REPORT:

TWIN HILLS GOLD PROJECT – ESIA SCOPING

REPORT

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Client Name: Mr Charles Creasy
Ministry Reference: APP-002920
Authors: Philip Hooks, Jessica Bezuidenhout, Lester Harker, and Matthew Bliss
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ENVIRONMENTAL COMPLIANCE CONSULTANCY CONTACT DETAILS:

We welcome any enquiries regarding this document and its content. Please contact:

Environmental Compliance Consultancy
PO Box 91193, Klein Windhoek, Namibia
Tel: +264 81 669 7608
Email: info@eccenvironmental.com

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EXECUTIVE SUMMARY

Environmental Compliance Consultancy (ECC) has been contracted by Osino Gold Exploration and Mining (Pty) Ltd. (OGEM), a Namibian company and subsidiary of Osino Resources Corp., to undertake an environmental and social impact assessment (ESIA). OGEM manages operations in Namibia as a wholly owned subsidiary of Osino Namibia Holdings (Pty) Ltd. which is in turn a subsidiary of Osino Resources Corp. ECC is conducting an ESIA for the proposed mining of precious metals on Mining Licence 238 (ML 238), located near the town of Karibib, Erongo Region, Namibia.

OGEM is the proponent for the proposed Project, referred to as “the Proponent”. The proposed Project will be a conventional open pit mine with a gold extraction process similar to those in existing gold mines in Namibia, such as the Otjikoto and Navachab mines. The proposed Project will be referred to as the “Twin Hills Gold Project” or the “Project” herein.

The proposed Project covers an area of approximately 8 000ha, excluding linear power and water supply infrastructure. The site is accessed from the C33 road in central Namibia, between the towns of Karibib and Omaruru.

In terms of the Namibian Environmental Management Act, 2007 and its regulations, the Ministry of Mines and Energy (MME) is the competent authority for the proposed Project. Mining operations trigger listed activities in terms of the Act, and as such, requires an environmental clearance certificate.

SCREENING PHASE

A high-level ESIA formed part of the company’s recently published preliminary economic assessment (PEA) and was incorporated into the screening phase. Alternative locations for key infrastructure, such as the processing plant and tailings storage facility (TSF), as well as potential road and river diversions, with possible mitigation measures, were considered.

The screening phase determined that the most likely potential environmental and social impacts could include:

- Surface and groundwater impacts
- Social impacts during construction, operations, and post-closure
- Habitat alteration and impacts on biodiversity
- Visual impacts affecting the sense of place
- Impacts to air quality
- Impacts on road and land users associated with the road diversion, and
- Impacts associated with the Okawayo river diversion.
SCOPING PHASE

The objective of the scoping phase is to obtain a thorough understanding of the biophysical and socioeconomic environment in which the Project is located, often using baseline and specialist studies. It also provides an opportunity for the public to have input into the scope of the assessment. The technical inputs combined with the inputs from the I&APs led to the development of the Terms of Reference (ToR) for the assessment phase. The following was considered during the preparation of the scoping report:

- Desktop and literature research
- Site visits by ECC and specialists
- Environmental monitoring data
- Specialist baseline studies, including:
  - Soil sampling and analysis
  - Acid-base accounting (ongoing study)
  - Surface and groundwater studies
  - Biodiversity study
  - Noise
  - Air quality
  - Road traffic study
  - Visual impacts on sense of place
  - Socioeconomic baseline
  - Heritage and archaeology study

TERMS OF REFERENCE

The ToR within the scoping report that is proposed for the assessment phase will cover the following:

- Soil impact assessment
- Acid mine drainage impact assessment
- Surface and groundwater impact assessment
- Biodiversity impact assessment
- Noise impact assessment
- Air quality impact assessment
- Traffic impact assessment
- Visual impact assessment
- Socioeconomic impact assessment
- Heritage impact assessment
- Blast and vibration assessment

The methodology that will be used for assessing impacts is described in the scoping report. A hierarchical decision-making process is followed, in order to prevent or eliminate, prevent, reduce or offset, mitigate or manage potential impacts. The draft scoping report and draft environmental management plan (EMP) will be provided to the public for review prior to submission to the competent authority, including MME and ultimately MEFT.
The next stage of this assessment will be the impact assessment phase. All comments received during the I&AP public review period on this scoping report will be collated in an addendum report, which will form part of the full submittal to government. All comments will be responded to, either through providing an explanation or further information in the response table, or by signposting where information exists, or where new information has been included in the ESIA report or appendices. Comments will be considered, and where they are deemed to be material to the decision-making, or might enhance the ESIA, they will be incorporated.

The final ESIA report, appendices, and the addendum report, will be available to all stakeholders, and all I&APs will be informed of its availability for review.

The ESIA report, appendices and addendum will be formally submitted to the competent authority, first the MME and then to the MEFT as part of the application for an environmental clearance certificate for the Twin Hills Gold Project. The phases of the ESIA are provided in Figure 1.

![Figure 1 - Simplified Namibian ESIA process noting Twin Hills progress](image-url)
# TABLE OF CONTENTS

1 **Introduction** .................................................................................................................. 14  

1.1 Company background ................................................................................................. 14  
1.2 Purpose of the scoping report .................................................................................. 16  
1.3 The proponent of the proposed project .................................................................. 16  
1.4 Environmental and social assessment practitioner .............................................. 17  
1.5 Environmental requirements .................................................................................. 17  

2 **Approach to the Assessment** .................................................................................... 22  

2.1 Purpose and scope of the assessment ....................................................................... 22  
2.2 The assessment process ......................................................................................... 22  
2.3 Study area ............................................................................................................... 25  
2.4 Public consultation .................................................................................................... 26  

2.4.1 Identification of key stakeholders and interested or affected parties ............... 26  
2.4.2 Summary of issues raised .................................................................................... 28  

3 **Review of the Legal Environment** ........................................................................... 29  

3.1 National regulatory framework .............................................................................. 30  
3.2 National polices and plans ...................................................................................... 36  

4 **Project Description** .................................................................................................. 40  

4.1 Need for the project .................................................................................................. 40  
4.2 Employment ............................................................................................................. 40  
4.3 Background of the project and exploration history .............................................. 41  
4.4 Geology and mineralisation ....................................................................................... 43  
4.5 Site layout .................................................................................................................. 45  
4.6 Mining infrastructure and services .......................................................................... 49  

4.6.1 Orebody .............................................................................................................. 49  
4.6.2 Mining method and equipment .......................................................................... 51  
4.6.3 Pit and haulage design ....................................................................................... 54  
4.6.4 Metallurgy and processing ................................................................................ 58  
4.6.5 Support infrastructure and services ................................................................... 60  
4.7 Utilities ....................................................................................................................... 62  

4.7.1 Power supply ....................................................................................................... 62  
4.7.2 Water supply ....................................................................................................... 63  
4.8 Mineral and non-mineralised waste ......................................................................... 65  

4.8.1 Waste rock .......................................................................................................... 65  
4.8.2 Tailings ............................................................................................................... 65  
4.8.3 General waste ...................................................................................................... 68
4.8.4 Effluent and wastewater ................................................................. 68
4.9 Alternatives considered ........................................................................ 68
4.9.1 Mine layout ....................................................................................... 68
4.9.2 Road diversion .................................................................................. 69
4.9.3 Water supply ...................................................................................... 69
4.9.4 River diversion .................................................................................. 69
4.10 Rehabilitation and closure .................................................................... 69

5 Environmental and Social Baseline .......................................................... 70
5.1 Baseline data collection ......................................................................... 70
5.1.1 Desktop and field surveys ................................................................. 70
5.1.2 Specialist studies ............................................................................... 70
5.2 Location ............................................................................................... 71
5.3 Land use ............................................................................................... 73
5.4 Geological setting ................................................................................. 75
5.5 Topography ............................................................................................ 77
5.6 Built environment and infrastructure ....................................................... 78
5.6.1 Infrastructure and bulk services ......................................................... 78
5.6.2 Traffic and transport ......................................................................... 80
5.7 Socioeconomic baseline ......................................................................... 82
5.7.1 Governance ....................................................................................... 82
5.7.2 Demographic profile ......................................................................... 82
5.7.3 Health ................................................................................................ 85
5.7.4 Employment ...................................................................................... 87
5.7.5 Crime .................................................................................................. 88
5.7.6 Economic and business activities ......................................................... 89
5.8 Heritage and culture .............................................................................. 90
5.9 Noise and vibration .............................................................................. 92
5.9.1 Atmospheric absorption and meteorology ......................................... 94
5.9.2 Terrain, ground absorption and reflection ......................................... 94
5.10 Visual and sense of place ...................................................................... 96
5.11 Lighting ............................................................................................... 103
5.12 Biophysical environment baseline ....................................................... 103
5.13 Geochemical ....................................................................................... 115
5.14 Water ................................................................................................. 118
5.15 Biodiversity ....................................................................................... 134
5.15.1 Flora .............................................................................................. 134
5.15.2 Fauna .............................................................................................. 136

6 Impact Identification & Evaluation Methodology ...................................... 139
6.1 Introduction .......................................................................................... 139
6.2 Assessment guidance ............................................................................ 139
LIST OF TABLES

Table 1 – Proponent’s details .............................................................................................................16
Table 2 – Activities potentially triggered by the Twin Hills Gold Project ........................................18
Table 3 – Details of the regulatory framework as it applied to the Twin Hills Gold Project ..............30
Table 4 – Namibian national policies and plans applicable to the Twin Hills Gold Project ............36
Table 5 – Specific permits and licence requirements for the Twin Hills Gold Project ..................37
Table 6 – Pit design parameters (Source Qubeka, 2021) .................................................................56
Table 7 – TSF design criteria (Source Prime Resources, 2021) ......................................................66
Table 8 – Waste rock and tailings volumes and tonnages (Source Prime Resources, 2021) ..........67
Table 9 - Specialist studies conducted for the ESIA ............................................................................70
Table 10 – Socioeconomic baseline study summary of key indictors ..............................................84
Table 11 – Classification of soil type ...............................................................................................105
Table 12 - The profile permeability class factor table .....................................................................108
Table 13 – Soil structure index .........................................................................................................108
Table 14 – Table of K-Factor calculation .........................................................................................109
Table 15 – Laboratory results for the element and organic matter (Geolab, 2021) .....................109
Table 16 – Soil erodibility factor (After Stewart et al. 1975 as cited by PNNL, 2021) ...............110
Table 17 – Sample materials used for geochemical testing .........................................................116

LIST OF FIGURES

Figure 1 – Simplified Namibian ESIA process noting Twin Hills progress .................................5
Figure 2 – Project location and regions ..........................................................................................15
Figure 3 – ESIA process and stages complete ..............................................................................24
Figure 4 – ESIA study area, infrastructure, and surrounds .............................................................25
Figure 5 – Neighbouring farms to the mining licence area ............................................................27
Figure 6 - A generalised graph showing employment levels of operations over the life of mine (Source Qubeka, 2021) ..............................................................................40
Figure 7 - Project location in proximity to towns and roads ............................................................41
Figure 8 – Tenement boundaries showing mining licence and EPLs ............................................42
Figure 9 - Contour map showing the Project layout .......................................................................46
Figure 10 – Conceptual site infrastructure layout (Source Lycopodium, 2021) ............................48
Figure 11 – Gold mineralisation and pit design (Source Qubeka, 2021) ........................................50
Figure 12 – Examples of equipment to be used on the Project (Source Qubeka, 2021)........53
Figure 13 – Pit design and terminology (Source Qubeka, 2021) ........................................55
Figure 14 – Twin Hills, Bulge, and Clouds pit design (Source Osino, 2021) ...........................57
Figure 15 – Twin Hills, Bulge, and Clouds pit dimensions (Source Qubeka, 2021) ............58
Figure 16 – Metallurgical process flow (Source Lycopodium, 2021) .................................59
Figure 17 – Proposed dam construction by SLR (2020) for surface water supply (source KP, 2021) ........................................................................................................................................64
Figure 18 – Downstream development of a TSF (source Prime Resources, 2021) ..........67
Figure 19 - Project location in proximity to towns and roads ...........................................72
Figure 20 - Project location in proximity to farms and mining claims ................................74
Figure 21 - Geological setting of the Project .................................................................76
Figure 22 - An image taken from the marble ridge overlooking the proposed Project area, with a view of the Erongo mountains ................................................................................77
Figure 23 - Road and rail infrastructure ........................................................................79
Figure 24 - Baseline conditions for intersection hourly traffic volumes ...........................80
Figure 25 - An infographic showing the Erongo Region demographic profile (Source Wessels, May 2020) ..................................................................................................................83
Figure 26 - An infographic showing infrastructure and services (Source Wessels, May 2020) ........................................................................................................................................85
Figure 27 - An infographic showing the health profile (Source Wessels, May 2020) ........86
Figure 28 - An infographic showing the employment profile (Source Wessels, May 2020) 88
Figure 29 - An infographic showing the crime profile (Source Wessels, May 2020) .........89
Figure 30 - An infographic showing the local economic profile (Source Wessels, May 2020) 90
Figure 31 - A map showing the location of archaeological sites .....................................91
Figure 32 - A photo of the 19th Century German buildings on the Okawayo farm ..........91
Figure 33 - Baseline noise survey and sensitive receptors .............................................93
Figure 34 - A graph showing daytime broadband survey results ....................................95
Figure 35 - A graph showing night-time broadband survey results ...............................96
Figure 36 - Viewshed model from the centre of WRD 1 ................................................98
Figure 37 - Viewshed model from the centre of WRD 2 ...............................................99
Figure 38 - Viewshed model from WRD 3 ..................................................................100
Figure 39 - Viewshed model from WRD 4 ..................................................................101
Figure 40 - Combined viewsheds from all waste rock and tailings facilities ...............102
Figure 41 - Wind roses for the period 23 July 2020 – 22 July 2021 from data gathered from the on-site weather station .................................................................104
Figure 42 - Dustfall monitoring locations and results .....................................................112
Figure 43 - pH values for waste rock and ore (Source ECC:RGS, 2021) ....................116
Figure 44 - EC values for waste rock and ore (Source ECC:RGS, 2021) .....................117
Figure 45 - Total sulfur concentrations for waste rock and ore (Source ECC:RGS, 2021) ...117
Figure 46 - Surface water flow showing ephemeral rivers and the Project area (source KP, 2021) ................................................................................................................................119
Twin Hills Gold Project – ESIA Scoping Report
Osino Gold Exploration and Mining (Pty) Ltd.

Figure 47 – Okawayo River catchment area (source KP, 2021) ............................................. 121
Figure 48 – Stormwater attenuation dam and diversion spillway (Option 1) (source KP, 2021) ................................................................. 123
Figure 49 – Cross-sections of the stormwater attenuation dam and diversion (source KP, 2021) ................................................................. 124
Figure 50 – The stormwater attenuation weir (Option 2) and diversion (source KP, 2021) ................... 125
Figure 51 – Cross-sections of the stormwater attenuation weir and diversion (source KP, 2021) .................. 126
Figure 52 – Proposed dam constructions by SLR (2020) for surface water supply (source KP, 2021) ................................................................. 128
Figure 53 – Classification of aquifers and hydrocensus results (SLR, 2020) ................................. 130
Figure 54 – Groundwater boreholes showing hourly yields (KP, 2021) ........................................ 132
Figure 55 – An image showing the vegetation on the marble ridge (Cunningham, 2021) ...................... 135
Figure 56 – An image showing vegetation within an ephemeral riverbed (Cunningham, 2021) ...................... 135
Figure 57 – An image of a pan with large trees creating a habitat for unique vertebrate species (Cunningham, 2021) ................................................................. 136
Figure 58 – Photos from the field biodiversity survey (Cunningham, 2021) ...................................... 137
Figure 59 – ECC ESIA methodology based on IFC standards ......................................................... 141
Figure 60 – ECC ESIA methodology based on IFC standards ......................................................... 142

APPENDICES

Appendix A – Draft Environmental Management Plan ................................................................. 152
Appendix B – Public Consultation Records ................................................................................ 153
Appendix C – Noise Baseline Assessment .................................................................................... 154
Appendix D – Air Quality Baseline Assessment ........................................................................... 155
Appendix E – Water Baseline Studies ......................................................................................... 156
Appendix F – Biodiversity Studies ............................................................................................... 157
Appendix G – Archaeological Baseline ....................................................................................... 158
Appendix H – Traffic Impact Studies ......................................................................................... 159
Appendix I – Socioeconomic Impact Assessment ......................................................................... 160
### TERMS AND ABBREVIATIONS

<table>
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<td>percentage sulphur</td>
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<td>particulate matter with an aerodynamic diameter of less than 2.5μm (thoracic particles)</td>
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<tr>
<td>Reg</td>
<td>registration</td>
</tr>
<tr>
<td>RGS</td>
<td>RGS Mine Waste and Management Consultants</td>
</tr>
<tr>
<td>ROM</td>
<td>run of mine</td>
</tr>
<tr>
<td>SAR</td>
<td>sodium absorption ratio</td>
</tr>
<tr>
<td>SGS</td>
<td>mining consultancy</td>
</tr>
<tr>
<td>SLR</td>
<td>SLR Global Environmental Solutions</td>
</tr>
<tr>
<td>SO2</td>
<td>sulphur dioxide</td>
</tr>
<tr>
<td>STRM</td>
<td>shuttle radar topography mission</td>
</tr>
<tr>
<td>t</td>
<td>tonnes</td>
</tr>
<tr>
<td>TB</td>
<td>tuberculosis</td>
</tr>
<tr>
<td>ToR</td>
<td>terms of reference</td>
</tr>
<tr>
<td>TSF</td>
<td>tailings storage facility</td>
</tr>
<tr>
<td>TSP</td>
<td>total suspended particulates</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>US EPA</td>
<td>United States Environmental Protection Agency</td>
</tr>
<tr>
<td>USGS</td>
<td>United States geological survey</td>
</tr>
<tr>
<td>V</td>
<td>vulnerable</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
</tr>
<tr>
<td>WRD</td>
<td>waste rock dump</td>
</tr>
<tr>
<td>Zn</td>
<td>zinc</td>
</tr>
<tr>
<td>μS/cm</td>
<td>microsieverts per cm</td>
</tr>
</tbody>
</table>
1 INTRODUCTION

1.1 COMPANY BACKGROUND

Environmental Compliance Consultancy (ECC) has been contracted to conduct an ESIA by Osino Gold Exploration and Mining (Pty) Ltd. (OGEM), a Namibian company and subsidiary of Osino Resources Corp. Osino Resources Corp. manages operations in Namibia through its wholly owned subsidiary, Osino Namibia Holdings (Pty) Ltd., the parent company of OGEM. ECC is conducting an ESIA for the proposed mining of precious metals on Mining Licence 238 (ML 238), located near the town of Karibib, Erongo Region, Namibia, see Figure 2.

The Proponent has focused on the acquisition and development of potential gold projects in Namibia through extensive exploration programmes. The advanced and successful exploration programme near Karibib has resulted in the development of the Twin Hills Gold Project, or Project. The proposed Project will be a conventional open pit mine with a gold extraction process similar to existing gold mines in Namibia, for example the Otjikoto and Navachab mines.
Figure 2 – Project location and regions
1.2 Purpose of the Scoping Report

An environmental and social impact assessment (ESIA) has commenced in compliance with the Namibian Environmental Management Act, 2007 and its regulations. This report presents the findings of the scoping study phase that forms part of the larger ESIA process. In addition to describing the prescribed ESIA process, the report describes the baseline biophysical and socioeconomic environments, provides a project description, outlines the terms of reference for the assessment phase, and presents a preliminary environmental management plan (EMP). The scope of the assessment was determined through undertaking a preliminary assessment of the proposed Project against the receiving environment, obtained through a desktop review, available site-specific literature, monitoring data, and site reports.

The scoping report and appendices will be submitted to the public for review and input on the impacts and the related ESIA terms of reference. The revised scoping report with public input is submitted to the Ministry of Mines and Energy (MME) as the competent authority for the Project, after which it will be submitted to the Ministry of Environment, Forestry and Tourism (MEFT) - Directorate of Environmental Affairs (DEA) for a record of decision.

Chapter 1 of the report is an introduction to the proposed project and ESIA. Chapter 2 provides detail about the ESIA approach, including the roles of the public and specialists. Chapter 3 provides additional detail on the legal environment and requirements. Chapter 4 provides sufficient detail on the project to identify and assess potential impacts. Chapter 5 provides an overview of the screening and scoping results and related baseline information identifying all relevant biophysical and social aspects. Chapter 6 provides an overview of the methodology for identifying and evaluation impacts. Chapter 7 and 8 cover the resultant Terms of Reference for the final assessment and the conclusions, respectively.

1.3 The PropONENT of the Proposed Project

Osino Gold Exploration and Mining (Pty) Ltd. is the PropONENT for the proposed Project. The PropONENT holds the rights to several exclusive prospecting licences (EPLs) located within the central and northern zones of Namibia's Damara gold belt, in proximity to and along strike of the operating Navachab and Otjikoto gold mines.

The PropONENT has a head office in Namibia's capital, Windhoek, and a regional office based in Omaruru. The PropONENT's details are provided in Table 1.

Table 1 – PropONENT's details

<table>
<thead>
<tr>
<th>Company Representative:</th>
<th>Contact Details:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr Heye Daun</td>
<td>Osino Resources (Pty) Ltd.:</td>
</tr>
<tr>
<td>Osino's co-founder with Alan Friedman</td>
<td>PO Box 3489, Windhoek</td>
</tr>
<tr>
<td>President and CEO</td>
<td><a href="mailto:info@osinoresources.com">info@osinoresources.com</a></td>
</tr>
<tr>
<td></td>
<td>+264 (61) 246 533</td>
</tr>
</tbody>
</table>
1.4 ENVIRONMENTAL AND SOCIAL ASSESSMENT PRACTITIONER

Environmental Compliance Consultancy (ECC) (Reg. No. CC 2013/11401) has prepared this scoping report and the preliminary EMP on behalf of the Proponent.

This report has been authored by employees of ECC, who have no material interest in the outcome of this report, nor do any of the ECC team have any interest that could be reasonably regarded as being capable of affecting their independence in the preparation of this report. ECC is independent from the Proponent and has no vested or financial interest in the Project, except for fair remuneration for professional fees rendered which are based upon agreed commercial rates. Payment of these fees is in no way contingent on the results of this report or the assessment, or a record of decision issued by Government. No member or employee of ECC is, or is intending to be, a director, officer, or any other direct employee of Osino. No member or employee of ECC has, or has had, any shareholding in Osino.

All compliance and regulatory requirements regarding this report should be forwarded by email or posted to the following address:

Environmental Compliance Consultancy
PO Box 91193, Klein Windhoek, Namibia
Tel: +264 81 669 7608
Email: info@eccenvironmental.com

1.5 ENVIRONMENTAL REQUIREMENTS

The Environmental Management Act, 2007, and its regulations, stipulates that an environmental clearance certificate is required before undertaking any of the listed activities that are identified in the Act and its regulations. Potential listed activities triggered by the Project are provided in Table 2.
### Table 2 – Activities potentially triggered by the Twin Hills Gold Project

**Source:** Environmental Management Act, 2007, and its regulations

<table>
<thead>
<tr>
<th>LISTED ACTIVITY</th>
<th>AS DEFINED BY THE REGULATIONS OF ACT</th>
<th>RELEVANCE TO THE PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy generation, transmission, and storage activities</td>
<td>The construction of facilities for:</td>
<td>- The Twin Hills Gold Project will need to generate and or transmit electricity for its operations.&lt;br&gt;- It is very likely that the mine will connect to the national power grid supplied by Nampower.&lt;br&gt;- There is a possibility that a renewable energy plant (i.e. solar) will be constructed for the generation of supplementary power.&lt;br&gt;- Power generated will be used to supply the mine operations, and potential surplus could be redirected into the national grid. (Section 4.7.1 Power supply)</td>
</tr>
<tr>
<td></td>
<td>(1a) The generation of electricity.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1b) The transmission and supply of electricity.</td>
<td></td>
</tr>
<tr>
<td>Waste management, treatment, handling, and disposal activities</td>
<td>2.1 The construction of facilities for waste sites, and the treatment and disposal of waste.</td>
<td>- The Project will require waste sites for the disposal of mineralised and non-mineralised waste. Hazardous waste may be generated by the operation.&lt;br&gt;- Facilities for the disposal of waste will need to be constructed.&lt;br&gt;- In terms of the Atmospheric Pollution Prevention Ordinance Act, the bulk storage and handling of mineralised or metallic ore on waste dumps designed to hold 100 000 metric tonnes or more, is defined as a scheduled process. (Section 4.8 Mineral and non-mineralised waste)</td>
</tr>
<tr>
<td></td>
<td>2.2 Any activity entailing a scheduled process referred to in the Atmospheric Pollution Prevention Ordinance Act, 1976.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.3 The importing, processing, use and recycling, temporary storage, transit, or exporting, of waste.</td>
<td></td>
</tr>
</tbody>
</table>
| Mining and quarrying activities | 3.1 The construction of facilities for any process or activities that require a license, right or other form of authorisation, and the renewal of a licence, right or other form of authorisation, in terms of the Minerals (Prospecting and Mining) Act, 1992.  
3.2 Other forms of mining or extraction of any natural resources, whether regulated by law or not.  
3.3 Resource extraction, manipulation, conservation, and related activities. | - This listed activity infers the provisions of the Minerals (Prospecting and Mining) Act 33 of 1992. The very nature of the Project is mining, which therefore triggers this listed activity.  
(Section 4.6 Mining infrastructure and services) |
| Forestry activities | 4. The clearance of forest areas, deforestation, afforestation, timber harvesting, or any other related activity that requires authorisation in terms of the Forest Act, 2001 (No. 12 of 2001) or any other law. | - Vegetation clearing will be required for site construction and infrastructure establishment.  
- During operations, vegetation clearing will be required as the Project develops.  
(Sections 4.9.1 Mine layout and 5.15 Biodiversity) |
| Water resource developments | 8.1 The abstraction of ground or surface water for industrial or commercial purposes.  
8.2 The abstraction of groundwater at a volume exceeding the threshold authorised in terms of the law relating to water resources.  
8.4 Construction of canals and channels, including the diversion of the normal flow of water in a riverbed, and water transfer schemes between water catchments and impoundments.  
8.5 Construction of dams, reservoirs, levees, and weirs. | - Ground and surface water may be abstracted to support the operation.  
- The sourced groundwater may likely exceed the threshold authorised in terms of the Water Act, and therefore permits for abstraction must be sourced.  
- The mining area is within a catchment area, and an ephemeral river runs through a section of the planned open-pit.  
- A dam may be constructed to provide water for the process plant. |
| 8.6 Construction of industrial and domestic wastewater treatment plants and related pipeline systems. 8.8 Construction and other activities in watercourses within flood lines. 8.9 Construction and other activities within a catchment area. | - Pipeline systems will be used to transport water or slurry within the site. (Sections 4.7.2 Water supply; 4.9 Alternatives considered and 5.14.1.2 Mine water supply and preliminary studies). |

| Hazardous substance treatment, handling, and storage | 9.1 The manufacturing, storage, handling, or processing of hazardous substance defined in the Hazardous Substances Ordinance, 1974. 9.2 Any process or activity that requires a permit, licence, or other form of authorisation, or the modification of, or changes to, existing facilities for any process or activity that requires amendment of an existing permit, licence or authorisation, or which requires a new permit, licence or authorisation in terms of governing the generation or release of emissions, pollution, effluent, or waste. 9.4 The storage and handling of dangerous goods, including petrol, diesel, liquid petroleum, gas, or paraffin, in containers with the combined capacity of more than 30 cubic meters at one location. 9.5 Construction of filling stations or any other facility for the underground and above ground storage of dangerous goods, including petrol, diesel, liquid, petroleum, gas, or paraffin. | - The mining operations and proposed process plant triggers this activity, as both fuel and hazardous substances are required for mining and processing. - Bulk fuel may be required for onsite generation of electricity, and for refuelling the mining fleet. - Consumer installation certificates are required for bulk fuel storage and dispensing. - Hazardous reagents will be used within the gold extraction and processing plant. |
| Infrastructure | 10.1 The construction of: (b) public roads. (j) masts of any material or type, and of any height, including those used for telecommunication broadcasting and radio transmission. | - Powerlines and telemetry for water and tailings pumping will be required. - Radio and telecommunication towers will be required for the site. - Diversion of gravel road D1941. |
2 APPROACH TO THE ASSESSMENT

2.1 PURPOSE AND SCOPE OF THE ASSESSMENT

The aim of this assessment is to determine which impacts are likely to be significant; to scope the available data and identify any gaps that need to be filled; to determine the spatial and temporal scope; and to identify the assessment methodology.

2.2 THE ASSESSMENT PROCESS

The ESIA methodology applied to this assessment has been developed using the International Finance Corporation (IFC) standards and models, in particular Performance Standard 1: ‘Assessment and management of environmental and social risks and impacts’ (International Finance Corporation, 2012 and 2017); Namibian Draft Procedures and Guidance for EIA and EMP (Republic of Namibia, 2008); international and national best practice guidelines; and ECC’s combined relevant ESIA experience.

Furthermore, this assessment was undertaken for the Proponent in accordance with Namibian legal requirements.

This assessment is a formal process. The potential effects that the Project will have on the biophysical, social, and economic environments are identified, assessed, and reported so that the significance of potential impacts can be taken into account when considering a record of decision for the proposed Project.

Final mitigation measures and recommendations are based on the cumulative experience of the consulting team and the client, taking into consideration the potential environmental and social impacts. The process followed, through the assessment, is illustrated in Figure 3, and is detailed further in the following sections.
2. Establishing the assessment scope

Where an ESIA is required, the second stage is to scope the assessment. The main aim of this stage is to determine which impacts are likely to be significant; to scope the available data and any gaps that need to be filled; to determine the spatial and temporal scope; and to identify the assessment methodology.

The scope of this assessment was determined through undertaking a preliminary assessment of the proposed Project against the receiving environment. Feedback from consultation with the public and the Proponent informs this process. The following environmental and social topics were scoped into the assessment, as there was the potential for significant impacts to occur. Impacts that are identified as potentially significant during the screening and scoping phase are taken forward for further assessment in the ESIA process. These are:

SOCIOECONOMIC ENVIRONMENT
- Employment
- Local businesses
- Visual impacts on sense of place

BIOPHYSICAL ENVIRONMENT
- Noise and air quality, including dust emissions
- Surface and ground water
- Heritage and culture
- Biodiversity
- Road traffic
- Soils and
- Mine waste characterisation

The following topics were scoped out of the ESIA, and they are therefore not discussed further in this report.
- An assessment of safety impacts or risks associated with developing the mine are not included within the scope of this assessment, and will be addressed by the Proponent in a site-specific safety management plan.
### 4. Impact identification and evaluation

**Future Stage**

The key stage of the ESIA process is the impact identification and evaluation stage. This stage is the process of bringing together project characteristics with the baseline environmental characteristics, and ensuring that all potentially significant environmental and social impacts are identified and assessed. It is an iterative process that commences at project inception, and ends with the final design and project implementation. The impact identification and evaluation stages will be updated in the assessment phase.

The final design of the proposed Project will be assessed, along with alternatives that were considered during the design process in accordance with the Environmental Management Act, 2007. Section 6 in this report sets out the assessment methodology to be used to assess the Project against the environmental and social baselines that would be affected.

### 5. Draft scoping report and EMP

**In Progress**

The scoping report documents the findings of the current process and provides stakeholders with an opportunity to comment and continue the consultation that forms part of the environmental assessment. The EMP provides measures to manage the environmental and social impacts of the proposed Project, and outlines the specific roles and responsibilities required in order to fulfil the plan.

This scoping report focuses on describing the ESIA process, project description, baseline description, and Terms of Reference for the assessment phase.

This report will be issued to stakeholders and I&APs for consultation, for a period of 7 days, meeting the mandatory requirement as set out in the Environmental Management Act, 2007. The aim of this stage is to ensure that all stakeholders and I&APs have an opportunity to provide comments on the assessment process, and to register their concerns, if any.

### 6. Final EIA and EMP

**Future Stage**

All comments received during the I&AP public review period will be collated in an addendum report, which will accompany this scoping report when submitted to the MEFT: DEA. All comments will be responded to, either through providing an explanation or further information in the response table, or by signposting where information exists, or where new information has been included in the ESIA report or appendices. Comments will be considered, and where they are deemed to be material to the decision-making, or might enhance the ESIA, they will be incorporated.

The final ESIA report, appendices, and the addendum report, will be available to all stakeholders, and all I&APs will be informed of its availability for statutory review period of 21 days.

The ESIA report, appendices and addendum will be formally submitted to the competent authority (MMED) and the MEFT: DEA as part of the application for an environmental clearance certificate.

### 8. Monitoring and auditing

**Future Phase**

In addition to the EMP being implemented by the Proponent, a monitoring strategy and audit procedure will be determined by the Proponent and competent authority. This will ensure key environmental receptors are monitored over time to establish any significant changes from the baseline environmental conditions, caused by Project activities.

### 7. Authority assessment and decision

**Future Stage**

The Environmental Commissioner, in consultation with other relevant authorities, will assess if the findings of the ESIA presented in the report are acceptable. If deemed acceptable, the Environmental Commissioner will revert to the Proponent with a record of decision and recommendations.

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Figure 3 – ESIA process and stages complete
2.3 STUDY AREA

This EIA study area has been defined according to the geographic scope of the receiving environment and potential impacts that could arise because of the proposed Project within that area. The receiving environment is a summary term for the biophysical and socioeconomic environment that is described in the baseline chapter. The study area is presented in Figure 4. The study area extends beyond the mining licence boundary and includes the nearby receptors such as farmsteads and Karibib town.

Figure 4 – ESIA study area, infrastructure, and surrounds
2.4 PUBLIC CONSULTATION

Public participation and consultation are a requirement stipulated in Section 21 of the Environmental Management Act, 2007 and its regulations, for a project that requires an environmental clearance certificate. Consultation is a compulsory and critical component of the ESIA process for achieving transparent decision-making and can provide many benefits. Consultation is ongoing during the ESIA process. The objectives of the public participation and consultation process are to:

- Provide information on the Project, and introduce the overall Project concept and plan in the form of a background information document (BID) (Appendix B)
- Determine the relevant government, regional and local regulating authorities
- Listen to and understand community issues, record concerns, and questions
- Explain the process of the ESIA and timeframes involved
- Establish a platform for ongoing consultation

2.4.1 IDENTIFICATION OF KEY STAKEHOLDERS AND INTERESTED OR AFFECTED PARTIES

A stakeholder mapping exercise see Figure 5, was undertaken to identify individual or groups of stakeholders, and the method in which they will be engaged during the ESIA process. Stakeholders were approached through direct communication (letters and phone calls), the national press, site notices, or directly by email. The list of stakeholders is included in Appendix B. A summarised list of stakeholders that were engaged during the public consultation process is given below:

- Directly and indirectly affected landholders
- The general public with an interest in the Project
- Ministry of Environment, Forestry and Tourism (MEFT)
- Ministry of Agriculture, Water and Land Reform (MAWLR)
- Ministry of Mines and Energy (MME)
- National Heritage Council (NHC)
- Ministry of Works and Transport (MWT) and the Roads Authority
- Erongo Regional Council
- Karibib and Omaruru Town Councils
- Town residents and business owners
- NamWater and NamPower
- Cellular network providers
- Quarry and mineral claims holders adjacent to the Project
- Khan River water users downstream of the Project
- Namibian Air Force, Karibib Air Base, and the Civil Aviation Authority

Appendix B provides a list of interested and affected parties, evidence of consultation, including notices of advertisements in national newspapers, minutes of public meetings, and a summary of the comments or questions raised by the public. A summary of the key concerns raised during the consultation process is provided in section 2.4.2.
Figure 5 – Neighbouring farms to the mining licence area
2.4.2 SUMMARY OF ISSUES RAISED

During the compilation of this scoping report, several stakeholders were engaged for input and feedback into potential issues or concerns regarding the proposed Project. Overall, the proposed Project received significant positive feedback, and was well received by the public. The records of the consultation meetings are provided in Appendix B of this scoping report.

The matters raised at the public meetings and via email could be considered typical concerns for this scale of Project, and these are summarised as follows:

- Heritage impacts
- Power and water supply
- Waste management
- Waste resource management
- Visual impacts
- Biodiversity impacts
- Socioeconomic and social impacts, such as job creation, staff housing and accommodation, and the lack of amenities in Karibib
- Potential pollution impacts
- Mine closure

To ensure that interested and affected parties can comment and provide feedback on the scoping report, the completed scoping report will be circulated to all neighbouring landholders, potentially interested and or affected parties, and stakeholders of the Project for a 7-day review period. Should stakeholders have comments or questions, or matters they feel require further consideration for the assessment phase, ECC will address these in the assessment phase.
3 REVIEW OF THE LEGAL ENVIRONMENT

This chapter outlines the regulatory framework applicable to the proposed Project. As stated in Section 1, an environmental clearance is required for any activity listed in the Government Notice No. 29 of 2012 of the EMA. The Proponent holds several current and valid environmental clearance certificates for the exploration phase of the Project.

The Project area is located outside of any national parks, heritage listed areas, or areas of significance. The Project area is not located within a groundwater-controlled area, as regulated under the Water Management Act of 1956.

A thorough review of relevant legislation has been conducted for the proposed Project. Table 3 below identifies relevant legal requirements specific to the Project. Table 4 provides the national policies and plan and Table 5 lists specific permits for the Project.
### 3.1 National Regulatory Framework

**Table 3 – Details of the regulatory framework as it applied to the Twin Hills Gold Project**

<table>
<thead>
<tr>
<th>NATIONAL REGULATORY FRAMEWORK</th>
<th>SUMMARY</th>
<th>APPLICABILITY TO THE PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constitution of the Republic of Namibia (1990)</td>
<td>The constitution defines the country’s position in relation to sustainable development and environmental management. The constitution refers that the state shall actively promote and maintain the welfare of the people by adopting policies aimed at the following: “Maintenance of ecosystems, essential ecological processes and biological diversity of Namibia, and the utilisation of living, natural resources on a sustainable basis for the benefit of all Namibians, both present, and future.”</td>
<td>The Twin Hills Gold Project is committed to the sustainable use of the environment, and has aligned its corporate mission, vision, and objectives within the ambit of the Constitution of the Republic of Namibia (1990).</td>
</tr>
<tr>
<td>Minerals (Prospecting and Mining) Act No. 33 of 1992</td>
<td>The Act provides for the granting of various licences related to mining and exploration. Section 50 (i) requires: “An environmental impact assessment indicating the extent of any pollution of the environment before any prospecting operations or mining operations are being carried out, and an estimate of any pollution, if any, likely to be caused by such prospecting operations or mining operations.”</td>
<td>The proposed mining activity requires an EIA to be carried out, as it triggers listed activities in the Environmental Management Act’s regulations. Mining activities shall not commence until all conditions in the Act are met, which includes an agreement with the landowners and conditions of compensation, if applicable.</td>
</tr>
<tr>
<td>NATIONAL REGULATORY FRAMEWORK</td>
<td>SUMMARY</td>
<td>APPLICABILITY TO THE PROJECT</td>
</tr>
<tr>
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<tr>
<td></td>
<td>The Act sets out the requirements associated with licence terms and conditions, such that the holder of a mineral licence shall comply with.</td>
<td>The Project shall be compliant with Section 76 of the Act with regard to records, maps, plans and financial statements, information, reports, and returns submitted.</td>
</tr>
<tr>
<td></td>
<td>The Act also contains relevant provisions for pollution control related to mining activities and land access agreements and provides provisions that mineral licence holders are liable for any damage to land, water, plant, or animal life, caused by spilling or pollution, and must take all such steps as may be necessary to remedy such spilling, pollution, loss, or damage, at its own costs.</td>
<td>As the Proponent may need to access privately owned land, the Proponent will ensure Sections 50 and 52 are complied with.</td>
</tr>
<tr>
<td>Environmental Management Act, 2007 (Act No. 7 of 2007) and its regulations, including the Environmental Impact Assessment Regulation, 2007 (No. 30 of 2011)</td>
<td>The Act aims to promote sustainable management of the environment and use of natural resources. The Act requires certain activities to obtain an environmental clearance certificate prior to Project development.</td>
<td>This environmental scoping report documents the findings of the scoping phase of the environmental assessment undertaken for the proposed Project.</td>
</tr>
<tr>
<td></td>
<td>The Act states that an EIA should be undertaken and submitted as part of the environmental clearance certificate application process.</td>
<td>The process has been undertaken in line with the requirements under the Act and its regulations.</td>
</tr>
<tr>
<td></td>
<td>The MEFT is responsible for the protection and management of Namibia's natural environment. The Department of Environmental Affairs, under the MEFT, is responsible for the administration of the EIA process.</td>
<td></td>
</tr>
</tbody>
</table>
### National Regulatory Framework

<table>
<thead>
<tr>
<th>regulations have not been passed – therefore the Water Act of 1956 remains the current piece of legislation relating to water management in Namibia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>This Act provides for the control, conservation and use of water for domestic, agricultural, urban, and industrial purposes; and to make provision for the control of certain activities on or in water.</td>
</tr>
<tr>
<td>The Department of Water Affairs, within the Ministry of Agriculture, Water and Land Reform (MAWLR), is responsible for the administration of the Act.</td>
</tr>
<tr>
<td>Measures to minimise potential surface and groundwater pollution are contained in the EMP.</td>
</tr>
<tr>
<td>The Project is obliged to have all permits relevant to its operations under this Act.</td>
</tr>
<tr>
<td>Abstraction of water from boreholes requires an abstraction permit to be obtained from the Ministry of Agriculture, Water and Land Reform.</td>
</tr>
<tr>
<td>The diversion of the Okawayo river, the location and placement of mining infrastructure, such as the tailings storage facility, and the location of industrial effluent storage ponds, require consideration in terms of the Water Act. This will be considered in the assessment phase of the ESIA.</td>
</tr>
</tbody>
</table>

#### Soil Conservation Act, No. 76 of 1969

<table>
<thead>
<tr>
<th>This Act makes provision for the prevention and control of soil erosion, and for the protection, improvement, and conservation of soil and vegetation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land clearing is an unavoidable necessity for the proposed Project, as large areas will be cleared for mining infrastructure.</td>
</tr>
<tr>
<td>NATIONAL REGULATORY FRAMEWORK</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>The Forestry Act, No. 12 of 2001 as amended by the Forest Amendment Act, No. 13 of 2005</td>
</tr>
<tr>
<td>National Heritage Act, No. 27 of 2004.</td>
</tr>
<tr>
<td>NATIONAL REGULATORY FRAMEWORK</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>Labour Act, No. 11 of 2007</td>
</tr>
<tr>
<td>Road Traffic and Transport Act, No. 22 of 1999</td>
</tr>
<tr>
<td>Hazardous Substances Ordinance, No. 14 of 1974</td>
</tr>
</tbody>
</table>

In cases where heritage sites are discovered, the 'chance find procedure' will be used.

The Project shall adhere to all labour provisions and guidelines, as enshrined in the Labour Act. The Project shall also develop and implement a comprehensive occupational health and safety plan to ensure adequate protection for its personnel throughout the Project lifecycle.

The Project will involve transportation activities in support of mining activities.

The employees and support business shall adhere to national road regulations on public roads. The Proponent will ensure that the diversion of the D1491 road will be conducted in compliance with the Act.

The planned Project will involve the handling and storage of hazardous substances such as fuels, reagents, and industrial chemicals. The Proponent shall ensure safe handling, transfer, storage, and disposal protocols are developed,
<table>
<thead>
<tr>
<th>NATIONAL REGULATORY FRAMEWORK</th>
<th>SUMMARY</th>
<th>APPLICABILITY TO THE PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Aviation Act, No. 6 of 2016</td>
<td>Section 55 of the regulations relates to safety and security protocols near aerodromes.</td>
<td>The Project is located in proximity to the military air base, and as such, the Proponent will ensure that all regulations regarding safety and security near aerodromes is complied with.</td>
</tr>
<tr>
<td>The Atmospheric Pollution Prevention Ordinance, No. 11 of 1976</td>
<td>The Ordinance pertains to the prevention of air pollution, with particular focus on public health, and contains detailed provisions on air pollution matters, including the control of noxious or offensive gases, atmospheric pollution by smoke, dust control, motor vehicle emissions, and other general provisions.</td>
<td>The nature of mining activities generates dust. Activities within the mining operations and processing plant will generate gases, odours, and air pollution. The Proponent will ensure that all measures reasonably practicable will be implemented to reduce and mitigate impacts to air quality, and this will be included in the EMP.</td>
</tr>
</tbody>
</table>
### 3.2 National Policies and Plans

<table>
<thead>
<tr>
<th>Policy or plan</th>
<th>Description</th>
<th>Relevance to the Project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vision 2030</strong></td>
<td>Vision 2030 sets out the nation's development targets and strategies to achieve its national objectives. Vision 2030 states that the overall goal is to improve the quality of life of the Namibian people aligned with the developed world.</td>
<td>The proposed Project shall aim to meet the objectives of Vision 2030 and shall contribute to the overall development of the country through continued employment opportunities and ongoing contributions to the gross domestic product (GDP).</td>
</tr>
<tr>
<td><strong>Fifth National Development Plan (NDP5)</strong></td>
<td>The NDP5 is the fifth in a series of seven five-year national development plans that outline the objectives and aspiration of Namibia's long-term vision. The NDP5 pillars are economic progression, social transformation, environmental sustainability, and good governance.</td>
<td>The planned Project supports meeting the objectives of the NDP5 through creating opportunities for continued employment.</td>
</tr>
<tr>
<td><strong>The Harambee Prosperity Plan ii (2021 – 2025)</strong></td>
<td>Second Pillar: Economic advancement – ensuring increasing productivity of priority key sectors (including mining) and the development of additional engines of growth, such as new employment opportunities.</td>
<td>The Project will contribute to the continued advancement of the mining industry and create an additional employment generation engine within the regional and national landscape.</td>
</tr>
<tr>
<td><strong>Minerals Policy</strong></td>
<td>The Minerals Policy was adopted in 2002 and sets guiding principles and direction for the development of the Namibian mining sector, while communicating the values of the Namibian people.</td>
<td>The planned Project conforms to the Policy, which has been considered through the ESIA process and the production of this report. The Proponent intends to continue to support local spending and procurement.</td>
</tr>
</tbody>
</table>
The policy strives to create an enabling environment for local and foreign investments in the mining sector and seeks to maximise the benefits for the Namibian people from the mining sector, while encouraging local participation.

The objectives of the Minerals Policy are in line with the objectives of the Fifth National Development Plan that include reduction of poverty, employment creation, and economic empowerment in Namibia.

The Project will comply with the general guidelines of the Policy through the adoption of various legal mechanisms to manage all aspects of the environment effectively and sustainably from the start. The ESIA is one such mechanism to ensure environmental integrity throughout the planned Project’s lifecycle.

<table>
<thead>
<tr>
<th>Permit or licence</th>
<th>Act / Regulation</th>
<th>Related activities requiring permits</th>
<th>Relevant Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental clearance certificate</td>
<td>Environmental Management Act, No. 7 of 2007</td>
<td>Required for all listed activities shown in Table 2.</td>
<td>Ministry of Environment, Forestry and Tourism (MEFT)</td>
</tr>
<tr>
<td>Mining licence</td>
<td>Section 90 (2) (A) of the Minerals Act, No. 33 of 1992</td>
<td>Written permission from the mining commissioner.</td>
<td>Ministry of Mines and Energy (MME)</td>
</tr>
<tr>
<td>Surface rights agreements (mine, infrastructure corridors)</td>
<td>Section 52(1)(A) of the Minerals Act, No. 33 of 1992</td>
<td>Included in the mining license application. Also required in the permit application for accessory works areas.</td>
<td>Ministry of Mines and Energy (MME)</td>
</tr>
<tr>
<td>Exclusive prospecting licences</td>
<td>Section 68 (2) (A) of the Minerals Act, No. 33 of 1992</td>
<td>Written permission from the mining commissioner before prospecting can commence.</td>
<td>Ministry of Mines and Energy (MME)</td>
</tr>
<tr>
<td>Accessory work permit</td>
<td>Section 90(3) of the Minerals Act, No. 33 of 1992</td>
<td>Written permission from the mining commissioner before accessory works can commence.</td>
<td>Ministry of Mines and Energy (MME)</td>
</tr>
<tr>
<td>Permit or licence</td>
<td>Act / Regulation</td>
<td>Related activities requiring permits</td>
<td>Relevant Authority</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Permit for boreholes (exploration and water boreholes)</td>
<td>A permit is issued under the Water Act, No. 54 Of 1956 (enforced)</td>
<td>Required before the drilling of boreholes for exploration and the abstraction of water.</td>
<td>Ministry of Agriculture, Water and Land Reform (MAWLR)</td>
</tr>
<tr>
<td>Tailings waste disposal permit</td>
<td>A permit is issued under the Water Act, No. 54 of 1956 (enforced)</td>
<td>Required for the disposal of tailings.</td>
<td>Ministry of Agriculture, Water and Land Reform (MAWLR)</td>
</tr>
<tr>
<td>Wastewater discharge permit</td>
<td>A permit is issued under the Water Act, No. 54 Of 1956 (enforced) but form types that fall under the Water Act, No. 24 of 2004 are used.</td>
<td>Required for discharge of sewage and/or excess industrial or mine wastewater.</td>
<td>Ministry of Agriculture, Water and Land Reform (MAWLR)</td>
</tr>
<tr>
<td>Permit for construction of river diversion</td>
<td>A permit is issued under the Water Act, No. 54 Of 1956 (enforced) and The Water Resources Management Act, No. 11 of 2013 (not enacted).</td>
<td>Construction of canals and channels, including the diversion of the normal flow of water in a riverbed, and water transfer schemes between water catchments and impoundments.</td>
<td>Ministry of Agriculture, Water and Land Reform (MAWLR)</td>
</tr>
<tr>
<td>Permit for the clearing of land</td>
<td>The Forest Act, 2001 (Act No. 12 of 2001)</td>
<td>This Act governs the removal of vegetation within 100 m of a water course, or removal of more than 15ha of woody vegetation, or the removal of any protected plant species.</td>
<td>Ministry of Agriculture, Water and Land Reform (MAWLR)</td>
</tr>
<tr>
<td>Permit for the destruction of heritage objects and artefacts</td>
<td>The Heritage Act, No. 27 of 2004.</td>
<td>This Act relates to interference with heritage artefacts during the Project life. Heritage sites could potentially be located within the proposed mining licence</td>
<td>National Heritage Council (NHC)</td>
</tr>
<tr>
<td>Permit or licence</td>
<td>Act / Regulation</td>
<td>Related activities requiring permits</td>
<td>Relevant Authority</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Consumer installation certificate for bulk fuel storage</td>
<td>Petroleum Products Regulations</td>
<td>A consumer installation certificate is required for bulk fuel storage and dispensing.</td>
<td>Ministry of Mines and Energy (MME)</td>
</tr>
<tr>
<td>Licence for explosives magazine</td>
<td>Minerals (Prospecting and Mining) Act, No. 33 of 1992; Mine Safety Regulations</td>
<td>This is also covered under the accessory works application.</td>
<td>Ministry of Mines and Energy (MME)</td>
</tr>
<tr>
<td>Permit for the storage and use of explosives, and the burning of packaging</td>
<td>Minerals (Prospecting and Mining) Act, No. 33 of 1992; Mine Safety Regulations</td>
<td>Part x (10), explosives and blasting.</td>
<td>Ministry of Mines and Energy (MME)</td>
</tr>
<tr>
<td>Emissions stack(s) and towers</td>
<td>Civil Aviation Act, No. 6 of 2016</td>
<td>Section 55 of the regulations relates to safety and security protocols near aerodromes.</td>
<td>Civil Aviation Authority</td>
</tr>
<tr>
<td>Aviation</td>
<td>Civil Aviation Act, No. 6 of 2016; Section 90(3) of the Minerals Act, No. 33 of 1992</td>
<td>This is also covered under the accessory works application.</td>
<td>Civil Aviation Authority</td>
</tr>
</tbody>
</table>
4 PROJECT DESCRIPTION

4.1 NEED FOR THE PROJECT

New mining activities could contribute to the national and local economies and may have a positive impact on the country's economy. Namibia's economy depends largely on mining. Should the Twin Hills Gold Project prove economically viable, the Namibian economy can expect benefits from revenues during the construction phase, royalties and taxes during the life of mine (LoM), and a positive contribution towards employment. Based on current mine plans, between 1000 and 1500 people will be employed during construction, and approximately 450 for the operational phase, providing jobs and livelihoods for them, and their families, for a minimum of 16.5 years.

4.2 EMPLOYMENT

The labour requirement for a typical gold mine the size and scale of the proposed project is expected to be approximately 1000 people during the construction phase, and approximately 750 – 850 during the operational phase. During operations it is expected that the split for the labour requirement will be; processing plant approximately 120 people, administration and management 235, mining approximately 450 people. A detailed labour plan covering all components of the operation will be developed as the project evolves. The labour compliment for the mining component at this stage comprises of the following:

- Management team
- Mine technical service team
- Mine support services team
- Production crew – drill and blast
- Production crew – load and haul
- Mine maintenance crew

The labour requirement for mining operations over the LoM ranges from 268 to 416 people at maximum production and is illustrated in Figure 6 (Source Qubeka, 2021).

![Mining Labour Requirements](image)

**Figure 6 - A generalised graph showing employment levels of operations over the life of mine (Source Qubeka, 2021)**
4.3 BACKGROUND OF THE PROJECT AND EXPLORATION HISTORY

The Twin Hills Gold Project is located in central Namibia near the regional towns and settlements of Karibib, Omaruru, Wilhelmstal, and Usakos in the Erongo Region of Namibia (see Figure 7).

Figure 7 - Project location in proximity to towns and roads.
Osino, through various locally held and majority-owned subsidiaries, holds 16 EPLs in central Namibia. The EPLs relevant to the Twin Hills Gold Project and the mining licence area are shown in Figure 8.
Parts of the Project area were explored historically by Anglo American and Bafex Exploration as of 2008, prior to Osino. Osino has actively and systematically explored the Project area since 2016, using a variety of exploration methodologies, including, but not limited to, geochemical surveys, soil sampling, limited trenching, and drilling (RAB, RC and diamond drilling) techniques. (CSA Global, 2021).

Osino has used government regional aeromagnetic data, and carried out a detailed ground magnetic survey, as part of the exploration programme to define the Project and numerous other targets along the Karibib fault zone and related structures.

The mineral resource estimated for the Twin Hills Gold Project includes three sub-areas, namely Bulge, Twin Hills Central, and Clouds. The mineral resource has an economically viable cut-off grade of 0.3 g/t Au (gold), as demonstrated in the company’s published PEA.

The Proponent has rapidly advanced the technical viability of the proposed Project through accelerated exploration drilling and fast-tracked development studies. The Proponent has drilled more than 85,000 drill meters with assays from the drilling that were used to support the maiden mineral resource, effective 1 April 2021.

4.4 GEOLOGY AND MINERALISATION

The Proponent has completed numerous in-depth studies in relation to the geology and mineralisation of the Twin Hills Gold Project. The CSA Global NI 43-101 Technical Report dated 21 May 2021 describes the geology and mineralisation in depth. Those descriptions are summarised in this section to provide a concise technical overview of the geology and mineralisation of the Twin Hills Gold Project. For more fulsome and technical descriptions, please find the CSA Global NI 43-101 Technical Report, 2021 on the Osino website, or as filed on SEDAR under the company’s profile at www.sedar.com.

The Project is located in an area of known gold deposits hosted within the inland arm of the Pan-African Neoproterozoic Damara Belt, a northeast-striking Neoproterozoic fold, thrust, and metamorphic belt. It reflects a Neoproterozoic rifting-accretionary event between the Congo Craton to the north and the Kalahari Craton to the south. Peak deformation within the Damara Belt occurred between 500Ma and 530Ma.

The Damara Belt comprises a gently folded Northern Zone, a Central Zone, and a Southern Zone. The Central Zone consists predominantly of calcareous and pelitic sediments that were deposited in a back-arc environment. The Southern Zone is considered to represent the suture zone and was intensely deformed, at high pressures and low temperatures, by a series of southeast verging thrusts. A range of syntectonic and post-tectonic intrusions are present, and these range from mafic to acid (i.e. gabbros to granites). Of these, the early syntectonic to late tectonic I-type Salem granites are the most abundant. These were followed by post-tectonic I-type granites. A much later Jurassic to Cretaceous event led to the emplacement of various alkaline ring complexes and granitic batholiths, as well as flood basalt provinces.
Geologically, the Project lies in the Southern Central Zone of the Damara Belt, lying to the south of a prominent regional scale lineament (the Omaruru lineament) and 20km to 55km east-northeast of the Navachab gold mine. The north-eastern part of the Project area is largely underlain by undifferentiated syntectonic Salem-type granite. The balance of the Project area is underlain by meta-sedimentary rocks of the Swakop Group. This group comprises the Arandis Formation (biotite schist, minor quartz schist calc-silicate rock and amphibolite), the Karibib Formation (dominantly dolomitic and calcitic marbles), and the overlying Kuiseb Formation (schistose, quartz, feldspar, mica, metagreywacke, and metapelite).

The sediments underwent polyphase deformation and metamorphism during the Damara Orogen. The larger, earlier folds have northeast-southwest striking axial planes, parallel to the Omaruru lineament. These were subsequently deformed into open basin and dome structures about fold axes with northwest-southeast orientations. Later crosscutting lineaments are also evident in the area. The Swakop Group sediments were intruded by a series of syntectonic, late-syntectonic, and post-tectonic granite and pegmatite bodies. Both generations of folds are recognised in drill core. Later, during the Damara Orogen, the crustal scale Karibib Fault Zone (KFZ) on the southern margin of the Karibib Basin was reactivated as a dextral fault with associated secondary and tertiary structures.

The structural geology of the Project area is dominated by features typical of the Southern Central Zone of the Damara Belt, namely: basement and/or basal Damara metasedimentary rocks in the cores of dome and anticlinal structures, and regional synclinal structures with thick packages of Kuiseb Formation schists “filling” these synclines.

The geology of the Goldkuppe prospect, 20km northeast of the Twin Hills deposit, is dominated by a series of interbedded marble and dolomite units belonging to the Karibib Formation. The marbles are folded into a first-order overturned anticline, which plunges gently to the northeast and verges towards the northwest. Small, medium and large-scale, tight to isoclinal reclined folds and sheath folds, with steep to sub-vertical fold axes and fold axial planes, dominate the structure in the Goldkuppe target area.

Osino has made a series of gold discoveries along the Karibib Fault Zone, which was originally interpreted from regional magnetic data to have a strike length of over 100km. Osino’s licences cover more than 70km of this strike extent. The Karibib Fault Zone is manifested as a belt of very high strain, intense silicification, and partial remelting. The calcrete covered central portion of the Karibib Fault Zone has been the most prospective to date, and is where the Twin Hills deposit is located. Twin Hills is a cluster of gold mineralised zones associated with schists of the Kuiseb Formation.

Gold mineralisation is closely associated with arsenopyrite and pyrrhotite, and the deposits and occurrences are classified as orogenic. Orogenic gold deposits are generally hosted by volcanic
and turbiditic sequences that have been metamorphosed to greenschist or, less commonly, amphibolite facies. (CSA Global, 2021).

The deposits are generally interpreted to form late in the orogenic cycle from mid- to lower-crustal metamorphic fluids. Gold mineralisation develops syn-kinematically, with at least one stage of major deformation of the country rocks, and they inevitably have a strong structural control involving faults or shear zones, folds, and other areas of competency contrasts. Mineralisation along the Karibib Fault Zone has been located, by Osino, for over 20km of strike to date, with the main target area at Twin Hills being associated with a structural jog along the Karibib Fault Zone. At a deposit scale, mineralisation is associated with shearing in the greywacke/turbidite sequence, parallel to the axial planes of isoclinal folds, and occurs in millimetre-scale veinlets as well as in more disseminated forms.

At Goldkuppe, 3km of mineralised strike has been defined, with mineralisation occurring in several discontinuous plunging shoots located predominantly within a dolomitic marble horizon. Mineralisation is typically associated with secondary fold noses, small-scale saddle reefs, and limb faults, and occurs in association with massive or semi-massive sulphides (chalcopyrite-pyrite and subordinate pyrrhotite). Low-grade mineralisation is also associated with pervasive skarn alteration adjacent to intrusive bodies.¹

Osino used an orogenic gold, mineral systems approach to select and prioritise its regional exploration targets, with the Karibib Fault Zone considered the priority regional structure.

### 4.5 SITE LAYOUT

An optimal site layout is based on designing the site around critical landform features such as topography and sensitive areas, while considering the efficiencies required for the mining operation. The proposed site layout is provided in Figure 9.

Figure 9 - Contour map showing the Project layout
The area surrounding the Twin Hills Central and Clouds open pits has relatively flat topography to the east and west of the Okawayo River course.

Potential waste rock dump (WRD) locations exist in the footwall and hanging wall of both pits, providing a flexible waste rock dumping strategy through the course of the mine life.

A potential plant site location is situated to the north of the Twin Hills Central open pit in an area of flat ground covered by Kalahari sands. The open area designated for the plant site is situated optimally for the transportation of most of the ore tonnes to be mined from the Twin Hills Central open pit.

The tailings storage facility (TSF) will comprise a downstream-type facility, constructed from the waste rock excavated from the open pit. It is envisaged that the tailings facility will accommodate filtered tailings inside the waste rock embankments, with the transportation of tailings undertaken by either haulage or conveyors. A detailed map of the proposed site layout is provided in Figure 10.
Figure 10 – Conceptual site infrastructure layout (Source Lycopodium, 2021)
4.6 MINING INFRASTRUCTURE AND SERVICES

Qubeka Mining Consultants (2021) conducted a mining study as part of the PEA. The following components are taken from their study, namely: orebody description, mining method, mine pit design, mining infrastructure, equipment and utilities, and staffing.

4.6.1 OREBODY

Sulfide-hosted gold mineralisation was interpreted and modelled from a combination of structural and assay data for each of the Twin Hills mineral resource areas (Bulge, Twin Hills Central, and Clouds) as indicated in Figure 11. The mineralisation, hosted in metagreywacke, dips between 60° and 80° and ranges from a few metres to 200m thick.
Figure 11 – Gold mineralisation and pit design (Source Qubeka, 2021)
The degree of stability for slopes in an open pit mine is critically important, in order to minimise the risks related to the safety of operating personnel and equipment, as well as the economic risk to the reserve. Ore recovery must be maximised, and waste stripping kept to a minimum throughout the productive life of the operation. The resulting compromise is typically a balance between formulating designs that can be safely and practically implemented in the operating environment and establishing slope angles that are as steep as possible and consistent with the ore body geometry and rock conditions.

4.6.2 MINING METHOD AND EQUIPMENT

The Twin Hills Gold Project will make use of conventional open pit mining methods, with the ore zone and waste zone being drilled and blasted at 10m benches, and ore material being loaded selectively. Ore and waste will be loaded with hydraulic excavators and hauled by diesel-powered trucks to the primary crusher, ROM pad stockpile, low-grade stockpile, or waste dump. At this stage it is assumed that the whole mining operation, except for the mine technical services function, will be outsourced to a reputable mining contractor company. All other mine technical services that include management, planning and grade control will be the responsibility of the Proponent.

The Project is planned as a multi-pit mining operation with nine pushbacks in the main Twin Hills / Bulge pit design, and one satellite pit, called the Clouds pit, to be mined in different phases throughout the life of mine (LoM). No equipment size trade-offs were performed during the PEA, and it is assumed that a contractor mining model will be deployed with 100-tonne class haul trucks and suitably sized loading equipment. The medium-sized equipment gives increased flexibility and allows better loading selectivity, which will limit dilution. The primary equipment will be supported by an array of secondary and support equipment.

The initial management team will include a globally experienced contingent, to ensure that operation start-up is safe and efficient, and that ramp-up targets are met. An approved localisation plan will be established to train and equip the local workforce sufficiently, to enable and ensure a seamless transition of responsibilities over time. The bulk of the equipment operators are expected to be unskilled (approximately 80%) and will require training from a basic level. The start-up strategy for mining operations takes account of this requirement.

The mine will operate 361 days per annum (allowing for lost days for public holidays and weather delays) on a 24-hour basis with three shifts rotating on an 8-hour duration.

4.6.2.1 Blast operations

Rock fragmentation will be undertaken by drilling and blasting, with the weathered zones requiring blasting with lower powder factors. Blasting will be a core component of the mining operation, impacting all downstream mining and comminution (crushing) processes, and also extending into the plant by way of ore recovery and dilution factors.
Blasting can substantially modify and control material flow within the mining operation, including the feed size to the primary crusher. Blast performance must be assessed in terms of the following outcomes:

- Fragmentation, relating to the feed size supplied to the primary crusher, as well as oversize material and the requirement for rehandling of material, and secondary breakage
- Shovel productivity, including wear and maintenance costs
- Use of track dozers to condition the bench floor and rip high bottoms
- Grade control
- Primary crusher power consumption, throughput, and maintenance costs
- Disruption to material flow during digging and crushing that affects truck efficiency

The pit configuration bench height is expected to be 5m for ore and selective waste benches, and 10m for bulk waste benches. The material type at the Project is suitable for a drill rig capable of drilling holes with a diameter of up to 171mm. Drill burden, spacing and sub-drill design will be functions of the selected powder factor, which is based on the unconfined compressive strength measurement results from the geotechnical study.

A lower relative energy factor was assigned to the waste rock because the waste material needs to be efficiently and economically excavated, hauled and placed on the waste rock dump. On the other hand, with the ore material's higher relative energy factor, any finer fragmentation could benefit the downstream crushing and milling costs of the Project.

In areas where mining slopes remain intact for extended periods, it is good practice to minimise the fracturing of the high walls during blasting. In such identified areas, wall control blasting, also known as pre-splitting, can be considered. Pre-splitting was provided within the final pit boundary along the high wall, to create safe working conditions in the lower areas.

4.6.2.2 Drilling

Drilling is the first operation performed at most open pit mining operations. Rotary drills are predominantly used, although for smaller holes (<171mm) down, the hole hammer drills have often been employed, and would be well suited for smaller surface operations. For this Project, a 260kW (1800rpm) diesel crawler down hole hammer drill rig has been selected for the production holes, for ore and waste benches, and the wall control blasting holes.

4.6.2.3 Load and haul operations

The overall scale of mining envisaged for the Project is a medium to large-sized mine with total material movements of approximately 25Mtpa. As a result of the limited extent of mineralisation, selective mining practices have been incorporated into the ore mining methodology.

Waste and ore mining operations will utilise medium-sized backhoe excavators – 200t bulk mining to 120t selective mining class range, combined with a fleet of 100t rigid dump trucks, has been selected. The hydraulic face shovel, wheel loader and hydraulic excavator can fit into primary loading functions, as shown in Figure 12. Multi-face loading or secondary functions do not favour
hydraulic shovels or excavators, but certainly favour wheel loaders, due to speed and flexibility. Rigid frame and articulated diesel trucks have been used in the mining of small to large open pits for many years, and their mechanical capabilities are well respected. It is for this reason that diesel-powered rigid haul trucks have been selected for the Project.

Figure 12 – Examples of equipment to be used on the Project (Source Qubeka, 2021)

4.6.2.4 Ancillary equipment

Ancillary equipment that is required for functions that fall outside of the primary production equipment’s scope, is also necessary for mining operations. Primary production costs are directly impacted by a number of aspects related to ancillary equipment. Support equipment is the lifeline of reliable and cost-effective mine production, and is required for the following functions or activities:

- Keeping the loading, tipping and haul road areas clean, thus prolonging tyre life and making the operation safe
- Contributing to the mitigation and reduction of mobile equipment noise (via good road maintenance)
- Maintaining haul road conditions, thus prolonging tyre life and making the operation safe
- Suppressing dust emissions from health, safety, environmental, and financial perspectives
- Supporting the full equipment maintenance and diesel requirements for remote, track-propelled equipment, and breakdowns
- Bench preparation and levelling
- Fuelling of track-mounted equipment, and dump trucks
- Rehabilitation

The tertiary support equipment fleet consists of units that assist in tasks that are required, in order to make primary and secondary fleets’ work easier and safer. Other functions they complete are not production-related and have no direct impact on production. The tertiary equipment fleet consists of:

- Small trucks used for maintenance activities
- Light delivery vehicles used to transport management, technical services, and maintenance personnel around the mine
- Buses used to transport operators from the change houses to the equipment in the field, and back
- Lighting plant to increase visibility around the excavators during night-time
- Pumping equipment for pit dewatering
4.6.2.5 Other mining activities or infrastructure

Most surface haul roads, dumps and stockpiles required for the LoM will have to be constructed during the first year of mining. The waste dump will progress by the haul truck tipping on the top elevation of the dump, with the dozer pushing the waste down. These actions will cause the waste dump to progress horizontally over time. Waste dumps should be progressively rehabilitated with suitable rehabilitation materials, subsoil, and topsoil where possible. Rehabilitation must be performed as soon as possible on the external faces of the waste dump, to reduce visual and air quality impacts. Ore stockpile dumps will be constructed in close vicinity to the primary crusher tipping point, in order to minimise the reclamation costs and meet the environmental management requirements.

Waste rock will be required for the construction of mine infrastructure such as run of mine (RoM) pad and tailings storage dam walls. During normal operations, the ore feed will be achieved by a combination of ore tipped directly into the RoM bin by the haul trucks from the pit with the RoM loader adding other appropriate ore material from RoM grade control stockpiles. The assumption is that 65% of direct ex-pit ore sent to the RoM pad would be stockpiled and rehandled due to ore blending and scheduling requirements, which affects mine materials handling and possibly environmental impacts and mitigation.

In-pit water management will mainly consist of run-off control around the pit perimeter and temporary sumps at the lowest elevation in the pit. Pit dewatering pumps will pump excess water to a suitable holding dam ready for use as dust suppression and plant make up water.

Haul road dust suppression is considered for the Project and will be handled through a comprehensive dust management system. A bitumen-based product may be applied during haul road construction and maintained on a customised maintenance programme.

4.6.3 PIT AND HAULAGE DESIGN

The pit design was developed from the pit optimisation study to produce a practical pit with ramps, bench and berm configurations. The ramp positioning within the overall pit design is an integral component of mine design because it influences the stripping ratio of the overall design, the performance of the equipment, as well as the operating costs. The exit positions of the ramps were determined taking into consideration the current position of the primary crusher and the waste rock dumps. Typical pit design and terminology components are rendered in Figure 13.
Figure 13 – Pit design and terminology (Source Qubeka, 2021)

Sufficient room for manoeuvring is required to promote safety and maintain continuity in the haulage cycle. The width criterion for a haul segment is based on the widest vehicle in use, which is the Komatsu 785-7 100 tonne rigid dump truck, with an operating truck width of 6.9m. To design for anything less than this dimension would create a safety hazard due to a lack of adequate clearance. In addition, narrow lanes often create an uncomfortable and unsafe driving environment, resulting in slower traffic, and thereby impeding production.

The haul road design parameters were established taking into consideration the type and size of hauling equipment that will be used during operations. The dimensions of the haul road were based on a Komatsu 785-7 rigid truck using global standards of good practice.

A haul road gradient of 1:10 (10% or 5.71°) was selected for the Project. The selection of the haul road gradient was based on the world best practice for the type of trucks that will be utilised. A haul road gradient of 1:8 (12% or 7.1°) was selected for the single lane ramp system utilised in the lower four benches of each pushback. The practical design width for the dual ramps will be 25m and for the single ramps will be 18m.

The design, construction and maintenance of haul roads have a considerable impact on haulage cost, which makes up a greater percentage of the total mining cost. It is therefore important that
appropriate, detailed sets of designs for haul road construction are compiled for the site. Haulage is the largest mining cost, and the design, construction and maintenance of haul roads has a major impact on the haulage costs.

The benefits of an improved haul road design are: efficiency of haulage by reduction in cycle time, reduced fuel burn, and reduced truck component wear. It is therefore desirable to generate a minimum site-wide construction standard for both new and existing haul roads. The minimum bench operating width for the pit is limited by the size of the equipment. The pit design parameters are summarised in Table 6.

**Table 6 – Pit design parameters (Source Qubeka, 2021)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum mining width (20m + Single Ramp Width)</td>
<td>(m)</td>
<td>35.0</td>
</tr>
<tr>
<td>Minimum pushback width</td>
<td>(m)</td>
<td>60.0</td>
</tr>
<tr>
<td>Dual ramp width</td>
<td>(m)</td>
<td>25.0</td>
</tr>
<tr>
<td>Single ramp width</td>
<td>(m)</td>
<td>18.0</td>
</tr>
<tr>
<td>Minimum turning circle</td>
<td>(m)</td>
<td>10.0</td>
</tr>
<tr>
<td>Ramp gradient (short ramps &lt; 400m)</td>
<td>(1:#)</td>
<td>8.0</td>
</tr>
<tr>
<td>Ramp gradient (short ramps &lt; 400m)</td>
<td>(%)</td>
<td>12.0</td>
</tr>
<tr>
<td>Ramp gradient (short ramps &lt; 400m)</td>
<td>(deg)</td>
<td>7.1</td>
</tr>
<tr>
<td>Ramp gradient (long ramps &gt; 400m)</td>
<td>(1:#)</td>
<td>10.0</td>
</tr>
<tr>
<td>Ramp gradient (long ramps &gt; 400m)</td>
<td>(%)</td>
<td>10.0</td>
</tr>
<tr>
<td>Ramp gradient (long ramps &gt; 400m)</td>
<td>(deg)</td>
<td>5.7</td>
</tr>
</tbody>
</table>

Ramp positioning within the pit design is an integral component of mine design. It influences the stripping ratio of the overall design, the performance of the equipment, as well as the operating costs. The exit positions of the ramps were determined taking into consideration the proposed position of the primary crusher and the waste rock dumps.

Figure 14 and Figure 15 show the Twin Hills, Bulge, and Clouds pit design and dimensions.
Figure 14 – Twin Hills, Bulge, and Clouds pit design (Source Osino, 2021)
4.6.4 METALLURGY AND PROCESSING

Gold recovery will be achieved using a conventional crushing, milling, gravity, pre-oxidation and carbon-in-leach (CIL) processing plant, as depicted in Figure 11. The process plant design is based on a robust metallurgical flowsheet developed for optimum recovery, while minimising initial capital expenditure and operating costs. The metallurgical flowsheet is based on unit operations proven in the industry, as shown in Figure 16.
Figure 16 – Metallurgical process flow (Source Lycopodium, 2021)
As stated in the PEA (2020), initial metallurgical test work was carried out by SGS (2020), with the objective of determining gold dissolution via cyanidation. The work showed average gold dissolution of 89% at an average grind of 93% passing 75 micron, but also indicated significant variability in gold dissolution.

The test work showed that the samples had an average head grade of 1.19g/t Au and 0.58g/t Ag, with a low concentration of base metals, carbonaceous material, sulphates, and carbonates. Several samples contained appreciable amounts of arsenic. Mineralogy was found to be reasonably consistent across the deposit, and relatively high concentrations of pyrrhotite were noted in the fresh west and east sample material.

A standard set of crushing, milling, and abrasion tests was carried out. This concluded that three stages of crushing, followed by ball milling, were likely to be the optimal configuration to achieve 80% passing 75μm in mill cyclone overflow.

Mineralised material is considered “medium to hard” in comparison with similar material from other deposits, with average comminution circuit power consumption estimated to be 14.9kWh/t at this grind size. Optimisation test work is ongoing.

The mill cyclone overflow product stream will be processed via a CIL circuit, carbon elution, electrowinning, and a gold room. CIL tails will be treated to achieve cyanide destruction before being pumped to the tailing’s thickener, with the underflow being filtered. Filter cake will be conveyed and disposed of as tails in the tailings storage facility. Tailings will either be disposed of in a lined TSF or it will be co-disposed with waste rock.

4.6.5 SUPPORT INFRASTRUCTURE AND SERVICES

4.6.5.1 Mining office block

The mining office block will be a modular structure installed on a mesh reinforced concrete slab. The building will provide office space to the mining personnel, including the mine manager and the technical services manager, geology personnel, surveyors, maintenance engineers, and mining support staff.

It is likely that the building will have offices, one main boardroom, two meeting rooms, male and female ablutions, a kitchen, a pit control room, a first aid room, and an open quadrant for landscaping.

4.6.5.2 Geological core shed

The geological core shed building will be a sheeted steel portal structure. The core shed will be used by the geology section to assess and store core and geological samples. Operations will include night shift, internal ablation facilities have been provided in the building.
4.6.5.3  **Mining changehouse**

The mining changehouse will provide ablution facilities to all mining employees, and production and maintenance crews, including foremen. All employees who use the changehouse will clock in through the changehouse turnstiles when they enter or exit the mining complex. A single tier locker will be allocated to each employee, either on shift or off shift, for personal belongings and clean overalls. Washing facilities will be included in the mining changehouse for washing overalls and clothing.

4.6.5.4  **Warehouse**

The mining warehouse (or stores) will be a sheeted steel portal structure. The warehouse shall be used for the storage of all critical and operational spares, as well as office and other consumables. Goods will be received by the store's personnel in fenced receiving bays prior to storage in the main building. Access to the stores building is limited to stores personnel, and dispatch will either take place over a goods issue counter or through a fenced dispatch bay. Stores yards external to the warehouse will be used for pipes, large equipment, and tyres, etc. Acetylene gas, oil, paint, and other flammable materials will be stored in separate areas and designed accordingly if storing dangerous goods.

4.6.5.5  **Heavy mobile equipment workshop**

The heavy equipment workshop is the main shop for maintenance and rebuilds of mining equipment. The building design is capable of handling maintenance work for 60t ADT trucks and support equipment as per the maintenance plan. The structure will be sheeted steel portal supported on concrete plinths, with double storey offices in brickwork. The workshop will be bunded with an internal drainage system into a suitable hydrocarbon collection and treatment facility. Wash bays will be required for equipment, before, during and after maintenance, and therefore settling dams/ponds will be required as part of the wastewater treatment system in the wash bay.

4.6.5.6  **Light vehicle workshop**

The light vehicle workshop will be used for maintenance of all mine light vehicles, including those operating in the processing plant areas. The structure will be sheeted steel portal supported on concrete plinths. Similar wash bay facilities and arrangements for the heavy equipment workshop will be required for the light vehicle workshop and will need to be designed accordingly.

4.6.5.7  **Fuel facility**

Diesel for mine operations will be delivered by trucks to a designated and designed site fuel facility. A site-based service provider will erect infrastructure and facilities for the storage and handling of fuel. The service provider will also be responsible for the supply, delivery, and management of stock for the life of mine. The Proponent will ensure the facility has the required installation certificates prior to commissioning the fuel facility.

A hard stand pad for minor maintenance will be provided for the servicing of mining equipment outside the pit perimeter. The hard stand will be 30m x 30m and will also be used for refuelling equipment from a fuel bowser.
4.6.5.8 Explosive magazine and bulk emulsion storage facility

The number and capacity of magazines are determined based on the defined mine production schedule and on rock mass conditions in terms of strength and moisture. A total of two explosive magazines have been determined:

- One magazine holding 200 cases of accessories
- One magazine holding 200 cases of high explosives

The designs are based on an explosive supplier’s recommendation and addresses all legal requirements. There is also provision for an emulsion storage silo of 42 tonne capacity.

An appointed contractor will be based on-site, and will provide explosives and blasting services to the mine. The contractor will establish and be responsible for the explosive magazine infrastructure, office, and workshop infrastructure. Space provision has been made for both sites, and the siting of the explosive magazine will be in conformance with the requirements of the Namibian Labour Act, Namibian Mining Legislation, and Regional Explosives Standards or regulations.

The location of the explosive magazines is southeast of the main offices, is more than 700m in radius away from any other infrastructure and is approximately 1km away from the open pit.

4.6.5.9 Communication

Radio, telephone, and internet connections will be required for the mining operation. Infrastructure, including communication masts, will be installed, and provisions will be made with the relevant service providers.

4.7 UTILITIES

4.7.1 POWER SUPPLY

The Project’s power requirement is estimated to be approximately 15MW, and the current strategy is to source power for the Project from the national grid. Electrical power is readily available in the area from the national power utility, NamPower.

The nearby Navachab gold mine is linked to the national grid by a 66kV transmission at Karibib. To link the proposed Project site into the national grid requires a 19km transmission line from Karibib. Further studies will assess the viability of solar power options to be integrated into a potential hybrid system.
4.7.2 WATER SUPPLY

The current mine design indicates a daily requirement of 4 100m$^3$/day (1.5 million m$^3$/annum) for the estimated 3.5 million tons per annum (mtpa) ore throughput, to sustain mining operations and related activities. Water supply options that were also addressed in the SLR (2020) Report were as follows:

- Three potential local dam sites on the Khan River, with catchment areas ranging from approximately 2 100km$^2$ to 2 400km$^2$ (See Figure 17).
- Obtaining a water use license from the existing NamWater Swakoppoort to Karibib Pipeline, provided that there is sufficient capacity for mining activity.
- A planned desalination pipeline, which will primarily be used to support the Central Area of Namibia (CAN). According to the CAN Surface Water Augmentation Report, the desalination pipeline will supply water, at the earliest, in 10 years.
- Groundwater supply from boreholes.
Figure 17 – Proposed dam construction by SLR (2020) for surface water supply (source KP, 2021)
Long drought periods of up to seven years, typically referred to as critical periods, are common to the Namibian climate. During a long critical period, the groundwater table drops significantly due to limited recharge, causing some boreholes to dry up. Similarly, surface water sources, which are already stressed, might not be able to support priority users, resulting in water restrictions being enforced to prevent the failure of the water resource. Local dam options are typically developed over a long timeframe, in excess of 5 to 10 years, due to land acquisition, environmental and social studies, and full design and construction cycles. Developing water resources is also very costly due to the aforementioned factors (Knight-Piesold, 2021).

The pipeline route for the desalination support to the CAN will follow the B2 Road from Swakopmund to Okahandja, adjacent to the mining operation. Water supply from the desalination pipeline will be costly due to the high pumping costs and the expensive desalination process itself. The desalination plant and pipeline are planned to be implemented in 2031, and it is estimated that one cubic meter of water is going to cost more than N$ 45 at 2020 infrastructure costs. The official reports have not yet been made publicly available. The unit cost is likely going to increase significantly, due to the inflation of electricity and general costs (Knight-Piesold, 2021).

Water supply is proposed from a combination of surface and groundwater sources and supply optimisation studies are ongoing.

4.8 MINERAL AND NON-MINERALISED WASTE

4.8.1 WASTE ROCK

Waste rock dumps will be designed as close to the pit exits as possible, in order to optimise productivity and minimise waste mining costs. Rehabilitation requirements are considered in dump location and design, and all dumping areas will undergo an ore sterilisation campaign prior to waste dumping. The waste rock dumping strategy is to reduce the hauling distance and similarly enable progressive rehabilitation of the waste dumps wherever possible. In-pit dumping will also be deployed where possible.

4.8.2 TAILINGS

The final design of the tailing storage facility will be based on a set of specific and detailed studies associated with international best practices for tailings storage facility design. The initial conceptual design comprises a downstream type of facility, constructed from the waste rock excavated from the open pit. The tailings facility will accommodate a total of 50Mt of filtered tailings inside the waste rock embankments over the 14-year life of mine.

The Project site layout and landforms surrounding the proposed open pit were assessed, and three sites or areas were identified for the TSF. Preliminary calculations demonstrate that each of the sites would need to comprise a footprint of approximately 185ha, which is considered to be sufficient to accommodate the storage of 50 million tonnes of tailings, including the associated waste rock embankments. The sites are described as follows:
- **Option 1** is located to the north of the open pit, and east of the Okawayo Stream, over an area with undulating topography, outcrops of calcrete and sparse vegetation.

- **Option 2** is positioned north of the open pit, to the west of the Okawayo Stream, and is characterised by gently sloping topography, covered by red Aeolian Kalahari Sand and sparse vegetation. The sand layer is estimated to be 500mm thick (on average) and is underlain by a hardpan calcrete layer.

- **Option 3** is positioned on an area to the south of the open pit, and south of the marble ridge that runs parallel with the open pit. This site is approximately 40m higher in elevation relative to the open pit area, with a gently sloping to flat topographic profile.

As a result of the arid climate of the Project area and the expected shortage of water, it is assumed that the selected method of processing will include the filtration of thickened tailings, to produce a “dry” filtered tailings material with a typical target moisture content ranging from 15% to 20%. The transport of filtered tailings is usually undertaken by haulage or conveyors.

The mining activities will also produce waste rock hauled from the open pit, which will be stored on the surface. The preliminary design of the TSF is based on the co-deposition of the tailings and selected waste rock, such that the tailings material is stored within a fully contained facility constructed from the waste rock. Table 7 summarises the key design criteria for the permanent storage of the tailings material.

**Table 7 – TSF design criteria (Source Prime Resources, 2021)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>LoM</td>
<td>14 years</td>
<td>Lycopodium</td>
</tr>
<tr>
<td>Production rate</td>
<td>3.5 Mt</td>
<td>Lycopodium</td>
</tr>
<tr>
<td>Tailings product type</td>
<td>Filtered</td>
<td>Lycopodium</td>
</tr>
<tr>
<td>Tailings dry density</td>
<td>1.8 t/m³ (assumed)</td>
<td>Prime Resources</td>
</tr>
<tr>
<td>Waste rock bulk density</td>
<td>1.8 t/m³ (assumed)</td>
<td>Prime Resources</td>
</tr>
<tr>
<td>Tailings total production</td>
<td>50 Mt</td>
<td>Lycopodium</td>
</tr>
<tr>
<td>Tailings volume requirement</td>
<td>27.8 Mm³</td>
<td>Prime Resources</td>
</tr>
<tr>
<td>Tailings deposition method</td>
<td>Haul, dump and spread</td>
<td>Prime Resources</td>
</tr>
<tr>
<td>Waste rock deposition method</td>
<td>Haul, dump, spread and compact</td>
<td>Prime Resources</td>
</tr>
</tbody>
</table>

This proposed type of facility comprises waste rock containment walls behind which the dry filtered tailings material is deposited. The bulk of the embankments are typically comprised of coarse material, with the upstream face zone constructed from selected finer material. The finer material allows for the installation of a geomembrane which reduces the risk of a puncture. The containment walls are sequentially raised in a downstream direction and may be developed in any number of phases or lifts, as shown in Figure 18.
The phased construction of the TSF allows for the deferral of capital expenditure and takes into account the possible limited availability of waste rock for the construction of the embankments. The embankments will be constructed continually, but the installation of the barrier will be undertaken in phases. The following summarises the proposed phasing of the TSF, a critical element of environmental and closure management to address during the LoM:

- **Phase 1:** Construction of a cell with a 10m high waste rock embankment and an internal footprint of 52.5ha. The basin and internal side slopes will be lined. This phase will have a tailings capacity of 4.35Mm$^3$, deposited over a period of 2 years.

- **Phase 2:** This phase will involve the construction a similar sized cell as in Phase 1, which will be constructed adjacent to Phase 1, such that the two phases share an embankment.

- **Phase 3:** This phase includes the raising of the TSF embankments to a height of 18m. The internal embankment side slopes will also be lined. Phase 3 will accommodate tailings with a further volume of 9.35Mm$^3$, deposited over a period of 4.8 years.

- **Phase 4:** The final raise of the TSF embankments to a height of 26m. This phase will accommodate 9.8Mm$^3$ of tailings over a period of 5 years. As per the previous phase, the internal embankment faces will likely be lined.

Each phase will allow for a minimum freeboard of 2m. The TSF can still potentially be developed beyond the proposed height and provide additional storage capacity. The volumes of tailings and waste rock for each phase is summarised in Table 8 below.

### Table 8 – Waste rock and tailings volumes and tonnages (Source Prime Resources, 2021)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Waste rock</th>
<th>Tailings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume (m$^3$)</td>
<td>Tonnage (t)</td>
</tr>
<tr>
<td>1</td>
<td>1 004 833</td>
<td>1 808 699</td>
</tr>
<tr>
<td>2</td>
<td>753 625</td>
<td>1 356 525</td>
</tr>
<tr>
<td>3</td>
<td>2 464 859</td>
<td>4 436 746</td>
</tr>
<tr>
<td>4</td>
<td>3 660 792</td>
<td>6 589 426</td>
</tr>
<tr>
<td>Total</td>
<td>7 884 109</td>
<td>14 191 396</td>
</tr>
</tbody>
</table>
4.8.3 GENERAL WASTE
Waste will be separated at source, stored in a manner that there can be no discharge of contamination to the environment, and either recycled or reused where possible. On-site facilities will be provided at a dedicated waste storage facility for sorting and temporary storage prior to removal and disposal to appropriate recycling or disposal facilities off-site (Karibib for general waste and Walvis Bay for hazardous waste).

Industrial waste will be sorted on-site and disposed of at appropriate facilities. Hazardous waste includes, but is not limited to, the following: fuels, chemicals, lubricating oils, hydraulic and brake fluid, paints, solvents, acids, detergents, resins, brine, solids from sewage, and sludge. A waste specification will be developed and included in the assessment phase and incorporated into the EMP.

4.8.4 EFFLUENT AND WASTEWATER
Sewage will be collected and will use gravity reticulation via buried sewer pipes to be transported to the treatment facility. Sewage will be treated in a purpose-built sewage treatment plant. The plant will have the capacity to treat the sewage generated on-site per day. The water output from the plant will be suitable for use in dust suppression, vehicle washing, irrigation, fire water, and process water. The wastewater treatment plant will also produce a small quantity of sludge, which will be dried in a sludge-drying bed located at a point lower than the plant. Dried sludge can be used as fertiliser for rehabilitation of mining landforms.

4.9 ALTERNATIVES CONSIDERED
The primary alternatives to be assessed, in addition to the mining landform positions, will be the proposed diversion of a tributary of the Okawayo river and the district road, D1491, both of which traverse the planned open pit.

Alternative mine designs, processing plant options, and the types of tailing disposal methods are all considered during the pre-feasibility and feasibility study stages of the Project. The availability of water, potential for acid mine drainage, long-term slope stability, safety, and climate change, etc. will all be considered when assessing the economic, technical, and environmental suitability of an alternative. For every alternative option there is a trade-off or an impact on another aspect of the Project. The detailed baseline environmental studies in the appendices, and summarised in the environmental baseline chapter, provide further information to the decision-making process.

4.9.1 MINE LAYOUT
Several site layout alternatives will be considered during the assessment phase. Layout options are currently constrained by the EPL boundaries, national roads, and the dimension stone prospecting claims held over the marble ridge. In addition, there are constraints with respect to the strike of the ore body, blue sky (possible future economic ore), a 500m blast zone around the pits, the volumes of waste rock, and the tailings to be disposed of. Details of the alternatives for
the positions, placements and designs for the waste rock dump and tailings storage facility will be included in the assessment phase.

4.9.2 ROAD DIVERSION

The D1941 currently provides access to the dimension stone quarries to the south of the mining licence area. The road passes through the mining licence area and across the future mine pit area. This same road continues and joins another district road. The alternative that is proposed, is the truncation of the D1941 at the Okawayo farmstead and the construction of a new section of the D1941 that will join the C33 road north of the mining area, thereby allowing access to the mine from the north and thoroughfare for district road users. Access to the dimension stone quarries would remain in place.

4.9.3 WATER SUPPLY

The alternatives for water supply are discussed in the utilities section above, and in more detail in the environmental baseline chapter of this report. The alternatives for water supply are as follows:

- NamWater supply from the Swakoppoort Dam
- NamWater supply from the Spesbona wellfield
- Surface water dammed in the Khan River
- Groundwater boreholes within the mining licence area
- Dammed water behind the proposed weir / dam wall that would divert the Okawayo river around the mine pit

Water supply optimisation strategies are currently in progress and will be included in the assessment phase.

4.9.4 RIVER DIVERSION

Knight-Piesold (2021) have proposed that in order to prevent the flooding of the mine pit and thereby halt mining, two options for diverting the Okawayo River can be considered. The environmental baseline chapter describes these two options for diverting the Okawayo River and at the same time providing surface water storage options subsequent to flow events.

4.10 REHABILITATION AND CLOSURE

The Proponent will commit to establishing a rehabilitation plan as part of the mine closure plan. An environmental consultant, in conjunction with the Proponent and the specialist consultants working on the mine design, and those undertaking the environmental impact assessment, will draft a conceptual mine closure plan as part of the EMP requirements, and this will be updated into the assessment phase.
5 ENVIRONMENTAL AND SOCIAL BASELINE

5.1 BASELINE DATA COLLECTION

Initial desktop baseline studies relevant to the Project formed part of the initial environmental assessments conducted for the exclusive prospecting licences on which the Project is situated. As part of this assessment, the baseline was studied in detail, with inputs from specialist studies commissioned as part of the environmental and social impact assessment process.

5.1.1 DESKTOP AND FIELD SURVEYS

Initial desktop baseline studies were completed between 2018 and 2020 for the EPL assessments. Additional desktop and field-based baseline studies were conducted between February and September 2021. These build on the dataset of site environmental monitoring data being collected since 2010.

This section sets out the biophysical and socioeconomic environments in which the Project is situated. It is an important part of the scoping component of the assessment, as it determines if there are any knowledge gaps that require additional information prior to the assessment phase being completed.

5.1.2 SPECIALIST STUDIES

The following specialist studies as outlined in Table 9 were commissioned and completed, in order to determine the current state of the baseline environments:

Table 9 - Specialist studies conducted for the ESIA

<table>
<thead>
<tr>
<th>STUDY AREA</th>
<th>PURPOSE</th>
<th>SPECIALISTS</th>
</tr>
</thead>
</table>
| Terrestrial ecology | – Biodiversity and habitat  
– Identification of species of concern and sensitive areas  
– Impacts of mining construction and operations on habitats and biodiversity | – Peter Cunningham |
| Hydrology | – Water supply  
– Storm protection and river diversion  
– Impact on heritage aspects  
– Clean and dirty water management systems | – SLR  
– Knight-Piesold |
| Groundwater | – Assess the potential for contamination of aquifers from TSF & WRD  
– Provide a model to determine impacts of drawdown and plume mobility  
– Assess the sustainability of boreholes for water supply | – SLR  
– Knight-Piesold |
| Air quality | – Provide emission standards and dust suppression requirements | – Airshed |
### 5.2 Location

The Twin Hills Gold Project is located approximately 180km inland from the Atlantic coastline. The site is in a triangular area bounded by the towns of Omaruru, Karibib, and Wilhelmstal. The Project area is shown in Figure 19, and is located northeast of Karibib. The Khan River is north of the Project. The site is accessed from Karibib along the C33 that runs northeast to Omaruru. The B2 runs parallel to the Project area and is separated by a marble mountain ridge. Omaruru is 45km north of the Project site. Karibib is the closest town ~15km to the southwest.
Figure 19 - Project location in proximity to towns and roads
5.3 LAND USE

The Project is situated in a commercial agricultural region and the land use is dominated by cattle, game and small stock farming. Figure 2 outlines the proposed mining licence area map with surrounding farms. A spatial review identified that one farm has a remnant orchard, but no large-scale irrigation farming was identified. The Okawayo farm has been described as a wildlife and hunting farm. Portions of the directly impacted farms will no longer be available for farming, as the area will form part of the mining operational footprint. Farming activities on surrounding properties will be able to continue relatively undisturbed by the proposed Project.

Dimension stone quarries are located on the marble ridge that occurs on the Okawayo farm, and several mining claims are held along portions of this ridge, as shown in Figure 20.

The Project area is not part of a communal conservancy. The closest is ǂGaingu, which is located in the Spitzkoppe area to the west of Karibib. The Project area is not situated within a freehold conservancy (Mendelsohn et al. 2002).
Figure 20 - Project location in proximity to farms and mining claims
5.4 GEOLOGICAL SETTING

The local geology is summarised from a collection of reports compiled by the Proponent during exploration activities and is provided in detail in the Project description chapter of this report. The Twin Hills Gold Project is situated within the Southern Central Zone of the Damara Supergroup. It comprises continental margin carbonates and silts that grade into turbidite sequences representing continental shelf and basin deposits. The regional mapping and reinterpretation of the available aeromagnetic data undertaken by the Proponent resulted in the identification of a large deep regional structure, the Karibib Fault, which strikes east northeast and has several 'splays' associated with it.

The Twin Hills deposit lies in the Kuiseb Formation, which is the uppermost portion of the Swakop Group, a sequence of turbiditic marine sediments several kilometres thick, which was folded during the Neoproterozoic Damaran orogen. The gold mineralisation is hosted within a metagreywacke unit, which has been tightly folded into an overturned syncline, underlain by biotite schist and cordierite schist. The host rocks are overlain by red Kalahari sands and calcretes between 2m and 25m thick. Faults and lithological contacts between the marble and the greywacke/schist are considered potential targets for groundwater supply investigations. The geological setting is shown in Figure 21.
Figure 21 - Geological setting of the Project
5.5 TOPOGRAPHY

The land in the Project area is dominated by calcisols, (commonly called calcretes), regisols, and rocky outcrops (Figure 3). The eastern portion of the Project area is moderately rough, with steep hill slopes. Conversely, the western portion of the Project area is relatively flat, covered by reddish sands, and slopes gently towards the northwest.

The southern half of the Project area is traversed by a marble ridge that tends northeast southwest across the property. North of the marble ridge, the topography slopes towards the Khan River, approximately 8km away. Figure 22 shows an image of the calcrete plain below the marble ridge. This flat plain area is where the open pits will be situated.

The marble ridge is bisected by the ephemeral Okawayo minor river, which drains northwards across the proposed open pit to the Khan River. This water course will need to be diverted before mining can commence, and is discussed in further detail within the water section of this baseline chapter.

Figure 22 – An image taken from the marble ridge overlooking the proposed Project area, with a view of the Erongo mountains
5.6 BUILT ENVIRONMENT AND INFRASTRUCTURE

5.6.1 INFRASTRUCTURE AND BULK SERVICES

The wide tarred B2 road south of the Project area, also known as the Trans-Kalahari Highway, carries large traffic volumes between Windhoek and Walvis Bay, and is considered the regional trade route. The tarred C33 road running north from Karibib to Omaruru is likely to be the primary access route to the site.

The D1941 gravel road traverses the proposed mine site, across the proposed open pit area. This road will have to be diverted, probably to the north of the mine. On the southwest of the site, the D1941 is used to access the marble quarries and other mining claims along the marble ridge.

The TransNamib Railway line parallels the B2 in the south, with a line branching north-eastwards (at Krazenberg, west of Karibib) towards Omaruru, Otjiwarongo, and on to Tsumeb. A 66kW powerline runs loosely parallel to this railway line, but not in the same corridor (Figure 23).

NamWater currently has an unused wellfield in the Khan River, with an associated pumpstation to the northwest of the proposed Project. A pipeline runs south-south-westwards from there towards Karibib.

Bulk water to Karibib is pumped by NamWater from the Swakoppoort reservoir to a treatment plant in Karibib.

The town is supplied by a 66kV overhead powerline by ErongoRED, terminating at the Karibib 66/11kV, 2.5 MVA substation. The power supply for the proposed Project has not yet been determined, but renewable and grid power will be considered. If future powerlines are required, then the line routes will require an assessment, as linear infrastructure is not included within the scope of this assessment. The Karibib Air Base, approximately 7km southwest of the proposed Project, is supplied by a 33kV line from Karibib.
Figure 23 – Road and rail infrastructure
5.6.2 TRAFFIC AND TRANSPORT

Innovative Transport Solutions (ITS Global) was commissioned by ECC to assess the road traffic baseline. The traffic study was completed in September 2021, at a time when there were no COVID-related travel restrictions or lockdowns, which would have affected the accuracy of the baseline study. The traffic baseline study can be found in Appendix H. It must be noted that this study presents the current baseline conditions of the road network in proximity to the Project. Details of how the Project could impact these roads will be provided in the impact assessment phase.

The current conditions of the roads and intersections in terms of traffic volumes, lane configuration, and traffic controls, are provided in Figure 24.
ITS Global (2021) engineers determined that all the intersections currently operate with a good level of service and have spare capacity. No upgrades are required. This preliminary statement shows that the introduction of more traffic associated with the Project would be possible.

The major existing roadways in proximity to the Project area include:

- B2 Road (T0106) – Class 1 principal arterial, with a surfaced lane (approx. 3.7 meters wide) per direction. Speed limit of 120km/h.
- C33 Road (T0203) – Class 2 major arterial, with a surfaced lane (approx. 3.5 meters wide) per direction. Gravel shoulders and a speed limit of 120km/h.
- C36 Road (M0080) – Class 3 minor arterial, with a gravel lane per direction. Speed limit of 100km/h.
- D1941 Road – Class 4 distributor, with a gravel lane per direction.

5.6.2.1 Additional traffic volumes associated with the Project

ITS Global utilised available information associated with the Project to determine the additional traffic volumes that will be added to the road infrastructure due to the proposed Project.

The trip generation for the Project was based on the number of trips required to transport the expected number of personnel, equipment, and supplies to site during construction and operations.

5.6.2.2 Site access

The current district road (D1941) runs through the Project area and will intersect the planned open pits. It will therefore need to be relocated. The proposed relocation of the D1941 will require the road to be moved northwards to a point within the Okawayo farm.

The proposed realignment of D1941 would be off the C33 Road just north of Karibib Air Force Base, as shown in Figure 10, and will need to meet the safety requirements set out by the Roads Authority of Namibia.

The current site access road from the C33 is surfaced (with asphalt) for approximately 17m and is gravel thereafter. The width of the existing asphalt road is 3m and it is recommended that the road width be increased to at least 7m, as part of the Project ramp up.

Based on the current capacity analysis, a separate right turn lane along the C33 Road onto the minor road is not warranted at this stage. However, it would be recommended that a separate righthand turning lane be installed for safety.

The current speed limit along the C33 is 120km/h. It is recommended that the speed along the C33 Road be reduced to 80km/h near the site access area (1.5km radius) for safety.
5.7 Socioeconomic Baseline

5.7.1 Governance

Namibia was established in 1990 and is led by a democratically elected and stable government. The country ranked fifth out of 54 African countries in the Ibrahim Index of African Governance in 2015 for indicators that include: the quality of governance and the government’s ability to support human development, sustainable economic opportunity, rule of law, and human rights (National Planning Commission, 2017).

As a result of sound governance and stable macroeconomic management, Namibia has experienced rapid socioeconomic development. Namibia has achieved the level of ‘medium human development’ and ranks 125th on the Human Development Index out of 188 countries (National Planning Commission, 2017).

Namibia is divided into 14 regions, subdivided by 121 constituencies. The Erongo Region is divided into seven constituencies. The proposed Project is in the Karibib constituency of the Erongo Region. The Erongo Regional Council is responsible for the planning and development of the region in a sustainable manner for the benefit of its inhabitants by establishing, managing, and controlling settlement areas and focusing on core services. The council is accountable for an area of 63,586km², which is about 7.7% of the total area of Namibia (Erongo Regional Council, 2017).

5.7.2 Demographic Profile

Namibia is one of the least densely populated countries in the world (2.8 persons per km²). Vast areas of Namibia are without people, in contrast to areas of dense concentrations, such as the central-north and along the Kavango River. Windhoek, the capital, is not only the main urban area with the largest population, but the concentration of private and public head offices attracts Namibians from all parts of the country in search for a better life.

The national population growth rate is estimated at less than 2%, which is lower than that of most African countries. Namibia’s population is young – although 57% falls into the age group 15 to 59, 37% of the total population is younger than 15 (Namibia Statistics Agency, 2017). Since 2005, there has been a steady improvement in life expectancy, which is currently estimated at 65 years. In 2018, it was estimated that 50% of all Namibians are urbanised, i.e. living in an urban settlement (retrieved from www.worldpopulationreview.com). The last national census was conducted in 2011, and counted 2.1 million Namibians (Namibia Statistics Agency, 2011). An inter-censal demographic survey was conducted in 2016 and estimated the total population at 2.3 million (Namibia Statistics Agency, 2017).

It is predicted that urbanisation will continue, with an increase from 43% of the population living in urban areas in 2011, to 67% in 2041. The populations of the Khomas and Erongo regions are projected to increase the most, with over a third of Namibia’s population expected to live in these two regions (Namibia Statistics Agency, 2011).
The proposed Project is in the Karibib constituency, and borders the Omaruru constituency. In this region, the gender split between males and females is almost equal, the unemployment rate is estimated to be 30%, and the average age of the population is 26 years. Figure 25 provides a pictorial representation of the baseline in relation to the Project area.

Figure 25 – An infographic showing the Erongo Region demographic profile (Source Wessels, May 2020)

The socioeconomic baseline study has collated information from a variety of resources, including the 2011 Census, Labour Force surveys, and the Namibian demographic health survey, amongst others – the study is provided in Appendix I. An overview of the two towns closest to the proposed Project is presented in Table 10.
### Table 10 – Socioeconomic baseline study summary of key indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Erongo Region</th>
<th>Omaruru</th>
<th>Karibib</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population estimate 2018</td>
<td>195 652</td>
<td>10 115</td>
<td>15 183</td>
</tr>
<tr>
<td>Gender ratio</td>
<td>53% male, 47% female</td>
<td>52% male, 45% female</td>
<td>48% male, 52% female</td>
</tr>
<tr>
<td>Average age</td>
<td>26</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>Number of households</td>
<td>57 000</td>
<td>2 400</td>
<td>3 500</td>
</tr>
<tr>
<td>Formal houses</td>
<td>65%</td>
<td>70%</td>
<td>67%</td>
</tr>
<tr>
<td>Informal houses</td>
<td>33%</td>
<td>28%</td>
<td>31%</td>
</tr>
<tr>
<td>Schools</td>
<td>19</td>
<td>Six schools:</td>
<td>Five schools:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Gvt secondary and boarding</td>
<td>2 Gvt secondary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Gvt primary</td>
<td>2 Gvt primary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 private primary</td>
<td>1 Pvt primary</td>
</tr>
<tr>
<td>Health facilities</td>
<td>4 hospitals</td>
<td>1 district hospital</td>
<td>1 district hospital</td>
</tr>
<tr>
<td></td>
<td>2 health centres</td>
<td>2 private healthcare facilities</td>
<td>3 clinics</td>
</tr>
<tr>
<td></td>
<td>18 clinics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Karibib is approximately 20km by road from the mine, whereas Omaruru is 52km by road. Despite the further distance, the Proponent has indicated a preference for mine employees to be housed in Omaruru, with its well-established stores, banks and restaurants. Karibib is known for the Navachab Gold Mine, and over 750 employees live in the town, contributing to Karibib’s economy. Figure 26 renders the Erongo population with projections in relation to access to infrastructure and services.
5.7.3  HEALTH

Since independence in 1990, the health status of Namibia has increased steadily, with a remarkable improvement in access to primary health facilities and medical infrastructure. In 2015, the World Health Organisation (WHO) recommended strategic priorities for the health system in Namibia, which entailed improved governance, an improved health information system, emergency preparedness, risk reduction and response, preventative healthcare, and the combating of HIV/AIDS and TB (WHO, 2016).

According to the website of the Ministry of Health and Social Services (MHSS), the Erongo Region has a total of 18 primary healthcare facilities, including two health centres, and four district hospitals. There are also private hospitals in Swakopmund and Walvis Bay. Figure 27 shows an overview of the health facilities in the two towns and region.

As with elsewhere in Namibia, HIV/AIDS remains a major reason for low life expectancy and is one of the leading causes of death in the region. HIV/AIDS remains the leading cause of death and premature mortality for all ages, killing up to half of all males and females aged 40 to 44 years in 2013 (IHME, 2016).
Tuberculosis (TB) is a leading killer of people infected by HIV/AIDS, and Namibia has a high burden in 2018 – 35% of people with TB were infected with HIV. The country is included among the top 30 high-burden TB countries in the world, with an estimated incidence rate of 423 per 100,000 people, and 60 fatalities per 100,000 people in 2018 (retrieved from www.mhss.gov.na).

As at the beginning of 2020, the coronavirus (COVID-19), caused illness in humans at a pandemic scale, and has resulted in an increasing number of deaths worldwide. The viral outbreak has adversely affected various socioeconomic activities globally, and with reports of a continually increasing number of people testing positive, it is anticipated that this may have significant impacts on the operations of various economic sectors in Namibia too. The disease caused many countries to enter a state of emergency, which included various levels of lockdown restrictions that had dire economic consequences. In addition, these measures have had a detrimental effect on tourism, and Namibia is, in both cases, no exception.

Figure 27 – An infographic showing the health profile (Source Wessels, May 2020)
5.7.4 EMPLOYMENT

The Erongo Region is one of the most affluent regions in Namibia, with the second highest per capita income in Namibia at N$16,819 per annum (Environ Dynamics, 2010). In Walvis Bay, most employment is through the harbour, fishing industry, and the processing of sea salt (Walvis Bay Municipality, 2008).

The labour force participation rate is the proportion of the economically active population, given as a percentage of the working age portion of the population (i.e. older than 15 years of age). The rate of labour force participation for the Erongo Region was 80.9% compared to the average of 71.2% for Namibia in 2018 (Namibian Statistics Agency, 2019).

In 2018, 53.4% of all working Namibians were employed in the private sector, and 21.5% by the state. State-owned enterprises employ a further 7.6%, and private individuals 16.6%. Agriculture (combined with forestry and fishing) is the economic sector with the most employees – 23% of all employed persons in Namibia work in this sector. Wages and salaries represented the main income source of 47.4% of households in Namibia (Namibian Statistics Agency, 2019).

Low education levels affect employability and prevent many households from earning a decent income. Of all employed people in Namibia, 63.5% do not have more than a junior secondary level qualification (Grade 10 and lower), and 11.8% of all employed people have no formal education. In total, 29.1% of all employed people fall into the category of “elementary occupation”, and 15.2% into the category of “skilled agriculture”.

Overall, the rate of unemployment is estimated at 33.4% for Namibia, using the broad definition of unemployment. The unemployment rate in rural and urban areas is almost the same – 33.4% in urban areas and 33.5% in rural areas. The highest unemployment rates are found amongst persons with education levels lower than junior secondary. The unemployment rate of persons with no formal education is 28.6%, with primary education at 34.6%, and junior secondary education at 32.7% (Namibian Statistics Agency, 2019).

According to the Namibian Chamber of Mines 2020 annual review, the mining industry employs over 9,000 people directly in the industry – 800 temporary employees and over 6,500 contractors. The mining industry spent almost 2 million Namibian dollars on skills expenditure, including operating mines, and exploration and development companies such as Osino. Figure 28 shows the employment profile of the two towns and the region.
5.7.5 CRIME

Namibia’s crime rate has been on the decline, in general and in the Erongo Region, since 2011. Namibia’s crime index is 65.49 as at October 2021. The town of Omaruru has a police station with 41 police officers, and compared with other towns, it is classified as having a below average rate of crime as shown in Figure 29. Anecdotally, a rising trend of substance abuse in Karibib has been reported during public consultation. The reason for this increasing trend is associated with the limited recreational and entertainment facilities in the Karibib area and is fuelled by the increase in disposal income from those working in the mining and quarrying industry in the area.
5.7.6 ECONOMIC AND BUSINESS ACTIVITIES

Key economic activities of the Erongo Region include agriculture, forestry and fishing, mining and quarrying, manufacturing, tourism, and retail as shown in Figure 30.

Mining plays a pivotal role in the economy of Namibia. Since independence, it has consistently been the biggest contributor to Namibia’s economy in terms of revenue, and accounts for 25% of the country’s income. Mining is one of the main contributors to GDP, and one of the largest economic sectors of Namibia. Mining is a pronounced industry in the Erongo Region, and the main commodities are uranium, gold, salt, and dimension stones.

In addition to the sectors mentioned, the economy of the Erongo Region is dominated by the local economies of Swakopmund and Walvis Bay. In the rural parts of the region, extensive livestock farming is a common activity, but intensive farming is also practiced along the lower part of the Swakop River, and at Omaruru. Several fresh crops are produced, mainly for local consumption.

In the Erongo Region, 67.5% of all households depend on salaries and wages as the main income (Namibian Statistics Agency, 2019). Exact figures do not exist, but this high percentage can be ascribed to the dominance of the mining, fishing, and manufacturing and processing sectors,
together with the prominence of state departments and the administrative sectors in the Erongo Region. A total of 12.6% of households receive their income from business activities (Namibian Statistics Agency, 2019).

Figure 30 – An infographic showing the local economic profile (Source Wessels, May 2020)

5.8 Heritage and Culture

The archaeological field survey and assessment was carried out on the proposed Twin Hills Gold Project site in early February 2021. Several minor archaeological sites were located see Figure 31, and colonial era structures (as shown in Figure 32) that might merit protection under the National Heritage Act (27 of 2004) were assessed by Dr John Kinahan (2021). The heritage assessment report is provided in Appendix G.

The ruined colonial farm building appears to be vulnerable, as is the well-constructed Okawayo farmstead, which was established in the late 19th century and is in relatively good condition. Both may potentially be affected by vibrations from mine blasting that will take place nearby. Further research from the national archives is required to determine the history of these buildings and will be presented in the assessment phase.
Figure 31 – A map showing the location of archaeological sites

Figure 32 – A photo of the 19th Century German buildings on the Okawayo farm
Archaeology has been studied in the areas surrounding the Erongo mountains, 20km to the northwest of the site, but no previous work has been completed at Okawayo itself. The field survey discovered several precolonial sites resembling historical Ovaherero settlements on the south side of the marble ridge, outside of the proposed Project area, but in proximity to the current dimension stone quarrying activities.

The archaeological report indicates that the Project area is considered moderately archaeologically sensitive. This scoping assessment determined that a blast vibration assessment would be required, in order to determine the effects of mining activities on these buildings. This will be presented in the assessment report.

### 5.9 Noise and Vibration

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound, in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable, as it is subjective rather than objective. The IFC General Environmental Health and Safety Guidelines on noise addresses the impacts of noise beyond the property boundary of the facility under consideration and provides noise level guidelines. The IFC states that noise impacts should not exceed levels or result in a maximum increase above background levels of 3 dBA at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity, an increase of less than 3 dBA in the general ambient noise level is not detectable. 3 dBA is, therefore, a useful significance indicator for a noise impact.

A noise baseline survey was conducted on the 7th to 8th of April 2021, at designated points as shown in Figure 33 for the Twin Hills Gold Project site. Airshed Planning Professionals (Pty) Ltd., a firm that specialises in all aspects of air quality, ranging from neighbourhood concerns to regional air pollution impacts, was appointed to conduct the modelling and assessment process. Airshed identified sites to be monitored for day and night-time noise level measurements, for the noise baseline report. Survey sites were selected after careful consideration of future activities, accessibility, potential noise sensitive receptors, and safety restrictions. A total of seven survey sites were selected.

These sites were chosen based on the sensitivity of the areas in terms of proximity to properties within the Project site. Noise sensitive receptors (NSRs) generally include private residences, community buildings such as schools and hospitals, and any publicly accessible areas. The ability of the environment to attenuate noise as it travels through the air was studied by considering land use and terrain. The same map shows the sensitive receptors near and at the proposed Project site.

The baseline acoustic environment was described in terms of the location of NSRs, that is, the ability of the environment to attenuate noise over long distances, as well as existing background and baseline noise levels.
Figure 33 – Baseline noise survey and sensitive receptors
The noise sources of the proposed Project are typical of opencast mining and ore processing facilities. Sources of noise at the Project site will include the following:

- Drilling
- Blasting – although not assessed as part of this study, the character of noise generated by blasting is mentioned. Blasting can cause noise and vibration, which can have an impact upon neighbouring noise receptors. Blasting usually results in both ground and airborne vibration
- Ore and waste handling (loading, unloading, dozing) in open pits, on waste dumps, and in crusher/plant areas
- Crushing and screening of ore
- Haul truck traffic
- Diesel mobile equipment use (including reverse warnings)
- Ore processing activities such as crushing, screening and milling

5.9.1 ATMOSPHERIC ABSORPTION AND METEOROLOGY

Meteorological data from an on-site station, for the period 23 July 2020 to 22 July 2021, was used for the baseline study. The measured data set indicates wind flow primarily from the southwest. At night, the predominant wind direction shifts to the southeast. On average, noise impacts are expected to be more notable to the northwest and northeast of the Project activities.

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a ‘shadowing’ effect for sounds. On a clear night, temperatures may increase with altitude, thereby ‘focusing’ sound on the ground surface. Noise impacts are therefore generally more notable during the night.

5.9.2 TERRAIN, GROUND ABSORPTION AND REFLECTION

Noise reduction caused by a barrier (i.e. natural terrain, installed acoustic barriers, buildings) feature depends on two factors, namely: the path difference of a sound wave as it travels over the barrier compared with direct transmission to the receiver, and the frequency content of the noise (Brüel & Kjær Sound and Vibration Measurement A/S, 2000). Readily available terrain data was obtained from the United States Geological Survey (USGS) website (https://earthexplorer.usgs.gov/) accessed in July 2021. A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

Sound reflected by the ground interferes with the directly propagated sound. The effect of the ground is different for acoustically hard (e.g. concrete or water), soft (e.g. grass, trees or vegetation), and mixed surfaces. Ground attenuation is often calculated in frequency bands, to take into account the frequency content of the noise source and the type of ground between the source and the receiver (AirShed, 2021a). Based on observations, ground cover was found to be acoustically hard.
The main findings from the baseline study were as follows:

- The flow field is dominated by winds from the southwest (daytime) and southeast (night-time)
- Sensitive receptors in the study area consist of industrial sites, individual households, and residential areas (i.e. Usab and Karibib)
- The baseline noise levels (LAeq) for the area surrounding the Project range between 28.6dBA to 54.8dBA for daytime, and 29.4dBA to 50.2dBA for night-time, as shown in Figure 34 and Figure 35

![Figure 34 – A graph showing daytime broadband survey results](image-url)
The aim of this investigation was to provide the basis for the environmental noise impact assessment plan to be conducted for the proposed Project. The following will be included in the environmental noise impact assessment study:

- Compilation of Project source term
- Attenuation modelling of all potential noise sources due to Project operations
- Evaluation of potential noise impacts on human receptors due to Project activities
- Recommendation of mitigation and management measures

The baseline noise study is provided in Appendix C. The noise impact assessment report has been completed and the outcomes of the noise assessment will be reported on in the ESIA Report.

5.10 VISUAL AND SENSE OF PLACE

The proposed Twin Hills Gold Project is situated in a sparsely populated area, with few farmsteads or other possible receptors. Apart from the hunting farm, Okawayo, no other tourist sites are known in the immediate vicinity of the Project. The sense of place of the Project area has already been disturbed by farming activities and the marble quarry, as well as the presence of the nearby airfield.

The marble ridge running northeast southwest across the property may block the view of the mine from Karibib and the B2, but it will be visible from sections of the C33. The Project’s mining landforms will be seen from sections along the C33 road and from the airfield. Project construction and operational processes may lead to excessive dust, and the waste rock dump and tailings
storage facility will alter the landscape in perpetuity. The visual assessment to be undertaken will include the viewsheds for several receptors. Figure 36 to Figure 40 render the expected viewsheds for WRDs and tailings of a facility height of 40m.

The residents of the properties to the northeast of the site will be able to see either a waste rock dump or a combination of waste rock dumps and tailing storage facilities from their properties. The sense of place will be altered for these residents.

The residents of the town of Karibib will not perceive the WRDs nor the tailings facility. They are approximately 15km away, and a 40m structure will not create an unpleasant horizon if sheltered by the marble ridge. Commuters along the C33 and members of the Namibian Airforce at the military airbase would be able to see these features.
Figure 36 – Viewshed model from the centre of WRD 1
Figure 37 - Viewshed model from the centre of WRD 2
Figure 38 – Viewshed model from WRD 3
Figure 39 – Viewshed model from WRD 4
Figure 40 – Combined viewsheds from all waste rock and tailings facilities
5.11 LIGHTING

The night sky in the area is undisturbed. Namibia is known for its clear night skies and excellent stargazing settings. Artificial lighting, floodlights, and lighting for evening mining activities are not visible from the Project site, although there are sites in proximity to the Project that are using lights for mining activities during nightfall. The baseline of undisturbed night skies from lights will be altered during construction and operations of the Project. Impacts associated with lights, and the management and mitigation measures will be addressed in the assessment phase and EMP.

5.12 BIOPHYSICAL ENVIRONMENT BASELINE

5.12.1.1 Climate and meteorology

Namibia is a hyper-arid country. Regionally, there is a growing demand for water due to climate change, population growth, economic development, and urbanisation, which increases pressure on existing water sources. The Twin Hills Gold Project is located in central Namibia in an area that experiences generally hot daytime temperatures throughout the year, while the nights are mild to cool in winter.

The mean annual rainfall is highly variable, ranging between 200mm to 300mm. Generally, evaporation exceeds precipitation, especially during the winter months of April to August, when there is little to no rainfall. The hot and dry season from September to December is dry with high daytime temperatures. Namibia’s rains tend to fall between January and April, but cognisance should be taken of potential changes in weather patterns because of climate change. Runoff in the ephemeral streams can be expected when the water deficit ratio is near neutral in January through April. Figure 41 below renders the wind roses for the period of July 2020 to July 2021 (AirShed, 2021).
Figure 41 – Wind roses for the period 23 July 2020 – 22 July 2021 from data gathered from the on-site weather station
5.12.1.2 Soil

The soil in the Project area is dominated by calcisols, (commonly called calcretes), regisols, and rocky outcrops based on mapping in the Atlas of Namibia. The mapping from the Atlas of Namibia is considered high level, and sampling done during this investigation can be used to improve the mapping of soils in the area.

A soil analysis baseline provides a description of the environment specifically related to soils that occur in the study area. It summarises the soil composition, fertility, land use potential, and erodibility. This information will contribute to the material balance, which could be used for cover material of selected mining landforms.

Eight (8) soil sampling locations were determined by the visible soil differences found on satellite imagery and the planned footprint areas, as depicted in the preliminary economic assessment report (PEA). The baseline soil types in the Project area are presented in Table 11.

Table 11 – Classification of soil type

<table>
<thead>
<tr>
<th>SAMPLE PHOTO</th>
<th>TYPE OF SOIL</th>
<th>REASONING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photo - Soil 1</td>
<td>Gypsic / Neocarbonate</td>
<td>Soft and hardened gypsum accumulation in alluvial material. Calcareous (though soil material dominates horizon); apedal to weak structure; colour variegation; absence of gleying.</td>
</tr>
<tr>
<td>Photo - Soil 2</td>
<td>Gypsic / Neocarbonate</td>
<td>Soft and hardened gypsum accumulation in alluvial material. Calcareous (though soil material dominates horizon); apedal to weak structure; colour variegation; absence of gleying.</td>
</tr>
<tr>
<td>Photo - Soil 3</td>
<td>Gypsic / Neocarbonate</td>
<td>Soft and hardened gypsum accumulation in alluvial material. Calcareous (though soil material dominates horizon); apedal to weak structure; colour variegation; absence of gleying.</td>
</tr>
<tr>
<td>SAMPLE PHOTO</td>
<td>TYPE OF SOIL</td>
<td>REASONING</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><img src="sample-photo-4" alt="Photo - Soil 4" /></td>
<td>Gypsic / Neocarbonate</td>
<td>Soft and hardened gypsum accumulation in alluvial material. Calcareous (though soil material dominates horizon); apedal to weak structure; colour variegation; absence of gleying.</td>
</tr>
<tr>
<td><img src="sample-photo-5" alt="Photo - Soil 5" /></td>
<td>Red apedal / Red Structured</td>
<td>Uniform red colouring; apedal to weak structure; non-calcareous. Uniform red colouring; moderate to strong structure; red cutans.</td>
</tr>
<tr>
<td><img src="sample-photo-6" alt="Photo - Soil 6" /></td>
<td>Red apedal / Red Structured</td>
<td>Uniform red colouring; apedal to weak structure; non-calcareous. Uniform red colouring; moderate to strong structure; red cutans.</td>
</tr>
<tr>
<td>SAMPLE PHOTO</td>
<td>TYPE OF SOIL</td>
<td>REASONING</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td><img src="sample_photo1.jpg" alt="Photo - Soil 7" /></td>
<td>Red apedal</td>
<td>Uniform red colouring; apedal to weak structure; non-calcareous. Quartz stone fragments within a red apedal horizon.</td>
</tr>
<tr>
<td><img src="sample_photo2.jpg" alt="Photo - Soil 8" /></td>
<td>Neocarbonate</td>
<td>Calcareous (though soil material dominates horizon); apedal to weak structure; colour variegation; absence of gleying.</td>
</tr>
</tbody>
</table>

### 5.12.1.3 K-factor

The soil erodibility factor (K-factor) is a quantitative depiction of the characteristic of a particular soil’s erodibility; it is the extent to which soil particles detach and are washed away by rainwater and runoff. The soil erodibility factor can in some cases be described as the rate of erosion per unit index from a specific area. The erodibility factor reflects the susceptibility between different soils when all other impacting factors (infiltration rate, permeability rate, dispersion and total water capacity, abrasion, and rain splash) are all kept constant. The soil erodibility factor (K-factor) ranges in value from 0.02 to 0.69, which is highly influenced by soil texture, although other factors such as permeability, organic matter content, and structure could play a contributing factor (Pacific Northwest National Laboratory, Environmental sciences and risk analyses tools, 2021: [www.pnnl.gov/projects/earth](https://www.pnnl.gov/projects/earth)).

\[
K_{fact} = (1.292)[2.1 \times 10^{-6} f_p^{114}(12 - P_{om}) + 0.0325(S_{struc} - 2) + 0.025(f_{perm} - 3)]
\]

In which:

\[
f_p = P_{silt}(100 - P_{clay})
\]
Where:

- \( f_p \) is the particle size parameter (unitless)
- \( P_{om} \) is the percent organic matter (unitless)
- \( S_{struc} \) is the soil structure index (unitless)
- \( f_{perm} \) is the profile-permeability class factor (unitless)

Soil infiltration rate is the most important factor because it determines how fast the transfer and distribution of water from surface to soil profile happens (Patle et al. 2018). The infiltration rate was calculated by means of a literature analysis, as it was not conducted on-site.

The infiltration rate was determined by making use of the sand, silt, and clay percentages, and the results are shown in Table 12. It was observed that sand content varies from 89% to 97%, with a mean value of 92.75%; silt content varies from 1% to 3%, with a mean value of 1.69%; and clay content varies from 2% to 9%, with a mean value of 5.63%. Table 13 to Table 16 provide details into the factors used in this assessment. The analysis from the first-class method (Patle et al. 2018) was used to determine the infiltration rate of the 8 soil samples, and thus is represented by the following formulae:

\[
EIR = 14.195.35 - 141.75(sand\%) - 142.10(silt\%) - 142.56(clay\%)
\]

**Table 12 – The profile permeability class factor table**

<table>
<thead>
<tr>
<th>THE PROFILE-PERMEABILITY CLASS FACTOR, ( f_{perm} )</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>for very slow infiltration</td>
</tr>
<tr>
<td>2</td>
<td>for slow infiltration</td>
</tr>
<tr>
<td>3</td>
<td>for slow to moderate infiltration</td>
</tr>
<tr>
<td>4</td>
<td>for moderate infiltration</td>
</tr>
<tr>
<td>5</td>
<td>for moderate to rapid infiltration</td>
</tr>
<tr>
<td>6</td>
<td>for rapid infiltration</td>
</tr>
</tbody>
</table>

**Table 13 – Soil structure index**

<table>
<thead>
<tr>
<th>THE SOIL STRUCTURE INDEX</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>for very fine granular soil</td>
</tr>
<tr>
<td>2</td>
<td>for fine granular soil</td>
</tr>
<tr>
<td>3</td>
<td>for medium or coarse granular soil</td>
</tr>
<tr>
<td>4</td>
<td>for blocky, platy, or massive soil</td>
</tr>
</tbody>
</table>
Table 14 – Table of K-Factor calculation

<table>
<thead>
<tr>
<th>Sample</th>
<th>FP</th>
<th>EIR (CM/H)</th>
<th>KFACT ((T HA H)·(HA MJ MM)−1)</th>
<th>SAND (%)</th>
<th>FPERM</th>
<th>SSTRUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topsoil 1</td>
<td>182</td>
<td>3087.634</td>
<td>0.074457</td>
<td>89</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Subsoil 1</td>
<td>182</td>
<td>3150.383</td>
<td>0.07462</td>
<td>89</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Topsoil 2</td>
<td>93</td>
<td>2267.078</td>
<td>0.144082</td>
<td>92</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Subsoil 2</td>
<td>186</td>
<td>2565.331</td>
<td>0.149459</td>
<td>91</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Topsoil 3</td>
<td>184</td>
<td>2833.253</td>
<td>0.106936</td>
<td>90</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Subsoil 3</td>
<td>276</td>
<td>3123.506</td>
<td>0.079819</td>
<td>89</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Topsoil 4</td>
<td>98</td>
<td>870.4121</td>
<td>0.102726</td>
<td>97</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Subsoil 4</td>
<td>96</td>
<td>1474.12</td>
<td>0.102639</td>
<td>95</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Topsoil 5</td>
<td>96</td>
<td>1508.773</td>
<td>0.144754</td>
<td>95</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Subsoil 5</td>
<td>94</td>
<td>2076.692</td>
<td>0.144624</td>
<td>93</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Topsoil 6</td>
<td>180</td>
<td>1580.933</td>
<td>0.149901</td>
<td>95</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Subsoil 6</td>
<td>192</td>
<td>1695.493</td>
<td>0.150637</td>
<td>94</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Topsoil 7</td>
<td>97</td>
<td>1090.751</td>
<td>0.102707</td>
<td>96</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Subsoil 7</td>
<td>192</td>
<td>1775.687</td>
<td>0.108282</td>
<td>94</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Topsoil 8</td>
<td>192</td>
<td>1709.169</td>
<td>0.150368</td>
<td>94</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Subsoil 8</td>
<td>186</td>
<td>2525.336</td>
<td>0.14996</td>
<td>91</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 15 – Laboratory results for the element and organic matter (Geolab, 2021)

<table>
<thead>
<tr>
<th>SAMPLE NO</th>
<th>PH (KCL)</th>
<th>P (Olsen) MG KG⁻¹</th>
<th>K MG KG⁻¹</th>
<th>CA MG KG⁻¹</th>
<th>MG MG KG⁻¹</th>
<th>NA MG KG⁻¹</th>
<th>ORG-C %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topsoil 1</td>
<td>7.5</td>
<td>4</td>
<td>238</td>
<td>2893</td>
<td>166</td>
<td>7</td>
<td>1.38</td>
</tr>
<tr>
<td>Subsoil 1</td>
<td>7.5</td>
<td>3</td>
<td>221</td>
<td>2978</td>
<td>165</td>
<td>10</td>
<td>1.21</td>
</tr>
<tr>
<td>Topsoil 2</td>
<td>7.7</td>
<td>1</td>
<td>91</td>
<td>2773</td>
<td>162</td>
<td>6</td>
<td>1.09</td>
</tr>
<tr>
<td>Subsoil 2</td>
<td>7.8</td>
<td>1</td>
<td>72</td>
<td>2756</td>
<td>167</td>
<td>4</td>
<td>0.90</td>
</tr>
<tr>
<td>Topsoil 3</td>
<td>7.6</td>
<td>2</td>
<td>217</td>
<td>2906</td>
<td>163</td>
<td>11</td>
<td>1.33</td>
</tr>
<tr>
<td>Subsoil 3</td>
<td>7.6</td>
<td>7</td>
<td>170</td>
<td>2935</td>
<td>264</td>
<td>63</td>
<td>1.21</td>
</tr>
<tr>
<td>Topsoil 4</td>
<td>7.4</td>
<td>2</td>
<td>226</td>
<td>1024</td>
<td>160</td>
<td>6</td>
<td>0.47</td>
</tr>
<tr>
<td>Subsoil 4</td>
<td>7.6</td>
<td>1</td>
<td>216</td>
<td>1074</td>
<td>152</td>
<td>4</td>
<td>0.37</td>
</tr>
<tr>
<td>Topsoil 5</td>
<td>6.9</td>
<td>1</td>
<td>144</td>
<td>792</td>
<td>224</td>
<td>7</td>
<td>0.12</td>
</tr>
<tr>
<td>Subsoil 5</td>
<td>7.1</td>
<td>0</td>
<td>112</td>
<td>951</td>
<td>283</td>
<td>6</td>
<td>0.10</td>
</tr>
<tr>
<td>Topsoil 6</td>
<td>7.1</td>
<td>2</td>
<td>182</td>
<td>775</td>
<td>196</td>
<td>3</td>
<td>0.08</td>
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<tr>
<td>Subsoil 6</td>
<td>7.7</td>
<td>1</td>
<td>137</td>
<td>2399</td>
<td>281</td>
<td>9</td>
<td>0.10</td>
</tr>
<tr>
<td>Topsoil 7</td>
<td>7.6</td>
<td>0</td>
<td>162</td>
<td>2839</td>
<td>214</td>
<td>22</td>
<td>0.37</td>
</tr>
<tr>
<td>Subsoil 7</td>
<td>7.7</td>
<td>1</td>
<td>138</td>
<td>2805</td>
<td>255</td>
<td>44</td>
<td>0.47</td>
</tr>
</tbody>
</table>
### Table 16 – Soil erodibility factor (After Stewart et al. 1975 as cited by PNNL, 2021)

<table>
<thead>
<tr>
<th>TEXTURAL CLASS</th>
<th>P_{OM}(%)</th>
<th>&lt;0.5</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>0.05</td>
<td>0.03</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Fine sand</td>
<td>0.16</td>
<td>0.14</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Very fine sand</td>
<td>0.42</td>
<td>0.36</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Loamy sand</td>
<td>0.12</td>
<td>0.10</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>Loamy fine sand</td>
<td>0.24</td>
<td>0.20</td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td>Loamy very fine sand</td>
<td>0.44</td>
<td>0.38</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Sandy loam</td>
<td>0.27</td>
<td>0.24</td>
<td>0.19</td>
<td></td>
</tr>
<tr>
<td>Fine sandy loam</td>
<td>0.35</td>
<td>0.30</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>Very fine sandy loam</td>
<td>0.47</td>
<td>0.41</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>Loam</td>
<td>0.38</td>
<td>0.34</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>Silt loam</td>
<td>0.48</td>
<td>0.42</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>Silt</td>
<td>0.60</td>
<td>0.52</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>Sandy clay loam</td>
<td>0.27</td>
<td>0.25</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Clay loam</td>
<td>0.28</td>
<td>0.25</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Silty clay loam</td>
<td>0.37</td>
<td>0.32</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>Sandy clay</td>
<td>0.14</td>
<td>0.13</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>Silty clay</td>
<td>0.25</td>
<td>0.23</td>
<td>0.19</td>
<td></td>
</tr>
</tbody>
</table>

#### 5.12.1.4 Soil fertility potential

According to the laboratory results, soils 1, 3, 4, 5 and 6 have a high pH and do not require any lime application. The soil sodium adsorption ratio (SAR) is low and does not require gypsum application.

In relation to understanding the soil material for closure and rehabilitation purposes, to improve the fertility potential of the soil from samples 1, 3, 4, 5 and 6 for planting pasture grasses, broadcast 300Kg/ha in a ratio of 1:1:0 (32), add Zn immediately before planting, and work within 10cm. Top-dress 200Kg/ha of limestone ammonium nitrate (LAN) six weeks after planting (Geolab, 2021).
Soil 2 also has a high pH and does not require any lime application. The soil sodium ratio is low and does not require gypsum application. In order to improve the fertility potential of this soil for the establishment of pasture grasses, broadcast 500Kg/ha in a ratio of 2:3:4 (30), add Zn immediately before planting, and work within 10cm. The top-dress is the same as the other soils, and has a requirement of 200Kg/ha LAN six weeks after planting (Geolab, 2021).

In conclusion, the soil analysis survey has determined that the soils have calcrete and marble that can act as a neutralising agent. The topsoil must be kept for rehabilitation, as it is fertile enough to produce grasslands. There will be no need to add lime or gypsum to any of the soils if it gets used for cover material, as the soils have a high pH and low Na and SAR values. The soils have a low erodibility in general.

It is suggested that a detailed soil map depicting stripping depths and available cover soil volumes be created once the final site layout plans are available. These maps should be used to start the stripping and topsoil stockpiling plan, as well as inform the active topsoil balance for life of mine.

5.12.1.5 Air quality

Since June 2020, Environmental Compliance Consultancy has been conducting environmental monitoring and assessments for the Twin Hills Gold Project, for the purpose of reporting on depositional dust, at eight dust monitoring stations located on the Project site. Air quality monitoring is crucial for determining the potential impacts that planned mining operations may have in an environment.

The potential expected sources of dust particulate matter resulting from the operational activities include, but are not limited to: construction activities; mineral material handling and processing; and mining activities like drilling, blasting, and hauling. Therefore, depositional dust monitoring station locations were based on the proposed infrastructure locations likely to generate dust, taking into account prevailing wind. Figure 42 shows the locations of the dustfall sampling locations. Baseline dust fallout conditions do not exceed 200mg/m²/day which is below the limits set for southern Africa. The threshold limits are included in the legend on Figure 42.
Figure 42 – Dustfall monitoring locations and results
Natural environments are complex systems that can be affected by anthropogenic interference such as mining activities, including mineral exploration. To understand the confounding factors and interpret the findings based on the baseline of the receiving environment, deductive and inductive approaches can be used. The wind vectors, topography (e.g. mountains and valleys), seasonal rainfall, and drought are identified as the potential factors that are likely to influence air quality. Wind direction and speed are the primary factors determining the distance of travel of a dust particle and the distribution of particles falling out.

Moreover, as the ESIA for the proposed gold mining activities at the Project site commenced, an air quality specialist study was deemed necessary to determine the potential impacts of atmospheric pollution to air quality for this Project. Airshed Planning Professionals were engaged to model and provide a technical report for the air quality baseline. The baseline report has been completed and is provided in Appendix D. The full air quality impact assessment will be completed, and the assessment outcomes will be reported on in the follow up full ESIA report. The full ESIA report includes a chapter on the degree of potential impact with descriptions of mitigation, and an amended EMP to reflect the assessment.

The ambient air quality guidelines, as contained within the IFC and EHS guidelines of 2007, shall be applied to the assessment. The findings, recommendations, and the way forward, as described in the baseline report, are described hereafter. The main findings from the baseline study can be summarised as follows:

- The terrain is hilly, with a ridge to the north and northwest, and a ridge on the southern side.
- On-site weather data is available for the period 23 July 2020 to 22 July 2021. The wind field is dominated by winds from the southwest and the east to southeast, with the strongest winds from the southwest. During the day, easterly winds prevailed with strong but less frequent winds from the southwest, and at night the wind field shifted to the southwest. Calm conditions were recorded for 7.5% of the time with a period average wind speed of 2.3m/s. Higher wind speeds occurred during the night, with the strongest winds recorded from the southwest. A maximum wind speed of 8.9m/s was recorded.
- Monthly variation in the wind field showed more frequent south-westerly winds during the summer months and a shift to easterly winds in May, and then to the southeast during April to July – the so called “east-winds”. In August, winds from the northwest prevailed, whereafter it shifted to the southwest in September with a remaining easterly component. The winter months were dominated by high velocity north-easterly winds.
- Maximum, minimum, and mean temperatures were given as 42°C, -3°C, and 23°C respectively from the Twin Hills Gold Project on-site weather station for the period Jul 2020 to Jul 2021.
- Rainfall over the 12-month period totalled 254mm, with the highest rainfall month being January 2021 (115mm).
- The main pollutant of concern in the region is particulate matter (TSP; PM10 and PM2.5) resulting from vehicle entrainment on the roads (paved, unpaved, and treated surfaces),
windblown dust, and mining and exploration activities. Gaseous pollutants such as SO2, NOx, CO, and CO2, would result from vehicles and combustion sources, but these are expected to be at low concentrations due to the few sources in the region.

- Sources of atmospheric emissions in the vicinity of the proposed Twin Hills Gold Project include:
  - Vehicle entrainment from roads: The national road to the south (B2) of the Project is the main road between Windhoek and Swakopmund, and one of the roads in the region with the highest traffic counts. It is a paved road with vehicle entrainment calculated to be a significant contributor to the regional paved road PM2.5 and PM10 emissions. The C33 is a paved road connecting the Karibib Airport to the B2, and although no information was available for this road, it is expected to have very low traffic counts and low PM2.5 and PM10 emissions.
  - Windblown dust: Windblown particulates from natural exposed surfaces, mine waste facilities, and product stockpiles can result in significant dust emissions with high particulate concentrations near the source locations, potentially affecting both the environment and human health. Windblown dust from natural exposed surfaces in and at the Twin Hills Gold Project is only likely to result in particulate matter emissions under high wind speed conditions (>10m/s), and since recorded wind speeds did not exceed 10m/s, this source is likely to be of low significance.
  - Mines and exploration operations: Pollutants typically emitted from mining and quarrying activities are particulates, with smaller quantities associated with vehicle exhaust emissions. Mining and quarrying activities, especially open-cast mining methods, emit pollutants near ground level over (potentially) large areas. Mines in proximity to the proposed Project are Navachab Gold Mine, located approximately 20km west-southwest of Karibib, and a number of marble quarries – Capra Hill, Dreamland, and Savanna Marble.
  - Regional transport of pollutants: Regional-scale transport of mineral dust and ozone (due to vegetation burning) from the north of Namibia is a significant contributing source to background PM concentrations.

The dust fall monitoring network comprises eight (8) single dustfall units placed at the Twin Hills Gold Project site, with dustfall data available for the period June 2020 to June 2021. Dustfall rates were generally low for the sampling period, and well within the dustfall limit of 600mg/m²/day (adopted limit for residential areas) and 1 200mg/m²/day (adopted limit for non-residential areas). Dustfall rates were the lowest during the months of June to September 2020, and might have been influenced by the regional lockdown due to COVID-19. The highest dustfall of 520mg/m²/day was recorded at AQ-02 in March 2021. The dustfall results show no clear spatial trend.
Based on the activities associated with the proposed Project (see Section 1.2 of Appendix D), an air quality impact assessment is proposed to be conducted as part of the ESIA. The scope of work will include the following tasks:

- The compilation of an emissions inventory, including the identification and quantification of all emissions associated with the proposed mining, processing, and smelting operations. Pollutants quantified should, as a minimum, include particulate matter (TSP, PM10 and PM2.5) and gaseous emissions (SO2, NO2 and CO). Use should be made of engineering design parameters, emissions standards, and emissions factors published by the US EPA and Australian National Pollutant Inventory (NPI).
- Dispersion modelling will be conducted using an internationally approved dispersion model such as the United Kingdom (UK) Air Dispersion Modelling System (ADMS).
- An impact assessment is to be compiled by comparing ambient pollutant concentration levels to the relevant air quality limits/guidelines, as set out in Section 2.4 of Appendix D, to assess the potential impact on the surrounding environment and human health.
- The identification of air quality management and mitigation measures based on the findings of the compliance and impact assessment.

5.13 GEOCHEMICAL

RGS-ECC is completing a geochemical assessment of mining materials for the Twin Hills Gold Project using relevant legislation, guidelines, and policies to inform the assessment (AMIRA, 2002; COA, 2016; and INAP, 2020). A geochemical analysis of the mine material (waste rock, and low-grade and high-grade ore) is being conducted to assess the mineralogical composition and potential for the generation of acid and metalliferous drainage (AMD), neutral and metalliferous drainage (NMD), saline drainage (SD), or dispersive issues from these materials.

A strategy was developed to collect and geochemically characterise representative samples of mining materials from drill core representing waste rock, low-grade ore and high-grade ore materials. The strategy was developed to align with Australian (AMIRA, 2002, COA, 2016) and international (INAP, 2020) technical guidelines for the geochemical assessment of mine waste materials.

Representative waste rock, and low-grade and high-grade ore samples for the assessment were collected as set out in the RGS-ECC Geochemical Sampling and Analysis Plan (RGS, 2021). A total of 131 samples from six drill holes from the Project were crushed and sub-sampled, pulverised to pass 75μm sieve size, bagged, labelled, sealed, and then transferred to a commercial laboratory (Analytical Laboratory Services in Windhoek and SGS in South Africa) for static geochemical testing as shown in Table 17.
Table 17 – Sample materials used for geochemical testing

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>Number of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twin Hills Central Waste Rock – no alteration, mineralisation</td>
<td>65</td>
</tr>
<tr>
<td>Clouds Waste Rock – no alteration, mineralisation</td>
<td>5</td>
</tr>
<tr>
<td>Twin Hills Central Waste Rock – alteration, mineralisation</td>
<td>28</td>
</tr>
<tr>
<td>Clouds Waste Rock – alteration, mineralisation</td>
<td>16</td>
</tr>
<tr>
<td>Twin Hills Central Ore – oxidised</td>
<td>3</td>
</tr>
<tr>
<td>Clouds Ore – oxidised</td>
<td>3</td>
</tr>
<tr>
<td>Twin Hills Central Ore – alteration, mineralisation</td>
<td>9</td>
</tr>
<tr>
<td>Clouds Ore – alteration, mineralisation</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>131</strong></td>
</tr>
</tbody>
</table>

The geochemical test program was designed to assess the degree of risk from the presence and potential oxidation of sulfides, acid generation, and the presence/leaching of soluble metals/metalloids and salts. The preliminary results from the ABA data trends are presented below.

**pH:** The pH of the samples tested ranges from 6.1-10.2 (i.e. in the neutral to moderately alkaline range) and has a median value of 9.4 (Figure 43). The only samples with a pH value less than 8 are three waste rock samples with phyllic alteration and pyrrhotite mineralisation from the Clouds deposit. Hence, the majority of the samples have moderately alkaline pH values greater than the deionised water used in the tests, suggesting that, at least initially, the addition of alkalinity to water in contact with these materials is likely.

![Figure 43 - pH values for waste rock and ore (Source ECC:RGS, 2021)](image-url)
Electrical conductivity (EC): The EC value of the 51 samples ranges from 19 to 272µS/cm and is generally low (median 58µS/cm) (Figure 44). The only samples with an EC value greater than 200µS/cm are two waste rock samples with phyllic alteration and pyrrhotite mineralisation from the Clouds deposit. Hence, at least initially, waste rock and ore materials are likely to have a low salinity value.

Figure 44 – EC values for waste rock and ore (Source ECC:RGS, 2021)

Total sulfur: The total sulfur content of the 131 waste rock and ore samples range from 0.005 to 3.08%S and has a low median value of 0.11%S. Most of the waste rock and ore samples that have not been altered, or are without mineralisation, have a very low total sulfur concentration below the median crustal abundance (0.1%S) for this element in unmineralised soils (INAP, 2020; Bowen, 1979).

In contrast, most of the waste rock and ore samples that are altered, and/or contain mineralisation, have elevated total sulfur concentrations that are likely to be present in the form of pyrrhotite and/or pyrite (Figure 45).

Figure 45 – Total sulfur concentrations for waste rock and ore (Source ECC:RGS, 2021)
Maximum potential acidity (MPA): Based on the total sulfur content, the maximum potential acidity (MPA) that could be generated by the 131 waste rock and ore samples ranges from 0.2 to 94.3kg H₂SO₄/t with a low median value of 3.4kg H₂SO₄/t. The altered and/or mineralised waste rock and ore samples have a much higher potential for generation of acidity through sulfide oxidation than the waste rock and ore with no alteration and/or mineralisation.

Acid neutralising capacity (ANC): The ANC value for the 131 waste rock and ore samples ranges from below the laboratory limit of reporting (0.5kg H₂SO₄/t) to 680.0kg H₂SO₄/t, and has a median value of 16kg H₂SO₄/t. The highest ANC values were recorded for the calcrete waste rock samples and is generally more than an order of magnitude greater than the median ANC value.

Net acid producing potential (NAPP): The NAPP is the balance between the capacity of a sample to generate acidity (MPA) minus its capacity to neutralise acidity (ANC). The calculated NAPP values for the 131 waste rock and ore samples ranges from -679.1 to +85.8kg H₂SO₄/t with a negative median value of -10.5kg H₂SO₄/t. The most negative NAPP values were generally recorded for the calcrete waste rock samples, and the most positive NAPP values were recorded for some of the altered and mineralised waste rock and ore samples.

The results of the information review and static geochemical test program to date have been used to provide some preliminary conclusions as to whether the exposed waste rock and ore materials at the Project will present environmental risks that will need to be managed.

The geochemical assessment to date has found that:

- Waste rock and ore materials that have not been altered and are not mineralised, generally have low sulfur content, excess ANC, and are classified as NAF. Calcrete waste rock is also a good source of acid consuming material as it has a very high ANC value.
- Altered and mineralised waste rock and ore materials generally have elevated sulfur content, low to moderate ANC, and are generally classified as PAF. These materials will need to be selectively handled and managed at the Project.

The results of the initial static geochemistry assessment programme on waste rock and ore materials at the Project indicate that most waste rock that has not been altered and is not mineralised, is likely to be NAF. Thus, it is potentially suitable for use in surface infrastructure and final landforms at the Project. In contrast, altered and/or mineralised waste rock and ore stockpile materials are not suitable for use in surface infrastructure and final landforms.

5.14 WATER

The Project area falls in the Khan River catchment, which is in turn a sub-catchment of the Swakop River. Drainage in the area is dendritic with ephemeral streams, often steeply incised, forming small tributaries of the ephemeral Khan River, which flows south-westwards towards the Swakop River (Figure 46).
Figure 46 – Surface water flow showing ephemeral rivers and the Project area (source KP, 2021)
Major surface drainage lines in the Project area include the Aroab Minor in the west, the Okawayo Minor in the centre, and the Slang Minor river in the east. The catchment area (Figure 47) upstream of the planed mining pit is approximately 92km², with a watercourse length of roughly 28km (Knight-Piesold, 2021).

Small streams also flow southwards off the marble ridge into a stream that flows parallel to the ridge, before turning north-westwards to dissipate in the red sands south of the airfield.
Figure 47 – Okawayo River catchment area (source KP, 2021)
The local surface water resources have not been significantly impacted by the current farming land use, although small dams and boreholes are expected to have supplied the farmsteads. There is also no urbanisation or industrial development in the larger catchment areas south of the proposed mine, so the local surface water resources are unlikely to be significantly polluted (SLR, 2020).

5.14.1.1 Stormwater control

Runoff generated within the planned mining area, processing plant, handling, haul, and waste management areas should be managed by adding stormwater infrastructure, consisting of diversion channels, silt traps, berms gutters, pollution control reservoirs, and other components. The infrastructure is required to prevent dirty water, which was in contact with the mining-related activities, to pollute the surrounding areas, and to allow for storage and retention of polluted water on-site (Knight-Piesold, 2021).

Knight-Piesold (2021) proposed that an attenuation dam be constructed upstream of the pit on the main catchment tributary, to prevent potential damage to infrastructure and pollution of the environment as result of a major flood event. The daily rainfall-runoff sequence was correlated against the scaled Spesbona flow gauging data, and it was determined that the simulated (i.e. modelled) runoff sequence is deemed acceptable for stormwater balance purposes upstream of the mining pit. This expectation is based on the conceptual model developed to date.

A high-level topographic assessment of the gorge upstream of the pit was conducted to determine elevation, area, and storage relationships. Two options were investigated:

Option 1 covers the construction of an attenuation dam and diversion channel upstream of the farmhouse (Figure 48). Studies suggest that there are heritage sites on the banks of the river in that ravine, and this option should not impact them. Figure 49 shows cross-sections of the infrastructure used in Option 1 simulations.
Figure 48 – Stormwater attenuation dam and diversion spillway (Option 1) (source KP, 2021)
Figure 49 – Cross-sections of the stormwater attenuation dam and diversion (source KP, 2021)
Option 2 is the construction of a diversion weir and channel closer to the current proposed pit layout (Figure 50), which acts as a stormwater diversion structure on the main watercourse between the two open pits. Figure 51 shows cross-sections of the infrastructure used in Option 2 simulations.

Figure 50 – The stormwater attenuation weir (Option 2) and diversion (source KP, 2021)
Figure 51 – Cross-sections of the stormwater attenuation weir and diversion (source KP, 2021)
The storage and elevation assessment for Option 1 indicated that the lowest elevation of the stormwater facility is at 1205masl, and the highest level of the reservoir at 1235masl, resulting in an approximate total storage volume of 18.4Mm³. The storage and elevation assessment for Option 2 indicated that the lowest elevation of the stormwater facility is at 1200.8masl, and the highest level of the reservoir is at 1210masl, resulting in an approximate total storage volume of 864 000m³ (Knight-Piesold, 2021).

The attenuation weir and diversion channel of option 2 would be sufficient for diverting stormwater away from the open pit. The weir would also provide some surface water for use in the mine processing plant. There would be sufficient freeboard and most of the flood water flowing from the catchment upstream would bypass the open pits. Option 2 would require that both the attenuation weir and dam would need constructing, the former acting as a backup in the event of any failure in the dam wall upstream. Most if not all flood water would be collected in the attenuation dam as it takes into account the flood capacity of a 1 in 50 year flood event. Option 2 would provide in the order of magnitude, 20 times the capacity of the weir structure which could potentially resolve the water supply needs of the mine thereby placing less pressure on the existing sources of water in the area, be it groundwater or Namwater pipeline water. Additional points on water supply are discussed in the next section.

5.14.1.2 Mine water supply and preliminary studies

The current mine design indicates a daily requirement of 4 100m³/day (1.5 million m³/annum) for the estimated 3.5 million tons per annum (mtpa) ore throughput, to sustain mining operations and related activities.

Water supply options that were also addressed in the SLR (2020) Report, were as follows:

- Three potential local dam sites on the Khan River, with catchment areas ranging from approximately 2 100km² to 2 400km² (See Figure 52).
- Obtaining a water use license from the existing NamWater Swakoppoort to Karibib Pipeline, provided that there is sufficient capacity for mining activity.
- Planned desalination pipeline, which will primarily be used to support the Central Area of Namibia (CAN). According to the CAN Surface Water Augmentation Report, the desalination pipeline will supply water at the earliest in 10 years.
- Groundwater supply from boreholes.
Figure 52 – Proposed dam constructions by SLR (2020) for surface water supply (source KP, 2021)
Long drought periods of up to seven years, typically referred to as critical periods, are common to the Namibian climate. During a long critical period, the groundwater table drops significantly due to limited recharge, causing some boreholes to dry up. Similarly, surface water sources, which are already stressed, might not be able to support priority users, resulting in water restrictions being enforced to prevent the failure of the water resource. Local dam options are typically developed over a long timeframe, in excess of 5 to 10 years, due to land acquisition, environmental and social studies, and full design and construction cycles. Developing water resources is also very costly due to the aforementioned factors (Knight-Piesold, 2021).

The pipeline route for the desalination support to the CAN will follow the B2 Road from Swakopmund to Okahandja, adjacent to the mining operation. Water supply from the desalination pipeline will be costly due to the high pumping costs and the expensive desalination process itself. The desalination plant and pipeline are planned to be implemented in 2031, and it is estimated that one cubic meter of water is going to cost more than N$ 45 at 2020 infrastructure costs. The official reports have not yet been made publicly available. The unit cost is likely going to increase significantly, due to the inflation of electricity and general costs (Knight-Piesold, 2021).

5.14.1.3 Groundwater

A desktop regional hydrocensus was conducted in 2020 (SLR, 2020) as part of the baseline studies, and a summary of the findings is presented here. Figure 53 provides a map of the classification of the aquifers and the hydrocensus results.
Figure 53 – Classification of aquifers and hydrocensus results (SLR, 2020)
The Project site falls within the Erongo groundwater basin. Twenty-four active boreholes were found in the Project area and show that the local groundwater table is relatively shallow, with water levels ranging from 6m to 57m below ground level. Groundwater is supplied from local boreholes to the farmers and quarry operations in the area. Borehole yields in the area are variable, and generally low, and the water quality is variable (SLR 2020).

The regional general groundwater flow, interpolated from the GROWAS database produced by SLR (2020), flows in a north-westerly direction from the high ground of the Otjipatera Mountains, southeast of the B2, across the proposed mine pit zone and towards the Khan River.

Knight Piesold is currently undertaking groundwater exploration on-site to determine the groundwater resource potential and have conducted drilling and aquifer test pumping. Figure 54 indicates the current distribution of boreholes that have been pump tested (including those from the SLR, Nov 2020 report), with the associated individual yields. As at the date of this report, the accumulated indicative yield is 70m³/hr (Knight-Piesold, 2021).
Figure 54 – Groundwater boreholes showing hourly yields (KP, 2021)
Additional boreholes that had higher blow yields are currently undergoing long-term constant discharge tests and will be added to the overall groundwater resource, which is estimated to add another 20m$^3$/hr to 30m$^3$/hr, making an estimated total of between 90m$^3$/hr to 100m$^3$/hr. Once the exploration program is completed, the test pumping results will be integrated into a Feflow numerical model to determine sustainable yields when abstracting from multiple boreholes, and to identify further exploration targets. The model will also determine the inflow volumes to the pit over the LOM, which can be added to the total groundwater resource (Knight-Piesold, 2021).

The maximum expected groundwater yield per annum could potentially contribute approximately 800 000m$^3$. Together with Option 2 of the surface water supply within the mining licence area of the same magnitude, the total supply to the mine could amount to 1.6M$^3$/per annum thus excluding the need to tap into the NamWater supply.

The groundwater yield is conditional on the following:

- Only if the Proponents pump for 24 hours every day.
- There is uncertainty as to how the boreholes will interact with each other (interference with drawdown cones).
- There is no need to adjust pumping rates and/or hours, etc.

These conditional points will be better understood with the numerical model and phase 2 fieldwork, which could include additional drilling and test pumping. This additional information will only be available at the end of the assessment phase. Due to the aforementioned drought conditions and current uncertainties regarding the sustainability of the groundwater yield, it will most likely be required that NamWater supply will also need to be considered.

Based on the Knight-Piesold (2021) study, the following conclusions were made:

- The mean annual runoff volume for the catchment is expected to be 650 000m$^3$, based on a unit runoff of 7mm per annum over the catchment upstream of storm water control Option 1.
- The flood attenuation model captures multiple day events, indicating that a dam size of 17.9 million m$^3$ is required to absorb a flood without any spills.
- The attenuated floodwater, in conjunction with a NamWater connection and/or groundwater resources, indicate that they can likely support the mining activities.

The following recommendations were made:

- The final dam and spillway capacity depends on a detailed financial and risk assessment, with detailed design.
- A more detailed topographical survey upstream of the mine pit should be conducted to determine a more accurate inundation boundary near the existing farmhouse and other relevant structures.
- Once the final mine layout is available, internal stormwater infrastructure and management should be assessed and stormwater intervention designed.
Review the proposed water supply options with the updated mine layout plan, as well as including the groundwater resource options.

5.15 BIODIVERSITY

Peter Cunningham (2021a; 2021b) undertook a rapid assessment study (screening initial project options) and a baseline study (fixed project scope) of the vertebrate fauna and flora. The reports are provided in Appendix F. The baseline study (Cunningham 2021b) is the basis upon which the full assessment will be carried out, notwithstanding the relevant information gathered and recorded in Cunningham’s (2021a) rapid assessment report, which was produced subsequent to the winter and summer biodiversity surveys.

5.15.1 FLORA

A literature review of the vegetation done by Peter Cunningham (2021a; 2021b), the ecologist undertaking the baseline study and site visits, determined that the area around Karibib is commonly referred to as the Semi-desert Savannah and Transition Zone (Giess 1971, Van der Merwe 1983) or as the Western Highlands, as described by Mendelsohn et al. (2002). This semi-desert and savannah transition zone, as referred to by Giess (1971), is typified by shrubs such as *Blepharis pruinosa*, *Leucosphaera bainesii*, and *Monechma genistifolia*. Larger woody species such as *Acacia erioloba* are confined to the drainage lines.

It has been estimated that at least 74 to 101 larger tree and shrub species, and up to 80 grass species occur in the general Karibib area, of which a high proportion are endemics.

Summer field studies have been undertaken for the Twin Hills Gold Project. Vegetation was lush following exceptional rains during December 2020 and January 2021. Three zones of vegetation were defined, the plains, hills and rivers. Protected tree species that occur within these zones include: *Acacia erioloba*, *Albizia anthelmintica*, *Aloe littoralis*, *Boscia albitrunca*, *Cyphostemma currorii*, *Faidherbia albida*, *Ziziphus mucronata*, *Commiphora glaucescens*, *Commiphora virgata*, *Euphorbia guerichiana*, *Euphorbia avasmontana*, *Ficus cordata*, *Maerua schinzii*, *Moringa ovalifolia*, *Sterculia africana*, *Combretum imberbe*, and *Euclea pseudebenus*.

These trees provide habitat or food for much of the fauna that is found in the area. Large trees are found along the drainage lines and should be protected. The greatest biodiversity will be found on the marble ridge, and although some of its length is excluded from the gold mining activity, potential cumulative impacts associated with the dimension stone quarrying activities of the neighbours are likely.

Seventeen grass species were identified during the field study, as were several invasive and alien vegetation types, mainly in the vicinity of the farmhouses. The invasive species will need to be removed, particularly where they are invading along drainage lines.

The most important areas identified were the following:

- The limestone/marble hills and ridges (Figure 55)
- The ephemeral watercourses (Figure 56)
- The ephemeral pans (Figure 57)
5.15.2 FAUNA

The Twin Hills Gold Project is located in an area of high biodiversity according to The Atlas of Namibia (Mendelsohn et al. 2002). Distribution maps show a high probability for the occurrence of leopard, brown hyena and African rock python. Various endemic reptiles and scorpions are also expected to potentially occur in the area. The area is also known for high levels of endemism for birds. Figure 58 renders an image of a rodent and lizard species.

The variety of geomorphological units (hill slopes, marble ridge, grasslands and streams) provides a number of diverse habitats, making it likely that there will be an equally high level of faunal diversity in the area. It is estimated that at least 75 species of reptile, 7 amphibian, 88 mammal, and 217 birds occur in the general/immediate Karibib area, of which a high proportion are endemics (e.g. reptiles ~45.3%).

The summer field investigation and results of surveys undertaken by the specialist in the same area confirmed that at least 34 species of mammals are present, including leopard and African wildcat. Another 3 species that were observed are: impala, Burchell's zebra, and eland but these were not included in the count as they were probably introduced to the game/hunting farm Okawayo.
Figure 58 – Photos from the field biodiversity survey (Cunningham, 2021)

Of the reptiles, only 12 species were confirmed from the area, which included 1 terrapin, 4 skinks, 3 Old World lizards, 2 agamas and 2 geckos. The farm manager confirmed another 8 species, which include: tortoise, python, 4 typical snakes (including black mamba), monitor lizard and a chameleon. Thus 20 species are confirmed from the area. A total of ± 26 species are confirmed if one includes species identified by the ecologist on other studies in the surrounding area.

The recent rains contributed to standing bodies of water on the farm and in the drainage lines. Most were unfortunately muddy and Phrynomantis annectens tadpoles were only seen in one drinking trough. Seven species of amphibians, of which 2 are endemic, are expected to occur in the area.

Field work confirmed the existence of 56 bird species of the 217 expected from the literature reviews. A total of at least 108 species are confirmed from the general area, with the inclusion of the farmer's sightings and other studies by the ecologist. The most important species confirmed from the area during the field work are Monteiro's hornbill (endemic), Kori bustard (NT), white-backed vulture (E), lappet-faced vulture (V), and secretary bird (V).

As an introduction to scoping out the potential impacts that could result from the Project, the specialist (Cunningham 2021a) stated the following:

- All developments change or are destructive to the local fauna and flora to some or other degree. Assessing potential impacts is occasionally obvious, but more often difficult to predict accurately. Such predictions may change depending on the scope of the development, i.e. development, once initiated, may have a different effect on the fauna and flora than originally predicted. Thus continuing monitoring of such impacts during the Project’s phase(s) is imperative.

The initial baseline study included an earlier high-level assessment of the various alternatives that were presented during the screening phase of the ESIA (Cunningham, 2021a). Since then, some aspects of the Project have changed and certain alternatives have been discarded. The baseline study was updated to consider the fixed options for the assessment phase. The latest baseline study by Cunningham (2021b) can be found in Appendix F.
In light of the fixed scope and layout of the Project, the following potential infrastructure impacts are discussed. These feed directly into the assessment phase and each will be assessed in turn. These aspects will look at reptiles, amphibians, mammals, birds, and the flora.

Vertebrate fauna species most likely to be adversely affected by the proposed mining/prospecting in the Twin Hills Gold Project areas would be sedentary species (i.e. species with limited mobility), such as unique reptiles (i.e. tortoises *Stigmochelys pardalis* and *Psammobates oculiferus*; pythons – *P. anchietae* and *P. natalensis*; Namibian wolf snake (*Lycophidion namibianum*) – *Varanus albigularis*; some of the endemic and little-known gecko species, e.g. *Pachydactylus* species; and species viewed as “rare”, i.e. *Rhinotyphlops lalandei*, *Mehelya vernayi*, and *Afroedura africana* (although very little is known about these species). Amphibians are not viewed as important in the area and mammals are more mobile. Although important species are known to occur and/or pass through the area (see elsewhere in this report), none are expected to be specifically associated and/or expected to be negatively affected by the developments. Although general disturbances could affect bird species of concern, i.e. species classified as endangered (violet wood-hoopoe, Ludwig’s bustard, white-backed vulture, black harrier, tawny eagle, booted eagle, martial eagle, black stork), vulnerable (lappet-faced vulture, secretary bird), and near threatened (Rüppel’s parrot, kori bustard, Verreaux’s eagle, peregrine falcon, marabou stork), birds are also mobile and not limited to the area.

Flora species most likely to be adversely affected by mining/prospecting would be the various protected species, although these species are not specifically associated with the development sites. Important areas in the general vicinity are viewed as hills (limestone/marble hills), ephemeral drainage lines, ground dams and pans, and bird flight paths.

The WRD 2 would cover parts of the northern tributaries of the Okawayo River and should be avoided. The proposed water pipeline should not be placed above ground, as this would act as a barrier to ungulates and ostrich and should be buried.

Bird flight diverters (BDFs) should be attached to the proposed 66kV transmission line from the tarmac road to the mine plant area, to minimise/prevent avifauna mortalities. Although the proposed Okawayo River diversion would affect vertebrate fauna and flora directly associated with the loss of habitat and thoroughfare, the diversion would eventually be vegetated again and serve the same purpose. This proposed diversion is viewed as the best option for the river diversion compared to other alternatives discussed in Cunningham (2021a).

It is not expected that mining/prospecting developments will adversely affect any unique vertebrate fauna and flora in the Twin Hills Gold Project areas, especially if the proposed recommendations (mitigation measures) are incorporated. The recommended mitigations are not listed here, as they need to be finalised based on the final assessment. These draft recommended mitigation measures can be read in each section of the Cunningham (2021b) baseline biodiversity report found in Appendix F. An assessment of the potential impacts will be carried out using the impact assessment methodology used by ECC in the assessment phase.
6 IMPACT IDENTIFICATION & EVALUATION METHODOLOGY

6.1 INTRODUCTION

Chapter 2 provides an overview of the approach used in this ESIA process, and details each of the steps undertaken to date. Prediction and evaluation of impacts is a key step in the ESIA process. This chapter outlines the methods that will be followed, in order to identify and evaluate the impacts arising from the proposed Project. The findings of the assessment will be presented in the full assessment report.

This chapter provides comprehensive details of the following:

- The assessment guidance that will be used to assess impacts.
- The limitations, uncertainties, and assumptions with regards to the assessment methodology.
- How impacts will be identified and evaluated, and how the level of significance will be derived.
- How mitigation will be applied in the assessment, and how additional mitigation will be identified.
- The cumulative impact assessment (CIA) method that will be used.

The aims of this assessment will be to determine which impacts are likely to be significant; to scope the available data and identify any gaps that need to be filled; to determine the spatial and temporal scope; and to identify the assessment methodology.

The scope of the assessment was determined through undertaking a preliminary assessment of the proposed Project against the receiving environment, and was obtained through a desktop review, available site-specific literature, monitoring data, and site reports, as set out in this scoping report.

6.2 ASSESSMENT GUIDANCE

The following principal documents will be used to inform the assessment method:

- Namibian Draft Procedures and Guidance for EIA and EMP (Republic of Namibia, 2008).

6.3 LIMITATIONS, UNCERTAINTIES AND ASSUMPTIONS

The following limitations and uncertainties associated with the assessment methodology will be considered in the assessment phase:
- Topic specific assessment guidance has not been developed in Namibia. A generic assessment methodology will be applied to all topics using IFC guidance and professional judgement.

- Guidance for CIA has not been developed in Namibia, but a single accepted state of global practice has been established. The IFC’s guidance document (International Finance Corporation, 2013) will be used for the CIA.

6.4 ASSESSMENT METHODOLOGY

The ESIA methodology applied to this assessment has been developed by ECC using the International Finance Corporation (IFC) standards and models, in particular performance standard 1: ‘Assessment and management of environmental and social risks and impacts’ (International Finance Corporation, 2017); Namibian Draft Procedures and Guidance for EIA and EMP (Republic of Namibia, 2008); international and national best practice; and over 25 years of combined ESIA experience. The methodology is set out in Figure 59 and Figure 60.

The evaluation and identification of the environmental and social impacts require the assessment of the Project characteristics against the baseline characteristics, ensuring that all potentially significant impacts are identified and assessed. The significance of an impact is determined by taking into consideration the combination of the sensitivity and importance/value of environmental and social receptors that may be affected by the proposed Project, the nature and characteristics of the impact, and the magnitude of any potential change. The magnitude of change (the impact) is the identifiable changes to the existing environment that may be negligible, low, minor, moderate, high, or very high; temporary/short-term, long-term or permanent; and either beneficial or adverse.
Figure 59 – ECC ESIA methodology based on IFC standards
Figure 60 – ECC ESIA methodology based on IFC standards
6.5 Mitigation

Mitigation comprises a hierarchy of measures ranging from preventative environmental impacts by avoidance, to measures that provide opportunities for environmental enhancement. The mitigation hierarchy is: avoidance; reduction at source; reduction at receptor level; repairing and correcting; compensation; remediation; and enhancement.

Mitigation measures can be split into three distinct categories, broadly defined as:

1. Actions undertaken by the ESIA process that influence the design process, through implementing design measures that would entirely avoid or eliminate an impact, or modifying the design through the inclusion of environmental features to reduce the magnitude of change. These are considered as embedded mitigation.
2. Standard practices and other best practice measures for avoiding and minimising environmental impacts. These are considered as good practice measures.
3. Specified additional measures or follow-up action to be implemented, in order to further reduce adverse impacts that remain after the incorporation of embedded mitigation. These are considered as additional mitigation.

The ESIA is an iterative process whereby the outcomes of the environmental assessments inform the Project.

The draft EMP (Appendix A) provides the good practice measures and specified additional measures or follow-up action.

Embedded mitigation and good practice mitigation will be taken into account in the assessment. Additional mitigation measures will be identified when the significance of impact requires it and causes the impact to be further reduced. Where additional mitigation is identified, a final assessment of the significance of impacts (residual impacts) will be carried out, taking into consideration the additional mitigation.
7 ASSESSMENT TERMS OF REFERENCE

A full impact assessment will be completed with input from stakeholders during the public participation phase. Specialist studies that have been received, may be reviewed or reassessed based on the findings from the public participation phase. A final draft EMP will be produced to manage residual impacts that cannot be mitigated through the Project evolution process.

A full environmental and social impact assessment (ESIA) is required for a large-scale mining operation like the Twin Hills Gold Project. The scoping phase progress to date has demonstrated that the following components should be included in the assessment phase.

These terms of reference (ToR) for the assessment phase will be updated, if necessary, once the public review of the scoping report has been finalised:

- Soil impact assessment
- Acid mine drainage impact assessment
- Groundwater study and surface water impact assessment
- Biodiversity impact assessment
- Noise impact assessment
- Air quality impact assessment
- Traffic impact assessment
- Visual impact assessment
- Socioeconomic impact assessment
- Mine blast vibration assessment
- Heritage impact assessment
8 CONCLUSION

This draft scoping report provides the baseline data for the assessment phase of the ESIA. The commissioned studies have filled in the data gaps. The following specialist studies have provided sufficient baseline data:

- Noise baseline
- Air quality baseline
- Biodiversity baseline
- Heritage baseline
- Socioeconomic baseline
- Water resource (surface water or groundwater)
- Traffic baseline
- Soil baseline
- Visual baseline
- Acid mine drainage baseline
- Blasting and vibration baseline

The finalised baseline studies and information have informed the scope of the terms of reference (ToR) for the assessment phase. Each study highlighted certain sensitivities that need to be assessed.

This draft scoping report with ToR for the assessment phase of the ESIA provides the basis needed, in order for the ESIA to be undertaken. This scoping report will only be finalised after the public review of the report. All concerns and comments will be considered, and the necessary changes to the ToR and additional aspects of the baseline will be incorporated accordingly.
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30 NOVEMBER 2021  REV 04  PAGE 146 OF 160

ECC Report No: ECC-103-332-REP-01-A


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APPENDIX A – DRAFT ENVIRONMENTAL MANAGEMENT PLAN
APPENDIX B – PUBLIC CONSULTATION RECORDS
APPENDIX C – NOISE BASELINE ASSESSMENT
APPENDIX D – AIR QUALITY BASELINE ASSESSMENT
APPENDIX E – WATER BASELINE STUDIES
APPENDIX F – BIODIVERISTY STUDIES
APPENDIX G – ARCHAEOLOGICAL BASELINE
APPENDIX H – TRAFFIC IMPACT STUDIES
APPENDIX I – SOCIOECONOMIC IMPACT ASSESSMENT