater's Central Namib Water Supply Area (source: NamWater) (The red square shows the GMR site).

The even older pipeline between Swakopmund and Walvis Bay is in a similar condition and likewise being upgraded to allow a significant increase in the volume of desalinated water that can be pumped to Walvis Bay. The pipeline replacement projects, should be completed before 2027, the envisaged commissioning date of GMRN's refinery and acid plant.

It has been reported that the EDP had to shut down for periods of up to one week when the seawater contained excessive hydrogen sulphide and elemental sulphur during so-called sulphur eruptions to avoid fouling of the reverse osmosis membranes. The available groundwater supply is insufficient to make up the shortfall, so some uranium mines had to stop their production during these events. According to ILF (2020), the NamWater desalination plant will be designed with adequate storage reservoirs to reduce supply interruptions under such conditions.

The current desalinated water contribution of over 12 Mm^3/a is mixed with around 3-4 Mm^3/a of Omdel water in the pipeline. Compared to pure Omdel groundwater with a total dissolved solids (TDS) concentration of over 1000 milligrams per litre (mg/L), a high carbonate content and scaling properties, the mixed water has a more balanced calcium carbonate precipitation potential (CCPP) and improved water quality that meets the Namibian general standard for potable water, except for boron (**Table 49**).

The water quality data have been obtained from the following sources:

- Kuiseb River and Swakopmund mixed water analyses: Geological Survey of Namibia, 2018.
- EDP analysis: Orano Mining Namibia, unpublished data (average values for 2023), used with permission (pers. comm. T. Gouws, 2025).

The data show that the Kuiseb River groundwater supplied to Walvis Bay is slightly less saline with TDS concentrations around 790 mg/L, but it has a higher total alkalinity, containing more calcium and magnesium.

The only drawback of seawater desalination is the higher water tariff that has to be charged to cover the substantial capital investment and operating costs of a desalination plant. Industries at Walvis Bay currently pay around N$50-60 per m^3, depending on their monthly consumption (Government Gazette No. 8179, 2023), while the NamWater bulk tariff is a matter of negotiation with each consumer. The relatively high cost may be an incentive to consider other water supply sources, such as recycled grey water.

Whereas surface water is only found for a short time after rainfall or floods in the desert, but there are two potential sources of industrial (grey) water in the vicinity: treated sewage effluent from the Rooikop army base and the airport or from the municipal sewage plant on the eastern edge of the town. While the airport seems to be using septic tanks and french drains, resulting in potentially substandard effluent quality, the municipality's activated sludge plant should be able to comply with the limits required in the national standard.

Some semi-purified effluent is used to irrigate the town's parks and sports fields, but at least 1 Mm3/a of surplus water was discharged into evaporation ponds in the dunes in the 2000s (pers. comm. A Brümmer, former Manager of the Water & Waste department). The ILF (2020) report recommended that direct potable water reclamation be implemented at Walvis Bay within 5-15 years (2025-2035). If the GMRN project does not require potable water quality a small reverse osmosis plant could easily treat grey water to an acceptable standard at a much lower cost than seawater desalination.

Table 49: Indicative water quality analyses of desalinated seawater from the EDP, mixed water at Swakopmund and Kuiseb River water at Walvis Bay.

Parameter	Namibian general standard	EDP (2023)	Swakopmund mixed (2017)	Kuiseb (2017)
pH	6-9	8.4	8.0	8.1
EC (mS/m)	<300	85	126	117
TDS (mg/L)	<2000	524	845	786
Turbidity (NTU)	<0.5	0.5	0.6	1.1
Total alkalinity (mg/L)	-	29	82	250
Total hardness (mg/L)	<400	50	-	-
Calcium (mg/L)	<150	23	39	92
Magnesium (mg/L)	<70	7.3	18	39
Sodium (mg/L)	<300	140	180	108
Potassium (mg/L)	<25	4.8	8	16
Chloride (mg/L)	<300	226	299	135
Sulphate (mg/L)	<300	21	49	167
Nitrate as NO_3 (mg/L)	<11	0.5	1.3	4.7
Fluoride (mg/L)	<1.7	0.1	0.2	0.1
Boron (mg/L)	<0.5	0.9	-	-
Silica (mg/L)	-	0.7	8	31
Iron (mg/L)	<0.3	-	0.01	0.02
Manganese (mg/L)	<0.1	-	<0.01	<0.01
Free chlorine (mg/L)	0.1-1.5	0.1	-	-
CCPP (mg/L)	1-6	1.7	-	-

6.2.3.1 Link to Impacts

The Namibian Water Corporation (NamWater) abstracts groundwater from the Omaruru and Kuiseb rivers and buys desalinated seawater from the Erongo Desalination Plant (EDP) to supply the Central Namib area. The hydrogeological regime and the supply constraints need to be understood to be able to assess potential impacts of water abstraction on other water users in the coastal region.

Please note: The water supply and infrastructure will be assessed in a separate EIA.

6.3 Geology

The bedrock at Farm 58 is made up of Precambrian rocks of the 850-550 million years old Damara Orogen. A sequence of tectonic periods has transformed the original sediments into strongly deformed metamorphic rock types. During and after the formation of the Damara Orogen, granites intruded into the older metamorphic sediments along structural weakness zones. Weathering over millions of years and fluvial transport of the weathered materials levelled the former orogen into a gently dipping desert plains of the central Namib Desert. The surficial sediments of the Namib Group were formed during the Tertiary and Quaternary.

A prominent outcrop of red Salem granite forms the 'Rooikop' close to the Walvis Bay International Airport, just south-east of Farm 58, while high sand dunes of the Namib Sand Sea are piled up in the west, in the area of 'Dune 7'. The GMRN site itself is mostly covered with surficial sand deposits of variable thickness. The coarser sand and grit particles and the silty layer found below the desert pavement mostly result from weathering of the underlying bedrock and transport by sheetwash over short distances, while the finer sand fraction could be windblown sand. No bedrock outcrops were observed during a site visit.

6.3.1 Link to Impacts

The geology of the project area could affect the layout of infrastructure. It also determines the underlying aquifer regime and it has a significant influence on groundwater flow through features such as dykes, channels, faults and fractures.

6.4 Biodiversity

The following section was sourced from EnviroScience (2025), the report is attached in **Appendix I**. Literature review, selected searches on biodiversity databases and three site visits in April and May 2025 were undertaken for the biodiversity specialist study. References stated in this section can be found in **Appendix I**.

6.4.1 Broader Biodiversity Context

The project area is located on the gravel plains of the Central Namib Desert. The central Namib is characterised by low rainfall (annual mean approximately 10 mm, https://weatherandclimate.com), but regular fog can surpass rainfall in the coastal area (Eckardt et al. 2013). Temperatures are moderate (annual mean 17 – 23ºC, https://weatherandclimate.com), and conditions are generally windy in this coastal area (a detailed weather summary is presented in **Section 6.1**). The vegetation in the project area is very sparse shrubland, classified regionally as *Arthraerua leubnitziae – Salsola nollothensis* unit (Hachfeld & Jürgens 2000).

The project area is wedged between the dune belt and the Rooikop outcrops, and bordered by the Walvis Bay airport to the south (**Figure 26**). This area is by no means pristine, as it was used as a training ground for South Africa's military base at Rooikop before Namibia's independence in 1990. Although this is more than 30 years in the past, signs of these activities are still present in the form of graded roads and numerous tracks criss-crossing the area, many of which are still visible today. Some tracks have, however, partly recovered.

Nevertheless, the project area is surrounded by habitats of conservation importance such as the dune belt to the west, which harbours Namib endemic reptile and invertebrate fauna, and the plains and washes to the south draining into the Kuiseb River. These support lichens as well as Namib endemic flora and fauna (Walvis Bay Municipality 2008).

In this context, gravel plains in the broader study area support the recently described Bill's sand lizard *Pedioplanis branchi* (Childers et al. 2021), which could potentially occur in the project area and is a Namibian endemic. It is also worth noting that the central Namib harbours a number of endemic invertebrates such as spiders, sun spiders, scorpions and beetles (Irish 2007), many associated with gravel plain habitats.

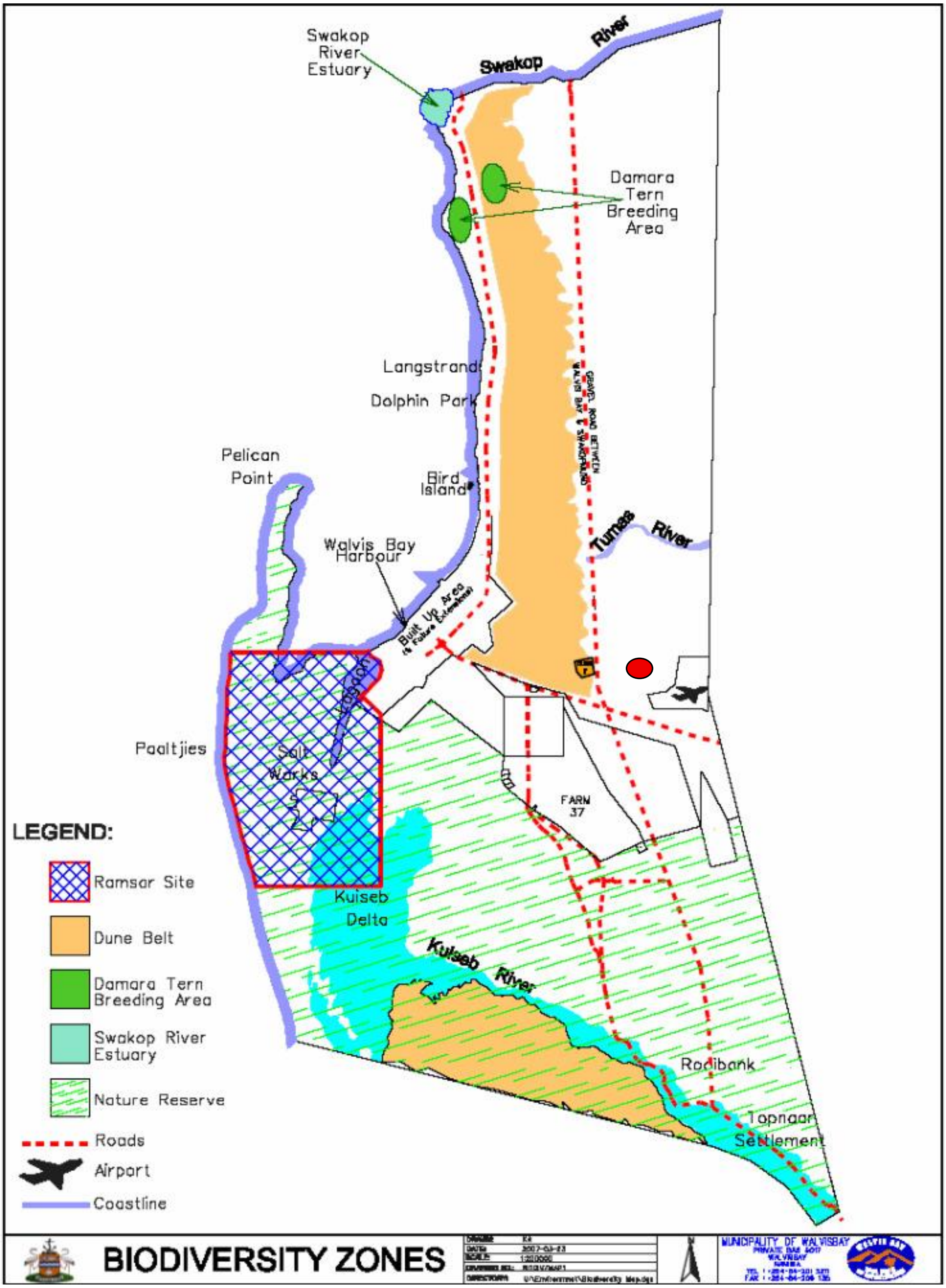


Figure 26: Approximate position of project area (red dot) in relation to biodiversity zones in the Walvis Bay municipal area (from Walvis Bay Municipality 2008).

6.4.2 *Findings of the Project Area*

The focus area (Project site) and broader area (vicinity of the Project site) covered by this survey are similar. The exception is that the southern portion of the broader area south of the dry river is very disturbed and was - and still is - used for sourcing building material by the City of Walvis Bay and various contractors (**Figure 27**). The portion north of the drainage line (dry river)has been disturbed by heavy vehicle traffic in the past, but partly recovered and also retained undisturbed patches between the track network (see **Figure 28**). The disturbances south of the dry river are not only more recent, but also more severe as the soil has been stripped to subsoil and bedrock level in most places, and has thereby removed all suitable substrate for natural recovery.

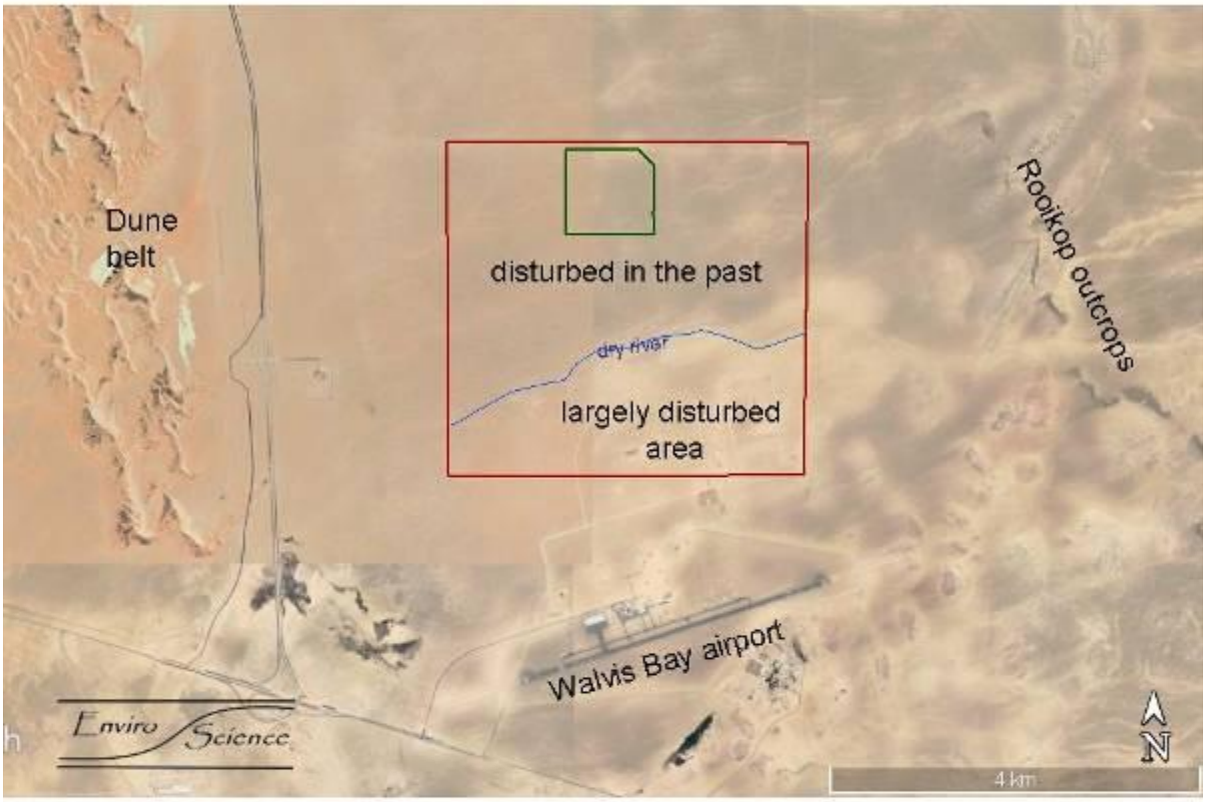


Figure 27: Broader area (red outline) and focus area (green outline) with current Google Earth backdrop.

Figure 28: The southern part of the broader project area has been severely disturbed by extraction of building and road material (foreground). This disturbance runs north, up to a dry river that separates the borrow-pit area from the remainder of the site (middle ground).

Therefore, the description below refers to the focus area and broader area north of the dry river.

6.4.3 Flora

The perennial flora (shrubs) is overall extremely sparse (< 0.1 % canopy cover) and consists of two species, the Namib endemic pencil bush, i.e. *Arthraerua leubnitziae* and the salt-tolerant shrub *Salsola nollothensis*. These are found in drainage lines, locally with a higher concentration of shrubs where they could reach 1% canopy cover. *Salsola nollothensis* is the dominant species and reaches up to 30 cm height. Sand accumulates around these shrubs.

Salsola (Caroxylon) nollothensis is neither rare nor endangered and forms large hummocks along the southern African west-coast from the northern Cape to Angola. There is some taxonomic debate around the inland species, which is considered a central Namib endemic (*S. swakopmundii*) (Botschanzev 1974) by some taxonomists, but this has not yet been confirmed by DNA studies. Whether the Salsola in the project area is the more widespread coastal *S. nollothensis* or the endemic *S. swakopmundii* could therefore not be established. However, this is not a reason to stop the project, but this controversy is mentioned to make the developer aware of such debates.

The pencil bush *Arthraerua leubnitziae* is restricted to the Namib fog belt, but occurs from the Kuiseb River to the northern Namib and into Angola. Although this is a Namib endemic plant it is often the dominant plant within its distribution range and is thus not rare.

Large amounts of seedlings of succulent herbs were observed throughout the project area. During the survey period four species emerged: *Aizoon galenioides. Mesembryanthemum hypertrophicum (*or *M. cryptanthum), Psilocaulon salicornioides* (or *Brownanthus kuntzei)* and *Zygophyllum simplex*. In seedling stage, *Psilocaulon salicornioides* and *Brownanthus kuntzei* cannot be distinguished and both possibilities are therefore mentioned. The two *Mesembryanthemum* species can only be distinguished with certainty when in flower, which was not the case. The small herb *Myxopappus hereroensis* emerged in drainage lines in May. The Namib endemic grass, *Stipagrostis namibensis,* could also be identified during the last site visit in May.

Aizoon galenioides and *Zygophyllum simplex* were abundant and grow on the plains and in washes, while *Myxopappus* sp. was only found occasionally in washes. *Stipagrostis namibensis* grows occasionally on plains and in washes where sand has accumulated and is very localised.

The majority of the plant species found on the project site are endemic to the Namib. *Aizoon galenioides* has an even more limited range and only grows in the central Namib desert.

Table 50 lists the plant species recorded during the field surveys, while **Figure 29** shows some of the plants encountered.

Table 50: Plant species recorded in the project area during April-May 2025 (in brackets recent name changes).

Plant species	Conservation status
Aizoon galenioides	central Namib endemic
Arthraerua leubnitziae	Namib endemic
Salsola (Caroxylon) nollothensis	no status
Mesembryanthemum hypertrophicum *and/or Mesembryanthemum cryptanthum*	both no status
Myxopappus hereroensis	Namib endemic
Psilocaulon salicornioides and/or *Brownanthus kuntzei*	no status Namib endemic
Myxopappus hereroensis	Namib endemic
Stipagrostis *namibensis*	Namib endemic
Zygophyllum simplex	no status

Figure 29: Perennial plant growth is restricted to the shallow drainage lines in the project area. Salsola nollothensis (left) is the dominant shrub, but the pencil bush Arthraerua leubnitziae also occurs (top right). Seedlings of succulent annuals emerged after the rains in March (bottom right).

6.4.4 Lichens

Lichens (a life form composed of two organisms: algae and fungi, living in mutual support of each other) attached to rocks, stones, soil surface and plants are present on the plains where these have not been disturbed by vehicle tracks. Although present throughout the project area, the lichens are widely scattered and patchily distributed, not forming a continuous cover as found in the Namib Desert lichen fields to the north. Yet, taken cumulative they contribute a sizable portion of the biomass to this desert ecosystem, serving as a food source for small animals and contributing to inserting nutrients into the ecosystem. **Figure 30** shows some of the lichens encountered.

Figure 30: The seemingly barren desert plains are patchily covered in lichens (top left), often associated with gypsum (top right). Also, large foliose lichens grow on stones (bottom).

6.4.5 *Fauna*

The one-day site visit does not provide a comprehensive or representative account of available wildlife, but observations are nevertheless mentioned here. A lark species, 2 black-backed jackals, a dead snake and several darkling beetles of the species *Cauricara eburnea* were observed 1 April 2025 (**Figure 31**). Signs of animal activity were several invertebrate burrows and spider nests among plants. This indicates that the project area is not devoid of fauna.

The darkling beetle *Cauricara eburnea* is endemic to the central Namib but occurs widely on the Namib's quartz gravel plains, often where these are associated with lichens. Once the seedlings of the annuals have developed further, particularly if these make it to flowering, a lot more invertebrate activity is expected. This, in turn, will attract small mammals, reptiles and birds.

The project area is sufficiently far removed from the coast and there is no open water nearby to attract coastal and wetland birds. Birds expected in this area therefore are those typical of the Namib plains, such as larks, chats and crows with occasional raptors passing over. However, the Namib endemic Gray's Lark, *Ammomanopsis grayi,* could be present and possibly nesting on these plains.

During the site investigation no animal spoors or faeces were observed. This could be due to the relatively recent rains which washed away traces of wildlife activity. Most drainage lines show signs of water having flowed which supports this observation. Often frequented paths of animals (wildlife corridors) would still be visible after the rains though. Their absence indicates that this area is not utilised frequently by large mammals. The area is close to human activities and has also been dry for many years. Animals expected to occur in this area are not limited to the site under scrutiny.

Figure 31: A darkling beetle was active during the field survey (top left), while no other small animals were encountered alive. Spider nests in plants, (top right), invertebrate burrows (bottom left) and a dead snake (possibly dwarf beaked snake *Dipsina multimaculata*) (bottom right) are testimony that these desert gravel plains are inhabited by wildlife.

6.1.6 Link to Impacts

This rapid biodiversity survey has not generated any plant or animal species that would ve classified as a fatal flaw in terms of the proposed development.

However, even if disturbed in the past and seemingly barren during dry periods, the project area supports noticeable amounts of lichens, although not forming dense ‘lichen fields’. The rapid field surveys indicated that these gravel and gypsum plains are not devoid of wildlife either.

Three points are important to highlight from the field surveys:

1. Adequate rains made it possible to obtain a comprehensive account of the flora on the study site, even if some of the annual succulents could not be identified during the study period. The fact that the project time frame accommodated repeated field surveys during a good season was essential to obtain a reliable flora inventory.
2. The majority of the plant species found on the project site are endemic to the Namib; one species is even only found in the central Namib Desert.
3. The high level of endemism found among plants is likely mirrored in smaller fauna, such as invertebrates, reptiles and possibly small mammals.

Although neither plant nor animal species is restricted only to this site, the site and broader landscape represent an intricate, fragile desert ecosystem with linkages between the different components and these are easily disturbed if one of the components is disturbed or removed. Careful environmental management is therefore required to avoid and minimise impacts on this fragile desert ecosystem.

Erecting structures that are presently not available in the project area, such as buildings will alter the topography and thereby habitats and ecological processes. Water flow and sand movement will be locally altered. Further, structures that are presently not available in the area could provide water sources (clarification pond) and perching and nesting sites, which may attract animals that are presently not frequenting the area, e.g. raptors and owls. In addition, scavenging animals are often attracted to sites where domestic waste is generated. These predators and scavengers could impact on the reptile, small mammal and bird fauna. These are some of the complexities in a desert ecosystem that have to be considered during the planning of this project.

6.5 Air Quality

The main objective of the air quality investigation is to quantify the potential impacts resulting from the project construction and operational activities on the surrounding environment and human health. As part of the air quality assessment, a good understanding of the regional climate and local dispersion potential of the site is necessary and subsequently an understanding of existing sources of air pollution in the region. This section was compiled by Airshed Planning Professionals and the report is attached in **Appendix F**. References stated in this section can be found in **Appendix F**.

6.5.1 Existing Sources of Atmospheric Emissions in the Area

Sources identified as possibly impacting on air quality in the region include, but are not limited to:

- Fugitive emissions from mining operations.
- Vehicle tailpipe emissions from national and main roads.
- Various miscellaneous fugitive dust sources (wind erosion of open areas, vehicle-entrainment of dust along paved and unpaved roads).

6.5.1.1 Vehicle Tailpipe Emissions

Air pollution from vehicle emissions may be grouped into primary and secondary pollutants. Primary pollutants are those emitted directly into the atmosphere, and secondary pollutions are those formed in the atmosphere as a result of chemical reactions, such as hydrolysis, oxidation, or photochemical reactions. The significant primary pollutants emitted by vehicles include carbon dioxide (CO_2), CO, hydrocarbons (HCs), SO_2, oxides of nitrogen (NO_x), particulates and lead. Secondary pollutants include NO_2, photochemical oxidants (e.g., ozone), HCs, sulphur acid, sulphates, nitric acid, and nitrate aerosols. Toxic hydrocarbons emitted include benzene, 1.2-butadiene, aldehydes and polycyclic aromatic hydrocarbons (PAH). Benzene represents an aromatic HC present in petrol, with 85% to 90% of benzene emissions emanating from the exhaust and the remainder from evaporative losses. Vehicle tailpipe emissions are localised sources and unlikely to impact far-field.

The newly upgraded D1984 (now T0202), which is the main carriage way for heavy duty vehicles to the Walvis Bay Harbour, is located 4 km to the west with the C14 (now T0201) 6 km to the south.

6.5.1.2 Mining Operations in the Region

Fugitive dust sources associated with mining activities include drilling and blasting operations, materials handling activities, vehicle-entrainment by haul vehicles and wind-blown dust from stockpiles. Mining operations represent potentially the most significant sources of fugitive dust emissions ($PM_{2.5}$, PM_{10} and TSP) with lesser amounts of NO_x, CO, SO_2, methane, and CO_2 being released during blasting operations and from mining trucks.

Experience has shown that fugitive dust emissions due to on-site operations are typically only of concern within 3 km of the mine boundary, depending on the location of the mine boundary and extent of the mining operations. Dust suppression methods that are most frequently used in local mining operations include wet suppression and chemical stabilisation of haul roads and storage piles, and the vegetation or rock cladding of tailings impoundments.

There are no mining activities in the immediate vicinity of the project, but mining activities are located further (more than 20 km) to the north-northeast and northeast of the site, with quarry operations approximately 9 km to the south-southeast. The Walvis Bay Salt Works is located ~ 25 km south-west of the site.

6.5.1.3 Airport emissions

Air pollution from airports results from aircraft emissions during landing, take off, taxi and idling, auxiliary power units, ground support equipment (such as baggage and people movers, aircraft tows, refuelling and catering vehicles), and land side passenger vehicles. Further emissions, of less overall significance, may include paint and solvent usage, fuel storage tanks, refuelling operations, engine testing, electroplating facilities, fire training and emergency services.

The most significant pollutants associated with combustion emissions include CO, CO_2, Total hydrocarbon compounds, (of which formaldehyde, benzene, 1,3-butadiene are perhaps the most important based on toxicity and quantity), SO_2, NOx, and PM.

Walvis Bay International Airport is approximately 4 km south of the Project site. Flights are however limited to a few aircrafts per day.

6.5.1.4 Fugitive Dust Sources

Fugitive dust emissions may occur as a result of vehicle-entrained dust from local paved and unpaved roads, and wind erosion from open areas. The extent of particulate emissions from the main roads will depend on the number of vehicles using the roads and the silt loading on the roadways. The extent, nature and duration of agricultural activities and the moisture and silt content of soils are required to be known to quantify fugitive emissions from this source. The quantity of wind-blown dust is similarly a function of the wind speed, the extent of exposed areas and the moisture and silt content of such areas.

6.5.2 Ambient Air Quality within the Region

As part of the baseline assessment, an ambient air quality sampling campaign (i.e. Passive gaseous sampling and **Particulate Sampling)** was conducted to run over a period of one month (two 14-day campaigns) at four sites (i.e. GMR01, GMR02, GMR03 and GMR04) to take PM_{10} and $PM_{2.5}$ samples, as well as SOx, NOx and VOCs (see **Table 51** and **Figure 32**).

Table 51: Sampled pollutants and methods.

Pollutants	Sampling Method
Particulates	UNC passive sampler developed by Wagner and Leith
SO_2, NOx and VOCs	Radiello passive diffusive samplers

6.5.2.1 Sampling Locations

The sampling campaign was initiated on 25 February 2025. The sampling periods for the two campaigns areas are provided in **Table 52** with the sampling locations provided in **Table 53** and **Figure 32**.

Table 52: Sampling campaign durations.

Campaigns	Pollutants measured	Locations	Installation date	Removal date
#1	SO_2, NOx and Particulates	4	25 Feb 2025	11 Mar 2025
#2	SO_2, NOx and Particulates	4	11 Mar 2025	25 Mar 2025

Table 53: Sampling campaign locations.

Location	X-Coordinate	Y-Coordinate
GMR01	-22.936280°	14.631293°
GMR02	-22.934730°	14.648930°
GMR03	-22.937356°	14.646082°
GMR04	-22.946930°	14.646770°

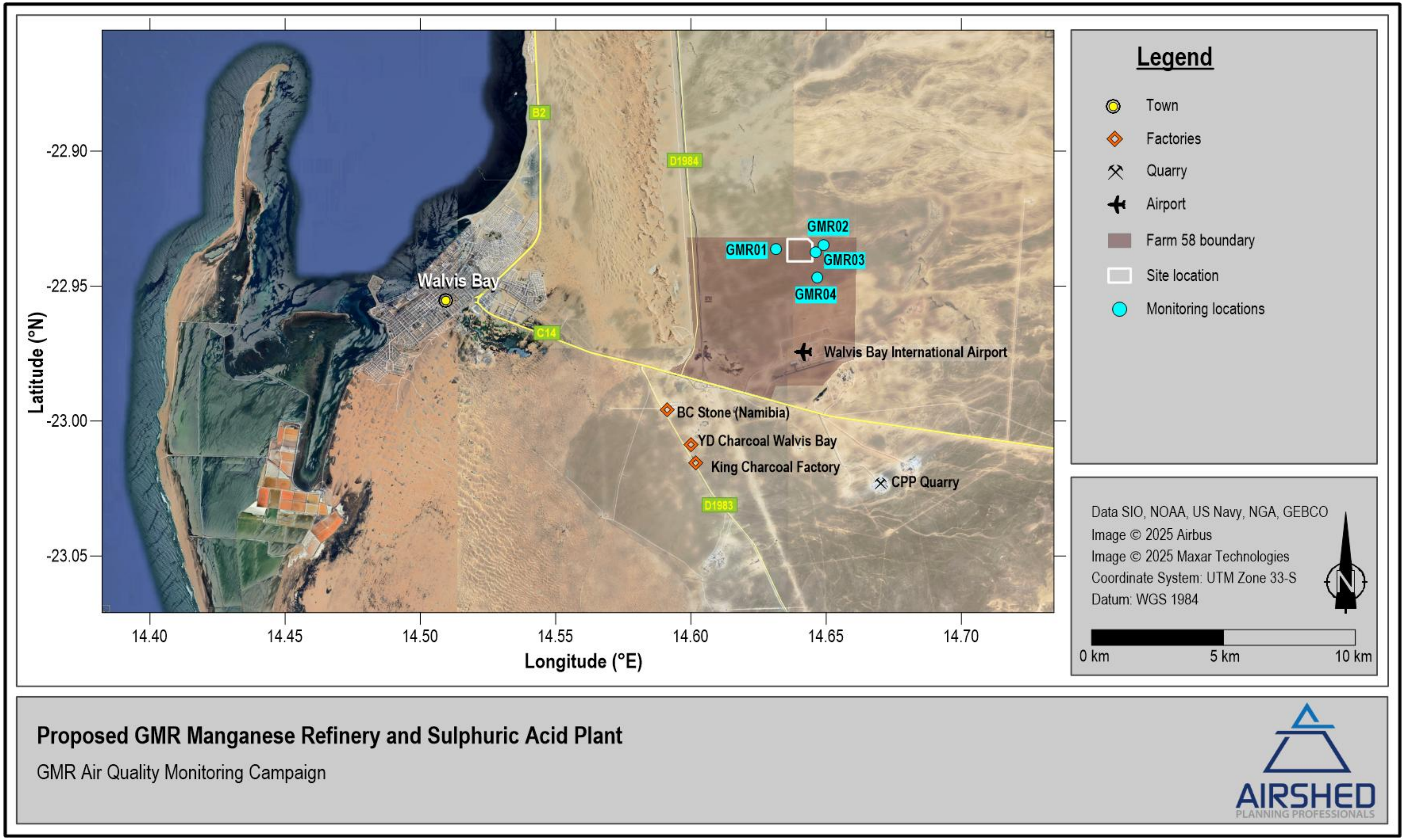


Figure 32: GMR Air quality sampling campaign locations.

6.5.2.2 Sampling Results

Sampling results for SO_2 and NO_2 are provided in **Table 54**. NO_2 and SO_2 concentrations are sampled onto passive samplers and are reported as a concentration per volume (µg/m³). The adopted annual average screening limits for NO_2 and SO_2 are 40 µg/m³ and 50 µg/m³ respectively. There are no limits available for the 14-day periods for which sampling was conducted, and these were compared to the annual limit as a conservative approach.

The sampled concentrations were very low, with most of the SO_2 below the detection limit. The maximum sampled NO_2 concentration of 5.55 µg/m³ is 14% of the annual AQO, where the maximum SO_2 concentration is 2% of the AQO. Due to the low concentrations over the two 14-day campaigns there is no need to extrapolate these to annual averages, which will be even lower.

Table 54: SO_2 and NO_2 sampling results.

	Sampling Campaign #1		**Sampling Campaign #2**	
Pollutant	NO_2	SO_2	NO_2	SO_2
AQO	NO_2 40 µg/m³	SO_2 50 µg/m³	NO_2 40 µg/m³	SO_2 50 µg/m³
GMR01	1.51	0.10	0.23	0.10
GMR02	0.35	0.10	2.03	0.10
GMR03	1.45	0.10	3.91	0.64
GMR04	5.55	0.86	0.23	0.10

6.5.2.3 Particulate Matter concentrations

This section presents the calculated results after image analysis was conducted for each PM sampler. The procedure to calculate PM concentrations from the imaged and analysed particles is outlined in Appendix A of the Air Quality Assessment Report **Appendix F**.

Table 55 outlines the measured concentrations at the 4 sampling locations over the two sampling campaigns. Since both results were measured over a 14-day period, they cannot be screened against the daily average AQOs to determine conformity. Since some days may have more suspended particulates than others, extrapolating to a daily average would likely distort the results. However, the measured concentrations give an estimate indication of what the ambient concentrations may be around the area, over a two-week period. The Beychok method[7] (Beychok, 2005) was used to extrapolate to annual averages to provide an indication of the significance of the concentrations.

$PM_{2.5}$ levels were highest at GMR01 (39.4 µg/m³) and GMR02 (33.7 µg/m³) during the first sampling campaign, with slightly lower concentrations at GMR03 and GMR04. The $PM_{2.5}$ concentrations were lower in the second campaign at three sites (12.6 µg/m³ at GMR01, 26.3 µg/m³ at GMR02 and 18.8 µg/m³ at GMR03) and similar at GMR04 at 32.2 µg/m³. PM_{10} concentrations were highest at GMR04 (58.7 µg/m³) and GMR02 (47.6 µg/m³) during the first campaign, and slightly higher in the second campaign (84.2 µg/m³ at GMR04 and 67.2 µg/m³ at GMR02). Concentrations at GMR03 also increased in the second campaign, but decreased at GMR01.

Concentrations at all sites were below the annual AQOs, with a maximum of 7 µg/m³ for $PM_{2.5}$ (15 µg/m³), and 15 µg/m³ for PM_{10} (40 µg/m³).

[7] It should be noted that this method is intended for dispersion modelling results and not ambient measurements. The intention of applying to the measured data is merely to get an indication of an annual average.

Table 55: measured concentrations at the 4 sampling locations.

Site ID	First Sampling Campaign (25/02/2025 – 11/03/2025)				Second Sampling Campaign (11/03/2025–25/03/2025)			
	Sampled Period Concentration (µg/m³)		Calculated Annual Average Concentration (µg/m³)		Sampled Period Concentration (µg/m³)		Calculated Annual Average Concentration (µg/m³)	
	$PM_{2.5}$	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**
AQO	-	-	**15 µg/m³**	**40 µg/m³**	-	-	**15 µg/m³**	**40 µg/m³**
GMR01	39.4	34.6	7.0	6.1	12.6	22.3	2.2	4.0
GMR02	33.7	47.6	6.0	8.5	26.3	67.2	4.7	11.9
GMR03	21.5	26.7	3.8	4.7	18.8	46.0	3.3	8.2
GMR04	30.2	58.7	5.4	10.4	32.2	84.3	5.7	15.0

6.5.3 Link to Impacts

The potential impacts relating to air emissions are health and nuisance to third parties. There are no permanent residential areas in close proximity to the project area (see **Section 6.11**). There are, however, a number of other receptors in relatively close proximity to the site which could also be impacted by emissions to air from the proposed project (see **Section 6.11.1**) for the closest receptors).

Also, a number of other existing sources of atmospheric emissions in the area (i.e. region) exist, and the cumulative effects are considered in the air quality assessment.

6.6 Physical Risks of Climate Change on the Region

The Climate Change Assessment Report is attached in **Appendix J**. References stated in this section can be found in **Appendix J**.

The CMIP5 (Coupled Model Inter-Comparison Project) is the main data source for the World Bank Group's Climate Change Knowledge Portal (CCKP), which builds the database for the global climate change projections presented in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC).

The total radiative forcing (cumulative measure of GHG emissions from all sources) pathway by 2100 was used to define four Representative Concentration Pathways (i.e. RCP2.6, RCP4.5, RCP6.0, and RCP8.5), where RCP2.6 represents a very strong mitigation scenario and RCP8.5 assumes business-as-usual scenario.

Namibia has an arid climate and is dependent on rain for agriculture, which makes it highly vulnerable to climate change impacts. Threats from drought, desertification, and land degradation are exacerbated by erratic rainfall and rising temperatures. This in addition to environmental degradation and social factors like poverty threatens the livelihood of the people.

6.6.1 Temperature and Rainfall trends

Based on the median, the annual average near surface temperatures for Namibia (2 m above ground) are expected to increase by between 1.5°C to 2.9°C for the near future (2040-2059) and between 3.3°C and 6.0°C for the far future (2080-2099). The total annual rainfall change is likely to increase by between -125 and 50 mm for the near future (2040-2059), while it is more uncertain for the far future (2080-2099) with potential decrease up to -200 mm. These trends are shown in **Figure 33** (World Bank Group, 2021). At the GMR site the temperature is likely to increase by 2°C (2040-2059) and by 3.75°C (2080-2099), with rainfall projected to decrease up to -25 mm (2040-2059) and up to -50 mm (2080-2099).

Temperature will increase progressively in Namibia throughout the end of the century and will increase across the whole country, but mostly at the inland regions. The greatest temperature increases will likely be during the spring months of September to November, with the smallest changes expected during the summer (December to February) and autumn months (March to May). Heat waves are projected to last between 6 to 29 days longer by 2080, and the number of cold days will reduce significantly.

Rainfall trends in Namibia are highly variable, and the total precipitation rates are projected to reduce by 19% by the 2080s. The dry season (April to October) will be the most affected with likely reductions from 5% to as much as 65%. Between November and March, the typical wet season, a small increase in precipitation is expected, with the greatest reduction for the interior of the country between December and February (World Bank Group, 2021).

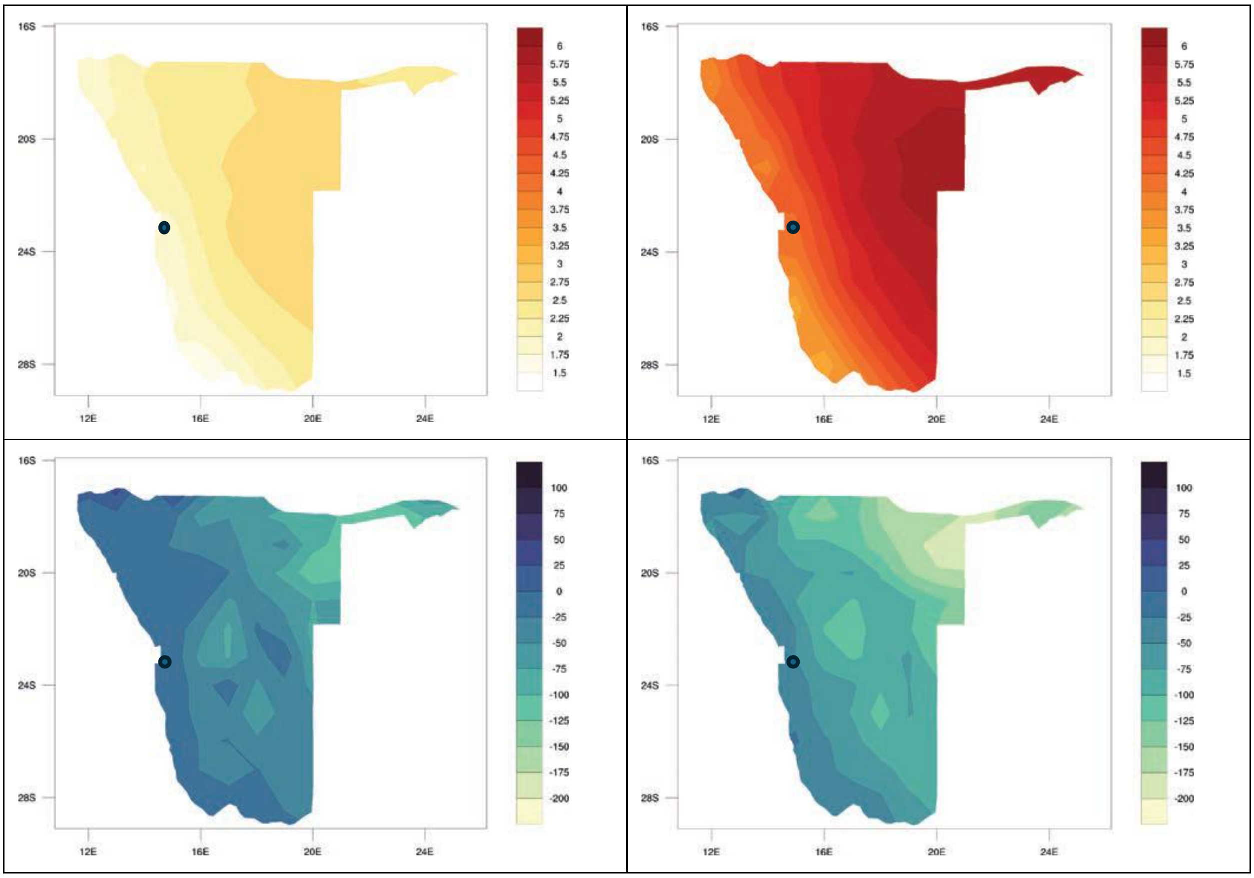


Figure 33: Multi-Model (CMIP5) Ensemble Projected Changes (32 GCMs) in Annual Temperature (top) and Precipitation (bottom) by 2040–2059 (left) and by 2080–2099 (right), Relative to 1986–2005 Baseline under RCP8.5. (Circle GMR site)

6.6.2 Water Stress and Extreme Events

Namibia is highly vulnerable to natural disasters such as droughts, flooding, water scarcity, extreme heat, and wildfires, with flooding the most regularly occurring hazard and climate change trends are expected to increase these risks in Namibia. Communities are most at risk from floods, drought, and disease outbreaks with drought regarded as the most devastating hazard for Namibia. This also increases the risk for weather-related disease outbreaks.

Wildfires have significant environmental and economic impacts due to its destruction of biodiversity, forests, and pasture lands. Lower rainfall will result in increased aridity, and the combination with increased temperatures are expected to significantly increase these risks.

Figure 34 show risks for Namibia for river and urban flooding, water scarcity and wildfires (World Bank Group, 2021). At the GMR site, the risk of River Floods is Medium, and High for Urban Floods, whereas the risk of Water Scarcity is High and the risk of Wildfires is also High.

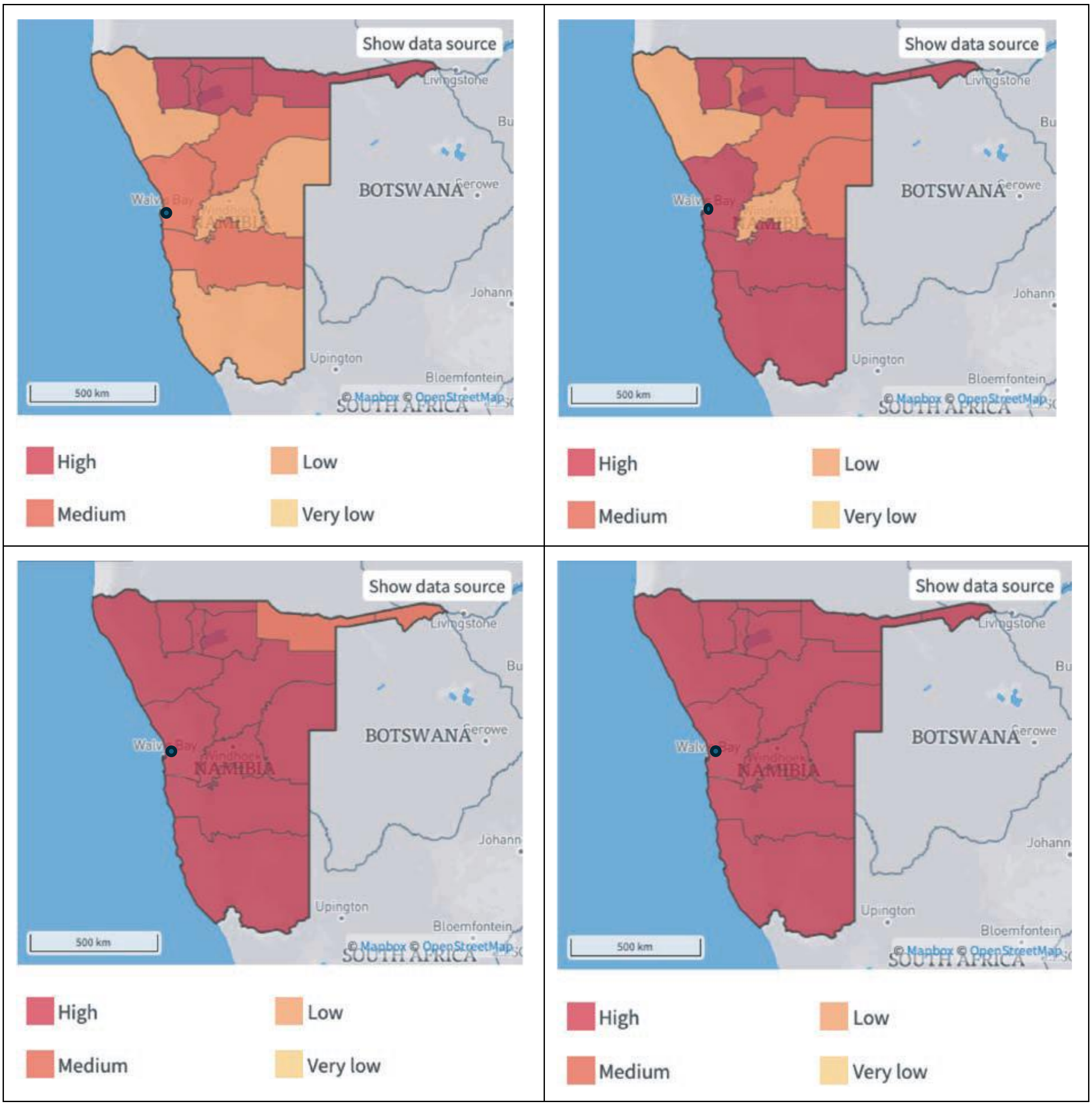


Figure 34: Risk of River Flood (upper left); Risk of Urban Flood (upper right); Risk of Water Scarcity (lower left); Risk of Wildfires (lower right).

6.6.3 Link to Impacts

Potential impacts that link to climate change include the following:

- Water stress increases: Less rainfall and higher evaporation raise pressure on scarce coastal water resources, increasing dependence on desalination and reducing ecological resilience.
- Higher dust and emissions impacts: Hotter, drier, windier conditions amplify dust generation and worsen air-quality impacts from refinery emissions.
- Ecosystems more vulnerable: Fog-dependent and heat-sensitive coastal/desert ecosystems (lichens, dwarf shrubs, invertebrates) become less resilient, so additional

industrial pollution has stronger effects.

- Extreme-event risks increase: Strong winds and occasional heavy-rain events raise the risk of spill dispersion, erosion, or containment failure.
- Higher energy demand and GHG emissions: Rising temperatures increase industrial cooling and electricity needs, elevating indirect emissions.
- Increase of risk of wildfires occurring due to the combination of lower rainfall and higher temperature which would increase aridity.
- Drought: Communities are most at risk from floods, drought, and disease outbreaks with drought regarded as the most devastating hazard for Namibia.

6.7 Noise

This section has been compiled by Soundscape. The Noise Assessment Report is attached in **Appendix K**. References stated in this section can be found in **Appendix K**.

A site visit and baseline noise survey in accordance with South African National Standard (SANS) 10103: 2008 “The measurements and rating of environmental noise with respect to annoyance and to speech communication”, and the International Finance Corporation (IFC) "General Environmental, Health, and Safety (EHS) Guidelines" of 2007, to quantify and describe the existing acoustic climate of the study area was conducted end March 2025.

6.7.1 Noise Sensitive Receptors

Potentially sensitive receptors with respect to noise impacts typically include residences and community facilities such as schools, hospitals, recreational areas, and parks located within a Project’s likely area of influence.

With reference to **Section 6.11**, there are no permanent residential structures within approximately 4 km of Project infrastructure. The closest residences are the Rooikop Army Base located directly southeast of Walvis Bay International Airport and about 4.5 km south-southeast of the Project.

Dune 7, a well-known tourist attraction and recreational site, is considered a sensitive receptor. It is popular for sandboarding, dune hiking, and sightseeing, drawing both local visitors and international tourists. As such, visitors may be temporarily affected by noise during project construction or operation.

There are other industrial, commercial, and quarrying activities in the surrounding area, but these are not expected to be sensitive to project-related noise.

In addition, any residences or community facilities located along the transport routes from Walvis Bay, whether used for road or rail movement of raw materials or finished products, should ideally be considered in the broader assessment of potential noise impacts. However, in built-up areas such as Walvis Bay, traffic associated with the Project is likely to be masked by existing urban traffic and port-related activity and therefore is unlikely to result in a perceptible increase in overall noise levels along these established corridors.

See **Figure 35** for sensitive receptor locations relative to the farm boundaries, servitudes, and Project infrastructure.

6.7.2 Noise survey results

The survey included the recording of the following:

- $\mathbf{L_{Aeq,1s}}$ The A-weighted, equivalent continuous sound pressure level over one second, expressed in decibels (dBA). $L_{Aeq,1s}$ data is logged for a one-hour period. Each $L_{Aeq,1s}$ value was calculated by integrating SLM using sound pressure level measurements taken every 100 milliseconds.

- **$L_{Aeq,1h}$** The A-weighted, equivalent continuous sound pressure level over one hour, expressed in dBA.
- **$L_{A,min}$** Minim time-weighted and A-weighted sound pressure level within the one-hour time interval and expressed in dBA.
- **$L_{A,max}$** Maximum time-weighted and A-weighted sound pressure level within the one-hour time interval and expressed in dBA.
- **L_{An}** A-weighted, sound level exceeded for n% of the measurement period, calculated by statistical analysis, where n is between 0.01% and 99.99%.
- **Unweighted 3rd octave frequency spectra** Breakdown of sound energy across standardised frequency bands, each one-third of an octave wide, typically ranging from 25 Hertz (Hz) to 20 000 Hz, to show how much noise occurs at different frequencies in the environment.

As part of the data validation process, the time history LAeq,1s data underwent a screening procedure. During this process, out-of-range and potentially erroneous data is identified and removed if required.

Key survey results i.e., LAeq,1h at each site during the day and night are summarised in **Table 56**. The table also includes supplementary results that, while not essential, may be valuable in characterising the noise climate or for additional analysis should it be required at a later stage. The locations of the two sites are shown in **Figure 35**.

Table 56: Noise measurement results.

Site	Location	Reference period	ID	Start date	Duration	$L_{Aeq,1h}$	$L_{A,max}$	$L_{A,min}$	L_{A90}
Site 1	On-site	Day	L0541	2025/02/27 15:01:38	01:00:00	44.7	70.9	23.4	29.8
		Night	L0544	2025/02/27 21:57:24	01:00:00	29.3	44.1	19.7	23.8
Site 2	Dune 7	Day	L0542	2025/02/27 16:41:14	01:00:00	42.3	63.6	27.4	31.8
		Night	L0545	2025/02/27 23:24:58	01:00:00	33.0	48.1	19.0	25.4

General observations:

- As expected, both sites were generally quiet, characteristic of rural areas with low human activity.
- All measured levels were below IFC NLG for residential, institutional, and educational receptors.

Site 1, on-site:

- Ambient noise sources:
  - Very distant road traffic from D1984 and C14
  - Occasional air traffic overhead
  - Very little to no insect or bird activity
  - Presence of a light breeze and occasional gusts
- Measured levels:
  - Daytime LAeq,1h 44.7 dBA
  - Night-time LAeq,1h 29.3 dBA

Site 2 – Near Dune 7 (adjacent to D1984/C14 intersection):

- Ambient noise sources:
    - More prominent road traffic noise, particularly from heavy vehicles and more noticeable at night
    - Occasional visitors and staff activity during the day
    - No visitor activity recorded at night
    - Some bird sounds audible during the day

Measured levels:

- Daytime LAeq,1h 42.3 dBA
- Night-time LAeq,1h 33.0 dBA

6.7.3 Link to Impacts

The more significant noise sources during construction include: earthmoving equipment, materials handling equipment, stationary equipment, impact equipment.

During the operational phase, the Project will include several noise generating activities and/or equipment, including: vibrating equipment including crushers, screens, feed hoppers etc., motor driven equipment incl. pumps, fans, compressors, conveyors, agitators etc., hydraulically and aerodynamically generated noise from pipes and ducts, steam turbine, cooling and heating systems, transformers and switchgear i.e., electrical equipment such as transformers and switchgear can generate humming sounds due to electromagnetic fields, venting and blowdown system, transport related noise via road or rail, auxiliary system: Other auxiliary systems, such as emergency diesel generators, fire pumps, and air conditioning units for control rooms and other critical areas etc.

The increase in ambient noise levels could cause disturbance or nuisance impacts to third parties.

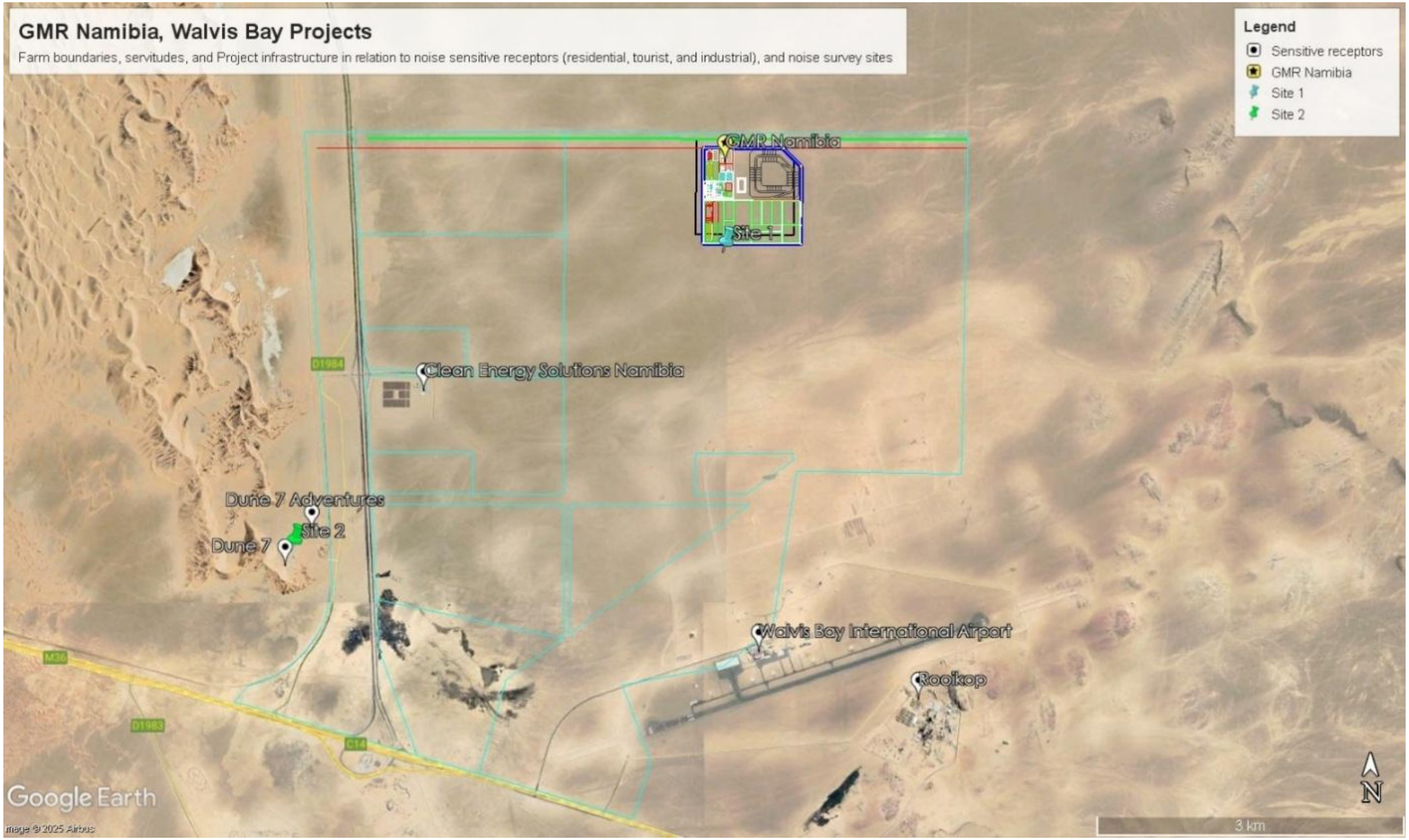


Figure 35: Baseline noise survey locations (site 1 (green) and site 2 (blue)) and sensitive receptor locations.

6.8 Archaeology

A field survey was carried out by Dr. J Kinahan over the proposed Project Site on Farm 58 to locate and document its archaeological features in January 2025. The report is attached in **Appendix L**. The following sections provides a summary with relevant extracts from this report.

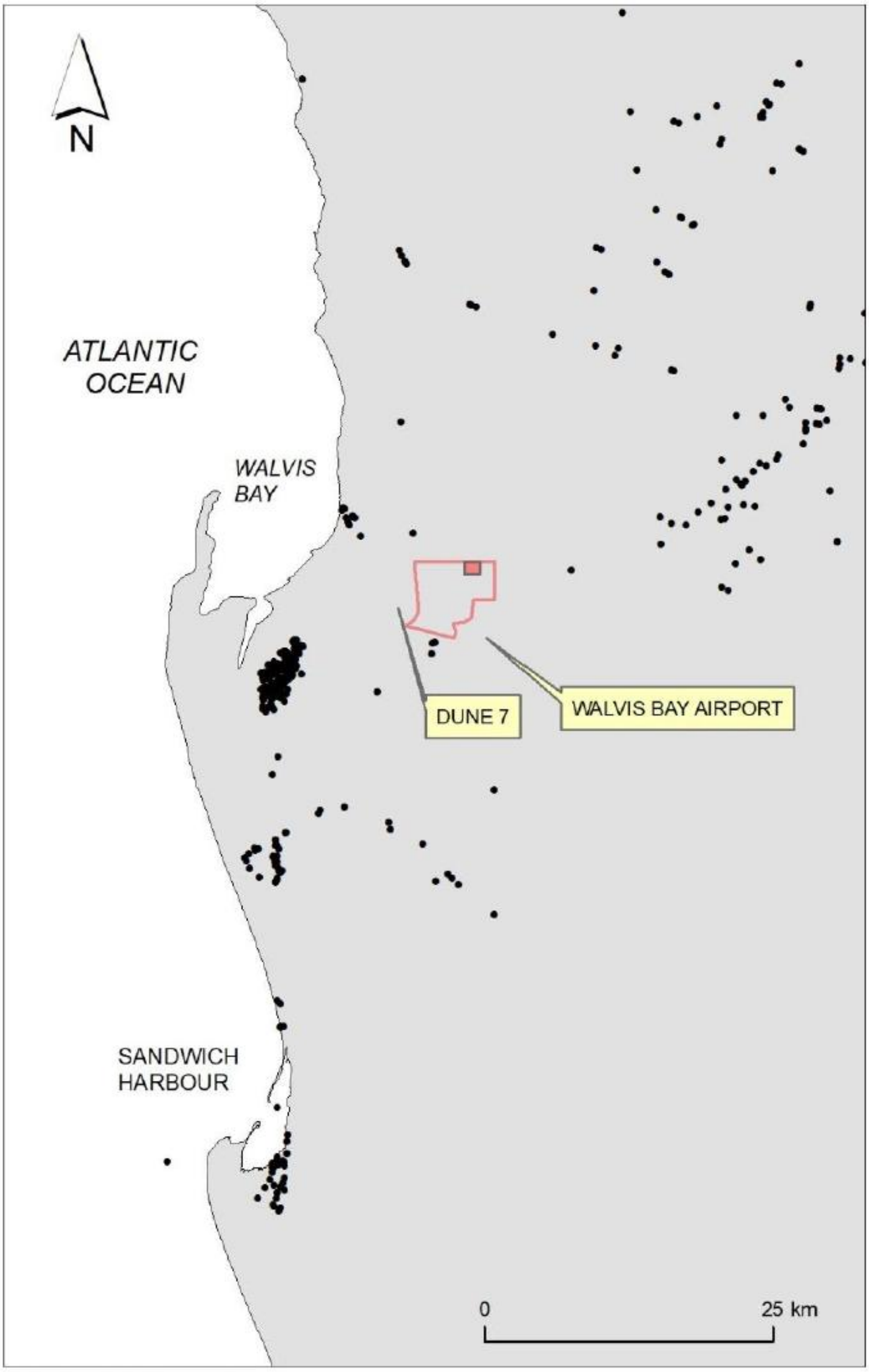
6.8.1 Archaeological Setting

The Archaeological Specialist Report, as well as the references stated in this section can be found in **Appendix L**.

The Namib Desert is recognised as a globally important archaeological landscape, having abundant evidence of human settlement spanning the last one million years (Mitchell, P., 2002). Of particular interest and significance are archaeological sites dating to within the last 10 000 years, a period of marked climatic instability that brought many changes in human settlement and subsistence behaviour (Deacon, J. & Lancaster, N., 1988). This period, the Holocene, commenced with the onset of warm, moist conditions following the Last Glacial Maximum, and saw a rapid expansion of human occupation over the entire Namib Desert. A sudden onset of arid conditions about 5 000 years ago caused a general retreat from the desert to refugium sites along the western escarpment. It was also at this time that the coastal zone of the Namib Desert became a key area of human occupation.

The available evidence shows a dense concentration of settlement in the vicinity of Walvis Bay, with relatively sparse settlement in the adjacent interior. Approximately 250 years ago European whaling and merchant vessels began to visit the Namib coast, concentrating particularly on Walvis Bay, which offered a safe anchorage and fresh water. It was from Walvis Bay that the first trading networks were established with the interior of the territory. A wagon route from Walvis Bay to Otjimbingwe and other interior settlements crossed the Namib Desert in the area where the project site is located.

The evidence of settlement in the desert by hunter-gatherer and nomadic pastoral communities tends to be widespread and insubstantial, requiring the recording and investigation of large numbers of small, scattered sites. Field survey and analytical methods have been developed in the last few decades of research in this area, to obtain the maximum yield of high-precision data from the available archaeological sites. Each new field survey and investigation draw from and builds upon previous work, leading thus to an improved understanding of the regional archaeology (Kinahan, J., 2020). The regional and local distribution of known archaeological sites in the survey area is shown in **Figure 36**.



QRS 365 J. KINAHAN (2025)

Figure 36: The regional archaeological setting (indicated by black dots) of Farm 58 (red polygon), with the project site shown as a red rectangle.

6.8.2 Field Observations

The field survey comprised a general assessment of Farm 58 and a detailed assessment of the project site. Farm 58 includes a well-defined linear infrastructure corridor along its western margin. The corridor contains the railway, a highway (Hifikipunye Pohamba), several powerlines and a number of unsurfaced roads. Adjacent to Farm 58 in the southeast is the Walvis Bay International Airport. There are, in addition, several small developments such as the Hydrogen Academy and a number of abandoned developments as well as large areas of surface disturbance comprising dense networks of off-road tracks, borrow pits and refuse dumps. In all, Fram 58 may be considered a brownfield site. However, the natural features of Farm 58 are to some extent still visible and representative examples of these are indicated in **Figure 37**.

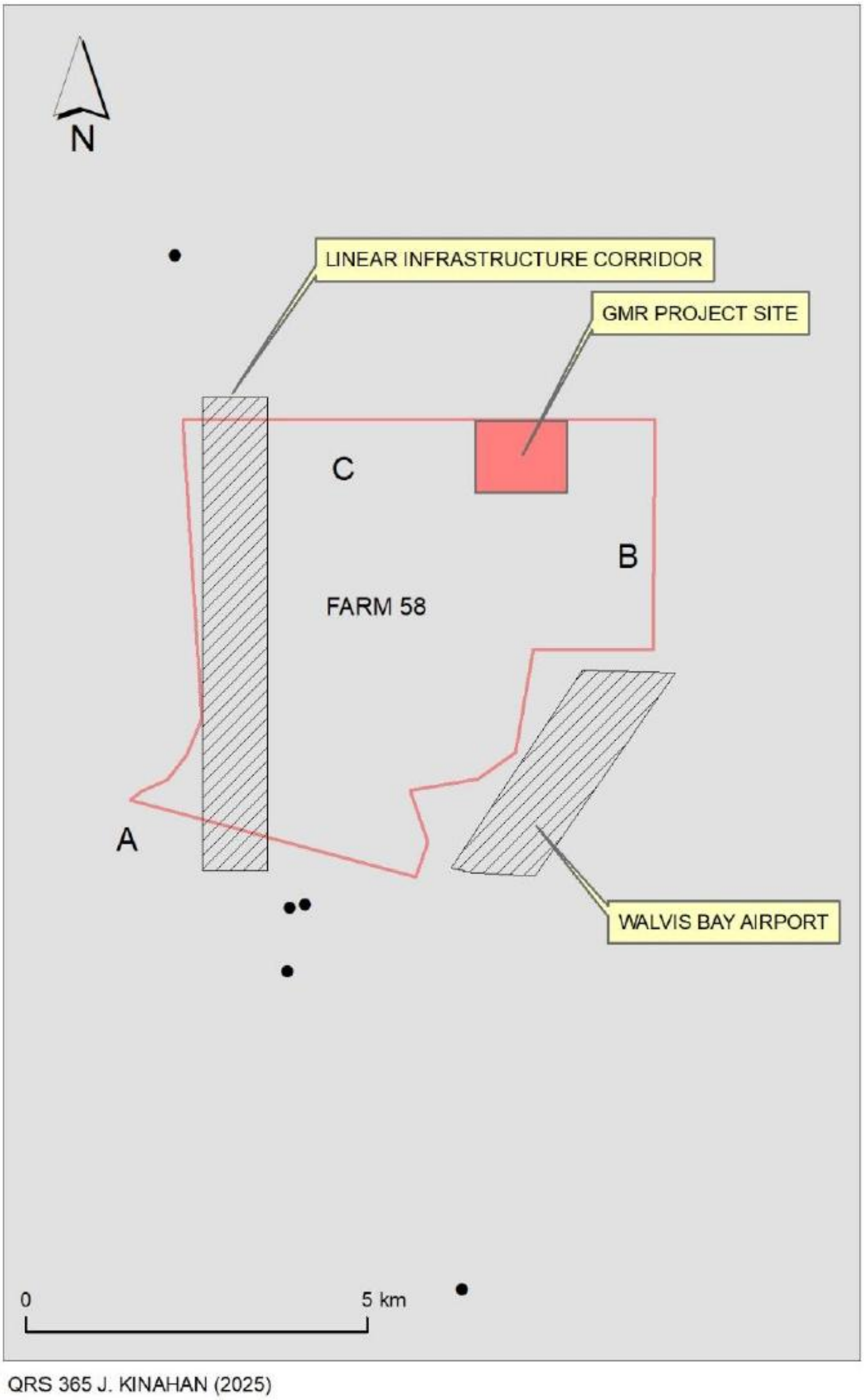


Figure 37: Farm 58 (red polygon) showing the location of the project site, the existing linear infrastructure corridor including the Walvis Bay Airport (indicative). See text below for discussion of localities "A", "B" and "C".

The locality labelled “A” in **Figure 37** lies at the foot of Dune 7, a well-known landmark. Locality “A” is characterised by outcropping pedogenic gypcrete of Neogene age associated with the littoral Rooikop gravels and fragmentary oysters, probably *Saccostrea* spp. (Kinahan, J., 2014). Elsewhere in the same area these are overlain by Pleistocene pebble horizons which sometimes contain Mode 3 stone artefacts associated with extinct mammalian fauna (Ward, J.D., 1987). Weakly cemented conglomerates of the Pleistocene gravels are found exposed by drainage incision in the vicinity of locality “C” in **Figure 37**. This unit is in turn overlain by unconsolidated outwash fan sediments associated with the now extinct Tumas River drainage system. To the east, locality “B” lies on the margins of outcropping syntectonic Salem granites, the highest of which is Rooikop, the prominent feature at the northern end of the Walvis Bay Airport landing strip.

Foot traverses over the project site shown as a red rectangle in Figure 2 yielded no traces of archaeological or palaeontological remains. There were however, scattered examples of munitions, munition crates and other discarded items left over from field exercises if the South African Defence Force, which were regularly carried out here until the late 1980s. The large number of vehicle tracks criss-crossing the landscape are assumed also to date from this time.

6.8.3 Link to Impacts

The field survey of Farm 58 and focusing on the project site yielded no evidence of archaeological or palaeontological remains as defined by the National Heritage Act (27 of 2004). On the basis of this survey the project site is not considered to be archaeologically sensitive. It is recommended that the project be granted consent to proceed under the National Heritage Act. The project proponent will however adopt the Chance Finds Procedure (this will be part of the construction EMP).

6.9 Socio-Economic Affected Environment

The sections below draw on the Socio-Economic Assessment (which includes the Traffic Impact Assessment, which is described in **Section 6.10**) compiled by independent consultant Auriol Ashby. The full report is attached as **Appendix M**, in which the references stated in this section can be found.

6.9.1 National Economic Overview

Namibia’s rich mineral base and small population of just over 3 million give it a World Bank classification of an upper-middle-income country, yet Namibia’s level of income inequality is among the highest in the world, with a Gini coefficient of 0.59[8] (NSA, 2019). In 2023, the Gross Domestic Product (GDP) per capita at market prices was N$50,079, a decline from N$64,023 in 2015 i.e. on average, people are poorer (IPPR, 2024). Structural constraints to growth are also hampering productivity gains and job creation. The debt-to-GDP ratio remains elevated, at about 70% of GDP, reflecting a period of low growth, expenditure pressures, and rising debt servicing costs.[9]

Namibia has abundant sun, potential for desalinated water from its coastal waters, some remaining fish stocks, widespread livestock production, an increasing urban population and high school attendance of both girls and boys up to Grade 11. However, there is widespread rural and urban poverty, low educational attainment, few technical skills, deepening unemployment and a severe

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[8] The Gini coefficient can take any values between 0 to 1 (or 0% to 100%). A coefficient of zero indicates a perfectly equal distribution of income or wealth within a population. Data show that the coefficient generally ranges from 0.24 to 0.63.

[9] The World Bank 2024 Namibia Overview sourced from https://www.worldbank.org/en/country/namibia/overview on 7/4/2025

housing back-log in all urban areas. Thirty-five years after Independence from South African rule, the governing political party, SWAPO, is under more pressure than ever before to improve the lives of Namibians. The economy shows signs of a slow economic recovery from the recession of 2016-2020 and the 2020/21 COVID-19 pandemic, mainly due to positive improvements in the mining and financial services sectors.

Tertiary industries (including the public sector, retail and wholesale, transport and services sectors) have been the most significant contributors to Namibia's GDP in recent years, contributing 54.5%, in 2024. Secondary industries contributed 15.6% to GDP and include manufacturing such as meat and other food processing, beverages, mineral processing, electricity generation and construction. The primary industries contributed 20.6% to GDP. The country's imports of goods and services continued to exceed exports, so the deficit continued to widen during 2024 and amounted to N$64.6 billion compared to N$53.8 billion reported in 2023 (NSA, 2025).

An analysis of the state of the Namibian economy (Sherbourne, 2022) recommends the way forward to include:

- A clampdown on corruption and adoption of a more technocratic approach to economic management;
- Oil and Green Hydrogen projects should start to take shape in coming years allowing government to borrow and bridge fiscal gap;
- Oil and gas revenues should be effectively managed, and benefits are distributed across the population leading to poverty reduction and resources for climate adaptation;
- Government uses oil and Green Hydrogen as a means of diversifying the economy.

6.9.2 Demographics

6.9.2.1 Population Profile of the Erongo Region

Between the census of 2011 and the latest census of 2023 (NSA, 2024), the population of the Erongo Region has grown at an annual rate of 3.9%, which is faster than the national growth rate of 3%, increasing the population to 240,206. This is largely due to people from all over Namibia migrating to the coastal towns of Walvis Bay and Swakopmund in search of work. The urban population in the region has now grown to 90% compared to the national average of 50%. More people (55%) have migrated to the region than were born in Erongo. The ratio of males to females is becoming more equal as increasing numbers of women migrate from other regions: in 2023 the ratio was 50% to 49% (NSA, 2024).

In 2023, the percentage of Erongo's population in the economically active age group of 15 to 59 years stood at nearly 65%, with noticeably more youth aged 20 to 34 years. The literacy rate among the youth population aged 15 to 34 years in Erongo stood at 97%, with slightly higher literacy rates among women than men (NSA, 2024).

Erongo had the lowest total fertility rate (average total number of children that would be born to a woman during her childbearing years) of any region at 2.9 children per woman in 2023. Nationally, the fertility rate has dropped by nearly 50% since Independence in 1991. The average age of mothers at their first live birth in the region was 22 years of age, one year above the national average. At the regional level, Erongo recorded the lowest household size with 3.1 persons per household, compared to the national average of 3.8 people. More households are headed by men in the region (57%) than the national average of 51%.

The next sections will focus on the towns of Walvis Bay, Swakopmund and Arandis from where GMRN anticipate their employees will live.

6.9.2.2 Walvis Bay's Population Profile

Walvis Bay and its townlands extend north to the Swakop River, south to the Kuiseb River and east to include Farm 58. It has the largest population of Namibia's coastal towns, as it has the major port and a long-established fishing industry.

Walvis Bay is the third largest town in Namibia with 102,704 people counted at the 2023 census, having grown from a population of 62,000 in 2011, which is an average annual growth rate of 4.2%. This is slightly higher than the overall national urban growth rate of 4.1%.

Unfortunately, the Namibia Statistics Agency (NSA) has not yet published the latest 2023 census constituency data sets. The latest detailed information on Walvis Bay is based on the work done for the Walvis Bay Integrated Urban Spatial Development Framework (IUSDF) by Urban Dynamics Africa and approved by the Walvis Bay Council in 2014 (UDA, 2013).

In 2011, the population of Walvis Bay is distributed in suburbs that reflect income inequalities: high-income areas (6% of the total population), middle-income areas (16%), low-income areas including back yard shacks (78%) (UDA, 2013). More detail can be found in the housing section below.

6.9.2.3 Swakopmund's Population Profile

Swakopmund is one of the oldest towns in Namibia and is the main coastal tourism resort having a protected beach and some quaint German colonial architecture dating back to the early 1900s. It is the second largest town on the coast, attracting jobseekers and residents from all over Namibia. The 2023 census recorded 75,921 people in Swakopmund, up from over 44,725 in 2011, which is a slightly higher growth rate of 4.4% compared to Walvis Bay's of 4.2%. Such growth rates are likely to present infrastructural, housing, management and administration challenges for both towns in the future.

In 2011, the average household size in Swakopmund was 3.1 but this is likely to have decreased given the growth rate and the influx of people moving into the informal settlements and back-yard shacks.

In 2011, 32% of households were headed by females (NSA, 2014). It is probable that female-headed households would follow the national pattern of having approximately 40% lower income and consumption levels than male-headed households (NSA, 2017).

6.9.2.4 Arandis' Population Profile

Arandis is located about 60 km east of Swakopmund and was established in 1970 to house employees of Rössing Uranium Limited (RUL); it was proclaimed a municipality in 1994. In 2023, the population of Arandis was 13,542 which is more than double the 2011 count of 5,170 people (NSA, 2014). No data is available on household sizes and composition as the constituency data includes Henties Bay, Wlotzkasbaken and some farms south near the border with the Hardap Region.

Although the town has always been economically dependent on RUL, it has made a significant effort to attract other industries. It has good transport links and infrastructure, and the town is well-laid out, with key areas such as the business centre and municipal offices being easily accessible to the whole population. Since the construction and opening of the Husab mine, Arandis has experienced considerable population growth and by 2023, the number of ratepayers had grown to 3,700 (domestic and business), a 61% increase since 2017.

The Arandis Town Council (ATC) has faced numerous constraints as its revenue base is narrow, depending primarily on rates and sewerage charges. In 2023, 95% of domestic users were in arrears with their rates bill, and occasionally the council would cut-off their water supply to force households to pay some arrears and reschedule payments. Even some big institutions and industries were in debt with the ATC. Nevertheless, new housing and increased property prices have increased the revenue base. An on-going challenge is that higher income earners tend to live in Swakopmund, thereby causing the local buying power to be insufficient to expand the retail base.

6.9.3 Housing

6.9.3.1 Walvis Bay

The different suburbs in the town reflect income inequalities: high-income areas (6% of the total population), middle-income areas (16%), low-income areas, including back yard shacks (78%) (UDA, 2013).

The older housing around the Central Business District and in Narraville in the north-east, is categorised as middle-income housing areas, while the high-income suburbs of Meersig and the Lagoon are close to the lagoon. Other high income "suburbs" are Langstrand, Dolphin Beach and Aphrodite Beach, which are located north of the town between the beach and the coastal road from Swakopmund; these coastal suburbs are dominated by holiday homes and characterised largely by absentee owners.

The two areas of low-income housing are Kuisebmond and Tutuleni; the latter is a small area of ultra-high density with four households living on each 300m² plot. Many of the single residential plots in Kuisebmond have allowed the construction of "back yard shacks" where the owner can charge up to N$1,000 rent from each shack. There are some new high density, modest, modern apartments that target professional workers opposite the naval base, north of the fish factories towards the oil storage facility.

With continuing rural-urban migration, the UDA predicted a population projection for 2030 of 180,000 people (based on a growth rate of 4.7% per annum which equates for the need of 90 new townships for the different income groups and houses for 44,200 households to be developed by 2030. (UDA, 2013). The actual average annual growth rate between 2011 and 2023 was lower than predicted at 4.2%, but nevertheless considerably more serviced land is required to meet the need for adequate housing for its population.

6.9.3.2 Swakopmund

As with most of the old towns in the country, apartheid planning concepts segregated people by racial groups and economic incomes in different suburbs (SPC Draft, 2021); this has proved difficult to change since Independence, and only new middle-income suburbs are truly diverse. Upper income housing has spread northwards along the coast and form the suburbs of Vineta, Hage Heights, and Mile 4, and also along the Swakop River's northern banks, which extend into small holding farms that produce some fresh agricultural produce. The middle to lower income suburbs of Mondesa and Tamariskia have smaller plots, while the informal settlements such as the Democratic Resettlement Community (DRC) and Wagdaar are expanding eastwards from the town into the windblown desert sands.

There is no data available on the number of people living in each suburb, but the majority of people live in the DRC, Wagnaar and Mondesa. In 2011, in the Swakopmund Constituency, the percentage of households living in improvised housing (informal housing/shacks) constituted the highest of the region's constituencies at 42% (NSA, 2014). Of the remaining households, 32% lived in detached houses, 10.9% in semi-detached and `0.7% of households lived in apartments/flats. In 2011, over 86% of households in Swakopmund had access to piped water directly into their plots or houses, while a further 13% could access piped potable water at public standpipes. About 84% of households in Swakopmund had access to a flush toilet, which significantly exceeds the national average of 45% (NSA, 2014b). With the rapid growth in informal settlements over the last 14 years, many more people do not have direct access to piped water or toilets in their yards. The public waterpoints in the DRC and Wagdaar are supplying hundreds of households.

The establishment of settlements on the periphery of Swakopmund, as well as new low-cost mass housing developments being developed on the northern periphery of the town is resulting in the urban poor being far removed from economic centres and workplaces (SPC Draft, 2021). What is more, there is poor connectivity between these peripheries and areas of employment – with transport being restricted mainly to large, busy roads. Limited public transport options require many residents to rely on taxis to go to work, the average monthly cost of which was about N$ 500 (assuming a single trip @ N$12 to and from the central business district per weekday) (SPC Draft, 2021).

The Municipality of Swakopmund Structure Plan 2020-2040 is based on the prediction that the population will increase to 113,000 by 2040 and the town will have to provide accommodation for an additional 22,000 households. To prevent further urban sprawl, the plan recommends the densification of existing suburbs, through compactness, mixed uses and high-rise buildings (SPC Draft, 2021).

In 2023, estate agents in Swakopmund reported that there are "hundreds of people on the rental waiting list", particularly for 1–2-bedroom places at lower prices away from the sea-view. There is not enough stock available. Developers have noticed this gap and several new developments for townhouses and apartments are being built in Kramersdorf and Ocean View for the middle- and upper-income market. There were only an estimated 10 erven in town on which town houses or apartments could be built in August 2023. The municipality needs to make more serviced land available for all types of housing[10].

6.9.3.3 Arandis

Since the construction and opening of the Husab mine, Arandis has experienced considerable population growth and has enabled housing development in Extension 5 and 7, mainly for workers at the Husab mine. The town has no informal settlement, but many houses have backyard shacks[11].

6.9.3.4 Housing Affordability and Availability

Key indicators on the state of housing in Namibia is that 2/3rds of the urban population live in informal settlements and lack access to adequate sanitation (MURD, 2022). This is confirmed by the 2023 census, which recorded that 40% of urban households live in informal dwellings or shacks (NSA, 2024).

The housing backlog nationwide has increased from an estimated 80,000 in 2011 to over 300,000 in 2023, with over 105,000 people on the Namibia Housing Enterprise list alone[12]. Affordable housing in all towns is scarce and is in short supply, which drives higher prices.

In 2023, the cheapest houses/flats available in a sample of suburbs in Walvis Bay, Swakopmund and Arandis are listed in **Table 57**, with the cheapest available being N$500,000 in Narraville, Walvis Bay.

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[10] Pers Com Max Schwieger, Nel's Estates and Madelein van Aardt at Susan Curtis Estates on 4/8/2023.

[11] Pers Com. Geraldine Tjiramba, Accountant, ATC on 15/3/2023

[12] https://www.namibian.com.na/govt-fails-to-meet-housing-construction-target/#:~:text=It%20said%20the%20country%20had,serviced%20only%201%20751%20plots, printed on 5 June 2023.

Table 57: Lowest prices of Properties available in different Suburbs in 2023.

	No. of properties for sale	Minimum Price N$	Minimum Price N$ in August 2023			
			1 bed	2 bed	3 bed	4+ bed
WALVIS BAY	1462					
Kuisebmund	27	340,000	-	525,000	900,000	2,150,000
Narraville	36	-	-	500,000	850,000	1,200,000
Walvis Bay Central	333	-	620,000	800,000	1,300,000	1,700,000
Meersig	215	650,000	-	950,000	1,400,000	1,800,000
SWAKOPMUND						
Matutura	14	600,000	-	600,000	650,000	1,800,000
Mondesa	69	575,000	-	525,000	790,000	2,250,000
Tamariskia	61	750,000	530,000	800,000	1,350,000	1,450,000
Kramerdorf	312	1,000,000	-	1,200,000	1,400,000	4,600,000
Extension 15 & Ocean View	331	900,000	-	1,500,000	2,200,000	2,900,000
Rossmund Golf Resort	104	735,000	-	850,000	3,300,000	3,885,000
ARANDIS	31	380,000		325,000	760,000	1,000,000

Source: https://www.myproperty.com.na/properties/erongo/swakopmund/for-sale on 1/8/2023

In 2022, FNB Market Research estimated that an income of N$15,000/month was required to buy a house valued below N$500,000, of which very few exist at the coast[13]. The 2018 Labour Force survey found that 82% of all employees in Namibia earned N$15,000 or less gross income (NSA, 2019), the vast majority of workers cannot afford to buy the available housing stock at the coast (**Table 58**).

[13] *Frans Uusiku, FNB Market Research 2022 The Housing Market presentation at the EAN Housing Symposium*

Table 58: Housing Affordability in Namibia.

			FNB Housing Segments				
Monthly gross income	Employees	% of workforce		Small	Medium	Large	Luxury
			Below N$500k	N$0.5m - N$1.5m	N$1.5m - N$3.4m	N$3.4m- N$6.5k	N$6.5m and higher
NAD 1 to NAD 1 000	62,598	15.6%					
NAD 1 001 to NAD 1 999	57,618	14.3%					
NAD 2 000 to NAD 3 000	71,264	17.7%					
NAD 3 001 to NAD 5 000	50,185	12.5%					
NAD 5 001 to NAD 7000	23,693	5.9%					
NAD 7 001 to NAD 9 000	19,674	4.9%					
NAD 9 001 to NAD11 000	19,573	4.9%					
NAD 11 001 to NAD13 000	12,603	3.1%					
NAD 13 001 to NAD15 000	12,070	3.0%					
NAD15 001 to NAD 17 000	7,611	1.9%					
NAD 17 001 to NAD19 000	8,653	2.2%					
NAD 19 001 to NAD 20 000	9,661	2.4%					
NAD 21 001 to NAD 25000	10,680	2.7%					
NAD 25 001 to NAD 30 000	7,471	1.9%					
NAD 30 001 to NAD 35 000	4,042	1.0%					
NAD 35 001 to NAD 50 000	6,448	1.6%					
NAD 50 001 to NAD 75 000	2,530	0.6%					
NAD 75 001 to NAD 100 000	1,332	0.3%					
NAD 100 001 to NAD 150 000	293	0.1%					
NAD 150 001 to NAD 200 000	278	0.1%					
More than NAD 200 000	371	0.1%					
Not recorded	13,323	3.3%					
Monthly motgage (N$)			5 000 and below	5 000 - 15 000	15 000 - 34 000	34 000 - 65 000	65000 and above
Salary required (N$)			15 000 and below	15 000 - 45 000	45 000 -102 000	102 000 - 195 000	195 000 and above
LFS sample outcome per segment			329279	59370	4804	571	371
Affordability level / proxy for total market			81.9%	14.8%	1.2%	0.1%	0.1%
Total Market (Population aged:16+): 1 467 919			1202458	216809	17542	2085	1355
Total Employees	401,972						

- **Note: This is a conservative view –Additional income streams for households and possibility for joint bonds not considered.**

Source: 2022, Frans Uusiku, FNB Market Research 2022 The Housing Market presentation at the EAN Housing Symposium

6.9.4 Poverty and Vulnerabilities

Poverty is defined as “the number of people who are unable to command sufficient resources to satisfy basic needs” (NSA, 2017). They are counted as “the total number of people living below a specified minimum level of income or below a national poverty line” (NSA, 2017). The upper middle-income poverty rate of 60.1% means the number of poor people in Namibia, living on the upper middle-income poverty line of USD6.85 (N$130)/person/day, has reached 1.56 million (World Bank, Oct 2024). The national rate of multi-dimensional poverty (based 11 indicators on living standards, health and education) averages at 43.3% of the population, with almost 60% living in rural areas compared to 25% of urban dwellers. Female-headed households, larger households and households with many children are more likely to suffer multidimensional poverty. Based on the 2011 census figures, the Erongo Region has the *lowest* incidence of multidimensional poverty in Namibia at 16.6% (NSA, 2021), although this is likely to be higher in 2025.

Due to the history of Namibia, poverty has evolved along racial and ethnic lines; white Namibians hold more wealth and power and are seldom found in the low-income and vulnerable groups. The most vulnerable groups at the coast are women and men living in poverty with low incomes. Many but by no means all, are recent migrants who have come to seek work and a better life from rural areas in Northern Namibia, whose home languages are Oshiwambo and Rukwangali. Language is a door opener, and people who can speak English, Afrikaans and German find it easier to source work.

In 2011, Swakopmund ranked the 7th *least* deprived constituency out of the 107 in the country because of its residents’ easy access to health, education and employment (NPC, 2015).

6.9.5 Indigenous Peoples

Namibia signed the United Nations Declaration on the Rights of Indigenous Peoples in 2007. The Constitution of Namibia emphasises equality and freedom from discrimination on the grounds of sex, race, colour, ethnic origin, religion, creed or social or economic status (Article 10).

"While most people in Namibia can be characterised in a strict sense as indigenous to the area, the San, Himba, Ovatue, Ovatjimba, and Ovazemba are recognised by the Government as particularly marginalised groups. The conditions of these groups, especially relative to other segments of the population of Namibia, can be identified as similar to those of groups identified as indigenous worldwide" (Anaya, 2013). In the same report, Anaya also recognised the Nama, a Khoesan people, as another non-dominant group who are descendants of some of the first inhabitants of present-day Namibia.

The ≠Aonin Topnaar is a clan of the Nama people, and about 350-400 ≠Aonin Topnaar reside and practice herding from both recognised and informal settlements such as Utuseb, Rooibank, Homeb and Amstraat along the Kuiseb river, about 30 km south-east of Walvis Bay. The communities mainly depend on small-scale livestock production of goats, cattle and donkeys, and government pensions as they are not allowed wildlife offtake from their former hunting grounds in the Namib-Naukluft National Park (NNNP). In other parts of Namibia, such recognised traditional authorities are given powers and budget lines through the Ministry of Urban and Rural Development. The Topnaar Traditional Authority is in a unique position in Namibia as they live within the NNNP as leaders of their people but have no rights to manage the area in which they live. This has been a bone of contention, and they feel it has caused lengthy delays in bringing them any development.

Some Himba (indigenous) people have moved from the Kunene Region to live in Swakopmund, attracted by the income from tourists who are keen to see their traditional costumes, but their numbers are not known. Indigenous peoples in the region often suffer extreme marginalisation.

No Indigenous Peoples, as defined under international standards such as IFC Performance Standard 7, were identified within the Project area or its immediate zone of influence. The Project area is located within a proclaimed industrial zone with no known recent traditional land use or customary tenure.

6.9.6 Gender

Patriarchal practices and rigid gendered social structures are common in Namibian households and in public life. This is often reinforced by Christian values (98% of the population identifies as Christian), under which the man is considered the head of the household. Gender and cultural norms that uphold men as the decision makers and women as dependents leave many women and their children among the most vulnerable. In most cases, these norms result in men having control over household resources and income from all sources. Gender norms include the expectation within households that women should be primarily responsible for care and domestic labour, while men take on the responsibility for "heavy work" and the role of primary income earners[14].

Many migrant workers are single women who have to care for and feed their children with little or no support from the children's father or from extended families. This pushes many women deeper into poverty, vulnerability and risk. Although there are progressive laws and policies in place to protect women, knowledge of these is not widespread; women are left to navigate the systems on their own. As a result, many of the most vulnerable are not benefiting from the legal protections which are in place to fight discrimination and gender-based violence.

[14] This section is largely based on work done by Brigit Rudd, a Namibian Gender and Development Specialist

In Walvis Bay, it is mostly women working the fish processing lines, while men are offered jobs on boats and vessels where there are no gender-separate sleeping and bathroom arrangements. In 2018, in the well-paid mining sector, males dominated the workforce by over 82%. Conversely, in the generally low-paid accommodation and food service sector, 77% of those employed were women (NSA, 2019).

Gender based violence (GBV) is widespread in Namibian society and is rooted in the structural inequality in power relations between women and men. GBV is defined as the physical, mental or social abuse (including sexual violence) that is attempted or threatened, with some type of force (such as violence, threats, coercion, manipulation, deception, cultural expectations, weapons or economic circumstances) and is directed against a person because of his or her gender roles and expectations in a society or culture. Forms of GBV include sexual violence, sexual abuse, sexual harassment, sexual exploitation, early marriage or forced marriage, gender discrimination, and denial (such as education, food and freedom). The Namibian GBV statistics are probably under representative but 33% of women have experienced physical or sexual violence; 28% of girls and 29.5% of adolescent boys believe beating is acceptable. Violence against women and girls has devastating short and long-term consequences on their health and well-being. All sectors of society need to intensify prevention efforts to address social norms, attitudes and behaviours that perpetuate inequalities and GBV (UNFPA, 2020).

6.9.7 Formal Education in Erongo Region

The 2023 census recorded improved adult literacy rates in the region at 95.4% and no major differences between men and women (NSA, 2024). School educational attainment from the 2011 census found that 30% of people over 15 years old had completed secondary education (up from 21% in 2001). Over the same period, the improvement of adults with tertiary qualifications from a university, a technical or teacher training college had only risen from less than 6% to 6.7% (NSA, 2014).

The Ministry of Education Arts and Culture (MoEAC) reported to Parliament in March 2023 that national school enrolment for 2023 had increased to 864,632 learners, an increase of 44,883 on 2022 figures. The ministry acknowledged overcrowded classrooms, and more resources are needed for more teachers and their continuous professional development, textbooks and stationery and the school feeding programme, which boosts school attendance. All 14 regions have a backlog for more infrastructure – classrooms, equipped science laboratories, libraries, ablution facilities, and learner and teacher accommodation[15].

The Erongo Region experienced a steady growth in the number of learners, teachers and classrooms in the region between 2015 and 2019 (MoEAC, 2020) as shown in the **Table 59**. Importantly, the learner-to-teacher ratio has remained fairly consistent over the years, as has the average number of learners per classroom.

[15] https://www.parliament.na/wp-content/uploads/2023/03/Vote-10-Ministry-of-Education-compressed.pdf accessed on 26 July 2023.

Table 59: Learner, teacher and classroom figures, Erongo.

Year	No. of schools	No. learners	No. teachers	No. Classrooms	Learner: Teacher ratio	Average number of learners per classroom
2015	63	36,626	1,469	1,244	24.9	29.4
2016	65	39,102	1,558	1,260	25.1	31.0
2017	71	41,287	1,659	1,350	24.9	30.6
2018	75	43,213	1,743	1,443	24.8	29.9
2019	75	45,142	1,811	1,480	24.9	30.5

Source: adapted from MoEAC, EMIS Education Statistics, 2015-2019

The Erongo Region MoEAC has stopped adding classrooms to existing schools as their other school infrastructure is at full capacity. It has calculated that with the continuing influx of people to the coast, it needs to build three new schools every year. The need and demand are particularly high for pre-primary places and Grade 1 learners.

6.9.8 Health Systems and Health

Private health care at the coast is of a good standard with a private hospital in Walvis Bay and Swakopmund and access to private clinics or doctors. Similarly, there are several good private emergency rescue services that operate at the coast. It is likely that not all of the GMRN workforce will want to contribute to a private medical aid scheme, and some will rely on the government public health care system.

Namibia's public health care system, managed by the Ministry of Health and Social Services (MOHSS) operates on a four-tiered structure consisting of primary health care sites (clinics and health care centres), district hospitals, intermediate hospitals and a referral hospital (Windhoek Central). Clinics are staffed by nurses and pharmacy technicians or assistants, whereas health care centres and hospitals are also staffed by doctors. If a patient's medical needs exceed the scope of a given facility, they will be referred up through the hierarchy of care (Christians, 2020).

The MoHSS runs a district hospital in Walvis Bay and Swakopmund, a health centre in Walvis Bay and a number of clinics in Swakopmund (3), Walvis Bay (4) and Arandis (1) (MoHSS, 2022).

Decreasing donor support (as a result of Namibia's ranking as an upper-middle-income country) and the country's economic downturn have resulted in budgetary constraints. As such, Namibia faces challenges in providing equitable primary health care, and disparities exist in terms of access to health care depending on geography and income. High staff turnover combined with budgetary constraints, causing a freeze on filling vacant posts, has resulted in a shortfall of the workforce across the whole frontline health care system, and staff are generally overstretched (Christians, 2020). **Table 60** shows that staffing levels of the government health facilities vary considerably between Walvis Bay, Swakopmund and Arandis.

Table 60: Health Care Workers Staffing Levels in 2022.

Facility Name	No. of Approved Posts	No. Filled	No. Vacant	Percent Filled	Staffing Resources
Walvis Bay					
Narraville Clinic	11	4	7	36%	**Under-resourced**
Coastal Clinic	9	4	5	44%	**Under-resourced**
Utuseb Clinic	7	3	4	43%	**Under-resourced**
Walvis Bay Clinic	10	6	4	60%	**Reasonable level of resources**
Kuisebmund Health Centre	28	22	6	79%	**Sufficient resources**
Sunshine Rehabilitation Centre	1	1	0	100%	**Well resourced**
Swakopmund					
DRC Clinic	14	0	14	0%	**Under-resourced**
Tamariskia Clinic	13	12	1	92%	**Well resourced**
Mondesa Clinic	18	17	1	94%	**Well resourced**
Arandis Clinic	9	7	2	78%	**Sufficient resources**

Source: (MoHSS, 2022)

In terms of the nation's health, non-communicable lifestyle diseases are becoming more prevalent while HIV/AIDS has been successfully managed largely due to international donor support (up until America's cuts to USAID in 2025) to government. In 2022, Namibia almost surpassed the UNAIDS 95-95-95 goals, achieving estimated 94-97-93 rates. This meant that 94% of people living with HIV knew their status, 97% of people who knew their status were on treatment, and 93% of people on treatment achieved viral load suppression. Namibia is estimated to have one of the highest tuberculosis burdens in the world[16]. The top ten causes of death in Namibia extracted from the National Population Registration System for all deaths registered in 2021 are shown in **Table 61.**

[16] https://www.cdc.gov/globalhealth/countries/namibia/default.htm accessed on 31/7/2023

Table 61: Top 10 Leading Causes of Deaths for both sexes and all ages in Namibia in 2021.

2021	%
COVID-19	18.6
Hypertensive disease	9.8
Lower respiratory infections	6.9
HIV	4.5
Diabetes mellitus	3.0
Self-inflicted injuries	2.8
Road traffic accidents	2.8
Nephritis and nephrosis	2.3
Endocrine disorders	2.3
Diarrhoeal diseases	2.2

Source: (NSA, 2023b)

The transition from communicable diseases to non-communicable diseases will likely place an increasing burden on the health care system in all regions in the future (Christians, 2020).

Of more concern is undernourishment and child malnutrition, which is widespread in Namibia. Despite promising progress and continual decreases in undernourishment and stunting since 2010, the prevalence of undernourishment stood at 28.8% in 2015, and 23.8% of children under 5 were stunted in 2013 (MoHSS, 2014). The prevalence of stunting stood at 16.7% in urban areas, and a worrying 27.8% in rural areas (NSA, 2019). The Erongo Region had one of the lowest levels of stunting nationally, decreasing from approximately 22% in 2006 to 15% in 2013 (MoHSS, 2014). However, malnutrition is likely to have increased since 2015/16 with increased poverty levels, especially in the informal settlements. Namibia's infant mortality rate (which is linked to maternal health and nutrition) has been declining: 44.9 in 2000 to 29 in 2021 (per 1000 live births)[17].

6.9.9 Employment

In the Erongo Region, the labour force stood at 106,500 in 2023, with a labour force participation rate[18] of 64% (69% among males and 59% among females), which is the highest of all the regions, compared to the national average of 46% (NSA, 2025). This is a decrease from a labour force of 112,800 in 2018 and a participation rate of 81% in 2018. The 2018 Labour Force survey found that 41% of those employed were in informal employment – such as working in private households or in agriculture and fishing – and had no social protections such as a pension scheme, medical aid, or social security (NSA, 2019b)[19].

Manufacturing employment as a percentage of the total employed population is an important indicator under the Sustainable Development Goal-9, which focuses on building resilient infrastructure, promoting inclusive and sustainable industrialisation and fostering innovation. It is significant because manufacturing is often seen as a driver of economic growth, technological innovation, and employment opportunities and this project should have a positive impact. In 2023, the highest regional share of employment in manufacturing was observed in the Erongo Region at 16.7% (12,000 people).

Regarding unemployment in 2023, the national rate stood at almost 37%, with the Erongo Region recording the third lowest regional unemployment rates at 32%. Women are more likely to be

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[17] (World Bank: https://data.worldbank.org/indicator/SP.DYN.IMRT.IN?locations=NA).

[18] The labour force participation rate (LFPR) is the proportion of the economically active population in the age group 15 to 65 years

[19] This detail was not captured in the 2023 census.

unemployed than men: 35% of women were unemployed, compared to 30% of men in the region (NSA, 2025). Youth unemployment, however, amongst people aged 15-34 years, was nationally at 44.4% and 40.7% in the region. Significantly more young women were unemployed compared to young men at 44.4% and 37.5% respectively (NSA, 2025). When the potential labour force[20] was combined with the unemployment rate, 61.4% of youth nationally faced an unmet need for employment, with this being lower in Erongo at 55% for young women and 46% for young men.

Unemployment levels among those who have completed some technical/vocational education have risen to nearly 37% nationally, compared to 33% in 2018. Unemployment among those who have completed other tertiary education has risen from 16% in 2018 to nearly 18% in 2023.

6.9.10 Availability of Project-related Skills and Training Institutions

The Engineering Council of Namibia (ECN) has a comprehensive list of engineers and technicians operating in Namibia, by discipline, by professional level and by nationality, as indicated in the figures below. **Figure 388** shows there are only 40 chemical engineers and 22 industrial engineers registered with the ECN, although there were 320 mechanical engineers in 2023[21].

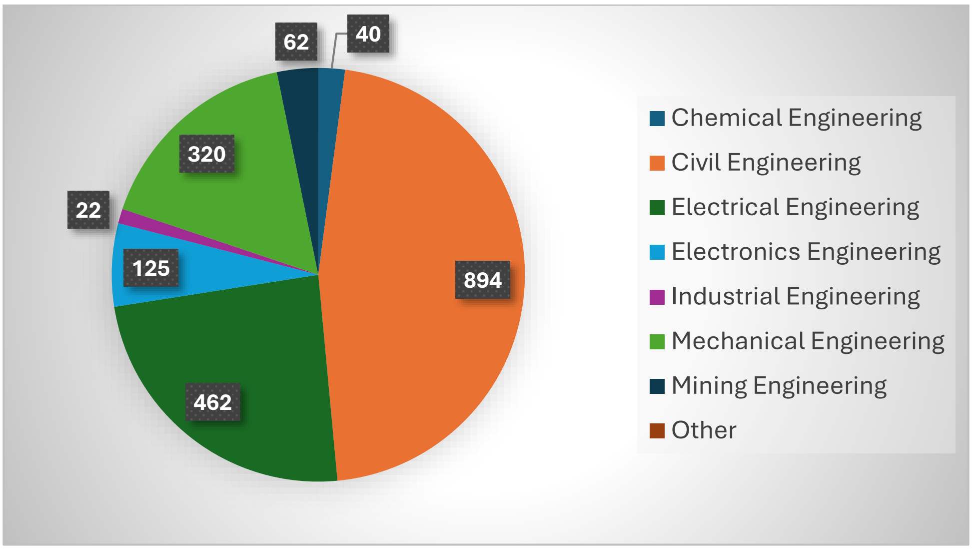

Figure 38: Engineers and Technicians by discipline registered with ECN.

Source: Engineering Council of Namibia (ECN) main page: ecn.org.na/ecn/

A graduate with a degree can register with the ECN as an engineer- or technician-in-training and after at least four years, she/he can apply to become a professional engineer. Some people may not register after training but will apply for membership only when they are ready to become a professional engineer; some may never apply to become professionals. Of the 1997 people registered, just over half (51%) are still in training or have not applied for professional membership (**Figure 39**). Approximately 18% of those registered are women.

[20] The potential labour force is defined as all persons of working age who were neither employed or unemployed but wanted work and were available or would be available soon for work.

[21] The ECN has not changed the figures on their website since 2023.

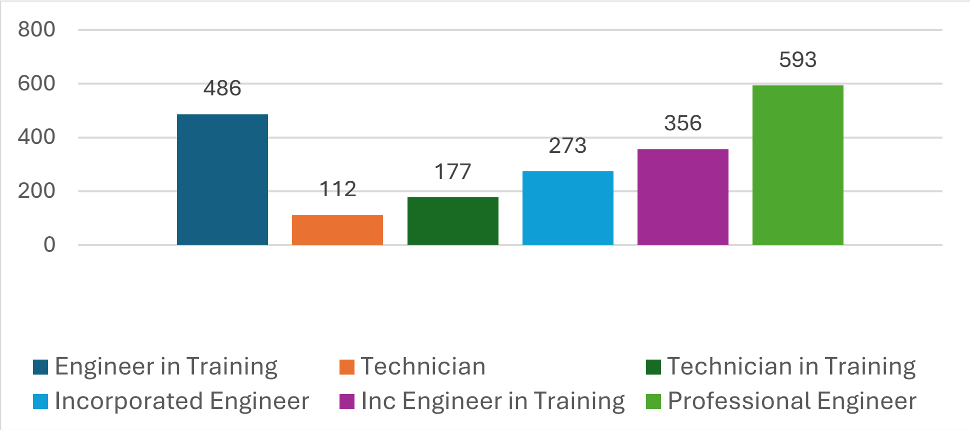

Figure 39: Number of Engineers and Technicians registered with the ECN 2023.

Source: Engineering Council of Namibia (ECN) main page: ecn.org.na/ecn/

Figure 40 shows that the vast majority (80%) of people registered with the Engineering Council are Namibian.

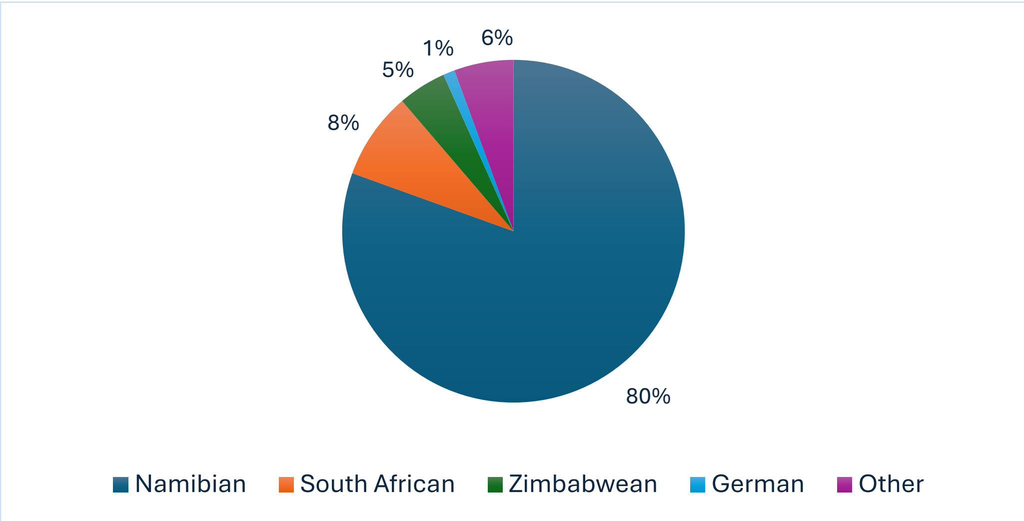

Figure 40: ECN Registered Engineers and Technicians, by Nationality.

Source: Engineering Council of Namibia (ECN) main page: ecn.org.na/ecn/

The following institutions offer courses in trades and subjects which may be of relevance to the project in its construction and operations phases:

The University of Namibia (UNAM) offers a variety of engineering courses, including BSc Honours and Masters' courses in chemical engineering, civil engineering, electrical engineering, mechanical engineering and electronics and computer engineering.

The Namibia University of Science and Technology (NUST) offers a 4-year Bachelor of Engineering In Chemical Engineering course. Its B.TECH in Electronic Engineering course provides training for instrumentation technicians.

Namibian Institute of Mining and Technology (NIMT) campus in Arandis offers the following Namibia Qualifications Authority-accredited courses:

- Instrumentation (Up to Level 3)
- Fitting & Turning (including Machining)
- Boilermaking/Plating/Welding
- Automotive Mechatronics

- Electrical
- Bricklaying/Plastering
- Carpentry/Joinery
- Plumbing/Sheetmetalwork
- Refrigeration/Air-conditioning

Swakopmund has the Namibia Institute of Welding and a Community Skills Development Centre (COSDEC), which offers Namibia Qualifications Authority-accredited training in Civil and Building Services Engineering (Plumbing to Level 1) and Metal Fabrication (Level 2)[22].

Namibians can also study chemical engineering and other relevant courses in South Africa at the University of Cape Town, the University of the Witwatersrand, Stellenbosch University, the University of Western Cape, University of Pretoria, Cape Peninsula University of Technology and the University of Johannesburg.

Many of the 30,400 school leavers nationally who did not qualify to remain in school and proceed to Grade 12 advanced subsidiary level in 2023 should have been advised to enter vocational institutions, but the demand for vocational training placements far outstrips supply. In addition, Namibia's vocational education and training system is not adequately geared towards the needs of the labour market (GIZ, 2021). It does not constitute a comprehensive and consistent network of providers/trainers, but it remains fragmented and has poor linkages with basic education, higher education and between its own components (UNESCO, 2016).

6.9.11 The Local Economy of Walvis Bay

The marine fishery sector consists of a primary sub-sector that harvests fish and a manufacturing sub-sector that processes fish for both the local and export markets. It is exclusively industrial, dominated by private enterprises with no direct government financial support and is internationally competitive. The main fish and seafood types are hake, monkfish, horse mackerel, rock lobsters and red crab, among others. The sector plays a dominating role in the economy of Walvis Bay as over 14,500 people were employed on fishing vessels and land-based factories in Walvis Bay in 2021, of which approximately 64% are women employed in the land-based factories[23]. Nationally in 2024, the sector accounted for over 14% of export earnings that were sourced from fish and fisheries products valued at N$14.38 billion, and this fisheries' export contribution to Gross Domestic Product (GDP) was 2.7% (NSA, 2024).

Other important employment sectors in Walvis Bay are in the service and retail industries, as shown in the figure below, which unfortunately is the latest available. Although the majority of adults had some employment, over one third (36%) were either unemployed or economically inactive (**Figure 41**).

[22] https://www.cosdef.org.na/cosdec-swakopmund/ accessed on 7/4/2025

[23] https://mfmr.gov.na/documents/411764/2631138/Industry+address+-+Minister+%282%29.pdf/eb064a04-d712-d4c6-ded6-a3bea1e81c54 using the National figures cited by MFMR less 3,500 employed in Lüderitz.

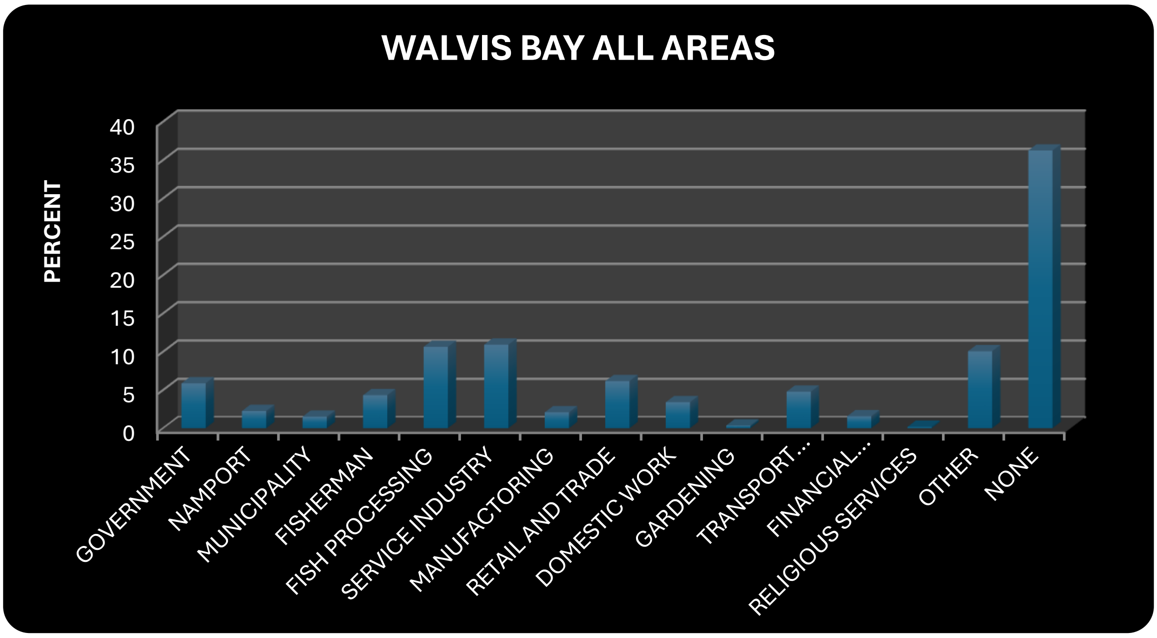

Figure 41: Employment across different sectors - and Unemployment.

Source: (UDA, 2013)

Similar to all of Namibia's towns, household incomes vary enormously in the different suburbs. Although the data is old, there is not likely to have been much change in the proportional distribution of income levels. In 2012 the income category shared by most households in the affluent suburbs was between N$20,000 – 30,000/ month while households in Naraville received slightly higher monthly incomes than those in Kuisebmond (**Figure 42**).

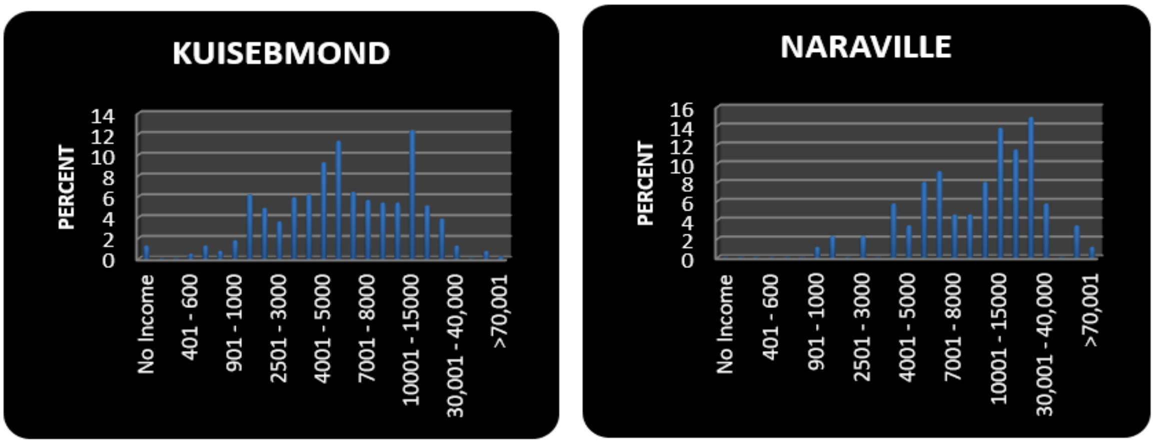

Figure 42: Monthly Income Distribution of Households in Low Income suburbs, 2012.

Source: (UDA, 2013)

6.9.12 The Port of Walvis Bay

Strategically located halfway down the coast of Namibia, the Port of Walvis Bay is Namibia's largest commercial port and in 2023/24 received 1,148 vessel calls and handled a record 6.82 million tonnes of cargo. The Namibia Ports Authority (Namport) handles container imports, exports and trans-shipments, as well as bulk and breakbulk volumes of various commodities. It supports inputs and exports for Namibia's mines and fishing industries, and imports of fuel and other essential commodities for Southern African Development Community (SADC). NamPort is a major employer in Walvis Bay; its total staffing at the close of the 2024 fiscal year was 816 permanent employees (including Lüderitz), of which the major work is from Walvis Bay (NamPort, 2024). The port supports a considerable number of other harbour-related industries – such as logistics, marine maintenance and repairs and operating supplies for ships that all create further employment opportunities in the town.

The Cooperative Bulk Handling Terminal (Pty) Ltd. (CBHT) is planning to construct and operate a sulphuric acid storage and handling facility of 40,000 tonnes within the Port of Walvis Bay and transport sulphuric acid to the Etango Mine. CBHT is a subsidiary of Bannerman Investments Namibia (Pty) Ltd. and part of the Bannerman Energy Ltd. Group of Companies. The company manages the logistical import and export of materials, including sulphuric acid, an essential reagent in the mining industry's uranium (U_3O_8) extraction. The sulphuric acid will either be sourced from a local Namibian supplier, such as GMRN, or from abroad and either transported by rail within Namibia or shipped by vessels to the port, and decanted into the storage tanks in the harbour. It will then be delivered to the mine by road trucks[24].

6.9.13 Mining in the Region

Mining makes a significant contribution to driving the region's economy through providing employment, and buying local (within Namibia) goods and services, which creates further jobs up and down the supply chains. The Rössing Uranium Ltd Mine (RUL), the Swakop Uranium Husab Mine and Langer Heinrich Uranium together employed over 6300 direct employees and contractors in 2023 (**Table 62**) and most of their families live in Arandis, Swakopmund and Walvis Bay**.**

From these three mines alone, almost N$1.5 billion was spent on direct wages to employees, and it is likely that a major portion of these wages was spent in the region. They spent N$7.54 billion on local procurement in 2023, which includes contractors' wages. These three mines currently import sulphuric acid for their uranium ore processing, and GMRN's supply should enable them to increase their share of local procurement further.

The turnover of the three mines was over N$15.5 billion in 2023 and contributed nearly N$784 million to government revenue in the form of royalties, export levies and corporate taxes. These mines also reported spending nearly N$64 million on training and skills development.

Table 62: Contribution of selected mines to the local economy in 2023.

	Selected Mines in the Erongo Region	Status	No. of Employees (perm & temp)	No. of Contractors	Wages paid N$ million	Turnover N$ billion	Local Procurement spend N$ billion	Royalties / Export levy /Corp. tax paid N$ million	Expenditure on training & skills N$ million	N$ Profit / Loss in 2023	Latest Estimated Life of Mine
1	Swakop Uranium Husab	Operational	1636	1438	1401	9.045	3.945	236	31.6	-1.620 million	2036
2	Rössing Uranium	Operational	871	1336	22.1	6.481	2.365	547.5	28.5	1.34 billion	2036
3	Langer Heinrich Uranium	Operational	265	761	70.1	Nil	1.228	Nil	3.8	-1.289 billion	2041
			2772	**3535**	**1493.2**	**15.526**	**7.538**	**783.5**	**63.9**	**0**	

Source: (CoM, 2023)

[24] Windhoek Observer published on 2024-10-03.

With the drive for low-carbon energy sources and the global uranium price increasing, the development of two new uranium mines namely Bannerman Resources' Etango Mine and Deep Yellow's Tumas Mine, are in the pipeline.

In addition to direct economic contributions, mining provides upstream, downstream and side-stream linkages for the Namibian economy. These bring indirect and induced benefits from the upstream linkages of the supply chains of mining inputs (to which GMRN will contribute) and services, the side stream linkages of transport services, power, water, skills, research and development, logistics, communications and financial services and the downstream linkages of the valuation addition – in this case, the processing of manganese.

6.9.14 The Tourism Sector

Tourism plays a significant role in the Namibian economy as it includes hospitality, retail, travel, handicrafts and leisure activities, which have positive direct and indirect impacts on businesses and livelihoods. The Tourism Satellite Accounts for 2022 indicate that during 2022, tourism's direct contribution to the Namibian economy was about N$14.3 billion or 6.9% of the total GDP of N$206.2 billion. Over 57,570 people were directly employed in the sector in 2022 (IPPR, 2024).

Official figures from the MEFT state that in 2024, 1.25million tourists arrived in Namibia, an increase of 45.5% from 2023 and 87% from 2022. This signifies almost a 79% recovery since the COVID-19 pandemic. The majority (71.7%) of tourists originate from within Africa, with most coming from South Africa, then in smaller significant numbers from Angola, Botswana, Zambia and Zimbabwe. The majority of overseas visitors are from Germany followed by the USA, UK, France and the Netherlands. Of the tourists arriving in 2024, 41% drove through the Southern border posts, while 25% entered through the North-Eastern border posts and only 8.9% through the Hosea Kutako International Airport MEFT, 2024.

Tourism is well served by Swakopmund as the wider area of dunes, desert and sea offers a variety of adventure and leisure tourism. The C14 (also known as the MR36 & MR44 and T0202) road between Walvis Bay and the Namib, Sossusvlei and the south, is a popular tourist route. The planned improvements to the road between Dune 7 and Walvis Bay will improve the safety for tourists, Namibians and businesses alike.

New visa requirements for Namibia were implemented on 1 April 2025, which means that nationals from 33 countries, including the US, UK, Canada, and France, now need a visa to enter Namibia. These countries were previously granted visa-free entry, and if cumbersome to apply for, may put a dampener on international tourism in the future.

Of relevance to this project is Dune 7, which is located within the Namib Sand Sea, a UNESCO World Heritage Site, known for its massive, ancient dunes and unique desert ecosystem. It is one of the world's highest dunes, at approximately 388m, and offers panoramic views of the sand dunes meeting the Atlantic Ocean. Dune 7 is accessed from the same turn-off at the Dr Hifikepunye Pohamba Freeway as Farm 58, used by Cleanergy Solutions Namibia and future industries, such as this Project. In 2022, the MEFT upgraded the ablution blocks, new water infrastructure, and a perimeter cable fence with a formal entrance gate. There are different entrance fees for Namibians, SADC visitors and international visitors.

One 15 June 2023, the MEFT announced it had awarded the Dune 7 Operator Concession to Sandwich Dune Tours and Safari. In their proposal, the company plans to offer various adventure activities at the spot, including paragliding, dune climbing, fat biking, stargazing as well as tours to Walvis Bay. Sandwich Dunes Tours and Safari will also develop a restaurant that is open daily and can host special events like weddings or corporate functions. The restaurant will include a swimming pool and a bar that will be open until late. Visitors to the area will also have the convenience of overnighting at the spot as the Company will construct 10 luxury chalets. While entrance to the restaurant will be free, the company will charge different levies to visitors for other Dune 7 activities, which will be communicated once the company starts operating. The MEFT has also given the company the optional right to erect and operate a tethered hot air balloon.

6.9.15 The Construction Sector and Labour Availability

The construction sector posted a positive growth for the first time in eight years in 2024, registering 6.4% increase from 2023. This recovery was driven by an increase in government construction activities of 'Civil Engineering and Related Services'. In the financial year 2023/24, the construction sector's contribution to GDP was over N$3.3 billion or 1.4% of GDP (NSA, 2025).

The 2023 population census found that 28,660 people were employed in construction, down from 45,000 employed in 2018, at which time 65% were informally employed and less than 6% were unionised. It is a very male-dominated sector with only 7% of females in the workforce. Over 45% of those employed were under 34 years of age, so it is a valuable contributor to youth employment (NSA, 2025). The mean monthly wage in 2018 was N$5,441 (NSA, 2019).

Contractors comprised of highly professional Namibians are readily available to provide skilled and unskilled construction workers to build the refinery and acid plant. The size of the crew will fluctuate over the construction period of approximately 18 months. The construction crew will mostly be sourced from Namibia, and where possible from the Erongo Region. As a result, no construction camp will be constructed, and the crew will make use of locally available housing in Walvis Bay, Swakopmund and Arandis. Construction will be done during a 12-hour day shift.

6.9.16 The Transport and Storage Sector

The Namibia government is in the process of developing the country into a regional leader in logistics and distribution by 2030, based on the Master Plan for Development of an International Logistics Hub for SADC countries in the Republic of Namibia (NPC, 2015). It focuses on improving infrastructure, developing logistics centres, and promoting the country's transport network. Key components include expanding the Ports of Walvis Bay and Lüderitz, upgrading the national road and rail infrastructure, a truck-stop development programme along major corridors, and an integrated border management programme.

The National Accounts for 2024 reported that the transport sector continued to experience positive growth of 11.4% from 2023, as Namibia remains a key player in cargo handling and transit for neighbouring countries. This performance was primarily driven by the Port Services subsector, which recorded a growth rate of 15.8% in 2024. Freight transport by road and air transport subsectors recorded growth rates of 9.7% and 8.1% respectively in real value added during the FY2024. In 2024, the transport sector contributed N$8.5 billion to GDP, and the storage sector nearly N$3 billion to GDP; that amounts to 2.3% and 1.2% of GDP, respectively (NSA, 2025).

The map below (**Figure 43**) shows the main road and rail network in the country. Note that the only international rail connection is at Ariamsvlei in the south, so there is no direct rail link from the manganese mines in the Northern Cape to Walvis Bay, except by road.

The Roads Authority (RA), whose core business is to construct and maintain the road infrastructure and the expansion of the road network, has contributed immensely to the economic development of Namibia and the SADC sub-region. Evidence of its road upgrading programme can be seen along sections of some national roads which will be used by the project, notably the B2 between Okahandja and Walvis Bay (see next section for more details).

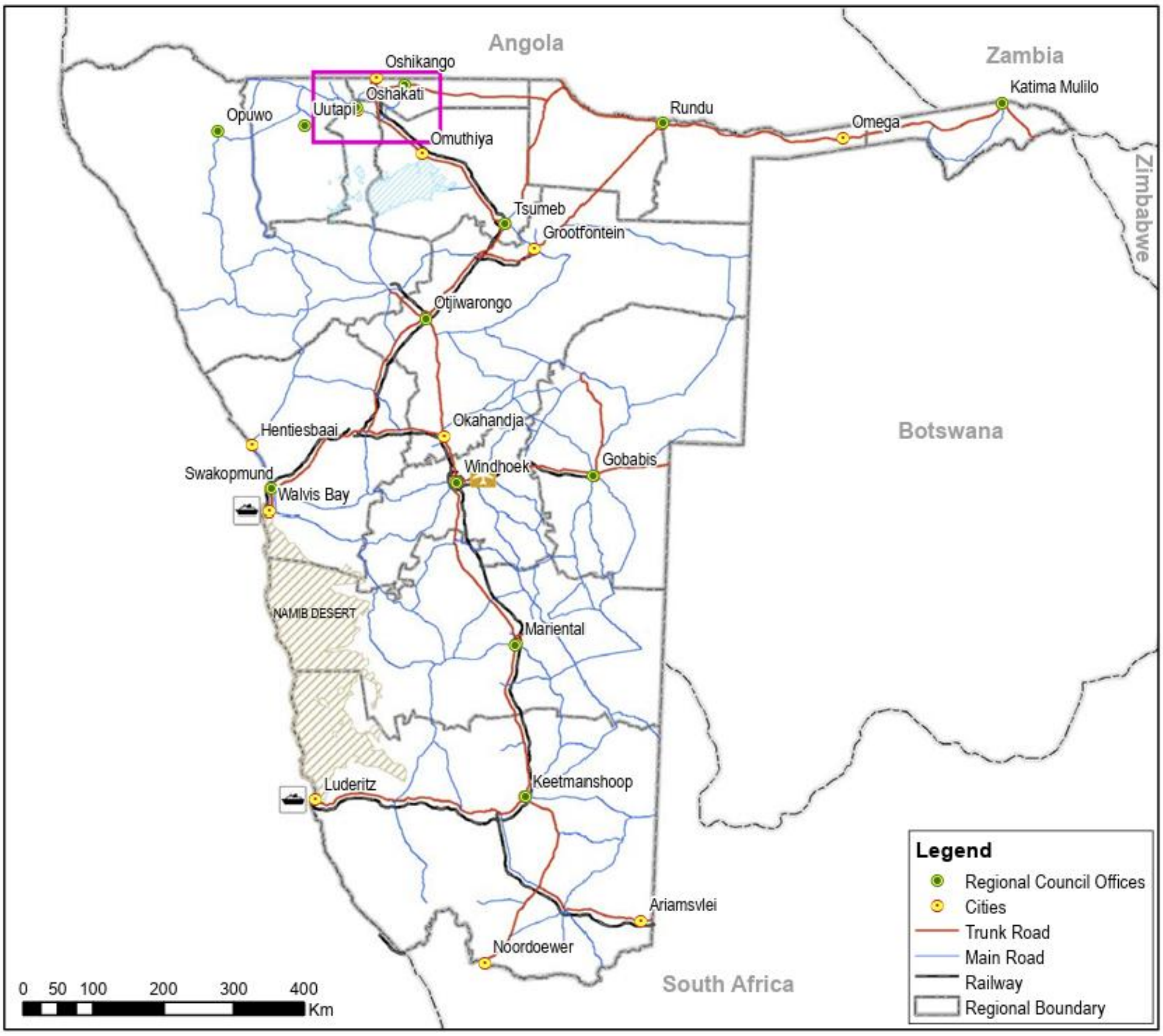

Figure 43: Map showing Namibia's main road and rail network.

Source: (NPC, 2015)

In 2024, according to a survey done by Statista[25], Namibia has the best quality road infrastructure in Africa. In terms of road conditions and extensiveness, the country reached an index rating of 5.57 on a scale from 1 (lowest) to 7 (highest). Egypt and Benin followed with scores of 5.53 and 5.00, respectively.

TransNamib is the national rail services operator in Namibia, and the Namibian rail system is linked to Transnet rail in South Africa near Ariamsvlei and to Angolan roads at Oshikango. TransNamib specialises in the transportation of bulk, break bulk and containerised freight. However, it has several major constraints which are hampering its potential contribution to the Logistics Hub plan. It is regarded as an unreliable operation, which struggles to make use of ageing locomotives and a lack of loading machines and facilities. Some sections of tracks between Walvis Bay-Kranzberg and Kranzberg –Windhoek are in a poor state and provide low reliability. Overall, it is still incapable of meeting an increasing potential demand for bulk cargo in Namibia due to the enormous investment expenditure required (NPC, 2015).

[25] https://www.statista.com/statistics/1285082/african-countries-with-the-highest-road-quality/ accessed on 13/4/2025

6.9.17 Community safety and corruption

During 2023/2024 fiscal year, NAMPOL recorded over 110,000 criminal cases nationwide with Khomas, Oshana, Otjozondjupa and Erongo Regions recording the highest rates at 33%, 11%, 8% and 8%, respectively. Crimes included robbery, rape and violence against women and children and other forms of domestic violence, murder, theft of motor vehicles and livestock, dealing in drugs, housebreaking and theft[26]. According to a Gallop poll of 120 countries in 2020/21, 41% of Namibians sampled did not feel safe walking streets alone[27].

In March 2025, The Namibian Police (NamPol) launched a Crime Intelligence Analytical Unit, which aims to combat transnational organised crime through data-driven policing strategies. It will form part of the broader ENACT (Enhancing Africa's Response to Transnational Organised Crime) project, supported by INTERPOL and the European Union and should give rise to a more sophisticated and coordinated approach to policing[28].

Namibia's law enforcement faces a range of challenges, including inadequate training, skills shortages, lack of resources, and corruption; social media has proven to be effective at exposing wrong-doing due to its prevalence. The justice system is burdened by backlogs, and criminal cases are often delayed, with inadequate resources and under-resourcing contributing to these problems.

The Corruption Perceptions Index is the leading global indicator of public sector corruption and Namibia has annually scored 49/100 from 2021 to 2024, on a scale of 0 (highly corrupt) to 100 (very clean)[29]. By comparison, Botswana's score has dropped from 65/100 in 2012 to 57/100, South Africa scored 41/100 and Zimbabwe 21/100 in 2024.

6.9.18 Link to Impacts

The following potential socio-economic impacts have been identified for further scrutiny in the EIA phase:

1. Positive economic impacts at local, regional and national levels
2. Potential impacts relating to job creation and skills development
3. In-migration and associated potential impacts on Walvis Bay, especially on housing and other infrastructure.

Other potential impacts which have been dismissed as insignificant are:

- Socio-economic impacts relating to Changes in Land Use, as the land is currently sandy desert, unoccupied, and unproductive.
- Socio-economic impacts relating to in-migration. The coastal towns experience on-going in-migration, and this project is unlikely to make a marked difference to Community Health, Safety and Security from a socio-economic perspective (IFC PS4).

[26] https://www.namibian.com.na/crimes-skyrocketing-in-namibia/ reported on 24/7/2024

[27] https://www.erongo.com.na/crime-ero/majority-of-namibians-feel-unsafe-report2022-11-11

[28] http reported on s://www.observer24.com.na/nampol-launches-intelligence-unit-to-fight-organised-crime/

[29] https://www.transparency.org/en/countries/namibia accessed on 14/4/2025

6.10 Transport Routes and Traffic Overview

The sections below draw on the Socio-Economic Assessment Study which includes the Traffic Impact Assessment compiled by independent consultant Auriol Ashby. The full report is attached as **Appendix M**, as well as the references stated in this report.

The roads to be used by project-related vehicles have had a series of name changes as clarified below:

v. The road section from Walvis Bay Traffic Circle to the Swakopmund Interchange was changed from C14 to MR36 & MR44 to **TR 2/1** (T0201 formally M0036 on the maps below). The road construction is scheduled to be completed in June 2027[30].

vi. The dual carriageway behind the dunes between Swakopmund and Walvis Bay, previously labelled the D1984, C34, A2, MR44 is now called the **Dr Hifikepunye Pohamba Freeway**.

vii. The B2 connecting Walvis Bay to the B1 at Okahandja is now named **T2/2** by the Roads Authority (also known as T0202) and links the Port of Walvis Bay to the rest of Namibia and the Southern African Development Community's (SADC) landlocked neighbouring countries via the Trans-Kalahari, Trans-Caprivi, and Trans-Cunene Corridors.

viii. The coastal road between Walvis Bay and Swakopmund is now called **M54**, previously called B2, M0054 and T0201.

During the proposed construction of the refinery and acid plant, it is anticipated that structural steel, piping and equipment will be imported through the Port of Walvis Bay and transported to site using the route marked T2/1 (formerly C14). Locally sourced materials for construction such as sand, gravel and cement and those for operations – lime and limestone - are likely to be transported to site using the Dr Hifikepunye Pohamba Freeway unless they are transported to Walvis Bay by rail and delivered to site via route T2/1 (C14).

It is anticipated that all project personnel will travel to and from the site to either Walvis Bay, along the T2/1 (C14), or to Swakopmund along the Dr Hifikepunye Pohamba Freeway and on to Arandis on the B2. Service vehicles are more likely to come from Walvis Bay, but some may be based in Swakopmund.

Figure 44 and **Figure 45** show the intersections. Here is a Road Over Rail Bridge between IC: Dune 7 and IC: 01 T0201 which was built specifically for the future construction of a railway to provide access to Farm 58. In addition, IC: Dune 7 Bridge is constructed to provide road access to Farm 58.

The access road to the Project site has yet to be determine. **The alignment of the access road needs to be stipulated by the Municipality of Walvis Bay as other erven are sited on Farm 58.**

[30] Pers Com Mr B. Sikanda (Project Engineer at Roads Authority of Namibia) by email on 31/3/2025.

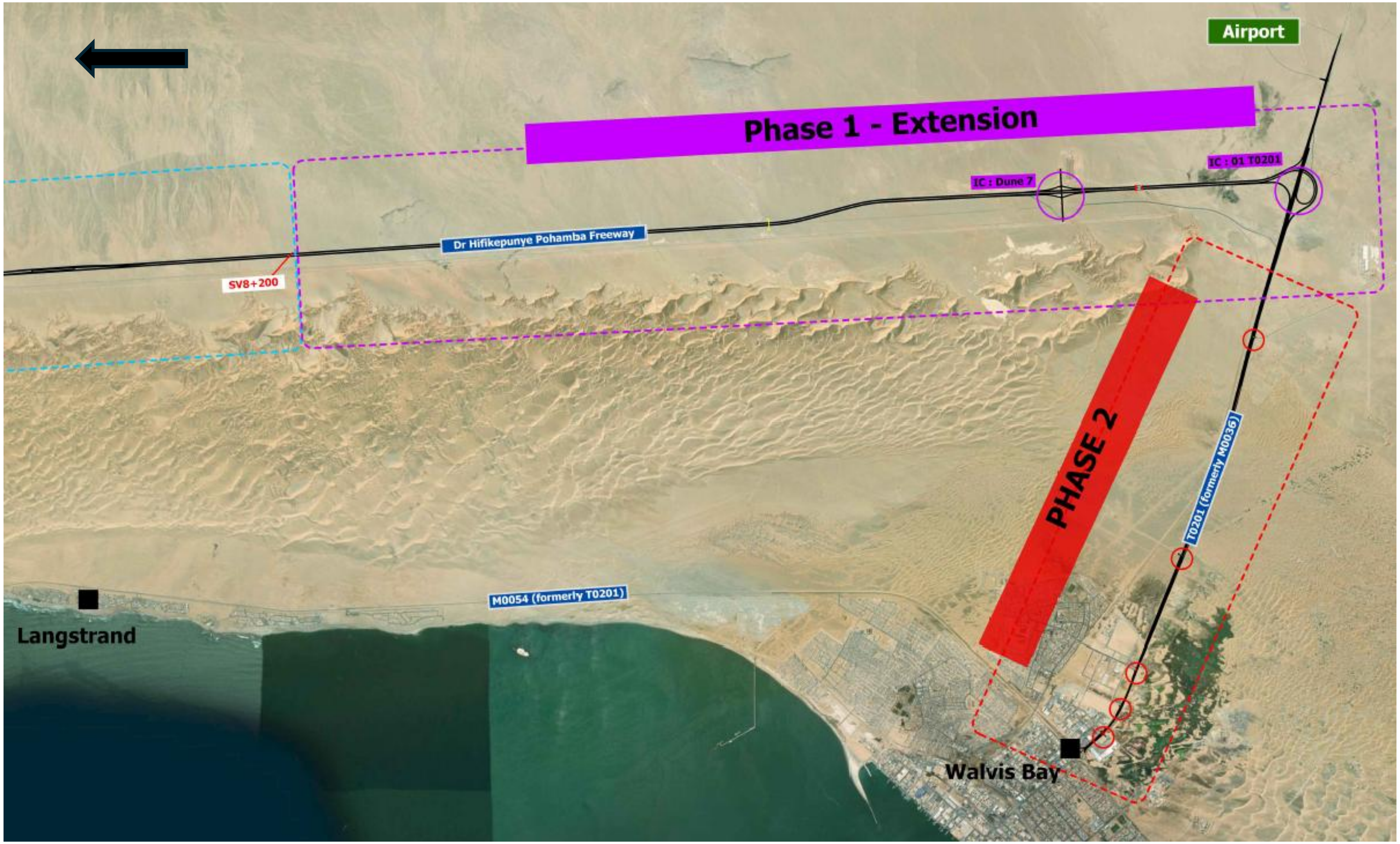

Figure 44: Road connections linking the Project site near Dune 7 intersection (the arrow indicates North).

Source: Roads Authority, March 2025

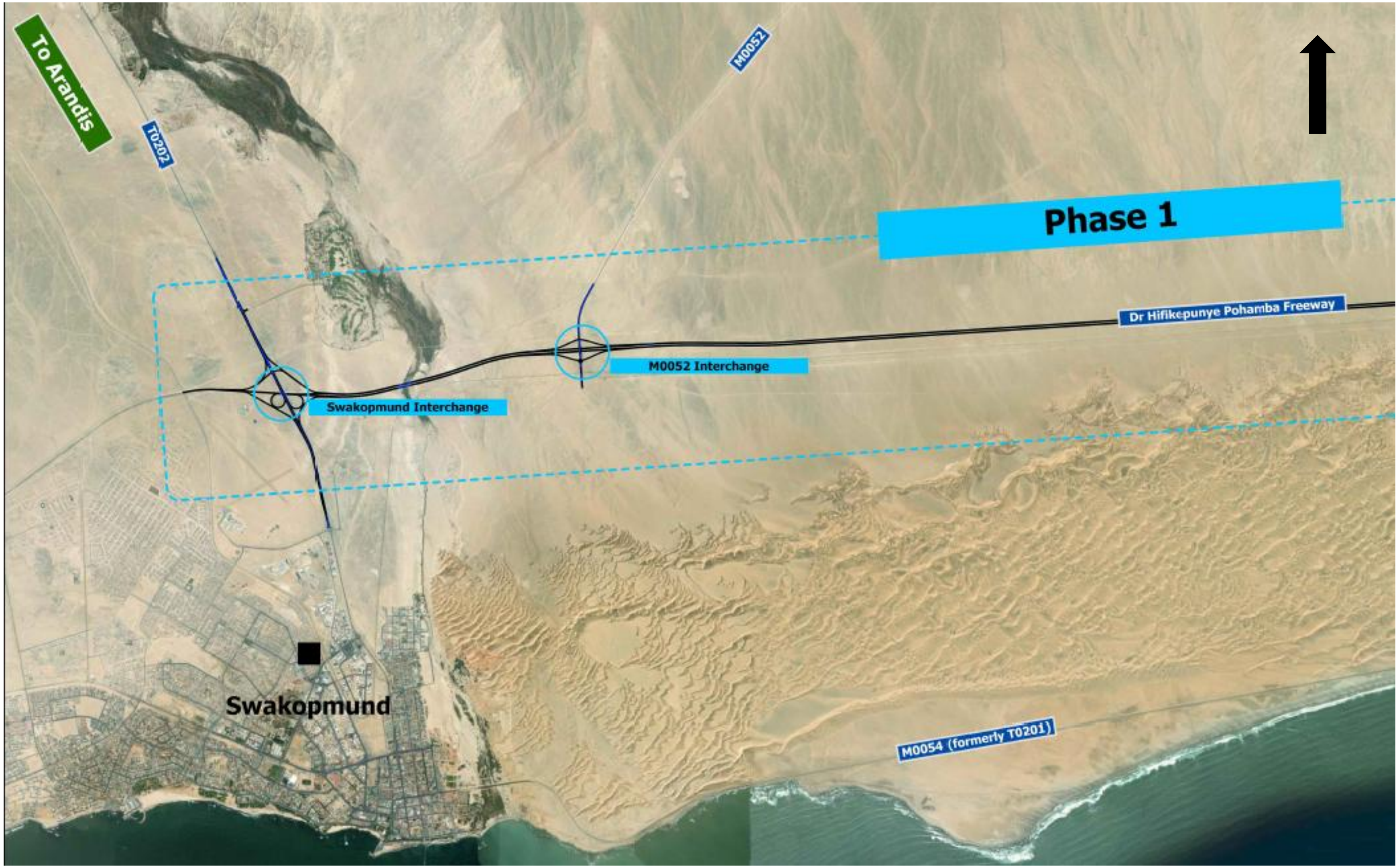

Figure 45: Road Interchanges with Swakopmund (the arrow indicates North).

Source: Roads Authority, March 2025

6.10.1 Link to Impacts

Traffic impacts will occur during the construction, operational and decommissioning phases when Project related vehicles make use of the public transport network to the Project site. The key potential traffic related impacts relate to road capacity and third party (i.e. public) road safety. These specifically relate to impacts of additional traffic on the Dr Hifikepunye Pohamba Freeway, T2/1 (C14) and T2/2 (B2).

6.11 Visual / Sense of Place, Land use, Surrounding Built Environment and Sensitive Receptors

6.11.1 Land use, Surrounding Built Environment and Sensitive Receptors

One of the major attractions to tourists visiting the NNNP and Dorob National Park and surroundings is the scenic beauty of the area. This is predominantly based on the absence of human activities and structures in most parts of the parks, coupled with the sense of remoteness.

The project area is located outside the Dorob National Park (bordering the Dorob National Park), wedged between the dune belt and the Rooikop outcrops, and bordered by the Walvis Bay airport to the south (**Figure 46**). Farm 58 and specifically the proposed Project area is not regarded as pristine, as it was used as a training ground for South Africa’s military base at Rooikop before Namibia’s independence in 1990. Although this is more than 30 years in the past, signs of these activities are still present in the form of graded roads and numerous tracks criss-crossing the area, many of which are still visible today. Some tracks have, however, partly recovered.

There are no communities living in the immediate vicinity of the project area. The nearest receptors are:

- Walvis Bay International Airport, situated approximately 4.5 km to the south of the proposed Project.
- Green Hydrogen Pilot Plant – approximately 3.5 km to the south-west of the proposed Project.
- Dune 7, a tourist attraction, but no permanent community – approximately 5.5 km to the south-west the proposed Project. This includes Dune 7 Adventures and Dune 7 Concession which was awarded in 2023 to Sandwich Dune Tours and Safari (see **Section 6.9.14**).
- Walvis Bays Town – the closest residents are approximately 10 km from the proposed Project.
- Informal settlements are located on Farm 37 and 33, approximately 8.5 km
- Rooikop Army Base southeast of the Walvis Bay International Airport
- The Topnaar Nama nomadic community – along the Kuiseb River between 30 to 40 km from the proposed Project (see **Section 6.9.6** for further details).

Other infrastructure in the area include:

- Dr. Hifikepunye Pohamba Freeway (D1984) that links Swakopmund to Walvis Bay and other road networks, as described in **Section 6.10**.
- Railway line.
- A powerline at the northern boundary of the proposed Project.
- Water supply pipelines.
- Various unnamed gravel tracks.

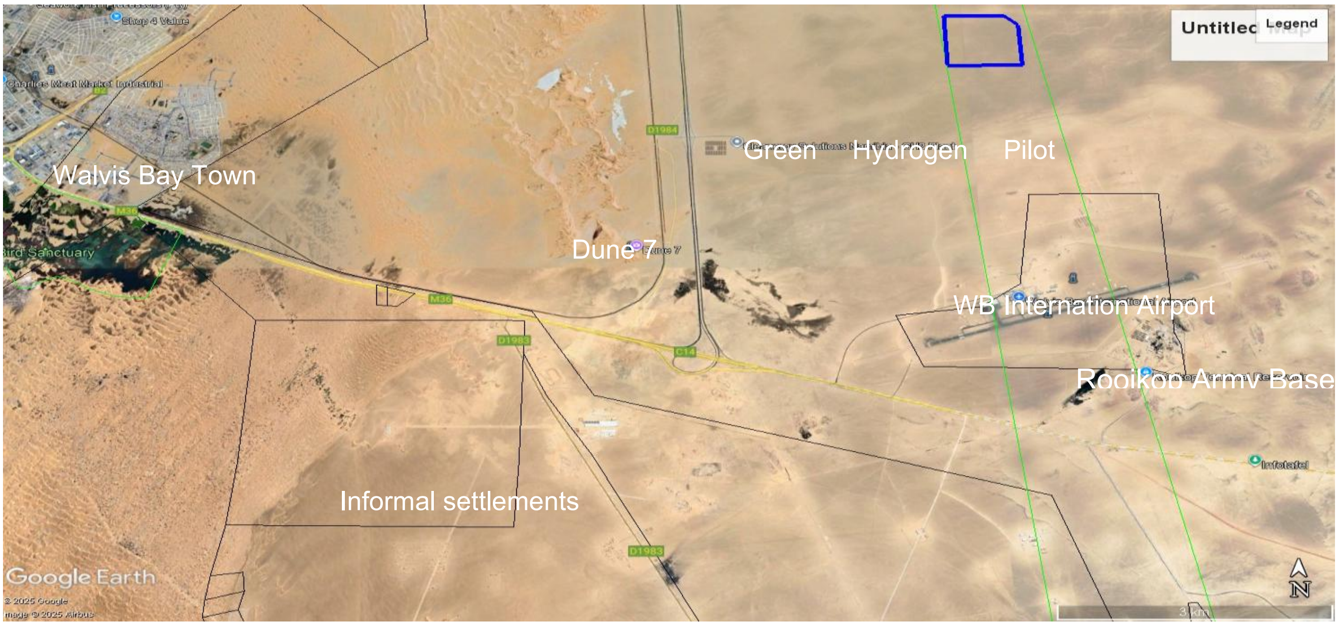

Figure 46: The map shows the nearest receptors to the project area (blue square).

6.11.2 Link to Impacts

Changes to the current topography through the development of the Project components may impact the visual aspects. Furthermore, lighting might cause impacts ("glow") at night.

The area is not pristine and, except for Dune 7 only commercial enterprise are in the closer vicinity. One also has to keep in mind that the proposed project is located within Farm 58, which has been zoned as a heavy industrial area for future planned development.

6.12 Aeronautical baseline in the region

The Walvis Bay Airport is located ~4.5 km south of the proposed Project area (see **Figure 46**). The runway is aligned approximately perpendicular to the proposed Project, therefore aircraft departing and approaching the airport is unlikely to fly directly over the Project Site and the proposed infrastructure.

With reference to **Section 2.4.1** and **Appendix D**, the Namibia Airports Company and the NCAA have communicated the following general safety considerations to be considered:

- Physical obstacles and height restrictions.
- Wildlife attractants (open water bodies, waste, vegetation).
- Fire, explosions, and emergency-response interactions.
- Air-quality and plume-dispersion risks.
- Visual disturbances and glare.
- Lighting and navigational interference.
- Electromagnetic interference (EMI).
- Construction-phase crane operations.

6.11.1 Link to Impacts

- Physical obstacles and height restrictions:

  Project infrastructure—such as stacks, chimneys, lighting masts, cranes, or temporary construction equipment—may infringe the airport's safeguarded airspace (typically within a 15 km radius). The airport authority must assess all permanent and temporary vertical structures to ensure compliance with obstacle-limitation and flight-path safety requirements.

- Wildlife attractants (open water bodies, waste, vegetation):

  Open water ponds, settlement basins, or poorly managed wastewater facilities may attract birds and other wildlife, increasing the risk of wildlife–aircraft collisions (bird strikes). Any infrastructure or landscaping that creates perching, roosting, or feeding opportunities near flight paths poses additional safety risk.

- Fire, explosions, and emergency-response interactions:

  The refinery's fire, explosion, and hazardous-materials risks could directly affect airport operations, air traffic, or evacuation routes.

- Air-quality and plume-dispersion risks:

  Emissions or dust clouds from stacks or process areas can impair pilot visibility or create turbulence/wake effects. Hot exhaust plumes may cause thermal lift or distort visual references during take-off and landing.

- Visual disturbances and glare:

  Excessive smoke, dust, night-time lighting, and reflections ("glint and glare") from metal roofs, water surfaces, or vehicles may impair pilot visibility or create distractive light sources near approach paths.

- Lighting and navigational interference:

  Bright industrial lighting or illuminated signage may be confused with aviation navigation lights. Glare or light pollution can reduce the visibility of runway lights or guidance systems.

- Construction-phase crane operations:

  Tall cranes can temporarily breach obstacle-limitation surfaces, requiring prior notification and approval. Frequent lifting operations may also create dust plumes affecting visibility.

All of the above aspects and associated potential impacts are qualitatively assessed in **Section 7.3.7**.

Electromagnetic interference (EMI) relating to large industrial facilities, heavy machinery, or communication systems may cause interference with radar, radio communication, or navigational equipment if not properly screened or coordinated with aviation authorities. Due to the proposed project's location in relation to the airport and the type of equipment that does not generate strong electromagnetic fields, switching noise, or radio-frequency emissions, this impact has been screened out and not further assessed in **Section 7.3.7**.

GMRN would, however, further engage with the NCAA, and the Namibia Airports Company prior to the implementation of the Project to share information on the final design layout and height of the proposed infrastructure (e.g. stacks) or other info as required – beyond the EIA process. This relates to the requirements that an application for the erection of permanent and / or temporary structures must be made prior to the project's implementation (see **Section 3.10**).

7 ASSESSMENT OF POTENTIAL IMPACTS

This Section describes and assesses the significance of potential impacts associated with the proposed GMRN Manganese Refinery and Sulphuric Acid Plant on Farm 58 near Walvis Bay for the unmitigated and mitigated scenarios and summarises key management and mitigation measures and design requirements necessary to avoid or reduce potentially significant impacts.

Potential environmental impacts were identified by ASEC and the team of environmental specialists in consultation with I&APs, regulatory authorities and GMRN. With reference to **Section 2.3.1**, the terms of reference for further specialist investigations were developed as a result of the Scoping Phase and presented in the Scoping Report (ASEC, 2025), which has been approved by MEFT (refer to **Appendix C** for a copy of the approval letter by MEFT).

This Section provides an assessment of the key impacts that the Project may have on the physical, social and economic environment, referring to the various specialist studies undertaken.

The impacts are discussed under issue headings in the various sections and considered in a cumulative manner where relevant, such that the impacts of the proposed Project are seen in the context of the baseline conditions described in **Section 6**. The assessment must therefore be read in conjunction with **Section 6**. All references stated in **Section 6** can be found in **Appendices F** to **M**.

7.1 Assessment Methodology

The discussion and impact assessment for each issue covers the construction, operational and decommissioning phases where relevant. This is described in each sub-section.

Key management and mitigation measures to address the identified impacts are discussed at the end of each section and included in more detail in the EMP that is attached in **Appendix A**. In most cases, unless otherwise stated, these management and mitigation measures have been taken into account in the assessment of the significance of the mitigated impacts.

In case of human-related impacts, the assessments focused on third parties and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by health and safety legislation, policies and standards, except for the risk assessment which assessed these impacts.

The approach and criteria used to assess the impacts and the method of determining the significance of the impacts comply with the Environmental Management Act, No. 7 of 2007 and its regulations. **Table 63** provides the impact assessment criteria and the approach for determining impact consequence (combining nature and intensity, extent and duration) and significance (the overall rating of the impact). Impact consequence and significance are determined from **Table 64** and **Table 65**, respectively.

All assessment ratings are provided as “negative” impacts, except if clearly stated as a positive impact.

Table 63: Criteria for assessing potential impacts.

IMPACT assessment criteria	
SIGNIFICANCE determination	Significance = consequence x probability
CONSEQUENCE	Consequence is a function of: • Nature and Intensity of the potential impact • Geographical extent should the impact occur • Duration of the impact

Ranking the NATURE and INTENSITY of the potential impact	
Negative impacts	
Low (L)	The impact has no / minor effect/deterioration on natural, cultural and social functions and processes. No measurable change. Recommended standard/level will not be violated. (Limited nuisance-related complaints).
Moderate (M)	Natural, cultural and social functions and processes can continue, but in a modified way. Moderate discomfort that can be measured. Recommended standard/level will occasionally be violated. Various third-party complaints expected.
High (H)	Natural, cultural or social functions and processes are altered in such a way that they temporarily or permanently cease. Substantial deterioration of the impacted environment. Widespread third-party complaints expected.
Very high (VH)	Substantial deterioration (death, illness or injury). Recommended standard/level will often be violated. Vigorous action expected by third parties.
Positive impacts	
Low (L) +	Slight positive effect on natural, cultural and social functions and processes Minor improvement. No measurable change.
Moderate (M) +	Natural, cultural and social functions and processes continue but in a noticeably enhanced way. Moderate improvement. Little positive reaction from third parties.
High (H) +	Natural, cultural or social functions and processes are altered in such a way that the impacted environment is considerably enhanced /improved. Widespread, noticeable positive reaction from third parties.
Very high (VH) +	Substantial improvement. Will be within or better than the recommended level. Favourable publicity from third parties.

Ranking the EXTENT	
Low (L)	Local: confined to within the project concession area and its nearby surroundings
Moderate (M)	Regional: confined to the region, e.g. coast, basin, catchment, municipal region, district, etc.
High (H)	National; extends beyond district or regional boundaries with national implications
Very high (VH)	International: Impact extends beyond the national scale or may be transboundary

Ranking the DURATION	
Low (L)	Temporary/short term. Quickly reversible. (Less than the life of the project).
Moderate (M)	Medium Term. Impact can be reversed over time. (Life of the project).

High (H)	Long Term. Impact will only cease after the life of the project.
Very high (VH)	Permanent

Ranking the PROBABILITY	
Low (L)	Unlikely
Moderate (M)	Possibly
High (H)	Most likely
Very high (VH)	Definitely

SIGNIFICANCE Description		
	Positive	**Negative**
Low (L)	Supports the implementation of the project	No influence on the decision.
Moderate (M)	Supports the implementation of the project	It should have an influence on the decision and the impact will not be avoided unless it is mitigated.
High (H)	Supports the implementation of the project	It should influence the decision to not proceed with the project or require significant modification(s) of the project design/location, etc. (where relevant).
Very high (VH)	Supports the implementation of the project	It would influence the decision to not proceed with the project.

Table 64: Determining the Consequence.

DETERMINING THE CONSEQUENCE					
INTENSITY OF IMPACT = LOW					
DURATION	**VH**	**Moderate**	**Moderate**	**High**	**High**
	H	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	M	**Low**	**Low**	**Low**	**Moderate**
	L	**Low**	**Low**	**Low**	**Moderate**
INTENSITY OF IMPACT = MODERATE					
DURATION	**VH**	**Moderate**	**High**	**High**	**High**
	H	**Moderate**	**Moderate**	**High**	**High**
	M	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	L	**Low**	**Moderate**	**Moderate**	**Moderate**
INTENSITY OF IMPACT = HIGH					
DURATION	**VH**	**High**	**High**	**Very High**	**Very high**
	H	**High**	**High**	**High**	**Very High**
	M	**Moderate**	**Moderate**	**High**	**High**
	L	**Moderate**	**Moderate**	**High**	**High**
INTENSITY OF IMPACT = VERY HIGH					
DURATION	**VH**	**Very high**	**Very High**	**Very High**	**Very high**
	H	**High**	**High**	**Very High**	**Very high**
	M	**High**	**High**	**High**	**Very High**
	L	**Moderate**	**High**	**High**	**Very High**
		L	**M**	**H**	**VH**

	EXTENT

Table 65: Determining the Significance.

DETERMINING THE SIGNIFICANCE					
PROBABILITY	VH	Moderate	High	High	Very high
	H	Moderate	Moderate	High	Very high
	M	Low	Moderate	High	High
	L	Low	Low	Moderate	High
		L	M	H	VH
		CONSEQUENCE			

7.2 Assessment of bio-physical Impacts

7.2.1 Potential Impacts on Surface Water and Groundwater

The information in this section was sourced from the water specialist study in **Appendix H** (S. Müller, 2025).

7.2.1.1 Alteration of drainage pattern and stormwater runoff

The project site occupies a gently dipping gravel plain covered with sheetwash deposits that are likely to soak up all but the most intense rainfall without creating much surface runoff. As described in **Section 6.2.4** there are only indistinct, shallow washes in the project area. Refinery infrastructure is thus unlikely to interfere with the existing drainage pattern or obstruct surface water runoff.

Note: The potential impacts associated with the change of habitat and water flow is assessed in **Section 7.2.2**.

Intensity, duration and extent

Project infrastructure will not interfere with the drainage pattern or be exposed to major stormwater damage risks, however, the placement of infrastructure will locally alter the flow conditions of the drainage lines in the development areas which could impact habitats (this issue is assessed in **Section 7.2.2.2**). No or very little impact is expected; the extent of the impact is local and the damage, if any, can be reversed at the end of the project. The intensity is rated as **Low**.

Consequence and Probability

The determining consequence is **Low**. Major rainfall events causing storm damage could occur during any rainy season, the average probability is however, unlikely (**Low**).

Significance

The described combination of factors results in a **low impact significance**.

Impact summary – alteration of drainage pattern and stormwater runoff

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	L	L	L	L	L	L
Mitigated	L	L	L	L	L	L

Mitigation Measures

No mitigation measures will be required to reduce the low environmental impact. The company may consider stormwater diversion berms to reduce the risk of damage and a stormwater pond to capture runoff for use in the process; these must be fenced off to avoid attraction of wildlife.

7.2.1.2 Water pollution

Surface and groundwater pollution from mineral waste facilities, general waste management and sewage or hydrocarbon spills is one of the main environmental risks experienced at industrial sites. It requires continuous management and awareness training. Waste types at the project will include domestic waste, general and hazardous industrial waste and medical waste. Hydrocarbons such as diesel and oil will be present in vehicles and storage tanks on site.

General and hazardous waste will be sorted and transported off-site to appropriate recycling or landfill facilities. Prior to removal, it will be stored on site in suitable containers to prevent littering and contamination of the environment. Mineral waste (dry ore processing residues with <15% moisture content, gypsum from the acid plant and brine from the water treatment plant) will be stored on site as shown in the site layout plan in **Section 4**.

As mentioned earlier, it is not certain if there are any appreciable volumes of groundwater at Farm 58, and if there is water, it will almost certainly be saline, i.e. not complying with the Namibian water quality standards and unfit for human consumption or stock watering. The international principle of highest beneficial use, which states that the water quality should be preserved to remain fit for the highest purpose to which it is currently being put, should be applied in this case.

Highest beneficial use means, for instance, if an aquifer supplied drinking water to a farm before the onset of pollution, the water quality must be maintained within the limits of the drinking water standards. In the case of GMRN, the highest beneficial use may be 'sustaining the ecology'. As no water quality guidelines are in place to determine what level of deterioration the ecology can tolerate, the principle of keeping the impact 'as low as reasonably achievable' applies.

Intensity, duration and extent

The botanical survey of the area has not found any vegetation that directly depends on groundwater and could thus be affected by groundwater pollution, the assessment will therefore be confined to surface water pollution. The negative impact intensity is expected to be **Moderate** without mitigation, and **Low** if hydrocarbon or other spills are cleaned up before they can pollute surface water. The risk of hazardous spills will persist for the duration of the project (**Moderate**), but spills will only affect a small area (**Low**).

Consequence

The consequence of spills causing water pollution is **Moderate** (unmitigated) to **Low** (mitigated).

Probability

The probability of major spills that could contaminate surface water occurring several times during the project duration is **Moderate**, even if rainfall is rare.

Significance

To reduce the **unmitigated impact significance** of surface water pollution (**Moderate**), the recommended mitigation measures should be implemented to reduce the impact to **Low**, to avoid damaging soil and biodiversity and to comply with good industrial practice.

Impact summary – surface water pollution

Mitigation	Intensity	Duration	Extent	Consequence	Probability of occurrence	Significance
Unmitigated	**M**	**M**	**L**	**M**	**M**	**M**
Mitigated	**L**	**M**	**L**	**L**	**M**	**L**

Mitigation measures

- Two monitoring boreholes to be drilled, one upstream and one downstream of the mineral residue facility, to determine the background water quality before the start of operation and from then on, GMRN should regularly (e.g. annually) analyse groundwater samples to detect any pollution from seepage.
- Avoid spills during the transfer of waste materials to the mineral residue facility (refer to the section on waste management for spill control measures).
- Store hydrocarbons in bunded areas able to accommodate 110% of the largest container or tank, equip parked vehicles and generators with spill trays.
- Train employees in the importance of waste management and spill emergency response to avoid littering and to clean up spills immediately.

Recommended monitoring

Carry out regular inspections to detect spills and improper waste management.

7.2.1.3 Sewage disposal

The disposal of untreated effluents from ablution facilities at the office, refinery and acid plant could cause soil and water pollution and expose employees and wildlife to infectious diseases. The company is considering chemical toilets during the construction phase, which would introduce an off-site impact related to the effect of chemicals on the functioning of the Walvis Bay municipal sewage works and the treated effluent evaporation ponds – known as the 'bird sanctuary' – an important fauna habitat. During operation, the treated effluent will be re-used in the process.

Intensity, duration and extent

Negative impacts of poor sewage treatment will be limited by the arid environment. The main concerns are related to effluent potentially emerging on the surface, attracting insects, birds and animals (see further impacts link to Aeronautical risks in **Section 7.3.7**), while also causing odours and health risks. The intensity of this impact could be **Moderate**, reduced to **Low** through mitigation measures such as a proper choice and design of the sewage treatment system. The extent of the impact will be local (**Low**), and the risk of it occurring will persist for the duration of the project (**Moderate**).

Consequence and probability

In the worst case, the consequence and probability of improper sewage treatment would be **Moderate**, but the construction of a well-functioning treatment system would reduce it to **Low**.

Significance

These factors indicate a **moderate impact significance without mitigation** and a **low significance with mitigation**.

Impact summary – sewage disposal

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**M**	**M**	**L**	**M**	**M**	**M**
Mitigated	**L**	**M**	**L**	**L**	**L**	**L**

Mitigation measures

- Design an appropriate sewage system for the number of people working on site.
- If using chemical toilets or conservancy tanks take the effluent to the Walvis Bay sewage plant for treatment.
- Carefully consider the method of discharging or reusing treated effluent from a containerised treatment plant, if such a plant is chosen.
- Apply for a wastewater treatment and reuse licence from the Ministry of Agriculture, Fisheries, Water & Land Reform (MAFWLR) and comply with its conditions.

Recommended monitoring

- Monitor the treated effluent quality as required by the MAFWLR licence.

7.2.1.4 Water Consumption

GMRN's water demand for the refinery and acid plant will range from 150 000 m^3/a initially to 600 000 m^3/a at full capacity (see **Section 4.4.6**). Although NamWater has confirmed that enough spare capacity was available, the condition of the supply network restricts the volume of water that can be pumped from Swakopmund to Walvis Bay. Currently, the wellfields in the Kuiseb River that supply Walvis Bay are probably used at maximum capacity, and NamWater is supplementing the groundwater supply with desalinated seawater from the EDP. The availability of groundwater is limited by the dry climate and the fact that groundwater recharge only takes place in years with exceptionally good rainfall.

Significant volumes of desalinated water can only be pumped to Walvis Bay once the old pipeline from Swakopmund has been replaced – a process that has been proceeding in small stages for several years and hampered by budget constraints. Once the replacement has been completed, there will be more than enough water to supply the project, while the initial lower water demand can most likely be met from the Kuiseb groundwater resources.

Negative impacts related to the use of desalinated water include possible changes to the marine environment, which will not be discussed in this EIA, and the negative social impact arising from higher water tariffs that have to be charged to cover the substantial capital investment and operating cost of the planned NamWater desalination plant. NamWater has tried to address this impact by introducing blanket tariffs for all towns within the scheme and charging bulk water users more than the full cost of desalination.

The municipal tariffs are set to ensure that low-income groups can still afford their basic water needs, meaning that residential consumers in the medium to high-consumption brackets are carrying the additional cost. This aspect will not be assessed here as it is only indirectly linked to the project.

Intensity, duration and extent

A **moderate** (M) negative impact could be expected if the project's full water demand was supplied from NamWater's groundwater resources. A more likely scenario is the supply of mixed groundwater and desalinated water, which will reduce the intensity of the impact to **Low** (L). The duration of the impact will correspond to the project's life-time (**Moderate**), while the extent would be regional (**Moderate**) due to the interconnected nature of the NamWater scheme.

Consequence

The consequence of GMRN's water consumption without mitigation is **Moderate**. Mitigation measures such as increasing the supply of desalinated water to conserve groundwater are outside of GMRN's control, but the company is planning to treat and reuse as much wastewater as possible to reduce the input of fresh water into the process, so the mitigated impact will be **Low**.

Probability

In the unmitigated case, it may be possible (**Moderate**) that the additional strain on the Kuiseb scheme could cause supply shortages that affect other water users at Walvis Bay. Provided that NamWater's supply system is fully upgraded by the planned start of production, the probability that the project will negatively affect the regional water supply will be **Low**.

Significance

The described combination of factors results in **moderate impact significance without mitigation**, while the **mitigated scenario has a low impact**.

Impact summary – water consumption

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**M**	**M**	**M**	**M**	**M**	**M**
Mitigated	**L**	**M**	**M**	**L**	**M**	**L**

Mitigation measures

An important mitigation measure – upgrading the NamWater Central Namib Scheme – is outside of GMRN's control, but still listed here as an important prerequisite for the successful implementation of the project. The second mitigation measure is wastewater treatment and reuse to reduce the freshwater demand.

GMRN to ensure a water supply agreement with NamWater is in place before Construction commences.

A separate EIA for the infrastructure associated with the bulk water-supply infrastructure to the proposed Project site does not form part of this EIA application or report. GMRN will initiate this application process as soon as an agreement has been finalised with NamWater regarding the required infrastructure, connections and related arrangements.

Monitoring recommendations

Install flow meters and monitor the water consumption during the construction and operation of the project.

7.2.1.5 Cumulative Impacts

The project's water consumption could have a cumulative impact on the water availability for other users. In the unmitigated case, the additional strain on the Kuiseb water supply scheme could possibly cause water shortages affecting other water users at Walvis Bay. Provided that NamWater's supply system is fully upgraded by the planned start of production, the probability that the project will negatively affect the regional water supply will, however, be low.

7.2.2 Potential Impacts on Biodiversity

The information in this section was sourced from the biodiversity specialist study in **Appendix I** (EnviroScience, 2025).

The impacts are applicable to different phases of the project. The following apply to all phases:

- Loss of vegetation, lichens and associated biota,
- Change of habitat and water flow, and
- Introduction of invasive alien plants and animals.

Relevant during construction and operation are:

- The effect of dust and airborne pollutants,
- Change of natural lighting conditions at night,
- Domestic waste and open water attracting animals (which could cause risks to aeronautical safety – see **Section 7.3.7** for further details), and
- Spillage of chemicals and hydrocarbons.

Remaining relevant at decommissioning are:

- Dust from the MRF facility, and
- Open water attracting animals (see comments above).

7.2.2.1 Loss of vegetation, lichens and associated biota due to clearing of vegetation

The construction of infrastructure requires the clearing of vegetation, not only for the footprint of the buildings and structures to be erected, but also for temporary lay-down areas, parking areas and areas where machinery needs to move. It is expected that the entire project site will be affected. The project site is only sparsely vegetated with perennial plants largely confined to washes. However, the good rains in the project area in March 2025 resulted in a flush of annual vegetation on the plains and in drainage lines, showing that this area is by no means barren and supports narrow-range, endemic plants. This is despite disturbances in the past when the land was used as a military training ground. The required clearing presents a loss of vegetation and lichen biomass, which provides an important habitat and food source for animals.

Where there is presently no vegetation to be cleared, the surface will be compacted and/or sealed by the infrastructure to be built. This alters the soil structure, which may not allow the re-establishment of plants and lichens after the buildings and structures have been demolished and removed at closure.

Intensity, duration and extent

Natural processes are locally altered, because vegetation cover will be reduced, which results in a **moderate** intensity, while the extent is **low**, as the impact will be local, confined to the project area which has a small footprint. The duration will be **moderate** due to the fact that the project will be medium-term.

Consequence

The consequence of this impact is without mitigation and mitigation **moderate**, as vegetation needs to be cleared, soil compacted, and the Mineral Residue Facility will stay after project decommissioning.

Probability

In the unmitigated case, the rating is **very high**, as vegetation needs to be cleared and soil compacted for the infrastructure development. In the mitigated scenario, it will be reduced to **high** as mitigation measures may preserve some natural areas within the project's footprint.

Significance

The described combination of factors results in **high impact significance without mitigation**, while the **mitigated scenario has a moderate impact**.

Impact summary – Loss of vegetation, lichens and associated biota due to clearing of vegetation

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**M**	**M**	**L**	**M**	**VH**	**H**
Mitigated	**M**	**M**	**L**	**M**	**H**	**M**

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Minimise ground disturbance.
- Rehabilitate all areas necessary for construction only immediately and test different methods of facilitating natural recovery (e.g. lay-down, parking and movement areas).

Monitoring recommendations

- The testing of rehabilitation methods will require monitoring of the test sites.
- Develop a protocol to restore lichen cover (e.g. topsoil removal before construction and storage for rehabilitation).

7.2.2.2 Change of habitat and water flow

The placement of infrastructure will locally alter the flow conditions of the drainage lines in the development areas. Water flow will either be blocked or rerouted. This will likely affect the downstream plant populations. The rains in March 2025 illustrated that even these shallow washes can flow during rains. Rains also generate sheetwash, which is water running freely on the surface. Any disruption of natural flows will likely diminish the water received by plants further downstream, but can also create catchments for water where water flows are blocked by structures. The creation of catchment areas is not necessarily a negative impact, but it does present a change in habitat.

The vegetation on site captures airborne sand and silt, which accumulates beneath the plants' canopies. Those sand-trapping services will now be replaced by infrastructure. This may not necessarily be a negative impact on biodiversity, but the changed sand accumulation and erosion alter the habitats and ecological processes. This does not only affect biodiversity, but could also affect the operations.

Intensity, duration and extent

The intensity in the unmitigated and mitigated scenario is **moderate**, as natural processes such as water flow and sand trapping are altered and vegetation cover removed. The extent in both, unmitigated and mitigated scenario, is **low**, as it is confined to project area. The duration in the unmitigated and mitigated scenario is **high**.

Consequence

The consequence of this impact is without mitigation and mitigation **moderate**, as vegetation needs to be cleared, soil compacted, and the Mineral Residue Facility will stay after project decommissioning.

Probability

Probability is **high** in unmitigated scenario, but **moderate** in mitigated scenario.

Significance

The described combination of factors results in **moderate impact significance without mitigation** and in the **mitigated scenario**.

Impact summary – Change of habitat and water flow

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**M**	**L**	**H**	**M**	**H**	**M**
Mitigated	**M**	**L**	**H**	**M**	**M**	**M**

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Maintain surface drainage channels for water flow during operation, where possible.
- Where water flow needs to be rerouted, consider the effect on downstream ecosystems.
- Re-establish natural flow conditions as far as possible at closure.

Monitoring recommendations

- Monitor the changes in water flow and sand transport created by the infrastructure.

7.2.2.3 Introduction of invasive alien plants and animals

The movement of machinery and materials and the alteration of natural habitats could result in introducing invasive alien plants such as *Argemone* sp., *Datura* sp., *Nicotiana glauca, Prosopis* sp. and *Ricinus communis.* This is particularly a concern if material/machinery which has been in touch with infested areas moves onto site.

Artificial water sources such as the clarification pond, reservoirs and pipelines are likely a nucleus for the establishment of invasive alien plants.

The project site is close to a national park and bringing pets such as dogs and cats on site will affect the local fauna. Although close to Walvis Bay, the area supports populations of reptiles, invertebrates and birds that would be affected by cats' and dogs' hunting behaviour.

Intensity, duration and extent

The intensity in the unmitigated scenario is **high** and in the mitigated scenario **moderate**, as some of the alterations to natural processes can be avoided or reduced by implementing the proposed mitigation measures. The extent in both, the unmitigated and mitigated scenario, is **low**, as it is confined to project area. The duration in the unmitigated is **moderate** and can be reduced to **low** in the mitigated scenario, if appropriate management can avoid or reverse potential impacts.

Consequence

The consequence of this impact without mitigation is **moderate** and can be reduced with mitigation measures to **low**.

Probability

In the unmitigated scenario the probability is **moderate** and can be reduced to **low** in the mitigated scenario.

Significance

The significance is **moderate without mitigation**, while the **mitigated scenario has a low impact**.

Impact summary – Introduction of invasive alien plants and animals

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**H**	**L**	**M**	**M**	**M**	**M**
Mitigated	**M**	**L**	**L**	**L**	**L**	**L**

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Bring no material from alien-infested sites on site; i.e. check sites for invasive aliens before loading; if invasive aliens cannot be avoided, treat material with relevant herbicide and spray tyres and underbody of machinery and vehicles.
- Prohibit pets on site.

Monitoring recommendations

- Monitor sites where disturbance and/or additional water could potentially lead to the establishment of invasive alien plants.

7.2.2.4 Effect of dust and airborne pollutants on vegetation and lichens

Dust along unpaved roads affect metabolic processes of vegetation in the direct vicinity of the dust plumes. Dust can clog stomata (the plant's breathing pores) and result in a reduced capacity for gas exchange and thus ultimately photosynthesis. This impact will be mostly during construction, but could remain at a lower level if areas where vehicles and machinery move are not paved and where the raw material is handled. If no mitigation measures are implemented, then dust plumes could go beyond the project footprint. This includes dust containing manganese, which could also affect areas outside the project footprint (Airshed 2025b).

Emissions from the sulphuric acid plant release additional chemicals into the air. The modelling of the SO_2 emissions indicated that annual average SO_2 ground level concentrations are raised beyond acceptable human health standards within the project footprint (Airshed 2025). However, projected, elevated SO_2 concentrations go beyond the project footprint, and these could potentially impact ecosystems in the surrounding. Sulphur eruptions in the Atlantic Ocean are a natural, sporadic occurrence in this coastal area (Ohde et al. 2007), and plants and lichens may have adapted to elevated sulphur levels. In fact, these eruptions are necessary to the development of gypsum in the soil, which is an important factor to explain the distribution of the Namib's lichen fields (Lalley et al. 2006).

The mineral residue facility (MRF), which will remain at the site after decommissioning, has the potential to provide a source of dust which did not exist before the project was developed. This impact would occur during operation and after closure. It would be permanent if no mitigation measures are implemented.

Intensity, duration and extent

The intensity in the unmitigated and mitigated scenario is **moderate**, the natural processes continue in an altered way, as photosynthesis will be reduced in dust-covered vegetation. The extent in both, unmitigated and mitigated scenario, is **moderate**, as most nuisance dust is confined to project area, but beyond for the manganese plume and dust along unpaved roads. The duration in the unmitigated and mitigated scenario is **low** for unpaved areas and will likely reversible after rainfall events. However, for the MRF the duration is **very high** for the unmitigated scenario and can be reduced to **moderate** if appropriate mitigation measures are implemented.

Consequence

The consequence of this impact without mitigation is **moderate** to **high** and can be reduced with mitigations to **moderate**, especially if the MFR is covered and windblown manganese impacts are reduced.

Probability

In the unmitigated scenario, the probability is **moderate - high** because driving on unpaved roads will generate dust and MRF may generate dust. This can be reduced with mitigation (if the MRF is continuously covered) to **moderate** if mitigated.

Significance

The significance is **moderate - high without mitigation**, while the **mitigated scenario has a moderate impact**.

Impact summary – Effect of dust and airborne pollutants on vegetation and lichens

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**M**	**L / VH**	**M**	**M - H**	**M - H**	**M - H**
Mitigated	**M**	**M**	**M**	**M**	**M**	**M**

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Refer to management and mitigation measures provided in **Section 7.2.3**.
- Use dust suppression measures at all dust sources.
- Ensure sulphuric acid plant is equipped with appropriate filters for emissions to reduce air pollution to an internationally acceptable standard.
- Plan for appropriate cover on top of MRF.

Monitoring recommendations

- Monitor dust impact on vegetation and lichens.

7.2.2.5 Change of natural lighting conditions at night

Lights at night will attract night-active animals such as flying invertebrates and small mammals, for example, rodents, hares and jackals. This could also affect birds migrating at night, such as flamingos and pelicans.

Insects flying into the light would be killed, while the same could happen to mammals blinded by vehicle and machinery traffic on roads, resulting in collisions.

Intensity, duration and extent

The intensity in the unmitigated and mitigated scenario is **moderate**, behaviour of animals will be changed and some casualties of wildlife can be expected. The extent in both, unmitigated and mitigated scenario, is **low**, as it is confined to project area. The duration in the unmitigated and mitigated scenario is **moderate**, as appropriate management can avoid or reverse this impact.

Consequence

The consequence of this impact without mitigation and mitigation is **moderate**.

Probability

In the unmitigated scenario the probability is **moderate**, but can be reduced to **Low**, especially with mitigation measures in place casualties of wildlife can be reduced.

Significance

The significance is **moderate without mitigation**, while the **mitigated scenario has a low impact** rating.

Impact summary – Change of natural lighting conditions at night

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**M**	**L**	**M**	**M**	**M**	**M**
Mitigated	**M**	**L**	**M**	**M**	**L**	**L**

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Use down-lighting and low impact lighting (by selecting appropriate light fittings), avoid tall lights on the periphery, and use motion sensors where possible. Down-lighting shall be from non-UV lights where possible, as the light emitted at one wavelength will attract fewer insects. This will reduce the likelihood of attracting insects and their predators (i.e. herpetofauna).
- Avoid white light as far as possible.
- Confine lighting to the areas to be illuminated (i.e. downwards towards ground) and avoid illuminating the sky.

Monitoring recommendations

None

7.2.2.6 Domestic waste and open water attracting animals

Readily available domestic waste attracts scavenging animals such as jackals and crows. They will be drawn to areas where they could be killed by moving machinery and vehicles. Interaction with humans could result in changed behaviour and the animal losing the ability to fend for themselves in nature. There is also a possibility that diseases are spread by wild animals, if they are in close contact with humans.

The clarification pond associated with the RMF may attract birds. The water could contain traces of chemicals and may not be of an adequate standard as a safe drinking water source for wildlife.

Note: the attraction of animals to site could further lead to aeronautical safety risks. These potential impacts are assessed in **Section 7.3.7**.

Intensity, duration and extent

The intensity in the unmitigated and mitigated scenario is **moderate**, behaviour of animals will be changed and some casualties of wildlife can be expected. The extent in both, unmitigated and mitigated scenario, is **low**, as it is confined to project area. The duration in the unmitigated and mitigated scenario is **moderate** as appropriate management can avoid or reverse this impact.

Consequence

The consequence of this impact with or without mitigation is **moderate**.

Probability

In the unmitigated scenario the probability is **moderate**, but can be reduced to **Low**, especially with mitigation measures in place casualties of wildlife can be reduced.

Significance

The significance is **moderate without mitigation**, while the **mitigated scenario has a low impact** rating.

Impact summary – Domestic waste and open water attracting animals

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**M**	**L**	**M**	**M**	**M**	**M**
Mitigated	**M**	**L**	**M**	**M**	**L**	**L**

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Develop a waste management strategy/management plan that avoids exposing domestic waste to animals (closed temporary waste containers, regular removal to managed landfill)
- Cover all waste storage areas.
- Prohibit feeding of wild animals.

Monitoring recommendations

- Test the water quality of clarification ponds and if unsafe for wildlife, place bird deflectors and/or fence off.
- Monitoring of animals coming to site and if increase apply adaptive management

7.2.2.7 Spillage of chemicals and hydrocarbons polluting soil

Chemicals used for processing and hydrocarbons necessary for machinery and vehicles will have to be handled on-site. Spillage of these onto the ground surface will pollute the soil and, depending on the material spilt, make it unsuitable for plants to re-establish.

Nature, intensity, duration and extent

The intensity in the unmitigated and mitigated scenario is **moderate**, and plant growth or establishing of growth might not be possible in contaminated areas. The extent in both, unmitigated and mitigated scenario, is **low**, as it is confined to the project area. The duration in the unmitigated and mitigated scenario is **moderate** as appropriate management can avoid or reverse this impact.

Consequence

The consequence of this impact with or without mitigation is **moderate**.

Probability

In the unmitigated scenario the probability is **moderate**, but can be reduced to **Low**, as chances of incidents of this nature are reduced when mitigation measures are implemented.

Significance

The significance is **moderate without mitigation**, while the **mitigated scenario has a low impact** rating.

Impact summary – Spillage of chemicals and hydrocarbons polluting soil

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**M**	**L**	**M**	**M**	**M**	**M**
Mitigated	**M**	**L**	**M**	**M**	**L**	**L**

Mitigation measures

The following mitigation measures have been identified by the biodiversity specialist:

- Provide adequate bunding wherever chemicals and hydrocarbons are stored to contain potential, accidental spills.
- Develop protocols for accidental spillages for each potential pollutant and have the necessary clean-up materials readily available on site.
- Drip trays shall be positioned under stationary vehicles and plant machinery that are not actively moving around the plant, to collect hydrocarbon spills.
- If extensive spills have occurred, the area must be rehabilitated appropriately. This will require consultation with an ecologist and soil scientist specialising in the rehabilitation of polluted habitats. This will further decrease the magnitude of the anticipated impacts arising from accidental spills.

Monitoring recommendations

- Monitor treated soil pollution levels until appropriate standards are reached.

7.2.3 Impacts on Air Quality

The information in this section was sourced from the air quality specialist study in **Appendix F** (Airshed, 2025).

The establishment of an emission inventory formed the basis for the assessment of the impacts from of the proposed operation activities on the receiving environment. An emissions inventory comprises the identification of sources of emission, and the quantification of each source's contribution to ambient air pollution concentrations. Dispersion simulations use the emissions together with the source parameters and meteorological data to determine the impacts on the surrounding environment, including closest receptors (i.e. third parties).

Note: The impacts of dust on vegetation and lichens are assessed in **Section 7.2.2.4**.

7.2.3.1 Sources and activities resulting in air pollution

The construction phase will include the establishment of required infrastructure and associated facilities such as workshops, maintenance areas, stores, wash bays, lay-down areas, batch plant, fuel handling and storage area, offices, change houses, etc. Activities that would result in air pollution during the construction phase are listed **Table 66**.

Table 66: Construction activities resulting in air pollution.

Activity	Associated pollutants
Handling and storage area for construction materials (paints, solvents, oils, grease) and waste	PM(a) and fumes (VOCs)
Power and water supply infrastructure	SO_2; NOx; CO; CO_2(b); PM
Clearing and other earth moving activities	Mostly PM, gaseous emissions from earth moving equipment (SO_2; NOx; CO; CO_2)
Stockpiling topsoil and sub-soil	Mostly PM, gaseous emissions from front-end-loaders (FEL) (SO_2; NOx; CO; CO_2)
Foundation excavations	Mostly PM, gaseous emissions from excavators (SO_2; NOx; CO; CO_2)

Activity	Associated pollutants
Opening and backfill of material (specific grade) from borrow pits	Mostly PM, gaseous emissions from trucks and equipment (SO_2; NOx; CO; CO_2)
Establishing access roads (scraping and grading)	Mostly PM, gaseous emissions from trucks and equipment (SO_2; NOx; CO; CO_2)
Digging of foundations and trenches	Mostly PM, gaseous emissions from diggers (SO_2; NOx; CO; CO_2)
Delivery of materials – storage and handling of material such as sand, rock, cement, chemical additives, etc.	Mostly PM, gaseous emissions from trucks (SO_2; NOx; CO; CO_2)
General building/construction activities including, amongst others: mixing of concrete; operation of construction vehicles and machinery; refuelling of machinery; civil, mechanical and electrical works; painting; grinding; welding; etc	Mostly PM, gaseous emissions from construction vehicles and machinery (SO_2; NOx; CO; CO_2)

Notes: (a) Particulate matter (PM) comprises a mixture of organic and inorganic substances, ranging in size and shape and can be divided into coarse and fine particulate matter. Total Suspended Particulates (TSP) represents the coarse fraction >10μm, with particulate matter with an aerodynamic diameter of less than 10μm (PM_{10}) and particulate matter with an aerodynamic diameter of less than 2.5μm ($PM_{2.5}$) falling into the finer inhalable fraction. TSP is associated with dust fallout (nuisance dust) whereas PM_{10} and $PM_{2.5}$ are considered a health concern.

(b) CO_2 and methane are greenhouse gasses (GHG).

Activities during operation of the Project likely to result in pollutants to air are listed in **Table 67**.

Table 67: Operational activities resulting in air pollution.

Activity	Type of source	Associated pollutants
Off-loading and tipping of Mn ore and dry products	Fugitive source	Mostly PM(a), gaseous emissions from mining equipment (Diesel Particulate Matter [DPM], SO_2; NOx; CO; CO_2)
Primary and secondary crusher and grinder	Fugitive source	Mostly PM(c), gaseous emissions from machinery (PM, SO_2; NOx; CO; CO_2)
Tipping onto secondary and tertiary storage piles	Fugitive source	Mostly PM(c) and windblown dust from storage piles
Mineral residue facility (MRF)	Fugitive source	PM(c) from windblown dust
Transportation of product	Fugitive source	PM from vehicle entrainment on unpaved road sections and gaseous emissions from truck exhaust (PM, SO_2; NOx; CO; CO_2)
Refinery – metal extraction	Point source	Volatile- and non-volatile acids
Sulphuric acid productions	Point source	Gaseous emissions (SO_2; NOx; SO_3, CO; CO_2)

Notes: (a) Particulate matter (PM) comprises a mixture of organic and inorganic substances, ranging in size and shape and can be divided into coarse and fine particulate matter. Total Suspended Particulates (TSP) represents the coarse fraction >10µm, with particulate matter with an aerodynamic diameter of less than 10µm (PM_{10}) and particulate matter with an aerodynamic diameter of less than 2.5µm ($PM_{2.5}$) falling into the finer inhalable fraction. TSP is associated with dust fallout (nuisance dust) whereas PM_{10} and $PM_{2.5}$ are considered a health concern.

(b) CO_2 and methane are greenhouse gasses (GHG).

(c) Metals include mainly manganese.

7.2.3.2 Emissions Quantification

Construction Phase

The main pollutant of concern from construction operations is particulate matter, including PM_{10}, $PM_{2.5}$ and TSP. PM_{10} and $PM_{2.5}$ concentrations are associated with potential health impacts due to the size of the particulates being small enough to be inhaled. Nuisance effects are caused by the TSP fraction (20 µm to 75 µm in diameter) resulting in soiling of materials and visibility reductions. This could, in effect, also have financial implications due to the requirement for more cleaning materials.

All operations associated with the construction phase are listed in **Table 66**. Each of the operations has their own duration and potential for dust generation. It is therefore often necessary to estimate area wide construction emissions, without regard to the actual plans of any individual construction process. Quantified construction emissions are usually lower than operational phase emissions, and due to their temporary nature and duration, and the likelihood that these activities will not occur concurrently at all portions of the site; dispersion simulation was not undertaken for construction emissions.

The US EPA documents emission factors which aim to provide a general rule-of-thumb as to the magnitude of emissions which may be anticipated from construction operations (US EPA, 2006). The quantity of dust emissions is assumed to be proportional to the area of land being worked and the level of construction activity. The approximate emission factors for general construction activity operations are given as:

$$\mathbf{E = 2.69\ Mg/hectare/month\ of\ activity\ (269\ g/m^2/month)}$$

The PM_{10} fraction is given as ~39% of the US EPA total suspended particulate factor. These emission factors are most applicable to construction operations with (i) medium activity levels, (ii) moderate silt contents, and (iii) semiarid climates. The emission factor for TSP considers 42 hours of work per week of construction activity. Test data were not sufficient to derive the specific dependence of dust emissions on correction parameters, and because the above emission factor is referenced to TSP, use of this factor to estimate PM_{10} emissions will result in conservatively high estimates. Also, because derivation of the factor assumes that construction activity occurs 30 days per month, the above estimate is somewhat conservatively high for TSP as well.

Areas assumed to be cleared of vegetation for infrastructure development include Erf GMR and the access road. These are listed in **Table 68** with the calculated emissions. The duration for the construction was assumed to be 12 months.

Table 68: Estimated emissions from construction operations.

Construction area	Area (m^2)	Area (ha)	Emissions (tpa)		
			TSP	PM_{10}	$PM_{2.5}$

Erf GMR	865 398	86.54	232.79	81.48	40.74
Access Road	32.13	0.0032	0.10	0.04	0.02

Operational Phase

Quantification of emissions from the proposed Project include both fugitive releases (non-point releases) and stack (point-source) releases as listed in **Table 67**. Particulates are the main pollutant of concern from fugitive sources with gaseous emissions (i.e. SO_2, NOx, SO_3 and CO) primarily from the refinery and sulphuric acid plant stacks, and to a lesser extent from diesel combustion from mobile sources.

Stage 3 of the operational phase was selected to be assessed to determine the worst-case impacts.

The emission equations used to quantify fugitive emissions from the proposed activities are shown in Table 4-4, with the stack emissions provided in Table 4-5 (these are based on engineering design) in Air Quality Specialist Study (Airshed 2025) in **Appendix F**.

Both unmitigated and mitigated activities were assessed. The estimated control efficiencies as obtained from literature (NPI, 2012) for the various activities are given in Table 4-6 in Air Quality Specialist Study (Airshed 2025) in **Appendix F**.

A summary of estimated particulate emissions from the proposed Project operations is provided in Table 4-7, with the gaseous emissions provided in Table 4-5 and Mn emissions in Table 4-8 in the air quality specialist study (Airshed 2025) in **Appendix F**.

Emission contributions between the source groups are shown in **Figure 47** for Scenario 1 (with no mitigation in place) and the emission reduction due to mitigation in place (Scenario 2) are shown in **Figure 48**. With no mitigation in place (Scenario 1), crushing and screening are the main contributors to TSP emissions followed by wind erosion, with wind erosion the main source of PM_{10} and $PM_{2.5}$ emissions followed by crushing and screening. With mitigation measures applied as described in Table 4-6 in **Appendix F**, the overall emissions reduce by 78%.

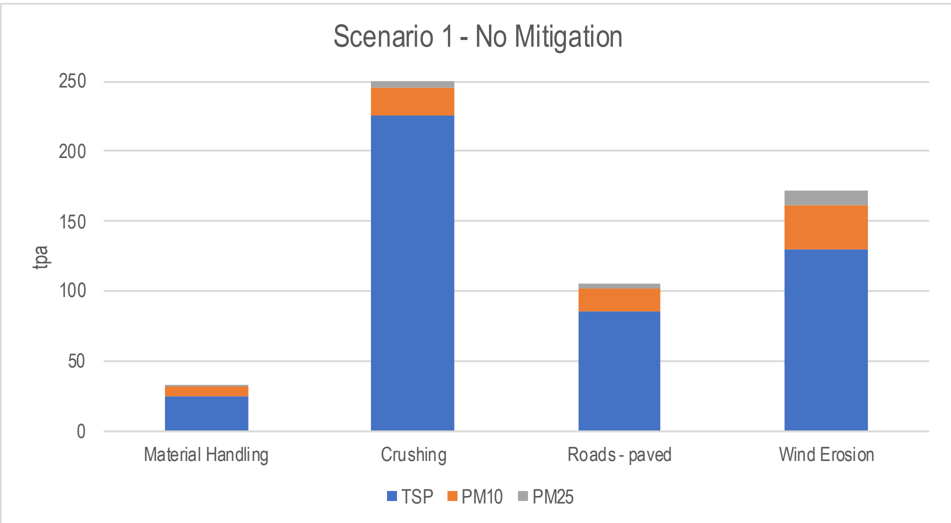

Figure 47: Emission contributions between the source groups with no mitigation in place: Scenario 1.

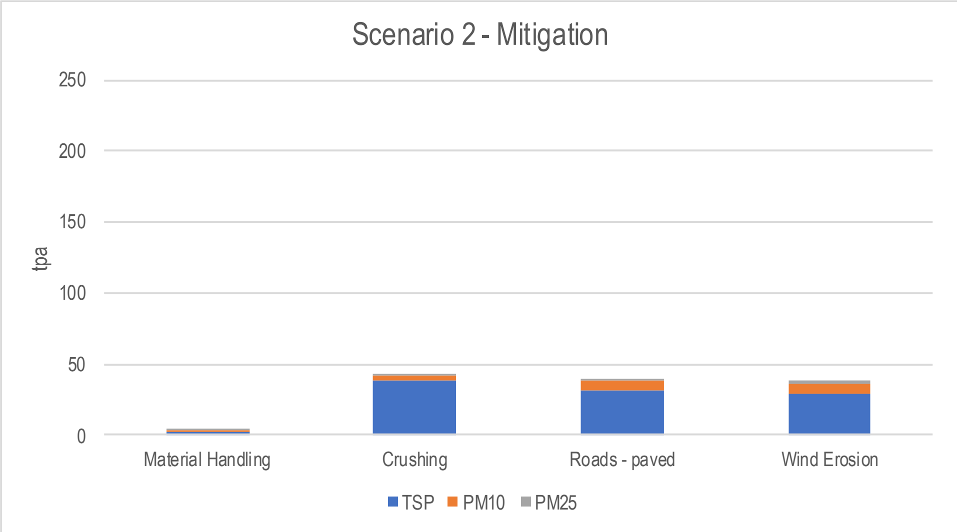

Figure 48: Emission reduction due to mitigation in place: Scenario 2.

Decommissioning

It is assumed that all the operations will have ceased by decommissioning of the Project. The potential for impacts during this phase will depend on the extent of rehabilitation efforts during decommissioning. Aspects and activities associated with this phase of the proposed operations are listed in **Table 69**. Simulations of the decommissioning phase were not included in the current study due to limited information and its temporary impacting nature.

Table 69: Activities and aspects identified for the decommissioning phase.

Impact	Source	Activity
PM emissions	Plant and infrastructure	Demolition of the plant and infrastructure
PM emissions	MRF	Dust generated during rehabilitation activities
Gaseous emissions	Vehicles	Tailpipe emissions from vehicles utilised during the closure phase

7.2.3.3 Dispersion Modelling Results

Dispersion modelling was undertaken to determine highest daily and annual average ground level concentrations (GLCs). Averaging periods were selected to facilitate the comparison of predicted pollutant concentrations to relevant ambient air quality and inhalation health criteria as well as dustfall regulations.

Pollutants with the potential to result in human health impacts which are assessed in this study include $PM_{2.5}$, PM_{10}, Mn, SO_2 and SO_3. Dustfall is assessed for its nuisance potential. Results are primarily provided in form of isopleths to present areas of exceedance of assessment criteria. Ground level concentration or dustfall isopleths presented in this section depict interpolated values from the concentrations simulated by AERMOD for each of the receptor grid points specified.

Isopleth plots reflect the incremental GLCs where exceedances of the relevant Air Quality Objectives (AQOs) **Table 15** (**Section 3.6.7**) were simulated.

It should also be noted that ambient air quality criteria apply to areas where the Occupational Health and Safety regulations do not apply, thus outside the property or lease area. Ambient air quality criteria are therefore not occupational health indicators but applicable to areas where the public has access i.e. off-site.

PM_{10}

The simulated highest daily and annual average PM_{10} GLCs for Scenario 1 (no mitigation) are provided in **Figure 49** and **Figure 50**, with the isopleth plots for Scenario 2 (mitigation) provided in **Figure 51** and **Figure 52**.

The main findings are:

- PM_{10} daily GLC for Scenario 1, with no mitigation applied to the activities, exceed the AQO (WHO IT-3 and SA NAAQS) for approximately 1 km to the east and along the access road to site (assumed that the road from the Green Hydrogen Pilot Plant will be extended to the Project site). With additional mitigation measures in place (Scenario 2), PM_{10} daily GLCs exceed the AQO (WHO IT-3 and SA NAAQS) only for small area to the northeast.
- PM_{10} annual GLC, for Scenario 1, exceed the AQO (WHO IT-3 and SA NAAQS) for approximately 100 m along the fenceline on the east and south. When mitigation measures are applied, there are no off-site exceedances.

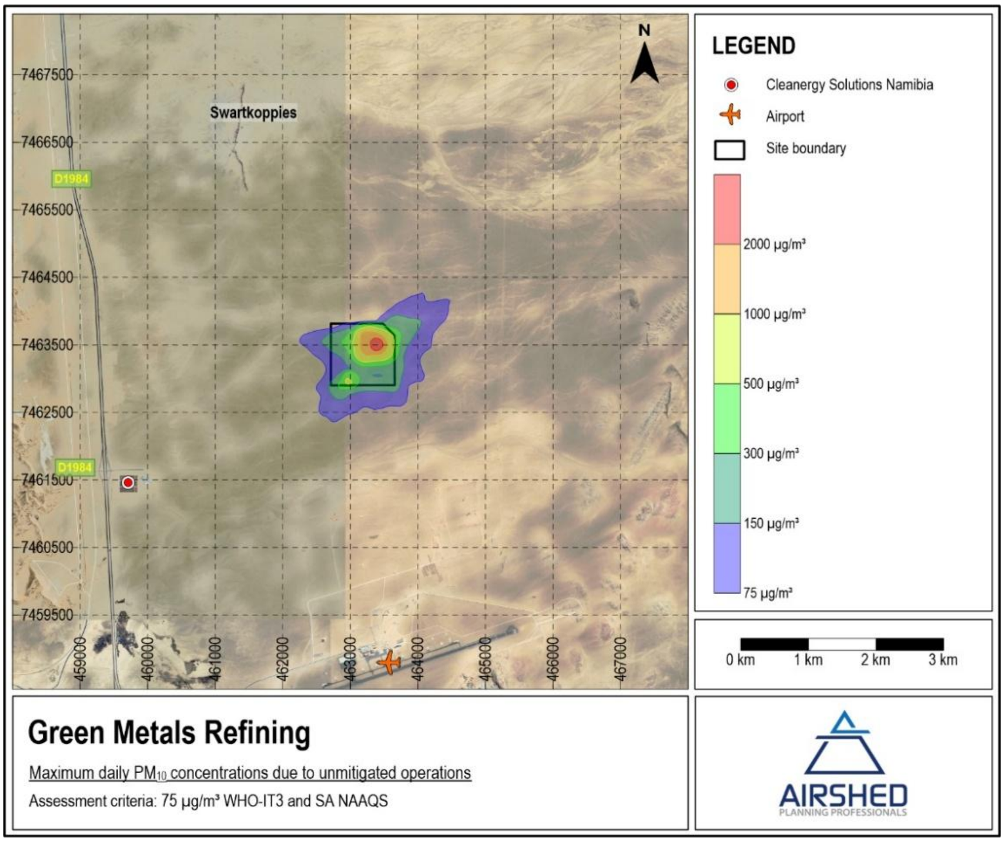

Figure 49: Area of non-compliance of daily PM10 AQO for Scenario 1 (no mitigation) for Stage 3.

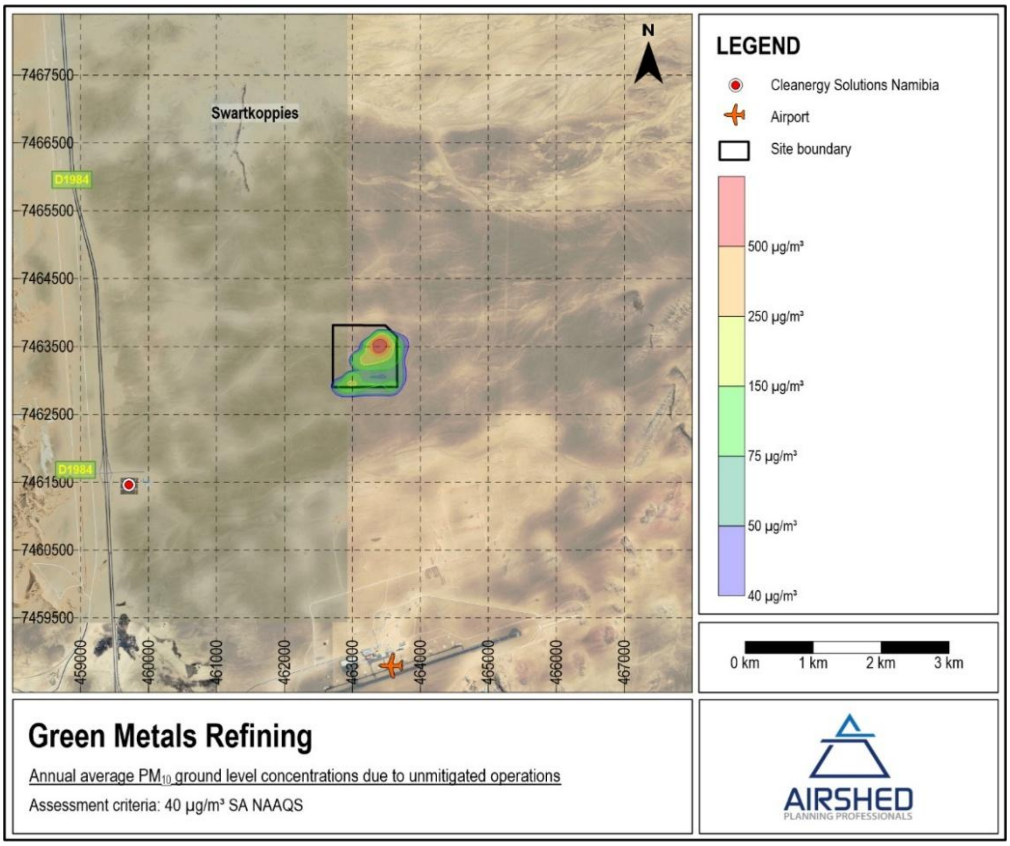

Figure 50: Annual average PM10 GLC for Scenario 1 (no mitigation) for Stage 3.

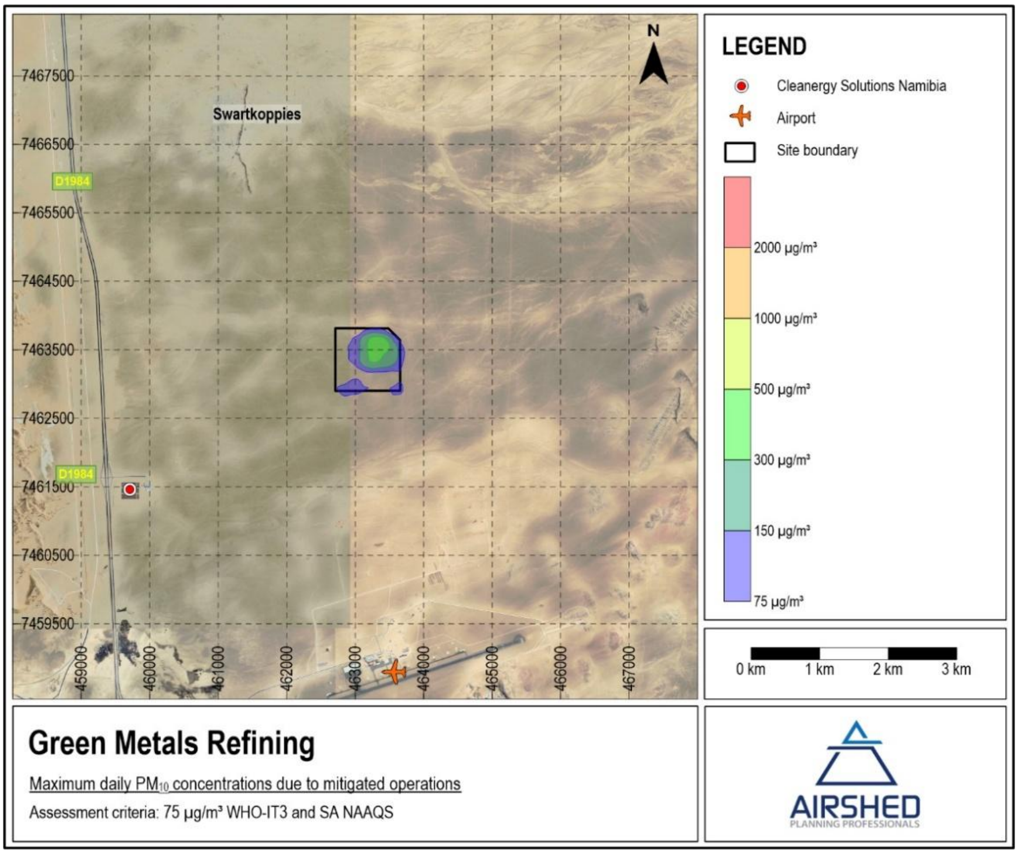

Figure 51: Area of non-compliance of daily PM10 AQO for Scenario 2 (mitigation) for Stage 3.

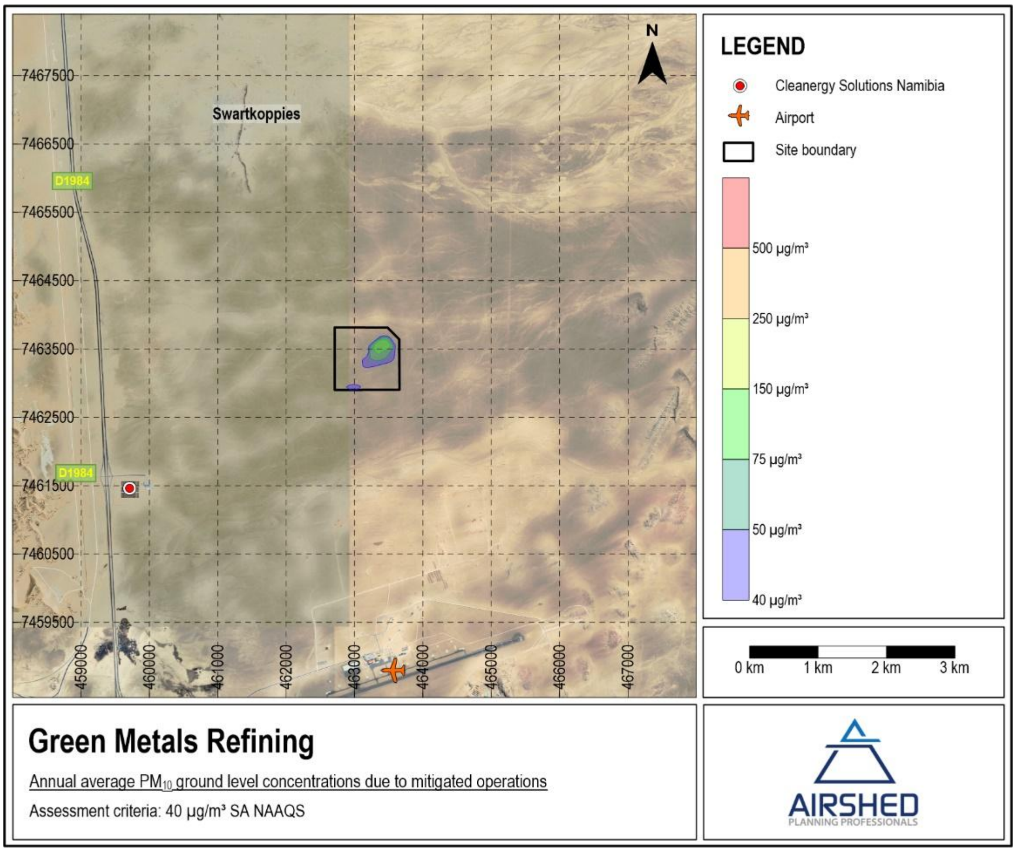

Figure 52: Annual average PM10 GLC for Scenario 2 (mitigation) for Stage 3.

$PM_{2.5}$

The simulated highest daily and annual average $PM_{2.5}$ GLCs for Scenario 1 (no mitigation) are provided in **Figure 53** and **Figure 54**, with the isopleth plots for Scenario 2 (mitigation) provided in **Figure 55** and **Figure 56**.

The main findings are:

- $PM_{2.5}$ daily GLC for Scenario 1, with design mitigation applied to the activities, exceed the AQO (WHO IT-3 and SA NAAQS) for approximately 500 m on the northeastern side of Erf GMR, and southwestern and western side. With design and additional mitigation measures in place (Scenario 2), $PM_{2.5}$ daily GLCs exceedance footprint reduces to about 200 m.
- $PM_{2.5}$ annual GLC, for Scenario 1, exceed the AQO (WHO IT-3 and SA NAAQS) only along the GMR boundary. When mitigation measures are applied there are no off-site exceedances.

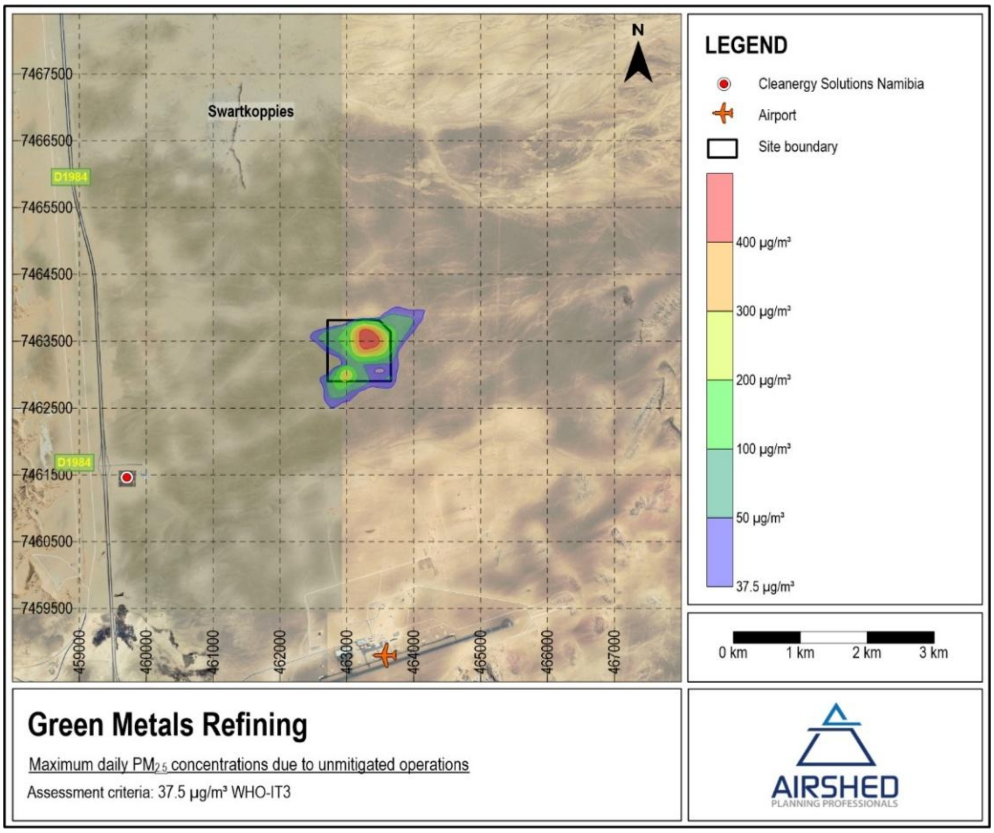

Figure 53: Area of non-compliance of daily PM2.5 AQO for Scenario 1 (no mitigation) for Stage 3.

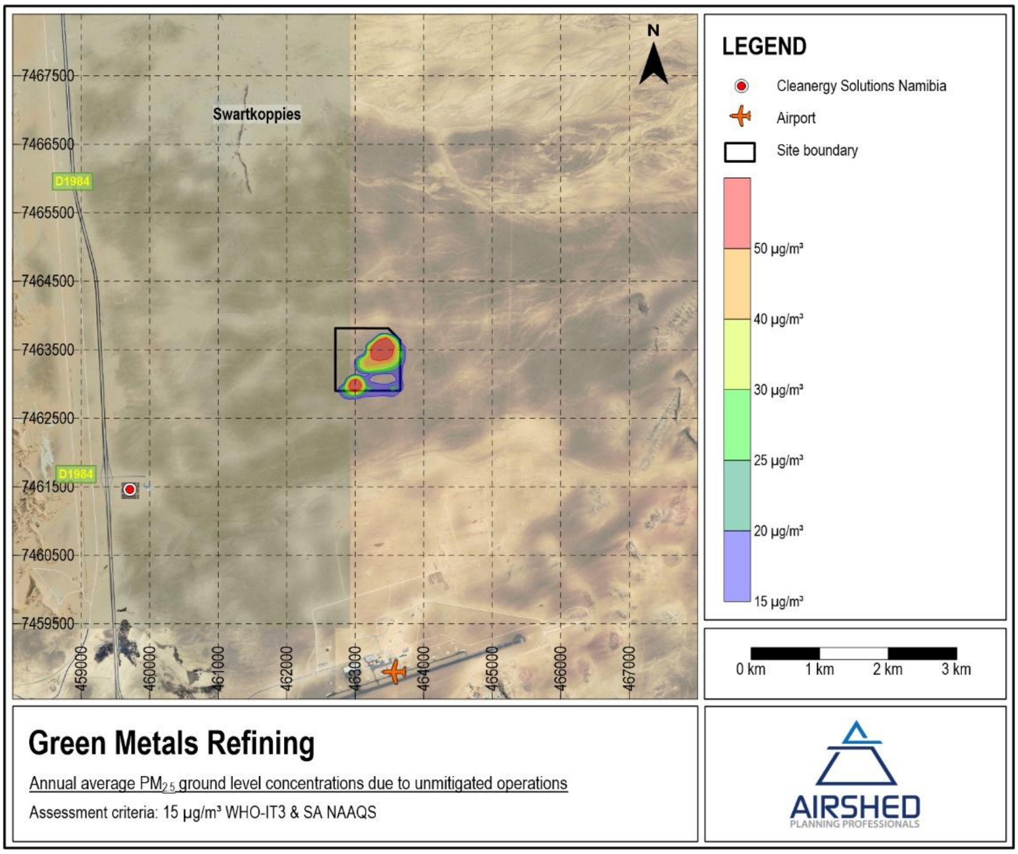

Figure 54: Annual average PM2.5 GLC for Scenario1 (no mitigation) for Stage 3.

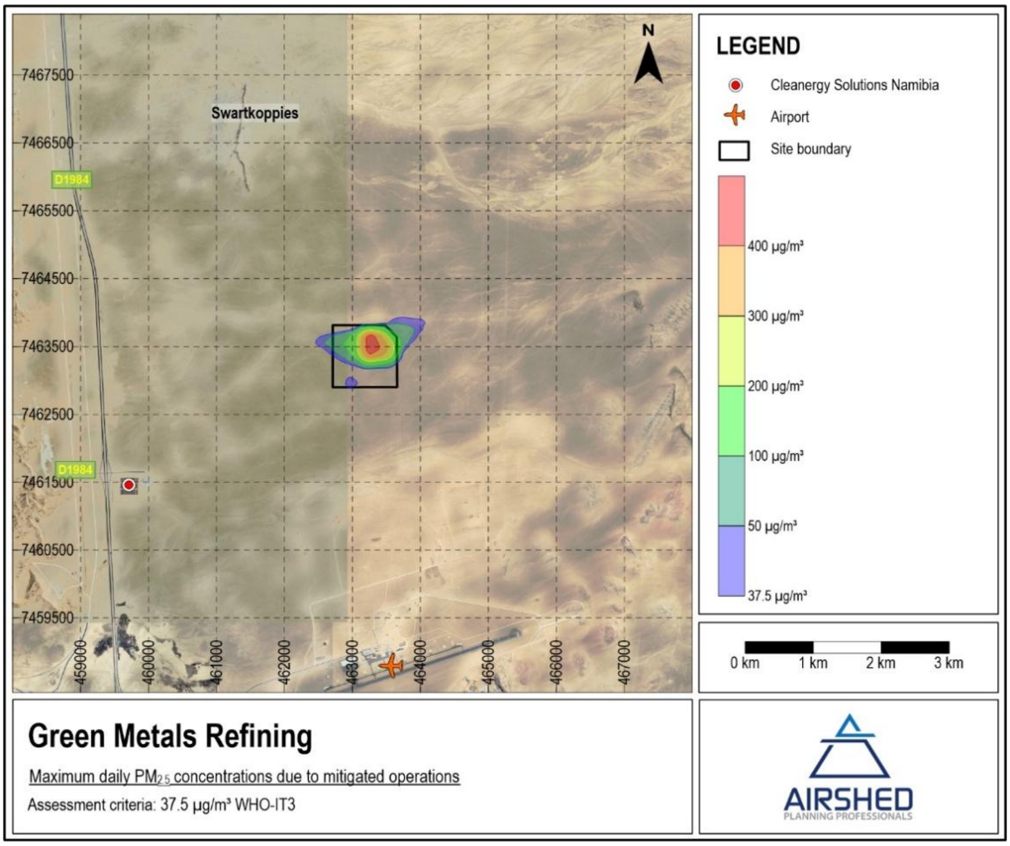

Figure 55: Area of non-compliance of daily PM2.5 AQO for Scenario 2 (mitigation) for Stage 3.

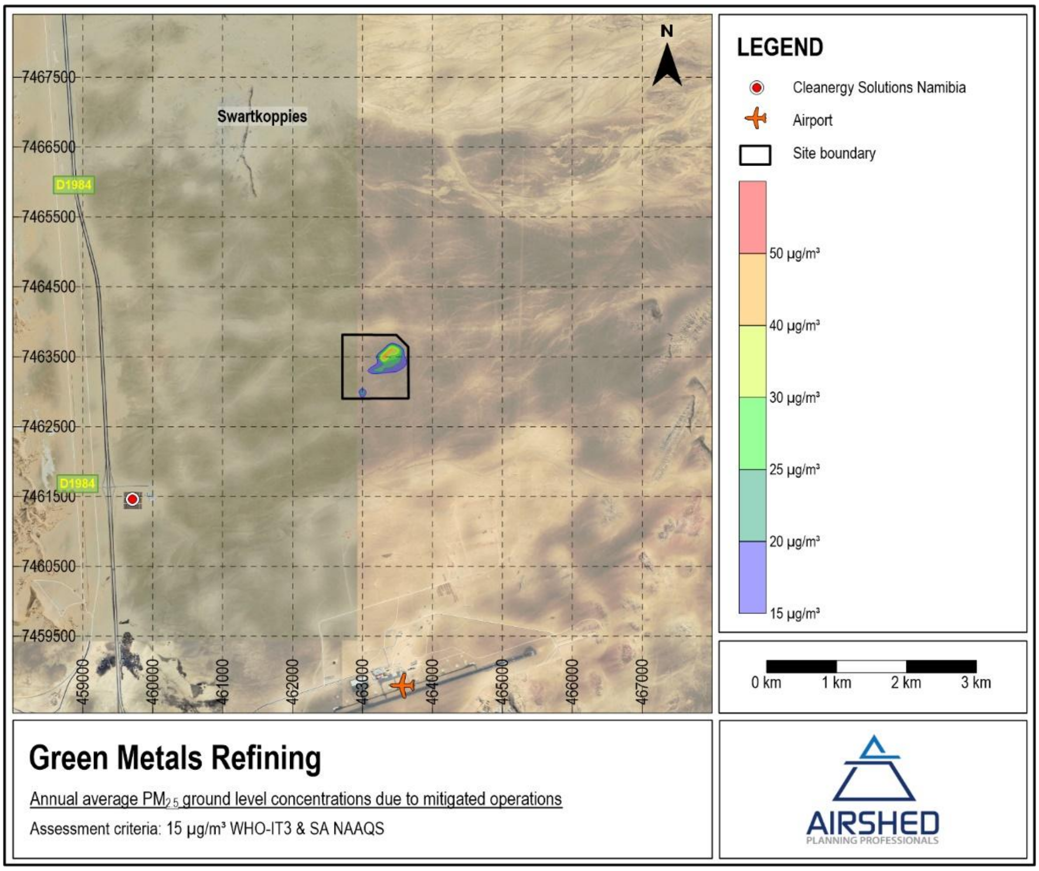

Figure 56: Annual average PM2.5 GLC for Scenario2 (mitigation) for Stage 3.

Manganese

Manganese (Mn) emissions within the PM_{10} fraction were modelled to assess potential health impacts. The modelled Mn annual average concentrations are shown in **Figure 57** for Scenario 1 (no mitigation) and in **Figure 58** for Scenario 2 (mitigation). Based on the estimated Mn content in the material, the impacts exceed the WHO limit for up to 3 km to the southwest and ~1.5 km to the northeast, but not at any sensitive receptors for Scenario 1. The impact area reduces significantly with mitigation measures in place (Scenario 2), exceeding up to about ~1 km from the site.

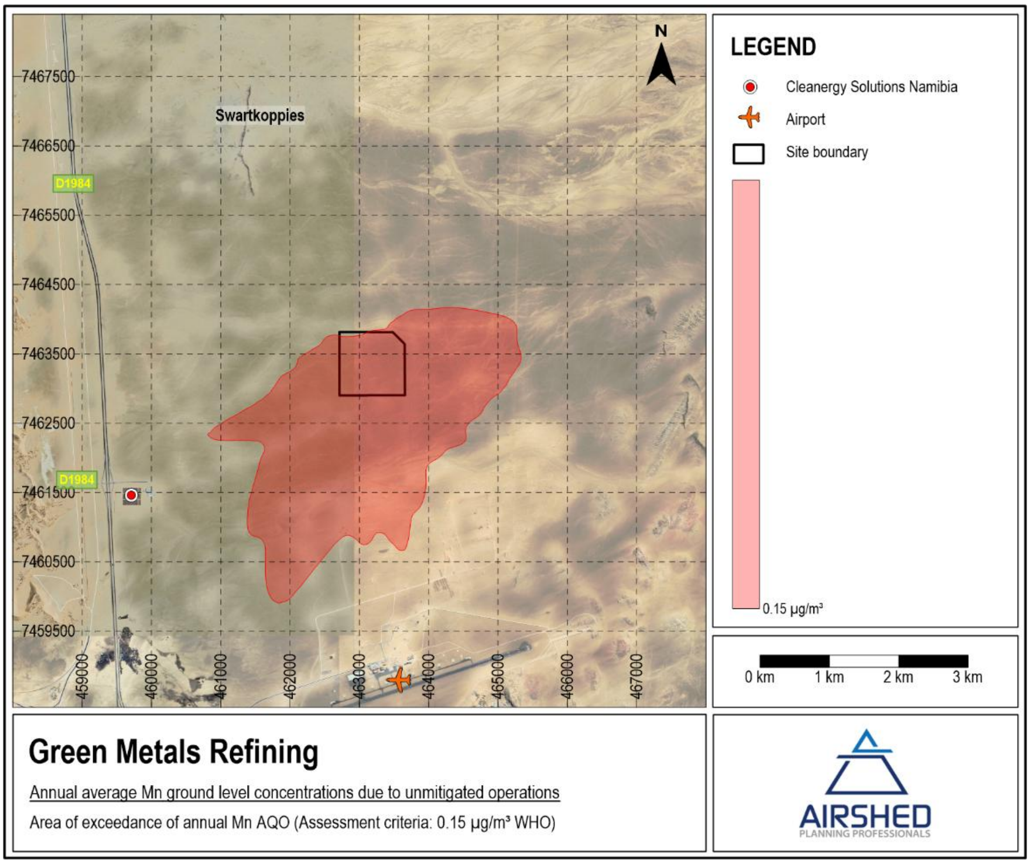

Figure 57: Annual average Mn GLC for Scenario 1 (no mitigation) for Stage 3.

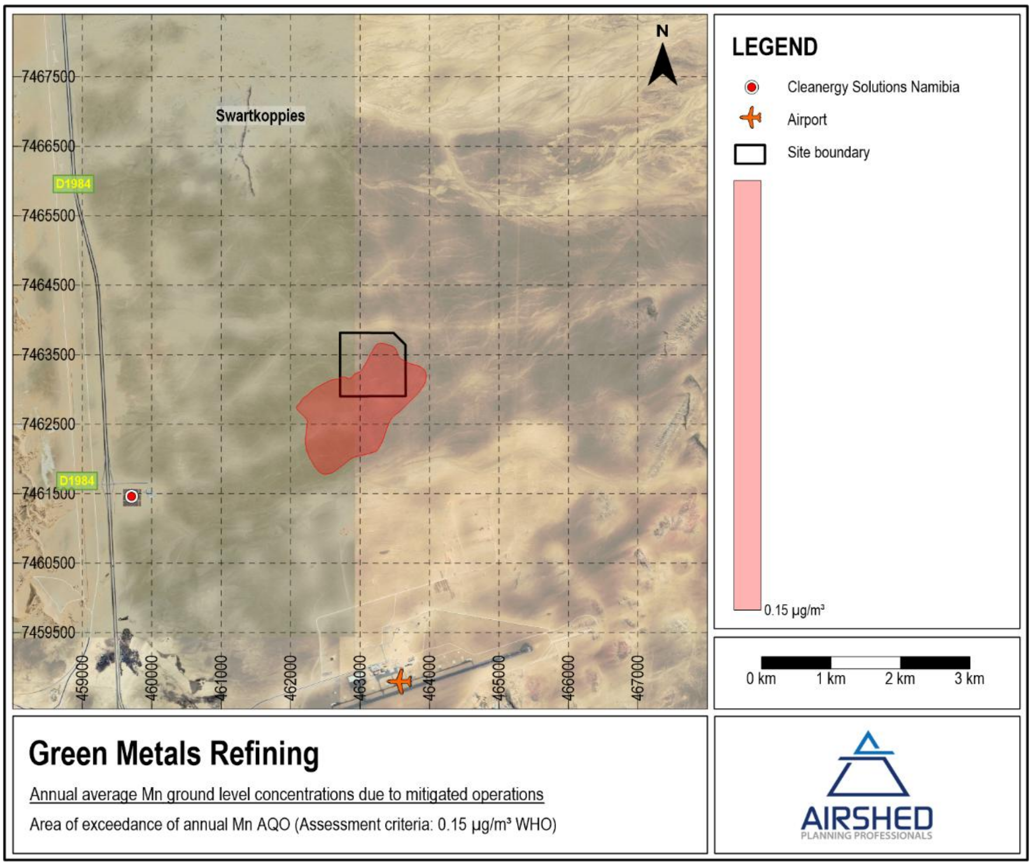

Figure 58: Annual average Mn GLC for Scenario 2 (mitigation) for Stage 3.

SO_2

The simulated highest hourly, daily and annual average SO_2 GLCs are low, with no exceedances of the respective AQOs off-site and no plots are included. The highest off-site GLCs are 85 µg/m³ for the highest hourly, 22 µg/m³ for the highest daily and 7.5 µg/m³ for the annual average.

SO_3

The simulated highest 8-hour average (**Figure 59**) and annual average (**Figure 60**) SO_3 GLCs result in no exceedances of the AQO off-site. The highest annual average GLC is 0.9 µg/m³.

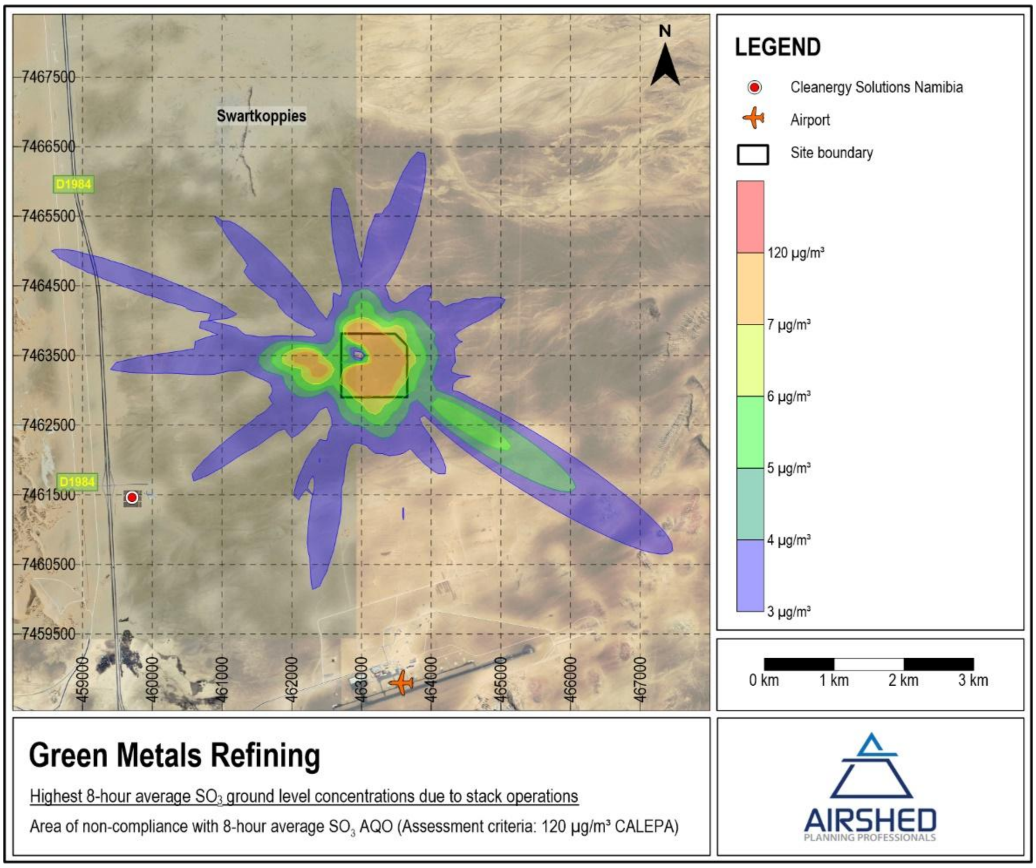

Figure 59: Acute (8-hour average) SO_3 GLC for Stage 3.

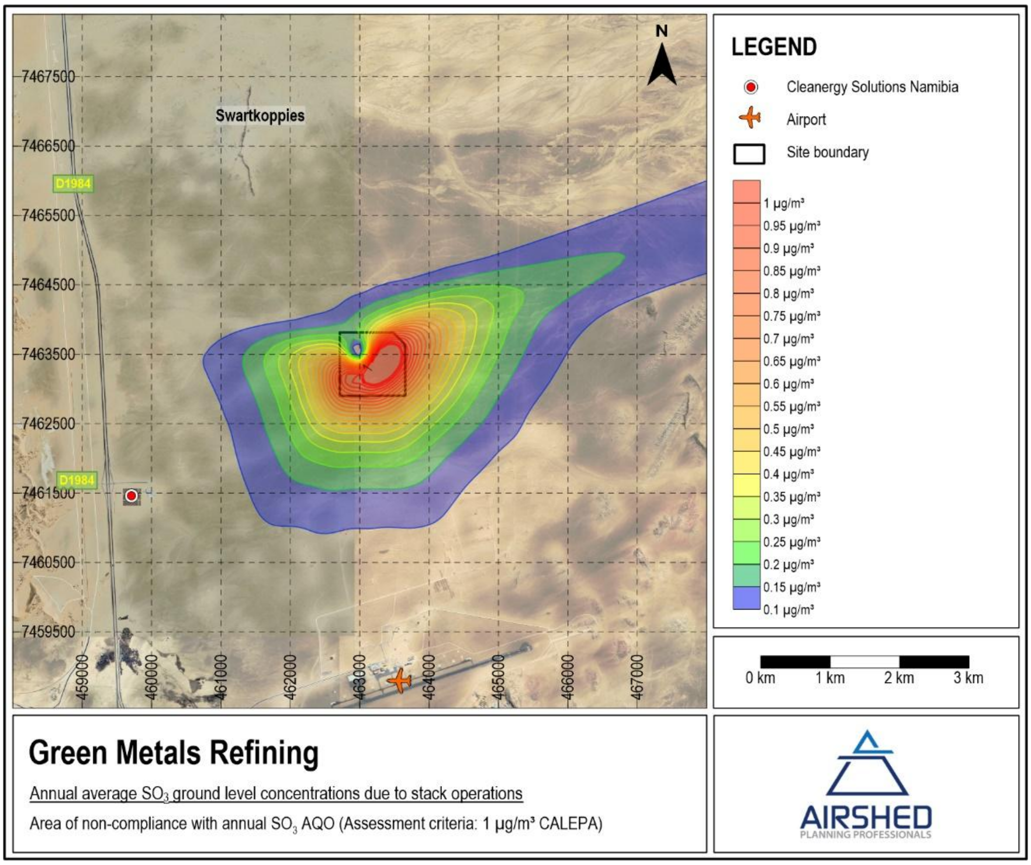

Figure 60: Annual average SO_3 GLC for Stage 3.

Dustfall

The simulated maximum daily dustfall rates for the proposed operations are provided in **Figure 61** for Scenario 1 (no mitigation) and **Figure 62** for Scenario 2 (mitigation).

Maximum daily dustfall rates for Scenario 1 only exceed the AQO limit (SA NDCR and Botswana industrial limit of 1 200 mg/m²/day) at the boundary on the east and south, with Scenario 2 not exceeding the AQO limit outside the GMR site boundary.

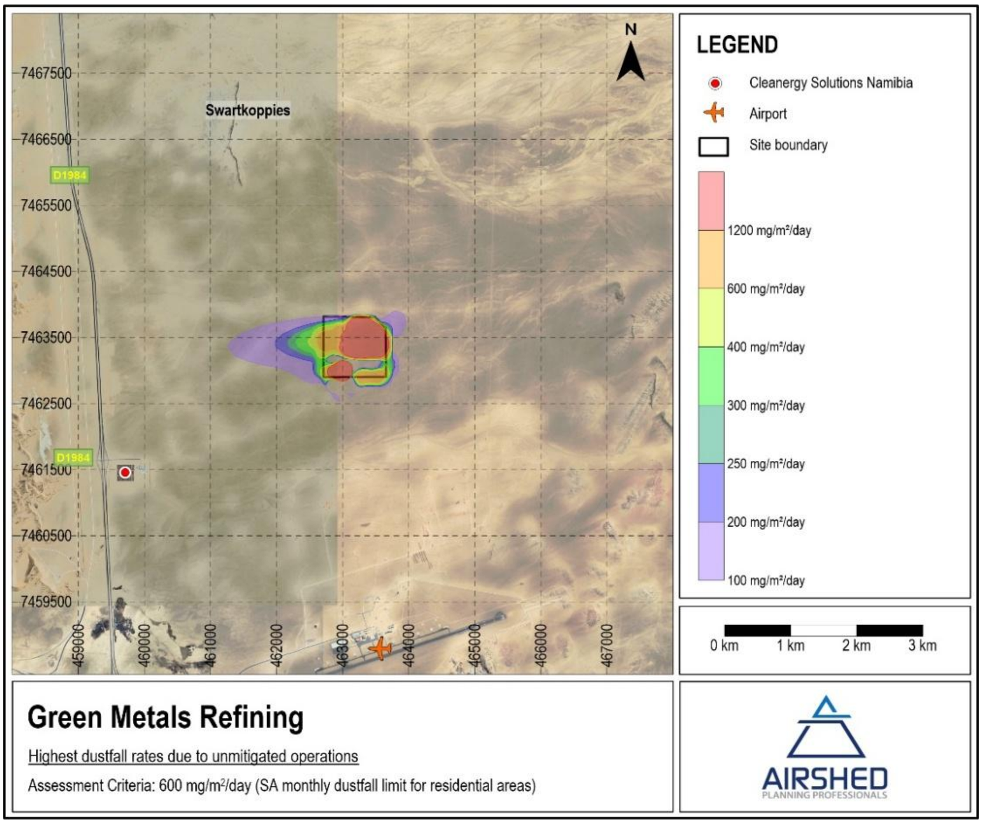

Figure 61: Area of non-compliance of dustfall limit values for Scenario 1 (no mitigation) for Stage 3.

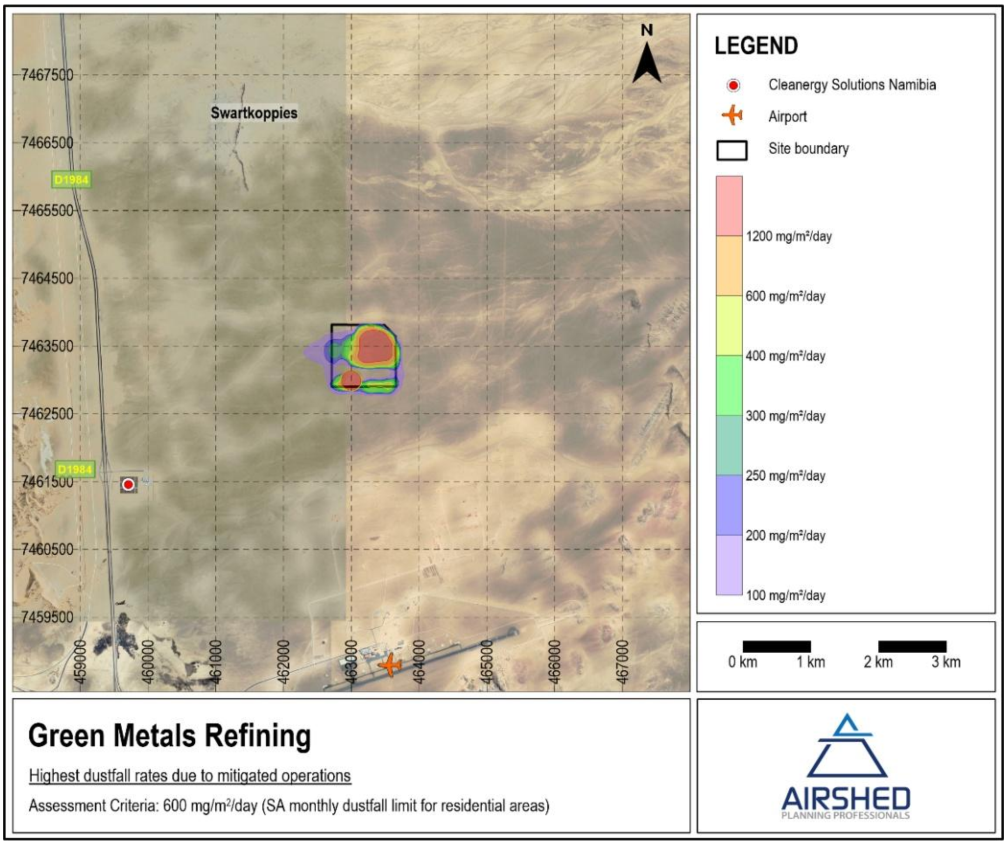

Figure 62: Area of non-compliance of dustfall limit values for Scenario 2 (mitigation) for Stage 3.

7.2.3.4 Cumulative Assessment

Background concentrations for SO_2, NO_2 and particulate matter are available from the sampling campaign conducted as discussed in **Section 6.5.2.2**. Measured SO_2 concentrations at the proposed GMR site were very low, and mostly below detection. The highest PM_{10} and $PM_{2.5}$ concentrations recorded over 30-days were 84 µg/m^3 and 39 µg/m^3, respectively, and when extrapolated to annual averages are 15 µg/m^3 and 7 µg/m^3, respectively.

- SO_2: Based on the low modelled SO_2 concentrations and the low measured concentrations, the cumulative impact from SO_2 is expected to be well below the AQO.
- SO_3: There are no other sources of SO_3 in the vicinity of the GMR site, and the modelled results indicated low off-site concentrations. The cumulative impacts from SO_3 are expected to be low.
- PM_{10}: Cumulative impacts from PM_{10} (with design mitigation only) are expected to be high, resulting in exceedances of the daily and annual AQOs on a regional level. The area of impact will reduce with additional mitigation in place, but likely still exceeding the AQOs cumulatively due to the high baseline concentrations.
- $PM_{2.5}$: The cumulative impacts from $PM_{2.5}$ will be on a smaller scale but expected to exceed the AQOs on a local scale, both with design mitigation and additional mitigation where the latter will impact a smaller domain.
- Mn: There are no other sources of Mn and hence the cumulative impacts are likely to be the same as the residual impacts.
- Dustfall: Dustfall impacts will be localised and likely to have the same residual impacts as cumulative impacts.

7.2.3.5 Impact Significance

The objective of this study is to provide an assessment of all proposed activities at the GMR Refinery and Sulphuric Acid Plant. The impact of construction, operational and decommissioning activities, based on qualitative (construction and decommissioning) and modelled air quality impacts (operational), are provided in **Table 70** reflecting the residual impacts. Cumulative impacts are provided in **Table 71**.

The criteria are applied as follows:

- *Nature and intensity*: PM_{10}, $PM_{2.5}$ and Mn impacts during the operational phase is regarded to have **H –** *nature and intensity* due to off-site (outside GMT boundary) impacts, whereas all the other impacts are limited to the GMR erf and thus regarded as either **M –** (exceedance at the boundary) or as **L –** where there are no off-site impacts. Cumulatively the significance does not change although the impacts will likely have a higher intensity.
- *Extent*: the impact area of all modelled pollutants other than Mn is within the industrial park and regarded as **L**, with Mn regarded as **H** since it exceeds over most of the modelling domain (>5 km from site). Cumulatively the extend for PM_{10} and $PM_{2.5}$ impacts may increase but not to national level.
- *Duration*: Construction and demolition will be for a short duration and regarded as **L**, whereas the operational phase impacts will be for as long as the facility is in operation hence **H**.
- *Probability*: Mn emissions were based on assumed Mn content within the dust and thus given a **M** probability, whereas the other pollutants have a **H** probability.

Table 70: Residual impact summary.

Project activity	Potential Impact	Nature and Intensity	Extent	Duration	Probability	CONSEQUENCE	SIGNIFICANCE
No Mitigation							
Construction operations	PM_{10} and $PM_{2.5}$ impacts	M -	L	L	H	Low	Moderate
	Dustfall impacts	M -	L	L	H	Low	Moderate
Operational phase	PM_{10} and $PM_{2.5}$ impacts	H -	L	H	H	High	High
	Mn impacts	H -	M	H	M	High	High
	SO_2 impacts	L -	L	H	H	Moderate	Moderate
	SO_3 impacts	L -	L	H	H	Moderate	Moderate
	Dustfall impacts	M -	L	H	H	Moderate	Moderate

Project activity	Potential Impact	Nature and Intensity	Extent	Duration	Probability	CONSEQUENCE	SIGNIFICANCE
Decommissioning	PM_{10} and $PM_{2.5}$ impacts	M -	L	L	H	Low	Moderate
	Dustfall impacts	M -	L	L	H	Low	Moderate
Mitigation							
Construction operations	PM_{10} and $PM_{2.5}$ impacts	L -	L	L	M	Low	Low
	Dustfall impacts	L -	L	L	M	Low	Low
Operational phase	PM_{10} and $PM_{2.5}$ impacts	M -	L	H	H	Moderate	Moderate
	Mn impacts	M	M	H	M	Moderate	Moderate
	SO_2 impacts	L -	L	H	H	Low	Moderate
	SO_3 impacts	L -	L	H	H	Low	Moderate
	Dustfall impacts	L -	L	H	H	Low	Moderate
Decommissioning	PM_{10} and $PM_{2.5}$ impacts	L -	L	L	M	Low	Low
	Dustfall impacts	L -	L	L	M	Low	Low

Table 71: Cumulative impact summary.

Project activity	Potential Impact	Nature and Intensity	Extent	Duration	Probability	CONSEQUENCE	SIGNIFICANCE
Design Mitigation							
Construction operations	PM_{10} and $PM_{2.5}$ impacts	M -	M	L	H	Moderate	Moderate
	Dustfall impacts	M -	L	L	H	Low	Moderate

Project activity	Potential Impact	Nature and Intensity	Extent	Duration	Probability	CONSEQUENCE	SIGNIFICANCE
Operational phase	PM_{10} and $PM_{2.5}$ impacts	H -	M	H	H	High	High
	Mn impacts	H -	M	H	M	High	High
	SO_2 impacts	L -	L	H	H	Moderate	Moderate
	SO_3 impacts	L -	L	H	H	Moderate	Moderate
	Dustfall impacts	M -	L	H	H	Moderate	Moderate
Decommissioning	PM_{10} and $PM_{2.5}$ impacts	M -	M	L	H	Moderate	Moderate
	Dustfall impacts	M -	L	L	H	Low	Moderate
Additional Mitigation							
Construction operations	PM_{10} and $PM_{2.5}$ impacts	M -	M	L	H	Moderate	Moderate
	Dustfall impacts	L -	L	L	M	Low	Low
Operational phase	PM_{10} and $PM_{2.5}$ impacts	M -	M	H	H	Moderate	Moderate
	Mn impacts	M	M	H	M	Moderate	Moderate
	SO_2 impacts	L -	L	H	H	Low	Moderate
	SO_3 impacts	L -	L	H	H	Low	Moderate
	Dustfall impacts	L -	L	H	H	Low	Moderate
Decommissioning	PM_{10} and $PM_{2.5}$ impacts	M -	M	L	H	Moderate	Moderate
	Dustfall impacts	L -	L	L	M	Low	Low

Mitigation measures

The main objective of the proposed air quality management measures for the project is to ensure that operations result in ambient air concentrations (specifically PM_{10} and $PM_{2.5}$) and dustfall rates that are within the selected AQOs (**Section 3.6.6**) outside the Project site boundary. To define site specific management objectives, the main sources of pollution need to be identified. Once the main sources have been identified, target control efficiencies for each source can be defined to minimise dust emissions and ensure acceptable cumulative ground level concentrations.

The ranking of sources serves to confirm the current understanding of the significance of specific sources, and to evaluate the emission reduction potentials required for each. Sources ranking can be established on:

- Emissions ranking: based on the comprehensive emissions inventory established for the operations (**Section 7.2.3.2**); and
- Impact ranking; based on the simulated pollutant GLCs (**Section 7.2.3.3**).

Source ranking for all fugitive sources is provided in **Table 72**.

Table 72: Sources ranked on emission contribution for Scenario 1 (no mitigation measures) and Scenario 2 (mitigation measures).

Sources of Emission	Scenario 1 (no mitigation)			Scenario 2 (mitigation)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Material Handling	4	4	4	4	4	4
Crushing	1	2	2	1	3	2
Roads - unpaved	5	5	5	5	5	5
Roads - paved	3	3	3	2	2	3
Wind Erosion	2	1	1	3	1	1

The main contributing fugitive emission sources can be summarised as follows:

- For both Scenario 1 and 2, crushing is the main source of TSP, with wind erosion the main source of PM_{10} and $PM_{2.5}$ emissions with no mitigation (Scenario 1) and with mitigation in place (Scenario 2).
- Wind erosion is the second highest contributor to TSP and crushing to PM_{10} and $PM_{2.5}$ emissions for both Scenario 1, with on-site roads the second highest contributor to TSP and PM_{10} and crushing to $PM_{2.5}$.
- The third most significant source of TSP, PM_{10} and $PM_{2.5}$ emissions is the on-site roads with no mitigation in place (Scenario1). For Scenario 2, the third most significant sources are wind erosion for TSP, crushing for PM_{10} and roads for $PM_{2.5}$.
- The main contributing source of Mn emissions is wind erosion (Scenario 1) and crushing (Scenario 2).

Using PM_{10} GLCs as an indicator of off-site impacts[31], vehicle-entrained dust from on-site roads is the main source, followed by wind erosion, then crushing circuit and lastly materials handling.

For construction the main contributing sources would likely be dust generation from scraping and grading (land clearing) and vehicle-entrained dust on-site, with drilling and digging and vehicle entrainment the main sources of dust generation during the site construction.

Decommissioning activities likely to result in dust impacts are the demolition and removal of infrastructure, rehabilitation of surroundings, and vehicle entrainment on unpaved road surfaces during rehabilitation. Once that is done, vehicle activity associated with the mining operations should cease.

[31] PM_{10} is the only pollutant resulting in H- nature and intensity, with the highest significance although moderate (Table 4-10 in Appendix F).

Point source ranking is discussed below. SS4 is the main contributor of both SO_2 and SO_3 emissions, followed by SS3.

Compared to the SA emission limits as provided in **Section 3.6.6**, only the refinery SO_2 emissions are within the limits with both SO_2 and SO_3 from the SAP exceeding the emission limits (**Table 73**).

Table 73: Point source emissions compared to emission limits.

Stack ID	Notes	Emissions (mg/Nm³)		Emission limit (mg/Nm³)	
		SO_2	SO_3	SO_2	SO_3
SS1	SAP Stage 3	786	98	350	25
SS2	SAP Stage 2	786	98	350	25
SS3	SAP Stage 1	786	98	350	25
SS4	SAP Stage 1	786	98	350	25
SS5	Refinery	786	-	1 000	-

Based on modelled impacts, SO_2 is well below the AQOs off-site for all averaging periods whereas SO_3, is just within the boundary.

Proposed Mitigation Measures and/or Target Control Efficiencies

The main unmitigated sources resulting in off-site impacts are onsite roads and windblown dust. The material properties (particle size distribution and moisture content) for the MRF were based on manganese mining operations and may differ from the process at GMR. Although the mineral residue will have high moisture content, and be compacted on the MRF, it is not known how it will behave once dried out. Mitigation measures for the onsite roads and the MRF should thus also be considered.

Mitigation measures that need to be considered for the Project include the following:

Construction and Decommissioning phase:

- Air quality impacts during construction would be minimised through basic control measures such as limiting the speed of trucks; limit unnecessary travelling of vehicles on untreated roads; and to apply water sprays on regularly travelled, unpaved sections.
- During closure and post-closure, the open exposed areas prone to wind erosion should be either covered with surface material or rehabilitated (compacted) to ensure the surfaces form a hard crust.

Operational phase additional mitigation measures (the control efficiencies are from NPI, 2012):

- The on-site roads at the plant should be kept dust free by regular sweeping, cleaning and removing spilled material. The area between the loading of mineral residue and the MRF is off concern due to the potential for spilled material that will dry out and become re-entrained as the trucks move over it. These roads should be maintained and the surface kept clean.
- The crushing circuit should be in an enclosed building with dust extraction. A control efficiency of 83% can be achieved by hooding with fabric filters, and even more by full enclosure.
- It is understood that the MRF will be constructed in phases and in compartments, and the entire footprint will only be exposed to wind erosion during the final phase 7, and phase 5 with the second largest exposed surface when it will be most susceptible to wind erosion (as assumed in the dispersion model). Also, the material will have a high moisture content when deposited. Aside from minimizing the active MRF deposition

compartments and ensuring the previous phases/ compartments are compacted and sealed, windblown dust from the MRF can be further managed through construction of natural berms/ screens on the eastern side of the MRF, or even a side wall comprising of more wind resistant material. The effectiveness (control efficiency) will be determined by (Baldauf, 2017):
  - Barrier height: the higher the vegetative/covered barrier, the greater the pollutant reductions; a height of 5 m or more is preferred.
  - Barrier density: the thicker the vegetative/covered barrier, the greater the pollutant reductions; a minimum thickness of 10 meters should provide enough of a barrier to remove particulate and enhance dispersion.
  - Barrier porosity: this should not be too high to allow pollutants to easily pass through the barrier or cause wind stagnation.
  - Barrier extension: extending the barrier beyond the area of concern protects against pollutant meandering around edges; 50 m or more.
- Off-loading of manganese ore will result in visible dust if not mitigated and off-loading in an enclosed building would reduce the dust by 70%. The dozer is the main materials handling dust generating activity and by changing to a grader on the MRF would result in a 99% reduction in emissions. In addition, water sprays could be added to open materials transfer points (50% control efficiency).
- It is recommended that the SAP stacks be designed for a lower SO_3 concentration to ensure there is no off-site impacts.

Key performance indicators

Key performance indicators against which progress of implemented mitigation and management measures may be assessed, form the basis for all effective environmental management practices. In the definition of key performance indicators careful attention is usually paid to ensure that progress towards their achievement is measurable, and that the targets set are achievable given available technology and experience.

Performance indicators are usually selected to reflect both the source of the emission directly (source monitoring) and the impact on the receiving environment (ambient air quality monitoring). Ensuring that no visible evidence of windblown dust exists represents an example of a source-based indicator, whereas maintaining off-site dustfall levels, at the identified AQSRs, to below 600 mg/m²-day represents an impact- or receptor-based performance indicator.

Except for stack emission testing, source monitoring at fugitive sources can be challenging such as wind-dependant nature of particulate emissions from the MRF. The focus is therefore rather on receptor-based performance indicators i.e. compliance with ambient air quality standards and dustfall regulations.

Source Monitoring

Stack sampling or direct measurement, as indicated in the preferred measure for determining pollutant emission rates from a point source (NPI, 2011).

Sampling is an attempt to collect representative samples of the total amount of a pollutant within a gas stream that is emitted into the atmosphere. Stack sampling is used for the assessment of the following (https://2ch002ss.files.wordpress.com/2013/12/stack-sampling.pdf):

- To determine the quantity and quality of the pollutant emitted by the source.
- To measure the efficiency of the control equipment by conducting a survey before and after installation.
- To determine the effect on the emission due to changes in raw materials and processes.
- To compare the efficiency of different control equipment's for a given condition.

- To acquire data from an innocuous individual source so as to determine the cumulative effect of many such sources.
- To compare with the emission standards in order to assess the need for local control.

The requirements for stack sampling, as obtained from https://2ch002ss.files.wordpress.com/2013/12/stack-sampling.pdf, is provided in Appendix C.

Ambient air quality monitoring

Ambient air quality monitoring can serve to meet various objectives, such as:

- Compliance monitoring;
- Validate dispersion model results;
- Use as input for health risk assessment;
- Assist in source apportionment;
- Temporal and spatial trend analysis;
- Source quantification; and
- Tracking progress made by control measures.

Dustfall monitoring: It is recommended that four (4) dustfall units be installed once operations commence, with one on each of the main wind directions of the GMR boundary (east, south, west and north). Dustfall should be collected monthly, and the results used as indicators to track the effectiveness of the applied fugitive mitigation measures. The dustfall units and sampling procedure is provided in Appendix D of **Appendix F**.

PM sampling: It is recommended that at least one, but preferably two, continuous PM samplers be installed, with one on the northeastern boundary next to the MRF and one on the southwestern boundary near the ore off-loading area since the dispersion modelling results showed high off-site PM concentrations. The PM sampler should be able to measure continuously for both PM_{10} and $PM_{2.5}$, and it should allow for gravimetric sample taking so that these filters could be analysed for Mn content. Measured Mn data could be used to determine the actual concentrations from the facility once operational and used to inform further management measures.

Gaseous sampling: Even though SO_2 and SO_3 impacts are likely to be low, it is recommended that bi-annual sampling campaigns be conducted at the same locations as the dustfall units. SOx/NOx passive sampling should be conducted using Radiello passive diffusive samplers exposed for 14-days at a time, with results reported as a concentration per volume (µg/m³). SO_3 get sampled through ad-hoc Volatile acids (HCl, HBr and HNO_3) and non-volatile acids (H_2SO_4 and H_3PO_4) samples collected onto 37-mm diameter quartz fibre filters using a Gillian™ pump. Collected samples gets analysed in the laboratory using ion-chromatography with conductivity detection technique and reported as a concentration in mg/sample. The sampling duration is usually a couple of hours. Sampling techniques are provided in Appendix D of **Appendix F**.

Periodic Inspections and Audits

Periodic inspections and external audits are essential for progress measurement, evaluation and reporting purposes. It is recommended that site inspections and progress reporting be undertaken at regular intervals (at least bi-annually), with annual environmental audits being conducted. Results from site inspections and monitoring efforts should be combined to determine progress against source- and receptor-based performance indicators. Progress should be reported to all interested and affected parties, including authorities and persons affected by pollution.

The criteria to be taken into account in the inspections and audits must be made transparent by way of minimum requirement checklists included in the management plan. Corrective action or the implementation of contingency measures must be taken in the event that progress towards targets proves to be unsatisfactory.

7.2.4 Climate Change Assessment

The information in this section was sourced from the climate change specialist study in **Appendix J** (Airshed, 2025).

The project was undertaken in accordance with the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard (WRI & WBCSD, 2004), which provides two approaches. This includes the assessment of GHGs based on: (1) the organisational boundaries and (2) operational boundaries. For the calculation of GHG footprint for GMR operations, the operational boundary approach was selected.

(1) Organisational boundaries

In setting organisational boundaries, a company selects an approach for consolidating GHG emissions and then consistently applies the selected approach to define those businesses and operations that constitute the company for the purpose of accounting and reporting GHG emissions. If the reporting company wholly owns all its operations, its organisational boundary will be the same whichever approach is used. For companies with joint operations, the organisational boundary and the resulting emissions may differ depending on the approach used. In both wholly owned and joint operations, the choice of approach may change how emissions are categorised when operational boundaries are set.

(2) Operational boundaries

To help delineate direct and indirect emission sources, improve transparency, and provide utility for different types of organisations and different types of climate policies and business goals, three "scopes" (scope 1, scope 2, and scope 3) are defined for GHG accounting and reporting purposes (**Figure 63**).

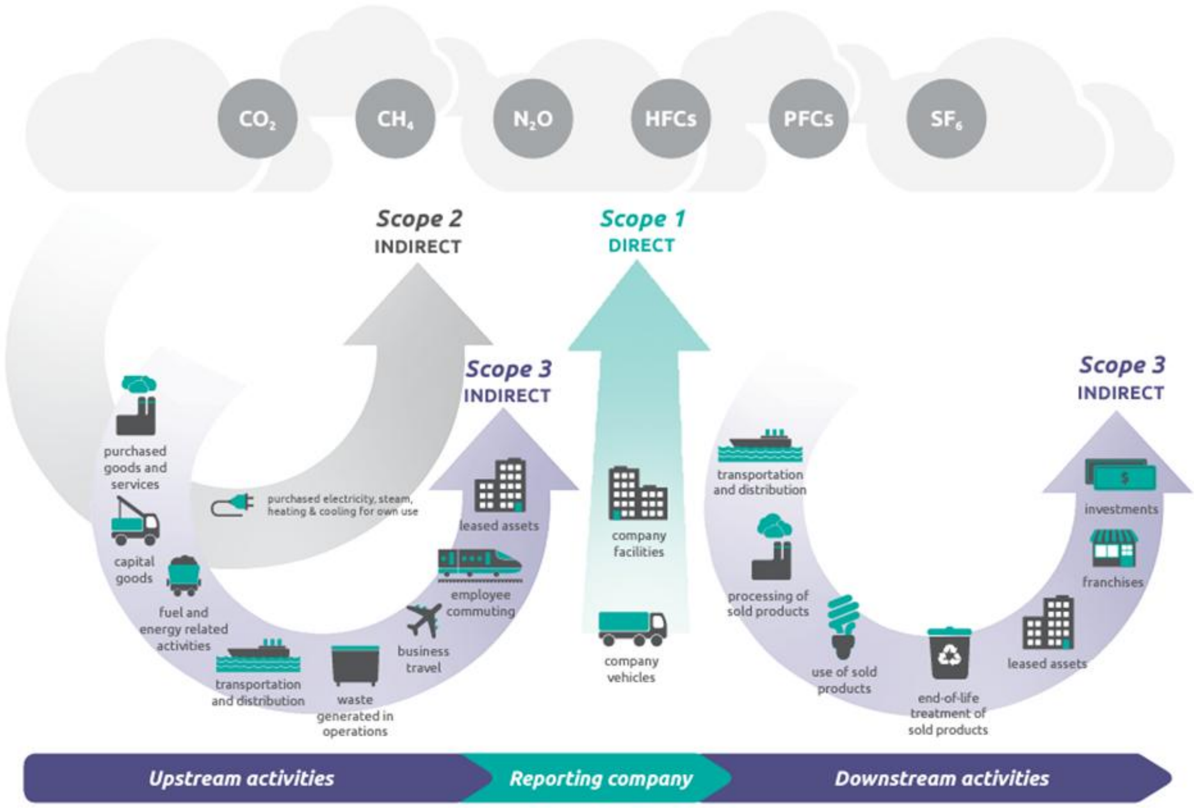

Figure 63: Overview of scopes and emissions (WRI & WBCSD, 2004).

Scope 1: Direct GHG Emissions

Direct GHG emissions occur from sources that are owned or controlled by the company, for example, emissions from combustion in owned or controlled vehicles, etc.; and/or emissions from chemical production in owned or controlled process equipment.

Scope 2: Electricity - Indirect GHG Emissions

Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.

Scope 3: Other Indirect GHG Emissions

Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company but occur from sources not owned or controlled by the company. Some examples of scope 3 activities are the extraction and production of purchased materials; transportation of purchased materials and product; and use of sold products.

7.2.4.1 Assessment Boundary

The following GHG emissions have been considered:

- Fuel (diesel) consumption during project activities
- Electricity consumption during project activities
- Water consumption during project activities
- Transport of raw materials to site
- Transport of product from site
- Workers commuting (only bus)

7.2.4.2 Exclusions

The following were excluded from the inventory:

- GHG emissions could not be quantified for the Construction phase due to insufficient information on fuel consumption by stationary and mobile equipment, raw materials used for construction (i.e. concrete, steel, bricks, etc.), and contractors commuting. The CO_2e contribution form the Construction phase to CO_2e from the life of the project is likely small.
- Embodied emissions in equipment used and transport of equipment to the project site.
- Scope 3 categories not regarded applicable to the project, including:
  - Upstream emissions:
    - *Purchased Goods and Services*: Emissions from the production of the goods and services a company buys.
    - *Capital Goods*: Emissions from the production of physical assets like buildings and machinery used by the company.
    - *Upstream Leased Assets*: Emissions from leased assets.
  - Downstream emissions:
    - *Processing of Sold Products*: Emissions from the processing of the company's sold products by other entities.

        - *Use of Sold Products*: Emissions from the use of the company's sold products by customers.
        - End-of-Life Treatment of Sold Products: Emissions from the treatment and disposal of sold products after their use.
        - *Downstream Leased Assets*: Emissions from leased assets by the company's customers.
        - *Franchises*: Emissions from franchises associated with the reporting company.
        - *Investments*: Emissions from investments made by the company.

- Scope 3 categories which didn't have enough information available:
    - Upstream emissions:
        - *Waste Generated in Operations:* Emissions from the disposal and treatment of waste created in a company's operations.
        - *Business Travel*: Emissions from employee business trips
        - *Employee Commuting*: Emissions from employees travelling to and from work in vehicles (only accounted for commuting by bus).

7.2.4.3 Emissions

GHG emissions were quantified for the Operational phase only, with data and assumptions used in estimating GHG emissions provided by GMR.

The emission factors used for the assessment were mainly sourced from the:

- IPCC guidelines (IPCC, 2006), and
- UK Government GHG Conversion Factors for Company Reporting developed by Department for Energy Security & Net Zero (DESNZ, 2025).

The estimated GHG emissions for the operational phase of the project are provided in **Table 74**.

Table 74: Estimated GHG emissions for the lifespan of the project.

Indicator	Emissions (tCO_2e)	Comments
Direct (scope 1) GHG emissions	**1 104**	
Diesel stationary combustion - generator	255.25	GMR direct fuel use
Diesel mobile combustion	848.39	GMR direct fuel use
Indirect (scope 2) GHG emissions	**20 498**	
Municipality electricity	20 498.40	GMR annual electricity use
Indirect (scope 3) GHG emissions	**3 864 622**	
3.1 Purchased goods and services	**19**	
Water supply	19.13	GMR water use
Water treatment	0.14	GMR water use
3.2 Fuel and Energy-Related Activities	**253**	
Diesel	253.03	GMR fuel use
3.3 Upstream transportation and distribution	**2 928 032**	

Cargo ship	1 568 322.54	GMR Sulphur from China
Cargo ship	806 565.88	GMR Reagents from China
Heavy Goods Vehicle (HGV)	522 610.08	GMR Ore from KML
HGV	10 369.90	GMR Reagents from Walvis Bay Harbour
HGV	20 163.70	GMR Sulphur from Walvis Bay Harbour
3.4 Employee Commuting	**5**	
Bus - diesel	5.49	Employee commuting (Walvis Bay Harbour to GMR)
3.5 Downstream Transportation and Distribution	**935 206**	
Cargo ship	476 790.91	HPMSM Product from Walvis Bay Harbour to Europe
HGV	9 876.10	HPMSM Product to Walvis Bay Harbour
HGV	448 539.36	Sulphuric Acid sold to clients in Erongo Region
Total emissions	**3 885 118**	**Scope 1, 2 and 3**

The annual GHG emissions for Scope 1 and 2 from the operational phase of the project is provided in **Figure 64**. GHG emissions due to diesel combustion will contribute 3.9% from mobile equipment and 1.2% from stationary sources (1.2%) with the largest contribution to the total project GHG emissions from Municipal electricity use (94.9%).

Annual GHG emissions for Scope 3, as shown in **Figure 65**, is dominated by 'Upstream transportation and distribution' contributing 76% and to a lesser extent 'Upstream transportation and distribution' at 24%. The other three categories contribute 0.01%.

Scope 1 GHG emissions for the project operations is 1 104 tCO_2e per annum, with Scope 2 at 20 498 tCO_2e per annum. For comparison, international reporting considers a small facility as producing 10 000 tCO_2e per annum, medium at 25 000 tCO_2e per annum and large at 100 000 tCO_2e per annum (for Scope 1 and 2 emissions).

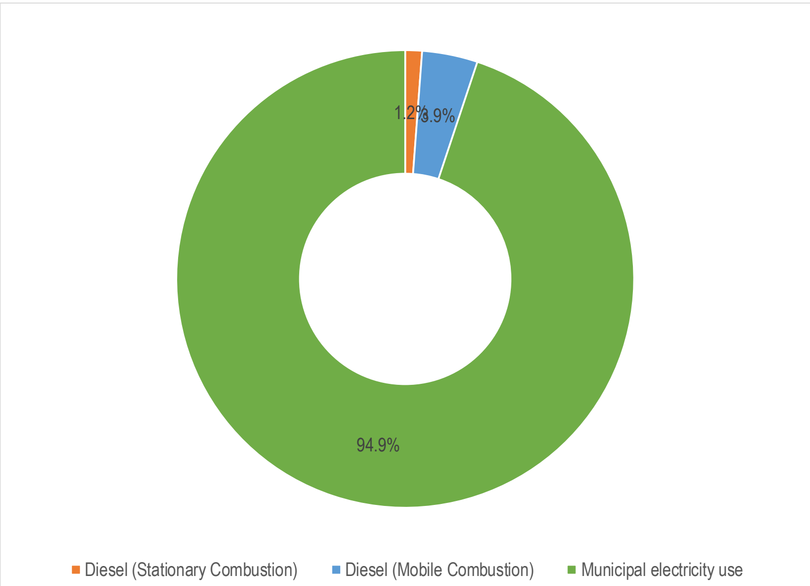

Figure 64: Percentage GHG emissions for GMR operations (Scope 1 and Scope 2).

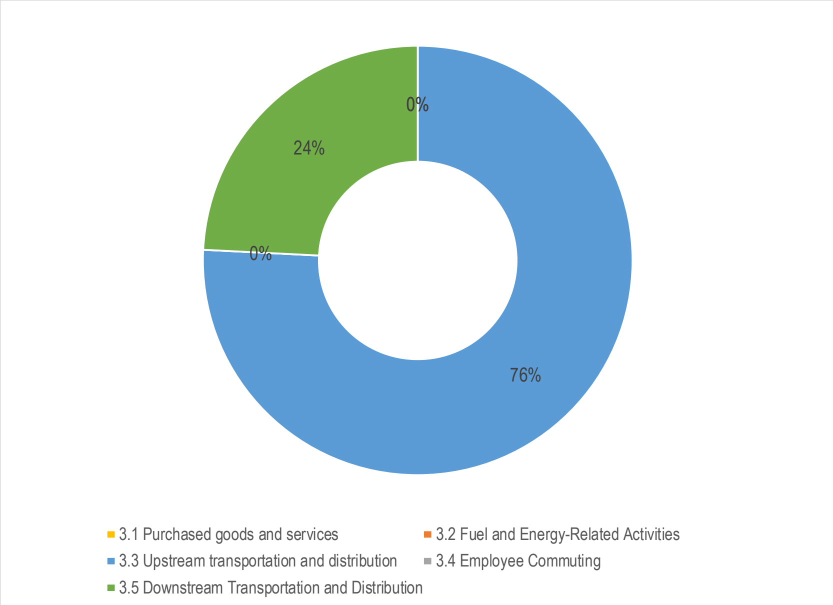

Figure 65: Percentage GHG emissions from GME for various Scope 3 categories.

7.2.4.4 GHG Impact of the GMR Project

The reported 2022 CO_2 emissions according to the NID1 totals 25 819 kt CO_2e, with Scope 1 and Scope 2 GHG emissions from the GMR operations adding a total of 21.6 kt CO_2e. The project activities would thus contribute approximately 0.084% tot the 2022 National GHG inventory total.

7.2.4.5 GHG Impact Significance rating

Gaseous pollutants released from the combustion of fuel is the main source of GHGs from the project. The release of GHG includes mainly carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). GHGs are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), CO_2, N_2O, CH_4 and ozone (O_3) are the primary GHG in the Earth's atmosphere. The effect of climate change is related to changing atmospheric GHG concentrations, increased temperatures, changing weather patterns and sea level rise (indirect negative impact).

The calculated CO_2e emissions from the project (scope 1 and scope 2) is summarised in **Section 7.2.4.3**, estimating 21 602 t per annum for the project operations. The project scope 1 and 2 emissions due to the project would contribute approximately 0.084% to the 2022 Namibian GHG inventory total.

Local reporting requirements have yet to be developed to describe and assess environmental impacts for GHGs. Guidance is thus taken from international guidelines such as those developed for the Sacramento Metropolitan Air Quality Management District (SMAQMD, 2014). As part of the process to determine if a full GHG analysis and mitigation programme is required, an Initial Study is implemented to determine if a project may have a significant effect on the environment. As such a threshold of 1.1 kt CO_2e (project construction phase) and 10 Gg CO_2e (operational phase) for stationary source projects per year is applied to new projects (SMAQMD, 2014). These thresholds were based on capturing 90% of the development projects across the state, ensuring that small projects, which generally have low emission levels, and would generally not be considered significant. As an alternative method of measure, a GHG threshold may be based on the classification of projects by the European Bank for Reconstruction and Development (EBRD), in which projects contributing more than

25 Kt CO_2e per year to have significant GHG emissions (EBRD 2019). This is in line with the International Finance Corporation (IFC 2012). Section 8 of the IFC Performance Standards on Environmental and Social Sustainability: "For projects that are expected to or currently produce more than 25 000 Kt CO_2e annually, the client will quantify direct emissions from the facilities owned or controlled within the physical project boundary, as well as indirect emissions associated with the off-site production of energy used by the project. Quantification of GHG emissions will be conducted by the client annually in accordance with internationally recognised methodologies and good practice". In terms of the Equator Principles, a developer that is seeking funding from a financial institution that subscribes to the Equator Principles is required to publicly report on its combined scope 1 and scope 2 GHG emissions if it exceeds 100 Kt CO_2e annually, for the operational phase of the project, during the life of the loan (Equator Principles, 2013). The Equator Principles also encourage clients to report publicly on projects emitting over 25 Kt CO_2e, in line with the IFC Performance Standards (Equator Principles, 2013). As a further example, the South African Declaration of Greenhouse Gases as Priority Pollutants (Government Gazette 40966 of 21 July 2017) define production processes in Annexure A of the Declaration with the requirement to submit a Pollution Prevention Plan (PPP) to the Minister for approval with GHG in excess of 100 Kt CO_2e.

When evaluating significance, all new GHG emissions contribute to a negative environmental impact; however, some projects could replace existing development or baseline activity that has a higher GHG profile. Therefore, the significance of a project's emissions should be based on its net impact over its lifetime, which may be positive, negative or negligible. To meet the Namibian NDC targets and interim budgets, action is required to reduce GHG emissions from all sectors, including projects in the built and natural environment. The proposed project must therefore consider whether and how the project will contribute to or jeopardise the achievement of these targets. Such an assessment would, however, require a much broader evaluation of the project against all current energy mix and their resources practised in Namibia. In the absence of such a comprehensive assessment, the current assessment will rely on using thresholds to define the significance of the GHG impact.

The proposed intensity rating for annual emissions is as follows:

25 Kt CO_2e : **Very Low** (i.e., threshold used by EBRD, IFC and Equator Principals)

25 – 100 Kt CO_2e : **Low** (i.e., DFFE PPP requirement threshold is 100 Kt CO_2e)

100 – 500 Kt CO_2e : **Medium** (i.e., DFFE PPP to 0.1% of the total gross SA GHG emissions)

500 – 5 000 Kt CO_2e : **High** (i.e., 0.1% to 1.0% of the total gross SA GHG emissions)

>5 000 Kt CO_2e : **Very High** (i.e., more than 1.0% of the total gross SA GHG emissions)

7.2.4.6 Residual Impacts

The combined GHG emissions for project operations of 21.6 kt CO_2e per annum are below the threshold used by EBRD (25 kt CO_2e). The impact significance is therefore considered to be **Very Low**.

7.2.4.7 Cumulative Impacts

The project emissions will add 0.084% tot the 2022 National GHG inventory total, which can be regarded as a **Low** significance.

7.2.4.8 Project Mitigation and Adaptation Measures

Climate change management includes both mitigation and adaptation. The main aim of mitigation is to stabilise or reduce GHG concentrations as a result of anthropogenic activities.

This is achievable by lessening sources (emissions) and/or enhancing sinks through human intervention. Mitigation measures are typically the focus of the energy, transport and industry sectors (Thambiran & Naidoo, 2017). Adaptation measures focus on minimising the impact of climate change, especially on vulnerable communities and sectors. Due to Namibia's vulnerability to climate variabilities such as rising temperatures, increasing droughts and unpredictable rainfall patterns, adaptation projects focus mainly on the agriculture sector, followed by fisheries and sustainable land management. Other focus areas include government, climate information and research, ecosystems and biodiversity, forestry, and energy (https://napglobalnetwork.org/2022/06/namibia-kicks-off-development-mel-system).

To minimise project specific GHG (Scope 1) emissions would require lower fuel use or use alternative lower-carbon fuels, where possible or switching to renewable energy for stationary sources. Effective rehabilitation of above-ground and soil-based carbon stocks could be an effective carbon sink during rehabilitation.

From an adaptation perspective, additional support infrastructure can reduce the climate change impact on the employees. For example, improving the thermal and electrical efficiency of buildings to reduce electricity consumption for air conditioning, ensuring adequate water supply for staff drinking water, amending summer operating hours to avoid the hottest part of the day and potential health and safety impacts for employees, and having shaded green rest areas for employees during their shift breaks.

7.2.5 Noise Impact Assessment

The information in this section was sourced from the noise specialist study in **Appendix K** (Soundscape, 2025).

Potentially sensitive receptors in terms of noise typically include places of residence and permanent community locations such as schools, hospitals and places of worship but can also include commercial and industrial facilities. With reference to **Section 6.11**, there are currently no permanent residential areas within a 4km radius.

7.2.5.1 Sources of Noise

The Project will generate noise during both the construction and operational phases.

Construction Phase

During site development, construction activities (which will include site clearing, ground excavation and earthworks, distribution and compaction of materials, concrete works, metal works, piling, transport etc.) will be highly variable in intensity, location, duration, and time of day, even over a 24-hour cycle. It is, however, generally **assumed that construction activities would be limited to daytime working hours**, typically from 07:00 to 18:00.

Noise generating construction equipment can be divided into distinct categories. These are:

- earthmoving equipment,
- materials handling equipment,
- stationary equipment,
- impact equipment, and
- other types of equipment.

The first three categories include machines that are powered by internal combustion engines. Machines in the latter two categories are powered pneumatically, hydraulically, or electrically. Exhaust noise tends to account for most of the noise emitted by machines in the first three categories (those that use internal combustion engines) whereas engine-related noise is usually secondary to the noise produced by the impact between impact equipment and the material on which it acts (Bugliarello, Alexandre, Barnes, & Wakstein, 1976).

Noise generated by mechanical equipment, including electric motors (drive units), gearboxes, pumps, fans etc. is dependent on the portion of total mechanical or electrical energy that is transformed into acoustical energy. Construction equipment generally produce noise in the lower end of the frequency spectrum. Reverse or moving beeper alarms emit at higher frequency ranges and are often heard over long distances.

If little information is available on the construction schedule, equipment, and activities, SANS 10328: 2008 allows for the use of information from proven data or from publications such as British Standard (BS) 5228-1, the "Code of practice for noise and vibration control on construction and open sites – Part 1: Noise" (BSI, 2014).

Operational phase

From the process and operations overview, it is clear that during the operational phase, the Project will include a multitude of noise generating activities and/or equipment, including:

- Vibrating equipment incl. crushers, screens, feed hoppers etc.
- Motor driven equipment including pumps, fans, compressors, conveyors, agitators etc.
- Hydraulically and aerodynamically generated noise from pipes and ducts.
- Steam turbine
- Cooling and heating systems
- Transformers and switchgear i.e., electrical equipment such as transformers and switchgear can generate humming sounds due to electromagnetic fields
- Venting and blowdown system
- Transport related noise via road or rail
- Auxiliary system: Other auxiliary systems, such as emergency diesel generators, fire pumps, and air conditioning units for control rooms and other critical areas etc., also contribute to the overall noise.

Procedures for calculating the sound power level of industrial machinery, such as those listed earlier, are available and is often used for modelling sound levels in an environment. Ideally, use should be made of acoustical data for individual equipment, specifically sound pressure, or sound intensity data.

Manufacturers often provide the estimated sound power level or the measured sound pressure level at one meter from their equipment, along with offering specialised low-noise options.

In cases where information from the manufacturer is unavailable, one should attempt to measure a comparable unit in operation at an installation. If such measurement is not feasible or if an estimate is required for a preliminary study, sound power level equations can be used.

Such equations are either based solely on measured data or are semi-empirical, and they tend to predict higher sound levels than those measured in the field. These require as a minimum, the power rating of the equipment (typically in kilowatt, kW), but for some equipment also parameters such as configuration, operating speed (in revolutions per minute, rpm), pressure differential, volumetric flow rate, and physical dimensions.

Such detail is often only available for some equipment. Where detail information is not available use will be made of the area-wide sound power level factors. For the operational phase of the Project, use is made of a combination of both supplier noise performance data, and sound power level equations and/or factors.

7.2.5.2 Noise Impact Assessment Methodology

The noise impact assessment was conducted in accordance with SANS 10328: 2008 titled *"Methods for environmental noise impact assessments"*. The methodology includes the following distinct steps:

1. Determine the **desired level** for the area and noise-sensitive receptors e.g., noise level

guidelines for residential and/or industrial receptors (**Section 3.5**).
2. Determine the **residual noise level** for the area, i.e., current the noise levels in the study area excluding the contribution of the proposed Project. This was done through measurement of existing noise levels (**Section 6.7.2**).
3. Determine the **expected noise levels** and **noise impact** as a result of the Project. Noise impact is the difference between the expected noise level and the desired or residual noise level. The magnitude of the impact is assessed against desired noise levels and thresholds for disturbing noise (below 3 dBA increase, IFC).

The findings of the noise impact assessment inform the **need for project-specific and good practice noise management and mitigation measures**. Once these measures were identified, the **significance of the noise impact is evaluated** in accordance with the methodology specified by ASEC (**Section 7.1**).

7.2.5.3 Expected noise levels and noise impacts

Construction Phase

If little information is available on the construction schedule, equipment, and activities, as is the case here, SANS 10328 allows for the use of information from proven data or from publications such as BS 5228-1, the “Code of practice for noise and vibration control on construction and open sites – Part 1: Noise” (BSI, 2014).

Sound level data for noise sources typically associated with the construction of industrial infrastructure on a Greenfields site are summarised in **Table 75**. Each main activity may involve several different types of equipment or sub-activities associated with it. A-weighted sound pressure levels (L_{Aeq}) in decibels 10 m from the source as listed in **Table 75** is per piece of equipment or sub-activity and are generally a function of the equipment power rating in kW. It was assumed that the construction of linear infrastructure would be limited to daytime hours.

Expected noise levels 10 m from construction activities will likely range between 52 and 95 dBA, depending on the specific activity, equipment involved, and duration. Since sound energy radiates outward spherically from a point source, the sound pressure level remains the same at all locations that are the same distance from the source. As the sound moves away from the source, its energy spreads over a larger area, causing the sound pressure level to decrease. Specifically, the sound level drops by 6 dB each time the distance from the source doubles. This rule applies if there are no significant effects from the ground or air that further reduce the sound. The expected noise level of a construction noise source generating 95 dBA at 10 meters will therefore decrease to below 55 dBA within about 1 km. Under such conservative assumptions regarding propagation, levels above 45 dBA may be expected up to a few kilometres from the activity.

In summary, **expected noise levels** during the **construction phase** will be **highly variable** in space and time, reflecting the specific activity, plant in use, and proximity to work fronts. **Short-term exceedances** of the area’s **desired rating levels** may occur **near active works**, but effects are unlikely to extend beyond roughly 1 km from the activity. There are no noise sensitive receptors within 1 km of the Project.

The **main potential noise risk** relates to residents or community facilities situated **near routes used for transporting construction materials**. However, projected traffic volumes are low, approximately 25 trucks per month over an 18-month period, and, if construction activities are restricted to daytime hours as is standard practice, the **overall risk is minimal**. In addition, noise from these vehicles is likely to be masked by existing road traffic, further reducing the potential for noticeable disturbance.

Table 75: Sound level data for construction and open sites (BSI, 2014).

Activity	Equipment	L_{Aeq} at 10 m (dBA)	Drive-by L_{Amax} at 10 m (dBA)
Sound level data on piling and ancillary operations			
Pre-cast concrete piling	Hydraulic hammer rig	89	
Tubular steel piling, hydraulic hammer	Hydraulic hammer rig, drop hammer pile rig power pack	69 - 88	
Tubular steel piling, hydraulic jacking	Piling, power pack	68 - 70	
Sheet steel piling, vibratory	Vibratory piling rig	88	
Sheet steel piling, hydraulic jacking	Piling, power pack, water jet pump	59 - 68	
Rotary bored piling, cast in-situ	Large rotary bored piling rig, tracked drilling rig with hydraulic drifter, crane mounted auger, mini piling rig, compressor, mini tracked excavator	68 - 83	
Continuous flight auger piling, cast in situ	Crawler mounted rig, tracked excavator, concrete pump	68 - 80	
Vibro stone columns	Vibro-displacement and compaction of stone columns	80	
Craneage for piling	Tracked/wheeled mobile crane	67 - 70	
Welding/cutting steel piles	Handheld welder, generator, gas cutter	57 - 73	
Sound level data on general site activities			
Distribution of materials	Articulated dump truck, dumper, wheeled excavator, wheeled backhoe loader, fuel tank lorry, fuel tanker pumping, tracked excavator	56 - 81	78- 81
Micing concrete	Cement mixer truck (idling, discharging), concrete mixer truck, cement mixer	61 - 80	76- 79
Pumping concrete	Concrete pump, boom arm, cement mixer truck	67 - 82	
Concreting other	Poker vibrator, vibratory tamper, pump boom and poker, concrete placing boom	63 - 78	

Activity	Equipment	L_{Aeq} at 10 m (dBA)	Drive-by L_{Amax} at 10 m (dBA)
Lifting	Wheeled and mobile telescopic cranes, tower crane, tracked crane, telescopic handler, wheeled excavator, lifting platform, diesel scissor lift, caged material hoist, site lift for workers	60 - 83	
Trenching	Tracked excavator, wheeled backhoe loader, mini tracked excavator	65 - 77	
Core drilling concrete	Core drill	85	
Cutting concrete slab	Petrol hand-held circular saw	91	
Cutting concrete blocks/paving slabs	Circular bench saw, hand-held circular saw	79 - 85	
Moving equipment	Tractor towing equipment/trailer	0	79
Power for site cabins	Diesel generator	56 - 74	80
Power for welder	Diesel generator	66	
Power for lighting	Diesel generator	65	
Pumping water	Water pump	68 - 79	
Sweeping and dust suppression	Road sweeper, dust suppression unit trailer	76 - 78	
Miscellaneous	Mounting supports, angle grinder, petrol generators, nail gun, directional drill	73 - 87	
Sound level data for linear infrastructure construction works			
Breaking road surface	Backhoe mounted hydraulic breaker, mini excavator with hydraulic breaker, handheld pneumatic breaker, compressor	65 - 88	
Breaking concrete	Hand-held pneumatic breaker	95	
Road planing	Road planer, mini planer	54 - 82	
Removing broken road surface	Wheeled excavator	73	
Spreading chipping/fill	Dozer	77 - 82	
Earthworks	Bulldozer, articulated dump truck, tracked excavator	80	81- 86
Rolling and compaction	Road roller, vibratory roller, asphalt compactor	67 - 82	80- 84

Activity	Equipment	L_{Aeq} at 10 m (dBA)	Drive-by L_{Amax} at 10 m (dBA)
Paving	Asphalt paver with tipper lorry	75 - 77	84
Trenching	Wheeled excavator, tracked excavator	70 - 74	
Cutting concrete slabs	Hand-held circular saw (petrol)	87	
Lifting formwork for underpass	Wheeled mobile crane	66 - 76	
Pumping water	Electric water pump	68	
Welding/cutting steel	Handheld welder, generator for welding, gas cutter	57 - 73	
Lifting	Cranes, lifting booms, handlers, scissor lifts etc.	61 – 83	

Operational Phase

Expected maximum rating levels during the operational phase of the Project (Stage 3) were determined through calculation using a noise propagation model populated with source and noise 'emissions' data, as well as local metrological and land use characteristics. A summary of calculations and input data is included in **Table 76**. See Annexure B of the noise specialist study (Soundscape, 2025), for detailed model input data.

Table 76: Source data and noise model setup.

<table>
<tr><th colspan="2">Source data</th></tr>
<tr><td>Mobile equipment</td><td>Sound power levels (L_W) calculated from the published relationship between engine power and sound power (Crocker, 1998):
$$LW = 99 + 10 \cdot \log kW - 4$$
Where L_W is sound power in (dB), and kW is the power rating of the mobile equipment.

<table>
<tr><th>Equipment</th><th>kW</th><th>Qty.</th><th>L_{WA} (dBA)</th></tr>
<tr><td>Mobile crane 100t</td><td>400</td><td>2</td><td>116.0</td></tr>
<tr><td>FEL (CAT 966M)</td><td>239</td><td>4</td><td>113.8</td></tr>
<tr><td>Dozer (CAT D6)</td><td>161</td><td>1</td><td>112.1</td></tr>
<tr><td>Water tanker truck</td><td>155</td><td>1</td><td>111.9</td></tr>
<tr><td>10t truck</td><td>250</td><td>1</td><td>114.0</td></tr>
<tr><td>5t truck</td><td>110</td><td>1</td><td>110.4</td></tr>
<tr><td>Light vehicles</td><td>150</td><td>5</td><td>111.8</td></tr>
<tr><td>Ambulance</td><td>150</td><td>1</td><td>111.8</td></tr>
<tr><td>Fire truck</td><td>150</td><td>1</td><td>111.8</td></tr>
</table>
</td></tr>
<tr><td>Crushing and screening plant</td><td>Crushing circuits are typically among the loudest areas within mineral processing plants, generating high levels of mechanical and impact noise from crushers, conveyors, and vibrating screens. Noise measurements from comparable metallic mineral operations in the Francois Malherbe Acoustic Consulting (FMAC) database were applied. Note, crusher plant operational during daytime only.

<table>
<tr><th>Source</th><th>L_{WA} (dBA)</th></tr>
<tr><td>Primary crusher</td><td>121.7</td></tr>
<tr><td>Secondary crusher</td><td>115.6</td></tr>
<tr><td>Primary screen</td><td>114.8</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th colspan="2">Source data</th></tr>
<tr><td></td><td>
<table>
<tr><td>Hopper</td><td>98.4</td></tr>
<tr><td>Conveyor</td><td>67.1</td></tr>
<tr><td>Total</td><td>123.3</td></tr>
</table>
</td></tr>
<tr><td>Milling and thickening plant</td><td>Similar to the crushing and screening plant, noise data for the milling plant were obtained from the FMAC database, based on measurements from comparable operations in the metallic minerals industry.
<table>
<tr><td>Source</td><td>L_{WA} (dBA)</td></tr>
<tr><td>Milling</td><td>110.1</td></tr>
</table>
</td></tr>
<tr><td>Other operational production/treatment sections of the facility</td><td>Assumed default L_{WA} for either commercial, light industrial or heavy industrial areas (EC WG-AEN, 2007).
<table>
<tr><th>Area</th><th>L_{WA}/m^2, (dBA/m)</th><th>L_{WA} (dBA)</th></tr>
<tr><td>Refinery:</td><td></td><td></td></tr>
<tr><td>Ore off-loading and storage</td><td>65</td><td>108.1</td></tr>
<tr><td>Leaching,</td><td>65</td><td>111.2</td></tr>
<tr><td>Reagent handling</td><td>65</td><td>106.2</td></tr>
<tr><td>Lay-down area</td><td>60</td><td>103.9</td></tr>
<tr><td>Water treatment plant</td><td>65</td><td>102.8</td></tr>
<tr><td>Precipitation and polishing</td><td>65</td><td>107.3</td></tr>
<tr><td>Crystallisation and packing</td><td>65</td><td>107.3</td></tr>
<tr><td>Product Warehouse</td><td>60</td><td>102.3</td></tr>
<tr><td>Offices</td><td>60 (45 night)</td><td>103.6 (88.6 night)</td></tr>
<tr><td>Stores</td><td>60</td><td>105.1</td></tr>
<tr><td>SAP:</td><td></td><td></td></tr>
<tr><td>Sulphur off-loading area</td><td>65</td><td>108.1</td></tr>
<tr><td>Workshops</td><td>60</td><td>92.6</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th colspan="2">Source data</th></tr>
<tr><td></td><td><table><tr><td>Offices</td><td>60 (45 night)</td><td>92.3 (77.3 night)</td></tr><tr><td>500 t plant area (no. 1)</td><td>65</td><td>101.5</td></tr><tr><td>500 t plant area (no. 2)</td><td>65</td><td>101.9</td></tr><tr><td>1,000 t plant area</td><td>65</td><td>105.4</td></tr></table></td></tr>
<tr><td rowspan="3">Traffic</td><td>21.6 vehicles per day via C14
28.8 vehicles per hour via A2
1.4 hourly return truck trips between refinery and MRF for residue disposal</td></tr>
<tr><td>Speed limits:
C14 and A2 100 km/h
On-site roads 40 km/h</td></tr>
<tr><td>100% heavy vehicles, includes staff transport by bus</td></tr>
<tr><th colspan="2">Noise propagation model setup</th></tr>
<tr><td>Software used</td><td>DataKustic CadnaA</td></tr>
<tr><td rowspan="2">Calculation standards</td><td>Concawe method for outdoor noise propagation from industrial noise sources</td></tr>
<tr><td>German RLS-90 calculation method for roadways and parking</td></tr>
<tr><td rowspan="3">Calculation domain and receptors</td><td>Domain 10 km by 10 km</td></tr>
<tr><td>Calculation grid resolution 25 m, receptor height 1.5 m</td></tr>
<tr><td>Representative noise-sensitive receptors as indicated in Figure 35 in Section 6.7.2</td></tr>
<tr><td>Ground cover</td><td>Acoustically ‘hard’ i.e. not conducive to noise attenuation</td></tr>
<tr><td rowspan="2">Results</td><td>Daytime noise level denoted as L_D for conciseness</td></tr>
<tr><td>Night-time noise level denoted as L_N for conciseness</td></tr>
<tr><td>Other key inputs and assumptions</td><td>Average ambient temperature and humidity; 20 ºC and 66%.
‘Worst case’ wind direction assumed
In absence of detailed development plans, the mitigating effect of building structures on noise propagation within the development footprint was not assessed.
Model inputs were intentionally conservative to ensure that potential noise emissions and associated impacts are not underestimated.</td></tr>
</table>

The simulation results are presented in tabular form (**Table 77**), showing the expected noise levels at sensitive receptors attributable to the Project, as well as in contour plots illustrating the spatial distribution of noise (**Figure 66** and **Figure 67**). The corresponding noise impacts, that is, the increase above existing baseline levels, are also indicated in **Table 77** and **Figure 68** and **Figure 69**.

Table 77: Expected noise levels and impacts.

Receptor	Desired levels		GMR Namibia, Walvis Bay Project		Cumulative noise levels		Noise impact	
	L_D (dBA)	L_N (dBA)	L_D (dBA)	L_N (dBA)	L_D (dBA)	L_N (dBA)	ΔL_D (dBA)	ΔL_N (dBA)
Dune 7	55	45	26.6	26.6	43.7	32.7	0.1	1.2
Dune 7 Adventures	55	45	28.8	28.8	43.8	33.4	0.1	1.9
Clean Energy Solutions Namibia	70	70	27.7	27.7	43.8	33.0	0.1	1.5
Rooikop	55	45	<20	<20	43.7	31.5	0.0	0.0
Walvis Bay International Airport	70	70	<20	<20	43.7	31.5	0.0	0.0

Notes:

(a) Based on site observations and measurements average residual noise levels (baseline) for the area was set at 43.7 dBA for daytime and 31.5 for night-time. See Section 6.7.2.

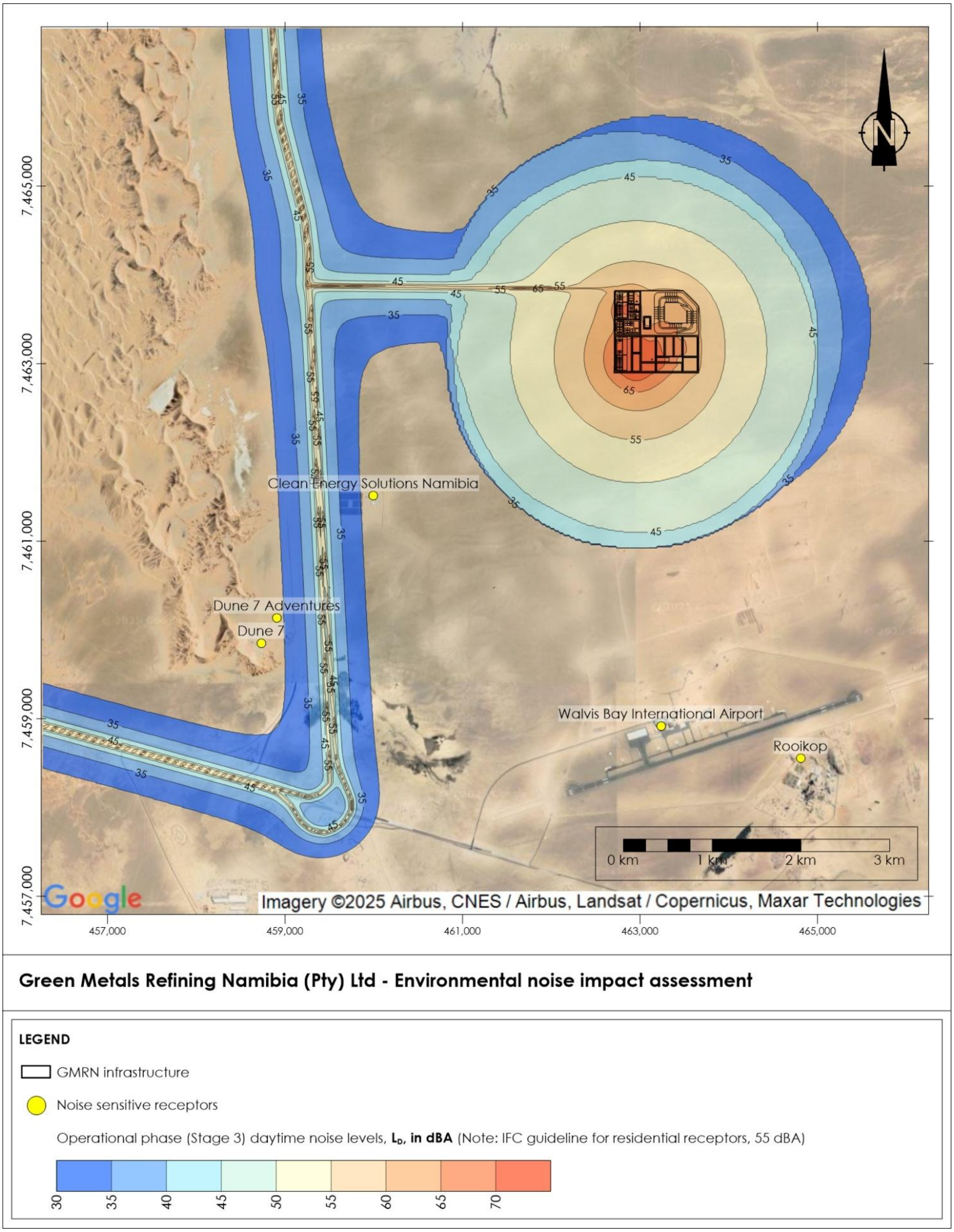

Figure 66: Expected maximum daytime noise levels (LD) associated with the GMR Namibia Project at full operational capacity.

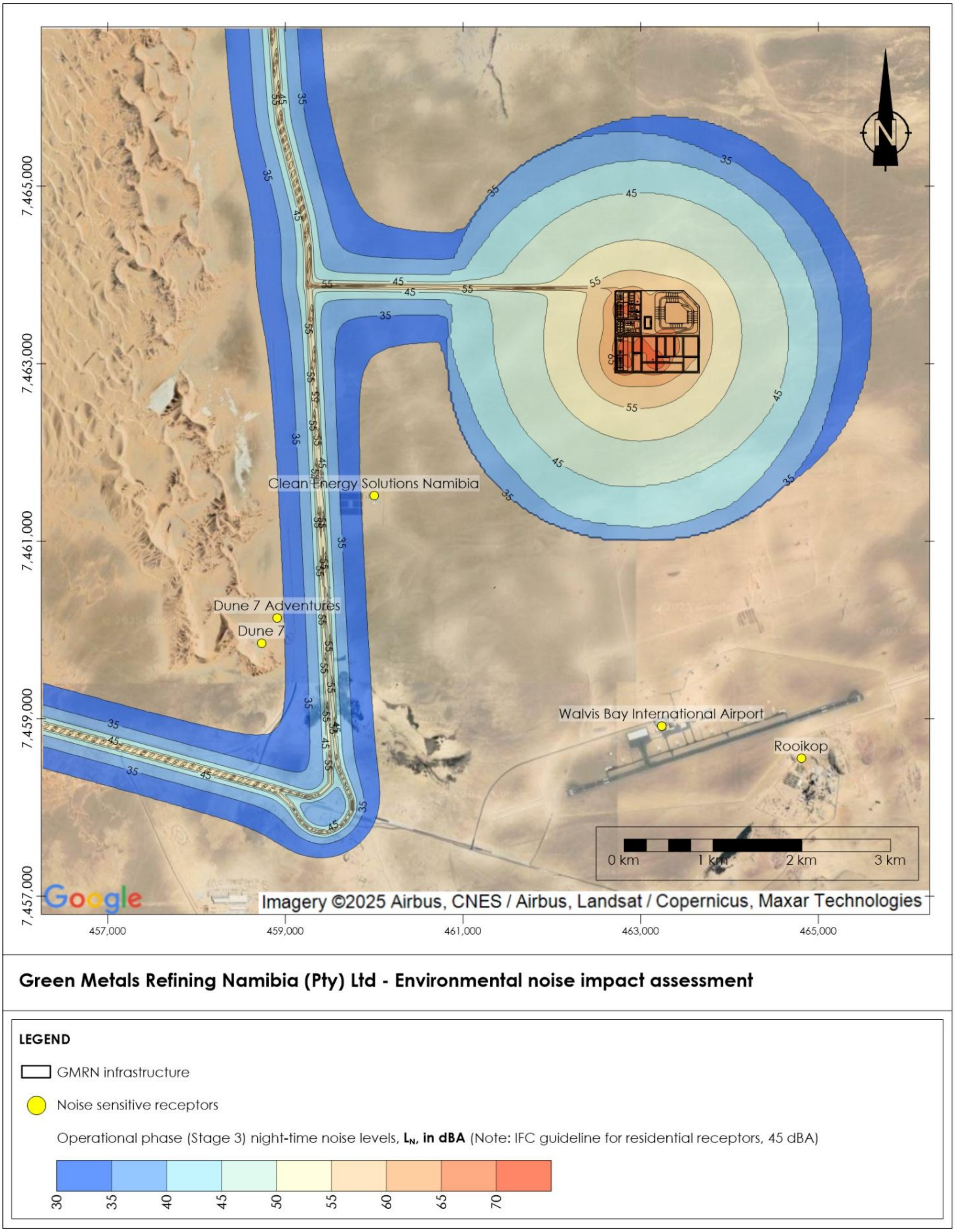

Figure 67: Expected maximum night-time noise levels (LN) associated with the GMR Namibia Project at full operational capacity.

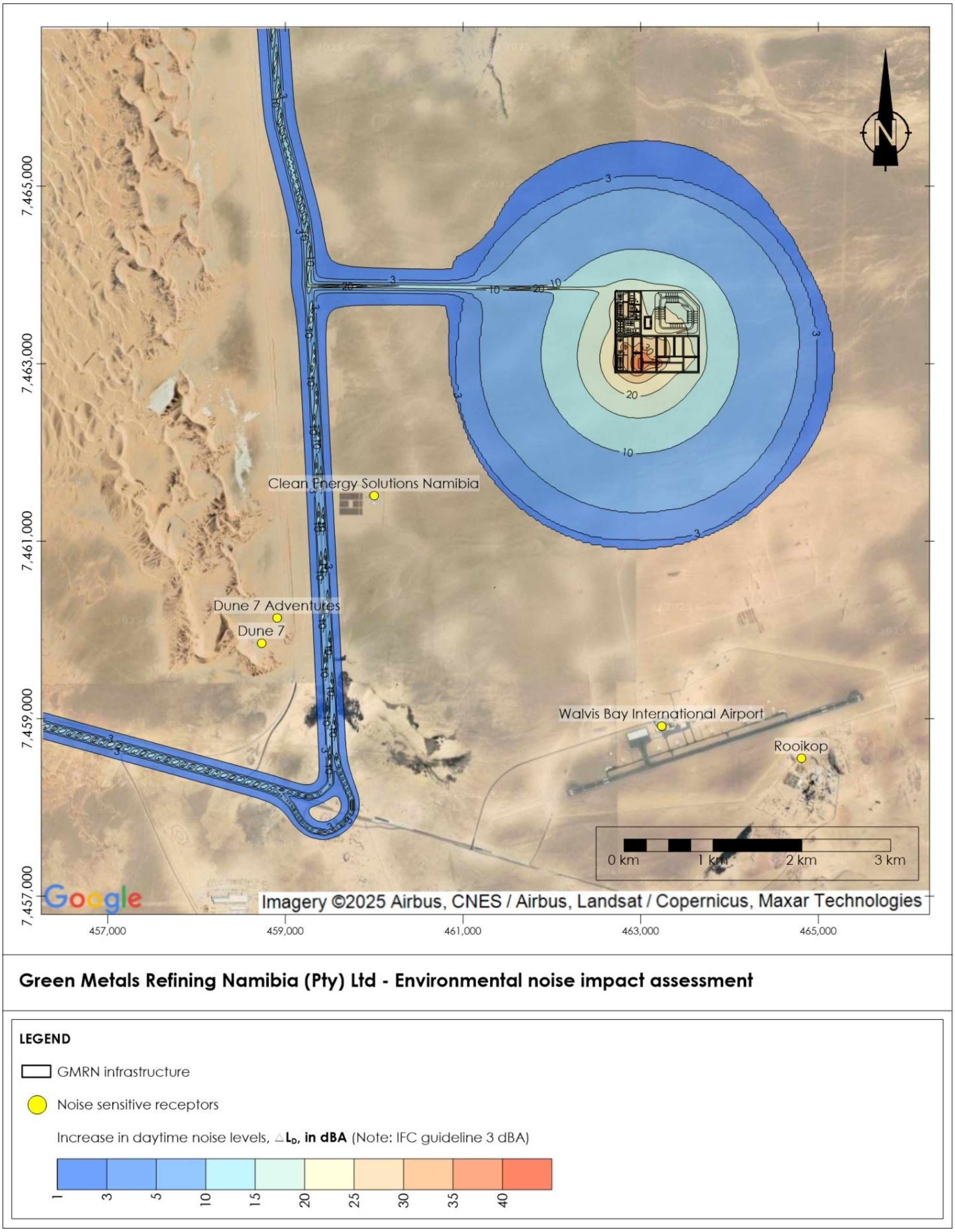

Figure 68: Noise impact; expected increase in daytime noise levels (ΔL_D) because of the GMR Namibia Project at full operational capacity.

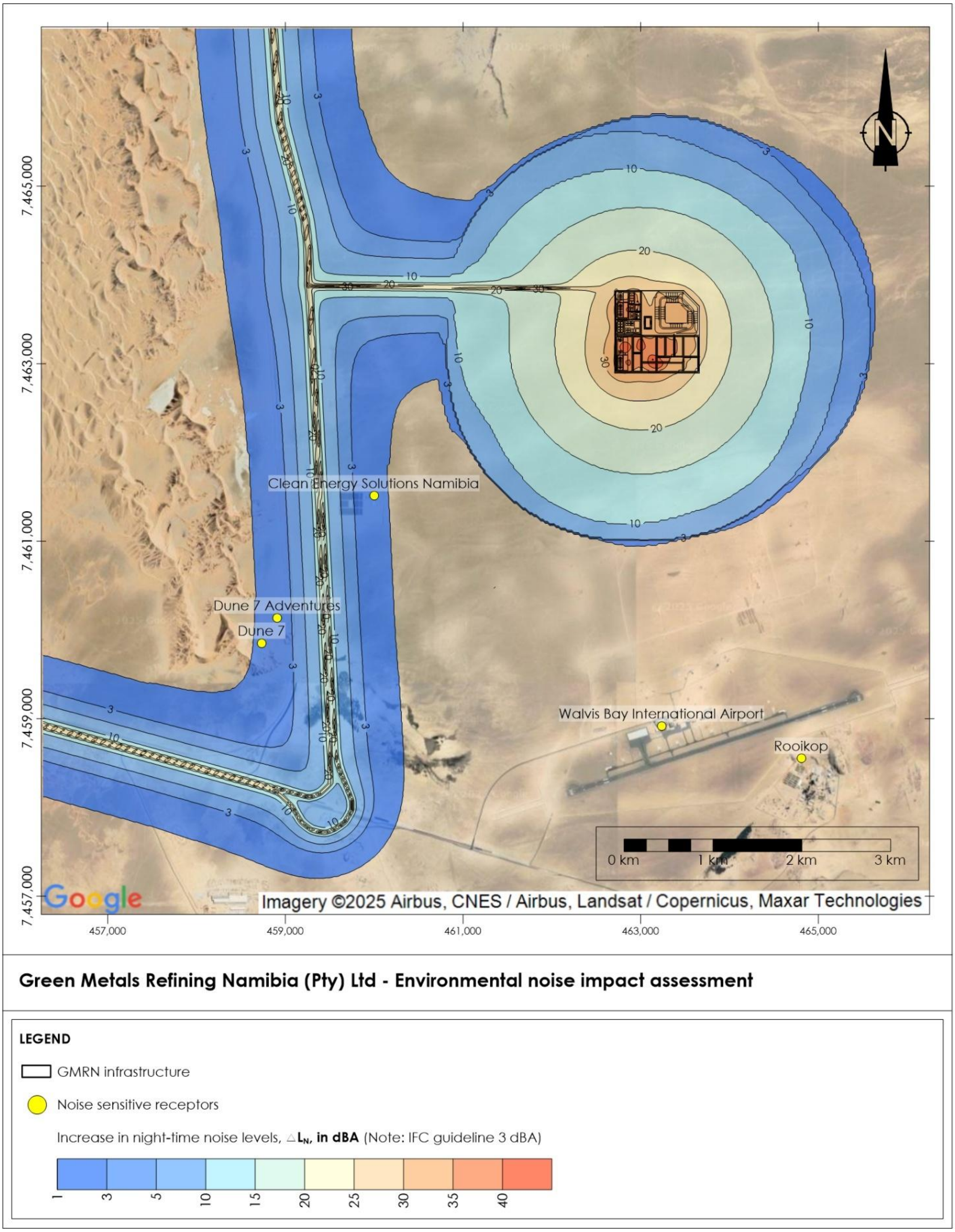

Figure 69: Noise impact; expected increase in night-time noise levels (ΔL_N) because of the GMR Namibia Project at full operational capacity.

Key findings:

- The assessment indicates that the project will **not result in any exceedance of the**

desired noise levels at sensitive receptors.

- Predicted noise increases at these receptors are **less than 3 dBA**, which is below the threshold of perceptibility.
- The **night-time impact area** extends up to **1.9 km**, primarily due to lower residual (baseline) noise levels rather than higher project emissions.
- **Receptors at Dune 7 and Dune 7 Adventures** are affected mainly by **road transport activities**, not by the **Refinery or SAP** operations.
- These locations are **not inhabited at night**, further reducing the potential for disturbance.
- **No noise impacts are predicted at residential receptors in Rooikop.**

7.2.5.4 Cumulative environmental noise impacts associated with the construction phase

Noise impacts are negative in nature and generally assessed for its potential nuisance impact. The construction phase impacts will last for approximately 18 months and will stop afterwards.

Nature, intensity, duration and extent

The nature, intensity and duration in the unmitigated and mitigated scenario are **low**, as the assessment showed the following:

- Exceedance of daytime NLG only within about 1 km of construction activities.
- Levels at the closest receptors will be well below NLGs.
- Impacts may be notable to some at receptors along transport routes.
- Minor effect on natural, cultural and social functions and processes
- Limited nuisance related complaints are expected

Consequence

The consequence of this impact with and without mitigatio is **low**.

Probability

In the unmitigated scenario the probability is **low - moderate**, but can be reduced to **low**, as impacts are possible but unlikely with mitigation.

Significance

Impact cannot be avoided altogether but significance of conservatively estimated construction phase noise impacts is **low**.

Impact summary – Cumulative environmental noise impacts associated with the construction phase

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**L**	**L**	**L**	**L**	**L - M**	**L**
Mitigated	**L**	**L**	**L**	**L**	**L**	**L**

7.2.5.5 'Maximum' cumulative environmental noise impacts associated with the operational phase

Noise impacts are negative in nature and generally assessed for its potential nuisance impact. Impact can be reversed over time but will last for the life of the project.

Nature, intensity and duration

The nature and intensity of the unmitigated and mitigated scenario are **low**, as the assessment showed the following:

- The project will not exceed desired noise levels at sensitive receptors, with predicted increases of less than 3 dBA, below the threshold of perceptibility.
- The night-time impact area (most significant) extends up to 1.9 km due to lower baseline noise, not higher emissions.
- Dune 7 and Dune 7 Adventures are affected mainly by road traffic, not refinery or SAP operations, and are uninhabited at night.
- No impacts are expected at residences in Rooikop.

The duration is in both scenarios, unmitigated and mitigated **moderate**, as the impact can be reversed over time, but will last for the life of the project.

Consequence

The consequence of this impact with and without mitigation is **low**.

Probability

In the unmitigated scenario, the probability is **low - moderate**, but can be reduced to **low**, as impacts are possible but unlikely with mitigation.

Significance

Impact cannot be avoided altogether, but the significance of conservatively estimated construction phase noise impacts is **low**.

Impact summary – Cumulative environmental noise impacts associated with the construction phase

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**L**	**M**	**L**	**L**	**L - M**	**L**
Mitigated	**L**	**M**	**L**	**L**	**L**	**L**

Mitigation measures

The objective of the noise mitigation and management plan is to ensure that cumulative noise levels from the proposed GMR Namibia Project near Walvis Bay remain below applicable assessment criteria at sensitive receptors, consistent with Good International Industry Practice (GIIP) and the NLGs. As the conservative impact assessment predicted noise levels and increases to be well within guideline limits, the emphasis is on maintaining emissions as low as reasonably practicable through the implementation of good practice measures. Noise will be managed in accordance with a hierarchy of controls, prioritising control at source before reliance on path or receptor-based mitigation, with the following sections outlining practical measures applicable to both construction and operational phases.

- General noise management measures (GIIP):
    - **Avoid unnecessary engine revving** and switch off equipment when not in use.
    - **Maintain internal haul roads** in good condition and avoid steep gradients to reduce engine strain and body rattle.
    - **Minimise material drop heights** and use **rubber linings** in chutes and dumpers to reduce impact noise.
    - **Startup plant and vehicles sequentially** rather than simultaneously.
    - **Restrict excessively or intermittently noisy activities** to normal daytime working hours where possible.
    - **Use broadband or smart reversing alarms** that maintain safety but minimise

    tonal noise.
  - **Enforce site speed limits** to reduce noise from tyres and drivetrains.
  - **Locate stationary equipment** such as generators, compressors, and pumps **away from sensitive areas**, and where possible, behind existing buildings, berms, or barriers.
  - **Orient directional noise sources** (e.g., fans, openings, exhausts) **away from receptors**.
  - **Avoid dropping materials**; instead, lower them carefully or onto resilient surfaces.
- Equipment selection, modification, and use
  - **Select low-noise equipment**, prioritising models with lower sound power levels.
  - **Fit high-performance exhaust silencers** or mufflers on engines and compressors.
  - **Install acoustic canopies or housings** around noisy equipment, ensuring adequate ventilation and maintenance access.
  - **Enclose portable or fixed generators** in **acoustically treated enclosures**.
  - **Consult manufacturers** before modifying equipment to ensure safety and performance.
  - **Apply damping materials** or stiffen body panels to reduce vibration resonance.
  - **Secure loose fittings** and use resilient mountings to prevent rattling.
  - **Install vibration isolation mounts** on rotating and reciprocating machinery.
  - **Keep acoustic covers closed** during operation to maintain attenuation.
  - **Avoid reflective surfaces** (e.g., concrete, glass, metal sheeting) near acoustic enclosures that could reflect noise back into the environment.
- Maintenance and operational controls
  - Implement a **preventative maintenance programme** to ensure all plant and machinery operate efficiently and quietly.
  - Regularly **inspect and service** silencers, mufflers, and enclosures.
  - **Balance rotating components** and maintain sharp cutting tools to minimise frictional and tonal noise.
  - **Lubricate moving parts** to reduce squeal or rattle.
  - Remove from service and repair any equipment identified as generating **excessive noise**.
  - **Supervise operators** to ensure adherence to noise management practices and proper use of equipment.
  - **Train personnel** in noise awareness, quiet operation techniques, and the importance of maintaining noise control devices.
- Community engagement and complaints management
  - A proactive approach to **community engagement** is essential to maintaining good relations and addressing any concerns promptly.

Monitoring recommendations

In the absence of noise-sensitive receptors within the Project's predicted noise impact area, **monitoring should be undertaken along the Project boundary**, where levels are required to remain below 70 dBA. The spread of noise and potential effects at **distant receptors can be inferred from boundary measurements** by the appointed acoustic specialist. Additional monitoring should be carried out in response to community complaints or when significant operational changes occur.

7.2.6 *Impact Assessment on Archaeology*

The field survey of Farm 58 focusing on the Green Metals Refining Namibia (Pty) Ltd (GMR Namibia) project site yielded no evidence of archaeological or palaeontological remains as defined by the National Heritage Act (27 of 2004). On the basis of this specialist study, the project site is not considered to be archaeologically sensitive and no assessment was carried out.

However, the **Chance Finds Procedure**, included in the EMP must be applied during construction.

7.3 Assessment of Socio-economic Impacts

Information in the following section pertaining to socio-economic impacts is taken from the socio-economic specialist study (Ashby, 2025).

The main objective of the impact assessment is to identify the significance of potential impacts that can be avoided and/or mitigated and to identify beneficial positive impacts which could be enhanced, during the construction, operation and decommissioning and rehabilitation phases of the Project on the receiving socio-economic environment.

A quantitative impact assessment is used, as far as possible.

7.3.1 *Economic Impact Assessment*

During both construction and operations, a range of economic impacts will be generated from various sources.

Construction: Importing and building the refining infrastructure will promote local procurement and will generate import taxes from components such as the crystalliser unit. Wages of contractors and inputs up and down the supply chain generate further economic activities.

Operations: Refining manganese ore, manufacturing sulphuric acid and exporting the final battery-grade manganese chemicals. Surplus sulphuric acid may become available for the local market. These create wages for employees and generate taxes. Inputs up and down the supply chain generate further economic inputs.

7.3.1.1 The Project's economics

Green Metal Refining has calculated its business plan and a business case with a capital estimate prepared to an AACE[32] International Class 5 (-20%/+50%), the lowest class level of cost engineering accuracy.

GMR estimates the initial capital costs (CAPEX) of the manganese refinery to be USD166M (N$2.94billion) with an accuracy of ± 95%. This is based on the manganese refinery having various crushers and mills, processing tanks, the adjacent acid plant, storage bunkers, warehouses, workshop, laboratory, stores, change house and offices on site. It includes other associated rail and road facilities; power, fuel, and water facilities; MRF; waste facilities; and port facilities associated with handling imported consumables and the export of product. (It also includes product marketing facilities in Europe or North America).

[32] AACE stands for the Association for the Advancement of Cost Engineering International which is a professional body for cost engineering and project management. Class 5 refers to the lowest level of project definition

The life of project (LOP) is projected to be 25 years, over which time the project is expected to produce over 3 million tonnes of high-purity manganese sulphate monohydrate (HPMSM) at an average annual production rate of 123,000 tonnes per annum. The revenue generated from HPMSM sales over the 25-year life of the project (LOP) is anticipated to be over USD6 billion (over NSD100 billion), and after all operating costs are deducted, the taxable income over the life of project is predicted to be USD2.6 billion (N$46 billion). It expects to pay USD527 million (N$9billion) in Corporate Income Tax to the Namibian Government over the life of the project. The expected profitability is such that the pre-tax Internal Rate of Return on investment is 39%, and the CAPEX will be paid back within three years. More financial detail is given in the table below (**Table 78**).

Table 78: Summary of Manganese Refinery Project economics.

Table Title centred	Unit	Value
Production		
Life of Project (LOP)	years	25
Annual ore production rate (average)	t/a	100,000
Contained manganese (LOP)	t	1,137,040
High-purity manganese sulphate monohydrate (HPMSM) produced (LOP)	t	3,078,225
HPMSM produced (average)	t/a	123,129
Revenue and costs		
Revenue from HPMSM sales	US$ million	6,156
Operating costs	US$ million	3,343
Operating profit (earnings before interest, taxes, depreciation, and amortisation)	US$ million	2,814
Initial capital cost	US$ million	166
Sustaining capital cost (Life of Project)	US$ million	125
Working capital in the first year	US$ million	20
Taxable income (Life of Project)	US$ million	2,618
CIT (LOP)	US$ million	527
Project economics		
Net free cashflow (LOP)	US$ million	2,518
Pre-tax NPV at 10% discount rate	US$ million	601
Pre-tax IRR	%	39
Payback	years	3

Source: GMRN: NPNB-I-MEM-002-00-F58Project Information received 15/7/2025

Sulphuric acid is required to leach the manganese out of its ore, and GMRN plans to build its own Sulphuric Acid Plant (SAP) on the same site as the manganese refinery. This is not the first SAP in Namibia: Dundee Precious Metals in Tsumeb and Skorpion Zinc in Rosh Pinah both produced sulphuric acid for their processing operations in the past. Currently, Husab Mine is producing sulphuric acid for its uranium mining operation. GMRN intends to build a standard design, modern, modular sulphur burning acid plant to produce 98% pure sulphuric acid for use by their manganese refinery and for third-party offtake.

The CAPEX for the first stage of the sulphuric acid plant is expected to be USD56.82 million (over NS1 billion). Sulphur prills, imported via Namport, are fed into a sulphur burner and, when mixed with potable water, produces sulphuric acid and steam, which can generate electricity. Based on a production rate of 175,000 tonnes/annum of sulphuric acid, revenue from the sale of sulphuric acid and electricity is expected to be USD735 million (NSD13 billion) over the life of project. After all costs are deducted, the taxable income is anticipated to be USD169 million (N$2.9 billion), generating over USD45 million (N$790 million) in Corporate Income Tax to the GRN over the 25 years. More detail is given in the table below (**Table 79**).

Table 79: Summary of the Sulphuric Acid Plant phase 1 Project Economics.

Table Title centred	Unit	Value
Production		
Life of Project	years	25
Annual acid production rate (average)	t/a	175,000
Net electricity generated	kWh/a	2,542
Revenue and costs		
Revenue from acid sales	US$ million	656.25
Revenue from electricity sales	US$ million	79.28
Operating costs	US$ million	438.86
Operating profit (EBITDA)	US$ million	296.67
Initial capital cost	US$ million	56.82
Sustaining capital cost (LOP)	US$ million	13.64
Working capital in the first year	US$ million	3.23
Taxable income (LOP)	US$ million	169.40
CIT (LOP)	US$ million	45.24
Project Economics		
Net free cashflow (LOP) after tax	US$ million	180.97
Pre-tax NPV at 10% discount rate	US$ million	59.36
Pre-tax IRR	%	20
Payback	years	5

Source: GMRN: NPNB-I-MEM-002-00-F58Project Information received 15/7/2025

7.3.1.1 Impact Assessment – All levels of the economy

Although a large part of the construction of the refinery and acid plant, and associated infrastructure will be from imported parts, purchases of local supplies such as concrete, which will require cement, gravel, sand and transport (all assumed to be Namibian). Other local services will be used, such as accommodation for expatriate workers. Construction will bring local economic benefits.

Direct economic benefits include the income earned from the sale of the refined battery-grade manganese chemicals, surplus sulphuric acid and electricity, the wages and salaries of the construction workers and the people employed during operations, including all benefits such as Social Security, pensions and medical aid. Other direct economic impacts of the project are interest and amortisation payments on capital and profits of the refinery and acid plant. The employees and contractors will pay personal income tax and VAT on goods and services they purchase, as will suppliers and their employees in the supply chains of goods and services. The Walvis Bay Town Council will benefit from rates and taxes on any services it provides to GMRN.

Indirect economic impacts arise through the provision of all Namibian inputs purchased to process the manganese ore and sulphuric acid (e.g. potable water), transportation of the products to Walvis Bay and local customers, as well as the inputs purchased by their suppliers to produce the refinery's inputs, and so on down the production chain. This backward chain is usually very extensive and includes the steel, cement, energy, machinery and equipment needed to construct the refinery and acid plant and other buildings; Indirect economic impacts during operations include inputs and replacement parts, and a wide variety of scientific, financial, accounting and technical services. In addition, some services such as security, catering, contractor/employee transport, laundry and cleaning will probably be outsourced to other Namibian companies. To align with Vision 2030, GMRN is urged to purchase Namibian-made goods or from the South African Development Community businesses, which will increase the multiplier effect on the Namibian economy.

The induced economic impacts are derived from the purchases of products and services by employees and contractors because of their increased spending power stemming from salaries and wages. If these products and services are produced locally, there will be a greater economic impact on the local towns and the Erongo Region at large. Moreover, this induced level has its own backward chain of purchases by the employees and contractors down the supply chain. Income to the employees is also spread to their immediate household members and to others living elsewhere in Namibia who depend on cash remittances to buy goods and services. The dependency ratio is estimated at 1 worker to 7 dependents which includes members of the wider extended family. The Namibian cultural norm is for an employed person “to share” his or her salary to help meet the needs of other family members, particularly towards meeting basic needs and education costs.

Nature of the Economic Impacts, intensity, duration and extent

The economic impacts, as described above, will bring about a **high positive (H+)** impact without enhancement measures. The duration of the impact will last beyond the project’s lifetime and is rated **High (H)** for several reasons, such as the accumulation of wealth by Namibian companies and individuals during the project lifespan, which is then invested in further economic activities. The extent of the impact will be beyond the local and regional economy, and thus ranked **High (H**), for example because wages are sent and invested in all regions of Namibia. Implementing the enhancement measures proposed below will increase the intensity of the economic inputs to **Very High (VH).**

Consequence

The economic consequence of the project is **High (H)** without any enhancement. Enhancement measures should raise the consequence rating to **Very High (VH+).**

Probability

There is a **High probability (H)** of economic benefits occurring during both construction and operations. On final closure, the infrastructure will have to be dismantled, re-purposed or disposed of, which will require different workers and services but will still generate economic activities of a lower intensity.

Significance

The described contributory factors result in a **High positive (H+)** impact significance without enhancement. Enhancement measures recommended below could increase the project’s significance to **Very High (VH+).**

To conclude, the project will generate new and positive contributions to the national, regional and local economy, especially during construction and operations, and these impacts will have high and positive values in terms of intensity, duration (25 years of LoP), and geographical extent.

Impact summary – Economic

Enhancement	Intensity	Duration	Extent	Consequence	Probability	Significance
Unenhanced	**H+**	**H+**	**H+**	**H+**	**H+**	**H+**
Enhanced	**VH+**	**H+**	**H+**	**H+**	**H+**	**VH+**

Enhancement measures

5. The Project and its contractors should purchase Namibian-made goods and services whenever possible, or if not available, from businesses within the South African Development Community.
6. The Project and its contractors should implement procurement policies which promote the use of small and medium enterprises (SMEs), owned and/or managed by previously disadvantaged Namibians.
7. GMRN should engage with government and other stakeholders to promote and facilitate the expansion of the manufacturing sector in Namibia.

Monitoring recommendations

- At the project's Development Phase, GMRN should identify indicators which will monitor its economic contributions to the local, regional and national economy.
- The Project should hold stakeholder meetings at least annually, as part of its stakeholder engagement plans, to monitor its economic and social contributions.

Cumulative impacts

As the refinery and sulphuric acid plant expand, the economic benefits will increase.

The manufacturing sector in Namibia is small and GMRN's presence may lead to more investors in the sector.

7.3.2 Job Creation and Skills Development Impact Assessment

The Project will create new jobs in the construction and operations phases and will provide opportunities for Namibians to gain skills.

At the start of the Feasibility Study phase of the Refinery, GMR, through its subsidiary GMRN, will employ a local team of five to oversee advanced study and field work, plan and execute environmental and social management, and perform corporate support functions.

During all project phases jobs will be created and skills transferred.

7.3.2.1 The Project's Manpower Requirements

Construction workforce

For the construction phase, GMRN will expand their local team to 34 people to manage the construction and later to employ the operational team as part of the operational readiness programme, as shown in **Table 80**. In addition, an engineering and procurement team will likely be based outside Namibia and will visit the site from time to time.

Table 80: GMRN's Owner's Team During Construction Phase.

Skill level	Paterson band[33]	Quantity	Employment
Programming	E2	1	Permanent
	E1	1	Contractor

[33] The Paterson system classifies jobs into bands ranging from A to F based on the level and complexity of decision making required. Band F represents the most senior tier in an organisation and is equivalent to GMR's corporate level. Each band is divided into up to four subcategories denoted by a number after the band. Essentially it classifies A - unskilled workers, B – semi skilled, C- skilled, D – middle management and E – senior management. The number grades are arranged hierarchically to represent increasing complexity and responsibility within each band, from 1 lowest to 5 highest.

Skill level	Paterson band[33]	Quantity	Employment
Interpretive	D3	4	Permanent
	D2	3	Permanent
	D1	6	Permanent
Skilled	C2	4	Permanent
	C1	3	Permanent
Semi-skilled	B1	8	Permanent
Unskilled	A1	4	Permanent
		34	

Source: GMRN: NPNB-I-MEM-002-00-F58Project Information received 15/7/2025

Contractors will be engaged to construct the Refinery and Acid Plant. The size of the crew and the level of skills required will fluctuate over a period of approximately 18 months, as reflected in **Table 81**.

Table 81: Contractor's Workforce for Construction.

Skill level	Quantity	Employment
Skilled	20 - 75	Contractor
Unskilled	75 - 450	Contractor
Total	100 - 500	

An estimated 500 jobs will be created during the construction phase of the Project. No information is available on specific skills required, but it is likely that semi-skilled workers will be contracted among the unskilled labour force indicated in the table above.

The construction crew will be sourced mostly from Namibia, and where, possible from the Erongo Region.

Operations Workforce

The Refinery and Sulphuric Acid Plant will be staffed mostly by Namibians. Certain key technical positions may be filled at first by expatriates until such time as Namibians can be trained to take over.

Apart from the crushing area in the refinery, which will operate on a 12-hour day shift only, both plants will operate 24 hours per day, seven days per week (24/7), on three 8-hour shifts. GMRN is anticipating that the refinery will operate 350 days per year while the SAP will operate every day of the year.

Three assignment categories have been identified:

- Managers: senior staff who work conventional working hours and do not require leave relief.
- Dayshift: staff that work on day shift only. These are typically supervising, administrative or maintenance personnel.
- Shift: most of the work force will be working a three-shift pattern, and allowance will be made for leave relief.

The operational staff is summarised in **Table 82**.

Table 82: Summary of Refinery and SAP operational staff.

Major area	Skill level	Paterson code	On Duty				Employed			
			Manager	Day shift	Shift	Total	Manager	Day shift	Shift	Total
Refinery	Programming	E2	1	-	-	1	1	-	-	1
	Interpretive	D3	5	-	-	5	5	-	-	5
		D2	5	2	-	7	5	4	-	9
	Skilled	C2	8	5	6	19	8	10	24	42
		C1	4	7	10	21	4	14	40	58
		D1	3	2	-	5	3	4	-	7
	Semi-skilled	B1	-	-	3	3	-	-	12	12
		B2	3		12	15	3	-	48	51
	Unskilled	A1	4	2	15	21	4	4	60	68
	Total Refinery		33	18	46	97	33	36	184	253
SAP	Interpretive	D3	1	-	-	1	1	-	-	1
		D2	-	2	-	2	-	2	-	2
		D1	-		1	1	-	-	4	4
	Skilled	C3	-	3	4	7	-	3	4	7
		C2	-	12	-	12	-	14	-	14
		C1	-	3	8	11	-	3	32	35
	Semi-skilled	B2	-	-	-	-	-	-	-	-
	Unskilled	A1	-	-	-	-	-	-	-	-
	Total SAP		1	20	13	34	1	22	40	63

Source: GMRN: NPNB-I-MEM-002-00-F58Project Information received 15/7/2025

During operations, it is anticipated that 253 people will be employed in the manganese refinery. Of these, 184 will work eight-hour shifts. The SAP will employ 63 people fulltime, of whom 40 will be rotated on the three shifts.

The site will have both male and female changing facilities that include locker rooms, showers, and washrooms. GMRN will contract a company to bus staff to and from the site from the neighbouring towns of Walvis Bay, Arandis and Swakopmund.

Where possible, local labour will be employed. When skills are imported, it will be done as part of a skills transfer programme.

Although GMRN may want to bring in their own senior management personnel and highly skilled operators to run the processing plant, the Ministry of Home Affairs, Immigration, Safety and Security has strict requirements to try and maximise the number of Namibians employed in available jobs. The Engineering Council of Namibia has a comprehensive list of engineers and technicians operating in Namibia, by discipline, by professional level and by nationality which is summarised in **Section 6.9.10**. The more highly skilled personnel will most likely be difficult to source locally and would be sourced at a national or where required, international level.

Indirect and induced jobs will be created through the Namibian suppliers of goods and services to the Project and its workforce. Examples will be jobs in the following sectors: construction, transport, security, laundry and cleaning, food, accommodation and retail.

7.3.2.2 Impact Assessment – New jobs and skills

The recent Housing and Population census of 2023 used a very narrow definition of employment that if you are of working age and have worked for at least 1 hour in the past 7 days (just 2.2% of the working week), then you are listed as "employed". Using this strict definition, the national unemployment rate is 36.9% in 2023.

However, in 2018, the National Statistics Agency used the "broad" definition of unemployment, used by SADC and AU countries, which drops the requirement of the person actively looking for work during the previous 7 days of the survey, i.e. it includes discouraged jobseekers. Using this broad definition, unemployment nationally has risen to 54.8%. National youth unemployment (those aged between 18 and 35 years) is particularly bad, with over 400,000 (61%) of youth unemployed. Women in every age group are about 8% less likely to be employed than men (Cirrus, 2025). In the Erongo Region, broad unemployment has risen from 29.7% in 2018 to 41.9% in 2023.

Nature of the Job Creation Impacts, intensity, duration and geographical extent

Both the construction and operating phases of the project will create direct, indirect and induced jobs, which are rated as **High Positive (H+) intensity**. Enhancement measures, such as specifications in the bidding process, can make contractual obligations to maximise the number of jobs taken up by local and regional residents, and to provide skills development and skills transfer. It is expected that the Project will develop and implement a policy that promotes preferential procurement from local Small, Medium, and Micro-sized Enterprises (SMME), which tends to further increase the number of local indirect jobs created. Such measures can increase the intensity to **Very High (VH+)**.

Although it is expected that unskilled and semi-skilled labour will be recruited locally, more highly trained and experienced staff are likely to be sourced nationally. Every job created is valuable, whether short term or permanent, and will assist in supporting each person's wider family network, so the **Extent is national and rated High (H)**. The duration of this impact will last the project's lifetime and is rated **High (H)**.

In terms of skills development and transfer, any work experience proving you can perform well is a great asset for obtaining further work. A wide range of tangible and intangible skills is transferable between jobs and is a long-term asset, so the intensity is rated as **High Positive (H+)**. The duration of additional work experience and added skills could last a lifetime and is permanent and cumulative so the **duration is Very High (VH)**. Often wages go to support the education of other family members who may live in other regions so the **extent will be national and is ranked (H)**.

Consequence

The consequence of the project's job creation is **High (H)** as the intensity, during and geographic extent are all **High**. Enhancement measures are recommended, which could raise the consequence rating to **Very High (VH**). As the impact on Skills Development can be permanent, the Consequence **is Very High (VH)** and with enhancement measures, it can increase to **VH++.**

Probability

There is a **very high probability (VH)** of employment benefits occurring during both construction and operations. On final closure, the infrastructure will have to be dismantled, re-purposed or disposed of, which will require different workers and services but will still generate jobs. Skills transfer and development require some commitment from GMRN, but the probability is rated as High (H) as it will lead to a more stable and contented workforce.

Significance

The high consequence and very high probability result in the significance of job creation and skills development resulting in **high positive (H+) impact significance** without enhancement. Enhancement measures recommended below could increase the project's significance to **Very High (VH+).**

To conclude, the project will generate new jobs and skills opportunities, especially during construction and operations, and these impacts will have high and positive values in terms of intensity and geographical extent. Decommissioning will result in a loss of these jobs, reversing these benefits, although some new short-term jobs will be created dismantling and making safe the infrastructure.

Impact summary – Job Creation

Enhancement	Intensity	Duration	Extent	Consequence	Probability	Significance
Unenhanced	**H+**	**H**	**H**	**H+**	**VH**	**H**
Enhanced	**VH+**	**H**	**H**	**VH+**	**H**	**VH+**

Impact summary – Skills Development

Enhancement	Intensity	Duration	Extent	Consequence	Probability	Significance
Unenhanced	**H+**	**VH**	**H**	**VH+**	**H**	**VH+**
Enhanced	**VH+**	**H**	**H**	**VH++**	**H**	**VH++**

Enhancement measures

Enhancement can be achieved by up-skilling Namibians at every available opportunity.

GMRN has the potential to benefit from intelligent but unskilled adults who, for a variety of reasons, were unable to complete their education or have been unable to find work, so they are unemployed. Skills acquisition and upgrading can provide great opportunities for the unemployed labour force to participate in the project, thereby making a crucial contribution towards long-term sustainability, beyond the life of the project.

Youth unemployment is high in the region. Gaining work experience can demonstrate reliability, punctuality, initiative, problem-solving, and can often lead to further work opportunities to climb the employment ladder. Where employees can gain skills through work experience and accredited training, the impact is even more beneficial. Several large projects in Namibia have identified bright people engaged in their construction and then selected them for training, and they become successful and loyal employees during operations.

<u>To promote skills development:</u>

1. GMRN should put in place skills development strategies and programmes prior to construction to maximise the use of the local labour force for both construction & operations phases.
2. GMRN should identify suitable training institutions and courses well in advance of the refinery and acid plant commissioning to send promising local people for training.
3. GMRN should have a long-term skills development programme in place which includes elements such as community outreach, apprenticeships, internships, bursaries, graduate programme, study assistance and in-house training.
4. GMRN should give tender weighting to construction companies that will detail how and what skills they will transfer to local workers during construction, or the % of gross

wages they will spend on training.
5. GMRN should provide training and skills development programmes specifically tailored to upskill employees. Such a programme should include life skills training, financial literacy and mentorship.

<u>To promote local recruitment and retention during construction and operations, which also minimises national migration to the coast:</u>

1. GMRN should give tender preferential weighting to supply companies which demonstrate their use of the local labour force, particularly youth and women, to enhance induced economic impacts and further job creation.
2. GMRN should base worker selection criteria on verbal and written English or Afrikaans reading and writing skills, and culturally sensitive ability tests rather than exclusively on education certificates.
3. GMRN should identify high performing local construction-phase workers and re-train them for operations.

<u>To promote empowerment and gender equality:</u>

1. GMRN should maximise opportunities to train and employ/contract women, youth and people from the marginalised Topnaar community.
2. GMRN should proactively identify bright local students for bursaries in the desired skills required for this project.
3. GMRN should ensure, wherever possible, that skills gained are accredited and transferable.
4. GMRN should adopt a focused approach to leadership training and development for supervisory and management levels to enable previously disadvantaged employees to rise through the company.

<u>To promote stable working conditions:</u>

1. GMRN should ensure that employees, and those of its contractors, are paid market-related wages, with housing allowances that can promote home ownership, pension contributions and medical aid.
2. GMRN should foster good labour relations and take responsibility to respect employees' human rights.
3. GMRN should establish credible and trusted operational procedures to address employees' concerns and grievances.

Monitoring recommendations

GMRN must report on the number of Namibians employed at all skill levels, by gender and youth, and these should also be part of their contractors' Key Performance Indicators.

GMRN should publicly report annually on the progress made by itself and its contractors, to transfer skills and jobs to Namibians.

7.3.3 Housing Impact Assessment

Impacts on housing will occur during the construction and operational phase.

Construction: Mostly single, construction workers will require short-term housing. Jobseekers will seek basic housing in the informal settlements and backyard shacks.

Operation: Single workers will seek longer term accommodation in the rental and possibly ownership market. Workers with families will require larger accommodation units & some school places. Newly arrived, unsuccessful jobseekers will seek basic housing in the informal settlements/backyard shacks.

7.3.3.1 Impact Description – Housing

GMRN predicts that up to about 500 workers will be involved in the construction of the manganese refinery and sulphuric acid plant, over an eighteen-month period. During the operations phase, predicted to be at least 25 years, it is anticipated that 253 people will be employed. Workers employed from other regions are likely to arrive and increase the demand for scarce, affordable and decent housing. Those workers already living at the coast may want to upgrade their current accommodation.

The Project will also attract unsuccessful job seekers to Walvis Bay, Swakopmund and Arandis. Unemployment is high throughout Namibia, so a new employer is likely to act as a magnet for skilled and unskilled people seeking new jobs. Job seekers who have heard of the project and come to Walvis Bay or Swakopmund, will seek accommodation with friends or family or find a spot on which to erect a temporary shack.

7.3.3.2 Impact Assessment – Housing

Section 6.8.3 on housing details the acute shortage of all types of affordable, decent housing in Walvis Bay and Swakopmund. Estate Agents have long waiting-lists already. The shortage has caused rental and property prices to be very high.

GMRN is predicting that construction will be done during a 12-hour day shift and no construction camp will be constructed on site or in the vicinity. This implies that GMRN expects construction workers to stay in existing housing in Walvis Bay and possibly the other two local towns; workers will be transported from these locations to the site and back each day by the construction company. Unskilled and semi-skilled construction workers may not be able to find decent housing, as Kuisebmond and Tutuleni are already very densely populated. GMRN should be aware that workers in cramped living conditions, may not have slept well and may be more at risk from workplace accidents.

Operation phase workers will want to choose from a full range of affordable decent housing options – rental or ownership - for low-, middle- and high-income workers, whether single or for families.

Nature of Impacts on Housing/ intensity, duration and geographical extent

The shortage of available housing is critical. Decent accommodation is hard to find in Walvis Bay, Swakopmund and Arandis. Rental prices are high and house prices are very expensive. The GMRN workforce will add additional pressure on an overstretched infrastructure system and housing shortage. Existing local residents are likely to face a further increase in rental prices as demand continues to exceed supply. Note however, housing impacts are influenced by broader regional market dynamics beyond the control of the Project. The nature and intensity of this negative impact is **High (H)**. The extent of the impact is confined to the region – the municipalities within the region and is therefore rated as **Moderate (M).** As this has been an issue for decades, it is likely that the duration will last the lifetime of the project **(M).**

Consequence

The impact of the project on the current housing stock will be **Moderate (M**) before mitigation measures. Mitigation measures might reduce the Intensity to Moderate, but this is unlikely to impact the Consequence unless GMRN facilitates the construction of new housing, which will reduce the Intensity, and therefore the Consequence rating to **Low (L).**

Probability

The probability of both construction workers and operations workers not being able to find decent housing and impacting negatively on local housing prices is **High (H)**. The probability of GMRN being willing and able to mitigate, such as to facilitate banks and developers to create new housing stock, is **Moderate (M).**

Significance

The significance of increasing the demand for already very limited housing stock is rated as **Moderate (M)**. From a socio-economic perspective, it is of **High** significance. The recommended mitigation measures of relevance to GMRN would focus on attracting and retaining a stable workforce and a strong health and safety record.

Impact summary – Housing

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**H**	**M**	**M**	**M**	**H**	**M**
Mitigated	**L**	**M**	**M**	**L**	**M**	**L**

Mitigation Measures

6. GMRN must consider the need to construct a construction camp, at least for low and semi-skilled workers, to ensure they have adequate housing and can sleep well to avoid workplace incidents and accidents.
7. GMRN must recruit from existing local residents to help reduce in-migration and avoid increasing the housing demand.
8. GMRN must identify and train local residents for available jobs for construction and operations, to minimise in-migration.
9. GMRN must collaborate with the local municipalities to ensure land is available for servicing and the construction of housing.
10. GMRN to collaborate with local banks and developers to create a package which facilitates workers to build and own their own homes in Walvis Bay, Swakopmund and Arandis.

Monitoring

GMRN will report annually on its stakeholder dialogue to improve the housing stock.

Cumulative Impacts

If other large employers come to the coastal towns, further pressure will be put on the limited decent housing stock, which will cause rents and house prices to rise further.

7.3.4 Increase in traffic Impact Assessment

Information and assessment were taken from the socio-economic specialist study (Ashby, 2025).

This section examines the predicted impacts which may occur from an increase in heavy trucks, busses and other passenger vehicles on local roads leading to and from the Project Site during the construction, operational and decommissioning phases. The key potential traffic-related impacts relate to road capacity and third party (i.e. public) road safety. (Note: The transport of the manganese ore from outside Namibia to the Dr Hifikepunye Pohamba Freeway is not part of this ESIA).

Impacts will arise during the construction, operational and decommissioning phase.

Construction: Transporting infrastructural materials to Farm 58.

Operation: Transporting inputs and outputs along the routes between Project site - Walvis Bay and regionally; personnel operating the Project.

Decommissioning: Transport required to de-construct and remove surface infrastructure.

7.3.4.1 Impact Description – The Project's traffic generation

During the 18-month construction period structural steel, piping and equipment will be imported through the Port of Walvis Bay (Namport) and transported to the site using 200 x 20t trucks and 100 x 30t trucks, along route T2/1 (also known as the C14, MR36, MR44 and T0201). Locally sourced materials, such as sand, gravel and cement, are likely to be transported to site in an estimated 121 x 20t trucks and 44 x 30t trucks, using the Dr Hifikepunye Pohamba Freeway (behind the dunes, previously called the A2, C34, MR44 and D1984) unless they are transported to Walvis Bay by rail and delivered to site via route TR2/1. (See **Table 83**).

Table 83: Estimated Total truck movement over the construction Period (18 months period).

Road	20t truck	30t truck	60t truck
TR 2/1 (C14)	200	100	-
Dr Hifikepunye Pohamba Freeway (A2)	121	44	-

Source: GMRN: NPNB-I-MEM-002-00-F58 Project Information received 15/7/2025

The estimated number of truck loads during construction amounts to an average of less than one truck per day using either road.

Table 84 summarises truck movements per week during the operations for both the initial 25 kt/a, and final 100 kt/a production capacities.

Table 84: Average weekly truck movements during operations (25-100 kt/annum plant capacity).

Road	20t truck	30t truck	60t truck
T2/1 – Imports via Namport	1 - 4	81 - 123	-
T2/1 – Product export to Namport	-	20 – 80[1]	-
A2 – Deliveries to site	2 - 8	4 - 16	9 - 36
A2 – Acid deliveries to third parties	-	87 - 115	-

[1]Product will be exported using the return legs of the delivery trucks

Source: GMRN: NPNB-I-MEM-002-00-F58Project Information received 15/7/2025

Table 84 predicts that during the first phase of operations with the refinery processing 25,000t of ore/annum and the acid plant processing 57,000t sulphur/a, an estimated 81 x 30t trucks will bring inputs from the harbour such as sulphur, caustic soda, soda ash light, quicklime and flocculant along the T2/1 (C14) per week, equivalent to approximately one truck every 50 minutes during daylight hours in a 6 day week.

When the manganese refinery is expanded to Stage 3 with its full capacity of processing 100,000 tons of ore per annum and the acid plant processes 228,000t of sulphur, the number of trucks will increase to 4 x 20t trucks and 123 x 30t trucks using the T2/1 (C14) per week. That is equivalent to approximately 20 x 30t trucks per day or 1 truck every 30mins (i.e. 2 truck per hour) during daylight, over 6 days (**Table 84**).

Heavy deliveries of manganese ore using 60t trucks will be transported from RSA and/or Botswana along the B1, T2/2 (previously B2) and the Dr Hifikepunye Pohamba Freeway (A2) to site, amounting to approximately 6 trucks per day.

During Stage 1 of acid production, transport of acid to third parties would amount to an average of one 30t acid tanker using the Dr Hifikepunye Pohamba Freeway (A2) approximately every 1.5hours during daylight over a 6-day week. By Stage 3, this will increase to one tanker carrying sulphuric acid leaving the site every 35 minutes during daylight over a 6-day week.

Generally, less than one 20t truck will bring imports from Namport per day and make deliveries using the T2/1 (C14) and Dr Hifikepunye Pohamba Freeway (A2).

One bus will transport personnel to the site using the T2/1 (C14) to and from Walvis Bay and another using the A2 to Swakopmund and Arandis – one in each direction for the three shifts every day.

Pre-Project Traffic Count

Figure 70 shows there was a gradual increase in all vehicles using Dr Hifikepunye Pohamba Freeway (A2) between January and November 2024, with the average daily truck traffic (ADTT) increasing from 770 to 993, with the percentage of heavy trucks generally around 62% of all traffic. This changed in December 2024, when there was a marked increase in light vehicles, likely due to an increase in local and regional tourists.

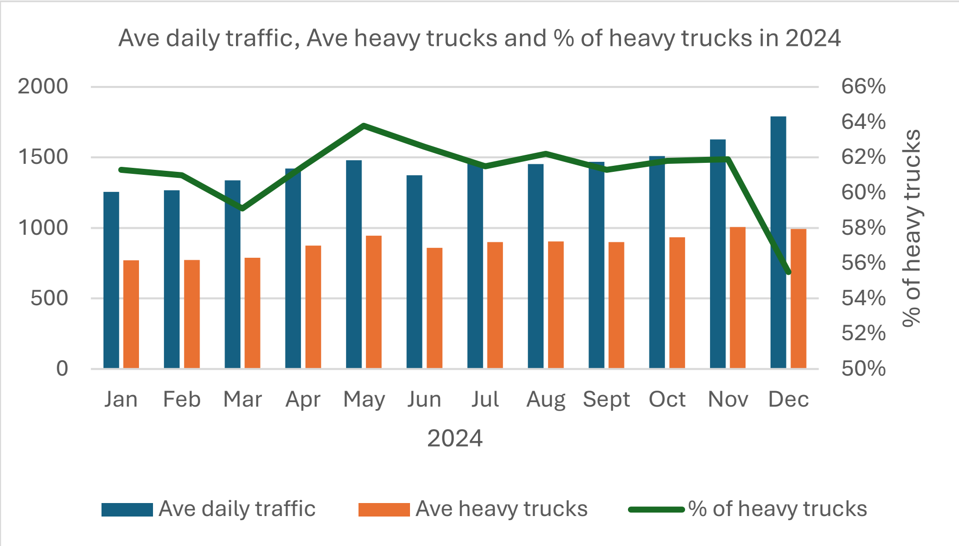

Figure 70: Average Daily Traffic Volumes along the Dr Hifikepunye Pohamba Freeway (A2) behind the Dunes.

Data Source: Roads Authority site 406, received 27/5/2024

More detailed data from the traffic counts along the Dr Hifikepunye Pohamba Freeway (A2) during 2024 show slightly more heavy trucks use the northbound carriageway from Walvis Bay to Swakopmund than the southbound carriageway. Generally, the average speed of heavy vehicles travelling north from Walvis Bay is around 78km/hr, while the heavy trucks travelling towards Walvis Bay are going slightly slower on average, about 76km/hr.

It can be assumed that most of the heavy trucks accessing the Dr Hifikepunye Pohamba Freeway (A2) will be using the T2/1 (C14) to and from Walvis Bay. Ad hoc Roads Authority 2022 and 2023 traffic surveys at this section on the T2/1 (C14) between the Dr Hifikepunye Pohamba Freeway (A2) turnoff and Walvis Bay traffic circle recorded between 1004 and 940 average daily heavy trucks (ADTT), which is higher than the more comprehensive counts of 2024.

The T2/1 (C14) road pavement infrastructure is currently being upgraded and widened and has safe junction ramps between the two roads, as shown in **Figure 71**. These improvements are aimed to reducing the risk of accidents and improving public safety.

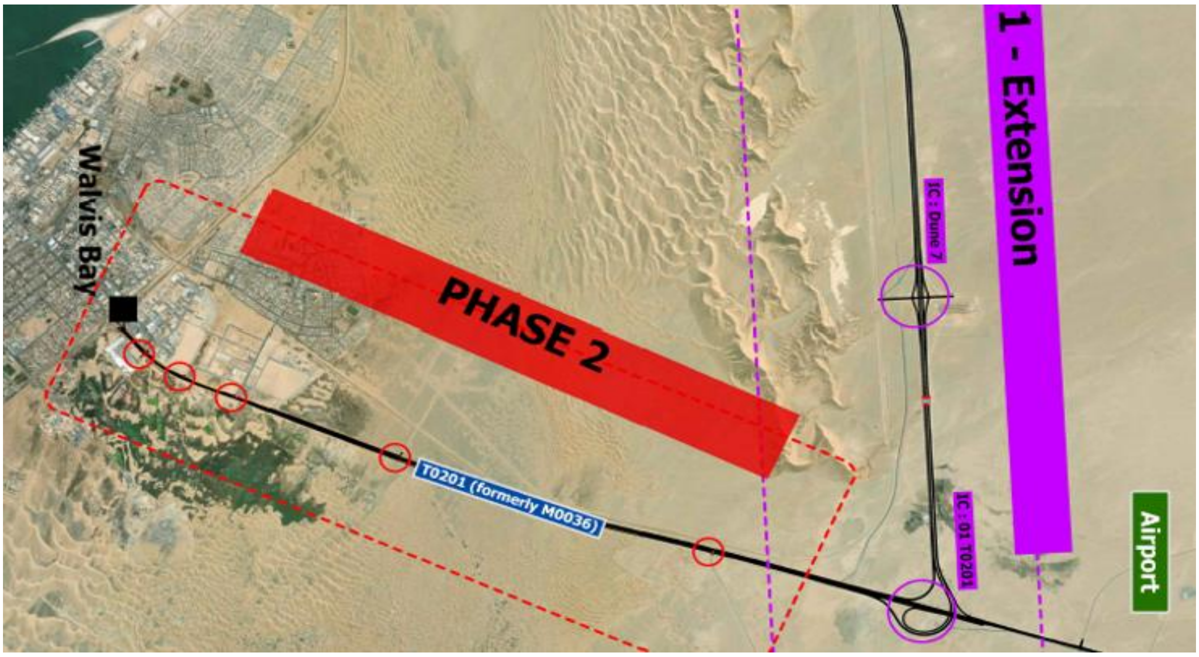

Figure 71: Map showing intersection of the T2/1 and the Dr Hifikepunye Pohamba Freeway.

Source: Roads Authority 11/2024

Other traffic using the T2/1 (C14) can be estimated using data shown in **Figure 72**, the 2024 two-way traffic at the Roads Authority site 256, approximately 27km beyond the turn off to the Dr Hifikepunye Pohamba Freeway (A2) towards Solitaire. The number of vehicles travelling from Solitaire towards Walvis Bay is consistently higher than in the other direction as most tourists travel from Windhoek to Sossusvlei and return via Swakopmund. The month with the highest traffic counts was August, which corresponds to the peak European holiday season. The daily average in August 2024, recorded 160 vehicles which travelled West while 93 travelled towards Solitaire. The daily average of heavy trucks peaked in March and April 2024 with 26 trucks recorded, and this figure slowly reduced to a total of 5 trucks in both directions by December 2024.

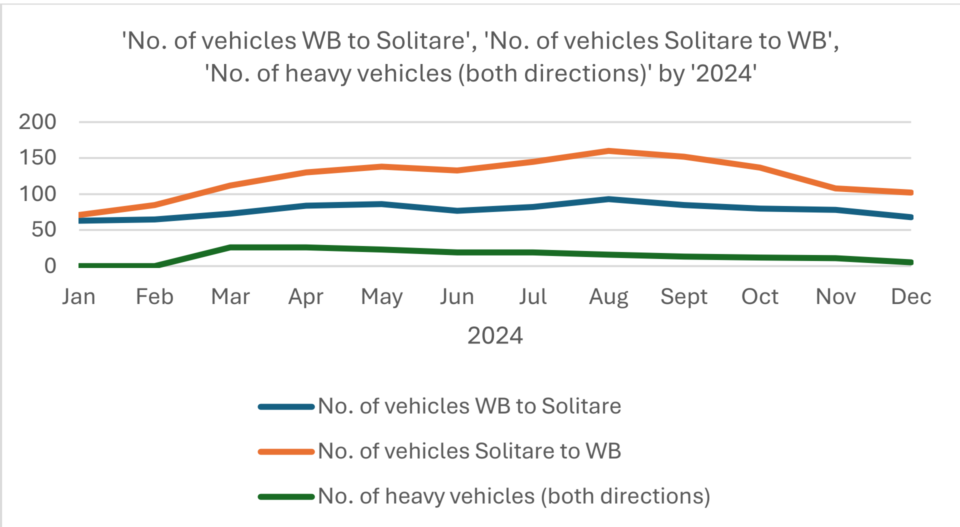

Figure 72: Traffic Counts on T2/1 (C14) Rd West of Solitaire.

Data Source: Roads Authority site 256, received 27/5/2024

A persistent problem is the continuous use of the M54 (B2) coastal road between Walvis Bay and Swakopmund by trucks, which only has a single lane in each direction. Analysis of the traffic counts south of Dolphin Beach (Roads Authority site 59) in 2024 found an average of 275 heavy trucks still use that road every day whereas they should be using the T2/1 (C14) and the Dr Hifikepunye Pohamba Freeway (A2) behind the dunes. The total number of daily vehicles using the coastal road averaged 7,496 per day during 2024 (**Figure 73**).

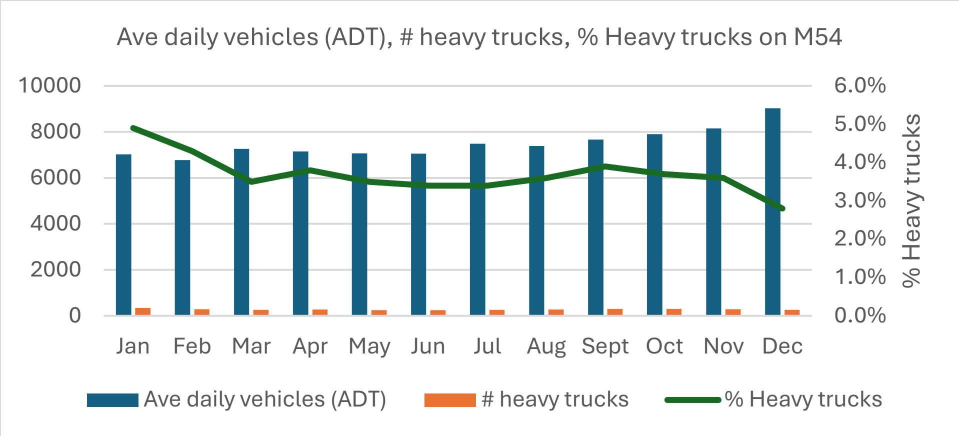

Figure 73: Average Daily Traffic Counts South of Dolphin Beach on M54.

Data Source: Roads Authority site 59, received 27/5/2024

7.3.4.2 Impact Assessment – Increased project-related traffic

The addition of Project-related traffic onto existing traffic levels is assessed as follows:

1. *The Dr Hifikepunye Pohamba Freeway (A2):* The 2024 average daily heavy trucks for November 2024 were 1007, which is consistent with 2022 and 2023 ad hoc counts on its access road T2/1 (C14). The Project predicts it will add 6 x 60t trucks per day, delivering manganese ore and up to 1 x 20t truck and approximately 3 x 30t trucks per day. The Project will generate approximately 2% of additional traffic (as trucks will return). The Dr Hifikepunye Pohamba Freeway (A2) itself and the access turn-off to farm 58 has been designed specifically for use by trucks. Along this route, the additional project-related traffic is assessed as a low impact.
2. *The TR 2/1 (C14) During the 18-month construction phase*: the anticipated project traffic using the TR 2/1 (C14) is anticipated to be 200 x 20t trucks and 100 x 30t trucks. This averages at less than one heavy truck per day, although it is likely that there may be days when there are several trucks in one day and then a week when there are none or very few. This compares with the existing traffic of approximately 1,000 heavy trucks using that road daily from 2022-2024 and is assessed as a low-risk impact.
3. *The T2/1 (C14) during Operations:* The Project predicts that during Stage 1, approximately 14 x 30t trucks per day will bring inputs from Walvis Bay using the T2/1 (C14), equivalent to approximately one truck every 50 minutes, in each direction, during daylight hours in a 6-day week. By Stage 3, this will increase to 20 x 30t trucks per day, i.e. approximately one truck every 30 minutes during daylight hours in a 6-day week in each direction. During Stage 1, a quarter of these trucks will return to the harbour carrying high-purity manganese sulphate monohydrate (HPMSM) and this proportion will increase to more than half by Stage 3. This amounts to a 4% increase of traffic and is assessed below.
4. During operations, most personnel will be transported between Walvis Bay, Arandis and Swakopmund to and from site using 60-seater buses. This small amount of project-induced passenger traffic is of low risk.
5. During decommissioning, predicted to be in 25 years or longer, heavy trucks will

transport sellable materials off site. This is likely to occur over a short length of time and is likely to be relatively low risk.

Nature of Traffic Impacts, intensity, duration and geographical extent

This assessment assumes that the road improvements to the TR 2/1 (C14) between Walvis Bay and the intersection with the Dr Hifikepunye Pohamba Freeway (A2) have been completed before the project commences. The predicted 4% increase on the 1000 heavy trucks per day that use this stretch of road between 2022 – 2024 is of particular concern due to the risk of incidents and accidents especially during the high tourism seasons of May to October with foreign tourists and December and April for regional tourists visiting Dune 7 and travelling to Sossusvlei. If death or permanent injury occurs, the negative impact intensity is expected to be **High (H)** without mitigation, and **Moderate (M)** when mitigation measures are in place as the nature of injuries should be less severe and non-life threatening. The **Extent** of any accident involving a national or foreign national is **Very High (VH)** and the **duration** is permanent if death or severe injury occurs, is rated as **Very High (VH)**.

Consequence

The consequence of the additional traffic is ranked as **Very High (VH)** without any mitigation. Mitigation measures are essential to reduce the Intensity to rating to **Moderate (M);** the extent will remain **Very High (VH)**, but the duration of less serious injuries will be reduced to **Moderate (M**). The Consequence with mitigation will therefore be reduced to **Moderate (M)**.

Probability

Once the road improvements are in place, the probability of traffic accidents occurring during operations is rated **Moderate (M)** as the T2/1 (C14) is busy and used by tourists who are not familiar with the road. Once the GMRN implements the recommended traffic mitigation measures, the probability of accidents occurring should drop to **Low (L)**.

Significance

The described contributory factors result in a **High (H)** negative impact significance, without mitigation. Mitigation measures recommended below could reduce this impact significance to **Low (L).**

Impact summary – Traffic accidents

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**H**	**VH**	**VH**	**VH**	**M**	**H**
Mitigated	**M**	**M**	**VH**	**M**	**L**	**L**

Mitigation measures

1. Deliveries of inputs and the transport of outputs should be limited to daylight hours only, whenever possible, until adequate lighting is installed along the Dr Hifikepunye Pohamba Freeway (A2) and the T2/1 (C14).
2. Deliveries of inputs and the transport of outputs along the T2/1 (C14) should exclude Sundays, to reduce the risk of local tourism traffic accidents.
3. GMRN should only contract transport companies which employ properly trained drivers, monitor their truck speed infringements on any stretch of Namibian roads and check truck road worthiness before every trip.
4. GMRN must weigh all trucks carrying outputs before they leave the site to avoid overloading.
5. Appropriately visible signage and warnings on vehicles carrying inputs and outputs must be used.

6. No off-road driving should be allowed on the T2/1 (C14).
7. GMRN should continue to lobby the GRN and TransNamib to rehabilitate and expand its rail network in order for inputs and outputs to use the rail network rather than roads.
8. GMRN should regularly engage with the Roads Authority and NamPol, as key stakeholders, to ensure signage and adequate policing enforces safe driving along the T2/1 (C14).

Monitoring recommendations

- Number of project-related traffic accidents.
- Any complaints received regarding traffic issues should be recorded together with action taken to prevent impacts from being repeated.

Cumulative impacts

As the refinery and sulphuric acid plant expands, the risk of traffic accidents will increase.

Roads Authority has planned the upgrades of the Dr Hifikepunye Pohamba Freeway (A2) and the T2/1 (C14) to accommodate the expansion of heavy industries on Farm 58 and other areas east of Walvis Bay.

7.3.5 Visual / Sense of Place Impact Assessment

Negative visual impacts are expected as a result of the visual intrusion by the proposed infrastructure, specifically when viewed from the surrounding tourist routes along the T0202 between Swakopmund and Walvis Bay and from Dune 7. Furthermore, passengers flying in and out of the Walvis Bay Airport will also see the proposed project infrastructure, particularly during take-off and landing. Large infrastructure components, i.e. stacks, and the MRF would be the most visual aspects of the Project. The MRF will remain post decommissioning. Night lighting from the manganese refinery and sulphuric acid plant could also impact on the sense of place around the area.

The more significant activities and infrastructure are therefore associated with the operational, decommissioning and closure phases.

The following is a qualitative assessment of the potential visual impacts and assessment of the sense of place, associated with the development of the proposed GMR Project.

7.3.5.1 Visual and landscape disturbance to the environment

Industrial projects might cause visual and landscape disturbance to the environment. The Project includes the development of various facilities and infrastructure. The most significant from a visual impact perspective are the stacks and the MRF. This infrastructure, along with the transporting material to and from site can cause change to the fabric and character of the Project area and possible visual intrusion in a sensitive landscape (i.e. Dorob National Park). The project area is located outside the Dorob National Park (bordering the Dorob National Park), wedged between the dune belt and the Rooikop outcrops, and bordered by the Walvis Bay airport to the south (see **Figure 1**). As discussed in **Section 6.10** there are no communities living in the immediate vicinity of the project area. However, the project infrastructure will be visible from top of Dune 7, a tourist attraction, frequented by visitors during the day.

With reference to **Section 6.11** the area is not regarded as pristine, as it was used as training ground for South Africa’s military base at Rooikop before Namibia’s independence in 1990.

Impacts will occur during all project phases due to transport, construction and operational activities and decommissioning.

Intensity, duration and extent

The nature and intensity of visual impacts is determined by assessing the change to the visual landscape as a result of the proposed new project and related infrastructure and activities. The (existing) visual landscape is determined by considering: landscape character, sense of place, aesthetic value, sensitivity of the visual resource and sensitive views.

When considering the potential change to the visual landscape, the key issues are: visual exposure, visual intrusion, and sensitivity of receptors.

Typical issues associated with industrial development projects are:

- Who will be able to see the proposed development, and from which locations or viewpoints?
- What will the development look like, and how will its form, scale, colour, and materials contrast with the existing landscape or townscape?
- Will the development affect sensitive visual receptors (e.g., residents, tourists, scenic routes, recreational users), and in what way?
- What will be the visual impact during the day and at night, including lighting, glare, skyglow, and operational activity?
- Will the development change the character, quality, or sense of place of the surrounding landscape?
- Will there be cumulative visual impacts when considered together with other existing or planned developments in the area?

The nature and intensity of visual impacts is determined by assessing the change to the visual landscape as a result of the proposed new Project infrastructure and activities. The (existing) visual landscape is determined by considering: landscape character, sense of place, aesthetic value, sensitivity of the visual resource and sensitive views.

With reference to **Section 6.11**, one of the major attractions to tourists visiting the NNNP and Dorob National Park and surroundings is the scenic beauty of the area. This is predominantly based on the absence of human activities and structures in most part of the parks, coupled to the sense of remoteness.

Dune 7 in Namibia is tourism attraction, not only due to the height and activities offered around the area, but also due to the views from the top of the dune, towering over 300 meters with sweeping, elongated forms and rich orange sand that shifts dramatically with sunlight. Its rippled textures, expansive panoramic views, and immersive desert environment create a profound sense of scale and solitude. Climbing the dune engages multiple senses—from the warm sand underfoot to the desert winds—offering a unique connection to the Namib's iconic landscape and a powerful sense of place that embodies Namibia's natural beauty.

Sections 6.8 and **6.11** describes that the proposed Project is located on Farm 58, an area zoned for heavy industrial development where additional projects of similar scale are anticipated. Farm 58 contains an established linear infrastructure corridor along its western boundary, comprising the railway line, the Hifikipunye Pohamba Highway, multiple powerlines, a water pipeline and several unsurfaced access roads. Adjacent to the southeast lies the Walvis Bay International Airport. The broader area also includes small developments such as the Hydrogen Project, several abandoned structures, and extensive surface disturbances from off-road tracks, borrow pits, and informal dumping sites. Overall, Farm 58 can be characterised as a brownfield site.

Taking all of the above into consideration, the broader landscape surrounding Farm 58 with all the current infrastructure can still be considered to have a significant visual landscape.

With reference to **Section 6.11**, the main visual receptors and sensitive viewers of the Project would be:

- Walvis Bay International Airport, situated approximately 4.5 km to the south of the proposed Project, including passengers flying in and out of the Walvis Bay Airport, particularly during take-off and landing.
- Green Hydrogen Pilot Plant – approximately 3.5 km to the south-west of the proposed Project, however, as this is another industrial site within Farm 58, it is not considered a sensitive visual receptor. Workers within this area typically have a different mindset and sense of place associated with an industrial working environment, and are therefore not regarded as visually sensitive.
- Dune 7, a tourist attraction, but no permanent community – approximately 5.5 km to the south-west the proposed Project.
- Walvis Bays – the closest residents are approximately 10 km from the proposed Project.
- Tourists using the T0201 and T0202 road to either enter into Walvis Bay or leaving Walvis Bay on the C14 towards Solitaire.
- Informal settlements are located on Farm 37 and 33 approximately 8.5 km
- Rooikop Army Base southeast of the Walvis Bay International Airport

Visual exposure is the extent to which the Project infrastructure and activities will appear in the various views. It follows that the closer the infrastructure and activities, the greater the visual exposure.

Most tourist related views will be from the Walvis Bay Airport, specifically passengers flying in and out of the Airport, particularly during take-off and landing and Tourists using the Dr Hifikepunye Pohamba Freeway.

Visual intrusion is the extent to which the infrastructure and activities will contrast with the visual landscape and can/cannot be absorbed by the landscape. The visual intrusion of the proposed Project is considered to be moderate to high for daytime.

The proposed Project (amongst other activities) poses a high risk to the contribution of long-term security for pristine night skies in the area. Light pollution is largely the result of bad lighting design, which allows artificial light to shine outward and upward into the sky, where it is not wanted, instead of focusing the light downward, where it is needed. Designed lighting washes out the darkness of the night sky and radically alters the light levels in rural areas where light sources shine as 'beacons' against the dark sky and are generally not wanted. Of all the pollutions faced, light pollution is perhaps the most easily remedied. Simple changes in lighting design and installation yield immediate changes in the amount of light spilt into the atmosphere (GYLA, 2022).

The negative effect of the Project's night lighting would be observed against dark skies. The effect would be particularly detrimental to people climbing Dune 7 and to a certain extent people using the the Dr Hifikepunye Pohamba Freeway. The visual intrusion of the proposed Project is therefore considered to be high for night time.

The sensitivity of receptors relates to the way in which people will view the visual intrusion. In this regard, it is anticipated that tourist receptors will be sensitive. This might change in future as the Proposed Project will be absorbed more and more into further such infrastructure development on Farm 58, all contributing to the cumulative visual / sense of place impacts.

Taken together, the unmitigated cumulative intensity of visual and landscape disturbance is high for the unmitigated scenario. With mitigation (see management and mitigation measures below), specifically to address the light pollution risks and the proposed mitigation measures for the MRF, which would likely be the only visible feature remaining after decommissioning, the intensity could be reduced to moderate to high.

The duration is high in the unmitigated scenario because the visual impacts would be experienced after the life of the Project, however, light pollution impacts would only be relevant for the LOP. Depending on the effectiveness of the proposed mitigation measures for the MRF in particular this may be reduced to moderate as all other activities will cease at the decommissioning phase, and all lights will be removed. The extent is moderate for both the unmitigated and mitigated scenarios.

Consequence

The determining consequence of the impact is therefore **high** for the unmitigated scenario and **moderate** for the mitigated scenario.

Probability

Without mitigation the probability of impact is considered **very high**. With mitigation the likelihood of impacts is rated as **moderate to high**.

Significance

The significance of the impact is rated as **high** for the unmitigated scenario and **moderate** for the mitigated scenario.

Impact summary – Visual impacts associated with the project

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**H**	**H**	**M**	**H**	**VH**	**H**
Mitigated	**M-H**	**M**	**M**	**M**	**H**	**M**

Mitigation measures

The following mitigation measure can reduce the visual impact:

- Land disturbance will be limited to what is necessary.
- Shaping of the MRF that will remain after closure by avoiding harsh and angular structures and shaping the structures to blend with the surrounding landscape.
- Limit visual intrusion by dust (see **Section 7.2.3.5**).
- Littering will be prevented.
- Minimise the number of light fixtures to the bare minimum required, including security lighting.
- Install light fixtures that provide precisely directed illumination to reduce light "spillage" beyond the immediate surroundings of the Project area.
- Avoid high pole top security lighting along the periphery of the site and use only lights that are activated on illegal entry to the site, where relevant.
- Visually monitor the light pollution, and install improved lighting measures if required.

7.3.6 Safety risk and potential impacts to third parties and infrastructure

Information and assessment were taken from the Quantitative Risk Assessment Study (RISCOM, 2025). The report is attached in **Appendix G**.

7.3.6.1 Methodology

The first step in any risk assessment is to identify all hazards. The merit of including a hazard for further investigation is then determined by how significant it is, normally by using a cut-off or threshold value.

Once a hazard has been identified, it is necessary to assess it in terms of the risk it presents to the employees and the neighbouring community. In principle, both probability and consequence should be considered, but there are occasions where, if either the probability or the consequence can be shown to be sufficiently low or sufficiently high, decisions can be made based on just one factor.

During the hazard identification component of the report, the following considerations are taken into account:

- Chemical identities;
- Location of on-site installations that use, produce, process, transport or store hazardous components;
- Type and design of containers, vessels or pipelines;
- Quantity of material that could be involved in an airborne release;
- Nature of the hazard most likely to accompany hazardous materials spills or releases, e.g., airborne toxic vapours or mists, fires or explosions, large quantities to be stored and certain handling conditions of processed components.

The evaluation methodology assumes that the facility will perform as designed in the absence of unintended events such as component and material failures of equipment, human errors, external events and process unknowns.

SANS 1461 (2018) is based on RIVM (2009) for process plants. The latter standards describe the minimum scenarios to be included in the assessment, as well as the assumptions to be used. As full compliance of SANS 1461 (2018) cannot be achieved within the Namibian legislative framework, general compliance of the aforementioned standards at this stage would be applicable and briefly described in the sections below. This general compliance assessment constitutes a quantitative risk assessment (QRA).

The QRA process is summarised with the following steps:

1. Identification of components that are flammable, toxic, reactive or corrosive and that have the potential to result in a major incident from fires, explosions or toxic releases;
2. Development of accidental loss of containment (LOC) scenarios for equipment containing hazardous components (including release rate, location and orientation of release);
3. For each incident developed in Step 2, determination of consequences (such as thermal radiation, domino effects, toxic-cloud formation and so forth);
4. For scenarios with off-site consequences (greater than 1% fatality off-site), calculation of maximum individual risk (MIR), taking into account all generic failure rates, initiating events (such as ignition), meteorological conditions and lethality.

7.3.6.2 Risk Assessment

Risk assessment was done of each processing unit by firstly selecting a scenario and then completing outflow modelling and the consequences. Consequences with possible impacts beyond the site boundary were retained for risk analysis of the unit.

Finally, the risk of the entire facility is determined as a combination of the risk calculated for each unit.

7.3.6.2.1 Sulphuric Acid Manufacture

The Purpose of the Processing Unit

Sulphuric acid is used in the manufacture of HPMSM. The raw material for sulphuric acid manufacture is elemental sulphur, which is imported and stored in an enclosed warehouse.

Sulphur dioxide and sulphur trioxide are intermediate products in the manufacture of sulphuric acid and are consumed in the process without any inventories.

Toxic Components Stored, Delivered or Processed

Sulphur dioxide and sulphur trioxide, produced during the process, are both considered to be acutely toxic.

Flammable or Combustible Components Stored, Delivered or Processed

Sulphur is combustible, producing sulphur dioxide as a combustion product.

Consequence Modelling

Toxic Vapour Clouds

- **Elemental and Molten Sulphur Storage**

Sulphur dioxide could be produced during a fire, when elemental sulphur combusts.

Sulphur piles burn gradually, often over hours or days, depending on pile size. No rapid flame spread unless sulphur is in dust form, which is explosive. The fire is typically self-limiting unless disturbed or oxygen-enriched.

Molten sulphur can sustain combustion more readily than solid forms. Other than the above investigations, no standardised burning rate has been published for open-air sulphur pile fires.

Exact burning rates are difficult to calculate and can vary significantly. In calculations by Batterman et al (1999) an average SO_2 emission rate from a large (25 000 m²) fire in the Western Cape (South Africa) was estimated to be 185 kg/s and lasted for approximately 21 hours. Burger et al (2001) proposed a SO_2 emission rate profile that increased from 145 kg/s to a maximum of 445 kg/s, with an average of 295 kg/s. These estimates give a burning rate of about 0.28 to 0.35 kg/m²/min or 0.6 to 0.7 kg SO_2 kg/m²/min.

For this project, assuming the heat of combustion, vaporisation and fusion as well as the melting point and boiling point of sulphur a burning rate of 0.7 kg SO_2 kg/m²/min was used. The area assumed to be used for storage of sulphur prills at any given time was assumed to be to 4 000 m². An SO_2 emission rate of 46 g/s was estimated.

The AEGL-2 concentration is the maximum air concentration below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or serious health effects or symptoms that could impair an individual's ability to take protective action. The AEGL-2 is used for emergency planning to indicate the furthest downwind distance to evacuation of nearby populations in the event of a release.

A number of release scenarios were considered, with the worst-case scenario producing a large AEGL-2 endpoint extending beyond 10 km from the release.

Emergency Response Planning Guidelines (ERPGs) are airborne concentrations of chemicals that have been evaluated for three levels of emergency response. These are a nuisance level, and level that would affect egress from an exposure or a level that is near, but below a life-threatening concentration. ERPG-3 is the maximum air concentration below, which it is believed that nearly all individuals could be exposed to without experiencing or developing life-threatening health effects. The ERPG-2 concentration is the maximum air concentration below, which it is believed nearly all individuals could be exposed to without experiencing or developing irreversible or serious health effects or symptoms that could impair an individual's ability to take protective action. The ERPG-2 is used for emergency planning to indicate the furthest downwind distance to evacuation of nearby populations in the event of a release.

As per SANS 1461 the worst case ERPG-3 must be represented graphically, although the ERPG-3 is not normally used in emergency planning or fatality determination. The ERPG-3 (25 ppm) as shown in **Figure 74**. In this instance, the worst case was for the formation of sulphur dioxide from the combustion of sulphur in the store.

The solid line represents the extent from a westerly wind, while the dotted line represents wind from all directions.

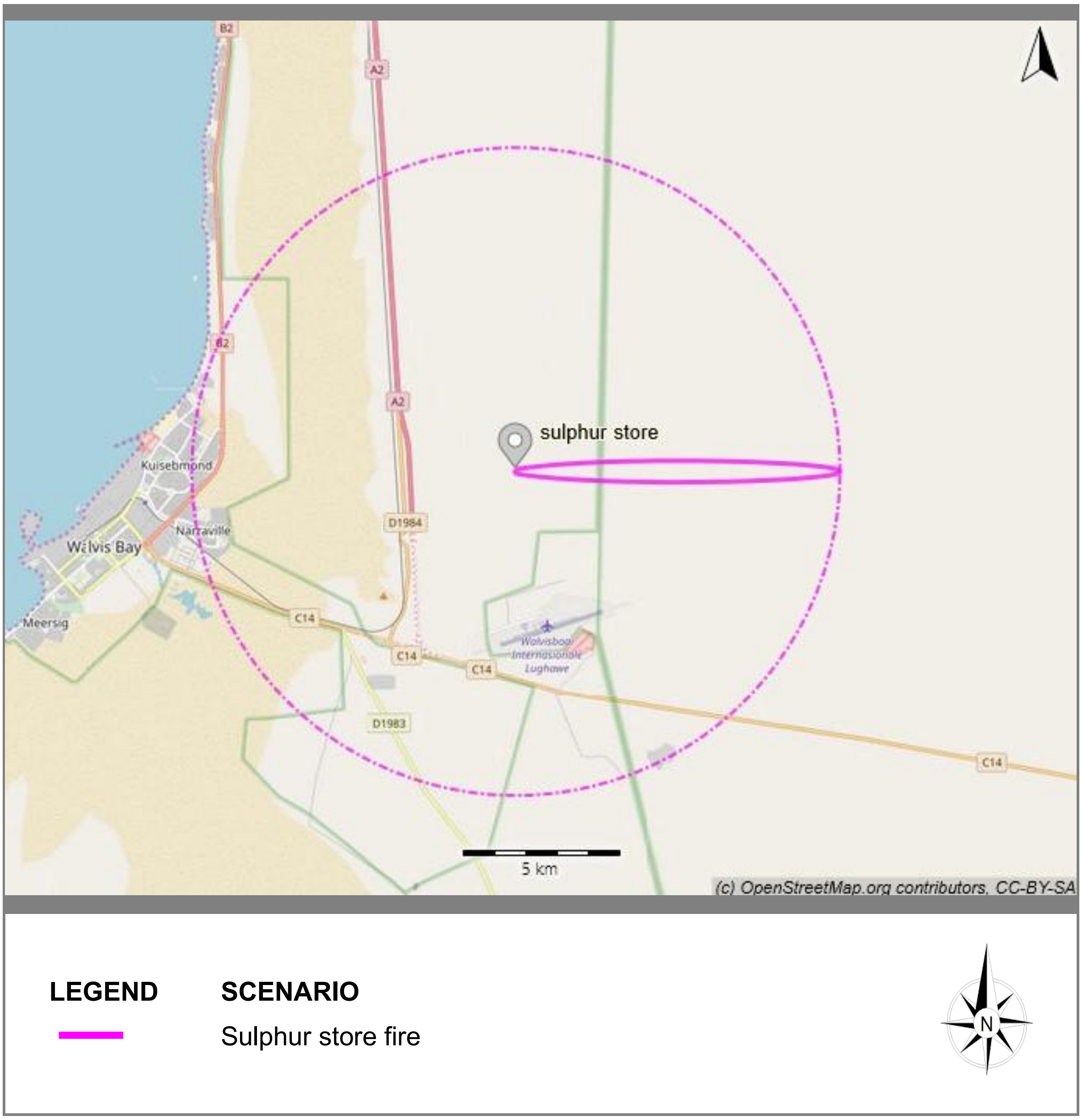

Figure 74: The extent of the ERPG-3 values of sulphur dioxide following a large release, using the ERPG-3 value (25 ppm).

The ERPG values indicate health effects from an one-hour exposure, but do not indicate the of probability of fatality. The 1% fatality represents the endpoint for these risk assessment calculations. Furthermore, the 1% fatality gives an indication of the extent of public liability in the event of a large release.

Figure 75 shows the scenarios with the largest distances to the 1% fatality, the furthest of which could extend 740m downwind. The solid line indicates the cloud plume from a westerly wind direction, while the dotted line represents the extent of the plume from all wind directions.

The 1% fatality could impact off-site but would not reach residential areas or the airport.

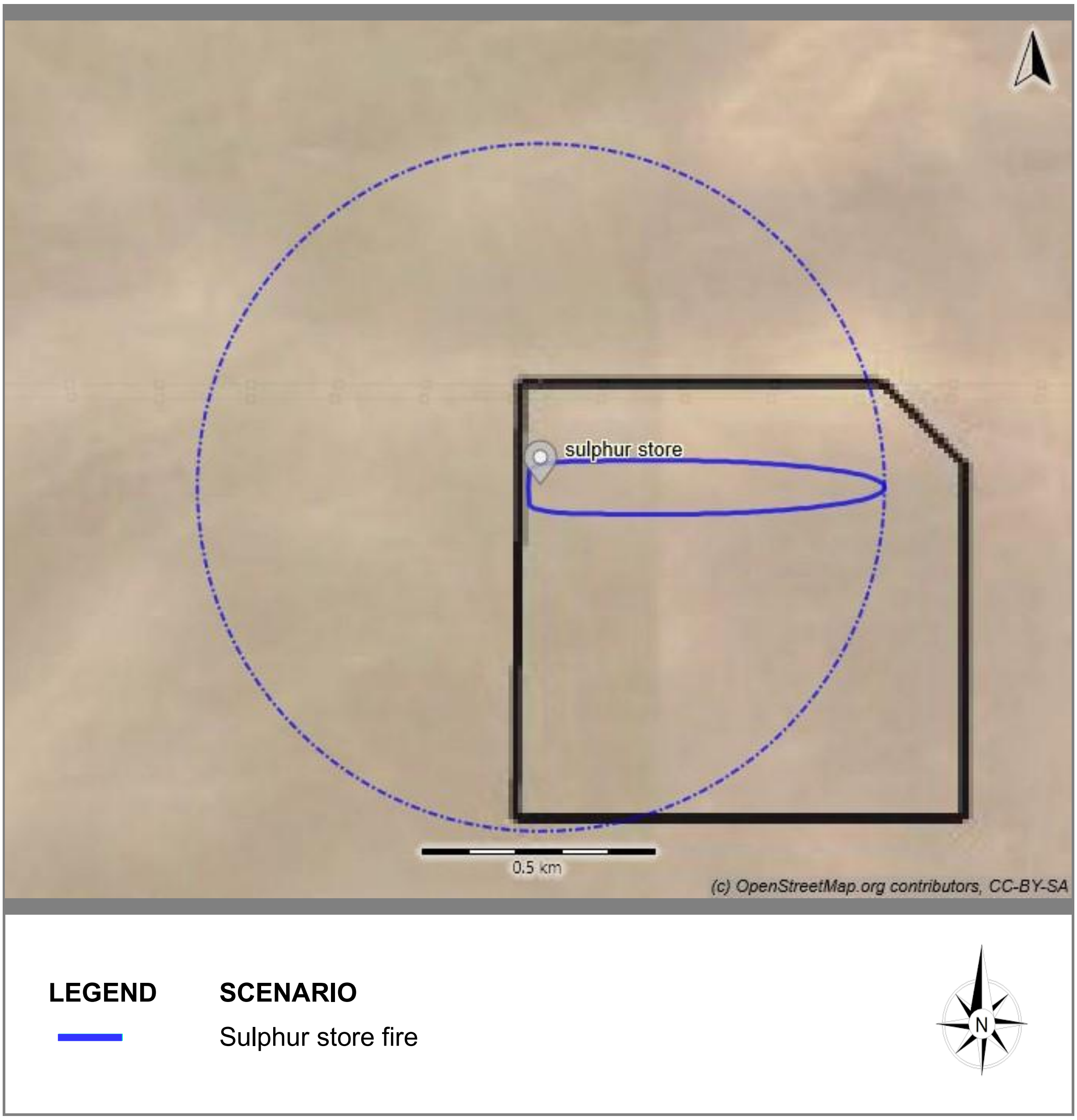

Figure 75: Maximum extent of the 1% fatality for major releases of sulphur dioxide. The black square represents the GMRN site.

- **Sulphuric Acid Manufacture**

At the sulphuric acid plants sulphur is combusted forming sulphur dioxide. The sulphur dioxide is converted into sulphur trioxide, which is then converted to sulphuric acid in the absorption towers. A loss of containment in the plant could result in a release of sulphur dioxide and sulphur trioxide.

Accidental releases at the points shown in **Figure 76** were simulated to determine the endpoints to the AEGL-2 guideline and the 1% fatality.

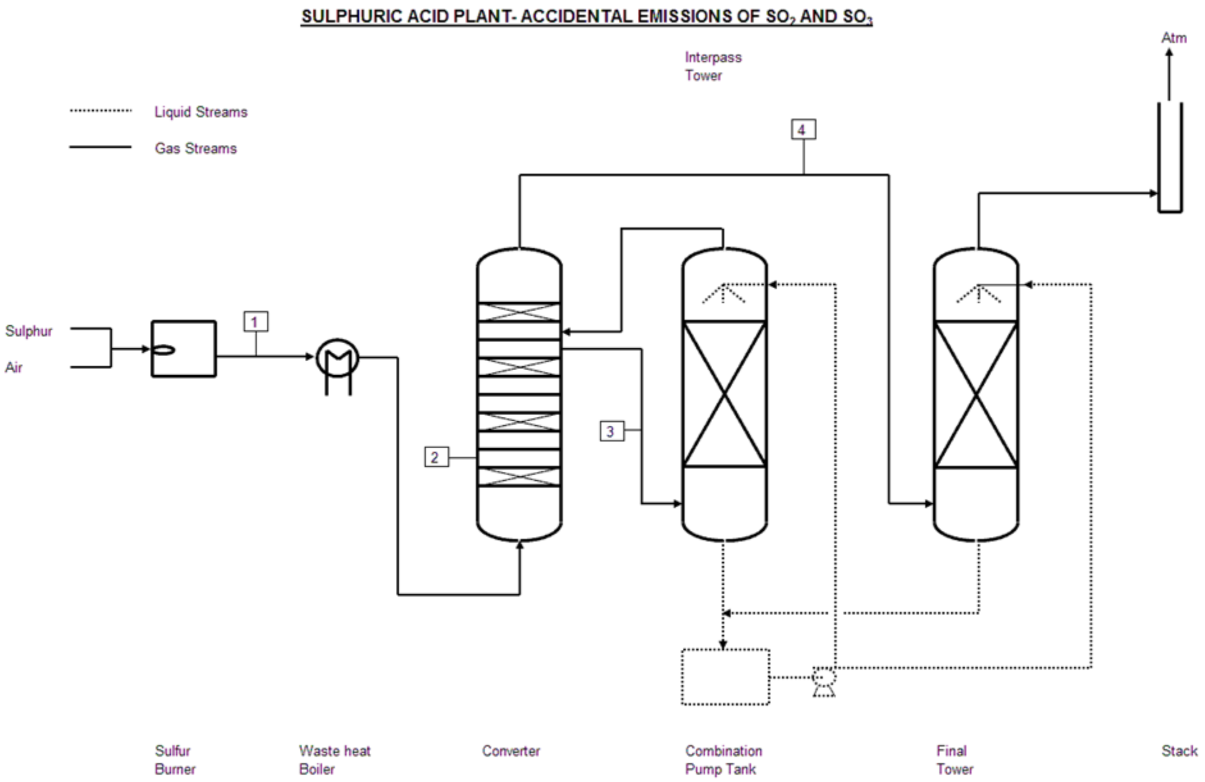

Figure 76: Accidental release points for sulphur dioxide and sulphur trioxide at the sulphuric acid plants.

The release rates, temperatures and pressures were based on the mass balance supplied by the engineering contractor or obtained from similar projects.

Releases for sulphur dioxide and sulphur trioxide from the process vessels were simulated for an instantaneous release of the entire contents and a 10mm hole. The orientation of the releases was simulated as horizontal.

Releases for sulphur dioxide and sulphur trioxide from the process pipes were simulated for a rupture and a leak in the pipes.

A number of release scenarios were considered, with the worst-case scenario producing a large AEGL-2 endpoint extending beyond 10 km from the release.

As per SANS 1461 the worst case ERPG-3 must be represented graphically, although the ERPG-3 is not normally used in emergency planning or fatality determination. The worst case ERPG-3 (25 ppm) for SO_2 is shown graphically in **Figure 77**.

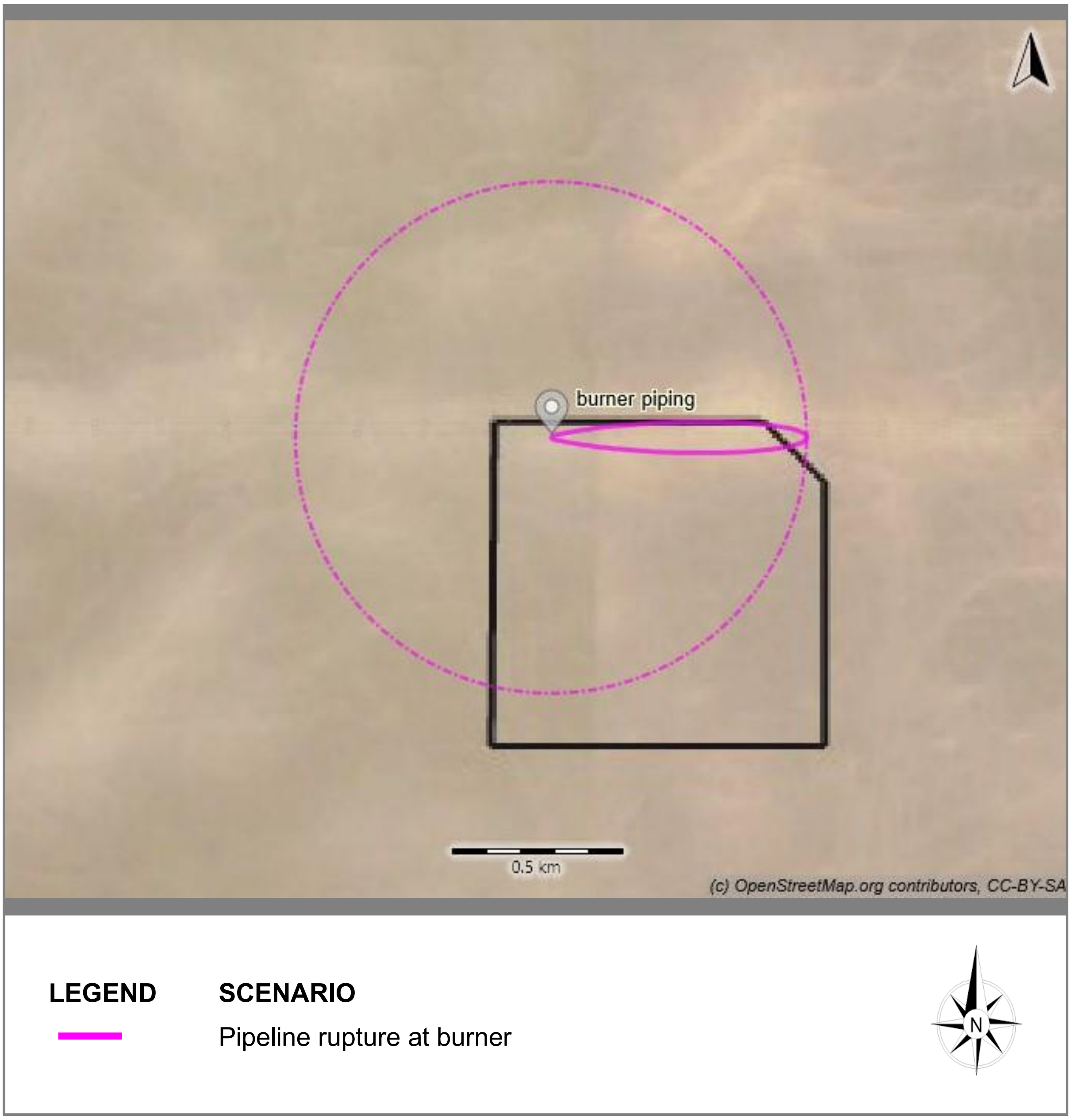

Figure 77: The extent of the ERPG-3 values of sulphur dioxide following a large release, using the ERPG-3 value (25 ppm). The black square represents the GMRN site.

Figure 78 shows the scenarios with the largest distances to the 1% fatality for sulphur dioxide. The solid line indicates the cloud plume from a westerly wind direction, while the dotted line represents the extent of the plume from all wind directions.

The 1% fatality does extend just over the site boundary with major failures of the piping.

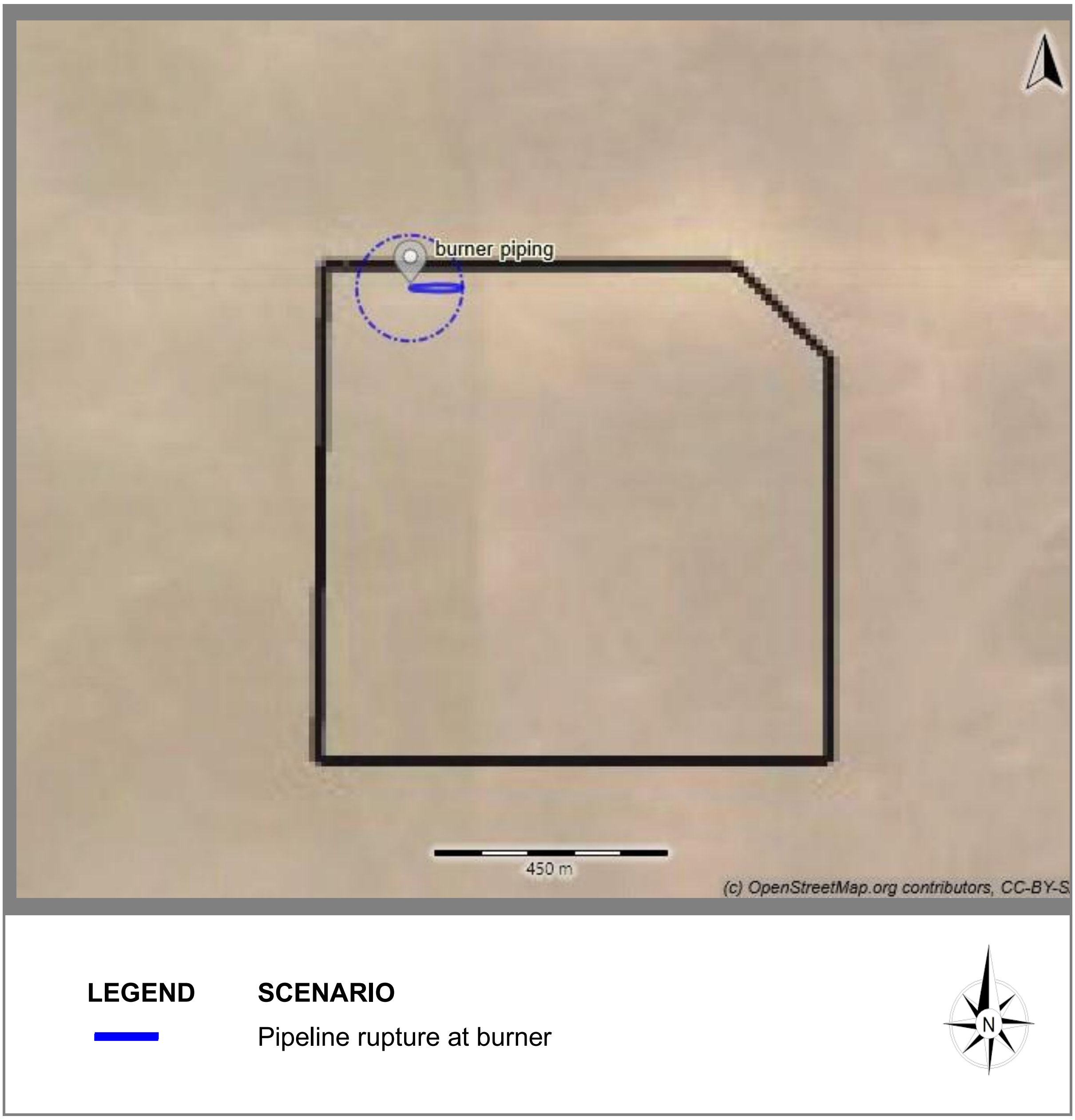

Figure 78: Maximum extent of the 1% fatality for major releases of sulphur dioxide. The black square represents the GMRN site.

As per SANS 1461 the worst case ERPG-3 must be represented graphically, although the ERPG-3 is not normally used in emergency planning or fatality determination. The ERPG-3 (120 mg/Nm³) for SO_3 is shown in **Figure 79**.

The solid curve represents the extent of a westerly wind, while the dotted line represents wind from all directions.

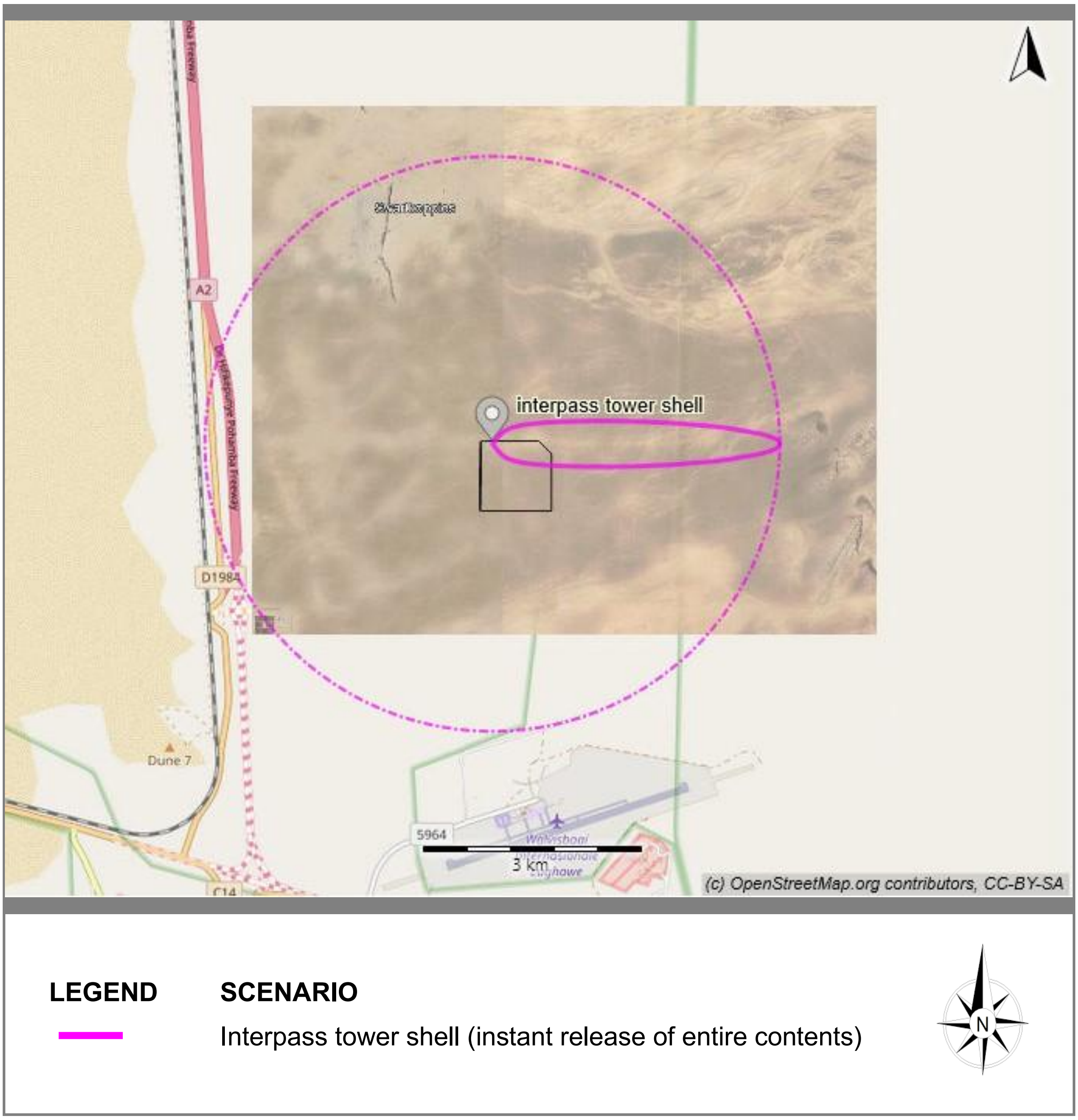

Figure 79: The extent of the ERPG-3 values of sulphur trioxide following a large release, using the ERPG-3 value (120 mg/Nm³).

Figure 80 shows the scenario with the largest distance to the 1% fatality for sulphur trioxide. The solid line indicates the cloud plume from a westerly wind direction, while the dotted line represents the extent of the plume from all wind directions.

The 1% fatality does extend over the site boundary with major failures of the interpass tower shell, but will not reach the residential area of Walvis Bay or the airport.

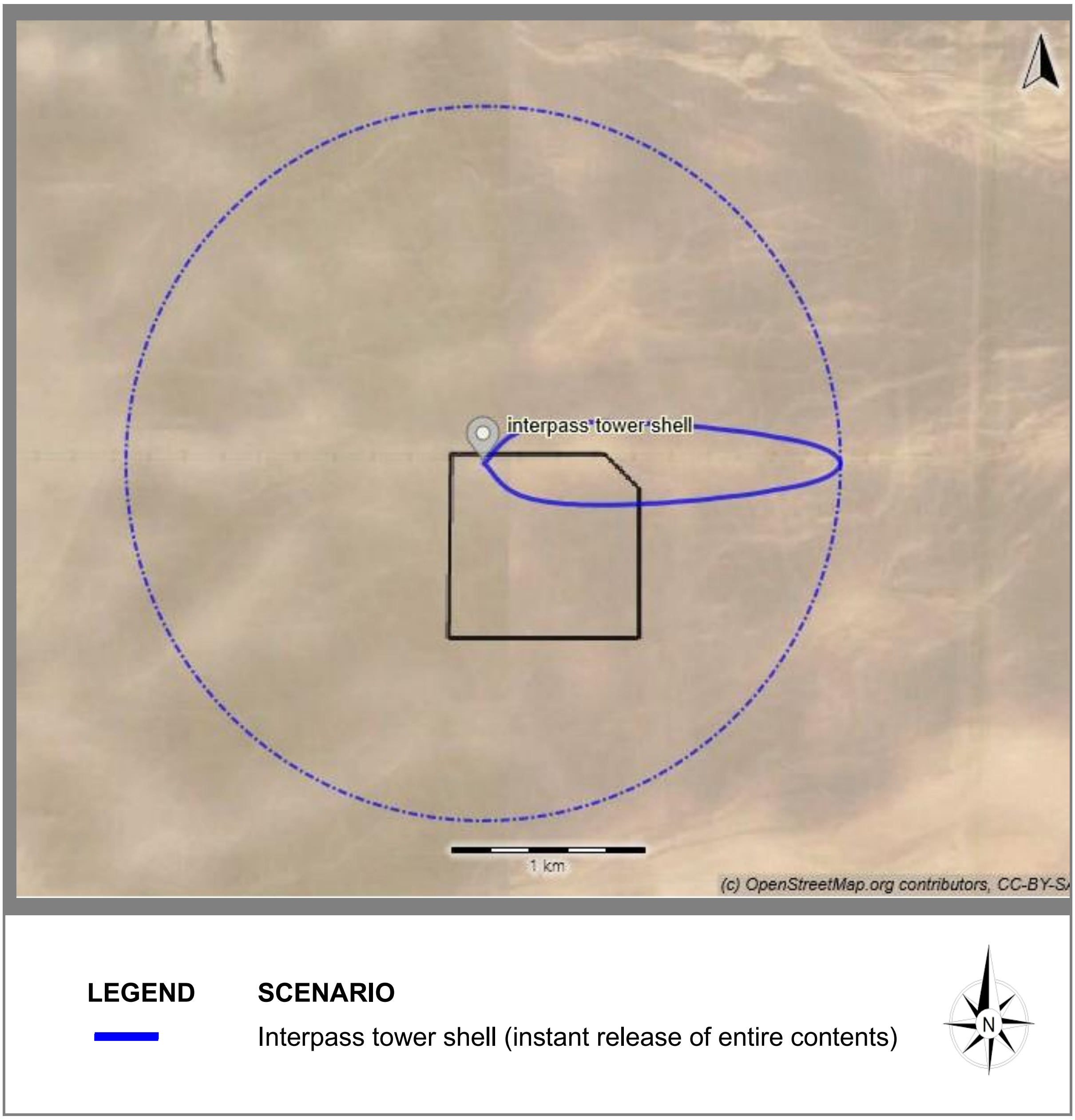

Figure 80: Maximum extent of the 1% fatality for major releases of sulphur trioxide.

7.3.6.2.2 Fires

There is no burning-rate relationship specifically developed for molten sulphur. Molten sulphur fires would require similar modelling as hydrocarbon pool fires.

Sulphur is normally a solid at ambient conditions and melts at about 113°C. Molten sulphur would be transported and stored at roughly 10°C above its boiling point to ensure that the viscosity of the material is sufficiently low to produce a free flowing and pumpable material.

A loss of containment of molten sulphur would result in rapid cooling down, forming a solid mass that would be difficult to ignite.

The maximum effect of pool fire from a loss of containment of the molten sulphur storage vessel is shown **Figure 81**.

The 10 kW/m² thermal radiation, representing the 1% fatality, does not extend over the site boundary. No further analysis would be required. The 35 kW/m² thermal radiation, indicating a 100% fatality and initial damage to steel, was not reached, limiting the damage to property.

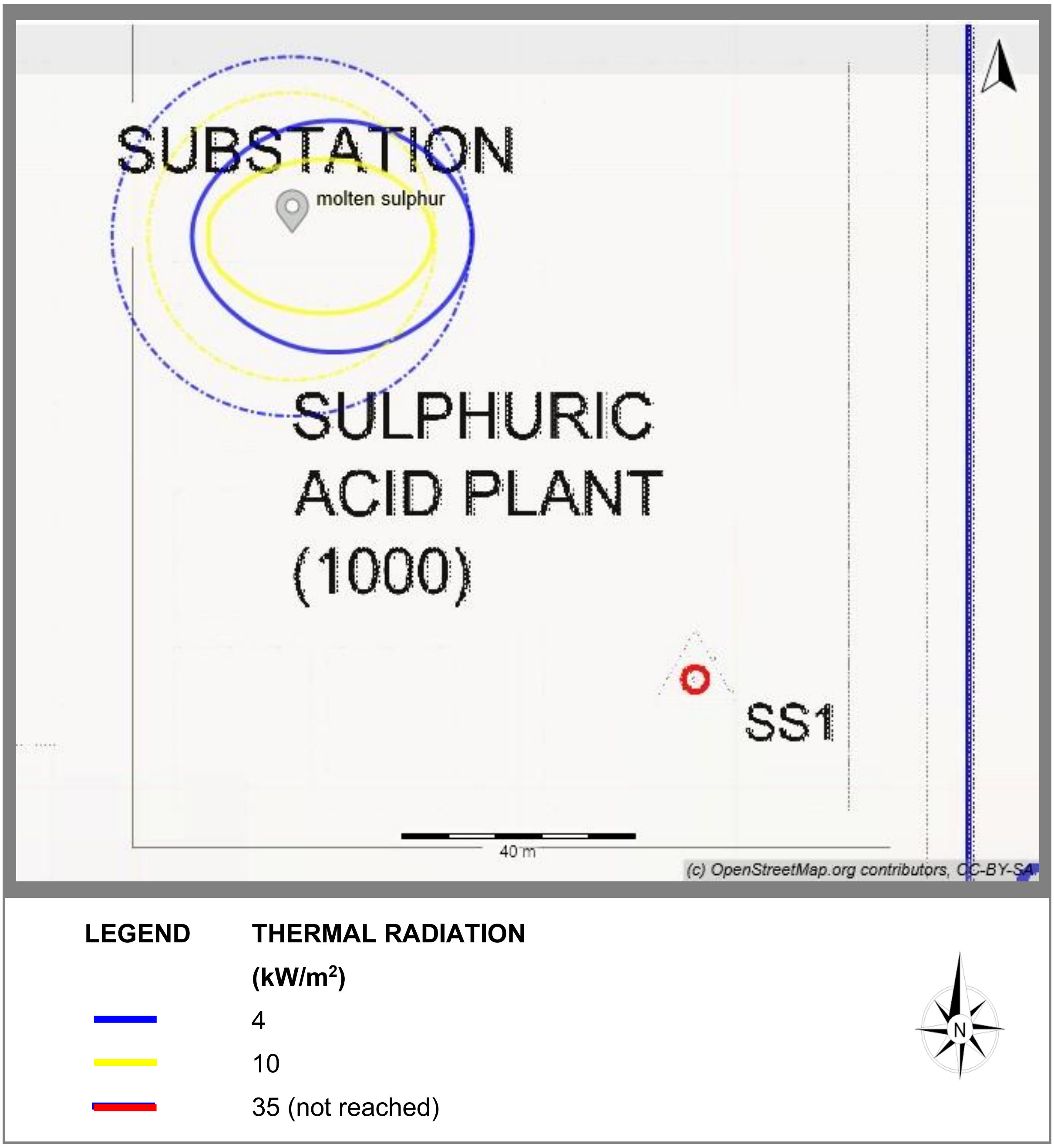

Figure 81: Thermal radiation from large molten sulphur pool fires.

7.3.6.2.3 Summary of Impacts

Maximum distances from the point of release to the 1% fatality, are summarised for each scenario in **Table 85** and **Table 86**.

Table 85: Maximum distance to 1% fatality from the point of release of SO_2.

Scenarios	Max. Distance to 1% Fatality (m)
Sulphur store	
Low momentum release	740
Pipe failure after burner	
Rupture in pipeline	100
Leak from 50 mm hole	31
Pipe failure at converter shell	
Rupture in pipeline	62
Leak from 50 mm hole	54
Pipe failure at interpass tower	
Rupture in pipeline	8
Leak from 50 mm hole	66
Pipe failure at final tower	
Rupture in pipeline	8
Leak from 50 mm hole	14
Interpass tower shell	
Instantaneous release of entire contents of the process vessel	8
Continuous release from a hole with an effective diameter of 10 mm	14
Final tower shell	
Instantaneous release of entire contents of the process vessel	8
Continuous release from a hole with an effective diameter of 10 mm	14

Table 86: Maximum distance to 1% fatality from the point of release of SO_3.

Scenarios	Max. Distance to 1% Fatality (m)
Pipe failure at converter shell	
Rupture in pipeline	694
Leak from 50 mm hole	165

Pipe failure at interpass tower	
Rupture in pipeline	1 813
Leak from 50 mm hole	165
Pipe failure at final tower	
Rupture in pipeline	262
Leak from 50 mm hole	47
Interpass tower shell	
Instantaneous release of entire contents of the process vessel	1813
Continuous release from a hole with an effective diameter of 10 mm	20
Final tower shell	
Instantaneous release of entire contents of the process vessel	218
Continuous release from a hole with an effective diameter of 10 mm	11

7.3.6.2.4 Diesel Storage and Offloading

Diesel will be used on site. Diesel is considered combustible and will sustain combustion when lit. It is not considered toxic. For this study, diesel has not been assessed.

7.3.6.2.5 Manganese Ore Storage and Crushing

Managanese ore will be transported to the site. It will also be crushed. Managanese ore dust has general dust explosion hazards common to any fine particulate matter in high concentrations. The hazards of manganese ore dust are described in **Box 1** below.

Box 1: Manganese

Finely powdered elemental manganese is pyrophoric, meaning it can spontaneously ignite upon exposure to air. However, manganese ore dust, which is primarily composed of manganese oxides, is not considered pyrophoric under normal conditions. It's important to note that the explosion hazard associated with elemental manganese dust is limited to situations where the airborne particles are present within a specific concentration range, which can support combustion or detonation.

Pure manganese may react violently or explosively on contact with water. May be ignited by friction, heat, sparks or flames. Some of these materials will burn with intense heat. Dusts or fumes may form explosive mixtures in air. Containers may explode when heated. May re-ignite after fire is extinguished.

The main hazards associated with manganese ore dust are health-related, specifically chronic inhalation leading to respiratory issues and neurological disorders (manganism), as well as general dust explosion hazards common to any fine particulate matter in high concentrations.

The minimum explosible concentration (MEC) for manganese dust specifically is not widely published, but based on general data for metal dusts and similar materials, the explosion hazard typically occurs when the airborne concentration is within the range of approximately (Rhodes, 1990), (Laurent, 2003), (Mills, 2004), Engineering Toolbox[34]) 20 to 500 g/m³ as the MEC:

- Aluminium 40 to 45 g/m³
- Chromium 230 g/m³
- Iron 100 g/m³
- Magnesium 20 to 30 g/m³
- Steel 100 to 120 g/m³
- Tin 190 g/m³
- Titanium 45 g/m³
- Zinc 400 to 481 g/m³

An up to 2 000 to 6 000 g/m³ as the maximum explosible concentration.

However, precise values should be determined through standardised testing (e.g., ASTM E1515) for the specific form of manganese being handled. This range can vary depending on factors such as:

- Particle size and shape
- Moisture content
- Ignition energy
- Dispersion method
- Test vessel geometry

The recommended occupational exposure limit for elemental manganese and its inorganic compounds is 0.0002 g/m³ (as Mn), averaged over an 8-hour workday. This limit, established under the Regulations for Hazardous Chemical Agents (Government Gazette No. 44348, 29 March 2021), aims to reduce the risk of subclinical effects on the lungs and central nervous system, as well as potential impacts on male fertility. In the context of this study, manganese ore dust has not been assessed, as the ore stockpile will be covered and dust generation from the crusher will be mitigated using conventional dust suppression methods, including water sprays, extraction systems, and bag filters.

7.3.6.2.6 Maximum Individual Risk

The risks on site due to a release of sulphur dioxide and sulphur trioxide, is shown in **Figure 82**. The risk of $1x10^{-6}$ fatalities per person per year extends beyond the site boundary into undeveloped land.

Risks greater than $1x10^{-3}$ fatalities per person per year would be considered intolerable for workers, but this was not reached. Risks greater than $1x10^{-4}$ fatalities per person per year, considered intolerable for the general public, do not extend beyond the site.

The scenario with the highest contributing risks was the release of sulphur dioxide, should the sulphur combust in the sulphur store.

[34] https://www.engineeringtoolbox.com/dust-explosions-temperature-d_394.html

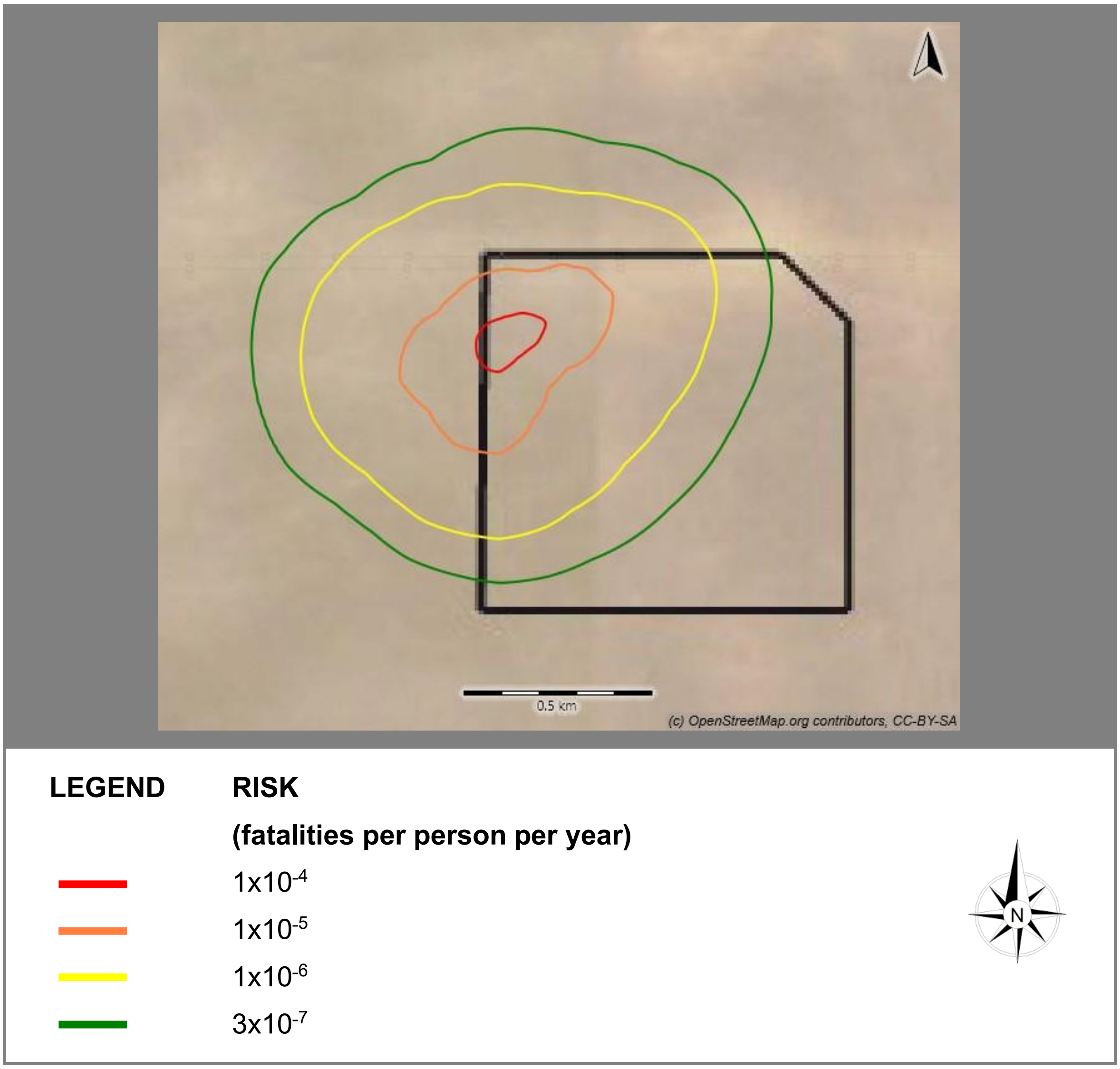

Figure 82: Lethal probability isolines associated with sulphur store and sulphuric acid plants.

Considering only the sulphuric acid plants, the risks on site due to a release of sulphur dioxide and sulphur trioxide, as shown in **Figure 83** would be considered tolerable and within the ALARP range.

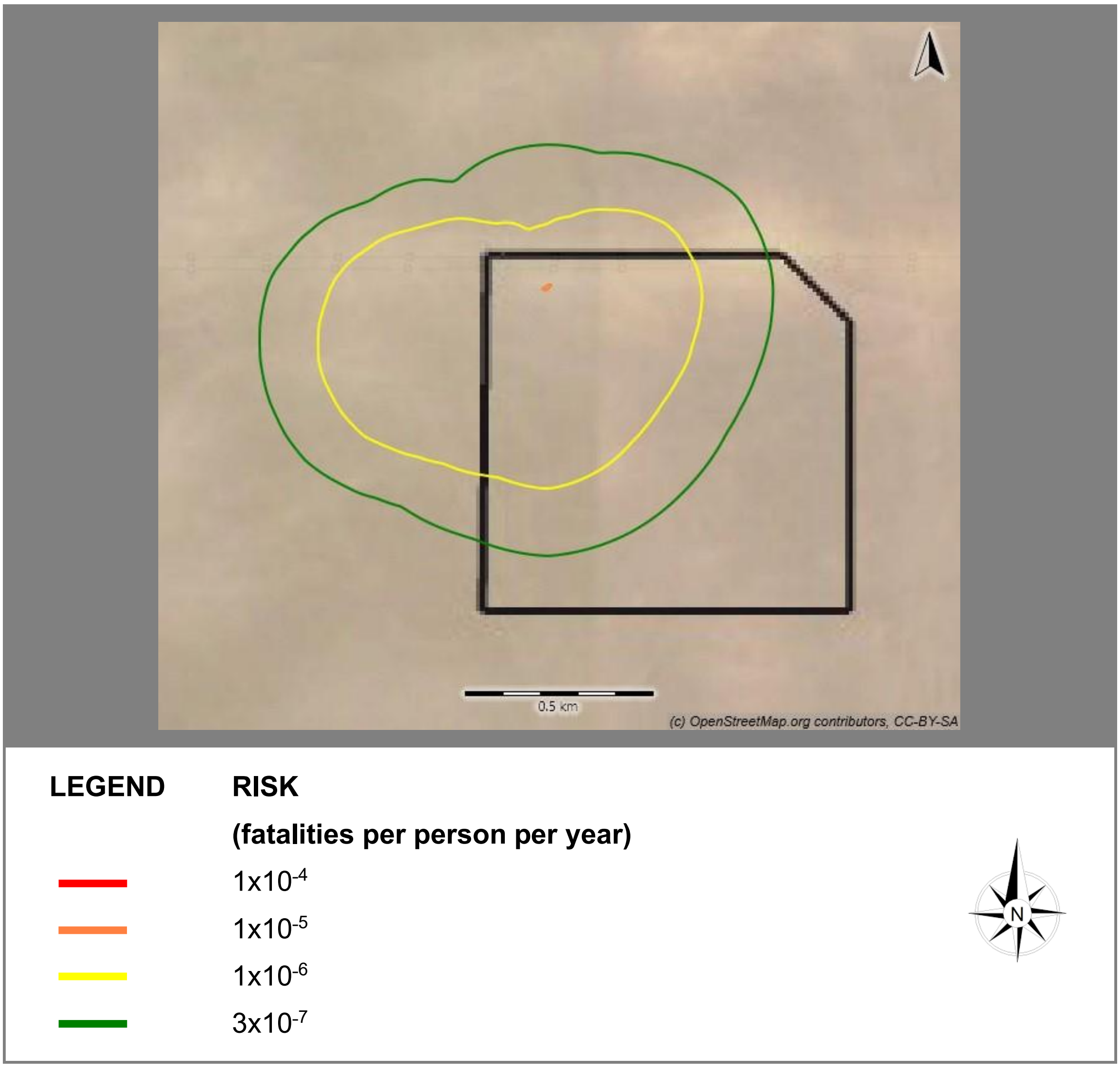

Figure 83: Lethal probability isolines associated with sulphuric acid plants.

The risk of $3x10^{-7}$ fatalities per person per year isopleth indicates the extent for land-use that would be suitable for vulnerable populations, such as hospitals, retirement homes, nursery schools, prisons, large gatherings in the open, and so forth. No such populations would be located within this area, indicating the acceptability of the location.

No new land planning should be approved without consultation of the PADHI land-planning tables attached in Appendix A of the Risk Assessment Specialist Report (**Appendix G**) and confirmed from the MHI risk assessment.

7.3.6.3 Impact Assessment of the proposed GMRN Facility at Walvis Bay

The following is the impact assessment of the proposed GMRN facility:

Nature:

Worst case loss of containment scenario – fire at sulphur store leading to combustion, toxic sulphur dioxide dispersion.

	Without Mitigation	With Mitigation
Extent	Low (local)	Low (local)
Duration	Low (short term)	Low (short term)
Intensity	High	Moderate
Probability	Low (unlikely)	Low (unlikely)
Consequence	Moderate	Low
Significance	Low	Low
Nature (positive or negative)	Negative	Negative
Irreplaceable loss of resources?	Yes (human)	Yes (human)
Can impacts be mitigated?	Yes	Yes

Mitigation:

Mitigation would include emergency response arrangements and systems, such as alarms and shutdown systems to allow for personnel to muster in case of emergency, as well as fire-fighting systems and cooperation with emergency responders. Preventive measures would include maintenance procedures to prevent the occurrence of a catastrophic loss of containment from corrosion, fire and gas detection and firewater systems to prevent escalation and strict control of ignition sources and other measures. Mitigation measures should include design controls to limit wildlife attractants, effective waste and water management. Ongoing coordination with the Namibia Airports Company and relevant aviation authorities is also required. Risk to airport re wildlife attraction, refer to **Section 7.3.7**)

Residual Risks:

Even with mitigation, there may be residual risk of occurrence due to failures in protection systems and break-down in procedures and documented systems.

No cumulative impact is anticipated as the proposed plant is located in a remote area with no other industrial activity nearby.

7.3.7 Aeronautical Impacts Assessment

7.3.7.1 Overview and Background

Walvis Bay International Airport is a public international airport, an aerodrome as defined in the Airports Company Act of 1998, serving Walvis Bay and the Erongo Region of Namibia, about 15 km east of Walvis Bay. Operated by the Namibia Airports Company, it is Namibia's second major international airport after Hosea Kutako International Airport.

Major upgrades, including a new terminal, longer runway, and modern air traffic systems, were completed in 2016, enabling international operations and higher passenger and cargo handling capacity.

Walvis Bay International Airport has one runway which is 3440 m in length and 60 m in width designation 09/27 - Precision CAT I (09) and Precision CAT II (27) but currently operating non-precision VOR instrument approach.

The Instrument Landing System (ILS) is a precision navigation system that helps guide aeroplanes to a safe landing in adverse weather or low-visibility conditions. The terminal processes up to approximately 200 passengers per hour, designed for up to 1 million passengers per year.

The types of Aircraft using the airport include:

- Regular operation of commercial regional jets and narrow-body airliners, including Boeing 737 series,
- occasional operation of larger aircraft such as Airbus A340-300, and
- general aviation, charter flights, and private light aircraft.

7.3.7.2 Impacts to Aviation Safety

7.3.7.2.1 Impacts to aviation - relating to additional obstacles

With refence to **Section 6.12**, various aspects and potential impacts relating to the proposed project activities and associated infrastructure on the safe operations of the Walvis Bay International Airport were identified for further assessment. These aspects are qualitatively assessed in the sections below, grouped under the following headings: *Impacts relating to additional obstacles*; *impacts relating to additional glare from infrastructure, lights and emissions or dust clouds / some from stacks*; and *impacts relating to Wildlife attractants (i.e. open water bodies, waste)*.

Information in the following sections pertaining to aeronautical impacts is drawn, among other sources, from discussions with the Walvis Bay International Airport Chief Safety Officer, Ms. Samantha Rencs, (see **Section 2.4.1**), including her assessment of aviation safety as regulated by the NCAA as well as the Namibian Civil Aviation Regulations.

The above-mentioned aspects and their related potential impacts are assessed in the sections below. Special thanks are extended to Ms. Rencs for her review, input, and valuable contributions to these assessments.

Also refer to **Section 7.3.6 f**or risk-related assessments relating to third parties.

7.3.7.2.1 Impacts to aviation - relating to additional obstacles

Walvis Bay International Airport is located approximately 4.5 km south of the proposed Project area (see **Figure 84**).

With reference to **Section 3.10**, the Namibian Civil Aviation Regulations – Part 139 (Aerodromes) governs aerodrome safety, obstacle limitation surfaces, and protection of aircraft operations. Any object that interferes with pilot visibility or Air Traffic Control (ATC) sightlines is treated as a hazardous obstacle, even if it is reflective rather than tall (refer to section 7.7.7.2.2 for the impacts relating to glare from infrastructure. Relevant principles included in the above-mentioned Regulations include the following:

- Protection of approach and take-off paths.
- Protection of ATC tower visibility.
- Control of visual hazards that may distract pilots.
- Requirements for assessment and approval of developments near aerodromes.

The impacts to aviation, relating to additional obstacles, therefore need to be considered. ASEC and GMRN, therefore, consulted both the NCAA and the Namibia Airports Company (see **Section 2.4.1** and **Appendix D**). The NCAA specifically requested that the Namibia Airports Company be consulted to review the location of the infrastructure and associated activities and the potential impacts on aviation safety.

Figure 84: Distance (yellow line, approximately 4.2km) from the southern border of the GMRN site (red) to the Walvis Bay International Airport.

Nature, intensity and duration

During the construction (and decommissioning) phases of the project, specifically when installing the stacks, etc. tall cranes will be used. During the operational phase, the proposed project infrastructure - specifically the sulphuric acid plant stacks with heights ranging from 30 m to 50 m - may pose aviation obstacle risks, as the site lies within a 15 km radius of the airport (refer to **Section 3.8**). Consequently, written approval from the Executive Director of the NCAA will be required.

The runway is aligned roughly perpendicular to the proposed Project, meaning that aircraft departing from or approaching the airport would not fly directly over the Project Site or the proposed infrastructure (see **Figure 85**).

An established obstacle limitation surface is an artificial boundary in space projecting from the ground upward in a conical shape that helps to classify requirements of infrastructure near an aerodrome. Typically, the further from the aerodrome, the higher the boundary will be.

The drawing below (i.e. **Figure 85**), provides a key to understanding the circular bands and the input required, i.e. the 'Blue area' is the outer horizontal which extends to a 15 km radius from the Aerodrome reference point (ARP). The proposed project is located outside the "Inner Horizontal" (green) area, falling in the "Conical slope" (yellow) area.

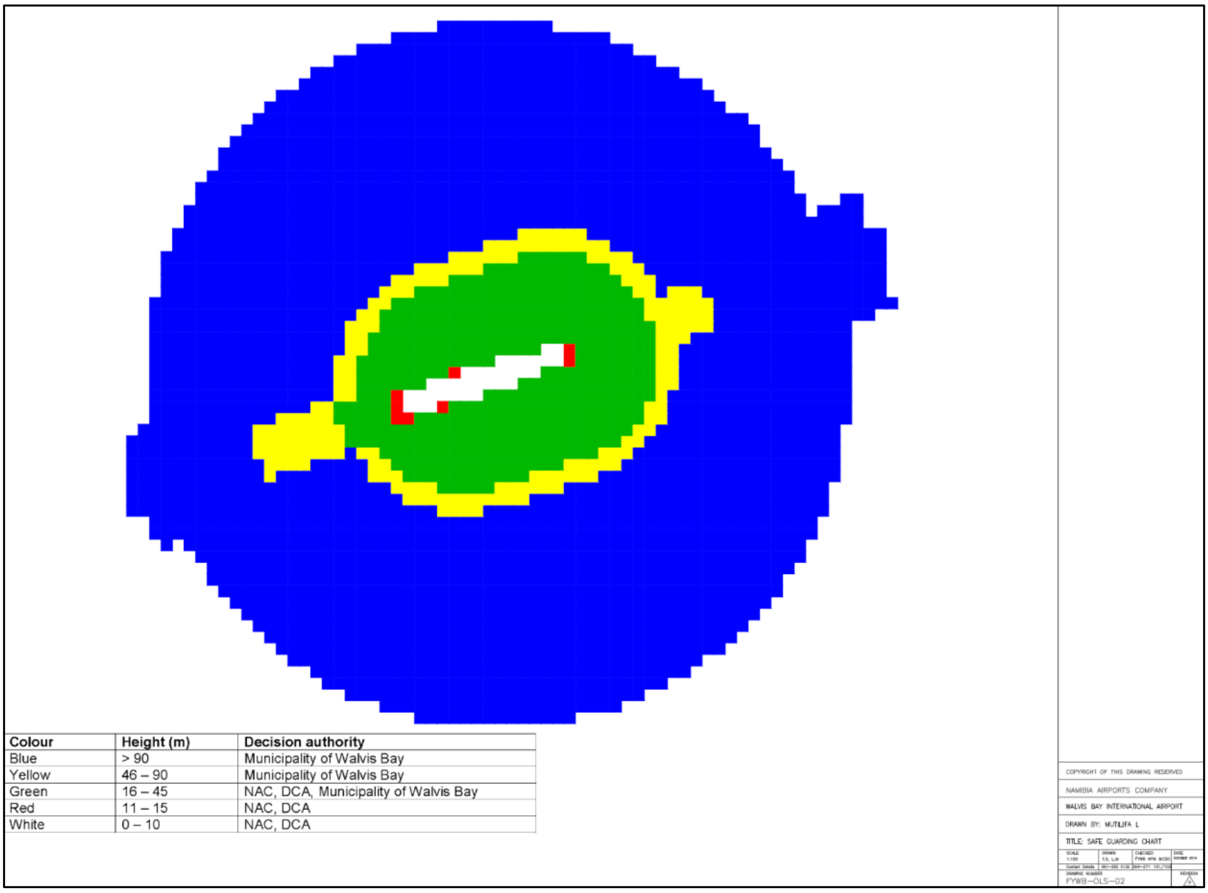

Figure 85: Safeguarding Chart (image provided by Ms Rencs).

Table 87 (provided by Ms Rencs) providing the dimensions and slopes of obstacle limitation surfaces relating to approach runways.

Table 87: Dimensions and slopes of obstacle limitation surfaces – approach runways (table provided by Ms Rencs).

APPROACH RUNWAYS

	RUNWAY CLASSIFICATION									
	Non-instrument Code number				Non-precision approach Code number			Precision approach category I Code number		Precision approach category II or III Code number
Surface and dimensions[a] (1)	1 (2)	2 (3)	3 (4)	4 (5)	1,2 (6)	3 (7)	4 (8)	1,2 (9)	3,4 (10)	3,4 (11)
CONICAL										
Slope	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Height	35 m	55 m	75 m	100 m	60 m	75 m	100 m	60 m	100 m	100 m
INNER HORIZONTAL										
Height	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m
Radius	2 000 m	2 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m
INNER APPROACH										
Width	—	—	—	—	—	—	—	90 m	120 m[e]	120 m[e]
Distance from threshold	—	—	—	—	—	—	—	60 m	60 m	60 m
Length	—	—	—	—	—	—	—	900 m	900 m	900 m
Slope								2.5%	2%	2%
APPROACH										
Length of inner edge	60 m	80 m	150 m	150 m	140 m	280 m	280 m	140 m	280 m	280 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1 600 m	2 500 m	3 000 m	3 000 m	2 500 m	3 000 m	3 000 m	3 000 m	3 000 m	3 000 m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	—	—	—	—	—	3 600 m[b]	3 600 m[b]	12 000 m	3 600 m[b]	3 600 m[b]
Slope	—	—	—	—	—	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	—	—	—	—	—	8 400 m[b]	8 400 m[b]	—	8 400 m[b]	8 400 m[b]
Total length	—	—	—	—	—	15 000 m	15 000 m	15 000 m	15 000 m	15 000 m
TRANSITIONAL										
Slope	20%	20%	14.3%	14.3%	20%	14.3%	14.3%	14.3%	14.3%	14.3%
INNER TRANSITIONAL										
Slope	—	—	—	—	—	—	—	40%	33.3%	33.3%
BALKED LANDING SURFACE										
Length of inner edge	—	—	—	—	—	—	—	90 m	120 m[e]	120 m[e]
Distance from threshold	—	—	—	—	—	—	—	c	1 800 m[d]	1 800 m[d]
Divergence (each side)	—	—	—	—	—	—	—	10%	10%	10%
Slope	—	—	—	—	—	—	—	4%	3.33%	3.33%

a. All dimensions are measured horizontally unless specified otherwise.
b. Variable length (see 4.2.9 or 4.2.17).
c. Distance to the end of strip.
d. Or end of runway whichever is less.
e. Where the code letter is F (Table 1-1), the width is increased to 140 m except for those aerodromes that accommodate a code letter F aeroplane equipped with digital avionics that provide steering commands to maintain an established track during the go-around manoeuvre.

Note.— See Circulars 301 and 345 (forthcoming), and Chapter 4 of the PANS-Aerodromes, Part I (Doc 9981) for further information.

Taking the above-mentioned into account, together with the proposed project's layout and height of relevant infrastructure, the Namibia Airports Company reviewed the proposed location of Project, specifically the stacks in relation to the Walvis Bay International Airport and assessed the potential impacts to their activities. With reference to an email with related assessment results received from the Namibia Airports Company (Strategic Business Unit: Operations Walvis Bay International Airport), Attached in **Appendix D**, the following was concluded:

"*The preliminary assessment has been conducted based on the submitted coordinates and heights (structures to be built) and none of the proposed structures penetrate the established* *obstacle limitation surfaces established for Walvis Bay International Airport, but that a formal application would need to be submitted following the direction or outcome received from the NCAA*".

Furthermore, "*the structures need to comply to requirements pertaining to visual aids denoting obstacles, necessitating marking and illumination*".

(Note: The "formal application" to the NCAA falls outside the scope of this EIA process and will be conducted by GMRN).

A screenshot of the indicate modelling results, including a summary of the bandings and their specifications, are show in **Figure 86**.

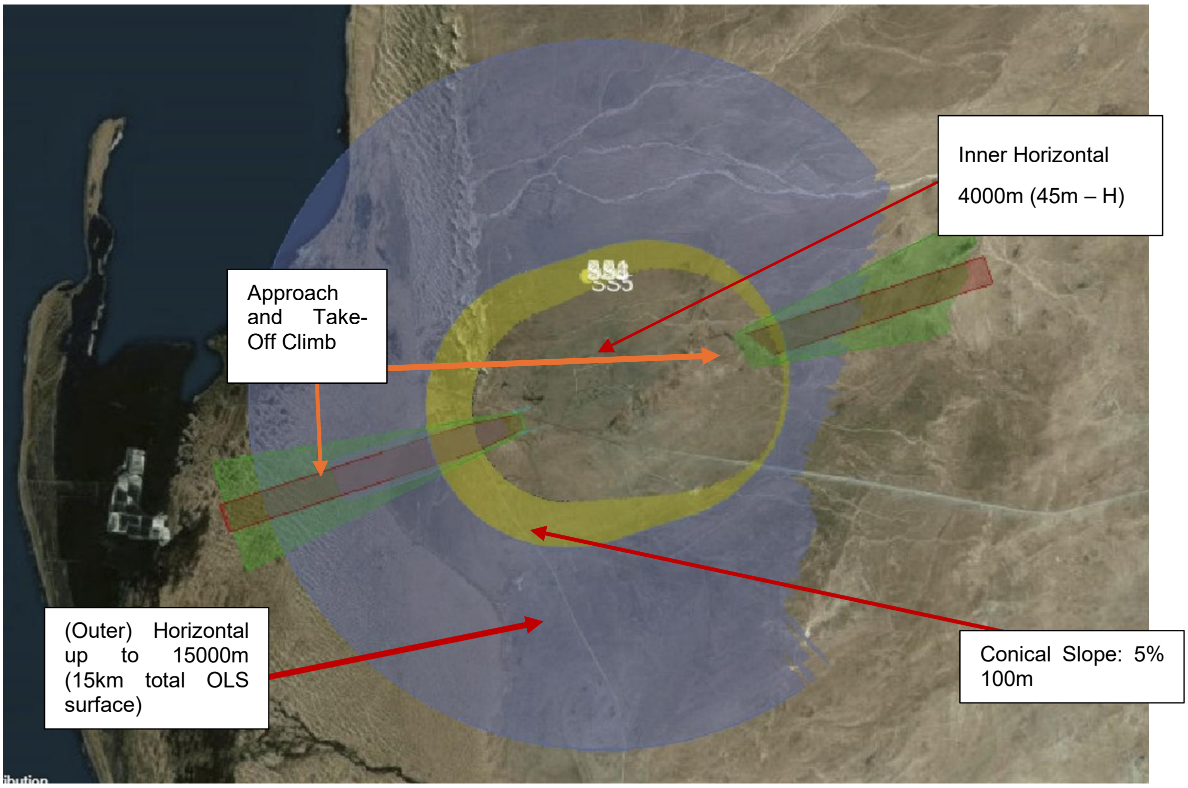

Figure 86: Screenshot of modelling conducted by the Namibia Airports Company.

Note: Figure 85 only provides an indicative indication of the project location in relation to the banding and their specifications. The full extent of the imaginary surface is currently 15km from ARP, however this is exceeded for take-off and landing.

Any aviation-related incident (e.g., stacks posing an obstacle to an aircraft) could have significant consequences. However, the risk of such incidents is low, as the stacks do not infringe upon the Obstacle Limitation Surface relating to the Walvis Bay International Airport.

Taking a precautionary approach, the unmitigated scenario rates the severity, duration, and extent of potential impacts as **moderate** to **high**. With the proposed mitigation measures in place, the infrastructure - including the stacks, which would be the tallest structures - poses a low risk from an aviation perspective, and the associated ratings are reduced to **low**.

Consequence

The determining consequence of the impact is therefore **moderate to high** for the unmitigated scenario and **low** for the mitigated scenario.

Probability

With reference to the above, the infrastructure—including the stacks do not infringe the obstacle limitation surface related to the Walvis Bay International Airport. Taking a precautionary approach, however, the unmitigated probability is rated as **moderate**. With mitigation, the stacks pose no risk from an aviation point of view and the rating is **low**.

Significance

The significance of the impact is rated as **moderate to high** in the unmitigated scenario and **low** with mitigation.

Impact summary – Impacts to aviation - relating to additional obstacles

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**M-H**	**M-H**	**M-H**	**M-H**	**M**	**M-H**
Mitigated	**L**	**L**	**L**	**L**	**L**	**L**

Mitigation measures

Refer to **Section 7.10** in the EMP (**Appendix A**). Key measures include the following:

- As early as possible GMRN must liaise with the NCAA and the Namibia Airports Company (Strategic Business Unit: Operations Walvis Bay International Airport), to share information on the final design, i.e. layout and height of structures (including the stacks) for the proposed Project. GMRN to confirm any specific requirements from the above-mentioned parties as part of their detail design stage.
- Submit application forms: FSS-AGA-FORM-032 (permanent structures) and / or FSS-AGA-FORM-033 (temporary structures), as may be required, prior to the erection of the structure(s). Hereafter, the applications are then evaluated, and a response is provided to the applicant by the NCAA.
- Adhere to the design specifications for the infrastructure (specifically the stack heights), as per communication shared with the NCAA and the Namibia Airports Company.
- No additional structures to be installed on top of the tall structures other than those required and approved by the NCAA and the Namibia Airports Company, e.g. visual aids denoting obstacles.
- The high infrastructure – specifically the stacks - must be suitably marked and or illuminated to indicate the presence of the object, as per approval with conditions from the NCAA and / or the Namibia Airports Company (Strategic Business Unit: Operations Walvis Bay International Airport.
- GMRN to share information on the "as build" (i.e. final design) layout and height of stacks to relevant Companies operating scenic flights, from Swakopmund / Walvis Bay Airport (in consultation with the NCAA), before construction of the stacks commence.

7.3.7.2.2 Impacts to aviation - relating to additional glare from infrastructure, lights and emissions or dust clouds / smoke from stacks

Scheduled commercial flights at Walvis Bay International Airport operate mainly during daylight and early evening, with no routine night arrivals or departures in published timetables. Night operations aren't standard but may occur for special or unscheduled flights arranged in advance.

Glare near airports is assessed by whether reflections or bright lights from nearby structures could impair pilot visibility during take-off, landing, or taxiing. A surface is considered a glare risk if it:

- Reflects sunlight directly into a pilot's line of sight.

- Produces reflections intense enough to distract or momentarily dazzle pilots.
- Occurs within critical flight areas such as approach, departure, or runway zones.
- Happens frequently or for long durations, especially during low-sun periods.

Dust and smoke can impair pilot visibility or create temporary visual distraction during take-off, landing, or taxiing. Thick or persistent plumes may also interfere with instrument readings or force aircraft to adjust flight paths.

With reference to **Section 3.10** the Namibian Civil Aviation Regulations – Part 91 (Regulation 2001) (General Operating and Flight Rules) prohibits any activity that creates a hazard to aircraft operations, including visual interference. This includes:

- Activities that impair pilot visibility.
- Objects or lighting that create distractions.
- Any installation that interferes with safe flight operations.

Part 139.01.33 (Obstacle Evaluation & Control) of the above-mentioned Regulations relates to obstacle evaluation, which includes any object that may:

- Interfere with aircraft operations.
- Affect visibility.
- Create confusion with aeronautical lighting.

Glare-producing surfaces and excessive smoke, amongst others, fall under this category because they can impair pilot situational awareness.

Table 89 summarises typical sources of glare or reflection risks and their potential impact.

Table 88: Summary of glare risk assessment of the Refinery and Sulphuric Acid Plant installation.

Source of glare	Examples	Risks
Reflective Structural Surfaces and equipment (including signage)	Stainless-steel tanks; process vessels; metallic cladding; glossy/light roofs; glass control rooms, PV panels; solar water heaters; reflective insulation; shiny pipe racks	Sustained glare or glint flashes causes ATC sightline interference and leads to confusion by pilots with aeronautical lighting.
Water Bodies & Liquid Surfaces	Firewater reservoirs; effluent ponds; cooling basins; stormwater ponds	Broad-area glare that varies by season causes pilots to confuse the glare with aeronautical lighting.
High-Intensity Lighting Systems	High-mast floodlights; security lights; emergency lights; flare-stack lighting	Pilots confuse the glare with runway or taxiway lights or are distracted by them.
Flare Stacks & Combustion Sources	Gas flares; sulphur burners; incinerators	Intense point-source brightness, flicker distraction or heat-shimmer distortion could affect pilots during nighttime operation.

Source of glare	Examples	Risks
Mobile Reflective Sources	Tanker trucks; polished trailers; mobile cranes; vehicles with work lights	Unpredictable glint or temporary glare that could distract pilots or the ATC.
Temporary Construction-Phase Sources	Reflective scaffolding; temporary lighting towers; contractor vehicles; temporary tanks	Construction activities cause short-term high-intensity glare or uncontrolled night lighting.

The following is a qualitative assessment done by ASEC, with input from the Namibia Airports Company.

Nature, intensity and duration

As stated in **Section 3.10**, the NCAA is responsible for regulating the safety and security of civil aviation operations in Namibia. This includes (amongst others) the protection of aerodromes from hazards that may interfere with aircraft operations or air navigation services. Glare-producing structures or activities fall under this mandate because they can impair pilot visibility, disrupt air traffic control operations, or compromise situational awareness during critical phases of flight.

Reflective or bright objects near an aerodrome could become an obstacle. Examples include solar panels, stainless-steel tanks, water bodies, high-intensity lighting and LED signage.

Any installation capable of producing glare within 5 nautical miles of an airport must undergo an aerodrome-safeguarding assessment, typically including:

- Glint and glare modelling
- Impact on approach and departure paths
- Impact on ATC tower visibility
- Seasonal and time-of-day reflectivity analysis

Note, the clint and glare modelling has yet to be undertaken and does not form part of the EIA.

The proposed Project infrastructure is located approximately 4.5 km north of Walvis Bay International Airport and is oriented roughly perpendicular to the runway. This alignment means that aircraft on approach or departure paths would not be flying directly over or along the structures, significantly reducing the likelihood of reflections affecting pilot vision.

In the unmitigated scenario, the tallest structures, such as stacks (i.e. if highly reflective material is used combined with low sun angles), could potentially create temporary visual discomfort for pilots, but even then, the risk is regarded a **low** due to the distance and location.

For the mitigated scenario where the stacks and other large / tall infrastructure is designed / painted with matte or non-reflective finishes, this further minimizing any potential for glare (see mitigation measures below).

Very bright operational lights not shielded or directed downwards could also create temporary visual discomfort for pilots. In the mitigated scenario, operational lighting will be shielded and / directed downwards, ensuring no distraction to pilots during take-off, landing, or taxiing.

Therefore, given the distance, perpendicular alignment, and non-reflective surfaces, the overall risk of glare impacting aviation operations is considered low, taking the further mitigation into consideration.

Emissions from a sulphuric acid plant are typically not clearly visible when the plant is operating properly. Modern sulphuric acid plants use efficient absorption systems and acid mist eliminators that remove most sulphur compounds and acid droplets from the exhaust gas. As a result, the gases leaving the stack usually appear clear or only produce a faint white plume due to water vapor.

In contrast, emissions from a manganese refinery can sometimes be visible depending on the specific process used and the effectiveness of pollution control equipment. Operations such as smelting, roasting, or material handling may generate particulate matter, including manganese oxide dust, which can create a grey or brownish plume if not fully captured by filtration or scrubbing systems. The visibility of these emissions therefore varies with plant design, operating conditions, and the performance of emission control technologies.

As the predominant wind direction for the Project area is from the south-southwest and west-southwest to west, and north-northeast, with little wind from the south to southeast (see **Section 6.1.1**), visible emission will likely not interfere with aviation activities.

Taking a precautionary approach, the unmitigated scenario rates the severity, duration, and extent of potential impacts as **moderate** due to the fact that industrial developments such as these may contain reflective surfaces or sources of glare, however, the development will be relatively far from the airport on an axis perpendicular to the flight path. This is also easy to mitigate, using conventional measures, which are used worldwide.

Therefore, with the proposed mitigation measures in place, the infrastructure—including the stacks, which would be the tallest structures—poses no risk from an aviation perspective, and dust is mitigated and the associated ratings are reduced to **low**.

Consequence

The determining consequence of the impact is therefore **moderate** for the unmitigated scenario and **low** for the mitigated scenario.

Probability

Given the distance, perpendicular alignment, and non-reflective surfaces, the overall risk of glare impacting aviation operations is considered low for the mitigated scenario. Unmitigated, taking a precautionary approach, the probability is **moderate**.

Significance

The significance of the impact is rated as **moderate** in the unmitigated scenario and **low** with mitigation.

Impact summary – Impacts to aviation - relating to additional glare from infrastructure, lights and emissions or dust clouds from stacks

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**M**	**M**	**M**	**M**	**M**	**M**
Mitigated	**L**	**L**	**L**	**L**	**L**	**L**

Mitigation measures

Refer to **Section 7.10** in the EMP (**Appendix A**). Key measures include the following:

- Refer to commitments in **Section 7.3.7.2.1**.

- During design ensure that the best available technology is applied to avoid or minimise any potential visual emissions.
- Install aviation warning lights on the tallest structures if required by the Civil Aviation Authority.
- Maintain regular consultation with the Namibia Airports Company regarding construction and operational activities.
- As part of permit application, GMRN should prepare:
    - Glint & glare modelling report (sun-path analysis, seasonal variation)
    - Lighting impact assessment (intensity, direction, shielding)
    - ATC sightline assessment (if applicable)
    - Mitigation plan with engineering and operational controls
    - Site layout showing all reflective/glare-producing elements
- Use matte or non-reflective finishes on all tall structures to minimize sunlight reflections.
- Orient any reflective surfaces away from runway approach and departure paths, as far as possible.
- Shield high-intensity lights and / or direct downwards and ensure lighting design complies with aviation standards to avoid pilot distraction, where relevant.
- Conduct regular inspections to ensure structures remain compliant with OLS and glare mitigation measures.
- Report any incident or near-miss related to aviation to the airport authorities promptly.
- Review mitigation measures periodically and update the EMP based on operational experience and regulatory changes.

Table 90 provides a summary of typical sources of glare and proposed mitigation.

Table 89: Summary of typical sources of glare or reflection and proposed mitigation.

Source of glare	Mitigation
Reflective Structural Surfaces and equipment (including signage)	Specify matte, anti-reflective surface coatings, using darker colours. Install shading fins/louvers or screens and re-orientate where required. Use low-glint PV modules.
Water Bodies & Liquid Surfaces	Use anti-glare bird balls or equivalent.
High-Intensity Lighting Systems	Specify warm-white full cut-off luminaires that are downward aiming.
Flare Stacks & Combustion Sources	Locate outside approach sectors, enclosed ground flares and limit routine flaring.
Mobile Reflective Sources	Specify matte, anti-reflective surface coatings, using darker colours.
Temporary Construction-Phase Sources	Include in HSE specification non-reflective sheeting, pre-approved lighting plans, restricted night lighting and glare controls.

7.3.7.2.3 Impacts to aviation - relating to Wildlife attractants (open water bodies, waste).

With reference to **Section 7.2.2.6**, readily available domestic waste attracts scavenging animals such as jackals and crows. The clarification pond associated with the RMF may attract birds. The potential impacts to the animals are assessed in the aforementioned section.

The section below provides a qualitative assessment of the potential impacts of attracting animals on aviation safety.

Nature, intensity and duration

Potential impacts of attracting animals (including birds) to new open water bodies and domestic waste associated with the proposed Project at Walvis Bay International Airport, include the following:

- Bird/animal strikes: Increased risk of collisions with aircraft (especially during take-off and landing), causing structural damage, engine ingestion, or loss of control.
- Engine ingestion & power loss: Birds or mammals sucked into engines can cause engine failure, emergency landings or aborted take-offs.
- Reduced flight safety: Higher probability of serious incidents or accidents, endangering passengers and crew.
- Operational disruption: Delays, go-arounds, diversions and cancellations while wildlife hazard is managed or runways are cleared.
- Increased maintenance & costs: More inspections, repairs and downtime after strikes or near-misses.
- Air traffic control workload: Extra procedures and warnings for pilots, increased monitoring and wildlife patrol activity.
- Wildlife habituation & population growth: Water sources can create persistent hazard hotspots as species learn to congregate there.
- Attraction of larger predators: Scavengers or predators drawn to the area can create additional collision risks and unpredictable animal movements.
- Passenger perception & liability: Reduced confidence in airport safety, possible legal/insurance consequences after incidents.
- Ecological spill-on effects: Changes to local wildlife patterns that may conflict with airport safety zones (e.g., nesting or roosting near approach paths).

Research which analysed risk areas where vultures overlap with aircraft flight paths in Namibia highlighted that collisions between aircraft and birds and other animals, in general, occur frequently and are known in the aviation industry as wildlife strikes. They are considered to be one of the most serious safety and financial risks to the global aviation industry. The International Civil Aviation Organisation, a United Nations specialised Agency, requires that the appropriate authority shall take action to eliminate or to prevent the establishment of any source which may attract wildlife to the aerodrome, or its vicinity, unless an appropriate wildlife assessment indicates that they are unlikely to create conditions conducive to a wildlife hazard problem. Namibian airports reduce the wildlife strike risk by managing the airport habitat and actively chasing birds and other hazardous animals away.

Hauptfleisch (2020) found in the above-mentioned study that a low risk of interaction between aircraft and vultures within the direct ASZ which is monitored by licensed airports, however, they found that up to 10 % of nesting vultures are a risk to both commercial and tourist aircraft on approach and climb phases within 50 km of the airports. Hosea Kutako International and Walvis Bay airports (Namibia's most important international airports), have the highest potential risk of vulture interactions during approach and climb.

Section 6.4.5 indicates that the project area is sufficiently far removed from the coast and there is no open water nearby to attract coastal and wetland birds. Birds expected in this area therefore are those typical of the Namib plains. However, around Walvis Bay International Airport, water birds such as flamingos and pelicans regularly move between the lagoon, nearby artificial wetlands (including sewage ponds), and offshore feeding or roosting areas. These movements create low-altitude flight paths that can intersect aircraft approach and departure routes, particularly during takeoff and landing. According to African Conservation Services cc (2022), in arid environments especially, many species may make nomadic movements, taking advantage of ephemeral food and water sources. Bird flight paths and flyways are likely to be opportunistic and to vary, depending on current environmental conditions, and are therefore not always easily predicted. Drainage lines are believed to be associated with flyways for some species, e.g. Ludwig's Bustard and the two flamingo species (see below) as well as Namaqua Sandgrouse.

Aquatic species such as flamingos are known to move up and down the coast regularly, between the coastal habitats. The results of (limited) GPS satellite tracking of five Lesser and Greater Flamingo locally from Mile 4 Saltworks in 2013-2015 indicate regular movements up and down the coast between these saltworks and Cape Cross to the north (100 km), and to the Walvis Bay wetlands in the south (45 km). During the above study it was not possible to track their movements inland, due to the prevailing drought conditions. Flamingos also move inland after good rains, in order to breed in Botswana and, occasionally, Etosha National Park. The flyways of Greater Flamingo and Lesser Flamingo on longer migratory routes between Botswana and elsewhere in southern Africa have been confirmed by satellite tracking, with some movements to Namibia, including for a Greater Flamingo from Etosha National Park to the Namibian coast. The details of their flight paths on such migratory routes within Namibia have not yet been confirmed. For Lesser Flamingo, regular movements have similarly been recorded between South Africa and Botswana, as well as more limited movements to Etosha National Park in the west (but not yet to the coast), and more widely ranging movements to Mozambique and Madagascar in the east (African Conservation Services cc, 2022).

With reference to **Section 4** there will small ponds in the water treatment area. All ponds will be covered with bird balls.

Taking a precautionary approach, the unmitigated scenario assesses the severity, duration, and extent of potential impacts as moderate to high. With the implementation of the proposed mitigation measures, domestic waste will be appropriately managed, open water sources will be minimised, and additional measures will be applied to prevent the attraction of animals to the site. As a result, aviation-related risks are substantially reduced, and the associated impact ratings are lowered to low.

Consequence

The determining consequence of the impact is therefore **moderate to high** for the unmitigated scenario and **low** for the mitigated scenario.

Probability

Taking a precautionary approach and considering that the proposed project area is located more than 4 km from the airport, the unmitigated probability of impact is rated as moderate. With the implementation of mitigation measures, the attraction of animals is minimised, thereby reducing the associated aviation safety risks, and the probability rating is reduced to low.

Significance

The significance of the impact is rated as **moderate to high** in the unmitigated scenario and **low** with mitigation.

Impact summary – Impacts to aviation - relating to additional glare from infrastructure, lights and emissions or dust clouds from stacks

Mitigation	Intensity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	**M-H**	**M-H**	**M-H**	**M-H**	**M**	**M-H**
Mitigated	**L**	**L**	**L**	**L**	**L**	**L**

Mitigation measures

Refer to **Section 7.10** in the EMP (**Appendix A**). Key measures include the following:

- Cover all water ponds with bird balls.
- Develop waste management strategy/management plan that avoids exposing domestic waste to animals (closed temporary waste containers, regular removal to managed landfill)
- Cover all waste storage areas.
- Prohibit feeding of wild animals.

Monitoring recommendations

- Monitor animals and birds visiting the Project area during both construction and operations phase. Should there be in increase in the number of animals (not due to natural reasons), further mitigation needs to be planned and developed.
- Ongoing consultation with the Namibia Airports Company.

7 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

The actions required to effectively implement design requirements, management and mitigation measures and monitoring requirements are detailed in the EMP (**Appendix A**). These actions are required to avoid / minimise the negative impacts and enhance positive impacts relating to the activities and infrastructure associated with the proposed GMRN Project, as assessed in **Section 7**.

The EMP gives the environmental commitments, which will be implemented by GMRN.

7.1 Environmental and Social Policy

GMR
Green Metals
Refining

Environmental and Social Policy

GMR Reference: CU-I-POL-002-00

Green Metals Refining Ltd (GMR) is committed to the development and operation of industrial facilities in a manner that protects people, the environment, and long-term value. Sound environmental and social management is integral to our licence to operate, our relationships with stakeholders, and our ability to secure responsible financing.

Compliance & Standards

GMR will comply with all applicable host country legislation, including but not limited to:

- Environmental Management Act (EMA) and EIA Regulations
- Water Resources Management Act
- Labour Act and associated regulations
- Hazardous Substances and Chemicals legislation
- Municipal and regional permitting requirements

Where required by financiers or aligned with project needs, GMR will apply Good International Industry Practice, including the IFC Performance Standards, World Bank Environmental and Social Standards, and relevant chemical sector guidelines.

Environmental & Social Risk Management

GMR will identify, assess, and manage environmental and social risks across the project lifecycle, including:

- Avoiding impacts where feasible, and minimising, mitigating where avoidance is not possible.
- Integrating biodiversity, water, air quality, waste, climate, and cultural heritage considerations into project design.
- Implementing process safety, hazardous materials management, and emergency preparedness measures appropriate for an industrial chemical facility.
- Providing safe, fair, and lawful working conditions for employees and contractors.

Resource Efficiency & Pollution Prevention

GMR will incorporate principles of sustainable water use, energy efficiency, and resource efficiency into project design and operations. Waste management will prioritise avoidance, reduction, reuse, recycling, and responsible disposal.

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Stakeholder Engagement & Grievance Management

GMR will maintain transparent, culturally appropriate engagement with affected communities, authorities, and stakeholders. A grievance mechanism will be established and maintained throughout the project lifecycles.

Governance & Accountability

Responsibility for environmental and social performance rests with GMR management and extends to all employees and contractors. Oversight will be provided by senior leadership, with periodic reporting to the Board. This Policy will be reviewed annually or upon a material change in project scope, communicated internally and made publicly available when appropriate.

Approved by the Board of Directors of Green Metals Refining Ltd on 12 January 2026.

7.2 Environmental Management System (EMS)

At the current planning and design stage of the Project, GMRN recognises its responsibility to manage environmental and social risks and impacts in a systematic and proportionate manner, consistent with applicable Namibian legislation and Good International Industry Practice. In line with the principles of IFC Performance Standard 1, the Company adopts a risk-based and phased approach to environmental and social management that is appropriate to the stage of project development.

During the planning, pre-construction, and construction phases, environmental and social management will be guided primarily by the approved Environmental Management Plan (EMP) and the conditions of the Environmental Clearance Certificate and any associated licences or permits issued by the MEFT. These instruments will serve as the primary mechanisms for managing environmental aspects and impacts, ensuring regulatory compliance, and implementing mitigation and monitoring measures relevant to these phases.

At this stage, the Environmental Management Plan will function as the core management framework, supported by project-specific procedures, method statements, and operational controls appropriate to design development, pre-construction, and construction activities. These measures will enable the identification, avoidance, and minimisation of environmental and social risks and impacts where practicable, and provide for monitoring, reporting, and corrective action as required.

GMRN recognises that IFC Performance Standard 1 promotes the establishment of an Environmental and Social Management System that evolves progressively over the life cycle of a project. In this context, the Company intends to further develop and formalise its environmental and social management arrangements as the Project advances towards operation, taking into account the outcomes of the ESIA process, regulatory requirements, stakeholder engagement, and the scale and risk profile of project activities.

International benchmarks such as ISO 14001 Environmental Management Systems represent one example of a recognised framework that may be considered at a later stage to support operational environmental management and continual improvement. Reference to such standards at this stage remains indicative, and does not constitute a commitment to certification or to the adoption of any specific management system. Any future system will be selected and implemented in a manner that is appropriate to the Project and aligned with regulatory requirements.

Throughout the planning, pre-construction, and construction phases, GMRN will apply duty of care principles in project design and execution, and will review and refine its management arrangements as the Project progresses, ensuring that environmental and social controls remain suitable, effective, and commensurate with the phase of development.

8 ENVIRONMENTAL IMPACT STATEMENT AND CONCLUSION

The receiving environment was evaluated during the Environmental Impact Assessment (EIA) process for the proposed Project (see **Section 6**). Environmental aspects and potential impacts associated with the Project's activities and facilities were identified during the Scoping Phase to inform further analysis in the Assessment Phase of the EIA (see **Section 7**). A detailed description of the facilities and activities planned for the construction, operation, and decommissioning phases of the Project is provided in **Section 4** of this report.

ASEC identified potential environmental impacts in consultation with IAPs, regulatory authorities, specialists (see the team of Specialists in **Section 1.4.4**), and the GMRN Project Team. The impacts were assessed under the identified issue headings in **Section 7**. Impacts were considered in a cumulative manner where relevant, such that the impacts of the proposed Project were assessed in the context of the baseline conditions described in **Section 6**.

Table 90 provides a summary of the environmental aspects / potential impacts associated with the proposed Project, along with the assessment ratings for the unmitigated and mitigated scenarios. Proceeding with the Project will result in significant positive economic impacts. It will, however, also result in negative environmental and social impacts for which relevant mitigation measures were proposed to reduce the impacts to acceptable levels. The no-go alternative was also investigated.

The GMRN refinery and sulphuric acid plant will have positive impacts on all levels of the economy and will increase the number of jobs available in Namibia. The coastal towns will benefit from the increased spending power of project personnel, but they may also face in-migration as job seekers and opportunists learn of the new project. Of particular concern is the limited housing stock at the coast, which will be under more stress if the project recruits workers from elsewhere. Recruitment policies will be focused on reducing this risk.

The socio-economic benefits of the project outweigh any potential negative impacts of the socio-economic aspects assessed. The increased risk of traffic accidents due to project-related traffic can be mitigated to acceptable levels.

The water, biodiversity and noise specialist studies showed that the identified potential negative impacts can be minimised and/or avoided if the proposed mitigation measures are implemented during the design, construction, operational phases.

The Quantitative Risk Assessment was performed with the assumption that the site would be managed and maintained to an acceptable level and that all statutory regulations would be applied. It was also assumed that the detailed engineering designs would be undertaken by competent service providers. GMRN remains the responsible party to make sure that the engineering design team and appointed contractors are competent and that the construction activities are undertaken according to the relevant specifications.

Table 90: Summary of the environmental and social aspects/potential impacts associated with the proposed Project and significance ratings, in the unmitigated and mitigated scenarios.

Environmental component	Environmental issues (i.e. environmental and social aspects/potential impacts	Assessment Significance Rating	
		Unmitigated	Mitigated
Surface Water and Groundwater	Impacts on alteration of drainage pattern and stormwater runoff	L	L
	Impacts from surface water pollution from mineral waste facilities	M	L
	Impacts from sewage disposal	M	L
	Impacts from Water consumption	M	L
Biodiversity	**Impacts on Flora and fauna:**		
	• Loss of vegetation, lichens and associated biota due to clearing of vegetation	H	M
	• Change of habitat and water flow	M	M
	• Introduction of invasive alien plants and animals	M	L
	• Effect of dust and airborne pollutants on vegetation and lichens	M - H	M
	• Change of natural lighting conditions at night	M	L
	• Domestic waste and open water attracting animals	M	L
	• Spillage of chemicals and hydrocarbons polluting soil	M	L
Air Quality	**Air pollution - Residual impact summary:**		
	***Construction phase*:**		
	• PM_{10} and $PM_{2.5}$ impacts	M	L
	• Dustfall impacts	M	L

Environmental component	Environmental issues (i.e. environmental and social aspects/potential impacts	Assessment Significance Rating	
		Unmitigated	Mitigated
	Operational phase:		
	• PM_{10} and $PM_{2.5}$ impacts	**H**	**M**
	• Mn impacts	**H**	**M**
	• SO_2 impacts	**M**	**M**
	• SO_3 impacts	**M**	**M**
	• Dustfall impacts	**M**	**M**
	Decommissioning phase:		
	• PM_{10} and $PM_{2.5}$ impacts	**M**	**L**
	• Dustfall impacts	**M**	**L**
	Air pollution - Cumulative impact summary:		
	***Construction phase*:**		
	• PM_{10} and $PM_{2.5}$ impacts	**M**	**M**
	• Dustfall impacts	**M**	**L**
	Operational phase:		
	• PM_{10} and $PM_{2.5}$ impacts	**H**	**M**
	• Mn impacts	**H**	**M**
	• SO_2 impacts	**M**	**M**
	• SO_3 impacts	**M**	**M**

Environmental component	Environmental issues (i.e. environmental and social aspects/potential impacts	Assessment Significance Rating	
		Unmitigated	Mitigated
	• Dustfall impacts	**M**	**M**
	Decommissioning phase:		
	• PM_{10} and $PM_{2.5}$ impacts	**M**	**M**
	• Dustfall impacts	**M**	**L**
Climate Change	Operational phase		
	• Combined GHG emissions for project operations	**VL**	**VL**
	• Cumulative impacts	**L**	**L**
Noise	Cumulative environmental noise impacts associated with the construction phase	**L**	**L**
	Maximum' cumulative environmental noise impacts associated with the operational phase	**L**	**L**
Socio-economic	All levels of the economy	**H+**	**VH+**
	Job Creation	**H+**	**VH+**
	Skills Development	**VH+**	**VH++**
	Housing	**M**	**L**
Traffic	Traffic accidents (Mn transport route excluded)	**H**	**L**
Visual / Sense of Place	Visual impacts associated with the project	**H**	**M**
Safety risk and potential	Fire at sulphur store leading to combustion, toxic sulphur dioxide dispersion	**L**	**L**

Environmental component	Environmental issues (i.e. environmental and social aspects/potential impacts	Assessment Significance Rating	
		Unmitigated	**Mitigated**
impacts to third parties and infrastructure			
Aeronautical	Impacts to aviation - relating to additional obstacles	**M - H**	**L**
	Impacts to aviation - relating to additional glare from infrastructure, lights and emissions or dust clouds from stacks	**M**	**L**
	Impacts to aviation - relating to Wildlife attractants (open water bodies, waste)	**M - H**	**L**

As part of the Quantitative Risk Assessment study, a number of incident scenarios were simulated, taking into account the prevailing meteorological conditions, and described in the report.

- Hazardous substances associated with this Sulphuric Acid Plant and associated facilities would include: sulphur; sulphur dioxide, sulphur trioxide and diesel. The risk of $1x10^{-6}$ fatalities per person per year isopleth was found to extend beyond the site boundary but did not reach any residential areas, the Cleanenergy site or the Walvis Bay Airport.
- A large release of sulphur dioxide could extend over a considerable distance, impacting the commercial and residential areas of Walvis Bay. However, potential fatalities will be limited to the industrial area and would not affect residential areas or the airport. No residential area or vulnerable institutions would be seriously impacted by the construction and operation of the proposed GMRN facility.
- The study concluded that the risk isopleths generated for the proposed project could fall within the ALARP range, resulting in land-use restrictions. As the designs have not been finalised, the full land-use and planning restrictions must be taken from the final risk assessment report. The current Quantitative Risk Assessment needs to be revisited once the final design of the SAP and MRF is available and risks regarding land planning on Farm 58 need to be discussed with the municipality of Walvis Bay.

The Air Quality Specialist Study concluded that GMRN operations are likely to result in PM_{10} and $PM_{2.5}$ ground level concentrations exceeding the selected AQOs outside the facility, with no mitigation in place. This can be reduced to only exceed at the boundary with mitigation measures in place such as enclosure of the crushing circuit and keeping the on-site roads dust free. Impacts from SO_2 and SO_3 as well as dustfall rates are expected to be low.

Impacts from Mn are expected to be high mainly as a result from windblown dust and crushing operations, which could be effectively mitigated.

It is the environmental consultants' and Air Specialist opinion that the proposed project could be authorised provided additional mitigation measures as provided in **Section 7.2.3.5** be implemented and the tracking of the effectiveness of these measures to ensure the lowest possible off-site impacts. Specific attention should be given to the management and mitigation of Mn dust.

From a climate change perspective, environmental specialists are of the opinion that the project be authorised, on the condition that GHG emissions are evaluated and reported annually. To reduce GMRN's carbon footprint, alternative or better 'Upstream and Downstream transportation and distribution' needs to be investigated.

The high-level aeronautical impact assessment showed that the significance of all potential impacts (obstacles, e.g. stacks; glare from infrastructure, lights and emissions or dust clouds from stacks and attraction of wildlife due to open water sources) can be reduced to low, if the suggested mitigation measures are implemented during design, construction and operation.

All potential negative impacts will require proper management and mitigation to minimise impacts as far as possible.

In this context, GMRN will be required to follow a three-pronged approach to managing its impacts:

- Management of its incremental impacts by implementing the various management, mitigation and monitoring requirements stipulated in the EIA and EMP.
- Follow an adaptive management approach to make sure that management decisions are based on the best available knowledge at the time, but with an effort to improve the knowledge base through analysis of data generated by a robust monitoring program.

- Air quality mitigation measures as provided in **Section 7.2.3.5** must be implemented. The effectiveness of these measures shall be tracked/measured/evaluated, to achieve the lowest possible off-site impacts. Specific attention should be given to the management and mitigation of manganese dust.

It is ASEC's opinion that the environmental aspects and potential impacts relating to the proposed Project have been successfully identified and assessed as part of this EIA process. Relevant management and mitigation measures and monitoring requirements have been provided to avoid/minimise key environmental and social impacts and enhance positive social impacts, where relevant. These measures are included in the EMP (**Appendix A**) and will become legally binding if MEFT provides a positive decision on the Application for the proposed Project.

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