GRAFEX ANCUABE GRAPHITE MINE PROJECT,
ANCUABE, MOZAMBIQUE

ENVIRONMENTAL, SOCIAL AND HEALTH IMPACT ASSESSMENT

DRAFT FOR SUBMISSION TO DPTADER AND MITADER

Prepared for:
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25 Setembro Avenue nº. 1383,
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JANUARY 2018
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Coastal and Environmental Services

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<tr>
<td>°C</td>
<td>Degrees Celsius</td>
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<tr>
<td>µg/m³</td>
<td>Microgram per cubic metre</td>
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<td>µm</td>
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1. INTRODUCTION

1.1. PROJECT OVERVIEW

Grafex Lda. ("Grafex") intend to develop and mine graphite in the district of Ancuabe, Cabo Delgado Province, northern Mozambique. The proposed Grafex Lda. Ancuabe Graphite Project "the project" spans three adjacent exploration licenses (EL 5380, EL 5305 and EL5336) and covers approximately 51,094ha. The proposed project infrastructure, for which a Direito do Uso e Aproveitamento da Terra (DUAT) is being applied, covers approximately 9,000ha within which there are four known resources that Grafex intend to exploit. However, only two of the deposits (T12 and T16) form part of this Environmental, Social and Health Impact Assessment (ESHIA). The other deposits may be mined at a later stage and will be subject to their own environmental assessment.

Each deposit contains large flake graphite which is ideal for creating cost efficient battery grade anode material which will be sold to the Asian markets for primary use in Lithium ion storage batteries. Lithium ion storage batteries are used for clean, renewable energy.

This project has been classified as a Category A project (Appendix A) by the Ministério da Terra, Ambiente e Desenvolvimento Rural (Minister of Land, Environment and Rural Development), or MITADER, and therefore requires a full environmental, social and health impact assessment (ESHIA) due to the nature of the expected impacts. Coastal and Environmental Services Limitada (CES) have been contracted to undertake the ESHIA in accordance with the National Environmental Management Act (Law 20/1997 of October 1st as amended by the Decree 42/2008); under Mozambique's most recent EIA regulations (Decree 54/2015 of December 31) and in accordance with lender standards, namely the International Finance Corporation.

MITADER is the lead environmental agency in Mozambique, and it is MITADER who is responsible for the review and issuing of an environmental licence.

1.2. THE PROPONEENT

*Grafex Limitada (Grafex)* is a Mozambican company with a portfolio of five (5) graphite prospecting licenses in the Cabo Delgado Province of Mozambique that have subsequently been converted to Exploration Licenses. *Grafex Limitada (Grafex) is a 80% owned subsidiary of Triton United Limited a United Arab Emirates offshore company which in turn is a 100% owned subsidiary of Minerals Limited (Triton)*, a diversified minerals exploration company in Australia and listed on the Australian Securities Exchange (ASX). In 2012 Triton made an agreement to purchase an interest in the mineral tenements of Grafex and has to date acquired an 80% share of Grafex.

Triton, via Grafex, aims to become a long term supplier to the premium graphite concentrate market via its projects in Mozambique, providing a sustainable future for several generations. The proponent for this project:

Grafex Limitada:

*Mr Gidião Mbanze*
Project Manager
Grafex Lda
25 Setembro Avenue nº. 1383,
6º floor, Flat 613
Maputo Moçambique
M +258823009604/+258877960361/+258843756599
E gmbanze@grafexlda.com
Triton Minerals Limited:

Mr Peter Canterbury  
CEO & Managing Director  
Triton Minerals Ltd  
Ground Floor, 10 Outram St  
WEST PERTH WA 6005  
Tel: +61 8 6489 2555  
Fax: +61 8 9388 1252  
Email: pcanterbury@tritonminerals.com  
Website: www.tritonminerals.com

1.3. THE CONSULTANTS

This document has been prepared by Coastal & Environmental Services Limited Mozambique (CES) to meet the National Environmental Laws, as well as various international standards. CES is a company registered in Mozambique, with the Ministério de Terras, Ambiente e Desenvolvimento Rural (MITADER) (Appendix 2) and has solid knowledge and multidisciplinary teams to conduct environmental impact assessments and environmental management programs.

The contact address of CES is:

Ms Sonne Odendaal  
Avenida da Mozal, Porta 2334 Beluluane Celula D. Quarteirao 02,  
Matola Cidade, Maputo,  
Mozambique.  
Tel.: +258 (84) 890 0914  
Email: sonneo2006@gmail.com  
Website: www.cesnet.co.za

In conjunction with:

Amber Jackson  
EOH Coastal and Environmental Services (CES)  
Suite 408, The Point, 76 Regent Road, Sea Point, 8005  
South Africa.  
Telephone: +27 21 045 0900  
Fax: +27 46 622 6564  
Website: www.cesnet.co.za  
Email: A.Jackson@cesnet.co.za

1.4. PURPOSE OF THIS REPORT

The key purpose of the ESHIA is to assess the environmental and social impacts of the proposed establishment of the project, and to provide key stakeholders, affected persons and communities in the study area, an opportunity to comment on the findings of the ESHIA. The ESHIA process intends to ensure that environmental and social concerns are integrated into the proposed development, and suggests ways of preventing, minimising, mitigating and/or compensating for possible adverse environmental and social impacts which may arise due to the proposed development.

This report provides information about the proposed mine and its associated infrastructure, the legal framework in which this is occurring, a summary of the baseline studies that have
been completed to assess this project, and an outline of the ways in which stakeholders are involved in the ESHIA process (public participation). It also provides an assessment of impacts on the natural and social environment, and presents recommendations to mitigate these effects and risks. Further detail on these recommendations is presented in an Environmental Management Programme (EMPr) that is a separate report volume.

The specific purposes of this Summary Report is to present the key findings of detailed Specialists Reports and the ESHIA report to Instituto Nacional de Minas in a clear and concise format, in order to provide the environmental analysis required to support Grafex’s mining concession application.

1.5. STRUCTURE OF THIS REPORT

The content of the various sections of this Environmental, Social and Health Impact Assessment is summarised below.

Chapter 1 (this chapter) provides an introduction to the proposed project and describes the purpose of this report and its structure.

Chapter 2 describes the proposed mining project, including primary infrastructure such as the mining process and processing plants, and secondary infrastructure required for the transportation of materials from the mine site to port, and infrastructural requirements for water and power.

Chapter 3 describes the biophysical environment of the proposed project site.

Chapter 4 describes the socio-economic environment of the proposed project site.

Chapter 5 provides a summary of the impact methodology.

Chapter 6 provides the key findings and impacts on the biophysical environment.

Chapter 7 provides the key findings and impacts on the physical environment.

Chapter 8 provides the key findings and impacts on the social environment.

Chapter 9 provides a conceptual closure and decommissioning plan.

Chapter 10 provides recommendations and concludes this report.

1.6. EXPERTISE OF THE TEAM

1.6.1. EOH Coastal & Environmental Services ESHIA Management Team

Dr Ted Avis – Project Leader / Quality Control

Ted Avis is a leading expert in the field of Environmental Impact Assessments, having project-managed numerous large-scale ESHIAs to international standards (e.g. International Finance Corporation). Ted was principle consultant to Corridor Sands Limitada for the development of all environment aspects for the US$1 billion Corridor Sands Project. Ted has also managed ESHIA studies and related environmental assessments of similar scope in Kenya, Madagascar, Egypt, Malawi, Zambia and South Africa. He has worked on large scale SEA’s in South Africa, and has been engaged by the International Finance Corporation (IFC) on a number of projects. Ted holds a PhD in Botany, and was awarded a bronze medal by the South African Association of Botanists for the best PhD adjudicated in that year, entitled “Coastal Dune Ecology and Management in the Eastern Cape”.

Coastal & Environmental Services

Ancuabe Graphite Project
Ms Amber Jackson – Project Manager, Faunal Specialist & Report Production
Amber is a Senior Environmental Consultant and has been employed with EOH CES for over 6 years. She has an MPhil in Environmental Management and has a background in both Social and Ecological work. Her undergraduate degrees focused on Ecology, Conservation and Environment with particular reference to landscape effects on Herpetofauna, while her masters focused on the environmental management of social and ecological systems. With a dissertation in food security that investigated the complex food system of informal and formal distribution markets. During her time at CES Amber has worked extensively in Mozambique managing a number of Environmental and Social Impact Assessments. She has conducted two large scale (> $100 000.00) ESIA for Green Resources (forestry Plantation Company based in Mozambique) to both MITADER standards and International lenders standards in fulfilment with lender requirements (AfDB, EIB and IFC). Her interests include: ecological studies dealing with indigenous fauna and flora, as well as land use and natural resource management.

Mr Justin Green – Water Quality Specialist, GIS Specialist & Report Production
Justin has a BSc. degree in Zoology and Entomology as well as a Post Graduate Diploma in Enterprise Management from Rhodes University. Justin has worked as an Environmental Consultant with CES for over five years and has worked extensively on mining based projects. He has four years of progressive experience encompassing both the public and private sectors and specializing in Water Resources Management and Aquatic Biomonitoring and Assessment using the South African Scoring System (SASS5) methodology. SASS5 is based on the presence or absence of sensitive aquatic macroinvertebrates collected and analysed according to the methods outlined in Dickens and Graham (2002). His work experience has been completed in South Africa, the Democratic Republic of Congo as well as numerous projects in Mozambique.

1.6.2. Specialist Team

The following studies were conducted by specialists:

<table>
<thead>
<tr>
<th>Specialist Assessment</th>
<th>Specialist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation Impact Assessment</td>
<td>Ms Alice Massingue</td>
</tr>
<tr>
<td></td>
<td>Ms Tarryn Martin</td>
</tr>
<tr>
<td>Terrestrial Fauna Assessment</td>
<td>Prof. William. Branch</td>
</tr>
<tr>
<td></td>
<td>Ms Amber Jackson</td>
</tr>
<tr>
<td>Fish Assessment</td>
<td>Dr Anton Bok</td>
</tr>
<tr>
<td>Land, Natural Resource Use and Agriculture Assessment</td>
<td>Dr Chantel Bezuidenhout</td>
</tr>
<tr>
<td></td>
<td>Mr Roy de Kock</td>
</tr>
<tr>
<td>Ground Water and Geochemical Assessment</td>
<td>Dr Koos Vivier</td>
</tr>
<tr>
<td></td>
<td>Mr George van Dyk</td>
</tr>
<tr>
<td></td>
<td>Mr Schalk Ferreira</td>
</tr>
<tr>
<td></td>
<td>Dr Robert Hansen</td>
</tr>
<tr>
<td>Surface Water and Aquatic Assessment</td>
<td>Mr Justin Green</td>
</tr>
<tr>
<td>Environmental Flow Requirement study of the Muaguide River</td>
<td>Mr Bill Rowlston</td>
</tr>
<tr>
<td>Socio-economic Impact Assessment</td>
<td>Mr Marc Hardy</td>
</tr>
<tr>
<td>Scoping level Health Impact Assessment</td>
<td>Mr Lungisa Bosman</td>
</tr>
<tr>
<td>Resettlement Action Plan</td>
<td>Mr Jan Anton Hough</td>
</tr>
<tr>
<td>Traffic, Transport and Visual Assessment</td>
<td>Mr Thomas King</td>
</tr>
<tr>
<td>Air Quality Assessment</td>
<td>Dr Lucian Burger</td>
</tr>
<tr>
<td></td>
<td>Mr Nick Grobler</td>
</tr>
<tr>
<td>Blast Impact Assessment</td>
<td>Mr JD Zeeman</td>
</tr>
<tr>
<td>Waste Management Assessment</td>
<td>Dr Eric E Igbinigie</td>
</tr>
<tr>
<td>Closure and Rehabilitation Study</td>
<td>Dr Chantel Bezuidenhout</td>
</tr>
<tr>
<td>Uranium</td>
<td>Mr. Japie van Blerk</td>
</tr>
</tbody>
</table>
2. THE LEGISLATED ESIA PROCESS IN MOZAMBIQUE

2.1. THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS IN MOZAMBIQUE

The ESIA process is regulated by Decree no. 54/2015 of 31 December 2015, applicable to all public and private sectors. The Ministério de terra, Ambiente e Desenvolvimento Rural (MITADER), through the National Directorate of the Environment (DINAB) and Provincial Directorate of Land, Environment and Rural Development (DPTADER) is the authority responsible for reviewing and approving the environmental assessment.

The Mozambican regulations (Article 4) define four project categories and these in turn define the level of environmental assessment required. This project has been classified as a Category A project based on its scale, complexity, nature and location and as such is subject to a full ESIA.

There are effectively six (6) main steps that are followed during the ESIA process:

2.1.1. Step 1: Application and Pre-evaluation (screening) process
The applicant is required to present a brief description of the project activities to the authorities and complete the requisite application form. All project activities are screened against Annexure I, II, II and IV as defined in Article 4 of the Environmental Assessment Regulations by the authorities in order to determine which category (A+, A, B or C) the project falls within.

The application form was submitted to MITADER on 27 June 2017 and a categorisation letter issued on 14 July 2017 (Appendix A). The authority has classified this project as a Category A project.

2.1.2. Step 2: Environmental Pre-feasibility Scoping Study and Terms of Reference
The Environmental Pre-feasibility Study (EPDA) is mandatory for all category A projects as defined by Article 10 of the Environmental Assessment Regulations. The key objectives of this phase as defined by the ESIA regulations are to:
- Determine any fatal flaws or environmental risks associated with the implementation of the activity.
- Determine the scope of the ESIA process and develop a Terms of Reference for this phase should no fatal flaws be identified.

The EPDA was submitted to the authorities on the 5 October 2017. The letter of acceptance for the EPDA was received on the 22 December 2017 (Appendix B) and our response to the comments raised included in Appendix D.

2.1.3. Step 3: Authority Review of the Environmental Pre-feasibility Scoping Study and Terms of Reference
The EPDA and ToR report is then presented in Portuguese to MITADER for review. The authority may request additional information, and should provide comment and recommendations in terms of the ESIA study within 30 days of receiving the final report.

2.1.4. Step 4: The Public Participation Process
The Public Participation Process (PPP) involves consultation with the wider public, to facilitate the dissemination of information about the project and identify Interested and Affected Parties (I&APs).

The proponent is required to undertake the PPP throughout the ESIA process. This includes advertising meetings and affording I&APs the opportunity to participate in public meetings and must be conducted in the presence of the authorities. The PPP is undertaken based on any
directives given by the relevant authority and the results of the process are summarised in a
final public participation report. The process includes at least two series of public consultation
meetings with the first one being undertaken for the presentation of the draft EPDA and the
second one for the presentation of the draft ESIA.

Disclosure of the EPDA to the authorities and affected communities was undertaken on the
8th and 10th of August 2017 and disclosure of this draft ESHIA will be undertaken on the 15th
and 19th of January 2018.

The details of the meetings held to date are included in the Public Participation Report.

2.1.5. Step 5: Environmental Impact Study and Environmental Management
Programme (EMPr)
The ESIA process is the responsibility of the proponent and the ESIA team, and is undertaken
in line with the Terms of Reference set out in the EPDA. To address the issues raised during
the EPDA process, the ESIA study includes specialist studies to provide a detailed and
thorough examination of key environmental impacts. Once completed, these findings were
synthesized into the ESIA report.

Specialist studies include specific recommendations aimed at avoiding, or where this is not
possible, reducing negative impacts and maximizing positive impacts during the construction,
operation and decommissioning phases of the proposed development. These
recommendations are synthesized into an Environmental Management Programme (EMPr).

2.1.6. Step 6: Authority Review of the Environmental Impact Report and Environmen-
tal Management Programme
The Environmental Impact Report, Specialist Studies Volume and Environmental
Management Programme are presented to MITADER for review. According to Decree no.
54/2015 of the 31st December, the review should be undertaken within 45 days of receiving
the final reports. Upon completion of the review, MITADER will provide a final decision. This
may be one of the following:

- Positive decision
- Total rejection of the activity based on the outcomes of the reports and the final
  environmental impact statement
- Partial rejection of the activity based on the outcomes of the reports and the final
  environmental impact statement

In providing an environmental license, the relevant authority may seek to place conditions of
approval that are legally binding on the proponent, or may request changes to the project
scope or additional ESIA studies.

The steps followed during the ESIA process and the review timeframes for the authorities have
been illustrated in Figure 2.1 below.

In the event that the ESIA is rejected, the Authorities make one of the following decisions:

- Total rejection of the implementation of the proposed activity with a report stating why
  the activity may not proceed;
- Partial rejection of the proposed activity with a request that further information be
  submitted or the project changed/redesigned; or
- Change of category of the proposed activity (from Category A to Category A+) in which
  case a new ESIA will need to be conducted. This is an unlikely scenario as the project
  is already a Category A. In this instance, additional information may be required.
2.2. APPLICABLE LEGISLATION

A summary of the legislation applicable to environmental licensing is provided in Table 2-1 below. It should be noted that the list provided below is not exhaustive, and has been restricted to documents that have direct relevance to either the environment and/or communities.
<table>
<thead>
<tr>
<th>LEGISLATION</th>
<th>DATE OF ENACTMENT</th>
<th>APPLICABILITY TO THE PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NATIONAL LEGISLATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constitution of the Republic of Mozambique</td>
<td>2004</td>
<td>Dictates the right to environment for each citizen in section 7.1: “All citizens shall have the right to live in a balanced environment and shall have the duty to defend it”.</td>
</tr>
<tr>
<td><strong>INDUSTRIAL LICENSING AND LABOUR LAW</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Investment Act</td>
<td>Law 3/1993 of June 24th</td>
<td>Mining Corporations are required to abide by the commercial laws of Mozambique.</td>
</tr>
<tr>
<td>Labour Act</td>
<td>Law no. 23/2007 of August 1st</td>
<td>Mining Corporations are required to abide by the labour regulation of the Mozambique.</td>
</tr>
<tr>
<td><strong>ENVIRONMENTAL FRAMEWORK LAW, EIA, INSPECTIONS AND AUDITS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment Act</td>
<td>Law 20/1997 of October 1st (As amended by the Decree 42/2008)</td>
<td>The project will have an environmental impact, and as such will fall under the ambit of the Environmental Act.</td>
</tr>
<tr>
<td>Environmental Impact Assessment Regulations</td>
<td>Decree 54/2015 of December 31</td>
<td>The process and rules to be followed when conducting an Environmental Impact Assessment.</td>
</tr>
<tr>
<td>Addendum to the EIA Process Regulations no. 45/2004</td>
<td>Ministerial Diploma 198/2005 of September 28th</td>
<td>The environmental authorization required prior to commencements of this project will be regulated by the EIA legislation.</td>
</tr>
<tr>
<td>General Directive for EIA</td>
<td>Ministerial Diploma 129/2006 of July 19th</td>
<td></td>
</tr>
<tr>
<td>General Directive for the Public Participation Process in the EIA process</td>
<td>Ministerial Diploma 130/2006 of July 19th</td>
<td>Public participation forms a crucial part of the ESIA process and is mandatory for category A+, A and B projects. At least two public consultation rounds must take place and a final public participation process report that addresses all questions, concerns and comments raised by I&amp;APs must be submitted with the EIR to the authorities.</td>
</tr>
<tr>
<td>Regulations for Environmental Inspections</td>
<td>Ministerial Decree 11/2006 of June 15th</td>
<td>The Regulation apply to both public and private activities influencing, directly or indirectly, environmental components. In particular, the regulation defines the types and contents of environmental audits, the related necessary competences and auditors’ profiles. Moreover, it regulates environmental audit reports and defines sanctions and penalties for non-compliance. Auditing and monitoring form crucial parts of the ESHIA process, and as such this act directly impacts upon the regulatory requirements to which the proponent must adhere</td>
</tr>
<tr>
<td>Environmental Audit Process</td>
<td>Ministerial Decree 32/2003 of August 12th</td>
<td></td>
</tr>
<tr>
<td>Extracts from the Penal Code</td>
<td>16 September 1886</td>
<td></td>
</tr>
<tr>
<td>Norms of application of fines and other sanctions prescribed in the Environmental legislation</td>
<td>Ministerial Diploma 1/2006 of January 4th</td>
<td>These regulations define the consequences of environmental non-compliance and infringement on the proponent.</td>
</tr>
<tr>
<td>Law on Crimes against the Environment</td>
<td>Ministerial Diploma of 2006/7</td>
<td></td>
</tr>
<tr>
<td>LEGISLATION</td>
<td>DATE OF ENACTMENT</td>
<td>APPLICABILITY TO THE PROJECT</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>SOCIAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection of the Mozambican Cultural Heritage</td>
<td>(Law No. 10/88 of December 22)</td>
<td>The purpose of this law is to protect the tangible and intangible assets of the Mozambican cultural heritage – e.g. monuments, buildings of historical, artistic and scientific sites and natural elements of scientific interest and particular aesthetic. This law extends to any cultural assets that may be discovered on Mozambican territory, in particular, in the soil, subsoil, inland bodies of water or the continental shelf. Heritage Resources may be disturbed and impacted by the mining activities, and as such fall under the ambit of these regulations</td>
</tr>
<tr>
<td>Archaeological Heritage</td>
<td>Decree 27/1994 of July 20th</td>
<td>Heritage Resources may be disturbed and impacted by the mining activities, and as such fall under the ambit of these regulations</td>
</tr>
<tr>
<td>Regulation on the Protection of the Archaeological Heritage,</td>
<td>Decree 27/97 of July 20th.</td>
<td></td>
</tr>
<tr>
<td>Regulation of Resettlement Process Resulting from Economic Activities</td>
<td>Decree 31/2012 of August 8</td>
<td>These regulations formulate the procedures for any resettlement in Mozambique, and especially articulate the assistance required from Government during a resettlement process. These regulations are used during the ESIA process to inform all project affected communities of their rights with regard to economic displacement. The articles in this regulation is used to structure most of the RAP procedures at community level if and when required.</td>
</tr>
<tr>
<td>Land Act</td>
<td>Law 19/97 of October 1st</td>
<td>The Land Act provides the legal framework for land ownership, as well as the control of land and natural resources in Mozambique. The process of determining land rights is also explained by this law. The law was created with the intention of encouraging the use and benefit of land, such that it contributes to the development of the national economy. The law establishes the terms under which all activities - relating to the right of land-use and benefits - operate (Article 2). It provides the basis for defining people’s land-use rights, and gives details on these rights based upon customary claims and the procedures for the acquisition of title for use and benefits by communities and individuals. The law recommends a consultation-based process that recognises customary rights as the means for identifying the claims of communities and individual members of communities without title. The Land Law also defines that the right to use land may be acquired through occupation by Mozambican individuals who have been using the land in good faith for at least ten years. The law therefore recognises and protects the rights of individuals to land acquired through inheritance or occupation (customary tenure), except in legally defined reserves or areas where land has been legally transferred to another person or body. All citizens have equal rights and duties according to the law. Existing rights to use land may be terminated through revocation of such rights for reasons of public interest, after the payment of fair compensation, in which case the non-removable improvements will revert to the state. Foreign individuals or corporate persons may be holders of a right to land-use and benefit, provided they have an investment project that is approved under the investment legislation and they are established or registered under the GoM (Article 11). Total and partial protection zones are part of the public domain, and no right of land-use or benefit can be obtained in these areas (Articles 7 and 9). Total protection zones include those areas specifically intended for conservation or preservation activities, whilst access to partial protection zones requires special licenses, which may be issued for specified activities. Right to land-use and benefit applications are authorised by provincial governors for areas up to 1,000ha, by the Minister of Agriculture and Rural Development for areas between 1,000 to 10,000ha, and by the Council of Ministers for areas exceeding 10,000ha (Article 22). Provisional authorisation is granted after the submission of an application for land-use and benefit. This provisional authorisation is valid for a maximum of five years in the case of nationals,</td>
</tr>
</tbody>
</table>
and two years in the case of foreigners (Article 25). Upon fulfilment of the exploitation plan within the provisional period, final authorisation will be given and the relevant title issued (Article 26).

<table>
<thead>
<tr>
<th>LEGISLATION</th>
<th>DATE OF ENACTMENT</th>
<th>APPLICABILITY TO THE PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Act Regulations</td>
<td>Decree 66/1998 December 8th (Amended by Decree 1/2003 of February 18th)</td>
<td>Land appropriation and ownership rights are pivotal to the project implementation. Relevant aspects of the regulations include: Where there is joint title, such title belongs to all the titleholders equally. When one of the titleholders dies, the other holders continue as the rightful titleholders; Consultations between the applicants for land and the local community are mandatory before a decision to grant title use is made by the provincial governor or higher authority; Good faith occupiers and local communities may apply for demarcation and title; and Titleholders are required to pay a tax for authorisation of the right to use land, plus an annual tax. Family businesses and local communities are exempt from such taxes.</td>
</tr>
<tr>
<td>Land Planning Act</td>
<td>Law 19/2007 of July 18th</td>
<td>The Land Planning Act (Law 19/2007 of July 18) creates a legal framework for land planning. The Act defines the mechanisms for preparation, approval, implementation, monitoring and supervision of land-use plans, as well as the responsibilities associated. This law applies to the entire national territory and, for purposes of planning, regulating relations between different levels of public administration, its relations with other public and private individuals, representatives of different economic, social and cultural interests, including local communities.</td>
</tr>
<tr>
<td>Regulation of the Land Planning Act</td>
<td>Decree no. 23/2008</td>
<td>This Act sets out measures and regulatory procedures to ensure the occupation and rationale and sustainable use of natural resources, appreciation of the diverse potential of each region, the infrastructure, urban systems and promoting national cohesion and population safety.</td>
</tr>
<tr>
<td>Protection for Employees and Job Applicants living with HIV/AIDS Act</td>
<td>Decree No. 19/2014 of 27 August</td>
<td>This Act establishes the rights and duties of those living with HIV and AIDS and provides measures necessary for pre-vention, protection and treatment related to the pandemic.</td>
</tr>
</tbody>
</table>

**WATER**

<table>
<thead>
<tr>
<th>WATER</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Water Act</td>
<td>Law 16/1991 of August 3rd</td>
</tr>
<tr>
<td>Water License and Concessions Regulations</td>
<td>Decree 43/2007 of October 30th</td>
</tr>
<tr>
<td>Water Policy</td>
<td>Decree 46/2007 of August 21th</td>
</tr>
</tbody>
</table>

**WASTE, EFFLUENT AND EMISSION**

<table>
<thead>
<tr>
<th>WASTE, EFFLUENT AND EMISSION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation on Environmental Quality and Effluents Emission</td>
<td>Decree No. 67/2010 amending Decree 18/2004 of June 2nd (As amended by Decree 67/2010)</td>
</tr>
<tr>
<td>Waste Management Regulations</td>
<td>Ministerial Decree 13/2006 of June 15th</td>
</tr>
<tr>
<td>Regulations on the management of municipal solid waste</td>
<td>Decree 94/2014 of December 31st</td>
</tr>
</tbody>
</table>
## LEGISLATION

<table>
<thead>
<tr>
<th>LEGISLATION</th>
<th>DATE OF ENACTMENT</th>
<th>APPLICABILITY TO THE PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation on management of hazardous waste</td>
<td>Decree N.83/2014 of December 31</td>
<td>This decree establishes the general rules for the production, management and disposal of hazardous waste in Mozambique. It applies to all entities involved in the disposal, management, import or distribution of hazardous waste and establishes fees and penalties for non-compliance.</td>
</tr>
<tr>
<td>Regulations on the management and control of plastic bags</td>
<td>Decree 16/2015 of August 5th</td>
<td>Management Regulations and Plastic Bag Control applies to all public and private entities, natural and legal persons involved in the production, import, sale and use of plastic bags in the country.</td>
</tr>
<tr>
<td>Regulations on Environmental Quality Standards and Effluent Emissions</td>
<td>Article 16 of Decree No. 18/2004</td>
<td>Present accountability actions in the implementation, monitoring and treatment of sewage and other effluents in an acceptable manner to preserve the water quality, ecosystem functioning and protection of the river basin.</td>
</tr>
</tbody>
</table>

## BIODIVERSITY AND WILDLIFE, LAND

<table>
<thead>
<tr>
<th>LEGISLATION</th>
<th>DATE OF ENACTMENT</th>
<th>APPLICABILITY TO THE PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildlife and Forestry Act</td>
<td>Law 10/1999 of July 7th</td>
<td>This Regulation applies to protection activities, storage, use, exploitation and production of forest and wildlife resources, and covers the marketing, transportation, storage and primary processing, trade or industrial applications of these resources.</td>
</tr>
<tr>
<td>Wildlife and Forestry Regulations</td>
<td>Decree 10/1999 of July 8th</td>
<td>The law is divided into nine chapters. Of relevance to this ESIA are the following chapters: Chapter 2 on the Protection of Forest and Wildlife Resources; and Chapter 3 on Sustainable Forest Resources, Exploitation Regimes and Sustainable Wildlife Conservation Regimes.</td>
</tr>
<tr>
<td>The Regulations on the Law of Wildlife and Forestry</td>
<td>Decree 12/2002</td>
<td>The Regulations on the Law on Forestry and Wildlife (Decree No.12/2002) provide further guidance to The Wildlife and Forestry Act (1999). The bush clearing procedures described in this act must be followed by the proponent.</td>
</tr>
<tr>
<td>National Strategy and Action Plan for the Conservation of Biological Diversity for Mozambique</td>
<td>Formulated by MICOA (now MITADER) and passed by the Council of Ministers in August 2003</td>
<td>Biodiversity and wildlife management will form part of the mitigation measures for the project.</td>
</tr>
<tr>
<td>Regulations on Pesticide Management</td>
<td>Decree No. 6 of 2009</td>
<td>The Regulation aims at guaranteeing the human health and the environmental quality standards are upheld, according to environmental legal proceedings approved by Law No. 20/97. The annexes specify offences and penalties to be paid for illegal activity.</td>
</tr>
<tr>
<td>Control of Exotic Invasive Species Act</td>
<td>Law 25/2008 of 01 July</td>
<td>Weed control required throughout the construction and operation phases will be directly regulated by these regulations.</td>
</tr>
</tbody>
</table>

## MINING ACTIVITIES

<table>
<thead>
<tr>
<th>LEGISLATION</th>
<th>DATE OF ENACTMENT</th>
<th>APPLICABILITY TO THE PROJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Health and Safety Regulations of Geological and Mining Activities</td>
<td>Decree No. 61/2006 of 26 December</td>
<td>The purpose of these regulations is to define measures aimed at ensuring health and safety conditions of employees engaged in mining operations, including the application of technical measures that prevent accidents, lowers risks and improves hygiene in the workplace in the mining sector.</td>
</tr>
<tr>
<td>Hiring regulations of Foreign Nationals in the Oil Sector and Mining</td>
<td>Decree n.º63 / 2011 of 7 December</td>
<td>Establishes the legal framework including the mechanisms and procedures for employing foreign nationals under the Petroleum and Mining Law, as long as those activities have been approved by the competent authority. Decree No. 63/2011 defines, that for short-term activities not exceeding 180 days, hiring of skilled foreign workers can be carried</td>
</tr>
<tr>
<td>LEGISLATION</td>
<td>DATE OF ENACTMENT</td>
<td>APPLICABILITY TO THE PROJECT</td>
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</tr>
<tr>
<td>Mining Act</td>
<td>Law 14/2002 of June 26th</td>
<td>Out without a permit from the Minister of Labour, provided the Ministry of Labour is notified within 15 days of the employee entering the country.</td>
</tr>
<tr>
<td>The Mining Law</td>
<td>20/2014 of 18 August</td>
<td>Law No. 20/2014, of 18 August (&quot;Mining Law&quot;), which entered into force on the same date the Mining Act (Law No. 14/2002 of 26 June) was repealed, intends to set the legal framework for the mining sector. It aims to ensure greater competitiveness and transparency, preserve the environment, ensure the protection of the rights and obligations of the holders of mining rights, safeguard national interests and benefit the communities.</td>
</tr>
<tr>
<td>Mining Law Regulations</td>
<td>Ministerial Decree 28/2003 of June 17th</td>
<td>Repealed</td>
</tr>
<tr>
<td>Mining Law Regulations</td>
<td>Ministerial Decree 20/2014 of 18 August</td>
<td>The purpose of this law is to regulate the use and re-use of mineral resources to ensure that the best and safest mining and socio-environmental practices are adhered to, allow for transparency and ensure the sustainable long term development of mineral resources and subsequent raising of revenues in favour of Mozambique.</td>
</tr>
<tr>
<td>Environmental Regulations for Mining Activities</td>
<td>Ministerial Decree 26/2004 of August 20th</td>
<td>This law defines the norms for the prevention, control, mitigation and compensation of adverse effects that mining activities might cause to the environment. It also provides specific environmental protection measures, defines the required environmental management instruments (e.g. the EIA process) and the use of licenses.</td>
</tr>
<tr>
<td>Mining Working Regulations</td>
<td>Decree 13/2015 of 03 July</td>
<td>The new regulation of mining work addresses a major gap in the legislation on professional work in this area that has generated employment for Mozambican citizens, although there are also a significant number of foreign workers in the sector. To fill the gap in the legislation, the Mozambican Government has approved the Mining Work Regulation through Decree 13/2015 of 3 July. The new regulation governs labour relations between mining and oil sector employers, including subcontractor companies, and their employees, whether Mozambican or foreign. It also provides for supervision of employment conditions.</td>
</tr>
</tbody>
</table>
2.3. **INTERNATIONAL STANDARDS APPLIED TO THIS PROJECT**

2.3.1. **International Finance Corporation Performance Standards**

Grafex Limitada have chosen to undertake this ESHIA to the International Finance Corporation (IFC) Performance Standards (PS). These standards are also environmental and social safeguards applied by the Multilateral Investment Guarantee Agency (MIGA). The IFC is a member of the World Bank Group, and one of the largest development institutions that focuses exclusively on the private sector in developing countries (IFC, 2012). The IFC was established in 1956 and works in developing countries to create job opportunities, generate tax revenue, improve corporate governance and, perhaps the most important of all, ensuring that projects contribute to the upliftment of its countries’ local communities. In respect of the latter, it is also the IFC’s vision for people to be presented with the opportunity to escape poverty and improve their standard of living.

The IFC published its Performance Standards (PS) on Environmental and Social Sustainability in April 2006, and published comprehensive Guidance Notes in April 2007. The PSs were revised in 2012 (cf. IFC, 2012).

The IFC’s PSs are exclusively tailored for managing projects and general project requirements for IFC support. In addition to these standards, the IFC also published supporting Guidance Notes on each standard, which provides guidance to clients and the IFC staff in order for projects to effectively meet the PS. These performance standards (see Table 2-2) have become the international benchmark for ESHIA’s and are used to measure the environmental performance and management of large international projects.

<table>
<thead>
<tr>
<th>Performance Standard 1: Social &amp; Environmental Assessment and Management Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Standard 2: Labour and Working Conditions</td>
</tr>
<tr>
<td>Performance Standard 3: Pollution Prevention and Abatement</td>
</tr>
<tr>
<td>Performance Standard 4: Community Health, Safety and Security</td>
</tr>
<tr>
<td>Performance Standard 5: Land Acquisition and Involuntary Resettlement</td>
</tr>
<tr>
<td>Performance Standard 6: Biodiversity Conservation &amp; Sustainable Natural Resource Management</td>
</tr>
<tr>
<td>Performance Standard 7: Indigenous Peoples</td>
</tr>
<tr>
<td>Performance Standard 8: Cultural Heritage</td>
</tr>
</tbody>
</table>

This ESHIA has been structured to meet the requirements of the IFC as outlined in the IFC’s Guidance Notes on Performance Standards on Social and Environmental Sustainability (IFC, 2012), as well as the IFC Environmental Health and Safety Guidelines for Mining (2007). In accordance with this, the ESHIA will be broadened to include social and health aspects, in accordance with IFC guidelines related to health assessment (IFC, 2009). Therefore this assessment has been referred to as an ESHIA, not an ESIA, to reflect the more detailed and broad approach used in this assessment.

**Performance Standard 1 (PS 1) addresses the social and environmental assessment and management systems.**

The primary objectives of PS 1 are to:

- To identify and evaluate environmental and social risks and impacts of the project.

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To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, Affected Communities, and the environment.

To promote improved environmental and social performance of clients through the effective use of management systems.

To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately.

To promote and provide means for adequate engagement with Affected Communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.

The main requirements of this standard are the development of environmental and social management programmes for the duration of the project. From a social perspective, the management programmes must at a minimum address health and safety, security, human resources, community engagement, labour and must address social management issues. All environmental, social and health impacts must be determined and ranked in terms of the risks they pose to the project.

All adverse impacts must be avoided and if this is not possible they must be minimised. Once the ESHIA process has been completed, a management programme must be compiled which outlines what mitigation measures are to be used, how they are to be implemented and how they will be monitored and evaluated. The management programme must outline the roles and responsibilities associated with implementation and monitoring requirements. The management programme should identify communication strategies to ensure community engagement throughout the project lifecycle. Generally a Stakeholder Engagement Plan (SP) is developed to achieve this requirement.

Monitoring programmes must be periodically reviewed by internal and external parties to ensure compliance and for evaluation purposes.

**Performance Standard 2 (PS 2) addresses labour and working conditions.**

The primary objectives of PS 2 are to:

- Establish, maintain, and improve the worker-management relationship.
- Promote the fair treatment, non-discrimination and equal opportunity of workers, and compliance with national labour and employment laws.
- Protect the workforce by addressing child labour and forced labour.
- Promote safe and healthy working conditions.
- Protect and promote the health of workers.

Most of these issues are dealt with in the management plans required under PS 1. However, PS 2 outlines in detail what working conditions are acceptable and how worker relationships should be managed, and also deals with occupational health and safety for the project (addressed in various management plans). Certain activities (e.g. radiation, Mineral Separation Plant health and safety procedures, etc.) will need to be dealt with on an activity by activity basis.

**Performance Standard 3 (PS 3) addresses pollution prevention and abatement.**

The primary objectives of PS 3 are to:

- Avoid or minimise adverse impacts on human health and the environment by avoiding or minimising pollution from project activities.
- Promote the reduction of emissions that contribute to climate change.
The primary requirement of PS 3 is that technologies and practices which avoid or minimise detrimental impacts of pollution are applied throughout the lifecycle of the project. In addition to the EHS General Health and Safety Guidelines, the IFC has sector specific guidelines which deal with pollution and human health issues associated with mining (IFC Environmental Health and Safety Guidelines for Mining, 30 April 2007). These guidelines will be used for this project and included in the management plans.

**Performance Standard 4 (PS 4) addresses community health, safety and security.**

The primary objectives of PS 4 are to:
- Avoid or minimise risks to, and impacts on, the health and safety of the local community during the project lifecycle from both routine and non-routine circumstances.
- Ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimises risks to the community’s safety and security.

The major requirement in terms of PS 4 is that all risks and impacts to the surrounding community are assessed and managed appropriately. This includes issues such as infrastructure and equipment safety, hazardous material storage and handling, hazards associated with the natural environment (e.g. floods, landslides, etc.), community exposure to disease and emergency preparedness and response.

**Performance Standard 5 (PS 5) addresses land acquisition and involuntary resettlement.**

The primary objectives of PS 5 are to:
- Avoid or at least minimise involuntary resettlement wherever feasible by exploring alternative project designs and layouts.
- Mitigate adverse social and economic impacts from land requisition or restrictions on affected persons’ use of land by (i) providing compensation for loss of assets at replacement cost; and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation and the informed participation of those affected.
- Improve or at least restore the livelihoods and standards of living of displaced persons.
- Improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites.

Consistent with the objectives and requirements of PS 5, a Resettlement Plan (as per the requirements of Decree 31/2012) will be produced as part of this ESHIA process. Prior to the preparation of the Resettlement Plan, a process of physical and socioeconomic data capture and analysis will take place. This will inform the elaboration of the Resettlement Plan, which will include the following elements:

a) Analysis of the socioeconomic profile of the affected households;

b) Evaluation and analysis of the tangible and intangible goods;

c) Definition of the degree of affectation – quantitative and qualitative;

d) Definition of the compensation criteria;

e) Presentation of solutions and technical alternatives and viable economically that enable to keep or improve the current living standard of the affected households.

The Resettlement Plan informs the pre-implementation phase of the project and provides the detailed foundation for the preparation of a full Resettlement Action Plan (RAP), which will be developed for all affected communities. PS 5 will only be addressed fully once a RAP is undertaken. The Resettlement Plan forms part of the present ESHIA, while the Action Plan for the Implementation of the Resettlement Plan (RAP) will form a separate study to the present ESHIA.
Performance Standard 6 (PS 6) deals with biodiversity conservation and sustainable natural resource management.

The primary objectives of PS 6 are to:

- Protect and conserve biodiversity.
- Promote the sustainable management and use of natural resources through the adoption of practices that integrate conservation needs and development priorities.

In order to conform to PS 6, the study has to consider ecosystem goods and services afforded by the natural environment in the project area. This assessment has to include an investigation into provisioning services, regulating services and cultural services. A biodiversity monitoring plan will be produced at a later stage to demonstrate how the project will monitor the plant and animal biodiversity in the project area to ensure it is properly managed and conserved. This plan will outline the monitoring and evaluation required to manage ecological aspects.

Specialist studies that focus on the biological environment (e.g. fauna, flora and fish surveys) will assess the status of the environment and determine whether this should be classified as modified, natural or critical habitat based on the guidelines presented in PS 6. The type of habitat will then inform the type of mitigation measures that are implemented. For example, in areas of natural habitat, mitigation measures will be designed to achieve no net loss of biodiversity.

Performance Standard 7 (PS 7) deals with indigenous peoples and does not apply to this project. This is because indigenous peoples are defined as:

“A distinct social or cultural group possessing the following characteristics in varying degrees:

- Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others
- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories.
- Customary cultural, economic, social or political institutions that are separate from those of the dominant society or culture
- An indigenous language, often different from the official language of the country or region."

This definition does not apply to the people in the project area.

Performance Standard 8 (PS 8) addresses cultural heritage.

The primary objectives of PS 8 are to:

- Protect cultural heritage from adverse impacts of project activities and support its preservation.
- Promote the equitable sharing of benefits from the use of cultural heritage in business activities.

Cultural heritage must be protected during the project, and care taken to ensure that cultural practises which the communities partake in are not impacted upon negatively as a result of the project. This will be investigated further during the specialist studies phase.

2.3.2. IFC General EHS Guidelines

The IFC General EHS guidelines (30 April 2007) are applicable to this project. The guidelines detail general impacts and ways to manage them. They cover environmental, occupational health and safety, community health and safety, performance indicators, and monitoring.
2.3.3. **IFC EHS Guidelines for Mining**

The IFC EHS Guidelines for Mining (10 December 2007) are applicable to this project. The guidelines detail industry-specific impacts and ways to manage them. They cover environmental, occupational health and safety, community health and safety, performance indicators, and monitoring.

2.4. **INTERNATIONAL CONVENTIONS**

Mozambique is a signatory to a number of international conventions. Those applicable to this project are summarised in Table 2-3 below.

**Table 2-3: International conventions applicable to the project.**

<table>
<thead>
<tr>
<th>INTERNATIONAL CONVENTIONS</th>
<th>Year</th>
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</thead>
<tbody>
<tr>
<td>African Convention on the Conservation of Nature and Natural Resources (Amended)</td>
<td>1968</td>
</tr>
<tr>
<td>Revised African Convention on the Conservation of Nature and Natural Resources (Amended Version) Not yet in force. Mozambique is a party and would be bound upon entry into force</td>
<td>2003</td>
</tr>
<tr>
<td>Constitutive Act of the African Union</td>
<td>2000</td>
</tr>
<tr>
<td>Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa</td>
<td>1991</td>
</tr>
<tr>
<td>Convention on Biological Diversity</td>
<td>1992</td>
</tr>
<tr>
<td>Convention on International Trade in Endangered Species of Wild Fauna and Flora (Cites)</td>
<td>1973</td>
</tr>
<tr>
<td>UN Convention Concerning the Protection of World Cultural and Natural Heritage</td>
<td>1972</td>
</tr>
<tr>
<td>Kyoto Protocol to the UN Framework Convention on Climate Change</td>
<td>1998</td>
</tr>
<tr>
<td>Convention on Oil Pollution Preparedness, Response and Cooperation</td>
<td>1990</td>
</tr>
<tr>
<td>Convention on Wetlands of International Importance Especially as Waterfowl Habitat (RAMSAR)</td>
<td>1971</td>
</tr>
<tr>
<td>Stockholm Convention on Persistent Organic Pollutants</td>
<td>2001</td>
</tr>
<tr>
<td>UN Framework Convention on Climate Change (read with Kyoto Protocol)</td>
<td>1992</td>
</tr>
<tr>
<td>Vienna Convention for the Protection of the Ozone Layer</td>
<td>1985</td>
</tr>
<tr>
<td>International Convention on Civil Liability for Oil Pollution Damage</td>
<td>1992</td>
</tr>
<tr>
<td>Montreal Protocol on Substances that Deplete the Ozone Layer</td>
<td>1987</td>
</tr>
<tr>
<td>International Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa</td>
<td>1994</td>
</tr>
<tr>
<td>Treaty Establishing the African Economic Community</td>
<td>1991</td>
</tr>
<tr>
<td>SADC Protocol on Mining</td>
<td>1997</td>
</tr>
<tr>
<td>African Charter on Human and Peoples’ Rights</td>
<td>1981</td>
</tr>
<tr>
<td>Convention on Safety of Life at Sea (SOLAS)</td>
<td>1974</td>
</tr>
</tbody>
</table>
3. PROJECT DESCRIPTION

3.1. PROJECT BACKGROUND

Graphite is a naturally-occurring form of crystalline carbon and is classified by form, size and purity. Flake (crystalline) graphite is considered more desirable and marketable than amorphous (microcrystalline) graphite (Leak, 2014), as it is of a higher quality than amorphous graphite and can be used in both traditional and hi-tech applications. By contrast, amorphous graphite can’t and is therefore not suitable for refractories or batteries, which are the two main market drivers of the graphite sector. Flake graphite derives its value through the size of flake and the concentrate purity. Ancuabe graphite is known for its large flake size (greater than 180 µm) and its properties result in a high purity flake concentrate. High purity graphite commands a significant premium in the Lithium Ion Battery (LIB) market and even higher prices for supply into the expandable graphite market. The target market regions include China and Asia, where many of the expandable graphite production facilities and Lithium ion battery upgrade facilities are located.

Grafex intend to develop a graphite mine and processing plant to produce high purity graphite concentrate at the Ancuabe site (EL 5380, 5305 and 5336) in Cabo Delgado, Mozambique (Figure 3-1). The Ancuabe Graphite Mine Project comprises of multiple deposits, two of which have been assessed by this ESHIA and form part of this project description. The remaining deposits will only be mined at a much later stage, at which time a separate EIA will be submitted for approval.

The company commenced with a technical scoping study, completed in April 2017, which concluded that the Ancuabe Graphite Mine Project justified further investigations into the potential to develop an operation at the site.

Definitive feasibility studies that included more extensive metallurgical test work were commissioned in April 2017, and are expected to be completed by December 2017. During this period significant site investigations were undertaken to support the ESHIA as well as mine development and planning. These studies included resource extension drilling, geotechnical investigations and facility location selection. This ESHIA assesses a mine life of 30 years of operation at a processing rate of 1 Mt/a. The mine will produce a total of approximately 30 Mt graphite concentrate and 80Mt of mine waste for stockpiling over the 30 year life of mine (LOM). The mine will operate 7 days a week, 24 hours a day.

3.2. RATIONALE FOR THIS DEVELOPMENT

The mining industry in Mozambique provides a modest contribution towards the GDP, but this has grown over the years from 1.5% in 2012, to 4.3% in 2013. The growth between 2012 and 2013 can be attributed to an increase in coal production and exports, large infrastructure projects and credit expansion in the private sector. GDP from mining in Mozambique decreased from 6,186 Million MZN in the third quarter of 2016 to 4,272 Million MZN in the fourth quarter of 2016. GDP from mining in Mozambique averaged 2,448 Million MZN from 2008 until 2016, reaching an all-time high of 6,186 Million MZN in the third quarter of 2016 from a record low of 844 Million MZN in the fourth quarter of 2008.

This type of growth rate in the mining sector highlights the importance of mining for future growth in Mozambique. The Mozambican government has recognised this and has committed

2 http://www.tradingeconomics.com/mozambique/gdp-from-mining
to encouraging FDI to develop Mozambique’s mining industry. The Project falls within this sector and will therefore contribute towards Mozambique's continued growth.

Locally, the project will have significant impact on the Project Affected Communities (PACs), bringing significant employment opportunities either directly or indirectly. The indirect employment opportunities will include mine support services, as well as support services for the people employed at the mine.

3.3. LOCATION

The Project is located in the Cabo Delgado province of north-eastern Mozambique (Figure 3-1), approximately 25 km east from the town of Ancuabe and approximately 93 km drive west of Pemba. The mine is accessible via the National road 106 from Pemba and the R243 towards the town of Ancuabe.

The majority of the project area is currently comprised of natural vegetation with few machambas located along the proposed access road and powerline corridor. There is very little in the way of infrastructure, which is limited to mobile offices, storage facilities for drilling equipment and temporary shelters for shade. However, a relatively large number of roads and access routes have been established in the localised area where drilling has taken place. Despite this, the project site is considered to be a greenfields site.

Figure 3-1: Location of the Ancuabe project within Cabo Delgado Province.
3.4. DESCRIPTION OF THE GRAPHITE MINING PROCESS

3.4.1. Site clearing

Vegetation and topsoil will be cleared and removed by mechanical means (chainsaws, bulldozers). The removal of vegetation will be done simultaneously at all infrastructure locations, and progressively at the pit. Cleared woody debris may either be stockpiled and burnt or harvested for timber and charcoal. Topsoil will be removed and either stored to assist in subsequent rehabilitation, as it contains the majority of the seedbank, or deposited immediately over the surface of impacted areas that are not required during the operational phase, to minimise losses and assist in rehabilitation.

3.4.2. Ore extraction

To begin with, the softer oxidised material near the surface (typically the top 5m of the deposit) will be ripped with a bulldozer and once hard rock is encountered, drill and blast techniques will be used. Pits will be constructed by initially drilling surface cores for placement of explosives, such as ANFO (ammonium nitrate) or emulsion. Thereafter, controlled demolition will be used to liberate the loosened surface material, which is then loaded and transported via dump trucks.

The mining process produces waste (also called overburden – the portion of the material that does not contain graphite) and ore (the portion of the material that contains graphite). The waste rock will be removed from the pit and, depending upon timing, initially transported to the site of the raw water dam or tailings dam to build the walls. On completion of the raw water dam, the waste rock will be transported to a dedicated waste rock dump (WRD) facility adjacent to the mine pit, or to the tailings storage facility to continue wall construction throughout the life of the project. The ore is transported to the Run of Mine (ROM) stockpile on the ROM pad.

3.4.3. Processing

Processing (Figure 3-2) commences at the Run of Mine (ROM) pad, where ore stockpiles are fed with haul trucks – transporting ore from the pit dumps. These ROM stockpiles are then transferred with front end loaders to the processing plant’s primary crusher station.

Crushing
The ore bearing rock must be crushed into a fine material so that the graphite can be removed. Ore is first broken down into <600 mm size rock using a mobile rock breaker, and then passing this rock through three stages of crushing. Secondary and tertiary crushed ore are then combined and directed to a screen. $P_{90}$ 12.5 mm or smaller product is conveyed to the Rod Mill using the product conveyor. Oversize material will be recirculated through the crushers until the required size is reached.

Primary Grinding
The crushed ore is conveyed to the crushed ore bin and fed into the mill feed conveyor. Primary grinding (milling) is the process when the crushed ore, which is now the size of small pebbles, is crushed further into a material almost as fine as sand using a Rod Mill. Ore is fed into the rod mill with water, operating in closed circuit with vibrating screens where the mill discharges on to double deck vibrating screens equipped with water sprays. The screen undersize $P_{95}$ 710-1000 µm is pumped to the flotation circuit and the screen oversize is recycled back to the rod mill via conveyors (Figure 3-2).

Flotation

Roughers
Flotation is the process of bubbling air through the milled sand and water slurry so that the
graphite, which is lighter than the sand, can be separated off. This is done by adding reagents to the flotation feed (milled "sand") and mechanically agitating the slurry mixture to produce rougher concentrate (graphite containing product) and rougher tailings (waste). The rougher concentrate is pumped to an attrition mill where the waste attached to the graphite is 'knocked off' the edges of the graphite, before being pumped to the Cleaners.

**Cleaning**
There are five stages of cleaning in the Cleaner circuit where the rougher concentrate is further refined and tailings removed.

**Filtering and drying**
The final concentrate is then filtered, dried and bagged before being transferred to a bulk graphite holding bin.

**Classification and concentration handling**
The graphite is fed to a line-up of enclosed screens to separate the graphite into five sized products:

- Flake > 300 μm
- 300 μm > Flake >180 μm
- 180 μm > Flake >150 μm
- 150 μm > Flake >106 μm
- Fines <106 μm

**Packaging and shipment**
The final concentrate, once classified, is then packaged into bags on site and stored temporarily, for transport from site using trucks. Each sized product will be transported to their respective storage bins. Each storage bin will discharge to the bagging system. The bagging system is designed for 1 ton capacity bags and includes a hopper and feeder with dust collection, a bag handler, load cells and pallet roller conveyor. Full bags will be handled using a forklift and pallets. Bagged concentrate products will be stored undercover and loaded either onto trucks or into containers for shipment from site to the Port of Pemba. The minimum shipment will be one container and maximum of approximately 250 containers.

**Tailings**
Tailings is the sand material that is left after the graphite has been separated from it. The tailings will be transferred to a tailings thickener where flocculent is added to the tailings thickener feed. The tailings are then pumped to the tailings storage facility (TSF) which will comprise two cells for the mine life. Prior to the development of the second cell, it is likely that the T16 pit will be backfilled with tailings. The tailings are discharged using sub-aerial deposition from multiple spigots located around the embankment crest, much like an agricultural irrigation and sprinkler system.

Tailings thickener overflow water will gravitate to the process water pond for recycling. Additional water is recovered from the surface of the TSF via a tailings return water system, which is then returned to the plant for reuse. The intention is to maximise water recovery and reuse throughout the project.

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3 The flocculent is an organic long chain polymer or a metallic sulphate such as Aluminium sulphate which creates the charge necessary to attract and collect fine particles which affect the clarity of water used in the processing. These are commonly used in swimming pools and water treatment plants and are harmless. They naturally break down through the pumping action and sun light.
3.5. SCHEDULE

The lifetime of the mine is anticipated to be 30 years.

3.5.1. Construction

A high level construction schedule is shown in the figure below.

Implementation will commence in Q1 2018, with detailed engineering design. Permitting activities will continue over the next 3 quarters. Mobilisation is planned for site in mid Q2 2018 to commence early construction works including the raw water dam construction.

<table>
<thead>
<tr>
<th>Activity</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
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</thead>
<tbody>
<tr>
<td>Ancuabe Graphite project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drilling</td>
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<tr>
<td>Technical investigations</td>
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<tr>
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<tr>
<td>Mining concessions permitting</td>
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<tr>
<td>DUAT process</td>
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<tr>
<td>Construction permitting</td>
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<td>Early works engineering</td>
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<td></td>
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</tr>
<tr>
<td>Commissioning</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.5.2. Operation

A variable production schedule was determined for both deposits:
- Year 1 – 15: Approximately 0.9 million t/a
- Year 16 – 30: Ramping up to 1.1 million t/a
- Year 31 onwards: processing 0.9 – 1.1 Mtpa from additional resources.

In this schedule, T16 is mined for the first fifteen years as well as the one year pre-production, and T12 is mined for the next 15 to 20 years.
Figure 3-2: Flow diagram illustrating the mining process.
3.6. **PROPOSED INFRASTRUCTURE**

The following mine infrastructure is required and described in more detail below (Figure 3-3):

- **Mine:**
  - Ore pits (T12 and T16);
    - Dewatering pumps
    - Lighting plants
  - Waste rock dumps for T12 and T16;
  - Tailings Storage Facility;
  - Process water dam;
  - Run Of Mine stockpiles; and
  - Processing Plant.

- **Supporting infrastructure**
  - Water Storage Dam and ancillary storage; and
  - Local bore hole (Mitchel’s borehole)
  - Power station, switchyard and transformers
  - Borrow Pit

- **Ancillary infrastructure**
  - Fuel storage areas and fuelling station;
  - Mine explosive storage facility;
  - Lay down area;
  - Mine and process plant workshops for maintenance and repairs;
  - Mine and process plant warehouses for temporary storage;
  - Reagent and consumable storage and preparation;
  - Offices, including control room;
  - Mobile plant;
  - Eating/mess area;
  - Ablutions;
  - Change house;
  - Laboratory;
  - Site roads;
  - Accommodation Camp, including:
    - Gate house;
    - Training room;
    - Parking facilities;
    - Site access gates;
    - Mine rescue and medical centre;
    - Sewage treatment facility;
  - Waste:
    - Sorting facility;
    - Landfill;
    - Pollution control dam and
  - Potable water treatment facility.

- **Infrastructure not assessed in this ESHIA**
  - Pipeline route from the Water Storage Dam to the Processing plant, the potable water treatment plant and to mine services
  - Future Ore Pits
  - Future Waste Rock dump
  - PV Powerstation
  - Placement of access road and powerline pylons within the Powerline and Haul Road Corridor
Figure 3-3: Project infrastructure for the Ancuabe
3.7. DETAILED DESCRIPTION OF PROPOSED MINING INFRASTRUCTURE

3.7.1. Ore Pits and associated infrastructure

Pits
This ESHIA cover the mining of two graphite deposits, named T12 and T16. Pit T12 will be 51.26 ha in extent, and more than 15 million tons of ore will be extracted. Pit T16 will be 29.07ha in extent, and approximately 15 million tons of ore will be extracted. The pits will be mined as open-cast pits with stepped sides at a slope angle of 40°, and will reach a final depth of 120 m below the pit crest. T16 will be mined initially, followed by T12.

As the pit progresses, access ramps will be designed and used to allow the trucks to exit and re-enter the pit for haulage. This will assist in reducing the distance the haulage trucks need to travel to deposit their waste rock or ore. It is expected that approximately 20 trucks per hour will be used to either haul waste or ore to their respective delivery points. An industrial water spray will be used to minimise any dust on the ramps.

Dewatering pumps
A variety of dewatering pumps will be required at strategic locations along the edges of the developing pit shells. Dewatering reduces risk from surface and groundwater contamination as well as increasing slope stability and safety (Straskraba, 1979). The precise position of the dewatering pumps are likely to change throughout the life of mine to most efficiently pump water from the pit shells.

In-pit water management will primarily consist of dewatering inflow from shallow groundwater and through fractures in the pit wall, runoff control and sumps. As the pit will be operating at depths of 120 m below the pit crest, specialist high lift pumps will be required. Pumps (to pump out the water) will be located outside a sump as shown in the figure below, so that the pumps do not get submerged as water levels rise in response to a rainfall event.

Plate 3-1: In-pit dewatering with a Godwin dewatering pump
The key operational requirements will be to:

- Minimise water flows into the pit using perimeter diversion bunds, drains and fill, where practical;
- Provide pit pumping capacity for sporadic/seasonal events;
- Maintain pit wall drainage; and
- Provide temporary sumps capable of handling the expected water inflows from shallow groundwater and fractures in the pit wall.

**Lighting plants**

Lighting plants will be required to illuminate the loading works. Lighting open cast mines, in particular the pit shells and haul roads, is considered difficult due to the low reflectance of the surfaces and the dark surroundings (Pal et al., 2012). Furthermore, lighting systems are generally required to be of temporary nature due to the regular advancement of the working face. A wide variety of lighting requirements and standards are in place for the satisfactory lighting of mine operations, and these may be met by various temporary and static lighting facilities. Commonly, single sided stand-alone photovoltaic lighting system are preferred due to their mobility, ease of installation, and the fact that they do not require connection to other components (Pal et al., 2012).

### 3.7.2. Waste Rock dumps

Two pit associated (T12 and T16) waste rock dumps (WRD) will be created, containing the waste rock component (i.e. rock that does not contain graphite). The waste dumps will be located immediately adjacent to the respective mine pits to reduce transport time and cost. The waste dumps cover the largest areas in terms of mine infrastructure, having footprints of 158.77 ha and 55.62 ha respectively. Waste rock dumps will hold up to approximately 80 million tons in the first 30 years of operation. The waste dumps will be designed with appropriate low wall angles in order to minimise the risk of slip. In addition, water will be collected and diverted to the process water system.

### 3.7.3. Tailings storage facility

Two low permeability lined Tailing Storage Facilities (TSF) will be constructed, to be used to store the slurry and tailings produced as waste from the processing of the ore (Figure 2-4). The shape of the TSF will be determined through manually creating berm sidewalls (from crushed rock or overburden material), followed by infilling with the tailings as processing continues. This will be done via numerous spigot points along the TSF walls, allowing for tailings to gravitate towards the centre of the TSF, and solids to settle out. Water recycling measures will be put in place to recover as much water as possible (to be reused in the processing plant).

The TSF will be monitored by downstream seepage pumps, and the water level within the dam managed via underdrainage pumps. The underdrainage system will consist of two interconnected drainage networks, namely the collector drains and the finger drains, reporting to a collection sump located at the upstream toe of the embankment.

As the dam will be lined, the water will be harvested from the surface of the TSF.

In an extreme, cyclonic rainfall event water may overflow via the emergency spillway. Overflow from such an event will be directed via downstream sediment control structures. In normal operation the TSF does not overflow, and water is harvested from the surface for process water.

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4 $10 \times 2.3 \text{ Mtpa} + 20 \times 3 \text{ Mtpa} = 83 \text{ Mt minimum}$
Each cell is designed to contain approximately 10 Mt of tailings.

![Diagram showing the design of the two Tailings Storage Facility cells.](image)

**Figure 3-4: Diagram showing the design of the two Tailings Storage Facility cells.**

### 3.7.3.1. Process water dam

The process water dam acts as a buffer / balancing dam between the tailings facility and the plant. The capacity is 1,100 m$^3$ live volume.

### 3.7.4. Run of Mine Stockpiles

Intermediate stockpiles will be required at various locations throughout the mine site, for short and medium term storage of materials. Stored materials may include any of the following:

- Waste and ore stockpiles;
- Construction material stockpiles (sand etc.). These are only required during construction, and will be very small, for sand harvesting activities in the Mogido River.

However, the run of mine stockpile (ROM) specifically refers to the ore stockpiles located ahead of the primary crusher. This is shown in Figure 2-5 below, at the top of the picture. Approximately 35,000t of ore will be located on the ROM, based on 7-10 days operation, required in the event that the mine is closed for an extended period of time.

Run-off from the ROM will be collected and directed to the process water system.

### 3.7.5. Processing plant

The 5.67 ha processing plant will house the Crushing circuit, Rod Mill, Flotation cells and dewatering equipment for the processing of ore and the on-site buildings (Figure 2-5).

- The crusher plant will be a dry feed plant, with minimal moisture of approximately 5%. It will be able to handle rocks sized from 525 x 535 x 605 mm to 1980 x 2456 x 1740 mm, depending on the model selected. Dust suppression sprays will be located on
conveyors and transfer chutes around the crushing plant to mitigate against airborne dust.

- The Rod Mill specifications will depend on the precise mill selected, and dimensions vary between 4.9–15.9 m in length, 2.3–8.8 m width, 2.0 – 6.8m in height, and weighing between 5.7-150 tonnes. The rod mill is motor driven with a speed reducer and peripheral large gear, or low speed synchronous motor with peripheral large gear.
- Conventional flotation cells used will depend on the classification of machinery used, and the volume for each flotation device may range from 0.37 m³ – 40 m³.

![Figure 3-5: The proposed layout of the process plant site, run-of-mine pad and long term stockpiles (foreground) and road network. PV Powerstation has not been assessed in this ESHIA.](image)

### 3.8. SUPPORTING MINING INFRASTRUCTURE

#### 3.8.1. Water

It is estimated that the project will use 1million m³ of water annually, which is approximately 1 m³ (1000 litres) of water per tonne of plant feed. Most of the water is required for the flotation process. Water will not be sourced from the national, provincial or municipal services provision. Grafex will construct an in-channel raw water dam on the Muaguide River.

##### 3.8.1.1. Raw water dam

The raw water dam will have a capacity of 1.5 - 2 Mm³, which is sufficient for over one year of production. The dam will be located approximately 1.5km north-east of the T12 waste dump (Figure 2-1 and Figure 2-6) on the Muaguide River, and has an annual catchment yield of between 18 - 23 Mm³. The dam will be built using construction material borrowed from the basin area, or pit waste – where suitable, and will consist of a zoned earth fill embankment, with a height to spillway of 10m and a crest height of 12m. The dam will continuously discharge water during the wet seasons. The spillway will be designed to act as a natural fish way (e.g. lined with rocks to hydraulically function as a natural rapid), to allow the migratory fish species present in the river downstream to migrate upstream past the wall. The spillway is designed to be a wide, rip rap lined spillway, and may thus not provide continuous hydraulic connection (very wide shallow flows during most overflow conditions).

This dam will be filled through natural run-off river flow, and must be sufficiently large to
provide enough water during the long dry season. Raw water will be pumped directly to the process plant, the potable water treatment plant and to mine services. A raw water tank will be constructed at the plant site to supply the fire fighting ring main water system, which supplies hose reels and fire hydrant points around the plant. The pipeline dimensions and route has not been assessed as part of this ESHIA.
3.8.1.2. **Potable water treatment plant**

The potable water treatment plant and tank storage facility will supply the water needs for staff personnel, camp accommodation and water for safety showers located around the site. This facility will be located at the process plant, to ensure close proximity between source and use. During construction, potable water will be trucked in and stored on site in temporary storage tanks, for use by the staff. Construction water will be sourced from the raw water storage dam or local boreholes, as required. Additional water sources include water from the mine pit dewatering (internal and external), storage of surface water runoff and water reclaimed from the tailings storage facility.

3.8.2. **Power supplies**

The total demand for the mine will be up to 50,000 MWh annually, which requires the following connected power requirements:

- Mine – 1 MW
- Process plant – 8.5 MW and
- Camp – 0.5 MW

Power for the site will be obtained from the National Grid subject to availability and approval.

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5 A megawatt is a unit for measuring power that is equivalent to one million watts. A megawatt hour (MWh) is equal to 1,000 Kilowatt hours (KWh). It is equal to 1,000 kilowatts of electricity used continuously for one hour. It is about equivalent to the amount of electricity used by about 330 homes during one hour. Approx 6.5 MW of power is required to generate 50,000 MWh/y.
by the Mozambique Electricity Authority (EDM) from 2022. The nearest transmission line is approximately 35 km from the project area, and Grafex will construct transmission lines from there to the proposed onsite substation when grid power becomes available.

Grafex has proposed dual power supply options. Power will be purchased from EDM and will be produced onsite by diesel powered generators, which will also act as alternative power sources during times when the national grid is unable to supply a reliable source of power. This will be done to ensure availability of reliable power, as well as reduce cost and load on the national grid. In the event that power from EDM cannot be delivered generators will run 24/7.

**On site power station**
The site power station will also comprise up to 1 MW photovoltaic power generation, and up to nine (9) 1 MW diesel generators. Waste heat from the power station will be recycled to the concentrate dryer to offset the diesel requirements.

**Transmission lines**
Thirty five kilometers of 33 kV transmission lines will be constructed, and strict access control to this transmission line will be required to ensure safety and minimize power disruptions. The main substation will transform the power to 11 kV for high voltage distribution on site. The power requirements are approximately 6.5 MW for the site.

The number of towers (Strain structures and Intermediate structures) and number of lines (Catena way and conductor strands) on the cross arm are still to be decided.

3.8.3. **Fuel storage areas and a fuelling station**

Self-bunded fuel storage areas and a fuelling station will be located at the plant, to ensure fuelling of haulage trucks and smaller vehicles and generators.

The following types of hydrocarbons will be stored on site:

- Diesel: Up to ten 67,000 l self-bunded diesel storage tanks will be located at the mine services area, distributing diesel as required to the mine vehicles, other light vehicles, the power station and concentrate dryer.
- Lubricants, motor and hydraulic oils will be stored in a designated area in the mine and process plant warehouses.
- Spent oils will be stored in the waste sorting area pending offsite disposal by licensed service provider/s.
- Reagents: will be stored in a designated area in the process plant. Containers will be stored in the waste sorting area pending offsite disposal by licensed service provider/s.

3.8.4. **Mine explosive storage facility**

Mine explosives will be managed by the mining contractor with a Mozambique approved supplier and operator. Blasting will be undertaken at the mine approximately every 3 weeks.

A minor amount of blasting may be required during project development. However, this will be minimal.

3.8.5. **Borrow Pit**

Less than 1500m$^3$ of sand will be sourced principally from the Mogido/Pulu river within the tenement and mining concession area for construction. Grafex have also proposed the sourcing of sand and other construction materials for construction from other areas within the project area.
3.8.6. Lay down area

A lay-down area for construction materials and equipment, of approximately 250 m x 250 m in total, across several locations will be required. These areas will continue to be used during the operational phase, although the actual area of land required may be reduced to an area of approximately 100 m x 100 m. Lay down areas may be used for a wide variety of purposes, with small, temporary stockpiles of construction materials being the most common use. Spares required for shutdowns may also employ these areas, or short term storage of moveable infrastructure such as portable toilets or fencing materials.

3.8.7. On-site building requirements

- Two workshops for maintenance and repairs; one will be located at the mine services area and one at the process plant. The process plant facility will be fenced;
- Two warehouses for temporary storage; one will be located at the mine services area and one at the process plant. The process plant facility will be fenced;
- Laboratory for metallurgical testwork and sample analyses;
- Reagent and consumable storage;
- Offices and control room;
- Mobile plant;
- Dining area;
- Ablutions;
- Combined ablutions and change house;
- Camp accommodation for construction and operations;
- Gatehouse;
- Training centre; and
- Medical centre.

3.8.8. Laboratory

A small materials testing laboratory will be erected on site, contained within the plant site (see Figure 2-3). Common chemicals used in the laboratory will be cleaning detergents, small (<20 L) quantities of acids and alkalis. These items will be stored in the laboratory, in designated areas according to their safety datasheet.

3.8.9. Secure site gatehouse and training centre

Access to and from the mine will be granted by a permanent site gatehouse at the site entrance, and a training centre will be located in close proximity to the gatehouse. Parking facilities, the site access gates and a small offices for security personnel will be located in this area. The gatehouse will be manned 24 hours per day.

3.8.10. Accommodation camp

The proposed camp is situated at the south-western access road to the mine. The entire 11.1ha camp will be fenced off and will have access control at the gate and managed by a catering contractor.

3.8.11. Mine rescue and medical centre

A small clinic will be available on site, situated at the camp, which represents a central and easily accessible point throughout the entire site. The clinic will require specialist goods transported in weekly (or as and when required), and will create hazardous waste.

The clinic fit out and operation will be contracted and manned by a paramedic, and site security personnel will be first aid trained.
3.8.12. Waste

Landfill

An onsite landfill will be required for disposal of general solid wastes (food, glass, paper, wood, metal, oils and lubricants). The following locations have been chosen based on environmental suitability:

- Construction phase - within the tailings facilities area which may be covered to minimize scavenger access; and
- Operational phase - within the tailings facilities cells, moving outwards as the tailings cell area increases. Additional areas may be identified and developed later in the operational phase.

Hazardous wastes, oil wastes, medical wastes, recyclables, and other wastes not able to be disposed of in a landfill, will be collected in the sorting area located between the mine facilities and process plant areas. The sorting area will be fenced and guarded, with regular collection by licensed service provider/s.

Pollution control

Stormwater runoff from the plant area and the pit is considered to be dirty water, and must be contained/captured to prevent contamination of the surrounding water resources and the environment. Stormwater runoff from the plant will be discharged into the tailings dam or process water dam. All wash water from the camp site would be treated and then stored in a dam for recycling where possible, or pumped to the TSF.

Introduction of Sediment Control Structures

Five sediment control structures have been proposed within the project area, three to capture sediment from the mine and process plant area and operations and two below the TSF. The sediment control structures are designed to be up to 5 m in height. The ground conditions are considered suitable to support the structures with low permeability material being available locally to construct the embankments. During typical operation, the facilities will contain particles coarser than medium to coarse silts. During storm events, it is expected that soil particles larger than coarse silts / fine sands will be contained within the structures.

Figure 3-7: Example of the Function of Sediment Control Structures (SCS) in relation to mine infrastructure
Sewage treatment facility

Sewage collection and pumping will take place from the mine services area, the process plant and camp, to the sewage treatment plant located at the camp. Water from the sewage treatment plant will be directed to the tailings storage facility, while the dried solid waste will be used as fertiliser.

3.8.13. Transport

National Roads
Minor road upgrades and temporary elevation of power lines will be required to accommodate large loads that exceed the Mozambique road transport limit (weight, dimension, etc.) and where possible loads will be managed within the Mozambican transport envelope.

Project Roads
Roads will need to be built and/or upgraded to enable transport via road to site for construction and operations.

Haul Road
An 18 km long x 8m wide access road with 20 m servitude have and 2m wide V-drains on each side will be constructed from the public road approximately 3 km north of Sunate, running past the mine camp and leading to the process plant. This two laned unsealed road will have a maximum design speed of 50 km/hr.

Site Road
A 4m wide access road leading to the TSF will be constructed along existing drill tracks. A 4m wide access road leading to the WSF will also be constructed. These roads will have a maximum design speed of 30 km/hr and made from compacted gravel.

Vehicles
In general, 20 tonne trucks will be employed during the operational phase, with only abnormal loads making use of the larger, 36 tonne trucks. It is estimated that ten, 20 to 36 tonne trucks will be used to transport the graphite product from the mine site to Pemba or Nacala Port each day and materials from the port of Pemba, Tanzania and South Africa to site

Buses will be used to transport labour to and from site on an eight hour cycle. Light delivery vehicles will also be used for the general running of the mine.

3.8.14. Employment opportunities

The following table is a breakdown of employment opportunities based on skill level required at each phase:

Table 3-1: Maximum number of individuals that will be employed during each phase

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<thead>
<tr>
<th>Type</th>
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<th>Operation Phase</th>
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<td>50</td>
</tr>
<tr>
<td>Semi-Skilled</td>
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<td>50</td>
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<tr>
<td>Unskilled</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>500</td>
<td>200</td>
</tr>
</tbody>
</table>

The operational staff will comprise of 75 mining staff; 75 process and maintenance staff; and 50 service /admin staff.

Additional to the construction staff will be the support staff who will man security, assist with catering, site management, transport and laundry.

Semi-skilled workers will be sourced from local villages; skilled workers sourced mainly from
Mozambican and South African contracting companies; and supervisory and management positions will come from South African contracting companies. For the first two years the expatriate compliment will be 10%, but will be reduced to 4-6% by year four.

All non-local workers will work a 6 week on 2 week off rotation working 9 hours a day, every day including Sundays. Local personnel will work a shift roster in operations in accordance with Mozambican labour laws.

**3.8.15. Corporate Social Responsibility Plan**

The guiding principle of Grafex's Corporate Social Responsibility (CSR) Plan is helping Project-Affected Communities (PACs) help themselves. This means avoiding the creation of a dependency mind set, instead encouraging and providing the resources for personal development. The key PACs identified are Silva Macua, Nankhumi, Natocua, Muaguide, and Nacussa.

Conditional on receiving its mining license, Grafex commits to signing a Memorandum of Understanding (MoU) with the District of Ancuabe local government and the PACs, to implement its CSR Plan. It also commits to adhering to the “Manual on the CSR implementation for Mining Industry”, set out as the Mining Industries' responsibilities and obligations within the Ministerial Legislation.

Grafex will commit to developing Mozambican-owned suppliers and service providers, by requiring (where possible) that supply chain procure goods and services for the mine via such entities.

In determining what CSR projects to develop, Grafex intends to make consultation with the local communities a critical step in the process i.e. all CSR projects developed will be those identified as necessary by the local communities. Adhering to the principle of personal development, communities will be encouraged to think about what they can contribute to these projects, and how Grafex can assist with resources. This will help to make projects more sustainable, by allowing communities to take ownership and leadership roles, lessening the chance of project collapse after Grafex's involvement lessens.

When the mine begins, the following tasks will be focussed on initially:

1. Working with Graphit Kropfmühl (GK – neighbouring mine) to support provision of power to four PACs: Nankhumi, Natocua, Muaguide, and Nacussa.
2. Maintenance of local boreholes.
3. Assisting farmers displaced by the mine by providing agricultural training.

After these initial tasks, the following initiatives will be pursued:

1. Development of a Training Centre. The Training Centre will initially offer training in skills related to construction. These skills will serve trainees during their employment during construction, and be useful to them after their employment ends. Trainees will be registered on Grafex's Human Resources Database, for possible future work for the mine.
2. Develop a Garden Market (known locally as a “Machamba”). This will be a farming area for community members from the PACs. Here they will be able to grow vegetables and crops, and sell their produce to the mine for its consumption.
3. Grafex will provide community members with access to a certain amount of water from its Raw Water Dam. This access will be provided at the dam
4. Awareness campaigns in the communities focussing on the following issues:
   a. Road safety, focussing on non-motorised road users (i.e. pedestrians, cyclists, etc).
b. Local Induction Course for staff and contractors, as newcomers to the area. The purpose of the course will be to sensitise participants to local customs and traditions, modes of behaviour, courtesy, etc.

c. Supporting a local football league, by:
   i. Providing footballs;
   ii. Sponsoring a team or the league;
   iii. Creating a team from staff representing the mine.

d. Health. Raising awareness regarding:
   i. HIV and Aids;
   ii. Cholera prevention;
   iii. Malaria prevention.

e. Raising awareness in the local communities on the importance of environmental protection.

5. Create protected areas within areas under its control to protect areas of high conservation value.

6. Work with the communities to establish a nursery for fruit and shade trees, which the mine will purchase for rehabilitation.

7. Establishment of a Grievance System for raising and dealing with complaints.

3.8.16. Resettlement Action Plan

As the project triggers economic displacement of machambas and some sacred sites, a Resettlement Plan (RP) is currently being conducted by Coastal & Environmental Services (CES) in accordance with the Resettlement Process Resulting from Economic Activities (Decree No 31/2012), as well as Ministerial Decree N.155/2014. For the aforementioned RP, land has been evaluated inside the proposed mine footprint area of 9,000ha during July and August 2017. This involved household-level (census) and farmland surveys. Apart from using enumerators, CES also ensured the active participation of community members to allow the enumerators to gain an understanding of the area and where the machambas were located. Each enumerator was therefore paired with a community representative and was assigned to survey a particular area. District, provincial and national government technicians provided overall supervision.

In the RP, five villages are considered to be the direct Project-Affected Communities (PACs), as farmers from these villages will need to be economically displaced: Nakusa, Nankumi, Muaguide, Natocua and Sunate. The mine footprint area has no residential (household living) structures, although there are secondary structures that will be lost (such as temporary shelters or storage buildings). The site access road contains most of the surveyed machambas (69) belonging to 61 households from the direct PACs who might need to be economically displaced in full or partially. The term partially is used as the proponent wishes not to disturb entire machambas along the principal access road, but rather just sections required for widening the road. One individual grave was recorded inside the mine footprint area, as well as an area which is used for small-scale gold mining. Most of the machambas are intercropped with crops such as cassava, maize, beans, peas and sesame. Some mango and cashew trees (mostly sapling, non-producing trees) were recorded on the machambas.

The RP is still on-going as the dates for the upcoming public consultations, as per Ministerial Decree N.155/2014, have to be set by the government.
4. DESCRIPTION OF THE BIOPHYSICAL ENVIRONMENT

4.1. CLIMATE

The project site is characterised by a tropical climate with two distinct seasons; a wet season that occurs from November to March and a dry season from April to October. The average annual temperature for Ancuabe ranges from a mean 33°C in November to a mean 19°C in July (Climatedata.eu, 2017). Ancuabe receives an annual average rainfall of 1147 mm with the wettest month occurring in December (mean of 213 mm rainfall) and the driest month occurring during the month of September (4 mm average) (Climatedata.eu, 2017).

4.2. TOPOGRAPHY, HYDROLOGY AND GEOLOGY

The study area gently slopes up from east [64 m above sea level (asl)] to west (350 m asl) and is located between the Muaguide River to the west and the Mogido River to the east (Figure 4-1 and Plate 4-1). Both rivers drain to Pemba Bay to the East. The Muaguide River flows during the months of November through to April and has an average depth of between 1 m and 2m. The river bed varies in width, but is on average 30 m wide with 2 m high banks. The Muaguide basin covers an area of 1,811 km² and a river length of 85 km. The Project Area covers 2% of the Muaguide basin and approximately 9.4km of the Muaguide River (Figure 4-2). Riparian woodland and forest occurs along these rivers, drainage lines and tributaries within the site. The Muaguide and its tributaries are seasonal, and cease to flow in the seven or eight dry months of the year. Approximately 90% of the 1147mm annual rainfall occurs in the four months from December to March, and results in the rivers flowing strongly, with considerable energy to pick up and transport sediment, most of which will be carried into the perennial Muaguide River. Water quality data indicates that the Muaguide and Mogido carry higher sediment loads during the high flows of the wet season than during the dry season.

The project site is located predominately on Proterozoic age Montepuez super group sediments. The geology in the complex ranges from orthogenesis to granitic to amphibolitic and paragneisses ranging from quartzite, meta-arkose, marble, quartz-feldspar gneiss and biotite gneiss. A minor section to the east of the project area is situated on Phanerozoic age Rio Mecole group sediments. The geology in this complex can be described as arkostic sandstone and conglomerate (Bjerkgard, 2006). The mineralogy in the project area is a true indication that the complex has undergone amphibolite-grade metamorphism.

Figure 4-1: Gradient of the Ancuabe Graphite Mine Project Area from West (left) to East (right)
Plate 4-1: The general topography found within the project area. Low lying depression in the foreground, and low ridge in the background.

4.3. HYDROGEOLOGY

The predominant geological units consist of granitic gneiss, granodioritic gneiss, biotite gneiss and graphite interlayered with meta-sandstone, conglomerate, quartzite and amphibolite. The weathered lithological units of the arkrostic sandstone and quartzites situated to the east of the study area may have the potential to create a good medium for ground water storage and are likely to provide significant flow.

Shallow saprolite lithological layers are usually associated with weathered material from hard-wearing underlying geological layers below. The underlying lithology consists of gneiss material of different magnitudes and amphibolite’s which indicate a largely un-weathered layer. Geological cores extracted on-site indicated that the presence of water was unobtrusive, indicating that the weathering process was staggered. As no hydro-geologically significant unit defines the aquifer base, the thickness of the aquifer is considered to be approximately 180 m. Secondary fault lines (derived from the 1:250 000 geological map) exist to the north-west and south-east of the project site. These units are likely to have higher permeability and hydraulic conductivities, and tend to provide secondary pathways for ground water distribution.

The water chemistry in the study area is typically of a Ca-Mg-HCO3 signature, which is indicative of freshly recharged ground water.
Figure 4-2: Surface hydrology of the Ancuabe Graphite Project Area
4.4. SURFACE WATER QUALITY

No *E. coli* was detected within the Muaguide River. Total coliform bacteria are common in soil or vegetation, and are generally harmless. If a laboratory detects only total coliform bacteria in drinking water, and no *E. coli*, the source is probably environmental and faecal contamination is unlikely.

There are very few exceedances from the most important constituent concentration limits specified in SANS 241:2015 and WHO 2011a in the surface water. The only exception is Manganese as Mn. This indicates that the baseline surface water quality is good.

It can reasonably be concluded that the waters of the Muaguide River were safe for human consumption during the latter half of 2015 (the dry season) and the early part of 2017 (the wet season). Given the relatively low level of development in the upstream catchment there is no reason to suppose that this will change in the near future, but regular and frequent water quality monitoring should continue in order to compile a longer pre-construction baseline record of water quality.

4.5. GROUND WATER QUALITY

All parameters except pH exceed either the SANS 241-2015 and WHO 2011 for groundwater. Electrical conductivity and nitrates exceed WHO standards only, but all other constituents exceed both standards. Therefore, it is concluded that the quality of groundwater is inherently poor. This has been attributed to the underlying geology and natural processes, since the area is largely undisturbed by anthropogenic activities.

4.6. LAND USE

Compared with other countries in the region, Mozambique has a rich natural resource base including untransformed indigenous forests, savannah, woodlands and coastal habitats. About 25% of the land has commercial forestry potential, 12.5% constitutes state-protected areas and a further 22% comprises potential wildlife habitat.

There is evidence of charcoal production through most of the site, but the project area’s natural resources are mainly used for subsistence purposes (Bicanic *et al.*, 2014). This usually includes collecting wood, thatch and bamboo for construction, but also collecting wild fruits, vegetables and bulbs, either for medicinal purposes or for food. Most of the households also make charcoal from felled wood, which many sell next to the road. There was no evidence of agriculture in the eastern portions of the study area, where the mine and its infrastructure will be located. The vegetation is largely intact, and dominated by Miombo Woodlands. However, towards the west clearing for the establishment of machambas, and for producing charcoal, has taken place (Plate 4-2). Consequently, the vegetation in this area is secondary in nature, with few large trees remaining, indicating a long history of disturbance.

Mineral extraction is the other major land use within the region, which has been responsible for much of Ancuabe’s economic development over the last few years (Bicanic *et al.*, 2014). Graphite is primarily mined, but to a lesser degree rubies are increasingly being exploited, often through illegal mining operations (Bicanic *et al.*, 2014). Local villagers were seen mining the dry river beds during the last site visit.
4.7. VEGETATION

Two main vegetation types within the study area are Miombo Woodland and Riparian Woodland. Areas with agricultural land are described and mapped as Machamba/Secondary Woodland Mosaic.

4.7.1. Miombo Woodland

This vegetation type is found throughout the study area and is a mosaic of *Tall Open Miombo Woodland* and *Tall Closed Miombo Woodland*. *Tall Open Miombo Woodland* is characterised by the presence of trees that are between 10-20 m in height, with an open canopy (1-10% cover) and a grass understory (Plate 4-3a). *Tall Closed Miombo Woodland* is characterised by the presence of trees that are also 10-20 m, but with a closed canopy cover (10-75%) and an understory that is a mix of herbs and grass. Although the structure of these two vegetation types differ, there was no distinct difference in species composition.

Dominant species include *Brachystegia spiciformis*, *Julbernadia globiflora*, *Sterculia appendiculata* and *Sterculia africana*, *Pterocarpus angolensis*, *Pterocarpus rotundifolio*, *Milletia stuhlmanii*, *Monodora junodii* and in some areas bamboo.

Although the *Miombo Woodland* has a high species diversity and is relatively intact, this vegetation type appears to be fairly widespread outside of the study area. As such it was determined to be of Moderate Sensitivity.
Plate 4-3: a) Tall Open Miombo Woodland is fairly intact, with limited harvesting occurring. The canopy cover is far more open and less than 75% b) riparian woodland.

4.7.2. Riparian Woodland

The riparian zone is only a few meters wide, and occurs adjacent to the rivers and streams throughout the study area\(^6\) (Plate 4-3b). The understory is generally comprised of small shrubs with a sparse grass cover. Tree height varied between 10 and 20 m and the canopy cover was between 10 and 75%. This vegetation was intact, which is unusual in Mozambique as these areas are usually degraded, having being cleared to grow water dependent crops such as rice, spinach and tomatoes. The lack of access and distance the site from the nearest village has contributed towards its preservation. This vegetation type was dominated by *Pterocarpus rotundifolia, Monodora junodii, Millettia stuhlmanii* and *Julbernardia globiflora*.

The Riparian Woodland has a high species diversity and in some instances this vegetation type shifts from woodland to forest, when the canopy cover is almost at 100%. This vegetation type provides important refugia for faunal species and functions as a natural corridor for the dispersal of seeds and movement of animal species such as amphibians, reptiles and mammals. This vegetation type has therefore been classified as an area of High Sensitivity. (Plate 4-3b).

4.7.3. Machamba/Secondary Miombo Woodland Mosaic

This vegetation type occurs in the western parts of the study area near the access road, and is closer to the villages. In the recent past it was Miombo Woodland, but has now been cleared and is used for the cultivation of crops such as maize and cotton (Plate 4-4). These areas contribute less towards ecosystem functioning and are typically comprised of pioneer and weedy species, and have therefore been assigned a Low Sensitivity.

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\(^6\) The study area in this report is defined as the mine’s exploration license area.
The project infrastructure will result in the removal of 666 ha of vegetation. Of the vegetation that will be cleared, the greatest impact will be on the **Miombo Woodland** with 492 ha being lost to the mine and associated infrastructure. Almost 73% of the area to be cleared is Miombo Woodland (Figure 4-3). This vegetation type is of moderate sensitivity and is fairly widespread. Of the remaining area, 25% of the cleared area is comprised of **Riparian Woodland** (High Sensitivity) and 2% of the affected area is comprised of **Machamba/Secondary Woodland** (Low Sensitivity).

### Species of Conservation Concern

The total species list from the site visit was assessed against the International Union for Conservation of Nature (IUCN) Red Data list, the Mozambique Red Data List and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The results are summarised in Table 4-1 and the full species list appears in Appendix A.

<table>
<thead>
<tr>
<th>Status</th>
<th>Number of Species</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IUCN Red Data List (international)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vulnerable</td>
<td>1</td>
<td><em>Millettia bussei</em></td>
</tr>
<tr>
<td>Lower Risk/Near Threatened</td>
<td>2</td>
<td><em>Dalbergia melanoxylon</em>, <em>Pterocarpus angolensis</em></td>
</tr>
<tr>
<td>Least Concern</td>
<td>2</td>
<td><em>Holarrhena pubescens</em>, <em>Bombax rhodognaphalon</em></td>
</tr>
<tr>
<td>Unknown (no information available)</td>
<td>153</td>
<td>Refer to Appendix A</td>
</tr>
<tr>
<td><strong>Mozambique Red Data List</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vulnerable</td>
<td>2</td>
<td><em>Sterculia appendiculata</em>, <em>Sterculia quinqueloba</em></td>
</tr>
<tr>
<td>Lower Risk-Near Threatened</td>
<td>1</td>
<td><em>Afzelia guanzensis</em></td>
</tr>
<tr>
<td>Lower Risk-Least Concern</td>
<td>1</td>
<td><em>Millettia stuhlmanii</em></td>
</tr>
<tr>
<td>Data Deficient</td>
<td>1</td>
<td><em>Millettia bussei</em></td>
</tr>
</tbody>
</table>
Figure 4-3a: Vegetation Map of the study area
Figure 4-3b: Vegetation Map of the study area
4.8. FAUNA

Faunal diversity was historically high in this region but the populations of certain groups, especially large mammals and birds, have been depleted. In some cases certain species have become locally extinct. Forty nine amphibian species may occur in Cabo Delgado Province, of which 25 were observed during the faunal surveys. Two amphibian SSC species occur, both probably representing new, endemic species that are being either described (Notophryne cf anotis) or are under investigation (Mertensophryne cf anotis). The amphbiid fauna is not obviously impoverished from that expected to have historically occurred in the region.

During the faunal surveys 30 reptiles were observed, and another three were reported to occur in the region. This number is a good reflection of the over 50 species that can be expected in the region, with secretive snakes being the most under-represented group. No reptile SSC or endemic species were confirmed in the project area, although one Near Threatened terrapin (Cycloderma frenatum) occurs in the region and may be present. Two new species of endemic lizard (Panaspis sp. and Platysaurus sp.) currently being described are present in the project area, but both have wider distributions within Cabo Delgado Province. A significant number (10) of reptile species listed on CITES appendices, with international trade either banned or subject to strict control, were recorded in the region. Due to persecution, the density of the larger, more conspicuous reptiles (e.g. pythons, cobras, mambas) may be impoverished from numbers expected to have historically occurred in the region. It is likely that the overall reptile diversity remains relatively intact. Although the incidence of snakebite in the region is reported to be low, at least 12 venomous snakes occur, bites from the majority of which have caused fatalities.

One hundred and thirty seven (137) bird species were observed during the faunal surveys. Although the number of birds recorded is low relative to the possible over 440 bird species that may occur, it is a good reflection of the common bird fauna of Miombo Woodlands. This number can be expected to increase with long-term observations. One IUCN threatened bird species (White-headed Vulture, Vulnerable) was recorded on site. However, a number (17) of CITES listed species were recorded. These were mainly Falconiformes (e.g. eagles, buzzards, goshawks, sparrowhawks etc) or Strigiformes species (owls). Of the Tauraco species that also fall under CITES, the purple-crested turaco was the only species observed on site.

Of the possible 145 mammal species which may occur in Cabo Delgado Province (99 terrestrial and 46 bats); only 24 were recorded during the surveys. A further 20 mammal species are reported to occur in the area, while a further 51 could possibly also occur in the area. Most of these are small mammals, such as rodents and shrews. Bats are poorly known in Mozambique and were not assessed during the surveys. Eighteen large to medium-sized herbivores and carnivores that historically occurred in the area are now either locally extinct or very rare vagrants. Six threatened mammals occur, but only elephant were confirmed to occur (at least occasionally) in the project area. All of these species are recorded in the adjacent QNP.

The most sensitive habitats utilized by the surviving fauna include: 1) the Riparian zone and wetlands; 2) Steep slopes and rocky ridges. None of these habitats are specific to the project area and are well represented in Cabo Delgado Province. The ephemeral catchments of the Muaguide and Mogido rivers represent particularly sensitive habitats, especially for amphibians and birds.

4.9. FISH

Nine fish species were captured in the study area during the survey. Of these nine fish, seven are listed on the IUCN as Least Concern and are widespread, one (Oreochromis mossambicus – Mozambique Tilapia) is listed as Near Threatened and one (Nothobranchius
cf. makondorum - Annual killifish) is listed as Data Deficient and is undescribed, probably a new fish species, that appears to be the same species found in the upper Montepuez River catchment (Bok & Chakona 2013).

The Mozambique tilapia (Oreochromis mossambicus) is categorized by the IUCN as near threatened (NT) due to the threat of hybridization with Nile tilapia (O. niloticus). The latter species is being spread by man beyond its natural range, including into the Zambezi River system. However, this hybridization threat is not yet apparent in northern Mozambique. As this is a hardy species able to tolerate poor water quality and thrive in stagnant pools, it is thought unlikely to be threatened by the mining activities.

The killifish (Notobranchius cf. makondorum) found in the study area is similar to but different from Notobranchius makondorum (hence the prefix cf.), and is considered a new species (pers. comm. Roger Bills, fish taxonomist, SAIAB, August 2015). However, this same species has also been found in upper tributaries of the adjacent Montepuez River system by Bok and Chakona (2013) and thus appears to be widespread throughout this region.

Plate 4-5: Local fisherman setting a gill net in a large pool in lower Muagide River on 24/07/2015.
5. DESCRIPTION OF THE SOCIAL ENVIRONMENT

5.1. THE PROJECT-AFFECTED COMMUNITIES

Project Affected Communities (PAC) refer to communities that are affected by the proposed project through either primary (direct) or secondary (indirect) effects. The distinction between direct and indirect PAC is a function of the extent and severity of the anticipated positive and/or negative impacts induced by the project on the particular communities.

5.1.1. Affected Communities

The project area is approximately 80 km by road west of Pemba and is located within the Ancuabe District in the Cabo Delgado Province of Mozambique. The nearest main town to the project area is the town of Ancuabe, which is still 20 km away. There are several villages located outside the project boundary, with the nearest being 10km away (Figure 5-1). The project area itself is characterised by very limited human activity.

Four villages are considered to be the directly affected:

1. Silva Macua (also known as Sunate);
2. Nankhumi;
3. Natocua; and

These villages occur inside the corridor of impact and will be affected by economic trade and commerce, and related demographic and livelihood changes. They will also be affected directly from the physical activities of the project itself, and some will be economically displaced as a result of the project’s land take.

The more peripheral settlements indicated on Figure 5-1, as well as the towns of Pemba, Metoro and Ancuabe are considered to be indirect PAC in that their experience of the project induced impacts will be indirect and of a lower significance. None of the directly affected PAC settlements are located inside the mine licence area, and there will be no physical resettlement. However, villagers but utilise the study area for natural resource harvesting and to a lesser extent cultivating farmlands (referred to locally as machambas). Most of the machambas occur within the most south western point of the haul road (where the haul road joins the main road: R243), although some machambas are located within the proposed dam site. Most of these machambas are cropped with cassava, maize, beans, peas and sesame. Some mango and cashew trees (mostly sapling, non-producing trees) and secondary structures (i.e. not physical living houses) were recorded on the machambas.

The study area has no physical living structures. The site access road contains the majority of the 69 identified machambas belonging to 61 households from the villages of Nakusa, Nankumi, Natocua and Sunate (also known as Silva Macua) who might need to be economically displaced in full or partially. Entire machambas will not be required along the principal access road, but rather just sections required for widening the road. One individual grave was recorded inside the study area, as well as an area which is used for small-scale gold mining. Thus, it is anticipated that only economic resettlement/displacement (the loss of economic activity and livelihoods, such as loss of crop fields) will take place. Overall, use of the majority of the project area for agriculture appears to be very limited (Figure 5-2), and the area is mainly utilised for natural resources (fuel wood, plant harvesting, charcoal production and hunting).
Figure 5-1: The project area (green polygon) in relation to nearest villages
Figure 5-2: Machambas located along the proposed haul road and in the project area
5.2. LOCAL DEMOGRAPHICS AND SOCIAL INFRASTRUCTURE

5.2.1. Local Demographics

The Ancuabe District is not very densely populated, and in 2013 had an estimated population of 118,926 people. The population estimates, obtained from the local leaders for the four affected villages, are provided in Table 5-1 below.

<table>
<thead>
<tr>
<th>Village Information</th>
<th>Nankhumi</th>
<th>Natocua</th>
<th>Sunate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of people</td>
<td>2,272</td>
<td>2,150</td>
<td>4,143</td>
<td>8,565</td>
</tr>
<tr>
<td>Total number of men</td>
<td>1,124</td>
<td>1,064</td>
<td>2,050</td>
<td>4,238</td>
</tr>
<tr>
<td>Total number of women</td>
<td>1,148</td>
<td>1,086</td>
<td>2,093</td>
<td>4,327</td>
</tr>
<tr>
<td>Number of households (families)</td>
<td>455</td>
<td>430</td>
<td>93</td>
<td>978</td>
</tr>
</tbody>
</table>

The data collected during the household surveys indicate that 45.8% of household members are below the age of 18 years, indicating a very young population cohort. This compares to the province’s large youth population (44.6%) under the age of 15, with 53.2% of the population within the working-age of between 15 and 64 (Knoema, 2015).

In terms of gender, females represent 51.6% of the population in the Cabo Delgado Province (ibid). Gender-related roles and responsibilities are clearly defined and culturally implicit. Men are considered the head of the household and the decision-makers. Their roles and responsibilities include hunting, fishing, farming, small businesses and the construction of houses. Women are responsible for child bearing and household chores, such as cooking, cleaning and collecting wood and water. Women assist with thatching and placing mud on houses while farming activities are undertaken by all household members (men, women, the youth and the elderly).

The youth divide their time attending school, playing sport, making crafts, fishing, charcoal burning, family machamba cultivation and assisting with child care.

The main language spoken by the communities is eMakhuwa, or Macua, and Portuguese. All surveyed households indicated that Macua was their home language, with 77% of respondents indicating that they speak Portuguese as well.

5.2.2. Educational Status

Each of the villagers has one primary school covering grades 1-5, and the number of learners at these schools range between 200 and 300. Most schools have around five teachers (including the headmasters). Very few household members seem to complete secondary schooling (2%), 7% have some secondary schooling, and only 9% have completed primary school. Almost 42% of households members have not attended school at all, which demonstrates why the illiteracy rates remain so high in the province. Cabo Delgado Province has the highest illiteracy rate in the country, where 60.7% of the population cannot read or write.

The primary schools face several challenges and require the following support:

- Most schools have a lack of classroom capacity and need to expand.
- There is a shortage of teachers in most schools, and support is needed to employ more teachers. Key informants also noted that accommodation for teachers is lacking.
- There are limited numbers of desks and chairs, whilst stationery and other materials are frequently in short supply.
- Proper toilets and water supply (boreholes) are required.

These challenges contribute to low school attendance rate, coupled with the fact that children...
work on farms instead of attending school. The nearest secondary schools are situated in Metoro and Ancuabe. Most of the children from the villages do not attend secondary school or university due to high fees and the distances from their villages.

5.2.3. **Culture and Religion**

Religions practiced in the local villages include Christianity and Islam, with churches and mosques found in all four villages.

Some households practice polygamy, a traditional system where husbands have more than one wife. Polygamy is often believed to enhance productivity as those who have a greater number of children who survive to productive years will have more children to work on *machambas* and therefore increased support through inter-generational transfers (Adui et al., 2008).

5.2.4. **Land Tenure**

Traditional rights to land in the study area are held under a traditional tenure system that is dominated by the area’s major ethnic group, namely the Makhuwa (although there are smaller ethnic groups such as the Munraha, for example).

Almost half of the surveyed households (47%) obtained the land on which they live through traditional tenure, followed by approximately 26% who inherited their land. Around 16% of the households bought their land, usually through informal arrangements which is not documented. Although land is held by the state, purchasing land is not an uncommon practice, especially if a family (or individual) wants to settle on a piece of land which used to be the homestead of someone else. Land that has a homestead or other infrastructure is purchased by use right applicants, while open or undeveloped land use title is given free of charge to local applicants. Land and houses can be rented by temporary occupants.

5.2.5. **Migrancy**

The households interviewed confirmed that they live there on a permanent basis, but they also note there are periodic influxes of people from as far as the town of Ancuabe who come to the area to farm on a temporary basis in order to supply their own villages (or towns) with agricultural produce. Farming-related migrancy is largely due to insufficient land being available in and around urban areas. These migrant farmers use farms in and around the local settlements, either through a land rental agreement with other households/families, or work on farms in exchange for either money or agricultural produce. These migrants are normally housed in the communities without having to pay for accommodation.

5.2.6. **Household Living Conditions**

Most houses and businesses in Metoro and Sunate are more robust brick, mortar and tin roof sheeting structures. However, traditional wattle and daub (thatch roof) as well as clay sun-dried brick structures are the dominant form of housing in the remaining villages (Plate 5-1).

5.2.7. **Social Infrastructure Assets**

The main district hospitals are situated in Ancuabe and Metoro. Discussions with Metoro (Plate 5-2) and Ancuabe hospital staff highlighted the challenges experienced by these health facilities, which largely relate to what these informants claim to be a lower than desired level of support from the Government, or a lack of medicine and/or general facility equipment. Related problems include a lack of medical facilities in general, poor drug storage facilities and a lack of transport to the rural clinics. Both hospitals indicated that ever increasing patient
loads place strain what little resources they have under strain, and invariably bed space is not enough, particularly in times of diarrheal disease outbreaks.

Plate 5-1: Typical housing and business structures found in the study area - both brick and mortar (left), as well as traditional wattle and daub houses (right).

Plate 5-2: Metoro Hospital

Community members also referred to a need for more health facilities in the area, as well as an upgrade to the existing ones. Distance to the available centres is often quoted as the limiting factor in accessing these services.

There are no police posts in the villages, with the exception of Sunate. The type of crime in the area is reported to be generally limited to petty crime and livestock theft, which is usually reported to village chiefs or leaders, as well as police stations when possible.

There are football fields in most of the villages, and majority of the villages also offer a dance
club for recreation. There are also women’s, men’s and youth organisations in most villages, with water and farmer’s associations in some of the villages. These recreational activities and associations create a sense of belonging, community pride and cohesiveness.

Most villages have their own shops and weekly market places where smaller items are sold or bartered/traded; varying from food items and agricultural produce to charcoal, medicine and general equipment. The largest market places are in Sunate, Chiure (around 25 km from Metoro), Metoro and Ancuabe. Around 40% of households (usually the women) go to markets on a daily basis, whilst the remaining households either go monthly or weekly.

The primary modes of transport include bicycles and motorbikes, but most villagers travel by foot to their machambas. For longer trips minibus taxis as well as larger buses operated by private companies or individuals are utilised. Very few villagers use cars.

5.2.8. Basic Infrastructure

There is no access to piped water and villagers depend on water points. The majority of the villages use wells, hand pumps or draw water from the river as water sources for drinking, bathing, washing clothes and for livestock. In many cases, the water from the boreholes’ overflow is used by livestock, as well as for washing clothes. There are 12 boreholes with hand-pumps in Sunate and three in Nankhumi. No borehole was recorded in Natocua, although the village has several wells. Several hand-pumps found in the villages are not functioning.

Almost all respondents (93% - 130/140) indicated that they believed the water was always drinkable, with the remainder indicating that sometimes it was perceived to be undrinkable.

The sanitation infrastructure in the villages comprise of self-constructed pit latrines with bamboo or thatch coverings, as there is no water borne sanitation system (Plate 5-3). The pit latrines are shared between 1 to 4 households, and 82% of households indicated that use pit latrines for their ablutions, with the remainder doing so in the surrounding bush.

Figure 5-3: Typical pit latrines and borehole water points utilised by communities

Almost half (44%) of the households burn their domestic refuse (waste), and 41% bury their waste. The remainder (15%) dispose of waste in the surrounding bush. The waste disposal comprises of hand-dug pits where waste is buried and/or burnt. There are no centralised landfill sites in any of the villages surveyed.

There is limited electricity in the study area, and most households are reliant on wood and/or charcoal for cooking, and wood and/or torches for lighting. Sunate is the only nearby village with access to electricity, but very few households have access to it. Some households and businesses use electricity from generators or solar panels. Wood and charcoal remain the
most significant energy source for the majority of households (approximately 70% combined), with lanterns extensively used for lighting purposes in the evenings. Wood from the local Mphakala Tree (*Julbernardia globiflora*) is most widely used.

### 5.3. HOUSEHOLD LIVELIHOOD STRATEGIES

#### 5.3.1. Employment Sectors

Most households in the villages in close proximity to the study area are subsistence farmers, some of whom sell produce locally. Labour exchange is commonly practiced in rural areas in Mozambique, where labour from the villages work on machambas owned by other households and receive payment in kind, such as a prepared meal. This is a cultural practice driven by moral obligation or reciprocity (Osbahr *et al.* 2008), often as a response to labour shortages.

Employment in mining and exploration has steadily increased in some of the districts, with several mines being constructed in the province. The mining sector is expanding in the region and will provide a range of employment opportunities in the future. However, only 7% (10/140) of survey respondents indicated that members of their households had formal employment, either with government (health and education departments) or working for mining companies in the area.

Only 2.8% (4/140) of surveyed households indicated that members left the area either for work purposes, or seeking greater experience outside of their local village. Farming is the main source of income and subsistence for villagers in the project area, who also rely extensively on natural resources.

#### 5.3.2. Natural Resource Use

The project area is utilised for natural resources and ecosystem services, including fuel wood, medicinal and edible wild plant harvesting, and hunting. The majority of households access these resources for firewood, thatch grass, charcoal production, weaving materials (reeds and grasses) and wood craft materials (Plate 5-4). Collecting wood, mud, thatch and bamboo for construction, but also collecting wild fruits, vegetables and bulbs either for medicinal purposes or for food occupies a lot of the households time. Some households are engaged in hunting and fishing activities, which are usually primarily subsistence strategies.

![Plate 5-4: The area’s natural resources are utilised for handcrafts and for extensive charcoal production that the majority of houses rely on for cash income.](image)

Only 2% (3/140) of the population fish on a regular basis, given the perennial nature of the rivers in the area this is not surprising. Most households also supplement their diets by sourcing fruits from tree crops (mostly around their homesteads), which include banana, papaya, mango, and guava trees. Vegetables, such as tomatoes, pumpkin and beans are
grown in food gardens. Income from fruit and vegetables can be significant and is sold in local markets or alongside the road.

5.3.3. **Local Livelihoods**

Most households use their land predominantly for subsistence purposes, as many are constrained by a lack of access to market, unimproved agricultural technology, limited or no access to chemical inputs such as fertilisers, and crucially, no capital for investment in improved production. All households have at least one machambas, but many have more (ranging from 3 to 7 machambas per household). The farmers in the area consider maize, cassava and beans to be the most productive crops, but sorghum, millet, ground nuts and sweet potatoes are also grown. Some also have smaller food gardens around their homesteads. Other crops not as commonly grown include cotton, sugar cane and rice. Crops are rain-fed and a rotational slash and burn agricultural system is implemented, where land is cleared of natural vegetation, cultivated for 2 to 3 years and left to lie fallow for approximately 4 years to allow the land to become fertile again.

5.3.4. **Household Income and Expenditure**

The majority of the households in the study area receive some form of income from their main household activities, namely agricultural (87%) and small business (5%) efforts. In terms of household cash income sources, agriculture is the primary source for most household (69%) income, followed by business activities (22%) and salaries (5.71%).

With such a limited cash economy, daily expenditures remain high. The most common expenditure items are food, clothes and school registration fees and schooling materials such as books and uniforms.

5.4. **FOOD SECURITY AND HOUSEHOLD VULNERABILITY**

5.4.1. **Food security**

The PAC have various levels of access to markets, farmland, hunting areas, rivers and natural resources due to the distances to these potential food sources. Very few households receive a formal income and therefore tend to borrow, barter, share or rely on food stocks and existing livelihood strategies, resulting in instability of food sources.

The quality and availability of water sources is relatively poor in the area, with some wells drying up in the dry season. Limited water sources, poor sanitation facilities and poor hygiene contribute to diseases and illnesses spread by food preparation and/or utilisation. Storage facilities are also limited as very few households have electricity, restricting the ability to keep fresh foods. Household diets are therefore restricted to food types that can be dried or stored.

Beans and maize meal porridge are the household staples, followed by rice, peas, cassava and fish as the main protein source. High starch diets are the norm in the study area and rural sub-Saharan Africa in general. Other protein sources such as chicken and red meat are not reported to be eaten often. Access to food/fruit trees is seasonally but form an essential part of the household diet. Most households report access to mango trees, with lemon, banana, papaya and guava trees also being utilised.

5.4.2. **Household Vulnerability**

A vulnerable household is a household that might suffer disproportionately or, “face the risk of being marginalized by the effects of resettlement” (Huggins and Lappeman, 2012). These households would be unable to anticipate, cope with, resist and/or recover from project-related risks.
Vulnerable groups do not have the social flexibility to withstand the stresses of the resettlement process. In any particular community, certain sections of the population are more vulnerable to change, having to adapt or mitigate their livelihoods in response to a new environment. Development creates a changing environment, and forces communities to adapt or diversify their livelihoods to accommodate the changes. Assessing the vulnerability context of the PAC ensures that developers pay attention to the needs of these groups.

Less that 2% of the surveyed population are above the age of 65, although it is likely to be much higher as many older people simply do not know how old they are. Although in the minority, these citizens should be considered as vulnerable for several reasons. The elderly normally require additional healthcare services that generally are not available to residents of the more isolated communities in the study area. Due to the absence of state services for senior citizens in the area, families typically assist elderly. They are often too old or infirm to grow (or collect) food for themselves, or sell their labour for income. Although not extensively reported in the household survey, all communities confirmed that there are children with disabilities in their villages. A lack of adequate government supported education and healthcare services for disabled children expose households with disabilities to a host of vulnerabilities, such as chronic illnesses and lack of schooling.

These villages are still predominantly patriarchal, based on the role men have in managing household finances, and overall decision making at the household level. However, the survey revealed that 14.2% of households were female-headed, and these are especially vulnerable to project-induced impacts, especially economic displacement, for the following reasons:

- In addition to heading the household, women are also responsible for everyday household chores, such as washing clothes, collecting wood, cooking and looking after the children. This means that females who head households have to work harder;
- This added responsibility compromises food security in female-headed households, as they are then also responsible for chores undertaken by men, such as household finances, and homestead maintenance; and
- A lack of security in land tenure, as women are typically not afforded the opportunity to own land, and risk being deprived of their central income-generating source. Land provides the primary source of income, but above all, food. Women are normally the first to have to deal with food insecurity and malnourished children (Gladwin et al. 2001).

In many rural communities, household finances are mostly managed by men. When women were questioned during a focus group discussion about household finances, the majority agreed that their husbands deal with the money. Some women strongly believe that they would be in a better position to manage household finances as, in their opinion, women have an emotional connection to the needs of their household members and would therefore firstly purchase food items. Men, alternatively, are believed by many women to be more absent-minded about spending money on the household, and would rather use the bulk of their households’ income on lower priority items, which often include alcohol.

One quarter of the surveyed households can be regarded as food insecure and therefore vulnerable, by virtue of the fact that they face shortages in the hungry periods and skip meals to compensate for this shortage. Possible vulnerable households directly affected by land acquisition will be identified during the compensation payment procedures phase of the resettlement plan. Each case will be investigated internally, and appropriate measures put in place at the time of compensation. This might include extra farming assistance in terms of any livelihood restoration initiatives supported by the company, or simply providing transport support to get goods to market.
5.5. COMMUNITY HEALTH STATUS

5.5.1. Healthcare facilities in the study area

The nearest referral hospital is situated in Ancuabe with a smaller hospital in Metoro, both of which are government funded. There are other smaller clinics in the study area but these are ill-equipped with too few beds, not enough staff, poor drug storage facilities and a lack of medicine and equipment.

The clinics get medical supplies from the government through the National Distribution System in Pemba, which provides medicine to the District centres. In addition to government supplies, local pharmacies also supply medicine, although the prices of medication is poorly regulated. In spite of the fact that the government and NGOs subsidise general treatment in Ancuabe and Metoro Hospitals, and the smaller centres, patients are still required to pay consultation fees for particular services. In addition to these facilities, many people use traditional medicine or doctors, especially if money for medicine is unavailable.

5.5.2. Communicable Diseases

Communicable diseases are transferred from person to person through airborne viruses/bacteria, blood and bodily fluid contact and include acute respiratory tract infection (ARTI), tuberculosis, leprosy, measles, meningitis and yaws.

Respiratory tract infection (RTI) from airborne viral and bacterial origins have been reported to be significant in the study area, especially during the dry and colder season (April-September) as a result of increased dust levels. Conditions are also worsened during the rainy period when more households tend to cook with wood or charcoal inside their houses. Children and the elderly are particularly at risk to these infections.

TB is an infectious disease that is caused by *Mycobacterium tuberculosis*, most commonly affecting the lungs (WHO, 2015c). The survey data indicates that 15 households (10%) had a member with TB at the time of study. All of these members were reported to be receiving treatment.

Although not regarded as highly contagious, leprosy is a disease that results in skin sores and nerve damage in the arms, legs and the eyes (WebMD, 2015a). There were no recorded cases of leprosy cases amongst the PAC during the survey.

Measles is a disease which is highly contagious, and symptoms include a rash over the body. No cases of measles were reported in the study area or the province in the last 12 months, although outbreaks were recorded during 2016.

The Centre for Disease Control (CDC) defines meningitis as a disease which is caused by inflammation of the protective membranes that cover the brain and spinal cord (known as the meninges). Household surveys did not indicate any cases of meningitis, nor did any key informant mention such cases in the study area.

Yaws is also known as ‘Framboesia’ or ‘Pian’ and is said to be caused by the spirochete bacterium *Treponema pallidum* (WHO, 2015e). No cases of yaws have been recently recorded in the study area.

5.5.3. Vector-related diseases

The most well-known vector-borne disease is malaria, which is transmitted by mosquitoes, and is ranked as the second most important cause of premature deaths in Mozambique (2010) and is considered the most important health issue in the country, accounting for approximately
29% of all deaths. The survey data indicates that almost two thirds (62.6%) of households have members who have been tested for malaria in the last 12 months, with 8% of respondents indicating that they had malaria cases in their households during the past year.

Filariasis results when a person is infected by the *filariae* parasite which is transmitted to humans through the bite of an infected mosquito (Dlamini, 2013). The parasite then develops into adults worms in the lymphatic vessels and causes severe damage and swelling (*ibid.*). Although this disease is endemic to Mozambique, there are no known cases in the Province, according to the key informants.

Arbovirus is transmitted to humans by insects (MedicineNet, 2015). Two arboviruses considered here are dengue and yellow fever. Yellow fever is not listed as a cause of premature deaths in Mozambique, nor has any key informant or health survey respondent indicated any cases of yellow fever in the study area. However, Mozambique has two areas which were recently reported to have yellow fever outbreaks. Dengue Fever is another mosquito-borne disease caused by the dengue virus (WebMD, 2015c), but it cannot be spread directly from person to person. In 2014, an outbreak of Dengue Fever was reported in Pemba, and Cabo Delgado province is the worst affected province in Mozambique. In 2015, the Health Ministry confirmed another outbreak of dengue fever (Reliefweb, 2015). Given the above it is clear that the project area remains at risk from Dengue fever outbreaks.

Human African Trypanosomiasis, also called the ‘African sleeping sickness’, is endemic in sub-Saharan Africa. It is transmitted by the tsetse fly and affects mainly poor communities. These flies are endemic in Mozambique. According to the WHO (2015d), Mozambique has not recorded any new cases of African sleeping sickness in over a decade. No known cases have been recorded in the study area.

### 5.5.4. Soil, water and waste related diseases

The poor water quality and sanitation that residents in the communities are exposed to result in the spread of the following ailments: diarrhoea, cholera, typhoid fever, Schistosomiasis (or bilharzia), Helminthiasis (Intestinal Worms), and Hepatitis A and B.

The WHO defines diarrhoeal diseases as the “[…] the passage of three or more loose or liquid stools per day (or more frequent passage than is normal for the individual)” (WHO, 2013: p.1). The health survey revealed that 14.6% of households had a member with a diarrhoea-related illness in the past 12 months. Diarrhoea is acknowledged by respondents to result from poor hygiene, bad sanitation and poor water quality (especially during the rainy season). Treatments are available at local health centres and hospitals.

Cholera is infectious and symptoms include diarrhoea. It is caused by drinking water contaminated by *Vibrio cholera* (WebMD, 2015d). In Mozambique, cholera outbreaks have been reported since the early 1990s, usually between December and June (i.e. the rainy season). Mozambique regularly experiences cholera outbreaks in several of its provinces, including Nampula and Cabo Delgado. Nevertheless, no household in the study area reported any cholera cases in the past 12 months. Treatment is available locally.

Typhoid fever is acknowledged as an acute illness caused by the *Salmonella typhi* bacteria (WebMD, 2015e). This bacterium is usually deposited in water or food by human carriers (also through urine and faeces) and, in this way, is spread to other people. No cases of Typhoid Fever have been reported in the study area.

Schistosomiasis (or bilharzia) is often labelled as a disease of poverty which can lead to chronic ill-health (WHO, 2015f). According to the WHO, this disease is caused by the larval forms of parasitic blood flukes (known as schistosomes) which live in water and infection is caused by swimming in or drinking infected water. A study conducted in Mozambique (Augusto...
et al., 2009) indicated that there is a lack of data on the prevalence of the disease in the country. This disease is said to be prevalent in the study area, and as such there seems to be awareness amongst community members, with confirmation from them that treatment is offered at the local health centers. However, no cases were reported in the past 12 months amongst the survey sample group.

The current prevalence of intestinal parasite infections could not be obtained in the study because of lack of data. Nevertheless, during the health survey, approximately 14% of households who had serious illnesses in their households in the last year confirmed that they had members with ‘general’ stomach problems. This might be severely under-reported (especially as respondents were not prompted by a list of stomach-related illnesses to choose from). Cases of intestinal worms are very often reported in school children, for which there are established district-level deworming programmes every six months at schools (Dlamini, 2013).

No reported hepatitis cases were recorded in the survey. Health professionals from Ancuabe Hospital and the Metoro Health Centre consulted during the survey were aware of this, but claimed that general knowledge about this is lacking in the study area as its prevalence is very low.

5.5.5. **Sexually transmitted diseases**

The following sexually transmitted diseases occur in the study area: HIV/AIDS, syphilis, gonorrhoea, chlamydia and genital warts. Amongst these, HIV/AIDS was the most prevalent, ranked as the number one cause of premature deaths in Mozambique (GBD, 2010). Syphilis was also noted as the 10th most deadly disease in Mozambique. In 2007 Mozambique’s HIV/AIDS rate for people aged between 15 and 49 was estimated at 16% by WHO. The rates are higher for women than men, and the ages within which the disease is contracted is also different for men and women. While women are likely to contract HIV/AIDS within the ages 25 -29, men are likely to contract the disease within the ages 35 – 39 (INSIDA, 2009). The HSIA also revealed that HIV/AIDS was more prevalent in the rural areas than in the urban setting. With regards to other less life threatening STDs (such as syphilis, gonorrhoea, chlamydia, genital warts), no statistics were available from the two hospitals covered by the study team.

5.5.6. **Food and nutrition related health issues**

The PAC’s nutritional status was assessed and the report revealed issues of food insecurity and malnutrition, and that there is a potential risk due to consumption pattern. Most of the community members depend on their farms for food, and according to respondents food insecurity is associated with a lack of land, low income level, poor health, poor weather and crop yields from the respondents’ perspective. In Mozambique, protein-energy malnutrition is ranked as the 12th cause of premature deaths. The CFSVA indicates that there has been an improvement in the children’s nutritional status for Mozambique, although chronic malnutrition is still a major problem in the country’s northern parts (CFSVA, 2014). This can be attributed to poor access to healthcare services, immunisation, poor (or lacking) water and sanitation facilities, inappropriate infant feeding practices and low levels of maternal education. The local communities identify malnourished cases from symptoms observed within the communities. For instance, the women indicated that they recognise a malnourished case through signs of mental illness, stomach ache, weakness, depression, dry lips, fatigue or headaches.

5.5.7. **Non-communicable diseases**

The WHO defines non-communicable diseases (NCDs) as chronic diseases which are not passed on from one individual to the other (WHO, 2015k). Usually, these diseases have a long progression period, and the main types include cardiovascular diseases, cancers, chronic respiratory diseases and diabetes. Figures by the WHO estimate that the probability for someone in the age bracket of 30 and 70 years in Mozambique to die from any type of NCD
is 17%, with major risks factors being tobacco smoking, alcohol consumption, high blood pressure and obesity (WHO, 2014c). Non-communicable diseases include cardio-vascular disease, diabetes- Mellitus, and cancer.

Cases of high blood pressure and heart related diseases appear low in the study area with about 2% of the respondents reporting that they have had members of their family suffering from hypertension; and 10% indicating that they had patients with heart problem. Similar to high blood pressure, diabetes is not common in the study area. Only 1.3% of the households surveyed reported that they had members with the diseases. Cancer was also identified in the study area with about 3.3% of the households surveyed acknowledging that they had patients suffering from the illness. It should be noted that cancer is ranked among the top 30 causes of death in Mozambique.

5.5.8. Accidents and injuries

The PAC are currently connected by the R243 bitumen standard road to the main Pemba-Ancuabe road junction. Seven of the respondent households (4.6%) indicated that they had members who have been involved in road traffic accidents in the past year - largely motorcycle incidents that resulted in injuries only. No fatalities were recorded.

5.5.9. Social determinants of health

According to the WHO, social determinants of health are, “[...] the conditions in which people are born, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life.” Five determinants are considered, namely mental health, health-seeking behaviours, life style, inequalities and education.

Although no data was available on the status of mental disorders in the province or district, key informants alleged that there are people with mental disorders who are usually treated by traditional doctors. These patients do not pose any real threat to their communities and most residents are aware of who these people are as well as their conditions. There are no facilities to deal with mental health cases.

Life style practices such as substance abuse are noted as sources of risks to residents in the study area. For instance, alcohol, drugs (cannabis largely) and tobacco abuse result in unpleasant behaviours including violence (inter or intra-household), sexual assaults and criminal activity.

5.5.10. Cultural health practices

Mozambique is known to have a wide range of traditional practices which are imbedded in cultural and social norms. Generally, it would seem that people only revert to traditional cures if they a) do not have money for western medicine, or b) if western medicine does not work. For example, many people do believe in traditional medicine for some cancers or even HIV/AIDS.

Similarly cultural practices promoting early marriages and birth for women as observed in the study area tend to threaten their reproductive and maternal health. Approximately 82% of those women in the study area interviewed had their first child before the age of 18 years. Some seem to have felt pressured by their partners into having children earlier than they would have preferred. The use of contraception is not a norm in the study area.
6. IMPACT METHODOLOGY

To ensure a balanced and objective approach to assessing the significance of potential impacts, a standardised rating scale was adopted in the EIA phase, which allows for the direct comparison of specialist studies.

This rating scale adopts four key factors that are generally recommended as best practice around the world:

1. **Temporal Scale**: This scale defines the duration of any given impact over time. This may extend from the short-term (less than 5 years, equivalent to the construction phase) to permanent. Generally the longer the impact occurs the more significance it is.

2. **Spatial Scale**: This scale defines the spatial extent of any given impact. This may extend from the local area to an impact that crosses international boundaries. The wider the impact extends the more significant it is considered.

3. **Severity/Benefits Scale**: This scale defines how severe negative impacts would be, or how beneficial positive impacts would be. This negative/positive scale is critical in determining the overall significance of any impacts. The Severity/Benefits Scale is used to assess the potential significance of impacts prior to and after mitigation in order to determine the overall effectiveness of any mitigations measures.

4. **Likelihood Scale**: This scale defines the risk or chance of any given impact occurring. While many impacts generally do occur, there is considerable uncertainty in terms of others. The scale varies from unlikely to definite, with the overall impact significance increasing as the likelihood increases.

These four scales are ranked and assigned a score to determine the overall impact significance. The total score is combined and used to determine the overall impact significance.

**Significance Ranking**

- **Impacts of low significance** are typically acceptable impacts for which mitigation is desirable but not essential. The impact by itself is insufficient, even in combination with other low impacts, to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural environment or on social systems.

- **Impacts of moderate significance** are impacts that require mitigation. The impact is insufficient by itself to prevent the implementation of the project but in conjunction with other impacts may prevent its implementation. These impacts will usually result in a negative medium to long-term effect on the natural environment or on social systems.

- **Impacts that are rated as being high** are considered to be serious impacts and may prevent the implementation of the project if no mitigation measures are implemented, or the impact is very difficult to mitigate. These impacts would be considered by society as constituting a major and usually long-term change to the environment or social systems, and result in severe effects.

- **Impacts that are rated as very high** are considered to be very serious impact which may be sufficient by itself to prevent the implementation of the project. The impact may result in permanent change. Very often these impacts are unmitigable and usually result in very severe effects or very beneficial effects.

The following assumptions and limitations are inherent in the rating methodology:

- **Value Judgements**: Although this scale attempts to provide a balance and rigor to assessing the significance of impacts, the evaluation relies heavily on the values of the person making the judgment. For this reason, impacts of especially a social nature need to reflect the values of the affected society.

- **Cumulative Impacts**: These affect the significance ranking of an impact because it considers the impact in terms of both on-site and off-site sources. This is particularly problematic in terms of impacts beyond the scope of the proposed development and the EIA. For this reason it is important to consider impacts in terms of their cumulative nature.

- **Seasonality**: Certain impacts will vary in significance based on seasonal change. Thus it is difficult to provide a static assessment. Seasonality will need to be implicit in the temporal scale and, with management measures being imposed accordingly (e.g. dust suppression measures being implemented during the dry season).
7. KEY PHYSICAL IMPACTS

7.1. GEOHYDROLOGY

7.1.1. Key findings

Water availability
The aquifer on site is classified as a sole-source aquifer (aquifer supplies 50% or more of domestic water) with an average measured static water level of 15.75 m (bgl) (Table 7-1).

The steady state groundwater levels and regime indicate a correlation to topography, with drainage towards the east via the major river systems surrounding the mining area, namely the Mogido River to the east and the Muaguide River to the west.

The current ground water balance is an average of 18,705 m³/d flowing into the delineated sub-catchment of 267.23 km². At first glance this appears to be a substantial amount of water, especially when compared to the mine's water requirement of approximately 3,500 m³/d. However, this amount refers to recharge over the entire sub catchment delineated, and it does not mean that the water is available for abstraction from boreholes as the inferred permeability is too low.

Water quality
The ground water quality is of a poor nature and the water is not of adequate quality to be utilized as potable/drinking water without further treatment, due to the geological and hydro-chemical influences in the area. Both ground water and surface water samples were non-compliant with SANS 241-2015 limits and WHO 2011 guidelines (Table 7-1). However, the intent would be to utilize most of the water as process water, which does not require potable quality water.

Increased concentration of Uranium was found onsite and radiological screening is required.

Table 7-1: Summary of geohydrological findings

<table>
<thead>
<tr>
<th></th>
<th>Surface water</th>
<th>Ground water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static water level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower 5th percentile</td>
<td>2.55m (bgl)</td>
<td></td>
</tr>
<tr>
<td>Upper 95th percentile</td>
<td>35.38m (bgl)</td>
<td></td>
</tr>
<tr>
<td>SANS 241-2015 limits</td>
<td>Manganese (Mn)</td>
<td>EC, TDS, NO₃-N, SO₄, F, Cl, Na, Se, U</td>
</tr>
<tr>
<td>WHO 2011 guidelines</td>
<td>Manganese (Mn)</td>
<td>TDS, F, Cl, Na, Fe, Mn, Se and U</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>447.43mg/l</td>
<td>1130mg/l</td>
</tr>
<tr>
<td>Upper 95th percentile</td>
<td>(575mg/l)</td>
<td>2337mg/l</td>
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<tr>
<td>pH</td>
<td>8.37 neutral to alkaline</td>
<td>8.75</td>
</tr>
</tbody>
</table>

Pit dewatering and process water availability
The Life of Mine (LoM) dewatering results are based on a 100 m (bwl) pit of 940 m wide at T12 and 1330 m wide at T16. The water from the pits will form part of the process make-up water in the plant, and will be sent to the tailings facilities.

- For the worst case scenario at peak (at year 26 of mining) the total volume of water that will need to be pumped out of the system per day is approximately 3,029 m³/d and 2,647 m³/d for T12 and T16 respectively.
- This is likely to be lower since evaporation rates, seasonal rainfall and on site...
permeability were not included in the worst case scenario. With these parameters included the mine water balance indicates a net dewatering volume of approximately 1,200 m³/d. The rate will increase over time as pit depth increase, but this is the maximum rate.

Process water from pit dewatering will not be available at the start of the mine and will be insufficient to meet process water demands at maximum pit depth.

7.1.2. Impacts of the mine on geohydrology

The poor in situ water quality decreases the risk from mining related impacts since the natural, baseline condition of the aquifer system indicates that it is not suitable for potable use, even though it is not polluted by human activity or any mining activity.

During the construction phase all impacts on groundwater will be negligible after mitigation. During the operational there are potentially two impacts of high, and eight of moderate significance. However, standard mitigation measures related to pit dewatering, pollution control and the implementation of measures to manage and limit the potential for acid mine drainage (described in more detail in Chapter 10 and below) results in no residual impacts of high significance on ground water, and only three of moderate significance. During the decommissioning phase all but one impact is of low significance.

Table 7-2: Summary of pre and post mitigation geohydrological impacts per phase

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>Overall Significance</th>
<th>Construction Phase</th>
<th>Operation Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact 1: Contamination of groundwater from oil, grease and diesel spillages from construction vehicles</td>
<td>LOW- Negligible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 2: Pollution of groundwater due to sanitation facilities</td>
<td>LOW- Negligible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 3: Ground and surface water pollution due to inadequate storage of chemicals and building materials</td>
<td>LOW- Negligible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 4: Deterioration of groundwater and surface quality from spillages from diesel (fuel storage) facilities</td>
<td>LOW- Negligible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 5: Lowering of local groundwater levels from dewatering zone of influence</td>
<td>MODERATE- LOW-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 6: Contribution to nitrate over-load in groundwater and surface water resources from use of explosives for mine pit development</td>
<td>MODERATE- LOW-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 7: Hydrocarbon contamination of groundwater and surface water resources from spillages from fuel storage facilities, fuelling and wash-bays</td>
<td>MODERATE- LOW-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 8: Flooding of the open pit could result in unsafe working conditions for employees</td>
<td>MODERATE- Negligible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 9: Pollution of groundwater due to inadequate sanitation facilities</td>
<td>MODERATE- Negligible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 10: Pollution of groundwater due to presence of uranium and selenium arising from mining activities</td>
<td>LOW- Negligible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 11: Seepage of metals, Nitrate and Sulphate from overburden dumps will cause a deterioration of groundwater quality</td>
<td>HIGH- MODERATE-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These dewatering volumes are conservative volumes/rates that indicate the maximum dewatering volumes/rates the mine should make capacity for during operations. Refined values based on detailed design are likely to be lower.
Environmental, Social and Health Impact Assessment

Coastal & Environmental Services
Ancuabe Graphite Project

Impact

<table>
<thead>
<tr>
<th>Overall Significance</th>
<th>Pre Mitigation</th>
<th>With Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact 12: Sulphate, Nitrate and metals leaching from the TSF will cause a deterioration of groundwater quality</td>
<td>HIGH-</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Impact 13: Contamination arising from T12 and T16 pit during mining operations could result in a deterioration of groundwater quality</td>
<td>MODERATE-</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Impact 14: Dewatering: Depletion of water levels in boreholes in vicinity of the mine due to over pumping - Higher and longer than recommended yield could result in the depletion of the groundwater resource which would impact on neighbouring users</td>
<td>MODERATE-</td>
<td>LOW-</td>
</tr>
<tr>
<td>Impact 15: Dewatering: Depletion of community water supply boreholes due to dewatering</td>
<td>LOW-</td>
<td>Negligible</td>
</tr>
</tbody>
</table>

Decommissioning Phase

<table>
<thead>
<tr>
<th>Overall Significance</th>
<th>Pre Mitigation</th>
<th>With Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact 16: Depletion of groundwater resource would impact on neighbouring users due to mine dewatering and evaporation</td>
<td>MODERATE-</td>
<td>LOW-</td>
</tr>
<tr>
<td>Impact 17: Post-closure pit flooding will have a negative impact on local groundwater resources</td>
<td>MODERATE-</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Impact 18: Deterioration of synthetic barrier system causing SO4 and metal leaching to arise will cause a deterioration of groundwater quality.</td>
<td>HIGH-</td>
<td>LOW-</td>
</tr>
<tr>
<td>Impact 19: Post operational erosion at the TSF facility could have a negative impact on local groundwater resources.</td>
<td>LOW-</td>
<td>Negligible</td>
</tr>
<tr>
<td>Impact 20: AMD arising from open pits could result in a deterioration of groundwater quality.</td>
<td>LOW-</td>
<td>Negligible</td>
</tr>
</tbody>
</table>

7.2. GEOCHEMISTRY

7.2.1. Key findings

Acid Mine Drainage (AMD) potential

Sulphate (SO\textsubscript{4}) does not have the capacity to break down and is the main chemical constituent that causes acid rock drainage. It has the potential to impact on ground water sources. Sulphate would leach from the WRD and TSF facilities.

Various scenarios were modelled to analyse the mass transport and leaching of sulphate, and the results are summarised in the table below and visually represented in Figures 7-1 and 7-2.

Table 7-3: Summary of AMD scenarios and potential AMD plumes over time

<table>
<thead>
<tr>
<th>Scenarios for potential sulphate plumes</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dewatering and mass transport from tailings and waste rock facilities over 26 year mining period</td>
<td>The plume has a maximum lateral extent of 500 m to the south-east, 290 m to the east and 170 m to the north from the TSF’s (Figure 7-1).</td>
</tr>
<tr>
<td>Post mining operations dewatering</td>
<td>The plume has a maximum lateral extent of 2 500 m to the north-east at T12 and 1 600 m to the south-east at T16 (Figure 7-1).</td>
</tr>
<tr>
<td>Mass transport from TSF over a 100 year period</td>
<td>The plume does not pose a threat of polluting the main receptor (Mogido River) to the east (Figure 7-2).</td>
</tr>
<tr>
<td>Mass transport from WRD over a 100 year period</td>
<td>The plumes migrates approximately 350 m to the south, 500 m to the east and 250 m to the north, and will not affect any sensitive receptors (Figure 7-2).</td>
</tr>
<tr>
<td>Operational mining mitigation scenario with the inclusion of a seepage capturing system for the TSF</td>
<td>The plume migration from the TSF is reduced to 160 m to the east and 104 m to the north when the TSF is lined, and will not affect any sensitive receptors (Figure 7-3).</td>
</tr>
</tbody>
</table>
Figure 7-1: Acid mine drainage plumes over 26 years of operation
Figure 7-2: Acid mine drainage plumes 100 years after mine operation
7.2.2. **Impacts on the geochemistry**

Due to the limited ground water users in the area, the inherently low ground water quality, and despite the high potential for AMD generation, the overall risks to ground and surface water is considered to be low. This is because the contaminant plume from the TSF does not pose a threat of polluting the main receptor (Mogido River) to the east during the operational phase if it is lined, and the impact is reduced from high to low. Contamination of groundwater, surface water and soil from sulphate in the tailings could also result in an impact of high significance, but with mitigation this impact is also low. The impacts of contamination by metals and metalloids and nitrates from waste rock dump and stockpile facilities is reduced from moderate to low. Likewise the development of acid mine drainage conditions from these facilities also results in a post-mitigation impact of low significance.

A conservative 100 year post operational simulated scenario was undertaken to analyse long term impacts and provide mitigation measures. This analyses demonstrates that all long-term impacts associated with the decommissioning phase will be low, except for the possible development of acid lake conditions in hurricane conditions, and elevated concentration of metal(oids) and sulphate and potential impacts on groundwater and surface water resources if the by sulphide zone in the pit is not covered by water. These impacts will be of moderate significance.
Table 7-4: Summary of pre and post mitigation geochemistry impacts per phase

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>Overall Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Mitigation</td>
</tr>
<tr>
<td><strong>Operational Phase</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 1: Development of acid mine drainage conditions from disposal of</td>
<td>HIGH-</td>
</tr>
<tr>
<td>tailings on tailings facility</td>
<td></td>
</tr>
<tr>
<td>Impact 2: Contamination of groundwater, surface water and soil by</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>metals and metalloids from disposal of tailings on tailings facility</td>
<td></td>
</tr>
<tr>
<td>Impact 3: Contamination of groundwater, surface water and soil by</td>
<td>HIGH-</td>
</tr>
<tr>
<td>sulphate from disposal of tailings on tailings facility</td>
<td></td>
</tr>
<tr>
<td>Impact 4: Contamination of groundwater, surface water and soil by</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>nitrate from disposal of tailings on tailings facility</td>
<td></td>
</tr>
<tr>
<td>Impact 5: Contamination of groundwater, surface water and soil by</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>metals and metalloids by disposal of waste rock onto waste rock dump</td>
<td></td>
</tr>
<tr>
<td>facility</td>
<td></td>
</tr>
<tr>
<td>Impact 6: Contamination of groundwater, surface water and soil by</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>sulphate by disposal of waste rock onto waste rock dump facility</td>
<td></td>
</tr>
<tr>
<td>Impact 7: Development of acid mine drainage conditions by disposal of</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>waste rock onto waste rock dump facility</td>
<td></td>
</tr>
<tr>
<td>Impact 8: Contamination of groundwater, surface water and soil by</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>metals and metalloids by disposal of low ore material on the</td>
<td></td>
</tr>
<tr>
<td>stockpile facility</td>
<td></td>
</tr>
<tr>
<td>Impact 9: Contamination of groundwater, surface water and soil by</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>sulphate by disposal of low ore material on the stockpile facility</td>
<td></td>
</tr>
<tr>
<td>Impact 10: Contamination of groundwater, surface water and soil by</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Nitrite by disposal of ore material on the stockpile facility</td>
<td></td>
</tr>
<tr>
<td><strong>Decommissioning Phase</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 11: Development of acid mine drainage conditions by disposal of</td>
<td>HIGH-</td>
</tr>
<tr>
<td>tailings on tailings facility</td>
<td></td>
</tr>
<tr>
<td>Impact 12: Contamination of groundwater, surface water and soil by</td>
<td>HIGH-</td>
</tr>
<tr>
<td>metals and metalloids disposal of tailings on tailings facility</td>
<td></td>
</tr>
<tr>
<td>Impact 13: Contamination of groundwater, surface water and soil by</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>sulphate and sulphate by disposal of tailings on tailings facility</td>
<td></td>
</tr>
<tr>
<td>Impact 14: Contamination of groundwater, surface water and soil by</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>nitrate by disposal of tailings on tailings facility</td>
<td></td>
</tr>
<tr>
<td>Impact 15: Contamination of groundwater, surface water and soil by</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>metals and metalloids by disposal of waste rock onto waste rock dump</td>
<td></td>
</tr>
<tr>
<td>facility</td>
<td></td>
</tr>
<tr>
<td>Impact 16: Contamination of groundwater, surface water and soil by</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>sulphate by disposal of waste rock onto waste rock dump facility</td>
<td></td>
</tr>
<tr>
<td>Impact 17: Development of acid mine drainage conditions by disposal of</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>waste rock onto waste rock dump facility</td>
<td></td>
</tr>
<tr>
<td>Impact 18: Development of acid lake conditions (hurricane conditions)</td>
<td>HIGH-</td>
</tr>
<tr>
<td>by post closure pit flooding scenario - sulphide zones not covered by water</td>
<td></td>
</tr>
<tr>
<td>Impact 19: Elevated concentration of metal(oids) and sulphate and</td>
<td>HIGH-</td>
</tr>
<tr>
<td>potential impacts on groundwater and surface water resources by post</td>
<td></td>
</tr>
<tr>
<td>closure pit flooding scenario - sulphide zones not covered by water</td>
<td></td>
</tr>
<tr>
<td>Impact 20: Development of acid lake conditions by post closure</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>pit flooding scenario - sulphide zones covered by water</td>
<td></td>
</tr>
<tr>
<td>Impact 21: Elevated concentration of metalloids and potential</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>impacts on groundwater and surface water resources by post closure</td>
<td></td>
</tr>
<tr>
<td>pit flooding scenario - sulphide zones covered by water</td>
<td></td>
</tr>
</tbody>
</table>
8. KEY BIOLOGICAL IMPACTS

8.1. VEGETATION

8.1.1. Key findings

The vegetation and floral communities found within the study area are typically intact, with some clearing occurring along the access roads that have been opened up during the exploration phase. The vegetation types that occur on site have an ecological sensitivity ranging from moderate to high (Figure 8-1a).

The Riparian Woodland has a high species diversity and occurs along the streams, rivers and drainage lines throughout the study area. In some instances this vegetation type shifts from woodland to forest, where the canopy cover is almost at 100%. This vegetation type provides an important refugia for faunal species and functions as a natural corridor for the dispersal of seeds and movement of animal species such as amphibians, reptiles and mammals. This vegetation type has therefore been classified as an area of High Sensitivity.

Although the Miombo Woodland has a high species diversity and is relatively intact, this vegetation type is widespread outside of the study area. As such it was determined to be of Moderate Sensitivity.

Areas that have been cleared for machambas (Machamba/Secondary Woodland Mosaic) have been transformed by the current land use. These areas don’t contribute towards ecosystem functioning and are typically comprised of pioneer and weedy species. These areas have therefore been assigned a Low Sensitivity, with most of these being along the road corridor (Figure 8-1b).

8.1.2. Impacts on vegetation

The key botanical issues arise from the need to remove the existing natural vegetation cover wherever mine related infrastructure needs to be constructed, and mine pits established. At the spatial scale of the study area the impacts will definitely be considerable, but these need to be seen in the context of the region as a whole or at a still larger spatial scale. Three issues require discussion:

- Issue 1 deals with the loss of the vegetation community as a whole. For example, the mine will result in the loss of two vegetation types identified as Miombo Woodland and Riparian woodland.
- Issue 2 discusses the impacts of this loss at the species level. For example, the mine will result in a reduction in general biodiversity levels in the project area and it could result in the reduction in species of conservation concern.
- Issue 3 looks at the impact that the mine could have on the biological processes important to organisms and their habitats. For example, the construction of a tailings dam in a woodland could inhibit seed dispersal by animals if they cannot cross this man-made barrier.

Twelve impacts that mining and associated activities will have on the vegetation and plant species were identified and assessed. With the exception of the loss of Miombo Woodland and the loss of Riparian Woodland, all the impacts can be mitigated to impacts of moderate and low significance (Table 8-1). After mitigation there will be two residual impacts of high significance, six of moderate significance and four of low significance.

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8 The study area in this report is defined as the mine’s exploration license area.
<table>
<thead>
<tr>
<th>Impact</th>
<th>Pre Mitigation</th>
<th>Post Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction Phase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 1: Loss of Miombo Woodland</td>
<td>HIGH-</td>
<td>HIGH-</td>
</tr>
<tr>
<td>Impact 2: Loss of Riparian Woodland</td>
<td>HIGH-</td>
<td>HIGH-</td>
</tr>
<tr>
<td>Impact 3: Loss of Biodiversity (general) and species of conservation</td>
<td>HIGH-</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Impact 4: Fragmentation of vegetation and edge effects</td>
<td>HIGH-</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Impact 5: Invasion of alien species</td>
<td>MODERATE-</td>
<td>LOW-</td>
</tr>
<tr>
<td>Impact 6: Smothering of vegetation as a result of increased dust levels</td>
<td>MODERATE-</td>
<td>LOW-</td>
</tr>
<tr>
<td><strong>Operational Phase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 7: Loss of intact plant communities (as an indirect impact)</td>
<td>MODERATE-</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Impact 8: Increased fire risk during the dry season could impact</td>
<td>MODERATE-</td>
<td>LOW-</td>
</tr>
<tr>
<td>Impact 9: Impacts of the Water Storage Facility on the Riparian</td>
<td>HIGH-</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Impact 10: Impacts of low soil pH on plant growth</td>
<td>HIGH-</td>
<td>LOW-</td>
</tr>
<tr>
<td><strong>Decommissioning Phase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 11: Smothering of vegetation as a result of increased dust levels</td>
<td>MODERATE-</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Impact 12: Loss of biodiversity as a result of increased access</td>
<td>HIGH-</td>
<td>MODERATE-</td>
</tr>
</tbody>
</table>
Figure 8-1a: Vegetation sensitivity map of the study area
Figure 8-1b: Vegetation sensitivity map of the study area
8.2. FAUNA

8.2.1. Key findings

The most sensitive habitats utilized by the surviving fauna include: 1) the Riparian zone and wetlands; 2) Steep slopes and rocky ridges. None of these habitats are specific to the project area and are well represented in Cabo Delgado Province. The ephemeral catchments of the Muaguide and Mogido rivers represent particularly sensitive habitats, especially for amphibians and birds.

The proposed development occurs in relatively pristine Miombo Woodland, where the presence of iconic threatened elephants still occur occasionally, and where a relatively large number of SSC still occur, even if as vagrants. Moreover, at least four known or potentially undescribed species occur within the region, which thus has high biodiversity importance.

The northern edge of the project area is in close proximity (<10 km) to the southern border of the Quirimbas National Park, adjacent to Block B. This is of three regions within the QNP where medium and large mammals are concentrated, and which has been identified as a potential zone for total protection due to the low density of human population. The project area falls in a ‘buffer zone’ which was established to buffer impacts from surrounding developments. Other than northern edge of raw water dam no activities in this buffer zone in first 15 years of operations.

The project area is increasingly accessed for natural resource extraction (bushmeat, timber, charcoal production, etc.) and the expansion of machambas for cultivation. In addition, ephemeral streams in the region are illegally accessed by artisanal miners for gold and gemstone extraction. These activities contribute to the existing high faunal impacts, and have been exacerbated by the development of a network of access tracks made during drilling and mine exploration, that now allow greater ease of access and resource extraction by surrounding people, either on foot or in vehicles.

8.2.2. Impacts on fauna

All faunal groups (reptiles, amphibians, birds and mammals) will suffer a general loss of biodiversity due to varied impacts, such as increased mortality from vehicle movements, loss and fragmentation of suitable habitat due to the clearing of habitats within the footprint of project structures, and various forms of pollution associated with traffic and development. This will be greatest for small, slow-moving species, e.g. amphibians, tortoises and snakes, and terrestrial species will suffer higher mortalities than arboreal or burrowing species. Volant species (birds and bats) will suffer less mortality, except where important breeding or roosting sites are lost. For all groups there will be increased mortality. The main impacts affecting faunal biodiversity include:

- Long-term displacement of faunal groups, leading to loss of diversity due to a loss of essential habitat, especially woodland habitat.
- Definite and permanent loss of daily movement corridors, as many fauna are dependent on closed-canopy vegetation or specialised (restricted) habitat along the drainage lines and rivers.
- Indirect, long-term impacts associated with increased anthropogenic encroachment and the non-sustainable use of natural resources (e.g. uncontrolled logging, charcoal extraction, and hunting).

A variety of impacts are likely to result from the construction of the various components of the mine. One of the most significant and widespread impacts results from increased traffic flow in the region. Roads are known to alter the physical characteristics of the environment and hence affect ecosystems, biological communities and species in numerous and different ways. Additionally, increased mortality of fauna directly from road kills, and indirectly from improved access to areas facilitating hunting increase impact significance.
There are nineteen (19) impacts that mining and associated activities will have on the terrestrial vertebrate faunal species and associated habitat. Nine of these impacts take place during the construction phase, eight during the operational phase and two at mine closure. After mitigation there will be no residual impacts of high significance. However, there are 11 impacts of moderate significance and eight of low significance. Moderate impacts result from the loss or fragmentation of habitats, as well as disturbances to fauna and risks associated with dust and pollution.

Table 8-2: Summary of pre and post mitigation faunal impacts per phase

<table>
<thead>
<tr>
<th>Impact</th>
<th>Overall Significance</th>
<th>Construction phase</th>
<th>Operational phase</th>
<th>Decommissioning phase</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Issue 1: Loss of Faunal diversity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 1: Loss of Amphibian Diversity</td>
<td>MODERATE</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 2: Loss of Reptile Diversity</td>
<td>MODERATE</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 3: Loss of Bird Diversity</td>
<td>MODERATE</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 4: Loss of Mammal Diversity</td>
<td>HIGH</td>
<td>MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 5: Loss of Species Special Concern</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Issue 2: Habitat Loss, Fragmentation and Degradation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 6: Faunal impact of habitat fragmentation and loss</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Issue 3: Other Impacts on Fauna</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 7: Effects of Dust on Fauna</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 8: Effects on Fauna of increased Noise levels</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 9: Effects on Fauna of Chemical Pollution</td>
<td>MODERATE</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Issue 1: Loss of Faunal Diversity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 10: Loss of faunal diversity</td>
<td>MODERATE</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 11: Loss of Species Special Concern</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 12: Introduction of alien fauna</td>
<td>LOW</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Issue 2: Habitat Impacts</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 13: Impact of habitat fragmentation and loss on fauna</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 14: Effects of Dust on Fauna</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 15: Effects on Fauna of increased Noise levels</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 16: Effects on Fauna of Chemical Pollution</td>
<td>MODERATE</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 17: Threats to faunal movements</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Issue 1: Effects on Fauna</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 18: Loss of Faunal Diversity</td>
<td>HIGH</td>
<td>MODERATE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 19: Loss of Species of Special Concern</td>
<td>HIGH</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.3.  **FISH**

8.3.1.  **Key findings**

The present-day stream-flows in the rivers within the study area are considered to be very close to natural, with most river reaches being in an undisturbed state, due to the absence of large instream dams and limited abstraction for domestic and agriculture use. The basic
ecosystem functioning of these rivers and streams are still predominantly unchanged, and these aquatic habitats are able to support diverse aquatic biota.

At isolated locations the watercourses within and adjacent to the proposed Ancuabe Graphite Mine Project Area are presently in a slightly disturbed state, mainly due to clearing (slash-and-burn) of vegetation for agricultural activities, particularly in the riparian zones; and from informal artisanal mining activities in the river channels. These impacts can result in soil erosion, river bank collapse and increased sediment input into the rivers, which negatively impact aquatic habitats.

8.3.2. Impacts on fish

A range of potential impacts on fish and aquatic habitats from the proposed mine were identified and assessed. It is anticipated that the project could potentially impact on the three recognized abiotic drivers affecting aquatic habitat integrity: water quality, fluvial geomorphology and river flow. Potential impacts include the proposed instream dam altering river flow patterns, and pollution of surface waters via contaminated runoff from the mine area, including from the TSF and WRD sites, entering the adjacent rivers and streams via natural drainage lines or from polluted groundwater seepage.

The possibility of Acid Mine Drainage (AMD) from sulphide bearing minerals in the ore-body and from WRD will need to be mitigated to prevent potential contamination of both groundwater and surface water. In terms of pH toxicity to aquatic life, no single guideline value can be easily set, but it is recommended that pH changes of not more than one pH unit compared to the receiving waters should be permitted (Dallas & Day 1993).

Groundwater

The groundwater component of the base-flow is important as it contributes to maintaining deep, refuge pools in the main channel of the Muaguide River during the dry season. In the vicinity of the mine pits, flows may be reduced as a result of mine dewatering lowering the water table in localized areas. This could impact negatively on fish biodiversity and population sizes. However, available evidence indicates that groundwater contribution from within the mine area to low flows in the Muaguide River is insignificant.

Streamflow

Instream dams can potentially alter the natural hydrology downstream of the dam wall, altering flow patterns and reducing both low flows and flood peaks. However, the relatively small capacity of the proposed Muaguide Dam in relation to the mean annual runoff (MAR), as well as the relatively small volume of water required for mining operations, indicates that the impact of the proposed dam on the natural hydrology of the Muaguide River will be low. This aspect is discussed further below.

The proposed instream dam in the Muaguide River could block upstream fish (and aquatic macroinvertebrate) migrations and disrupt natural flow patterns and sediment movement in this river, unless fish passage facilities are provided. On the positive side it also has the potential to become a fisheries resource.

This investigation identified a number of negative impacts on aquatic habitats and fish associated with the proposed mining venture that were rated as HIGH before mitigation. However, it is anticipated that the impacts of high significance before mitigation can easily be reduced to MODERATE or LOW significance provided appropriate mitigation and careful environmental management is implemented during all phases of the proposed mining venture. With effective mitigation measures in place, there will be three residual impacts of moderate significance, and five of low significance. There is also a positive impact of high significance as the dam offers a new habitat for fish, and this resource can be utilised by local communities.
### Table 8-3: Summary of pre-and post mitigation Fish impacts per phase

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>Overall Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Mitigation</td>
</tr>
<tr>
<td>Construction (C), Operation (O), Decommissioning (D) and All project phases (All)</td>
<td></td>
</tr>
<tr>
<td><strong>Issue 1: Water Quality</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 1: Sedimentation &amp; increased turbidity in rivers (All))</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Impact 2: Contamination from non-ore pollutants (C &amp; O)</td>
<td>HIGH-</td>
</tr>
<tr>
<td>Impact 3: Ore-related contamination – AMD (C, O &amp; D)</td>
<td>HIGH-</td>
</tr>
<tr>
<td><strong>Issue 2: Hydrology</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 4: Alternation of river flow dynamics (C &amp; O)</td>
<td>MODERATE-</td>
</tr>
<tr>
<td><strong>Issue 3. Habitat Modification</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 5: Aquatic habitat modification (C &amp; O)</td>
<td>HIGH-</td>
</tr>
<tr>
<td>Impact 6: Loss of species of special concern (C &amp; O)</td>
<td>MODERATE-</td>
</tr>
<tr>
<td><strong>Issue 4. Habitat Fragmentation</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 7: Instream structures blocking migrations (C, O &amp; D)</td>
<td>HIGH-</td>
</tr>
<tr>
<td><strong>Issue 5. Fisheries Resource</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 7: Over-utilization of fish resources (C, O &amp; D)</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Impact 8: Creation of new fish resource (O) <em>(Positive socio-economic Impact)</em></td>
<td>MODERATE-</td>
</tr>
</tbody>
</table>

### 8.4. SURFACE WATER

#### 8.4.1. Key findings

The major river in the area, the Muaguide River, is presently in a relatively unmodified state. No evidence of upstream human impact was noted, but the river is impacted by small-scale agriculture, with clearing of the riparian areas in some cases. The construction of informal river crossings is also evident. These impacts have resulted in some soil erosion in the vicinity of the activities, and a general increase in sediment flows in the river. Despite this, the river has a high present ecological state and should be able to maintain significant ecosystem functionality, and be able to support many aquatic vertebrate species.

#### 8.4.2. Impacts on surface water

Mining infrastructure is situated at the lower end of the relatively large catchment of the Muaguide River. All the watercourse in the mining area drain into the much smaller Mogido River. Both rivers and their tributaries are seasonal, and cease to flow in the seven or eight dry months of the year. About 90% of the 900 mm annual rainfall occurs in the four months from December to March, and this results in the rivers flowing strongly, with considerable energy to pick up and transport sediment, most of which are carried into the Muaguide River. Water quality data indicates that the Muaguide and Mogido rivers carry higher sediment loads during the high flows of the wet season than during the dry season. Introducing additional sediment loads due to mining activities is to be avoided.

Exposed soils can lead to a number of impacts, such as erosion, sediment production and loss of topsoil. This may result in an accumulation of sediment and organic debris in watercourses, increased nutrient loads and changes to stream flows, which may affect fish...
and other aquatic populations. If unchecked, mining activities during the construction phase may impact on water quality resulting in the loss of existing aquatic habitat diversity.

By reducing the number of stabilising structures in and on the surface of the soils, (such as root systems and plant cover that reduces the velocity of runoff and bind the soil), vegetation clearing results in the soils becoming more prone to erosion. It also results in a net increase in surface water runoff, which can lead to increased erosion. A secondary, linked impact is the loss of topsoil. Topsoil is critical to successful plant growth and must be conserved at all times. Once lost, topsoil is extremely difficult to restore.

Increased erosion will lead to increased sedimentation of the watercourses into which surface runoff flows. Sedimentation can have severe negative impacts on the receiving aquatic environments. These include increased turbidity (which decreases light penetration into water, thereby reducing photosynthetic activities in the water column), reduced oxygen concentration in the water column and benthic environment, and the smothering of benthic biota resulting in loss of food and spawning beds. This can have severe long-term negative impacts on aquatic habitats.

Hazardous materials and chemical pollutants (e.g. hydrocarbons from construction machinery and vehicles, floatation reagents, uncured cement and paints) associated construction activities, as well as washing detergents and soap, poorly-treated domestic effluents from the construction camp, construction workers using riparian zones for ablutions, can all pollute both groundwater and surface water. These pollutants could be harmful to aquatic biota and impact on drinking water quality for communities and domestic stock downstream. Spillages of hydrocarbons and other pollutants may lead to development abnormalities and fatalities of invertebrate species.

As the ore deposit is high in sulphide, this will end up in the tailings stream and therefore the tailings storage facility (TSF), as well as the waste rock dumps (WRDs), will generate acid mine drainage (AMD). There is various ways of managing the discharge of low pH water, and mitigating the effects of AMD. Mitigation measures to minimize the potential for AMD generation will reduce the risk of downstream contamination of water bodies.

During construction and operation, earthworks associated with mining could alter the natural topography. This could destroy drainage lines and/or alter natural flow patterns within the project area.

The proposed mine may change the water chemistry by changing one or more of the following parameters: Temperature, Suspended Solids, pH level, Conductivity and Total Dissolved Solids, Dissolved oxygen, Organic Enrichment, Nutrient Enrichment and Trace Metals.

A specific river system will support a unique assemblage of species adapted to the prevailing flow conditions that determine temperature, sediment transport and nutrient flow. A decrease or increase in any of these flow conditions could lead to changes in the community structure within the system, such as loss of a particular species or a population increase in others. The changes may also provide conditions for new or previously scarce species to flourish.

All of the impacts for both construction and operational phase can be mitigated to low significance, and there are no residual impacts of high or moderate significance.

### Table 8-4: Summary of pre-and post-mitigation Surface Water impacts per phase

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>Overall Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Mitigation</td>
</tr>
<tr>
<td><strong>Design and Planning Phase</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Issue 1: Water Quality</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 1: Sedimentation and elevated turbidity in rivers</td>
<td>LOW</td>
</tr>
</tbody>
</table>
8.5. EFFECTS OF THE WSF ON THE FLOW REGIME OF THE MUAGUIDE RIVER

8.5.1. Key findings

First impoundment

Year 1: Scenario 1

This scenario looked at the dam being completed and hence filling during an abnormally dry season, when the volumes of water in the river are less than half of those during years of average runoff (Year 1 of Scenario 1). This delays the onset of flow in the downstream reaches of the river by two months, from November until January. Volumes of flow in the river for the four months January through April (after which spills cease) progressively increase from 64% (January), 82% (February), 92% (March) to 91% (April) of the very low pre-dam volumes.

This is the worst-case scenario in terms of impacts on the flow regime downstream of the dam wall, in which the six-month period during which the river would normally be expected to be flowing is reduced to four months. The volumes of flow during the subsequent four spill months are, however, close to - between 64% and 92% of - the pre-dam volumes. It is important to note that the pre-dam flows during a very dry year could be expected to be less than half those of an average year, and it is possible that the ecological functioning of the river is already at a lower-than-normal level. This scenario is not impossible, but it is based on an average return interval of 100 years. A wetter start of-impounding year is more probable.
Year 1: Scenarios 2 & 3

This scenario looked at the dam being completed during a year of average runoff (Year 1 of Scenarios 2 & 3), and is the most likely scenario. This delays the onset of flow in the downstream reaches of the river by one month, from November until December. Volumes of flow in the river for the five months December until April (after which spills cease) progressively increase from 60% (December), 97% (January), 93% (February), 97% (March) to 97% (April) of pre-dam volumes.

Commencing impounding during an average year reduces the six-month period during which the river would normally be expected to be flowing by only one month, and the reductions in volumes spilling downstream for the remaining five months are, apart from a 40% reduction in the first month of spill, only slightly less (3% to 7%) than the pre-dam volumes.

Years after first impoundment

- In a year of average runoff, irrespective of conditions in the preceding year, the commencement of flow into the downstream reaches of the river is always delayed by one month, from November until December. Volumes of flow in the river for the five months December until April (after which spills cease) progressively increase from 60% (December), 97% (January), 93% (February), 97% (March) to 97% (April) of pre-dam volumes.

- In a year of abnormally low runoff, irrespective of conditions in the preceding year, the commencement of flow into the downstream reaches of the river is always delayed by two months, from November until January. Volumes of flow in the river for the four months January until April (after which spills cease), progressively increase from 77% (January), 82% (February), 92% (March) to 91% (April) of the very low pre-dam volumes.

The principal impact of the WSF is to reduce the length of the period during which the river would normally be expected to be flowing from six months to five in a year of average runoff, and from six months to four in a year of abnormally low runoff. These estimates are very coarse due to the use of monthly data, and might possibly be refined by using runoff data at a smaller temporal resolution. The river is, however, highly seasonal, and the start of the wet season is highly variable from year to year, and there is little to be gained from such a refinement.

8.5.2. Impacts of the Water Storage Facility on the flow regime of the Muaguide River

Construction of the dam wall when the river is flowing is not optimal from a construction perspective, and is not considered likely. The intention is to commence construction of the dam during the dry season, when the river is not flowing. Impoundment is scheduled to begin at the beginning of the next wet season. Thereafter it is anticipated that the reservoir will fill to FSL during the second month of impounding during an average runoff year (third month if impoundment commences during a very dry year). No impacts on the flow regime of the river are anticipated during construction.

During operation abstraction of water from the impoundment will definitely reduce the monthly volumes of water flowing into the river downstream of the dam wall, and will delay the commencement flow during the wet season by up to one month. The capacity of the impoundment is such that attenuation of floods through the impoundment (lengthening of the flood hydrograph and reduction of its peak discharge) is not expected to be significant. The spatial extent of the impact will be limited to the reach of river between the dam wall and the Muaguide / Namuta confluence, some 2 km downstream of the wall. The impacts will occur for the duration of mining activities, and longer if the WSF is left in place (as a fishery resource, for instance) when mining ceases.

If the dam wall is left in place and intact when water abstraction for mining ceases, the flow...
regime of the river will, to all intents and purposes, be restored to its pre-dam state, since evaporation losses and attenuation effects will be negligible, and all inflow will pass over the spillway. Removal of the dam wall will also restore the flow regime of the river to its pre-dam state.

The significance of the impact of the WSF on the flow regime of the river downstream of the dam wall is rated low negative. Since there are no practical mitigation measures the significance remains low negative.

Table 8-5: Summary of pre and post mitigation WSF Flow impacts per phase

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>Overall Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact 1: Impact upstream and downstream of a dam on the Muaguide river</td>
<td>LOW - LOW -</td>
</tr>
</tbody>
</table>

8.6. AIR QUALITY

8.6.1. Key findings

The study area is characterised by limited activity. The only settlements in the study area are machambas that occur along the southwestern part of the site access road, where the road joins the R243 main road; and approximately five machambas within the original location of the proposed WSF dam site. Future sensitive receptors include the accommodation camp at the Ancuabe Graphite Project during the construction period, the Ancuabe Graphite Project mining camp during the operational period as well as a small on-site clinic for staff and contractors.

Current emissions sources in the immediate vicinity of the proposed mining and processing operations includes mostly non-anthropogenic sources, with most baseline anthropogenic sources located close to the R243 main road.

The wind field is mainly from the southern and north-eastern sectors, with very infrequent winds recorded from the west. The average wind speed during the period 2013 to 2015 was 2.52 m/s. During the day, the wind speeds are generally lower than during the night, with calm conditions more prevalent during the day.

Monthly average PM$_{10}$ concentrations sampled at similar rural locations in Mozambique were between 20 µg/m$^3$ and 30 µg/m$^3$. It is likely the PM$_{10}$ concentrations in the study area are similarly low, with elevated concentrations during isolated high wind speed events and when wild fires occur in the area.

NO$_2$, SO$_2$ and CO concentrations sampled at similar rural locations in Mozambique were very low. It is likely that concentrations of these pollutants are similarly low in the study area, with slightly higher baseline concentrations in the villages located close to the R243 main road.

8.6.2. Impacts on Air Quality

The most significant sources of particulate emissions are vehicle entrainment emissions from the ROM and site access roads. Mining fleet exhaust emissions are the most significant source of gaseous emissions, but generator exhaust could have a significant contribution to gaseous emissions during the construction phase and at least the first two years of operation when the generators will be operated 24/7.

- Simulated annual average and highest daily PM$_{10}$ concentrations due to the construction phase are below the WHO AQG for all areas in the study area.
Simulated unmitigated operational phase PM$_{10}$ concentrations are in exceedance of the WHO, IT-3 and IT-2 over a wide area, including at sensitive receptor locations located along the site access road.

With mitigation measures applied to unpaved roads the spatial extent of PM$_{10}$ exceedances is much smaller, with only the WHO AQG exceeded just outside the project boundary.

Simulated PM$_{2.5}$ and NO$_2$ concentrations exceed the WHO AQG and Mozambican Standard (NO$_2$ only) inside the project boundary, but are in compliance with these standards and guidelines for all areas outside the project boundary, including at all sensitive receptor locations.

Simulated SO$_2$ and CO concentrations due to operational phase sources are below 10% of the Mozambican Standards and below 25% of the WHO AQGs for all averaging periods over the entire study area.

Simulated annual average dust fallout rates due to unmitigated operational sources are well below the identified international guideline values for all areas outside the project boundary.

Nine (9) impacts that mining and associated activities will have on the air quality have been identified. All the impacts are of low significance before mitigation. Through the implementation of industry standard mitigation measures, all can be mitigated to impacts of low to no significance, and there are no residual impacts of concern on air quality.

### Table 8-6: Summary of pre and post mitigation Air Quality impacts per phase

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>Overall Significance</th>
<th>Pre Mitigation</th>
<th>With Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction Phase</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Issue 1: Increase in air pollutants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 1: Ground level PM10 Concentrations</td>
<td>LOW</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Impact 2: Ground level PM2.5 Concentrations</td>
<td>LOW</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Impact 3: Dust fallout rates</td>
<td>LOW</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td><strong>Operation Phase</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Issue 2: Increase in air pollutants during the operational phase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 4: Ground level PM10 Concentrations</td>
<td>MODERATE</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Impact 5: Ground level PM2.5 Concentrations</td>
<td>LOW</td>
<td>no impact</td>
<td></td>
</tr>
<tr>
<td>Impact 6: Ground level NO2 Concentrations</td>
<td>LOW</td>
<td>no impact</td>
<td></td>
</tr>
<tr>
<td>Impact 7: Ground level SO2 Concentrations</td>
<td>LOW</td>
<td>no impact</td>
<td></td>
</tr>
<tr>
<td>Impact 8: Ground level CO Concentrations</td>
<td>LOW</td>
<td>no impact</td>
<td></td>
</tr>
<tr>
<td>Impact 9: Dust fallout rates</td>
<td>LOW</td>
<td>no impact</td>
<td></td>
</tr>
</tbody>
</table>

### 8.7. WASTE ASSESSMENT

#### 8.7.1. Key findings

A review of relevant legislation and policy documents suggested that waste management in Mozambique is still in its infancy. Waste management infrastructure is lacking in the Cabo Delgado Province and, as such, the developer should employ measures to effectively manage the waste generated from the project in order not to contribute to poor waste management.

The mine process activities will generate two main process waste streams: waste rock (over burden) from the mine; and tailing materials from the process plant. Others process wastes may include, spillage of the ROM, process dust and potential Acid Mine Drainage (AMD) generation.
The following non-process solid and liquid waste streams associated with the Ancuabe Graphite Project were identified:

- Cleared vegetation;
- General (non-hazardous) solid waste;
- Hazardous solid & liquid waste;
- Sewage & domestic wash water;
- Medical waste;
- Machine and vehicle wash water;
- Storm water and other runoff; and
- Laboratory waste.

8.7.2. Impacts on waste

Issues 1 to 4 below are process waste-related issues resulting from the project activities, including mining and processing. Issues 5 to 7 are non-process related wastes issues. Thirteen (13) waste related impacts have been identified. Five of these have the potential to result in impacts of high significance, and the remainder could result in impacts of moderate significance. However, the implementation of standard mitigation practices and good housekeeping results in all residual impacts being of low significance.

Table 8-7: Summary of pre-and post mitigation waste impacts per phase

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>Overall Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Mitigation</td>
</tr>
<tr>
<td><strong>Operation phase</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Issue 1: Disposal of waste rock and tailings</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 1: Health and safety of employees and local communities</td>
<td>HIGH</td>
</tr>
<tr>
<td><strong>Issue 2: Spillage of Run of Mine while Trucking and use of conveyor belt</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 2: Disruption of ecological function</td>
<td>MODERATE</td>
</tr>
<tr>
<td><strong>Issue 3: Storage of effluent in the process water pond</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 3: Pollution of soil and water resources</td>
<td>MODERATE</td>
</tr>
<tr>
<td>Impact 4: Risk to health and safety of employees</td>
<td>HIGH</td>
</tr>
<tr>
<td><strong>Issue 4: Disposal of potentially hazardous process chemicals</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 5: Risk to health and safety of employees</td>
<td>HIGH</td>
</tr>
<tr>
<td>Impact 6: Pollution of water resources and soil</td>
<td>HIGH</td>
</tr>
<tr>
<td><strong>Construction, Operation and Decommissioning</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Issue 5: Management of non-process general and hazardous wastes</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 7: Pollution of land and water</td>
<td>MODERATE</td>
</tr>
<tr>
<td>General (Non-hazardous) wastes</td>
<td></td>
</tr>
<tr>
<td>Impact 8: Nuisance impact (Production of odours, visual impact and attraction of pest and vermin)</td>
<td>HIGH</td>
</tr>
<tr>
<td><strong>Issue 6: Disposal of domestic wastewater and sewage sludge</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 9: Pollution of soil and water</td>
<td>MODERATE</td>
</tr>
<tr>
<td>Impact 10: Health impacts to employees and communities</td>
<td>MODERATE</td>
</tr>
<tr>
<td>Impact 11: Nuisance impacts (odour and flies)</td>
<td>MODERATE</td>
</tr>
<tr>
<td><strong>Issue 7: Disposal of run-off / storm water</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 12: Pollution of land and water</td>
<td>MODERATE</td>
</tr>
</tbody>
</table>
8.8. **BLAST ASSESSMENT**

8.8.1. **Key findings**

The closest structures are the village houses (household) on the southern side of the T16 Pit Area. The planned minimum and maximum charge evaluated showed acceptable levels of impact, with no specific negative influences expected. The ground vibration levels predicted ranged between 0 mm/s and 1.8 mm/s for structures surrounding both pit areas. Ground vibration at all other structures is well below any specific levels that could cause damage. Air blast predictions showed some concerns for opencast blasting. Maximum air blast levels predicted showed levels just greater than the limit for structures. Minimum and maximum charge predictions identified that only the village houses closest to Pit T16 could experience levels of air blast that may be experienced or heard, but with no specific negative structural damage. The current accepted limit on air blast is 134 dBL. Damages are only expected to occur at levels greater than 134 dB. It is maintained that if stemming control is not exercised this effect could be greater with an increased number of complaints, or damage. The pits are located such that “free blasting” – meaning no controls on blast preparation – will not be possible. An exclusion zone for safe blasting was calculated. The exclusion zone was established to be at least 595 m. Review of the calculated unsafe zone showed that there are no points of interest for Pit T12 and Pit T16 within the unsafe zone (Figure 8-2 and Figure 8-3).

8.8.2. **Impacts of Blasting**

Blasting operations cause:

- Ground vibration: The amplitude of ground vibration depends on the type and size of blasting operations conducted. Ground vibrations are of importance when surface structures near or around the operation need to be protected from damage.
- Air blast: The amplitude of air blast will depend on the type, size and preparation of blast holes when blasting operations are conducted. Air blast are of importance when surface structures near or around the operation needs to be protected from damage.
- Fly rock: The distance and quantity of fly rock is dependent on the blast preparation and the stemming lengths and material. Fly rock are of importance when areas need to be cleared for blasting and people and equipment moved to a safe distance.

Nine (9) blast related risks were identified. All the impacts were rated as being of low significance.

**Table 8-8: Summary of pre and post mitigation blasting impacts per phase**

<table>
<thead>
<tr>
<th>Risks</th>
<th>Pre Mitigation</th>
<th>With Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction Phase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 1: Ground vibration</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td>Impact 2: Air Blast</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td>Impact 3: Fly rock</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td><strong>Operation Phase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 4: Ground vibration</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td>Impact 5: Air Blast</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td>Impact 6: Fly rock</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td><strong>Decommissioning Phase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 7: Ground vibration</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td>Impact 8: Air Blast</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td>Impact 9: Fly rock</td>
<td>LOW</td>
<td>LOW</td>
</tr>
</tbody>
</table>
Figure 8-2: Identified sensitive areas for T12 Pit

Figure 8-3: Identified sensitive areas for T16 Pit
9. SOCIO-ECONOMIC AND HEALTH IMPACTS

9.1. SOCIO-ECONOMIC IMPACTS

9.1.1. Key findings

Most of the PAC inhabitants are uneducated and unskilled, with limited alternative livelihood strategies and economic opportunities open to them. The villages surrounding the project area rely largely on subsistence farming and the collection of natural resources and wild foods to meet their household food needs, with very little in the way of formal employment opportunities available to them.

9.1.2. Impacts on Social

The villages lack basic infrastructure and sanitation facilities, with poor healthcare facilities and limited access to secondary or higher education. The village members do hold high expectations for the project and hope to benefit directly or indirectly through positive project-related impacts.

The assessment of construction phase impacts indicated that, without mitigation, land acquisition during the construction phase will result in high impacts from reduced community access to agricultural land, reduced access to natural resources and ecosystem goods and services, and on cultural heritage resources. Mitigation reduces these impacts to moderate, and possible heightened food insecurity for in-migrant households can become a moderate positive impact with mitigation. Overall, impacts from land acquisition and consequently on local PAC food security throughout the construction and mining phases is deemed to be of moderate and low significance, if the recommended mitigation and enhancement measures are implemented. With the exception of in-migrant households that are expected to settle in the project area during the construction phase, it is only these that have been identified as being potentially worse off once project work opportunities decline. It is these remnant households, and not the local PAC, who will in all likelihood be left more vulnerable to the project’s boom and bust economic cycle.

Beneficial impacts from the project arise from economic development, and specifically direct and indirect employment opportunities, economic opportunities and training and skills development, and in the operational phase improvements in basic infrastructure, social services and the provision of socio-economic development. These impacts are of moderate to high significance. The only negative impact arising from economic development in both the construction and the operational phase is localised community conflict due to perceived differential benefit distribution and in-migrant influx, but this impact is of low significance.

Project-related activities may lead to increased health, safety and security risks due to improved roads and resultant increased traffic, as well as an increased health risk due to increased transmission of communicable diseases. Both these impacts are of moderate significance after mitigation, in both the construction and the operational phases. Nuisance related impacts from increased dust, traffic and noise are of low significance.

The influx of people searching for employment and economic opportunities results in two impacts will be of high negative significance without mitigation measures, due to increased pressure on social infrastructure and an increase in social pathologies. Both can be reduced to moderate negative if the recommended measures are implemented. Other in-migration related impacts are of low significance.

The socio-economic benefits to the surrounding communities during the operational phase are substantial, and with optimisation through the establishment of community development and training programmes, benefits are of high positive significance. It is, however, essential that project-related activities consider the cultures and traditions of the local communities. It is
necessary to maintain engagement with local communities as well as with local and district authorities throughout the project phases to ensure that communities are aware of project related activities and that the proponent is aware of any community grievances or concerns and can, where feasible, address these timeously and effectively.

Crucially, the more serious negative impacts associated with in-migration to the study area, will need to be managed and controlled in cooperating with local PAC, traditional leadership and government stakeholders if the detrimental effects of these is to be minimised.

Table 9-1: Summary of pre and post mitigation Social impacts per phase

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>Overall Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Impact</strong></td>
<td><strong>Pre Mitigation</strong></td>
</tr>
<tr>
<td><strong>Construction phase</strong></td>
<td></td>
</tr>
<tr>
<td>Land Acquisition</td>
<td></td>
</tr>
<tr>
<td>Impact 1: Reduced community access to agricultural land</td>
<td>HIGH - MODERATE -</td>
</tr>
<tr>
<td>Impact 2: Heightened food insecurity and increased local food prices</td>
<td>MODERATE - MODERATE +</td>
</tr>
<tr>
<td>Impact 3: Reduced access to natural resources and ecosystem goods and services</td>
<td>HIGH - MODERATE -</td>
</tr>
<tr>
<td>Impact 4: Impact on Cultural Heritage Resources (disruption of graves and sacred sites)</td>
<td>HIGH - MODERATE -</td>
</tr>
<tr>
<td>Impact 5: Loss of ‘sense of place’</td>
<td>MODERATE - LOW -</td>
</tr>
<tr>
<td>Economic Development</td>
<td></td>
</tr>
<tr>
<td>Impact 6: Provision of direct and indirect employment opportunities</td>
<td>MODERATE + HIGH +</td>
</tr>
<tr>
<td>Impact 7: Increased economic opportunities</td>
<td>LOW + MODERATE +</td>
</tr>
<tr>
<td>Impact 8: Training opportunities and skills development</td>
<td>MODERATE + HIGH +</td>
</tr>
<tr>
<td>Impact 9: Localised community conflict due to perceived differential benefit distribution and in-migrant influx</td>
<td>MODERATE - LOW -</td>
</tr>
<tr>
<td>Health, Safety and Security risks</td>
<td></td>
</tr>
<tr>
<td>Impact 10: Increased transmission of communicable Diseases (TB, STD, HIV etc)</td>
<td>HIGH - MODERATE -</td>
</tr>
<tr>
<td>Impact 11: Dust impacts due to additional access roads and construction traffic</td>
<td>MODERATE - LOW -</td>
</tr>
<tr>
<td>Impact 12: Increase in noise and traffic due to improved roads</td>
<td>MODERATE - LOW -</td>
</tr>
<tr>
<td>Impact 13: Road traffic safety risks and potential mortality</td>
<td>HIGH - MODERATE -</td>
</tr>
<tr>
<td>Impact 14: Increased household vulnerability</td>
<td>MODERATE - LOW -</td>
</tr>
<tr>
<td>In-migration</td>
<td></td>
</tr>
<tr>
<td>Impact 15: Increased pressure on natural resources</td>
<td>MODERATE - LOW -</td>
</tr>
<tr>
<td>Impact 16: Increased pressure on social infrastructure</td>
<td>HIGH - MODERATE -</td>
</tr>
<tr>
<td>Impact 17: Increased competition or conflict over project benefits between in-migrants and local residents.</td>
<td>MODERATE - LOW -</td>
</tr>
<tr>
<td>Impact 18: Increase in social pathologies, prostitution, petty criminality and domestic violence.</td>
<td>HIGH - MODERATE -</td>
</tr>
<tr>
<td>Operational phase</td>
<td></td>
</tr>
<tr>
<td>Economic Development</td>
<td></td>
</tr>
<tr>
<td>Impact 19: Provision of direct and indirect employment opportunities</td>
<td>MODERATE + HIGH +</td>
</tr>
<tr>
<td>Impact 20: Increased economic opportunities</td>
<td>MODERATE + HIGH +</td>
</tr>
<tr>
<td>Impact 21: Training opportunities and skills development</td>
<td>MODERATE + HIGH +</td>
</tr>
</tbody>
</table>
### Impact Assessment

<table>
<thead>
<tr>
<th>Impact</th>
<th>Overall Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Mitigation</td>
<td>With Mitigation</td>
</tr>
<tr>
<td>Impact 22: Community conflict due to perceived differential benefit distribution</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Impact 23: Social development opportunities</td>
<td>MODERATE +</td>
</tr>
<tr>
<td><strong>Health, Safety and Security risks</strong></td>
<td></td>
</tr>
<tr>
<td>Impact 24: Increased transmission of communicable Diseases (TB, STD, HIV etc)</td>
<td>HIGH -</td>
</tr>
<tr>
<td>Impact 25: Dust impacts due to additional access roads and construction traffic</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Impact 26: Increase in noise and traffic due to improved roads</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Impact 27: Road traffic safety risks and potential mortality</td>
<td>HIGH -</td>
</tr>
<tr>
<td>Impact 28: Increased household vulnerability</td>
<td>MODERATE -</td>
</tr>
</tbody>
</table>

#### Decommissioning phase

**Economic Development and Employment**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Overall Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Mitigation</td>
<td>With Mitigation</td>
</tr>
<tr>
<td>Impact 29: Indirect and direct employment opportunities</td>
<td>LOW +</td>
</tr>
<tr>
<td>Impact 30: Decreased economic development opportunities</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Impact 31: Reduced training and skills development</td>
<td>HIGH -</td>
</tr>
<tr>
<td>Impact 32: Impacts on local livelihood strategies</td>
<td>MODERATE -</td>
</tr>
</tbody>
</table>

### 9.2. HEALTH

#### 9.2.1. Key findings

Community access to primary healthcare facilities in the project area is challenging as transport to the nearest hospitals at Metoro and Ancuabe is difficult to arrange and expensive. In addition, the hospitals are perceived by informants to have inadequate support from the government, resulting in a lack of medicine and equipment, poor drug storage facilities and not enough bed space to accommodate patients, particularly in times of diarrheal outbreaks.

Vector related diseases (such as malaria) and communicable diseases (such as TB) are a high risk to the health of communities, with malaria being one of the most significant causes or mortality in the study area. Malnutrition and soil, water and waste –related diseases such as diarrhoea are also prevalent in the study area.

#### 9.2.2. Impacts on Health

**Health systems** - With an influx of job-seekers and related socio-economic changes it is anticipated that the health of the communities could be affected due to potential pressure on the very few available healthcare facilities. The mine will establish a small clinic for its own personnel, but this is not intended to service the communities. The company is encouraged to assist in developing the area’s health infrastructure by providing support to existing health centres, and if this is done the impact changes from a moderate negative one, to a positive impact of high significance.

**Communicable diseases** - Mitigation measures are required to avoid community exposure to any communicable diseases that could possibly result from project activities and personnel movements. One of the most significant means of disease transmission results from population movements, and a potential increase in overcrowded or unsanitary living conditions where these job-seekers may settle. This threat of increased disease transmission further reinforces the need for the company to develop an influx management strategy to mitigate against both social and health impacts arising from these population movements. Potential impacts from increased incients of TB is considered high, and respiratory tract infections
could be moderate. Mitigation can reduce these impacts to low.

**Vector-Borne diseases** - could be affected by specific mining-related activities, such as the creation of new water bodies, or changing exiting surface hydrology drainage patterns. As with many other diseases, arguably one of the most significant causes of the spread of these diseases could be the movement patterns of people. All of these changes could potentially affect the spread of vector-borne disease and where they occur. Malaria is most relevant to the project area, could cause an impacts of moderate significance if not mitigated.

**Soil, water and waste related diseases** - Stagnant water bodies are known breeding grounds for a variety of water-borne diseases, and therefore the project’s infrastructure might increase the prevalence and significant of existing water-borne disease, namely diarrhoeal diseases, cholera, intertinal worms and Bilharzia. Whilst these impacts could be significant if they are not managed, mitigation is easy and can reduce significance to low.

**Sexually transmitted diseases** - An influx of people could also result in increased rates of STI and HIV/AIDS infections. Although not quantified, the qualitative data indicates that HIV/AIDS exists in the communities and that the local health system does provide the requisite treatment. An increase in sex work, coupled with promiscuous and/or unsafe sexual behaviour in the area can be expected, and could result in a high negative impact. Mitigation is difficult and only reduces impact significance to moderate.

**Food and nutrition-related issues** - Additional strain on existing land use and agricultural yields, and increased food prices associated with an influx of job seekers could increase the number of cases of malnutrition in the area. Subsistence agriculture is essential in the project area, and any changes to land availability (its agricultural potential) or quality will directly affect households’ harvests. An increases in malnutrition cases in the study area could cause an impact of high significance. Support in the form of providing agricultural extension services and food garden programmes and other interventions could change this to a positive impact.

**Non-communicable diseases**, such as cancer are not considered to be heavily influenced by the introduction of the project, and these impact are considered negligible.

**Accidents and injuries** - Increased vehicular traffic potentially can lead to death or injury of community members if vehicle movements not appropriately manged and drivers are not adequately trained. Speed reduction, especially when travelling through denser areas of occupation along the transport route, is the most effective means of reducing the significance of this impact.

**Hazardous material** – There is not a significance risk that contaminants will be released into the environment from the mining operation, according to the geohydrological specialist study, and the possibility for these to contaminate soil and water are very low.

**Social determinants of health** - It is believed that the project could have an effect on the host community’s social determinants of life, especially a possible increase in substance abuse and domestic violence that can potentially be associated with more money circulating in these communities, which will be as a result of employment with the project. Both of these pathologies are observable in the study area. However, the impacts can be minimised with the implementation of appropriate mitigation and management measures.
Table 9-2: Summary of pre and post mitigation health related impacts per phase

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>Overall Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Mitigation</td>
</tr>
<tr>
<td><strong>Construction Phase</strong></td>
<td></td>
</tr>
<tr>
<td>Local Health System Pressures</td>
<td></td>
</tr>
<tr>
<td>Impact 1: Increased pressure on Health Facilities, Equipment</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>and Medicine Supply</td>
<td></td>
</tr>
<tr>
<td>Communicable Diseases</td>
<td></td>
</tr>
<tr>
<td>Impact 2: Increased Rates of Tuberculosis</td>
<td>HIGH -</td>
</tr>
<tr>
<td>Impact 3: Increased Rates of Respiratory Tract Infections</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Vector-Related Diseases</td>
<td></td>
</tr>
<tr>
<td>Impact 4: Changes in Malaria prevalence rates</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>Soil, Water and Waste-Related Diseases</td>
<td></td>
</tr>
<tr>
<td>Impact 5: Changes in the prevalence of Diarrhoeal Diseases</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Impact 6: Increased Rates of Cholera</td>
<td>HIGH -</td>
</tr>
<tr>
<td>Impact 7: Changes in the prevalence of Schistosomiasis (Bilharzia)</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Impact 8: Changes to the Prevalence of Soil-Transmitted Helminthiasis (Intestinal Worms)</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Sexually Transmitted Diseases</td>
<td></td>
</tr>
<tr>
<td>Impact 9: Increased Rates of HIV/AIDS</td>
<td>HIGH -</td>
</tr>
<tr>
<td>Impact 10: Increased rates of Venereal Disease/STI</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Food and Nutrition-Related Issues</td>
<td></td>
</tr>
<tr>
<td>Impact 11: Changes to the Prevalence of Malnutrition</td>
<td>HIGH -</td>
</tr>
<tr>
<td>Non-Communicable Diseases</td>
<td></td>
</tr>
<tr>
<td>Impact 12: Increased rates of Cardiovascular Diseases</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Impact 13: Increased rates of Diabetes Mellitus</td>
<td>LOW -</td>
</tr>
<tr>
<td>Impact 14: Increased rates of Cancer</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Hazardous Materials, Noise &amp; Malodours</td>
<td></td>
</tr>
<tr>
<td>Impact 15: Increased or New Exposures to Heavy Metals in Soil and Water</td>
<td>LOW -</td>
</tr>
<tr>
<td>Social Determinants of Health</td>
<td></td>
</tr>
<tr>
<td>Impact 16: Increased prevalence of Mental Health issues</td>
<td>LOW</td>
</tr>
<tr>
<td>Impact 17: Increased Prevalence of Substance-Abuse</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Impact 18: Increased prevalence of Domestic Violence</td>
<td>MODERATE -</td>
</tr>
<tr>
<td><strong>Operation Phase</strong></td>
<td></td>
</tr>
<tr>
<td>Local Health System Pressures</td>
<td></td>
</tr>
<tr>
<td>Impact 19: Increased pressure on Health Facilities, Equipment</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>and Medicine Supply</td>
<td></td>
</tr>
<tr>
<td>Communicable Diseases</td>
<td></td>
</tr>
<tr>
<td>Impact 20: Increased Rates of Tuberculosis</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Impact 21: Increased Rates of Respiratory Tract Infections</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Vector-Related Diseases</td>
<td></td>
</tr>
<tr>
<td>Impact 22: Changes in Malaria prevalence rates</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Soil, Water and Waste-Related Diseases</td>
<td></td>
</tr>
<tr>
<td>Impact 23: Changes in the prevalence of Diarrhoeal Diseases</td>
<td>MODERATE -</td>
</tr>
<tr>
<td>Impact 24: Increased Rates of Cholera</td>
<td>MODERATE -</td>
</tr>
</tbody>
</table>
## Impact Assessment

### Overall Significance

#### Pre Mitigation | With Mitigation
--- | ---
Impact 25: Changes in the prevalence of Schistosomiasis (Bilharzia) | MODERATE - | LOW +
Impact 26: Changes to the Prevalence of Soil-Transmitted Helminthiasis (Intestinal Worms) | MODERATE - | LOW +

### Sexually Transmitted Diseases

| Impact 27: Increased Rates of HIV/AIDS | HIGH - | MODERATE - |
| Impact 28: Increased rates of Venereal Disease/STI | MODERATE - | LOW + |

### Food and Nutrition-Related Issues

| Impact 29: Changes to the Prevalence of Malnutrition | HIGH - | MODERATE + |

### Non-Communicable Diseases

| Impact 30: Increased rates of Cardiovascular Diseases | MODERATE - | LOW - |
| Impact 31: Increased rates of Diabetes Mellitus | LOW - | NONE |
| Impact 32: Increased rates of Cancer | MODERATE - | LOW - |

### Hazardous Materials, Noise & Malodours

| Impact 33: Increased or New Exposures to Heavy Metals in Soil and Water | LOW - | NONE |

### Social Determinants of Health

| Impact 34: Increased Prevalence of Substance-Abuse | MODERATE - | LOW - |
| Impact 35: Increased prevalence of Domestic Violence | MODERATE - | LOW - |

## 9.3. LAND AND NATURAL RESOURCE USE

### Key findings

The communities rely extensively on the use of natural resources to support their basic needs for shelter, food and medicine by harvesting plant materials and hunting for wild animals. They are also used as important sources of supplementary household income through, for example, the production of charcoal and alcohol and by collecting and selling wild honey.

Although the agricultural potential of the study area is moderate, agricultural capability and actual productivity remains low due to limited access to water in areas away from perennial and non-perennial rivers and/or streams. There is also limited agricultural aid in terms of training, and the use of traditional farming methods instead of mechanical methods further reduces potential yields.

### Impacts on Land and Natural Resource Use

Activities associated with the construction and operation of the mine will result in the loss of access to natural resources in the region, as well as a loss of agricultural land.

The removal of topsoil and bulk earthworks can lead to soil erosion, which in turn leads to the loss of topsoil and a reduction in the fertility of the soil for agricultural purposes. In addition, soil erosion may lead to sedimentation of the water courses, which would result in a reduction of water quality. Leakages and spillages from storage areas and construction vehicles could pollute the soil, which would also negatively impact the agricultural potential within the area. These unmitigated impacts are of moderate significance, but after mitigation impacts are low.

The occupation of the land by mining infrastructure will exclude agricultural use of that land for the duration of the project. Although minimal cultivated land has been identified in the project area, it is likely that the road will impact on cultivated areas, an the loss of land and the loss of subsistence and cash crops result in an impact of moderate significance. The...
implementation of a Resettlement Action Plan (RAP), and the provision of replacement land reduces the impact to low.

Although not extensively used currently, the clearing of vegetation at the mine pits and for the placement of infrastructure is likely to impact the nearby community’s access to natural resources in the future, although the impact is of low significance. In addition, an influx of job seekers, the employment and accommodation of staff and increased trading opportunities will increase the demand for food, charcoal, building materials, thatch etc and will place additional pressure on existing resources, resulting in impacts of moderate significance. In some cases mitigation will be difficult, as it is constrained by the lack of capacity of local and provincial institutions to manage the use of natural resources, which in turn results in an impact of moderate significance. However, in general impacts on land and natural resources are of moderate and low significance after mitigation.

Table 9-3: Summary of pre and post mitigation project impacts on PAC Land and Natural Resource Use per phase

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>Overall Significance</th>
<th>Pre Mitigation</th>
<th>With Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Phase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 1: Increased soil erosion</td>
<td>MODERATE - LOW-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 2: Soil contamination</td>
<td>MODERATE - LOW-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 3: Loss of agricultural land due to establishment of mining infrastructure</td>
<td>MODERATE - LOW-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 4: Loss of subsistence and cash crops due to establishing mine infrastructure</td>
<td>HIGH- LOW-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 5: Loss of natural resources</td>
<td>MODERATE - LOW-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 6: Clearing virgin land for small scale farming as a result of agricultural displacement</td>
<td>MODERATE - LOW-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 7: Increasing demand for natural resources</td>
<td>HIGH- MODERATE-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 8: Capacity of institutions to manage use of natural resources</td>
<td>HIGH- MODERATE-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact 9: Pollution of water resources</td>
<td>MODERATE- LOW-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation Phase</td>
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<tr>
<td>Impact 10: Increased erosion</td>
<td>MODERATE- LOW-</td>
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<tr>
<td>Impact 11: Loss of topsoil as a result of erosion of stockpiles</td>
<td>HIGH- LOW-</td>
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<tr>
<td>Impact 12: Soil contamination</td>
<td>MODERATE- LOW-</td>
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<tr>
<td>Impact 13: Increasing demand for natural resources</td>
<td>MODERATE- LOW-</td>
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<tr>
<td>Impact 14: Capacity of institutions to manage use of natural resources</td>
<td>HIGH- MODERATE-</td>
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<tr>
<td>Impact 15: Pollution of water resources</td>
<td>MODERATE- LOW-</td>
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<tr>
<td>Decommissioning Phase</td>
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<tr>
<td>Impact 16: Disturbance to the existing soil profile will result in a decrease in agricultural capability when the mine is decommissioned</td>
<td>HIGH- MODERATE-</td>
<td></td>
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</tr>
</tbody>
</table>

9.4. VISUAL IMPACT

9.4.1. Key findings

Two Visually Sensitive Areas were identified within the study area (which is the area within 12km of the project area):
- The Quirimbas National Park; and
- Eleven villages.
The border of the Quirimbas National Park lies 9.6km from the project area. About 1,200 hectares of this park (0.15% of total) lies within the “element of landscape” zone. Only very small patches of the Quirimbas National Park will have views of the mine. Combined with the distance from the mine infrastructure, the impact on this park is negligible.

Of the eleven villages, only Nankhumi village will have a high visual exposure of the mine while Sunate, Ntutupue and Natocua will have a moderate exposure. The remaining villages will have negligible exposure.

9.4.2. Visual Impacts

Various activities will take place during construction which will have impacts on sensitive visual receptors:

- Large areas of vegetation will need to be cleared to make way for construction.
- There will be a large increase in the movement of vehicles in the area: large trucks delivering supplies and construction material; graders, excavators and bulldozers; light vehicle movement around site; large trucks hauling rubble and construction waste, etc.
- Soil stockpiles and heaps of vegetation debris.
- Dust emissions from construction activity.

During the operational phase the relatively large plant equipment is likely to stand out in contrast to the surrounding, undeveloped nature of the area. The passage of large vehicles and the influx of people associated with the mine will have an impact on the sense of remoteness of the region. Dust from mining activity is likely to increase the severity of the visual impact.

Impacts associated with the decommissioning phase will be similar to those identified for the construction phase. Visual impacts are difficult to mitigate, but during construction good housekeeping reduces the impact to low, but it remains moderate during the operational and closure phases.

Table 9-4: Summary of pre and post mitigation Visual impacts per phase

<table>
<thead>
<tr>
<th>IMPACT</th>
<th>Overall Significance</th>
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<tbody>
<tr>
<td></td>
<td>Pre Mitigation</td>
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<tr>
<td>Construction Phase</td>
<td></td>
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<tr>
<td>Impact 1: Construction phase visual impacts on</td>
<td>MODERATE-</td>
</tr>
<tr>
<td>surrounding sensitive receptors</td>
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<tr>
<td>Operation Phase</td>
<td></td>
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<tr>
<td>Impact 2: Operation phase visual impacts on</td>
<td>MODERATE-</td>
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<tr>
<td>surrounding sensitive receptors</td>
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<tr>
<td>Decommissioning Phase</td>
<td></td>
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<tr>
<td>Impact 3: Decommissioning phase visual impacts on</td>
<td>MODERATE-</td>
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<tr>
<td>surrounding sensitive receptors</td>
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</tbody>
</table>

9.5. TRAFFIC AND TRANSPORT

9.5.1. Key findings

A range of vehicle types are likely to be used during the construction of the mine. Heavy vehicles which will be required to transport goods, materials and equipment to site will include:

- Three, five and seven axle trucks;
- Flatbed semi-trailers; and possibly; and
- Road trains pulling a number of trailers.
Tracked vehicles such as excavators and bulldozers will be transported to site on low-loaders. It is also probable there will be some abnormal loads for large items such as transformers which cannot be assembled on site.

Large pieces of equipment will be shipped to either the Port of Pemba or Nacala. Thereafter, they will be transported by road to site. The port to which equipment will be delivered will depend on the following factors:

- Whether the port is on the shipping line’s route;
- Whether the port has the on-shore equipment necessary to unload items;
- Whether the port is large enough for the type of vessel transporting the equipment; and
- Port fees.

The graphite concentrate will be transported to Pemba in 1 tonne bulk bags loaded onto flat-bed trucks. Bulk bags will either be transported loose or already packed within shipping containers.

There will also be increased light and medium-heavy passenger vehicle traffic due to the transport of mine employees and contractors.

### 9.5.2. Traffic and transport Impacts

The project is expected to cause a large increase in traffic volume. All of the roads to be used by the project are paved, and for the most part are in good condition. Project traffic will pass through numerous settlements between the mine site and Pemba. Frequently, market activity is clustered alongside the road, where existing, non-mine-related traffic volume is highest. In these settlements of concern, vehicles are pulling onto and off the road without using their indicators, pedestrians cross the road at random points, children play alongside the road. The risk of accidents in these environments, especially when drivers are working to a tight delivery schedule, is increased.

In addition, the project’s traffic could cause congestion on public roads in a number of ways:

- Poor timing of deliveries resulting in all deliveries arriving at once;
- Poor maintenance of vehicles resulting in break-downs on public roads;
- Delivery of abnormally sized loads at inappropriate times; and
- Overloaded vehicles moving exceptionally slowly on public roads.

During the operational phase additional impacts include damage to public roads if the haul trucks and mine vehicles are overloaded, as well as increased noise levels associated with an increase in traffic volumes.

**Table 9-5: Summary of pre and post mitigation traffic and transport impacts on communities per phase**

<table>
<thead>
<tr>
<th>RISK</th>
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<tbody>
<tr>
<td><strong>Construction Phase</strong></td>
</tr>
<tr>
<td>Vehicle accidents resulting in loss of life and serious asset damage</td>
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<tr>
<td>Vehicle accidents resulting in serious injuries and serious asset damage</td>
</tr>
<tr>
<td>Vehicle accidents resulting in minor injuries and asset damage</td>
</tr>
<tr>
<td>Vehicle accidents resulting in major delays to the construction schedule</td>
</tr>
<tr>
<td>Bureaucratic issues resulting in the delay of the import of materials</td>
</tr>
<tr>
<td>Poorly managed traffic flow resulting in congestion on public roads</td>
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<tr>
<td>RISK</td>
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<tr>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Operational</td>
</tr>
<tr>
<td>Vehicle accidents resulting in loss of life and serious asset damage</td>
</tr>
<tr>
<td>Vehicle accidents resulting in serious injuries and serious asset damage</td>
</tr>
<tr>
<td>Vehicle accidents resulting in minor injuries and asset damage</td>
</tr>
<tr>
<td>Vehicle accidents resulting in the loss of graphite product</td>
</tr>
<tr>
<td>Bureaucratic issues resulting in the delay of the export of materials</td>
</tr>
<tr>
<td>Poorly managed traffic flow resulting in congestion on public roads</td>
</tr>
<tr>
<td>Damage to public roads</td>
</tr>
<tr>
<td>Vehicle noise</td>
</tr>
</tbody>
</table>
10. CUMULATIVE IMPACTS

10.1. INTRODUCTION

The IFC (2012) defines cumulative impacts as those “that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.”

Cumulative impacts result from incremental changes caused by other past, present or reasonably foreseeable actions acting in concert with the project. Individually minor impacts from different developments can interact in various ways over time to become collectively significant. Barbour (2007: 39), adapting work by Cooper, 2004, describes cumulative impacts as impacts which “may be:

- **Additive**: the simple sum of all the effects (e.g. the accumulation of ground water pollution from various developments over time leading to a decrease in the economic potential of the resource);
- **Synergistic**: effects interact to produce a total effect greater than the sum of individual effects. These effects often happen as habitats or resources approach capacity (e.g. the accumulation of water, air and land degradation over time leading to a decrease in the economic potential of an area);
- **Time crowding**: frequent, repetitive impacts on a particular resource at the same time (e.g. multiple boreholes decreasing the value of water resources);
- **Neutralizing**: where effects may counteract each other to reduce the overall effect (e.g. infilling of a wetland for road construction, and creation of new wetlands for water treatment); and,
- **Space crowding**: high spatial density of impacts on an ecosystem (e.g. rapid informal residential settlement).

It is important therefore not only to assess the individual impacts of the proposed Ancuabe Graphite Mine, but also the cumulative impacts potentially associated with this project. In addition to considering the potential synergistic effects of individual minor impacts resulting directly from the Grafex project, it is also necessary to consider the broader geographical context and other planned developments.

In assessing cumulative impacts it is important to identify valued ecosystem components (VECs), or social dynamics that are potentially affected by the proposed project. The assessment methodology needs to be able to determine what other past, present and future human activities have affected, or will affect, these VECs and social dynamics, and more importantly suggest how to manage these cumulative impacts.

Cumulative impacts are, however, difficult to accurately and confidently assess, owing to the high degree of uncertainty, as well as them often being based on assumptions. It is therefore difficult to provide as detailed an assessment of cumulative impacts as is the case for direct and indirect project induced impacts. This is usually because of the absence of specific details and information related to cumulative impacts and their causes. In these situations any assumptions made as part of the assessment must be made clear. Accordingly, this chapter only includes an overview and analysis of cumulative impacts related to a variety of project actions which may interact with the proposed Grafex project, and does not provide a significance rating for these impacts, as was done for direct project induced impacts. The objective is to identify and focus on potentially significant cumulative impacts (mainly additive and synergistic effects), so these may be taken into consideration in the decision-making process. In reading this chapter it is important to realise these constraints, and to recognise that the assessment will not and indeed cannot be perfect. However, the potential for cumulative impacts has been considered, rather than omitted from the decision making-process, and is therefore of value to the project and the environment.
10.2. BROADER DEVELOPMENT OR LAND-USE CHANGES WITHIN THE GREATER PROJECT AREA

10.2.1. Other developments

Mozambique has two well-established Spatial Development Initiatives (SDI): the Maputo Corridor and the Beira Corridor which are arguably within the top most successful SDIs in Africa because they had the effect of boosting support within SADC for the concept of multi-sectoral economic development corridors, and for the particular planning and investor mobilisation. In 2013 infrastructure rehabilitation was mostly financed by donors and Mozambiques Action Plan for the Reduction of Absolute Poverty (PARPA II) called for greater investment in economic sectors to enable the creation of a favourable business climate (DHV B.V., 2012).

There are additional SDIs being developed, namely the Nacala Corridor, Libombo Corridor (linking the Maputo Corridor to coastal areas of South Africa); the Limpopo Corridor (connecting Maputo by rail to Zimbabwe); and of most relevance the Mueda and Lichinga Corridors (linking Lake Niassa to the coastal port of Pemba and Tanzania). Three of these SDIs (Maputo, Beira and Limpopo) are supported as Regional Spatial Development Initiative Programs (RSDIP) within the SADC framework, making Mozambique the country with the most RSDIPs in sub-Saharan Africa (AfDB, OECD, UNDP; 2015).

In 2016 the African Development Bank provided funding for the development of a 70km section of the Mueda Corridor. The project includes the development of a masterplan for transport infrastructure and connectivity for the Northern regions of Mozambique (Niassa, Cabo Delgado and Nampula provinces). The Masterplan will target various sub-sectors such as maritime, railways, roads and bridges, and will act as an update to existing national plans, in light of the anticipated major economic transformation in the Northern region (Club of Mozambique, 2016).

The Ancuabe Graphite Mine is located within the Lichinga Corridor, which extends from Lake Niassa to Pemba Port, through the inland areas of Mozambique, to the neighbouring country Malawi (Figure 10-1). The concept of the Lichinga Development Corridor was derived jointly by the governments of Malawi and Mozambique in order to exploit the significantly under-utilised natural resources present in the two countries (de Beer, 2001). The inadequacies of the infrastructure networks (roads, ports, railways and communication network) to distribute goods to and from rural areas has hampered the utilisation of this development potential in both countries (DHV B.V., 2012; de Beer, 2001). The most significant of the proposed economic development projects in the Lichinga corridor include:

1. Mining and mineral processing (graphite, reserves of bauxite, gypsum and limestone, gold, gemstones and titanium).
2. Industrial development.
3. Expansion of agriculture and value add processing, including forestry.
4. Tourism (natural and cultural): coastal developments, game/nature reserves (Niassa and Quirimbas) and Lake Malawi islands.

It is therefore within this context of significant regional and local development, both in terms of transport infrastructure (road and rail) and economic development (including graphite mines) that the cumulative impacts of the Ancuabe Graphite Mine must be assessed. In addition, it is important to consider that it is the future intention of Grafex is to extend the mine to include extraction of other deposits both in Ancuabe and a new mine in Montepuez, over-and-above that assessed in this ESHIA.
10.2.2. Other mining developments

To assess the cumulative impacts the Ancuabe Graphite Mine will have it is necessary to identify developments in and around the project area, especially those of a similar in nature. The following mining projects and proposed developments have been identified:

Existing mine projects
- The operational Syrah Graphite Mine located in Balama District;
- The operational Gemfields Ruby Mine located in the Montepuez District;
- The GK Graphite Mine; and
- Mustang Ruby mine.

Other possible future mines include:
- The proposed Suni Resources Montepuez Graphite Mine located in Montepuez District;
- The proposed Triton Minerals Nicanda Hills Graphite Project located in Montepuez District;
- Rovuma Resources Nickle Mine;
- Two exploration licenses have been granted to Mozambi Resources Limited; one license is contiguous with the Triton Minerals Nicanda Hills project and the other resource is further south.
- In addition, Suni Resources holds two other exploration license areas in the province that may be exploited in the future.

10.3. IDENTIFICATION OF CUMULATIVE IMPACTS

Based on a review of other potential developments within the vicinity of the Ancuabe Graphite Mine and a detailed assessment of the potential impacts associated with the Ancuabe Graphite Mine, the following cumulative impacts have been identified:

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- Habitat alteration, fragmentation and loss of biodiversity.
- Impacts on land availability due to population influx.
- Change to water availability and quality.
- Change to the socio-economic and health status quo.
- Change to local waste profiles and knowledge of waste management.

The purpose of the remainder of this chapter is to discuss each of the potential cumulative impacts in greater detail.

10.4. ASSESSMENT OF CUMULATIVE IMPACTS

The effects of the potential impacts associated with various project stages may be nullified or amplified by impacts associated with other developments in the area producing cumulative effects.

10.4.1. Habitat alteration, fragmentation and loss of biodiversity

The following cumulative impacts could affect the flora of the region:
- Loss of vegetation communities (i.e. Miombo Woodland and Riparian Vegetation) through direct (clearing) and indirect (displacement of agriculture) impacts will be exacerbated;
- Loss of biodiversity and Species of Conservation Concern (e.g. Sterculia species) will be exacerbated to the point where local extinctions in the area could be expected; and
- The risk of invasion of alien plant species colonising disturbed areas could increase to the point of displacing entire sections of indigenous vegetation.

Potential developments, as well as changes to population demographics (especially the in-migration of potential job seekers) are likely to result in an increased human population in the region. This could see an increase in the alien fauna associated with people (e.g. feral dogs and cats, house sparrows, rats and mice, etc) resulting in cumulative impacts on biodiversity.

The development of urban centres and the supporting industries and services accompanying them will increase pressure on infrastructure and services in northern Mozambique. The primary negative cumulative impacts would be the gradual transformation of undeveloped areas, with associated impacts on the ecological functioning of affected ecosystems. Increased conversion of natural landscape to accommodate burgeoning human populations and the construction of additional social infrastructure will increasingly impact biodiversity. The environmental baseline studies have contrasted the proposed project’s impacts with those already existing, including current agricultural practices that have transformed extensive areas of natural landscape, and resulted in an alteration of these habitats to the detriment of various fauna species.

10.4.2. Impacts on land availability and productivity due to population influx

Mining development within the Cabo Delgado Province are steadily increasing. With the development of mining in the area, the focus is slowly shifting from agriculture to mining. In addition, due to the relatively large areas of land required for mining and associated infrastructure, there has been a steady decline in land available for agricultural purposes. In addition, and as noted above, in-migration also increases the land take as villages and communities expand at a more rapid rate than might otherwise occur.

This may have an overall detrimental impact on agriculture and ultimately food production, especially considering the current low yields due to traditional agricultural practices (i.e no irrigation, fertilisers, etc). Thus, there will be a gradual reduction of available agricultural land in Cabo Delgado Province as a consequence of an increase in mining developments.
10.4.3. Change to water availability and quality

Water Quality
In terms of deterioration of water quality in watercourses downslope of the mine, the cumulative impacts of the various mining operations, as well as indirect impacts from the increased human population living in the river catchments, could potentially all combine to exacerbate the individual impacts. These individual impacts include increased sedimentation and turbidity, increased discharge of domestic effluent such as sewage and detergents, and pollution from chemicals or hazardous substances used in mining, including possibly acid mine drainage originating from mine ore.

The cumulative impacts on water quality associated with the various mining operations and influx of work-seekers into the local catchments could potentially all combine to exacerbate the individual impacts. An increased number of people living in the area will increase the pressure on the water resources through increased demands for potable water, irrigation water, and the use of water sources for sanitation activities. This, coupled with increased utilization of water bodies for food (fishing, planting rice in wetland areas), and natural resource harvesting (e.g. reed harvesting) will all impact on the ecosystem services offered by these water bodies.

Additional factors that will tend to cause cumulative impacts on water quality include:
- Reduction in runoff to rivers (e.g. due to dewatering for the mine pit, abstraction for mining operations, increased evaporation losses from the proposed dams) will tend to increase the impact of any pollution event due to the reduction in the beneficial effects of dilution, and
- The clearing of riparian vegetation and reducing the width and density of the riparian buffer zone (mainly from increased use of these areas by local communities) would reduce the important function this habitat plays in screening sediment-laden run-off and absorbing and filtering polluted run-off before it can enter the river channel.

Water Quantity
A number of mines are likely to require raw water dams, and this could mildly alter the flow regime of the rivers in which these facilities are constructed, by reducing the period of wet season flow in these systems. A change in flow (whether it is an increase or decrease or change from continuous to sporadic) will alter the physical habitat of the water course and thus alter species composition within the river systems. However, most of these facilities will have a dam wall designed to act as an overflow, resulting in only slightly below average flows in the wet season. Thus, this cumulative impact is not significant.

10.4.4. Changes to the socio-economic and health status quo

The development of multiple new initiatives is likely to have positive and negative cumulative socio-economic impacts on local communities.

Positive cumulative socio-economic impacts:
- A general improvement in the economic status of many of the households within the region as a result of greater employment opportunities.
- An increase in the number of employed individuals within the area should encourage the establishment of a range of smaller businesses by local entrepreneurs thus further enhancing the economic profile of the region through the socio-economic multiplier effect. These may include small-scale commercial farms.
- As the proposed initial development projects within the portion of the Ancuabe Graphite Mine DUAT are realised, and the economic profile of the region improves, it is likely that development of additional and improved social infrastructure, such as hospitals and schools, will follow. This will be of benefit to local communities.
- Development of human capital (training and skills development).
- Increased awareness of health and safety.
• Community development and social infrastructure upgrades.

Negative cumulative socio-economic impacts:
• Health impacts can be cumulative and synergistic, i.e. often clustered and interdependent. Therefore, it is important to assess the extent to which the project could compound or indeed even reduce these impacts. Social and health impacts can change as community dynamics and social processes change. Consequently, the Grafex project is only one of a number of possible contributing factors to this on-going change, and hence cannot be viewed in isolation from the broader social and economic dynamics of the area.
• The project could potentially affect the spread of cholera, bilharzia and intestinal parasite infections through a significant influx of people. These effects will be compounded by poor sanitation (or increasing defecation in the bush), unhygienic living conditions, the use of infected water or food, and the creation of new and stagnant water bodies from the mining activities increasing disease vectors. The significant increase in people in the study area will also add strain to the existing healthcare system, all of which could potentially weaken the response to, and management of, any cholera outbreak and bilharzia and intestinal parasite infections.
• Since Mozambique’s economy is growing rapidly due to foreign investments, it is highly probable that other mines and/or large scale projects be developed close to the study area during the lifespan of the project. Even though the possible extent of the cumulative impacts from additional mine development cannot be determined, it is still important to try and identify the negative and positive impacts which may arise in the long term, and these include:
  o Increased pressures on existing social services.
  o Increased conflict over access to benefits from multiple projects in the study area.
  o An overall loss of sense of place or community identity.
  o Increased traffic congestion and road degradation. The Ancuabe Graphite Project is the fourth of its type in the region, and there may still be more developments in the future as the full extent of the graphite resource is realised. The EN242 was recently upgraded, and this should lead to increased non-mine related vehicular traffic in the region, although it is likely that mine-related vehicles will still remain the largest contributors to traffic. Truck traffic associated with the Syrah Resources Graphite Mine will not use the EN242 between Sunate and Pemba, but will travel south from Metoro along the 106 to Nacala. All traffic will share the EN242 to the ports of Pemba.

10.4.5. Change to local waste profiles and knowledge of waste management

Key considerations are the cumulative change in the profile of waste streams produced by local communities, and an increased awareness amongst local community members about the management of wastes.

Based on available information, there appears to be a lack of well-designed and operated waste management infrastructure, including disposal facilities and recycling initiatives in the Cabo Delgado Province. The knowledge amongst local community members about the management of waste is limited. While this may not pose a significant risk while communities subsist largely off agriculture and the use of natural resources, the potential risks to environmental and human health are expected to increase as communities become more affluent and densely populated, and their waste profile changes to resemble those more commonly associated with urban societies. In particular, the quantity of waste may increase and waste streams may start to include a greater proportion of plastic (bottles, packets etc.) and non-biodegradable materials, and even small quantities of hazardous wastes.

It is expected that a significant proportion of the employees will come from local communities. In addition, other individuals from the same villages may be employed at other large-scale
developments proposed for the area. Through their employment, they will be trained in a range of environmental issues, including the correct management of waste. This knowledge may then be transferred to other members of the local communities, thus resulting in a general increased awareness of the importance of waste management, and potential opportunities for recycling, within the local communities.

The proposed development, together with others in the region, will elevate the economic profile of the local communities and will result in a change in the profile of community waste streams, both in terms of quantity and the nature of the wastes. If existing waste management practices are not adapted, this could result in potential visual impacts as well as health, safety and environmental impacts around the communities.

10.5. CONCLUSION

Cumulative impacts remain difficult to assess in the absence of a regional or strategic environmental assessment. However, various specialist studies have dealt with cumulative and incremental impacts, and the reader is referred to individual Specialist Reports for more information on these.

Mitigation and management of the negative cumulative impacts depend on the development of effective national and regional management strategies to reduce environmental risks and to offset impacts where mitigation is not possible. Strategic spatial planning by the Government of Mozambique and its agencies at this early stage is important to ensure development in the region is promoted, while maintaining ecosystem functions and services to enhance social well-being.
11. PROJECT ALTERNATIVES

11.1. PROJECT ALTERNATIVES

One of the objectives of the EIA process, and a legislated requirement under Mozambican law, is to investigate alternatives to the proposed project. Alternatives in relation to a proposed activity would mean investigating different ways of meeting the general purpose and objectives of the activity, and can include alternatives to:

- The property on which, or location where, it is proposed to undertake the activity;
- The type of activity to be undertaken;
- The design or layout of the activity;
- The technology to be used in the activity;
- The operational aspects of the activity; and
- The option of not implementing the activity i.e. the no-go option.

Only feasible and reasonable alternatives to the activity that could minimise harm to the environment should be considered, as there is no point in assessing non-viable alternatives. The EIA process must identify and comparatively assess these alternatives. However, if after having identified and investigated the alternatives, no feasible and reasonable alternatives are found, no comparative assessment of alternatives, beyond the comparative assessment of the preferred alternative and the option of not proceeding, is required. The alternatives must aim to address the key impacts of the proposed project by maximising benefits and avoiding or minimising the negative impacts.

11.2. FUNDAMENTAL ALTERNATIVES

Fundamental alternatives are developments that are totally different from the proposed project and usually involve a different type of development on the proposed site, or a different location for the proposed development.

11.2.1. Mine Pits

In the case of a mine it cannot include alternatives to the property on which, or location where, it is proposed to undertake the activity, as the mine is bound by the location of the resource. Thus, no alternative locations for the mine pits can be assessed (Figure 11-1). However, alternative locations for infrastructural components of the project that are not locality bound can be considered, as described below.
11.2.2. Water Storage Facility (Dam)

Two options were considered for the position of the water storage facility (refer to Figure 11-2). The preferred WSF (referred to as the Lizard Dam) is located on the Muagide River and the alternative WSF (referred to as the Dragon Dam) is located on the Mogido River. These options were assessed on financial and technical aspects by Knight Piésold Consulting.
**Option 1 - WSF on the Mogido River (Dragon Dam)**

This dam would be located across the Mogido River, towards the south east of the site and approximately 3 km east of the TSF. The initial site investigation indicated that the river bed in this location comprises approximately 5 m of sand with low fines content underlain by highly fractured rock. Groundwater at the time of the investigation was just below river bed surface and, in places, at surface.

The implications for the water dam design were that the foundations may have a very high permeability and result in high seepage loses making the storage inefficient.

The difficulty of constructing a deep cut off trench (+6 m) through the water bearing alluvial sand was also considered challenging. This location was discounted and an alternative site (Option 2) investigated.

**Option 2 - WSF on the Muagide River (Lizard Dam) - Preferred**

The alternative WSF site is located approximately 5 km to the west of the site and across the south to north flowing Muagide River. The WSF embankment is proposed to be approximately 250 m wide, 14 m high, have a maximum water depth of 12 m and an impoundment length of approximately 2.5 km. The river valley is typically narrow with steeper sides than the originally planned water dam site, and this will help reduce evaporation losses. Limited alluvials were encountered at the planned embankment location and in situ rocks on which the embankment will be founded were generally massive, and with limited fracturing.

Assuming average climatic conditions, the inundation area fills up within 2 month of the wet season commencing, to its full capacity of about 1.6 Mm$^3$ and overflows thereafter (generally in December). Approximately 80% of the water inflow overflows via the spillway (~15Mm$^3$/year) during an average climatic year. The water stored within the WSF is sufficient to supply the required raw water as well as the make-up water to the plant.

**11.2.3. Site Access Road**

Two options were considered for the position of the site access road, which is the major transport route to the project area (Figure 11-3). The preferred route (Option 2) is located to the south, and the alternative is located to the north.
Option 1 - Northern Access Road

The proposed northern access road is 16 kilometres long and connects the project site to the main road (EN243) just south of Nacussa and 16 kilometres north of Sunate.

This option requires:
- This option would utilise the already well-established tertiary access road to the project area.
- Crossing the Muaguide River and the upper reaches of the proposed WSF Option 1 (Lizard Dam) requiring the construction of a bridge
- There are machambas situated within and in close proximity to the EN243 end of the road corridor for approximately 8 kilometres along
- Passing through five villages

Option 2 - Southern Access Road

The proposed southern access road is approximately 18km long (EN243 to plant site). It is to 1.5 kilometres south of Nankhumi and 3.3 kilometres north of Sunate.

This option would utilise the already well-established tertiary access road to the project area and does not cross any major rivers or water courses, and therefore no bridges are required. There are machambas situated within and in close proximity to the EN243 end of the road corridor for approximately 6.6 kilometres along. However, it is unlikely that any machambas will require to be relocated as the road will be routed where possible to avoid these (Refer to Section 11.3.7.) and those that will need to be relocated form part of the RAP.

Alternative Assessment
Road Option 2 is the preferred haul road route as it requires less infrastructure to be built as it is 13km shorter on the EN243 and will utilise existing tertiary roads. There is less clearing of natural vegetation and it will not disrupt any ecologically sensitive rivers. There will be fewer disruption to neighbouring villages as it only passes through one village, and machambas will not be relocated unnecessarily. Shorter routes would be beneficial from a health and safety perspective as the drivers of the trucks have a shorter distance to cover, reducing road fatigue and therefore possible accidents. As there are less villages that the trucks pass through, the risk of accidents involving community members is reduced. However, both options pass through Sunate.

11.3. INCREMENTAL ALTERNATIVES

11.3.1. Layout Iterations

Throughout the ESHIA process a number of individual project components were relocated. The layout iterations are summarised as follows, and presented in the maps below (Figure 11.4 to Figure 11.6). A detailed discuss of the layout alternatives are presented in the sections that follow.

- **Layout Option 1** – Initial Layout
- **Layout Option 2** – Secondary Layout
  - Relocation of Camp Site
  - Change of Tailings Storage Facilities from single cell to a double cell and lined
- **Layout Option 3** – Final Layout (Preferred)
  - Relocation of Plant Site
  - Relocation of ROM PAD
  - Inclusion of Sediment Control Structures
Figure 11-4: Layout Option 1 – Initial Layout

Legend
- ESHIA Project Boundary
- Site Layout Initial
- Rivers and Drainage
- Existing Project Roads

Access Road Options
- Option 2: Southern Access
- Option 1: Northern Access
Figure 11-5: Layout Option 2 – Secondary Layout
Figure 11-6: Layout Option 3 – Final and Preferred
11.3.2. Mine component alternatives

The Plant, ROM Pad and Mine Services Area (MSA) are all located between the pits and TSF. The Upolo River separates the ROM pad from the process plant and mine services areas. The catchment of this stream comprises the majority of the pit, waste dump and plant site area. The stream flows in an approximately west to east direction and discharges into the Mogido River downstream.

11.3.3. Plant site

The plant site is located between the pits and TSF and has been designed to be constructed above the flood level of the Upolo River (Figure 11-7). Two alternatives were considered for the position of the plant site, with option 2 being preferred.

![Figure 11-7: Mine component alternative locations](image)

**Plant Site Option 1**

Option 1 is 460 x 690 m area. The site falls within the Miombo Woodland (moderate ecological sensitivity) and Riparian Forest/Woodland, which was identified as highly sensitive. A single drainage line is located in the north-west corner of the plant site, covering 4.8 Ha (Table 11-6). The plant site is adjacent to the ROM PAD, on the same southern side of the drainage area.

**Plant Site Option 2**

Option 2 is 240 x 240 m and is situated entirely in Miombo Woodland (moderately sensitive) and does not disrupt a drainage line. Option 2 is located next to the mine maintenance area to the south of the drainage area. In option 2 the ROM PAD is located to the north of the plant site above the drainage line that separates the sites.
4.2.3.1 Assessment of Plant Site Alternatives

Plant site option 2 is the preferred alternative because it infringes less on the drainage lines in the area and has a smaller footprint, thus reducing the impact on the highly sensitive vegetation (Table 11.2). Plant site option 2 is preferable from an ecological perspective because it has a smaller footprint that option 1 and since T16 will be mined first it is also technically preferred because it is closer to T16 than option 1.

![Figure 11-8: Layout Option 3](image)

Table 11-1: Assessment of Plant Site alternative options

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footprint size</td>
<td>31.6 Ha</td>
<td>5.7 Ha</td>
</tr>
<tr>
<td>Loss of vegetation/habitat.</td>
<td>Miombo Woodland, Riparian Forest/ Woodland, Drainage line</td>
<td>Miombo Woodland, Minor loss to Riparian Forest/ Woodland</td>
</tr>
<tr>
<td>Proximity to catchment and drainage lines</td>
<td>Drainage line runs through the north-west area of the Plant site</td>
<td>190 m from drainage line to the north</td>
</tr>
<tr>
<td>Distance to process related infrastructure</td>
<td>225 m south of ROM PAD, 550 m north of TSF Cell 1</td>
<td>220 m south of ROM PAD, 750 m north of TSF Cell 1</td>
</tr>
<tr>
<td>Location relative to other infrastructure</td>
<td>3,820 m east of Camp Site</td>
<td>3,275 m east of Camp Site</td>
</tr>
</tbody>
</table>
11.3.4. ROM PAD

Two options were considered for the position of the ROM Pad within the project area (Figure 11-8).

**ROM Pad Option 1**

The ROM PAD Option 1 is situated in a vegetation type identified as Miombo Woodland, and falls over two drainage areas to the north-west of the site as well as to the south-west. The Riparian Forest/Woodland vegetation type was identified as an area of high sensitivity due to the fact that these areas are all relatively intact and have high species diversity. This option would require additional infrastructure to be put in place to allow for the transport of materials across the drainage line to the pad, resulting in higher costs, as well as a higher degree of ecological sensitivity.

**ROM Pad Option 2**

The ROM PAD Option 2 is currently designed as a 300 x 500 m pad that is located to the north of the plant site. The ROM pad is likely to be approximately 15 m high. It is situated in an area that is mainly Riparian Forest/ that is considered to have a high ecological sensitivity. Although the pad has been placed in an area of higher ecological sensitivity, the result would be that it is located to the north of the drainage line, would require less infrastructure in place to operate and would not infringe on the drainage line to the south.

**Assessment of ROM Pad Alternatives**

ROM PAD Option 2 is preferable in terms of its allocated footprint size, being considerably smaller than Option 2. However, its location is almost entirely within the Riparian Forest/Woodland vegetation type that is regarded as highly sensitive. Option 1 has a larger footprint size, but the majority of the site is located within Miombo Woodland which less sensitive. The site does fall over two minor drainage lines, but these are minor in comparison to the area covered by Option 1.

![Figure 11-9: ROM Pad Options](image-url)
Table 11-2: Assessment of ROM Pad alternative options

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footprint size</td>
<td>• 11.1 Ha</td>
<td>• 15.0 Ha</td>
</tr>
<tr>
<td>Loss of vegetation/habitat.</td>
<td>• Miombo Woodland</td>
<td>• Miombo Woodland</td>
</tr>
<tr>
<td></td>
<td>• Minor loss to Riparian Forest/ Woodland</td>
<td>• Larger loss to Riparian Forest/ Woodland</td>
</tr>
<tr>
<td>Proximity to catchment and drainage lines</td>
<td>• Two drainage lines through site</td>
<td>• No drainage lines through site</td>
</tr>
<tr>
<td></td>
<td>• 390 m south of north drainage</td>
<td>• 45 m north of drainage line</td>
</tr>
<tr>
<td></td>
<td>• Southern edge falls over southern drainage line</td>
<td>• 140m south of northern drainage line</td>
</tr>
<tr>
<td>Distance to process related infrastructure</td>
<td>• 2,040 m south-west of T16 Pit</td>
<td>• 725 m south-west of T16 Pit</td>
</tr>
<tr>
<td></td>
<td>• Adjacent to Plant Site</td>
<td>• 220 m north of Plant Site</td>
</tr>
<tr>
<td>Location relative to other infrastructure</td>
<td>• 580 m north of TSF Cell 2</td>
<td>• 1,250 m north of TSF Cell 2</td>
</tr>
</tbody>
</table>

11.3.5. Camp Site

Two options were considered for the position of the Camp Site within the project area (Figure 11-10).

Camp Site Option 1

The majority of Camp Site Option 1 is situated in a vegetation type identified as Riparian Forest/ Woodland with the remaining being Miombo Woodland (Figure 11-10). The Riparian Forest/ Woodland vegetation type is of high sensitivity due to the fact that these areas are all relatively intact and have high species diversity. According to the vegetation assessment the impacts on this vegetation type were considered to be high negative and it was recommended that this area should be left intact and non-essential infrastructure, such as the mine camp, be moved to a less sensitive area.

Camp Site Option 2

Camp site option 2 is situated in an area that has a vegetation type identified entirely as Miombo Woodland, considered to have a moderate sensitivity. The camp site is located within the haul road corridor and far from any mining infrastructure as well as the blast radius. With mitigation measures in place, this impact could be reduced to low significance.

Alternative assessment

Due to the proximity of the camp site option 1 to the TSF cells, it is not advisable to have the camp site located here. The camp site option 2 is the recommended site due to its location along the access road, position in relation to other infrastructure, as well as within less sensitive vegetation away from any existing drainage areas.
Figure 11-10: Alternative Options assessed for the Camp Site

Table 11-3: Assessment of Camp Site alternative options

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footprint size</td>
<td>• 11.1 Ha</td>
<td>• 11.0 Ha</td>
</tr>
<tr>
<td>Loss of vegetation/habitat.</td>
<td>• Riparian Forest/ Woodland; &amp;</td>
<td>• Miombo Woodland only</td>
</tr>
<tr>
<td></td>
<td>• Miombo Woodland</td>
<td></td>
</tr>
<tr>
<td>Proximity to catchment and</td>
<td>• Majority within drainage area</td>
<td>• No drainage area</td>
</tr>
<tr>
<td>drainage lines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance to process related</td>
<td>• 250m south-west of TSF Cell 2</td>
<td>• 570m south-east of T12 WRD</td>
</tr>
<tr>
<td>infrastructure</td>
<td></td>
<td>• 1.3km south-east of T12 Pit</td>
</tr>
</tbody>
</table>

11.3.6. Tailings Storage Facilities

Two options were considered for the position of the tailings storage facility (refer to Figure 11-11). These options were assessed on financial and technical grounds by Knight Piésold Consulting, who concluded that Option 2 (lowest cost prior to start-up) would be preferred.
Figure 11-11: TSF Alternative options Single Cell vs Double Cell (Option 2 - preferred)

**Tailings Storage Facility Option 1**

Option 1 is 135.6 ha and is located within areas of moderate and high ecological sensitivity. These areas are covered by Miombo Woodland and Riparian Forest/Woodland. The one cell borders a major drainage line and will remove two minor drainage lines (Figure 11.13).

**Tailings Storage Facility Option 2**

Option 2 is 173.6 ha and is located within areas of moderate and high ecological sensitivity. These areas are covered by Miombo Woodland and Riparian Forest/Woodland. The two cells border a major drainage line and will remove three minor drainage lines (Figure 11.13).
Figure 11-13: TSF Option 1 (above) and Option 2 (below)
Assessment of Tailings Storage Facility Alternatives

In summary, from an ecological perspective, option 1 is preferred because it is approximately 40ha smaller and impacts one less drainage line. However, from a financial perspective option 2 is preferred.

Table 11-4: Assessment of each TSF layout iteration as alternative options

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
</table>
| Footprint size                       | • 135.6 Ha                                   | • 91.5 Ha (Cell 1)  
                                           |                                               | • 82.1 Ha (Cell 2)  |
| Loss of vegetation/habitat.          | • Riparian Forest/Woodland;  
                                           |                                               | CELL 2  
                                           | • Miombo Woodland  
                                           |                                               | CELL 1  
                                           | • Riparian Forest/Woodland;  
                                           |                                               | • Miombo Woodland  |
| Proximity to catchment and drainage lines | • Major Drainage area through western edge;   | CELL 2  
                                           | • Minor drainage through centre of site      | • Major drainage through north-west corner of the site  
                                           |                                               | • Minor drainage through northern area of the site  
                                           |                                               | CELL 1  
                                           | • Major drainage through south-east section of the site  
                                           |                                               | • Major drainage through centre  
                                           |                                               | • No minor drainage  |
| Distance to process related infrastructure | • 760 m from Plant Site option 1  
                                           |                                               | • 760 m from Plant Site option 2  
                                           | • 1,670 m from T16 Pit  
                                           |                                               | • 2,200 m from T16 Pit (Cell 2)  
                                           | • 1,730 m from T12 Pit  
                                           |                                               | • 1,890 m from T12 Pit (Cell 2)  |
| Location relative to other infrastructure | • 600 m from Camp Site option 1  | • 1,790 m from Camp Site option 2  |

Coastal & Environmental Services 129 Ancuabe Graphite Project
11.3.7. Introduction of Sediment Control Structures

A series of sediment control structures were introduced to the layout downstream of the mine and its infrastructure.

Figure 11-12: Sediment Control Structures (SCS) in relation to mine infrastructure

Figure 11-13: Function of Sediment Control Structures (SCS) in relation to mine infrastructure

Source: Knight Piesold Consulting
11.3.8. Future incremental alternatives: site access road and powerline corridor

The proposed site access road and powerline corridor is 550m wide within which a 18 km x 8m wide road will be placed, together with a portion of the 35 km 33 kV transmission lines and associated pylons.
For the most part the road will follow the existing tertiary road. Impacted machambas will be be extended, and as a last resort relocated, as part of the on-going RAP. The corridor is 550 m wide of which only 8 m will be used for the road and only the base of the towers (pylons) will have a footprint within the 550m corridor. The number of towers and the siting of each tower will need to be ground truthed to ensure placement is ecologically and socially acceptable. This will be undertaken in consultation with EDM.

11.4. THE “NO-GO” ALTERNATIVE

Under the “no-go” or no project scenario, the current disturbance caused by the local communities, which include artisanal mining, natural resource use, the felling of trees for charcoal production, timber extraction and the establishment of mashambas will continue, and may even expand, resulting in more disturbed areas and habitat fragmentation. Given the current status of this area the no-go option is considered to be of a lower impact than that of the proposed mine. However, the mine may offer some protection to the existing site, and even the creation of new habitats (the dam), thereby increasing biodiversity.

In addition to the above, no socio-economic benefits would accrue to the nearby communities and the government. If the proposed project is not implemented benefits such as the opportunity to increase revenue at local and regional levels, as well as the creation of employment will be lost, resulting in unimproved living conditions for the population in the project area. Furthermore, if the project is not implemented, the opportunities for growth and improved quality of life associated with the proposed social programmes will decrease, as will the secondary impacts that stem from higher income earning (such as support for local businesses).

11.5. SUMMARY OF ALTERNATIVES

The following alternatives were accessed based on their footprint, vegetation loss and proximity to sensitive environmental features (rivers) and the preferred option chosen based on the environmental impacts.

- Water storage facility
  - Option 1: Lizard Dam (Maugido river) - Preferred
  - Option 2: Dragon Dam
- Access Road
  - Option 1: Northern Access
  - Option 2: Southern Access - Preferred
- Camp Site
  - Option 1
  - Option 2 - Preferred
- Tailings Storage Facilities
  - Option 1: Single Cell – Preferred ecological
  - Option 2: Double Cell – Preferred financial
- Plant Site
  - Option 1
  - Option 2 - Preferred
- ROM PAD
  - Option 1
  - Option 2 - Preferred
- Inclusion of Sediment Control Structures
- Micro sitting of Haul road and pyloin towers within Powerline corridor
### Table 11-5: Summary of the Infrastructure Alternatives

<table>
<thead>
<tr>
<th>Infra-structure</th>
<th>Area Hectares (Ha)</th>
<th>Hectares of Vegetation Lost</th>
<th>Rivers</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Miombo woodland</td>
<td>Riparian Forest/Woodland</td>
<td>Proximity/ On Village (V)/Machambas (M)</td>
</tr>
<tr>
<td>Water Storage</td>
<td>93.6</td>
<td>18.4</td>
<td>8.8</td>
<td>69.3</td>
</tr>
<tr>
<td>Access Road</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Servitude</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camp Site</td>
<td>11.1</td>
<td>4.5</td>
<td>11.1</td>
<td>6.6</td>
</tr>
<tr>
<td>Mine Maintenance</td>
<td>25.0</td>
<td>19.3</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>Plant Site</td>
<td>31.6</td>
<td>5.7</td>
<td>26.8</td>
<td>5.5</td>
</tr>
<tr>
<td>ROM PAD</td>
<td>42.9</td>
<td>15.0</td>
<td>39.2</td>
<td>4.6</td>
</tr>
<tr>
<td>TSF</td>
<td>135.9, 208.7</td>
<td>126.1, 173.5</td>
<td>9.8</td>
<td>35.3</td>
</tr>
<tr>
<td>WSF</td>
<td>93.6</td>
<td>18.3</td>
<td>9.3</td>
<td>69.3</td>
</tr>
</tbody>
</table>
12. CONCEPTUAL DECOMMISSIONING AND CLOSURE PLAN

12.1. WHY A PRELIMINARY MINE CLOSURE PLAN IS REQUIRED

Mine rehabilitation must be viewed as an on-going programme designed to restore the physical, chemical and biological quality or potential of air, land and water regimes disturbed by mining to a state acceptable to the regulators and to post-mining land users. Rehabilitation can take place throughout the life of mine, whereas mine closure by definition refers to those activities that take place after production has ceased.

The developed world (e.g. Australia and United Kingdom) are among the leading countries in developing mine closure and rehabilitation programmes and objectives. This is well articulated in the International Council on Minerals and Metals (ICMM) Planning for Integrated Mine Closure Toolkit, and is amongst the most widely used international guideline document for mine closure. The recommendations included in this report draw from the ICMM Guidelines which are explained in more detail below (Figure 12-1).

A Mine Closure Plan for the project will be developed by Grafex, initiated at this early stage as a Conceptual Closure Plan. These outputs differ:

- a Conceptual Closure Plan should communicate the expected outcomes and goals of the closure activities;
- The Mine Closure Plan is a detailed plan that includes timeframes and milestones, detailed methodologies for achieving goals, more detailed budgets, rehabilitation and site amelioration specifications, and monitoring and validation processes. This detail can only come later, when more details on the engineering designs of all components of the project are available.

This Conceptual Closure Plan is developed now for use during pre-feasibility, feasibility and design phases of the project, and to inform the EIA process. Its active life may be a few years, but if well-defined and based on effective community and stakeholder engagement, it may not change much during the first five years of construction and mining. However, the closure plan must be reviewed every five years over the life of the mine, in order to accommodate any changes in mining area, approaches to mining and other technical refinements that are likely to take place during the start and ramp-up phases of the project. These changes would also trigger a revision of the Closure Plan budget, to ensure that sufficient funds are available to cover any additional costs.

This rest of this section provides the broader principles and methodologies that will be adopted by the company to guide further closure planning, and provides the anticipated outcomes and objectives of the Conceptual Closure Plan.

12.2. TARGET CLOSURE OUTCOMES AND OBJECTIVES

The target closure outcomes of the Mine Closure Plan should be to (ICMM, 2008):

- Restore as much as possible of the mine area to a condition consistent with the pre-determined post closure land use objective;
- Ensure that the mine area is left in a condition which poses an acceptable level of risk to public health and safety;
- Reduce, as far as is practically possible, the need for post closure intervention, either in the form of monitoring or on-going remedial works;
- Minimise or prevent post-closure environmental degradation (to the soils, water and air), by ensuring that the mine area is left in a condition that is chemically and physically stable; and
- As far as practical, minimise the immediate negative economic impacts to local communities associated with mine closure, and maximise the likelihood of lasting
benefits to local communities. This will include leaving infrastructure in place that has a post mining value to the communities.

The objectives of the Mine Closure Plan are further expanded upon below:

- **Physical Stability** - Mine structures that remain post closure should be physically stable such that they do not pose a hazard to public health and safety as a result of failure or gradual degradation. These structures should only erode and/or release solids into the environment to the extent that degradation of the surrounding area does not occur.

- **Chemical Stability** - The infiltration, leachate or run-off from the mine site or waste storage facilities should not endanger public health and safety, or result in the pollution of soil, surface water or groundwater, or non-compliance with statutory water quality limits.

- **Land Use** - Post closure, the mine site should be compatible with the surrounding land, to the extent that it is both practical and economical to do so.

- **Social** - Post closure the mine should ensure that the needs of communities impacted and dependent on the mine are appropriately addressed. Social risks must be identified, and goals need to be defined and set for, *inter alia*, the following: poverty alleviation, education, health care, employment and employability, and improving social infrastructure. This will include leaving infrastructure in place that has a post mining value to the communities.

### 12.3. SITE SPECIFIC CLOSURE OUTCOMES, OBJECTIVES AND TARGETS

At this stage, the proposed post closure land use will likely be a combination of agriculture (*mashambas*) and natural vegetation within defined ecological corridors. Alternatively, components of the project might be used for conservation purposes (e.g. the dam, and offices could be used for the provincial or national conservation agency – ADEL- CD), although no final decision has been made. The following main objectives have been set:

- Disturbed areas are to be returned to as close to their original state as practicable, by implementing a revegetation and replacement strategy;

- The mine pits will be retained as voids, which will fill with water. They will be designed for long-term stability by sloping the perimeter walls of the open pit at 1:3 (18º) angles, and access will be controlled;

- Waste rock dumps are to have a 1:5 slope and be covered with a minimum of 300 mm of topsoil and/or other suitable growing medium (e.g. saprolite covered with organic matter or wood chips) and vegetated with indigenous species;

- The TSF is to be capped at closure with 300 mm of saprolite and covered with organic matter or wood chips, and must be dome shaped to avoid the ponding of water, and vegetated;

- No topsoil shall be harvested from undisturbed areas for use in the rehabilitation and revegetation strategy;

- Socio-economic impacts (including the loss of employment) will be minimised through careful planning and preparation for closure, beginning three to five years before closure takes place; and

- Retrenchments and job losses are to be minimised by developing self-sustaining community development projects during the life of mine, as part of the company’s ongoing but yet to be developed Community Development Programme.
The above principles and concepts will be refined as part of on-going detailed closure planning and costing during the life of mine.

This preliminary closure report has been compiled in fulfilment of the relevant Mozambican legislation. The overarching item of environmental legislation is the Environmental Framework Act (Law No. 20/97, 1 October 1997) which governs the use and correct management of the environment and its components, and to ensure sustainable development. It is the foundation for the legal instruments for the preservation of the environment. According to the Environment Act, the mining operation is liable for the costs of rehabilitating the degraded environment or restoration thereof.

In terms of the above-mentioned Act, the ESHIA conducted for the proposed mine must include a Closure Plan. The Closure Plan has to provide an indication of the rehabilitation costs related to the closure of the mine as mining activities are required to provide a bond to cover the costs of rehabilitation during mine closure. The value of the bond is set by the Government and is reviewed every two years. The bond may take the form of an insurance policy, a bank guarantee or a deposit in cash in a bank account that the Government maintains specifically for the purpose.
12.4. DECOMMISSIONING, REHABILITATION AND CLOSURE OF SPECIFIC COMPONENTS

12.4.1. Mine void/pit rehabilitation

The objective of pit rehabilitation is to ensure that the site is left in a state that poses minimal risk to the health and safety of humans and fauna (wildlife and livestock) and the health of the environment. The two pits (T12 and T16) will disturb approximately 80ha of land. Since the Hydrogeological and Geochemical specialist investigation (2017) determined the potential for Acid Mine Drainage and leaching of metals, it was recommended that the pits are backfilled to reduce oxidation and minimise the lowering of the pH and metal leaching that may arise. However, only one pit (T16) can be backfilled and it is therefore recommended that the second pit (T12) is flooded with water to just below the static water level to prevent oxidation of the sulphide zones. Two scenarios were modelled:

1) Sulphides in pit wall rock will be exposed to the atmosphere and the lake oxidation zone water (i.e. sulphide zones in the pit will not be completely flooded) in which case pit water could reach a pH of 3.3; and

2) Sulphides in pit wall rock is exposed only to the lake oxic zone water (i.e sulphide zones in the pit will be completely flooded), in which case the pit water will reach a pH of 5.2.

It is recommended that flooding simulations are undertaken during the operational phase to determine flood levels, and the anticipated time period required to reach optimal levels. This is important to predict which mitigation measures will be required (as outlined in the geochemical assessment for each of the options) post-closure.

Flooding the T12 pit could, however, present a significant risk at closure as it will take a significant amount of time (years) for an in-pit lake to form. Should someone fall into the pit, they will not be able to get out. Suitable benching of the pit is therefore required to create a shallow surface (1 m deep) along the edge of the pit, and an access route out of pit needs to be created, most likely by using the access ramp required during operation.

Alternatively, all pit walls must be sloped at a 1:3 (18º) angle to the pit floor, or to the stable groundwater level that could establish within a reasonable period (being 15-30 m below land surface). This pit wall sloping renders the pit safe for humans and domestic animals, but increases the size of the pit at surface. Where concerns exist regarding the risk that the pit water poses to humans and animals, it will be necessary to implement measures to reduce access to the pit. As fences would be stolen, this may be achieved by the construction of a sizable berm around the entire perimeter of the open pit to keep domestic animals out and restrict human access. A further option is to plant an impenetrable vegetation barrier around the pit, using a spiny, fast growing but non-invasive species such as sisal. Prior to making a choice about a suitable species, a risk assessment to determine the potential for the species to become invasive must be undertaken.

Signs will be erected around the open pit and on all approach roads warning the public of the potential dangers of falling or drowning. These signs will be in English, local languages and symbols for illiterate people. Access ramps to the open pit will be closed off to prevent vehicle access. In addition, as part of the closure process, local communities will be informed directly of the potential hazards and precautionary measures to be observed around the pit.

12.4.2. Waste Rock Dumps

Two Waste Rock Dumps (WRD) will be established, one for each of the pits outlined above. The WRD will consist of all overburden and waste material generated during the mining process. To significantly reduce the costs of rehabilitation, the slope angle of the WRD should
not exceed 1:5. This angle should also be maintained for WRD areas that have reached final profiling.

Upon closure the WRD sides and tops must be covered with a minimum of 300mm of topsoil and vegetated with indigenous species during the wet season. Generally, average re-profiled outer slopes that have been re-vegetated will curb storm water flow velocities on the slopes. In addition, this should reduce precipitation percolating into the WRD. Should the WRD not be decommissioned with a proper cover system, monitoring of geotechnical properties within the WRD must be undertaken on an on-going basis to ensure the stability of the WRD. In addition to the above mentioned objectives, it is recommended that the shaping of the WRD slopes be undertaken during the operational phase of the mine.

The generation of AMD from the waste rock material is unlikely to occur (Hydrogeological and geochemical specialist investigations, 2017), as the sulphide mineral content of the waste rock is much lower than that of the tailings. The iron sulphide minerals are concentrated in the ore and not the host rock of the ore body, and the tailings is crushed waste material from the ore. However, if acid generating waste rock is identified during the operational phase, this should be separated from non-acid generating waste rock.

Acid generating waste rock will need to be encapsulated within non-acid generating waste rock in order to prevent/minimise the risk of acid mine drainage formation. This can be achieved by covering the WRD with saprolite and topsoil and revegetating the site. Run-off from the surface of the waste rock dumps should be directed via the site drainage system into the open pit. This will minimise the risk of contamination of local watercourses.

12.4.3. Tailings Storage Facility

The TSF will be located south of the proposed plant location and is expected to cover a total footprint area of approximately 210 ha over the 30 year Life of Mine (LoM).

Post closure, the TSF will be a source of sulphide minerals, and has the potential to cause AMD. According to the Hydrogeological and geochemical specialist investigations (2017) that were completed as part of the ESHIA “the development of acid mine drainage (AMD) conditions is likely to occur in the tailings facility due to the presence of sulphides and an absence of minerals with neutralising capacity. The AMD is however limited to the outer shell of the tailings facility, implying that tailings toe seepage is likely to be acidic at a model pH of 2.51.” Acid rock drainage or Acid Mine Drainage (AMD) from tailings impoundments is likely to reduce groundwater quality due to the amount of sulphide mineral present. Additionally, iron, manganese, aluminium, selenium and sulphate concentrations in the outer shell of the tailings is also expected to be elevated.

To minimise the potential negative environmental impacts (both chemical and physical) of the TSF at closure and post-closure, the following is proposed for the TSF:

- During the construction phase, topsoil must be stripped (at least 100 - 300 mm and subsoil/saprolite (minimum 300 mm)) before the TSF is constructed. These materials will be used to cover the WRD and TSF post closure;
- A permanent spillway must be constructed during the construction phase of the TSF to ensure physical stability of the facility during storm events;
- The TSF should be covered with a saprolite layer (at least 300 mm thick, but contoured to ensure free drainage of surface runoff post-closure) followed by 100 – 300 mm topsoil, on which vegetation must be established;
- The TSF should be graded to form a dome, to allow incidental rainfall to run off the surface of the TSF and to reduce water ingress into the tailings mass;
- The TSF should have an external slope of 1:3 (vertical:horizontal) to ensure that it remains a stable landform in the long term, and to make it suitable for revegetation;
12.4.4. Roads

The proposed haul and access roads around the site should be ripped, except those needed to access the facilities for inspection after closure. Roads that can and will be used by other users post closure should, however, be left, provided this is agreed upon by all parties concerned. These roads should then be handed over to the relevant authority (such as the Department of Roads) in order to ensure their proper maintenance in the long term.

Any roads which will no longer be required will be rehabilitated. In general, the following will be undertaken:

- Bridges, culverts and ducts will be removed where they are no longer required;
- The natural water flow will be restored and any disturbed section of the watercourse will be stabilised and revegetated;
- The road surface, shoulders and embankments will be graded to a slope suitable to prevent erosion. Cuttings will be assessed and where necessary measures to improve safety and erosion stability will be implemented; and
- The road surfaces will then be revegetated with suitable indigenous species.

12.4.5. Processing Plant and Other Infrastructure

Certain infrastructure may remain post closure. The objectives are to:

- Hand over the haul and access roads to the appropriate government department (i.e. Department of Roads) for utilisation by the local communities or conservation agency once mining has been completed;
- Hand over the water storage dam to the appropriate government department to provide a permanent water supply to the local communities in the area, or to serve as a waterhole for game, in the event that the buffer area is incorporated into the QNP;
- Hand over the clinic service to the provincial directorate or suitable NGO's (e.g. Foundation Ariel Glaser) so it can be used by local communities in the area, which will be of benefit to the local communities as healthcare facilities are scarce commodities within the region;
- Consider handing over the administration facilities for modification into a secondary school for the area, or alternatively to ADEL- CD to manage the QNP; and
Consider handing over the workshop and maintenance area, and use this to support a post closure training programme for local community use. This will require the development of a technical training programme as part of the mine’s CSD programme prior to closure.

Once closure is complete, a decision to either demolish any other remaining facilities or hand them over to the local authorities for conversion into social infrastructure will need to be made through a consultative process. The structural integrity of any structures that are to remain on site for use by local communities must be assessed by an independent specialist prior to handover. Any structures that are found to be structurally defective must either be demolished or repaired prior to handover. All other infrastructure will be decommissioned as follows:

- Any surface buildings and infrastructure which are no longer required will be demolished, unless specific directives to the contrary are received from the authorities. Such directives may result from community requests. This will need to be confirmed through a stakeholder engagement process undertaken as part of the closure plan goal refinement exercise;
- A detailed plan indicating the location of any remaining infrastructure will form part of the closure plan;
- All brick and concrete buildings associated with the processing plant will be demolished and the rubble buried either on site to a minimum depth of 1.0 m, or placed in the TSF and then covered with saprolite and top soil;
- Foundations will either be removed or will be covered with a layer of soil, or soil forming material, the depth to be determined following trials to be undertaken;
- Non-re-useable materials including rubble and waste will be disposed of at suitable sites in accordance with the waste management and disposal plan that will be developed;
- Following the removal of the infrastructure, a soil contamination assessment will be undertaken by an independent specialist, and remediation and re-vegetation activities implemented where necessary;
- Support infrastructure buried underground, such as tanks and their pipes, and other pipes and service tunnels will, depending on the proposed future use of the site, either be kept as is or be unearthed and removed from the site. If they are to be left in-situ, the integrity of all underground pipes and tanks will be assessed by an independent expert. If the integrity of sub-surface infrastructure is compromised, it must be removed;
- Any sub-surface infrastructure (including but not limited to pipes and tanks) that are likely to contain hazardous chemicals (including fuel) must be removed;
- Any remaining openings and access ways will be blanked;
- Electrical equipment and infrastructure such as transmission towers, electric cables and transformers which are no longer required will be demolished and removed from the site. The soils in the vicinity of transformers will be assessed for contamination and appropriate decontamination measures will be implemented, in accordance with Mozambique regulatory requirements, if necessary;
- All disused mining plant and equipment, such as winches, pumps and heavy machinery will be removed from the site. It is not anticipated that any of this machinery or equipment will be contaminated. However, the mine will confirm this before any machinery or equipment is removed from the site. If any of the machinery or equipment is found to be contaminated it will be appropriately decontaminated before being removed;
- During the mitigation and rehabilitation works, particular attention will be paid to the places where equipment was parked. The mine will assess these sites and if the soils are contaminated appropriate remedial measures will be taken in compliance with Mozambican regulatory requirements; and
- There will be a landfill on site for general waste. The design of this landfill has not yet been finalized. At closure the following will apply:
  - On completion of the landfill the covers will be completed and re-vegetation of the cover undertaken.
  - The Closure Plan for the mine will include details for the closure of the landfill and will ensure that the closure of this specific facility meets the requirements of
Mozambique legislation and international best practice. Post-closure monitoring of these facilities may be required.

- The soil and vegetation function of the mine footprint will be restored.

12.4.6. General Surface Rehabilitation

General surface rehabilitation should ensure the surface topography emulates the surrounding area, is free draining, has a "neat" appearance and is re-vegetated. Special attention must be given to shaping and removal of heaps of excess material, scrap and waste. The entire area is to be ripped, covered with 100 to 300 mm of topsoil and vegetated. The details of the revegetation must be documented in a comprehensive rehabilitation plan.

12.5. SOCIAL COMPONENTS OF CLOSURE

Post closure the mine should ensure that the project affected communities and those who have become dependent on the mine are suitably catered for. The following must be considered:

- The future public health and safety of local communities are not compromised;
- The after-use of the site is beneficial and sustainable to the affected communities in the long term; and
- Adverse socio-economic impacts are minimized and socio-economic benefits are maximized.

Although an SIA and HIA have been undertaken for the ESHIA, these studies focused on the construction and operation phase, with little detail on the decommissioning phase. As part of the mine closure process, Graphex Limitada should conduct a Closure Social Impact Assessment (SIA). This study can be used as a basis to engage with communities to understand perceived impacts, identify how best to manage adverse impacts and explore opportunities that mine closure may bring. The Closure SIA will take the following strategic issues into consideration:

- Job losses – IFC Performance Standard 2 states that prior to retrenchment, alternatives to retrenchment must be considered. Only if no viable alternative is available should retrenchment be implemented, in accordance with a retrenchment management plan that has been developed in order to minimise adverse impacts of retrenchment on workers. The retrenchment management plan must be non-discriminate and reflect sufficient consultation with workers, their relevant organisations and if applicable the government. In addition, the retrenchment management plan must comply with any existing bargaining agreements;
- Psychological impacts (on employees and the broader community);
- Impacts on suppliers (business planning workshops pre-closure with SMME to assist them moving on from reliance on the mine);
- Health impacts;
- Loss of income to local and government institutions (fiscal impacts);
- Discontinuation of Social Labour Plan (SLP) and Corporate Social Responsibility (CSR) activities;
- The nature of the current economic / social contribution compared to the future contribution / loss of contribution post closure; and
- General site hazards that pose a risk to the safety of local communities: According to the IFC EHS Guidelines risk management strategies for general site hazards may include:
  - Restricting access to the site, through a combination of institutional and administrative controls, with a focus on high risk structures or areas. This depends on site-specific situations, and might include fencing, signage and communication of risks to the local community.
  - Removing hazardous conditions on sites that cannot be controlled effectively.
through site access restrictions. This should include covering openings to small confined spaces, ensuring a means of escape for larger openings such as trenches or excavations and removing hazardous materials.

The information that will be gathered from this study will provide room for engagement between the company and other interested and affected parties, such as local councils, government and other organizations, about impact mitigation policies and the legacy aspects of mine closure.

Engagement with affected communities throughout the life of the project is essential and to this end, the company will be guided by the approach recommended by the ICMM. It is recognized that to achieve effective closure that is beneficial to the operating company and the community that hosts it, the views, concerns, aspirations, efforts and knowledge of various internal and external stakeholders must be brought together. This should be determined using a multi-stakeholder process that includes regulatory agencies, local communities, traditional land users, adjacent leaseholders, civil society and other impacted parties. For the Grafex Lda mine this will involve:

- Incorporating closure planning into the early stages of project development and operations;
- Collating the goals and views of various stakeholders (project owner, local community, government, and non-governmental organizations (NGOs)) at the early feasibility (EIA) stage of project to inform closure and post closure goals;
- Acting to meet the goals by working with the relevant stakeholders;
- Using the concepts of risk and opportunity to both minimize liability and maximize benefits to all relevant parties;
- Using multidisciplinary expertise and multi-stakeholder processes to ensure that mitigation of risk in one area does not increase risks in another; and
- Ensuring that the social closure phase ties in with the infrastructural and environmental closure phases.

Thus, engagement with internal and external stakeholders will be undertaken throughout the life cycle of the project, and to achieve lasting benefits at a local and regional level, Grafex appreciates that the views of external stakeholders must be understood. To ensure that these benefits are delivered, Grafex will identify key external stakeholders and engage with them to foster a two-way understanding of mutually beneficial outcomes. These outcomes will be explained and presented in the Comprehensive Closure Plan and disclosed to stakeholders in a manner consistent with the requirements of the applicable standards referred to above.

12.6. POST CLOSURE MINE SITE INSPECTION, ENVIRONMENTAL MONITORING AND REPORTING

The post closure period usually comprises three phases:

- Active phase, years 1-2;
- Passive phase, years 3-5; and
- Inspection phase, years 5-8.

During the active two-year period the company will continue supplying specific social services to surrounding communities in line with the corporate social responsibility agreements that would have been put in place during the mining operation.

During the life of the mine, the company will continuously engage the local authorities and traditional leadership structures as part of the handover process (i.e. handing over the infrastructure and services). All actions will be guided by the on-going dialogue between the mine and relevant stakeholders. The passive three-year period will most likely entail the handover of the infrastructure and services to the relevant local and/or provincial authority (i.e.
Grafex proposes that at the same time it will provide advice on technical or social issues that may arise during this 3-year period with a final sign off taking place in the 5th year post closure.

Grafex will implement a programme of post closure environmental inspection and monitoring to assess the success of mine reclamation and verify that the various components of the closed mine are not adversely impacting adjacent watercourses and groundwater, and do not pose a potential health risk and/or danger to the public. The purpose of monitoring is to ensure that the objectives of the rehabilitation programme are met, and that the progressive rehabilitation process is followed as planned during the life of the mine. The regularity of the monitoring will be dependent on the aspect being monitored. For example, dust and groundwater monitoring will be ongoing and will be initiated prior to construction to obtain baseline values, whereas biodiversity monitoring will take place progressively throughout the operational and closure phases. An independent consultant will conduct the site inspection and environmental monitoring.

Grafex proposes that post closure environmental inspection and monitoring be conducted bi-annually for the first two years to establish seasonal variations. Bi-annual site visits will be made before the rains and at the end of the rains (active phase). It is expected that final inspection and monitoring will be conducted five years after mine closure, but this will depend on the success of the closure and rehabilitation process (passive phase). The findings of this inspection will determine whether or not any further post closure site inspection is necessary (inspection phase), or whether further interventions to improve, for example, the revegetation of areas will be required. Detailed tracking of the progress of progressive rehabilitation will also permit the annual review of the closure plan to reflect this progress, thus reducing or increasing the quantum required for final closure costs. The physical aspects of rehabilitation should be carefully monitored during the operational phase as well as during closure, so that deviations from expectation can be catered for in subsequent versions of the mine closure plan and costing. Post closure environmental inspections will focus on:

- TSF and WRD wall stability;
- Pit wall stability and water levels;
- Erosion on the waste rock dump sidewalls and upper surfaces;
- Surface and ground water quality and quantity;
- Success of establishing an indigenous vegetation cover in areas where it has been established;
- Proportion of mined land that has been fully rehabilitated;
- Any activity by the general public or persons unknown that may adversely affect the stability of disused mine structures, pose a danger to the community or possibly result in environmental degradation;
- The condition of site access roads, bridges and culverts;
- Alignment of actual final topography to agreed planned landform;
- Depth of topsoil stripped and placed;
- Chemical, physical and biological status of replaced soil;
- Community health and safety; and
- Socio-economic status of affected communities.

Consultations will be held with local community leaders to listen to and record any issues of concern pertaining to the closed mine site.

An external consultant should produce an annual post-closure environmental monitoring report at the end of years 1 and 2, and a final post closure environmental report at the end of year 5. These post closure environmental reports will be submitted to Mozambique government entities and made available to all stakeholders. The reports will present the findings of the mine site inspections/walkovers and the results of the environmental monitoring programmes. Where rehabilitation/reclamation activities have not obtained the desired result, the consultant will make recommendations on what additional reclamation work is required to
achieve full reclamation. Any areas of concern will be highlighted. The reports will include a post closure photographic record of mine reclamation.
13. CONCLUSIONS AND RECOMMENDATIONS

13.1. FULL DESCRIPTION OF THE PROCESS FOLLOWED

Grafex have proposed the development of the Ancuabe Graphite Mine Project and associated infrastructure. An Environmental Impact Assessment process was undertaken in line with the Mozambique legislative requirements for a Category ‘A’ project. The process was subjected to public participation to ensure that all interested and affected parties had sufficient opportunity to partake in this process. In order to determine the baseline and assess the identified impacts, a total of 15 specialist studies were undertaken. This collectively informed the outcome of the ESHIA, and this chapter provides a summary of the findings of the ESHIA, and a comparative assessment of the positive and negative implications of the proposed project.

This chapter provides a summary of the project impacts, the EAP’s opinion as well as the reason(s) for the opinion and recommendations should the project be authorised.

13.2. SUMMARY OF ALL IMPACTS

Without implementing mitigation measures, the key concerns relate to construction and operational impacts on flora and fauna, operational impacts on the aquatic environment and pollution of key ecological areas. As indicated in the pie charts below (Figure 13-1; 13-2; 13-3), most impacts can be reduced to an acceptable (defined as low (-) or moderate (-)) significance with the implementation of mitigation measures.

The EIA identified a total of 41 impacts that will affect the physical environment (landscape, ground water etc.), and all are negative. Before mitigation 8 are low negative; 24 are moderate negative; and 9 are high negative. After mitigation the majority of the impacts are negligible (10) or of low significance (25), with only 6 being moderate negative. This indicates that mining related impacts on the physical environment can be effectively mitigated.

The EIA identified a total of 85 impacts on the natural environment. Before mitigation, 23 impacts are low negative; 42 are moderate negative; and 21 are high negative. After mitigation the majority of the residual impacts (58 of the 86) are reduced to low negative, with 20 being moderate negative, 5 being negligible and only two of high negative. There is also one high positive impact. The two negative impacts of high significance that still remain is the loss of Miombo Woodland and the loss of Riparian Woodland. The high positive impact is the creation of a new fish resource (WSF). Thus, there are only two residual impacts of high significance.

Whilst impacts on the natural environment are usually negative, socio-economic impacts are both positive and negative, as the project creates potential socio-economic benefits. There are a total of 85 socio-economic impacts.

- However, before mitigation only 8 are positive, but after mitigation and the optimization of benefits, 24 become positive, with 8 being of high positive significance, 5 of moderate and 11 of low significance.
- In terms of the negative impacts, before mitigation the are 77, with 4 being of low negative; 51 are moderate negative; and 22 are high negative. After mitigation the majority of the impacts (39) are reduced to low negative, with only 18 being moderate negative, and 4 regarded as negligible. Importantly, there are no residual socio-economic impacts of high negative significance.
Figure 13-1: Pie chart illustrating the number of high, moderate, low negative impacts on the physical environment pre-and post mitigation.

Figure 13-2: Pie chart illustrating the number of very high, high, moderate, low negative and positive biophysical impacts pre-and post mitigation.

Figure 13-3: Pie chart illustrating the number of very high, high, moderate, low negative and positive social impacts pre-and post mitigation.
13.3. ASSUMPTIONS, UNCERTAINTIES AND GAP

This report is based on information that is currently available and, as a result, the following limitations and assumptions under which this report was compiled are implicit:

- All specialist studies are accurate and offer an unbiased opinion of the findings.
- Individual specialist assumptions are provided in the respective reports.

The assumptions and limitations specific to the specialist studies can be found in the respective specialist reports.

Due to the complex and dynamic nature of the environment, uncertainty and gaps in our knowledge are inevitable. The Precautionary Principle has been adopted to account for this uncertainty throughout the Scoping and ESHIA Phase of the proposed project. The Precautionary Principle ensures that:

- Uncertainty surrounding impacts are identified and addressed appropriately;
- Preventative measures are taken into account throughout the project;
- Various alternatives are thoroughly explored;
- Adequate and transparent public participation is conducted;
- A holistic approach is adopted to ensure social, economic and ecological impacts are explored, and mitigation measures are determined, through an integrated and balanced approach; and
- An adaptive approach is adopted to account for the complexities and dynamism inherent in environmental processes.

The Precautionary Principle ensures that potential impacts are predicted, avoided and mitigated to avoid threats of a serious or irreversible nature (IUCN, 2007).

13.4. RECOMMENDATIONS

Specialists informed the final layouts and where necessary the design was changed, and were possible infrastructure components were excluded from an ecologically sensitive area.

13.4.1. Key construction and operational phase recommendations

- Consider relocating the ROM Pad, Plant Site and Mine Services Area out of drainage line and allow for a 30m buffer.
- It is recommended that “No-Go” areas (including river reaches) within the project site and other areas over which the mine has management control, and which have been defined as sensitive, or as ecological corridors, be excluded from development in order to implement conservation enhancement measures.
- If the project receives environmental clearance to go ahead, and if rehabilitation to existing environmental condition is required, then it is imperative that linkages between conservation and graphite mining in the region are explored.
- The proposed development occurs in relatively pristine miombo woodland, where the presence of iconic threatened elephants still occur in passage, and where a relatively large number of SSC still occur, even if as vagrants. It is recommended that an ecological corridor be established between the northern riparian and mature miombo habitats and the adjacent QNP needs to allow faunal migrations, particularly of large mammals such as elephants. This will be essential for the maintenance of existing faunal diversity, and repopulation on decommissioning.
- Define suitable ecological corridors and maintain these during operation to provide ecological linkages between areas of high sensitivity.
- Appoint a qualified ecologist, familiar with both vegetation and fauna, to be on site and act as the owners team environmental control officer during the construction phase.
- Minimise clearing of vegetation during the construction phase.
- Implement dust control measures in all phases.
- Use aesthetically pleasing building design, and select roof colours that blend in.
- Use lighting systems that minimise light pollution, light spill and energy usage.
- As far as possible, avoid river drainages and small associated wetland areas.
- Develop a standard river crossing method statement that is designed to limit impacts on riparian areas and wetlands.
- Employ an environmental manager to monitor environmental impacts during the operational phase.
- Design and construct the Muaguide Dam spillway to function as a natural fishway or by-pass channel, to allow the natural upstream and downstream movement of migratory aquatic biota (especially fish) past the wall for overwintering, feeding and breeding purposes.
- Manage the Muaguide Dam so that it is able to support substantial fish populations, which can then be used as a fisheries resource, but do not stock the dam with alien fish species.
- Wherever possible, prevent or minimise production of wastes at source. Where prevention or further minimization is not possible, wastes should be re-used, recycled and then disposed of responsibly to minimise impacts to the environment.
- Locate, design and operate the non-hazardous waste landfill to international standards. This involves isolating the wastes and preventing environmental contamination, particularly groundwater contamination.
- Obtain an environmental licence for the landfill site from MITADER by ensuring that the design and site selection of the landfill site is done in accordance with Annex I of the Regulations on Waste Management, Mozambique (Decree 83/2014 of December 31st).
- Construct the landfill site in accordance with Annex I of the Regulations on Waste Management, Mozambique.
- Before the landfill facility is fully operational, all general waste produced during the construction phase must be stored on site in a secure access control area, in a legally-compliant manner that minimises environmental impacts.
- Consider alternative options for the management and disposal of hazardous wastes. These would be to either develop a dedicated and specially-designed hazardous waste cell within the new on-site landfill or, alternatively, to construct a bunded and secure facility for temporary storage of hazardous waste on site until such time as it can be transported off-site for safe disposal.
- Develop a corporate social responsibility programme and provide funds as soon after operation as possible to initiate community projects. Projects requiring land-take must be established in degraded areas in close proximity to villages, and not in indigenous woodland.
- Develop a Resettlement Action Plan (RAP).
- Assist with the replacement of arable land parcels that are lost due to the mining project, as detailed in the Resettlement Action Plan (RAP).
- Ensure that the identification of replacement land considers the ecological sensitivity of the replacement sites.
- Ensure that no rock, silt, cement, grout, asphalt, petroleum product, timber, vegetation, domestic waste or any deleterious substance disperses into any river, wetland and/or lake.
- Ensure that wash water does not disperse directly into natural wet areas, unless it is safe to do so and that its discharge meets the required water quality standards.
- Ensure any potentially hazardous materials are kept out of the rain to control contaminated runoff at source.
- Place dustbins and recycling receptacles around the site to minimise litter.
- Clean up leaks, drips and other spills immediately to prevent contamination.
- Regularly maintain all vehicles and machinery to ensure they are free of leaks from oil, fuel or hydraulic fuels.
- Designate a contained area for vehicle parking, vehicle refuelling and routine equipment maintenance, away from wet areas and ensure the site has a hard surface, a berm or an oil trap.
- Minimise the need for trucks to reverse and activate their reverse sirens.
- Maintain road surfaces to avoid corrugations and potholes.
- Install road signs to control traffic speed and to provide other useful notifications and warnings.
- Avoid the delivery of material and product transport at night.
- Avoid the formation of convoys.
- Transport of abnormal loads should be arranged with the relevant traffic authorities.
- Ensure that drivers’ delivery schedules do not result in fatigue, speeding and safety risks.
- Ensure that mine vehicles are not overloaded.
- When designing roads, avoid need for excessive acceleration and deceleration by minimising slopes.
- In the event that Grafex provide community boreholes, this water will need to be treated before consumption.
- The water supplied by the camp borehole ANWB02 should be treated before human consumption, as chemical constituents exceed the WHO 2011 standards in all water samples.
- Ground water and surface water sites that exceeded the SANS 241-2015 or the WHO 2011 fourth edition standards should be re-sampled and re-tested by an accredited laboratory before the water can be deemed as safe for human consumption.
- A baseline microbiological study should also be conducted on both ground water and surface water sites to improve the accreditation of the baseline study for future reference.
- The Mozambican and IAEA requirements should be evaluated to determine whether the site should be screened for radiological requirements.
- The monitoring program needs to be honoured to effectively detect and mitigate any contaminant migration in the subsurface aquifer systems.
- Additional shallow and deep boreholes should be drilled downstream of the TSF and WRD’s to monitor any possible seepage from these facilities.
- Pump tests should be conducted on the newly drilled monitoring boreholes surrounding the project area to determine local and site specific aquifer parameters, as well as the sustainability of the boreholes.
- Data loggers should be installed in specific ground water sites to understand temporal trends as well as rainfall, runoff and recharge relationships to further develop the site water model.
- Site specific rainfall and evaporation data should be determined.
- It is recommended that mitigation measures at the TSF be focussed on the capturing of toe seepage and to limit the migration of the small amount of seepage likely to seep into the subsurface. The establishment of a seepage system should be considered in the operational phase with the long term view of post-closure.
- The numerical ground water and mass transport model should be updated as soon as aquifer parameters are determined and after that every two years.
- Drilling in the alluvium deposit should not be considered as the only possible ground water source for mining operations with geophysical results indicating the possibility of intersecting the deep hard rock fractured aquifer system. At least five to six drilling positions to explore this possible resource could be considered, especially the geological structures that targeted the regional structures as indicated on the regional geology map (TT11 and TT10). These boreholes will have to be drilled to at least 100 meters below ground level with diameters similar to the alluvium boreholes.
- An area extending down gradient from the Mogido River could be considered as a possible drilling area for ground water exploration. Proposed drilling positions are indicated according to geophysical results as well as possible geological structures that might intersect the Mogido River. These boreholes can be drilled to 50 meters
below ground level and depending on the ground water potential, range in diameter from six inch to eight inch. It will be important to perform pump testing on these boreholes to evaluate ground water potential and sustainable abstraction.

- A detailed surface water study should be completed to estimate and quantify the surface run-off and surface flow potential that will arise from the mine developments and infrastructure during drought and flooding conditions.

### 13.4.2. Recommended Management Plans and Programmes

- It is highly recommended that a **Biodiversity Offset Management Plan** be designed and implemented in conjunction with key stakeholders and the authorities. This will be in keeping with best practice standards set out by Performance Standard 6 of the IFC, which requires developers to mitigate the loss of natural habitat with like-for-like offsets. The *National Biodiversity Offset System: A Road Map for Mozambique* (2016) are a set of guidelines that assist developers with implementing biodiversity offsets in Mozambique.

- It is recommended that a **Biodiversity Management Plan** is developed and implemented. This plan should include:
  - An alien management plan to identify and remove alien species when encountered,
  - Conservation Management Plan: including implementation of set aside areas, ecological corridors and ecological support areas for preservation.
  - Search and rescue plan for species of conservation concern.

- **Animal-Human Conflict Management Plan**

- Develop a **Closure Plan**, incorporating a **Rehabilitation Management Plan**.

- **Construction Environmental Management Plan** (CEMP)

- **Operational Environmental Management Plan** (OEMP)

- It is recommended that a **Monitoring Programme** is implemented to obtain a more detailed baseline of:
  - Surface water and groundwater quality monitoring to include physico-chemical constituents and biomonitoring of the aquatic ecology
  - Dust fallout sampling and PM$_{10}$ levels at the project boundary in four main wind directions.
  - PM$_{10}$ and NO$_2$ sampling at the closest sensitive receptor locations, possibly along the Site Access road. Short term sampling campaigns must be undertaken at these locations, and at least annually during the operational phase.
  - The presence and the rate of vegetation clearing, especially during the planting season.

- **Labour Recruitment and Influx Management Plan** (LRIMP)

- **Stakeholder Engagement Plan** (SEP)

- **Resettlement Action Plan** (RAP) and **Livelihood Restoration Plan** (LRP)

- **Social Development Plan** (SDP)

- **Chance Find Procedure** (including a Grave Relocation Plan)

- **Community Health and Safety Plan** (CHSP)

- **Influx Management Plan**

- **Health and Safety Management Programme** (CHSMP), based on a MoU between the proponent and the local health authorities, to ensure that the mine does not become the de facto healthcare provider in the area. Include a Community Health Monitoring Programme and a nutritional monitoring programme.

- **Traffic management plan**

- **Emergency Preparedness and Response Plan**

- **Code of Conduct**

- **Integrated Waste Management Plan** to manage all waste streams according to the waste management hierarchy and the Regulation on the Management of Municipal

13.4.3. Environmental practitioner opinion on whether the project should be authorised

It is the opinion of the EAP that provided the above recommendations are agreed to, and that they will be implemented by the developer through the establishment of the recommended plans and programmes listed above, the impacts resulting from the project are an acceptable trade-off between the socio-economic gain from the development, and the loss of natural assets.

The decision to recommend that the proposed development proceed was based on the following:

Mine
- The loss of high sensitivity Miombo Woodland and Riparian Woodland and habitat associated faunal species, cannot be avoided, minimise or mitigated and thus requires a like-for-like biodiversity offset.
- There is an opportunity to maintain existing faunal diversity while allowing for repopulation after decommissioning, by creating ecological corridors between the northern riparian and mature miombo habitats and the adjacent QNP.
- The border of the Quirimbas National Park lies 9.6km from the project area. Only very small patches of the Quirimbas National Park will have views of the mine. Combined with the distance from the mine infrastructure, the impact on this park is negligible.
- The impact on ground and surface water quality can be adequately mitigated by managing construction and operational activities to prevent erosion, sedimentation, pollution and acid mine drainage.
- AMD can be reduced to industry standard acceptable levels through appropriate mitigation measures

Water Storage Facility
- The construction of the dam will be done in the dry season and will not alter the flow of the river.
- In the worst-case scenario flow regime the flow downstream of the dam wall will be reduced from a six-month to a four month period. However, the volumes of flow during the four months are close to - between 64% and 92% of - the pre-dam volumes. In a normal year the flow downstream of the dam wall will be reduced from a six-month to a five month period. The impact of the proposed dam on the hydrology of the Muaguide River is thus anticipated to be low.
- The spatial extent of the dam will be limited to the reach of river between the dam wall and the Muaguide / Namuta confluence, some 2 km downstream of the wall.
- Vertebrate fauna and fish diversity will be maintained and even improved by the provision of a permanent water source at the dam.
- The construction and operation of the water storage facility will alter existing stream characteristics, thereby altering stream habitats and consequently aquatic species composition of the receiving streams, but these alterations are deemed acceptable.

General
- All recommendations in the ESHIA report are detailed in an Environmental and Social Management Programme (ESMP) which provides the environmental framework to govern actions to be taken during all phases of the project to mitigate negative social and environment impacts. It also provides detail on the management tools that will be required to bring about effective management of the environment throughout the life of the project, and the human resources required to achieve this. The monitoring
requirements for the project, to ensure that the mitigation measures proposed during the ESHIA are effectively undertaken, are also presented.

No-go project scenario

Under the “no-go" or no project scenario, the current disturbance caused by the local communities, which include artisanal mining, natural resource use, charcoaling and timber extraction will remain, and may even expand, resulting in more disturbed areas and fragmentation. Given the greenfields status of this area the no-go option is considered to of a lower impact than that of the proposed mine. However, the mine may offer some protection to the existing site, and even the creation of new habitats, thereby increasing biodiversity.

In addition to the above, no socio-economic benefits would accrue to the nearby communities and the government. If the proposed project is not implemented benefits such as the opportunity to increase revenue at local and regional levels, as well as the creation of employment will be lost, resulting in unimproved living conditions for the population in the project area. Furthermore, if the project is not implemented, the opportunities for growth and improved quality of life associated with the proposed social programmes will decrease, as will the secondary impacts that stem from higher income earnings (such as support for local businesses).

The social and ecological benefits of the proposed project outweigh the potential negative ecological impacts, and thus the “no-go" option in this case is considered to be detrimental to affected communities within the projects area of influence.

13.4.4. Project description and conditions to be included in the EA

- It is also suggested that the recommendations made in ESMPr be made a condition of approval.
- The exploration sites that do not form part of the mining project must be rehabilitated to their natural state.
- A Biodiversity Offset must be implemented.
- Micro siting and ground truthing required for:
  - Onsite borrow pit
  - Pylon placement within the haul road and powerline corridor
  - Haul road placement within the haul road and powerline corridor
  - Lay down areas
- This ESHIA does not include a pipeline or PV Power station

13.5. CONCLUSION

The proposed project has the ability to increase the economic growth and employment opportunities for the local communities and add to livelihood diversification and stability. Furthermore, the project will generate tax and revenue for the government. The implementation of the project will increase the economic productivity of the area through:

- Hiring local resources to both build and work on the mine site;
- Aligning project objectives with national legal requirements that will in turn generate tax and royalty revenues for the government; and
- Increase household economic dependency through the multiplier effects which will be generated from the proposed project.

However, from a biophysical perspective, if not properly managed, the project could negatively impact the environment through the loss of plant and animal species, habitat fragmentation and the pollution of land and water resources. With the implementation of the suggested mitigation measures and continued monitoring, these impacts can be reduced to acceptable levels.
13.6.  THE WAY FORWARD

All stakeholder included in the database will be notified of the release of the draft EIR, ESMPr and specialist reports for a period of 30 days. These stakeholders will be notified 15 days prior to the public meetings, which will be held during the public review period at each village and at the District of Ancuabe.

Following public review, the Draft ESHIA, together with the Public Participation Report, Specialist reports and the ESMPr, will be updated as necessary and finalised, by incorporating any comments received. It will then be submitted to MITADER for decision-making. Upon thorough examination of the Final ESHIA, the authority will issue a decision which either accepts or rejects the report. Should the ESHIA be accepted the authority will then issue an environmental license which will either grant (positive) environmental authorisation or not grant (negative) authorisation. Should an Environmental License be granted, it usually carries Conditions of Approval. The applicant is legally obliged to adhere to these conditions.
REFERENCES


Coastal & Environmental Services, April 2017, Grafex Ancuabe Graphite Mine Project Draft Environmental Prefeasibility Scoping Study and Terms of Reference, CES, Cape Town


pers. comm. Roger Bills, fish taxonomist, SAIAB, August 2015


APPENDIX A: CATEGORIZATION LETTER

REPÚBLICA DE MOÇAMBIQUE
GOVERNO DA PROVÍNCIA DE CABO DELGADO
Direção Provincial da Terra, Ambiente e Desenvolvimento Rural
Departamento do Ambiental

À:
GRAFEX, LDA

N. Ref: 551/DPTADR/CD/DA/200/17
Pemba, 14 de Julho de 2017

Assunto: Instrução do Processo de Mineração de grafite, no Distrito de Ancuabe

Exmos Senhores,

Em resposta ao requerimento que V. Excis já nos endereçaram a 03 de Julho do ano corrente, através do qual solicitam que lhes seja instruído um processo de Avaliação do Impacto Ambiental do projecto acima mencionado, uma equipa técnica desta Direcção deslocou-se ao local, em harmonia com o previsto no artigo 8, do Decreto nº 54/2015, de 31 de Dezembro (Regr.amento sobre o Processo de Avaliação Ambiental).

Após a realização da pré-avaliação ao referido local, segundo o disposto no número 2, do artigo 8, do Decreto nº 54/2015, de 31 de Dezembro (Regr.amento sobre o Processo de Avaliação Ambiental), a actividade em questão é classificada como de Categoria “A”, e para o seu Licenciamento Ambiental, V. Excis deverão submeter ao Estudo do Impacto Ambiental (EIA) do projecto à Direcção Nacional de Avaliação do Impacto Ambiental (MITADER, Maputo), anexado pelos EFA e TdE, em 6 cópias impressas a cores e 01 versão electrónica; enquanto para esta DITADER deverão enviar 02 cópias impressas e 01 em versão electrónica de acordo com o Decreto acima mencionado.

Assim sendo, o estudo deverá ser acompanhado por duas consultas públicas (uma na comunidade afectada e, a outra na Sede do Distrito), respeitando o previsto no número 1, do artigo 48, da Constituição da República de Moçambique.

Sem mais assunto de momento, apresentamos a V. Excis, os nossos melhores cumprimentos.

[Assinatura]

Rua Jerónimo Romero No 51 – Tel/Fax: +258 272 203 53 – Pemba
APPENDIX B: EPDA ACCEPTANCE LETTER

Assunto: Relatório de Revisão do Estudo de Pré-viabilidade Ambiental e Definição do Âmbito (EPDA) e Termos de Referência TdR do Projecto de Mineração de Grafite em Ancuabe, na Província de Cabo-Delgado

1. Introdução

O projecto acima mencionado, submetido à Direcção Nacional do Ambiente (DINAB) para apreciação e tomada de decisão, localiza-se no Distrito de Ancuabe, na Província de Cabo-Delgado. O proponente do projecto é a empresa Moçambicana Grafex, sendo esta subsidiária da Triton, uma companhia de exploração de minerais diversificados. O projecto pretende desenvolver uma mina de grafite e uma planta de processamento para produzir concentrado de grafite de alta pureza. Actualmente a empresa é detentora de três licenças nomeadamente EL5305, EL5336, EL5380 numa área de 63 535 hectares.

2. Formação da equipa de revisão do EPDA e TdR

Para a revisão do projecto constituiu-se a respectiva Comissão Técnica de Avaliação composta pelas seguintes instituições: (i) Ministério da Terra, Ambiente e Desenvolvimento Rural (Direcção Nacional do Ambiente, Direcção Nacional de Terras, Direcção Nacional de Florestas e Direcção Provincial de Terra, Ambiente e Desenvolvimento Rural de Cabo-Delgado); (ii) Ministério da Saúde (Direcção Nacional de Saúde Pública) e (iii) Ministério dos Recursos Minerais e Energia (Direcção Nacional de Geologia e Minas).

3. Contexto de realização do EPDA e TdR

O presente estudo foi realizado na fase preliminar da actividade.

4. Participação Pública

O EPDA e TdR apresentam informação referente à Consulta Pública realizada no Distrito de Ancuabe.

5. Avaliação da equipa de consultores responsável pelo EPDA e TdR

O EPDA e TdR foram elaborados pela Empresa de Consultoria Ambiental Coastal Environmental Services (CES) registada pelo MITADER de acordo com o Decreto 54/2015, de 31 de Dezembro.
6. Comunicação dos Resultados

O EPDA e TdR cumprem com o legislado no artigo 10 do Regulamento sobre o Processo de Avaliação do Impacto Ambiental, aprovado pelo Decreto 54/2015 de 31 de Dezembro.

7. Comentários

1. No Resumo Não Técnico, nos riscos socio-econômicos associados ao projecto, anexo V, faz-se menção que poderá ser necessário algum reassentamento, mesmo que este seja limitado, o documento não faz menção ao número de famílias e das machambas que poderão ser afectadas pelo projecto;

2. Nas páginas 67 a 75 foram identificados e avaliados todos os impactos ambientais dos riscos biológicos, sociais e de planeamento, no entanto no documento não se especificou se estes impactos irão decorrer na fase de construção, operação ou desativação;

3. Alguns acrónimos usados no documento não constam na respectiva lista como AAE e SSMA;

4. Na pág. 49, no capítulo sobre Geologia e solos, o proponente apresenta um esboço geológico que não ilustra a legenda da geologia local, bem como, os complexos e unidades geológicas e a classificação dos solos da área de estudo.

8. Conclusões e recomendações

O presente estudo fornece informação suficiente para a tomada de uma decisão favorável à sua aprovação. Contudo, para o REIA recomenda-se:

1. A observância do Regulamento sobre o Processo de Avaliação do Impacto Ambiental, aprovado pelo Decreto nº 54/2015, de 31 de Dezembro;

2. A descrição dos impactos negativos e respectivas medidas de mitigação nas fases de construção, operação e desativação do projecto;

3. A inclusão da legenda da geologia detalhada da área de estudo;

4. A inclusão de todos os acrónimos na lista de abreviaturas/acrónimos;

5. A apresentação dos principais impactos na saúde dos trabalhadores e da comunidade circunvizinha derivada pelas acções do projecto e as principais medidas de mitigação.
6. A descrição detalhada das condições de armazenamento dos materiais a serem usados;

7. A descrição detalhada das medidas de mitigação que serão tomadas de modo a controlar as poeiras e o ruído;

8. A apresentação do plano de contingência de derrames de óleos lubrificantes e combustíveis;

9. A indicação da quantidade de mão-de-obra, destacando o número de mulheres e homens que a mina irá contratar, sua origem, período de início de mobilização e necessidades de formação;

10. A concepção e apresentação de um sistema de gestão de resíduos sólidos e outros detritos de modo a assegurar que estes não constituam focos de contaminação da água da região entre outros impactos na saúde pública;

11. O levantamento actualizado das famílias e benfeitorias a serem afectadas pelo projecto;

12. A indicação do processo de tratamento das águas residuais resultantes do processamento do minério;

13. A apresentação de procedimentos para a gestão dos estaleiros durante a fase de construção da mina, incluindo a sua desactivação;

14. A realização das reuniões de consulta pública na fase do Estudo de Impacto Ambiental (EIA) envolvendo a DINAB e outros sectores chave, de acordo com o preconizado no Decreto 54/2015 de 31 de Dezembro e com base no Diploma Ministerial nº 130/20016, de 19 de Julho, Directiva Geral para o Processo de Participação Pública;

15. A apresentação de forma detalhada, do sistema de gestão ambiental integrado que inclua os planos chaves nomeadamente: (i) Plano de Gestão Ambiental (todo o sistema de controlo ambiental), (ii) Plano de Emergência, de Segurança Técnica e de Saúde Ocupacional; e (iii) Plano de Encerramento e Reabilitação da Minha e sua respectiva planilha de custo, observando o preconizado na legislação aplicável;

16. A apresentação do valor total de investimento do projecto e respectiva planilha de custos, contendo no mínimo a seguinte informação:

- Lista nominal do equipamento e máquinas previstos para o projecto e seu respectivo custo;
• Construções;
• Equipamento de climatização;
• Mobiliário, equipamento de escritório;
• Quantidade de Equipamento de Protecção Individual e Colectiva;
• Material e equipamento de segurança e outro equipamento adicional necessário.

Os itens acima referidos devem ser apresentados de forma diferenciada, indicando os custos de aquisição directa e/ou custos de arrendamento ou aluguer. Esta informação será objecto de vistoria no âmbito da emissão da Licença Ambiental de Operação.

17. A avaliação do destino/usos da mina após a desactivação do Projecto, tendo em conta o desenvolvimento da Cidade de Pemba e da Província de Cabo Delgado no geral;

18. A apresentação dos Projectos de responsabilidade social da empresa.

A equipa técnica de coordenação da revisão:

/Nilza Racune
Quimica/Biologia

Bento Natal
Geógrafo

Rosalina Niquice
Engª Agrónoma
## APPENDIX C: RESPONSE TO EPDA ACCEPTANCE LETTER

<table>
<thead>
<tr>
<th>Comments</th>
<th>MITADER</th>
<th>CES RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7.1</strong></td>
<td>In the non-technical summary, in the section about socio-economic risks associated with the project, Annex V, it is mentioned that some kind of resettlement may be necessary, even if it is limited, the document does not mention the number of families and <em>machambas</em> (plantation fields) that may end up being affected by the project.</td>
<td>The Resettlement Action Plan currently underway will ensure an accurate survey of project affected families refer to ESHIA section 3.8.16</td>
</tr>
<tr>
<td><strong>7.2</strong></td>
<td>On pages 67 to 75, all environmental impacts of biological, social and planning risks were identified and assessed, however it is not specified in the document if these impacts will occur during the construction, operation or deactivation phase.</td>
<td>All impacts are presented for each category Biological, physical and social per construction, operation or deactivation phase</td>
</tr>
<tr>
<td><strong>7.3</strong></td>
<td>Some acronyms used in the document are not in the respective list, such as AAE and SSMA.</td>
<td>Corrected as follows: AAE = Strategic Environmental Assessment (SEA) SSMA = Environmental Health and Safety (EHS)</td>
</tr>
<tr>
<td><strong>7.4</strong></td>
<td>On page 49, in the chapter on geology and soils, the proponent presents a geological sketch that does not illustrate the legend of the local geology nor the geological complexes and units and the classification of the soils of the study area.</td>
<td>Included refer to ESHIA Chapter 11, Section 11.2.1, Figure 11.1</td>
</tr>
</tbody>
</table>

### 8. MITADER Conclusions and Recommendations

1. The observance of the Regulation on the respective measures of mitigation of the Environmental Impact, approved by the Decree nº 54/2015, of 31 of December. All mitigation measures are specified in the ESMPr in Chapter 8.

2. The description of the negative impacts and respective mitigation measures in the phases of construction, operation and deactivation of the project. All impacts are discussed in the respective specialist and the ESHIA:
   - Key physical impacts Chapter 7 pg. 71-77
   - Key biological impacts Chapter 8 pg. 78-92
   - Key Socio-economic impacts Chapter 9 pg. 97-106
   - Cumulative Impacts Chapter 10 pg. 107-113

All mitigation measures are specified in the ESMPr in Chapter 8 as follows:
   - Design & Construction Phase Mitigation Measures Section 8.3.1 pg36
   - Operational Phase Mitigation Measures Section 8.3.2 pg47
   - Decommissioning Phase Mitigation Measures Section 8.3.3 pg. 56

3. The inclusion of the legend of the detailed geology of the study area. Included refer to ESHIA Chapter 11, Section 11.2.1, Figure 11.1
<table>
<thead>
<tr>
<th></th>
<th>The inclusion of all acronyms in the list of abbreviations / acronyms</th>
<th>See List of Acronyms pg. ii</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>The presentation of the main impacts on the health of workers and the surrounding community derived from the project actions and the main mitigation measures</td>
<td>Impacts on health are presented in the ESHIA Chapter 9, Section 9.2.2 pg. 99 and the Health Impact Assessment the relevant mitigation measures are outlined in the Health impact Assessment and ESMPr Chapter 8</td>
</tr>
</tbody>
</table>
| 6. | A detailed description of the storage conditions of the materials to be used | Description of the Fuel storage areas and a fueling station can be found in the ESHIA Section 3.8.3 and the Mine explosive storage facility in the ESHIA Section 3.8.4. The ESMPr prescribes the storage conditions required for all materials onsite, these can be found under the mitigation measures for each phase; for example:  
  • all chemicals, fuel and hydrocarbons must be stored in a bunded area.  
  • bulk storage of flammable liquids, including fuels, must be designed and operated according to international BPEO  
  • The compatibility of chemicals must be confirmed prior to storage and signage showing the chemical names and hazardous properties of the chemicals should be visible in the designated temporary storage area; ETC. |
| 7. | A detailed description of the mitigation measures to be taken to control dust and noise | The ESMPr prescribes the mitigation requirements to control dust and noise and can be found under each source of noise and dust generating impact per each phase in Chapter 8 of the ESMPr |
| 8. | Presentation of the contingency plan for lubricant and fuel oil spills | The ESMPr states the requirement for Grafex to develop an Emergency Preparedness and Response Plan which caters for dealing with lubricant and fuel oil spills. |
| 9. | Indication of the quantity of labor, highlighting the number of women and men that the mine will contract, its origin, period of initiation of mobilization and training needs | Refer to employment opportunities Section 3.8.14 of the ESHIA.  
  Grafex response: There is no specific gender split as that will be driven by the local communities when they apply for positions. However, all contractors are being advised that while no quotas will be set initially, if they are not proactively employing women where possible, a quota will be imposed. |
| 10. | The design and presentation of a system for the management of solid wastes and other debris in order to assure that these were not sources of contamination of the water of the region among other impacts on public health | Refer to the ESHIA Section 3.8.12 on the Waste and Chapter 8 of the ESMPr as well as the Waste Impact Assessment. |
| 11. | An updated survey of families and improvements to be affected by the project | An updated survey was conducted and reported on in the:  
  • Social Impact Assessment,  
  • Summarized in the ESHIA section 5.1.1 |
## Environmental, Social and Health Impact Assessment

### Ancuabe Graphite Project

- The Resettlement Action Plan currently underway will ensure an accurate survey of project affected families refer to ESHIA section 3.8.16.

The improvements offer by the project are detailed in the ESHIA Chapter 3: Project Description specifically:
- Access to the Raw water dam section 3.8.1.1
- Employment opportunity section 3.8.14
- Corporate Social responsibility Section 3.8.15

### 12. Indication of the waste water treatment process resulting from the processing of the ore

The waste water from the processing plant will be treated at the process water dam (ESHIA Section 3.7.3.1) as well as the pollution control and sediment control structures (ESHIA Section 3.8.12).

### 13. The presentation of procedures for the management of the shipyards during the construction phase of the mine, including its deactivation

Please refer to the Traffic and Transport specialist study and impact assessment.

### 14. The implementation of the consultation meetings publishes the Environmental Impact Study (EIA) phase involving DINAB and other key sectors according to the pre-set in Decree 54/2015 of December and based on Ministerial Diploma 130/2016, 19 of July, Directiva Geral for the Process of Public Participation

Noted, this will be done.

### 15. The presentation of the Integrated Environmental Management System, which includes the chastity plans, namely:

(i) Environmental Management Plan (the entire Environmental Control System);

(ii) Emergency, Technical Safety and Occupational Health Plan; and

(iii) Mine Closure and Rehabilitation Plan and its respective cost sheet, in compliance with the applicable legislation

(i) Please refer to the ESMPr

(ii) The ESMPr states the requirement for Grafex to develop an:
   a. Emergency Preparedness and Response Plan;
   b. Occupational Health and Safety Plan; and an
   c. Occupational Health and Safety Monitoring (ESMPr Section 10.5)

(iii) Please refer to the Mine Decommissioning and Closure Report in the annex to the ESMPr

### 16. The presentation of the total investment value of the project and its respective worksheet, contain at least the following information:

- Nominal list of the equipment and machines provided for the project and their respective cost;
- Constructions;
- Air conditioning equipment;
- Furniture, office equipment;
- Quantity of Individual and Collective Protection Equipment;

Please refer to the attached letter from Grafex Lda.
- Safety equipment and equipment and other necessary equipment. The above items should be presented in a differentiated manner, indicating the costs of direct procurement and/or rental or rental costs. This information will be inspected in the ambit of the issuance of the Environmental Operating License.

17. The evaluation of the destination/use of the mine after the project's decommissioning, taking into account the development of the City of Pemba and the Province of Cabo Delgado in general

Please refer to the *Mine Decommissioning and Closure Report* in the annex to the ESMPr

18. The presentation of the projects of social responsibility of the company

The improvements offer by the project are detailed in the ESHIA Chapter 3: Project Description Section 3.8.15 Corporate Social responsibility
Aos:
Ministerio da Terra, Ambiente e Desenvolvimento Rural
Gabinete do Ministro
Rua de Kassuende, N.º 167, C.P. 2020
Maputo
Moçambique

Data: 22.01.2018

Exmo Srs.,

Re: Response to EPDA approval dated 22 December 2017

We refer to MITADER’s request for the following information:

“The presentation of the total investment value of the project and its respective worksheet, contain at least the following information;

- Nominal list of the equipment and machines provided for the project and their respective cost;
- Constructions;
- Air conditioning equipment;
- Furniture, office equipment;
- Quantity of Individual and Collective Protection Equipment;
- Safety equipment and equipment and other necessary equipment.

The above items should be presented in a differentiated manner, indicating the costs of direct procurement and/or rental or rental costs. This information will be inspected in the ambit of the issuance of the Environmental Operating License.”

As per the Mining Concession submission, which was submitted to INAMI on 17 November 2017, the following information is available:

Within the submission the major equipment and it cost excluding freight etc. is included as attachment 1. The capital cost for the project is shown below.

### Tabela 1: Estimativa da Capital Inicial do Projecto

<table>
<thead>
<tr>
<th>Área</th>
<th>Valor (US$M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central de Processo</td>
<td></td>
</tr>
<tr>
<td>Área 101 – Britagem</td>
<td>4,82</td>
</tr>
<tr>
<td>Área 102 – Trituração e Classificação</td>
<td>5,32</td>
</tr>
<tr>
<td>Área 103/4/5 – Flutuação mais grossa e Flutuação mais limpa</td>
<td>9,21</td>
</tr>
<tr>
<td>Área 106 – Resíduos e Retorno de Decante</td>
<td>1,86</td>
</tr>
<tr>
<td>Área 107 – Desagamento do Concentrado (Filtrar, Secar)</td>
<td>3,00</td>
</tr>
<tr>
<td>Área 107 – Seleccão e Embalagem de Concentrado</td>
<td>6,40</td>
</tr>
</tbody>
</table>
Air conditioning equipment is not separated from the equipment to which it is related and is not able to be quantified at this stage. However, it is expected that the offices and laboratory will be air conditioned, as will the motor control centres. Some accommodation may be air conditioned.

Furniture and office equipment are not specified and the costs are included in the operating costs. They are not able to be separated from the other costs which are included as one number as this is a contract.

The personal protective equipment (PPE) has not been itemised and is identified as an allowance within the personnel costs where it is associated with Grafex direct costs, and not reported separately by the contractors which Grafex will engage.

The PPE for individuals is expected to include similar equipment that Grafex already issues to the people who work on the project: safety glasses, trousers, boots, and long-sleeved...
shirts. Additional PPE which will be required and issued during construction includes hearing protection and hard hats. For specialist roles additional PPE will be issued as required.

We appreciate the questions raised by MITADER and look forwards to progressing the ESHIA with MITADER.

Gidilão Mbanze  
Gestor do Projecto / Project Manager  
Grafex Lda  
Telephone numbers: +25882309604/+258877960361/+258843756599  
Email: gmbanze@grafexlda.com
## Attachment 1: Key equipment list and supply cost

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Uninstalled Supply Capital Costs USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crushing circuit</td>
<td>4,200,000</td>
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<tr>
<td>Rod Mill</td>
<td>1,977,776</td>
</tr>
<tr>
<td>Flotation cells</td>
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</tr>
<tr>
<td>Roughers 576.600</td>
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<tr>
<td>Cleaner 1 194.250</td>
<td></td>
</tr>
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<td>Cleaner 2 194.250</td>
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<td>Cleaner 3 194.250</td>
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<td>Cl 2 con 367.500</td>
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<tr>
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<tr>
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<td>Bagging facility</td>
<td>3,543,460</td>
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<tr>
<td>Power station</td>
<td>7,160,107</td>
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<tr>
<td>Fuel storage</td>
<td>737,958</td>
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