SYRAH RESOURCES BALAMA GRAPHITE PROJECT
MOZAMBIQUE

FINAL

WASTE AND WASTEWATER ASSESSMENT REPORT

PREPARED BY	PREPARED FOR
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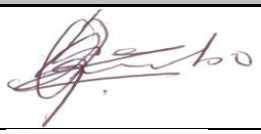
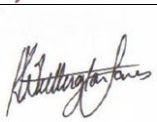
Lead Author	*Dr Eric Igbinigie e.igbinigie@cesnet.co.za*		
Reviewer	*Dr Kevin Whittington-Jones k.whittington-jones@cesnet.co.za*		
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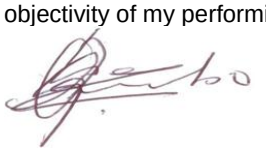
DECLARATION OF INDEPENDENCE

I **ERIC IGBINIGIE, PhD** declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed project, in application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.



SIGNATURE:

I **KEVIN WHITTINGTON-JONES, PhD** declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed project, in application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

SIGNATURE:

EXECUTIVE SUMMARY

Project Background

Coastal and Environmental Services (CES) was contracted by Syrah Resources Ltd. to prepare a waste management assessment report for Syrah Resources Graphite mine proposed to be constructed and operate on a 30 km^2 (3000 hectares) of land in the Cabo Delgado province in the District of Namuno of northern Mozambique. The proposed site is approximately 7 km away from the town of Balama and 265 km by road west of the port town of Pemba, a deep water container port, which is the third largest port in Mozambique. Syrah Resources Ltd currently holds a 106 km^2 (106000 hectares) Prospecting License in the Cabo Delgado province in the District.

In order to assess the likely significance of impacts associated with the management of waste streams from the proposed development and to make recommendations regarding the management of these waste streams, it was necessary to consider the biophysical context of the project as well as the current legal framework and institutional capacity relating to management of wastes in Mozambique and, as far as possible, the project area.

Terms of Reference

The purpose of this study was to assess potential environmental impacts and recommend appropriate management strategies for the various solid and liquid waste streams likely to be associated with the proposed Syrah Graphite mine Mozambique. The specific Terms of Reference included:

a) Compile an inventory (identify, describe and, where possible, quantify) of the various waste streams to be generated by the project. This did not include the analysis of solid waste samples.
b) Briefly describe the processes giving rise to the waste streams and the anticipated volumes and tonnages of waste streams.
c) Identify and describe the possible impacts of any solid and liquid wastes on the quality of surface and groundwater.
d) Provide recommendations on the most feasible options for the disposal of solid and liquid wastes.
e) Describe the nature of hazardous waste likely to be associated with the project, paying particular attention to any material that might be regarded as radioactive, and make recommendations for the disposal and/or recycling of these materials.
f) Relate levels of any potentially toxic waste to recognised international standards, and ensure that any waste management strategy is in line with these standards.

Assumptions and Limitations

Much of the information regarding the proposed development and quantitative data relating to waste streams on which this report was based was provided by the Client. While every effort was made to verify the information, it was assumed that it was correct and valid.

Due to the remote location of the mine site, general (non-hazardous) waste from the development will probably be disposed of at a new general landfill site that will be constructed in the area. The size and location of this facility is currently unknown. The scope of this report does not include impacts or guidance related to the design, construction and operation of the landfill site or the application for permit(s) that may be required to operate the landfill site. Key impacts associated with the establishment of a new landfill site within or outside the project boundary are likely to relate primarily to water resources and air quality but are not assessed in this report.

This specialist report was subject to the following additional assumptions and limitations:

- The specialist team did not visit the proposed project site. As such, all project-specific information was based on information supplied by client and was assumed to be accurate.

- Estimates were provided on expected quantities of process waste and effluent streams.
- The impacts to air quality associated with the proposed mine are not covered but assessed in a separate air quality specialist report.
- The study assumes product transportation to port (including road transport, storage at port and ship loading and shipping requirement) will be contracted to a third party.

Approach

Prior to the assessment of the likely environmental impacts associated with the management of the various waste streams, it was necessary to understand the context of the operation. This included a review of the bio-physical and social context, the institutional capacity, legal framework and waste management infrastructure. Key legislation and international agreements and standards relevant to waste management for the Syrah mining development include the following documents:

- Constitution of the Republic of Mozambique (2004)
- Environmental Act (Law 20/97) (1997)
- National Environmental Management Programme (1995)
- Regulation on Environmental Quality Standards and Effluent Emission Decree No. 18/2004 as amended by the Decree No. 67/2010
- Regulation on the process of EIA Decree No. 45/2004 as amended by Decree 42 of 2008
- Regulation on the Environmental Audit process Decree No. 32/2003
- Regulations on Waste Management, Decree No. 13/2006
- Regulation on the Management of Bio-Medical Waste Decree No. 8/2003
- Stockholm Convention (acceded in 23rd of May, 2001)
- Basel Convention (acceded on the 13th of March, 1997)
- Bamako Convention (acceded on 5th February, 1999)
- African Development Bank Guidelines for Mining (1995)
- IFC Performance Standards on Environmental and Social Sustainability (2012)
- IFC General Environmental, Health and Safety Guidelines (2007)
- IFC EHS Guidelines for Mining (2007)

Information regarding the process, expected waste volumes and properties of the wastes was obtained directly from the client. Additional information was obtained from relevant reference sources. A life cycle assessment approach with a limited spatial scope was used to identify all key waste streams associated with the proposed project. The assessment covered waste streams during the construction, operation and decommissioning phases but excluding transportation of product to the port at Pemba and all port related activities.

For the purposes of this report, waste streams generated during the operation phase have been defined as either process wastes or non-process wastes. The former may be defined as any liquid or solid wastes generated directly as a result of the core process while non-process wastes refer to those wastes that are generated from auxiliary operations or services. It is likely that the process and non-process waste streams will include both hazardous and general (non-hazardous) wastes.

A standardised impact assessment methodology was applied to assess the significance, both positive and negative, associated with the management of waste streams from the proposed development.

Results and conclusions

A review of relevant legislation and policy documents suggested that waste management in Mozambique is still in its infancy. Waste management infrastructure for the safe management of wastes 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.

A total of 15 impacts were identified and of these, with mitigation, 11 were considered to be of LOW negative significance and three of MODERATE negative significance. One impact was considered beneficial and of Moderate significance with mitigation. However, due to the potential long-term nature of waste-related impacts, it is essential that the developer adhere to national legislative requirements and international best practice with regards the management of all waste streams. While a number of specific mitigation measures have been included in the document, further detailed guidance on the management of key waste streams is provided in the documents referenced in this report.

A summary of the various waste-related impacts associated with the proposed Syrah Resources Graphite project is presented below.

Without mitigation					**With mitigation**	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
ISSUE 1: Disposal of waste rock and tailings						
Impact 1.1: Health and safety of employees and local communities						
Long Term	Localized	May Occur	High	**HIGH**	*Slight*	**LOW**
ISSUE 2: Spillage of Run Of Mine						
Impact 2.1: Disruption of ecological functions						
Long term	Localized	May occur	*Moderate*	**MODERATE**	*Slight*	**LOW**
ISSUE 3: Storage of water in the Process Water Pond						
Impact 3.1: Pollution of soil and water resources						
Without mitigation					**With mitigation**	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Medium Term	Localized	Unlikely	Very Severe	**MODERATE**	*Very Severe*	**LOW**
Impact 3.2: Risk to health and safety of employees						
Without mitigation					**With mitigation**	
Medium Term	Localized	Unlikely	Severe	**HIGH**	*Slight*	**LOW**
ISSUE 4: Disposal of potentially hazardous chemicals						
Impact 4.1: Risk to health and safety of employees						
Long Term	Localized	May occur	Severe	**VERY HIGH**	*Slight*	**MODERATE**
Impact 4.2: Pollution of water resources and soil						
Long Term	Localized	May occur	Severe	**VERY HIGH**	*Slight*	**MODERATE**
ISSUE 5: Management of non-process general and hazardous wastes (All phases)						
Impact 5.1: Pollution of land and water						
General (Non-hazardous) wastes						
Long term	*Study area*	Probable	*Moderately Severe*	**MODERATE**	*Slight*	**LOW**
Hazardous wastes						
Permanent	*District*	Probable	*Very Severe*	**VERY HIGH**	*Moderate*	**MODERATE**
Impact 5.2: Nuisance impact (Production of odours, visual impact and attraction of pest and vermin)						
Long-term	District	Probable	*Moderately severe*	**MODERATE**	*Slight*	**LOW**
ISSUE 6: Disposal of domestic wastewater and sewage sludge (All phases)						
Impact 6.1: Pollution of soil and water						
Long-term	*Study area*	Probable	*Moderately severe*	**MODERATE**	*Slight*	**LOW**
Impact 6.2: Health impacts to employees and communities						

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Long-term	District	Probable	*Severe*	**MODERATE**	*Slight*	**LOW**
Impact 6.3: Nuisance impacts (odour and flies)						
Short-term	Study area	Probable	Moderately *Severe*	**MODERATE**	*Slight*	**LOW**
ISSUE 7: Disposal of run-off / storm water						
Impact 7.1: Pollution of land and water						
Long-term	*Study area*	Possible	Moderately *Severe*	**MODERATE**	*Slight*	**LOW**
ISSUE 8: Regional waste profiles and community awareness						
Impact 8.1: Local knowledge of waste management practices						
Permanent	*District*	Definite	Slightly beneficial	**LOW (+ve)**	*Beneficial*	**MODERATE (+ve)**
Impact 8.2: Change to waste profiles in the local communities						
Permanent	*District*	Definite	Slightly beneficial	**MODERATE**	*Slight*	**LOW**

Recommendations

It is recommended that all waste streams should be managed according to the waste management hierarchy and according to Decree 13/2006, of 15 July: Regulation of Waste Management. This specifies that wherever possible, production of wastes should be prevented or minimised at source. Where prevention or further minimization is not possible, wastes should be re-used, recycled and then disposed of responsibly so as to minimise impacts to the environment. Further guidance on the management of waste streams is provided in the IFC General EHS Guidelines (2007) and the IFC EHS Guidelines for Mining (2007). In the event that there are no national standards available, the proponent must comply with internationally recognised standards developed by international organisations such as the IFC. In the case where there are several standards available for use, the proponent must provide justification for the choice of use, other than the use of the most stringent.

Due to the local situation as per the remote location of the project site and relevant legislation, it is recommended that the proponent establish a non-hazardous waste disposal facility on the site. Furthermore, practical options will need to be considered 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.

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ABBREVIATIONS

ACRONYM	MEANING
AfDB	African Development Bank
BPEO	best practicable environmental option
CES	Coastal & Environmental Services
DPCAs	Provincial Directorates for the Coordination of Environmental Affairs
EA	Environment Act
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
ESHIA	Environmental, Social & Health Impact Assessment
FAO	Food and Agriculture Organisation
GIIP	Good International Industry Practice
ICRC	International Committee of the Red Cross
IFC	International Finance Corporation
IMO	International Maritime Organisation
KPI	Key Performance Indicators
LC	London Convention
MICOA	Ministry for the Coordination of Environmental Affairs
MSDS	Material Safety Data Sheets
NEMP	National Environmental Management Programme
PS	Performance Standards
SPDI	District Planning and Infrastructure Services
tpa	tons per annum
TSF	Tailings Storage Facility
VIP	Ventilated Improved Pit

1 INTRODUCTION

1.1 Project background

Syrah Resources Ltd. an Australian resource company listed on the Australian Stock Exchange proposes to construct and operate a graphite mining project on 30 km^2 (3000 hectares) of land in the Cabo Delgado province in the District of Namuno of northern Mozambique. The proposed site is approximately 7 km away from the town of Balama and 260 km by road west of the port town of Pemba a deep water container port, which is the third largest port in Mozambique. Syrah Resources Ltd currently holds a 106 km^2 (106000 hectares) Mining concession in the Cabo Delgado province in the District.

Coastal & Environmental Services (CES) was contracted to prepare a waste management assessment report for the proposed Syrah Resources Graphite project.

1.2 Terms of reference

A Waste Management Assessment is required to meet the requirements of International Finance Corporation (IFC) Performance Standards (PS) 3. It will focus on the environmental impacts that may arise from the handling, storage and disposal of solid and liquid wastes from the mining and mineral processing activities and ancillary facilities, excluding the transportation of product to the port and all port related activities such as storage and loading of product. The specific terms of reference are as follows:

a) Compile an inventory (identify, describe and, where possible, quantify) of the various waste streams to be generated by the project. This did not include the analysis of solid waste samples.
b) Briefly describe the processes giving rise to the waste streams and the anticipated volumes and tonnages of waste streams.
c) Identify and describe the possible impacts of any solid and liquid wastes on the quality of surface and groundwater.
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f) Relate levels of any potentially toxic waste to recognised international standards, and ensure that any waste management strategy is in line with these standards.

1.3 Assumption and information available

Much of the information regarding the proposed development and quantitative data relating to waste streams on which this report was based was provided by the Client. While every effort was made to verify the information, it was assumed that it was correct and valid.

Due to the remote location of the mine site, general (non-hazardous) waste from the development will probably be disposed of at a new general landfill site that will need to be constructed in the area by the proponent. The size and location of this facility is currently unknown. This report does not cater for the design, construction and operation of the landfill site or the application for permit(s) that may be required to operate the landfill site. Key impacts associated with the establishment of a landfill site within or outside the project boundary are likely to relate primarily to water resources and air quality and are not included in this report.

This specialist report was subject to the following additional assumptions and limitations:

- The specialist team did not visit the proposed project sites. As such, all project-specific information was based on information supplied by client and was assumed to be accurate.
- Estimates were provided on expected quantities of process waste and effluent streams.
- The impacts to air quality associated with the proposed mine are not covered but assessed in a separate air quality specialist report.
- The study assumes product transportation to port (including road transport, storage at port and ship loading and shipping requirement) will be contracted to a third party.

1.4 Structure of the report

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Chapter 2 – Project Description
Chapter 3 – Overview of waste management in Mozambique
Chapter 4 – Methodology
Chapter 5 – Waste Classification and Quantification
Chapter 6 – Assessment of Potential Environmental Impacts
Chapter 7 – Conclusions and Recommendations
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1.5 Study team

The following team members were involved in the specialist study:

Dr Kevin Whittington-Jones (Project Leader and Report Review)
Kevin holds a PhD in Environmental Biotechnology and an MSc in Zoology (marine ecology) and is a Director at CES. His professional interests include environmental business risk, management systems, waste management and climate change. Prior to joining CES he held various academic posts at Rhodes University, including that of Senior Lecturer at the Rhodes Investec Business School. Kevin has undertaken environmental work at many of the ports in South Africa, including environmental risk assessments, a climate change risk assessment, strategic environmental assessments and an integrated waste management plan. Kevin has also been involved in a number of industrial EIA projects within South Africa and internationally, both as Project Manager and as a waste management specialist. More specifically, he has conducted specialist waste management studies for the Port of Mossel Bay (South Africa), two heavy mineral mining projects (Egypt and Madagascar), manganese smelters (Kalagadi and Exxaro, both in South Africa), biofuel projects (Sierra Leone, Liberia and Mozambique), brewery projects (Mozambique) and the Rabai Power Station (Kenya). He is currently managing the EIAs for large-scale developments in Mozambique and is assisting Kenmare Resources' heavy mineral mine to comply with the requirements of the IFC Performance Standards.

Dr Eric Igbinigie (Project Manager and Report Production)
Eric is a Senior Environmental Consultant and a registered Professional Natural Scientist (Pr.Sci.Nat.). Eric holds a PhD in Environmental Biotechnology and his professional interest is in Sustainable Integrated Environmental Management with a keen interest in Waste & wastewater specialist assessment, Environmental due diligence, Contamination assessment and remediation, and Environmental & Social management compliance audits. Eric has successfully conducted several related local and international environmental projects across Africa in compliance with the requirements of Equator Principles Financial Institutions including the IFC, SWEDFUND, DEG and AfDB, where he served as both specialist consultant and project manager. Before joining CES Eric served as a Senior Research Scientist at the Institute for Environmental Biotechnology, Rhodes University conducting postgraduate lectures and led a research group tasked with the successful beneficiation of coal spoils, facilitating the re-vegetation of coal mine dump sites evident in Witbank, South Africa.

2 PROJECT DESCRIPTION

2.1 Introduction

This Chapter of the report provides a brief overview on the elements of the proposed Syrah Resources Graphite project in Mozambique that will give rise to hazardous and non-hazardous solid and liquid wastes. This includes waste generated as a result of direct project process and non-process related activities. Inclusion of a detailed project description was not considered necessary as this will be provided elsewhere in the main Environmental Impact Report (EIR).

2.2 Project context

Mozambique is located along the eastern coast of southern Africa between 10°27' and 26°52'' South and 30°12' and 40°51'East. It covers a surface area of 799 380 km^2 and is bordered by South Africa, Swaziland, Zimbabwe, Zambia, Malawi and Tanzania (Ribeiro and Chauque; 2010).

The country is divided into eleven provinces; the study site occurs within the Cabo Delgado Province in the district of Namuno in northern Mozambique. The project site is located near the town of Balama and is approximately 265 km west of the port town of Pemba.

Cabo Degado, Mozambique has a tropical climate with two distinct seasons. The wet season occurs from November to March and the dry season from April to November. Between 2010 and 2012, climate data for Balama, the nearest town to the project site, received an annual total rainfall maximum and average of 1 342 mm and 746 mm respectively, with the highest total monthly precipitation (392 mm) observed in January (Digby Wells Air Quality Assessment, 2013).

There is little variation in the average maximum and minimum temperatures throughout the year. The warmest months occur between October and May and the cooler months between June and September. The annual average high temperature is 30.5°C and the annual average low temperature is 22.4°C..

North-eastern Mozambique is predominantly underlain by Proterzoic rocks that form a number of gneiss complexes that range from Palaeo to Neoproterozoic in age. The project site is underlain by metamorphic rocks of the Neoproterozoic Lurio Group that are included within the Xixano Complex.

The study area is relatively flat to gently undulating with sporadic inselbergs (Mount Nassilala and Mount Coronge) rising from the flat plains. The altitudinal range varies from 480 to 830 m above sea level (asl) with the highest point occurring on Mount Nassilala.

The Mehucua River flows through the southern section of the project site in a South-west to North-east direction. A few small wetlands occur in the project area, the most notable being a swampland located approximately 2 km south west of the proposed site and a wetland located approximately 7 km east south-east. The largest water body in the area, but outside of the project area, is the Chipembe Dam which is located 12 km northwest of the site.

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.

Land use in the area is primarily for subsistence agriculture. Crops such as maize, cotton and cassava are grown on the flat areas which are cleared using slash and burn techniques. Some small livestock is reared in the area although these animals were only noted near the villages and are not abundant in the project site.

Almost all households are heavily reliant on the natural resources for their livelihoods. Natural resources are used for construction, medicinal consumption and to supplement their food. Small scale charcoal production was also evident in the project site.

2.3 Project overview

Syrah Resources Ltd plans to construct a graphite mine situated 7 km from the town of Balama, in the Cabo Delgado province, northern Mozambique. The locality map below depicts the location of the project site with the four surrounding villages, as well as the key infrastructures (Figure 2.1).

It is the intention that conventional open pit mining will be used to extract the ore with a baseline scenario of 2 million tonnes per annum. The extraction of the graphite will require conventional flotation processing. The Chipembe dam, located approximately 13 km northwest of the project site, will be the primary source of water for this process. It is estimated that 1 m^3 of water will be required per tonne of ore processed. This requirement of water has been discussed between Twigg (Syrah) representatives and ARA-Norte and the availability of 2 million m^3 has been confirmed (Licence no 07/2012 valid till October 2018). Water will be transferred to site via a 13 km pipeline.

To extract the graphite (and possibly vanadium) conventional flotation processing will be undertaken. The water for this process will be acquired from the Chipembe dam, located approximately 12 km northwest of the project site. It is estimated that 1 m^3 of water will be required per tonne of ore processed. The water will be transported to site via a pipeline.

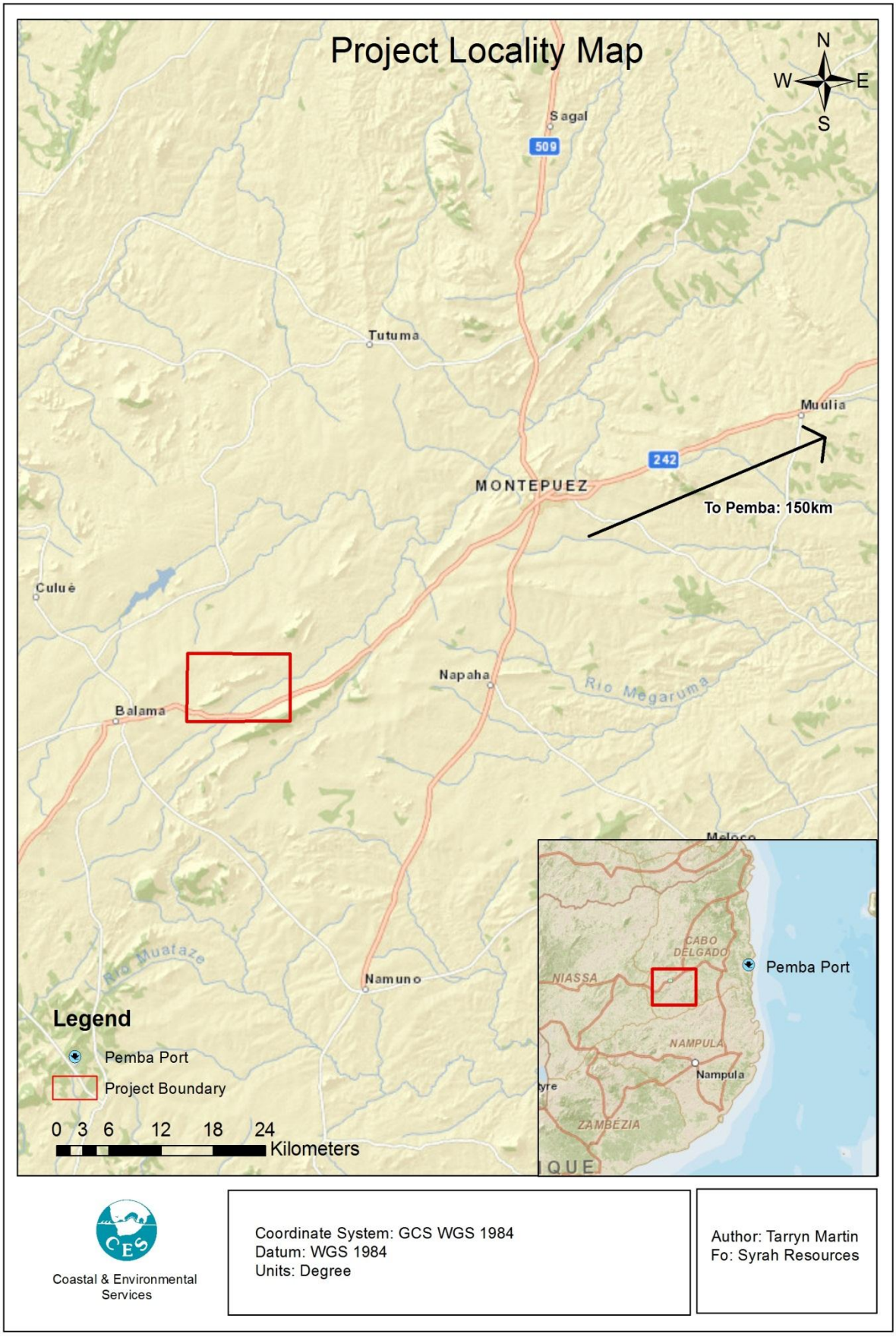

Figure 2.1: Locality map indicating the position of the proposed Balama Graphite Mine area

2.3.1 Process description

Balama is anticipated to be a very large graphite deposit and excluding market considerations, has the potential to deliver a mine life of 100 years at a process rate of 1 200 000 tpa. A mining license application for a period of 25 years will be submitted (an effective mine life of 23.5 years to allow for closure) with an option to extend for a further 25 years. The plant will operate for 24hr over 365 days per year but will only be available for 90% of the time over those days with three shifts of 8hr per day. A detailed process description can be found in Chapter 3 of the ESHIA Vol. 3 (2013) and a summary process description is provided here.

The site preparation would require the clearing of vegetation from the project sites for the construction of process facilities including the east and west mine pits, plant site, Tailings Storage Facilities (TSF) and waste rock dumps. Vegetation clearing would also be required during site preparation for auxiliary facilities described below. Site preparations would amount to the aggregation of vegetation waste requiring disposal. Over-burden, which would include top soil and waste rock, would have to be excavated at the east and west mine pits in order to access the Run of Mine (ROM) ore. The excavated waste rock would be stockpiled at waste rock dumps to be constructed and the mined material sent for processing at the processing plant.

A brief description of the ore processing steps is provided below and a flow diagram for the process is provided in Figure 2.2. Details of the mining and processing including Run of Mine Ore, Crushing, Milling, Floating/Secondary Grinding, Regrinding, Thickening, Drying and Graphite handling, Reagent Storage, Tailing disposal and management are provided in the main ESHIA report.

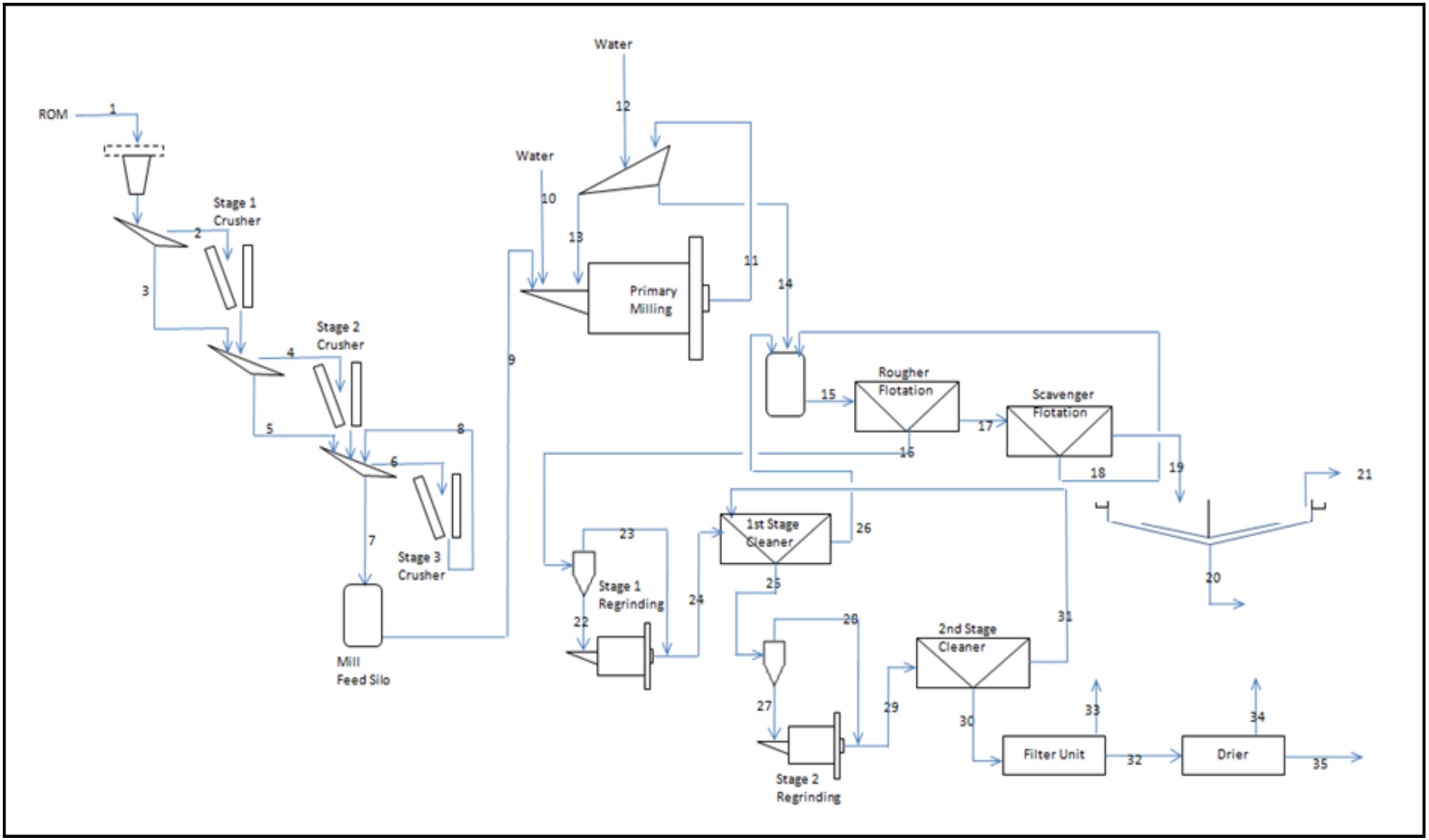

Figure 2.2: Proposed process flow sheet for the Balama Graphite plant (Metallicon, 2013).

2.3.2 Auxiliary (Non-process) Facilities

In order to determine the types of non-process wastes likely to be produced by an industrial development of this nature, it is also necessary to obtain a clear understanding of the non-process activities, also referred to as auxiliary operations or facilities.

The duration of the construction phase is expected to last between 8 and 12 months. The following infrastructure will be required in the development and will be assessed during the EIA:

- 12 km pipeline from the Chipembe dam to the project site;
- Pump houses at the dam and project site;
- Water reservoirs at the project site;
- Offices and accommodation at the project site to cater for between 300 and 500 persons during the construction phase and 250 persons during operational phase;
- A lay-down area for construction materials and equipment. This area will continue to be used during the operational phase, although the actual area of land required may be reduced;
- Workshops for repair of equipment and machinery;
- Bunded storage areas for diesel fuel, lubricants, paraffin and waste oil;
- A diesel powered electricity generation plant and fuel storage shed;
- Storage for equipment, spares and consumables;
- Offices for site staff;
- Ablution facilities and associated sewage treatments plants;
- Additional infrastructure such as roads, mess/kitchen, ablution facilities and associated sewage treatment plants, laboratories;
- Temporary hazardous waste storage facility;
- Landfill site (location is undecided); and
- Product sheds.

The project will make use of the regional clinic located at Balama, which is about 7 km away. The clinic in Balama, which has approximately 100 beds and is staffed with one nurse and one doctor by the government, complies with the standard practice in Mozambique for small regional clinics. According to the BFS Scoping Study (2012) a first aid room will be built at the campsite and government recommendations are that the mine should keep an ambulance onsite for transporting patients through to the Balama clinic. Medical waste generated at the first aid facility will be stored temporarily at the temporary hazardous waste storage facility prior to its transportation to the Balama regional clinic for disposal. Alternatively, the option of a small incinerator will be investigated for the pre-treatment of medical waste on site prior to disposal of the residual material at the on-site landfill.

The residents of the neighbouring village of Ntete and surrounding hamlets of Piriri, Maualia, Muape and Nquide are largely unemployed and will supply the unskilled labour for the project (BFS Scoping Study, 2012). This group of personnel will be housed in their respective villages but a change in income levels and population size could contribute to cumulative waste-related impact for the area.

3 OVERVIEW OF WASTE MANAGEMENT IN MOZAMBIQUE

3.1 Introduction

Before characterizing waste streams or considering alternatives for their management and disposal, it is important to consider the relevant institutional arrangements, legislative framework and existing infrastructure. Apart from consideration of the broader Legislation, Policies and Standards related to the protection of environmental and human health, it is also necessary to consider the definitions of waste, the goals and objectives of applicable waste management strategies and policies, the desirability of recycling and reuse, and any permitting requirements.

When assessing the management options for solid waste streams, it is necessary to review the institutional capacity for waste management in the country of the proposed project and to also consult the country-specific guidelines for identification of general and hazardous wastes.

3.2 Definition of waste

The Regulation of Waste Management Decree 13/2006 of 15 July, Mozambique, define waste *"as any substances or objects that are discarded, intended to be discard or are required to be discarded by law".* The regulation classifies waste into two categories hazardous and non-hazardous wastes. Defining hazardous waste as *"waste that exhibits characteristics of risk for their being ignitable, explosive, corrosive, toxic, infectious or radioactive, or for exhibiting any other forms that could pose a hazard to the lives or health of persons and other living beings and to the quality of the environment"* and that it contains any of the characteristic listed in Annex III of the regulation. Non-hazardous waste is defined as "*the waste that contains no characteristics of risk"* and does not contain any of the characteristics listed in Annex III of the regulation. The definition of hazardous waste provided in the regulation is in accordance with the Annexes I, II and III of the Basel Convention.

As many of the large-scale development projects on the African continent are financed to some degree by international lending agencies, it is also important to consider the International Finance Corporation's definition of waste. According to the Section 1.6 (Environment: Waste Management) of the IFC EHS Guidelines (30 April 2007), waste is defined as, "*any solid, liquid or contained gaseous material that is being discarded by disposal, recycling, burning or incineration". It can be:-*

- *A by-product of a manufacturing process, or;*
- *An obsolete commercial product that can no longer be used for intended purpose and requires disposal.*

The Guideline document goes on further to differentiate between solid (non-hazardous) wastes and hazardous wastes (Table 3.1). The classification of waste is discussed in more detail in section 5 of this report.

Table 3.1: Definition of solid (non-hazardous wastes) and hazardous wastes according to the IFC General EHS Guidelines (2007)

Waste Type	Definition and Examples
Solid (non-hazardous) wastes	Examples of such waste include domestic trash and garbage; inert construction/demolition materials; refuse such as metal scrap and empty containers (except those previously used to contain hazardous materials which should, in principle, be managed as a hazardous waste); and residual waste from industrial operations, such as boiler slag, clinker, and fly ash.
Hazardous wastes	Share the properties of a hazardous material (e.g. ignitability, corrosivity, reactivity, or toxicity), or other physical, chemical, or biological characteristics that may pose a potential risk to human health or the environment if improperly managed. Wastes may also be defined as "hazardous" by local regulations or international conventions, based on the origin of the waste and its inclusion on hazardous waste lists, or based on its characteristics. Sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility, and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial operations needs to be evaluated on a case-by-case basis to establish whether it constitutes a hazardous or a non-hazardous waste.

3.3 Institutional framework

Prior to reviewing the legislative framework and the implications thereof for the proposed project, it is important to review the roles and responsibilities of various authorities within the country.

In terms of Article 24 of the EIA Regulations (as amended), the Ministry for the Coordination of Environmental Affairs (Ministério para a Coordenação da Acção Ambiental (MICOA)) is responsible for making regular inspections of construction sites for new activities and the operations of existing facilities. In a complex situation or where environmental conditions justify it, MICOA is mandated to request an environmental audit to be conducted. MICOA has two broad domains of responsibility (1) implementing the National Environmental Management Plan and associated environmental policy and legislation and (2) coordinating with other ministries on environmental matters to integrate environmental aspects into their projects, programmes and policies. MICOA is organised into the following five National Directorates:

- Environmental Impact Assessment (including waste management);
- Environmental Management;
- Land Planning;
- Promotion of Environmental Awareness; and
- Planning and Studies.

In order to discharge its mandate more effectively, and in line with the government's decentralisation policy, MICOA has been establishing an increasing institutional presence at lower government levels since 1995. At the provincial level, MICOA is represented by the Provincial Directorates for the Coordination of Environmental Affairs (Direcção Provincial para a Coordenacção da Acção Ambiental (DPCAs)). At district level, MICOA's representation is through the District Planning and Infrastructure Services (Planejamento do Distrito e Serviços de Infraestrutura (SDPI)) under the Ministry of Public Works. This department is responsible for handling issues related to land use planning, as well as any issues related to environmental protection. DPCAs have been set up in all 10 provinces of Mozambique. The role of the DPCAs is, in principle, to facilitate the local implementation of centrally developed environmental legislation, policies and programmes, including the EIA Regulations and Guidelines. Most provincial government structures include departments of environmental management and some (e.g. those in Nampula and Cabo Delgado Provinces) have separate EIA departments. Table 3.2 shows potentially applicable sector waste legislation.

Table 3.2: Institutional responsibilities for waste management in Mozambique

Sector	Primary Agency	Title and Date of Document	Purpose
Waste – liquid effluents	MICOA	Decree No. 18/2004, Regulations on the Parameters for Air Quality and Effluent Emissions(Amended by Decree 67/2010 of 31 December).	The Regulations set standards for discharge to marine and coastal environments, as well as for surface irrigation of waters. Responsible for environmental auditing and the issuance of environmental licences and permits.
Waste Management	MICOA	Decree No. 13/2006, of 15 June, Regulations on Waste Management	Article 10 of the Decree provides that MICOA will issue a Waste Management Licence for scheduled waste management activities contained in Annex VI (Disposal activities) and VII (Recycling / Recovery Facilities). The License will be valid for a period of 5 years after which it needs to be reviewed. Applications for renewal must be submitted at least 180 days before the expiry date of the licence.
	District Government (Rural areas)	Decree No. 13/2006, of 15 June, Regulations on Waste Management	In terms of waste management it is the responsibility of district governments in the areas under their jurisdiction to establish the means, procedures for collection and means of collection, transportation, disposal and treatment of waste, particularly, hospital and other toxic waste; Establish fees, render services in collection, removal, transportation, disposal and treatment of waste, including hospital and other toxic waste; License facilities involved in hazardous and toxic waste management.
	Each municipality (i.e. only urban)	Municipality Law No. 2/97	Local municipality ensures basic sanitation and quality of life within their municipalities. The Law sets out municipal responsibility to develop programmes for ecological protection and procedures for the removal of solid waste, and the treatment and disposal of solid residues, including medical and hazardous waste.
Waste Management Plan	MICOA	Decree No. 13/2006, of 15 June, Regulations on Waste Management	Article 7 of the Decree requires companies involved in the management of waste to develop a Waste Management Plan (WMP) before commencement of operations. The contents of the WMP are prescribed in Annex I and II of the Decree.
Transport of Hazardous Waste	MICOA	Decree No. 13/2006, of 15 June, Regulations on Waste Management	Hazardous waste may only be moved to the exterior of the facilities of the producing entity by transport operators or transporters duly certified by the MICOA, for collection and removal of such waste.

Licensing and auditing of Landfill Sites	MICOA	Decree No. 13/2006, of 15 June, Regulations on Waste Management	All public or private entities carrying out activities related to solid waste management should prepare their waste management plan, prior to entering into business, which should contain at least, information required in for landfill operation and submit to MICOA for approval.
Permitting of Waste Management Facilities	MICOA	Decree No 45 of 2004 EIA Regulation as amended by Decree 42 of 2008	MICOA is responsible for the environmental permitting of waste management facilities as designated in Category A listed activities contained in Decree No 45 of 2004 (EIA Regulations) viz. facilities for 'treatment and disposal of solid and liquid waste : a) Places for disposal of municipal waste with a load greater than 500 tonnes per day; b) Storage, transportation, treatment and disposal of dangerous industrial waste; c) Facilities for the disposal / treatment of storm water / sewage with capacity for more than 150 000 inhabitants.

3.4 Relevant National Environmental Legislation, Policies and Standards

A number of Mozambican laws will apply to this project, and the following section provides a brief summary of those that have bearing on the management of wastes. The summary is not exhaustive at this stage, and a more detailed review or the most recent relevant regulatory instruments will be undertaken during the detailed EIA phase of the assessment.

It is apparent that the sound management of solid and liquid waste is an area of focus of the local government in Mozambique and that a sound understanding of the relevant Policies and Acts is important for any developer wishing to operate within Mozambique. An understanding of this legal framework is also essential when evaluating options for the management of wastes. The following documents have bearing on the management of wastes in Mozambique:

- Constitution of the Republic of Mozambique (2004)
- Environmental Act (Law 20/97) (1997)
- National Environmental Management Programme (1995)
- Regulation on Environmental Quality Standards and Effluent Emission Decree No. 18/2004 as amended by the Decree No. 67/2010
- Regulation on the process of EIA Decree No. 45/2004 as amended by Decree 42 of 2008
- Regulation on the Environmental Audit process Decree No. 32/2003
- Regulations on Waste Management, Decree No. 13/2006
- Regulation on the Management of Bio-Medical Waste Decree No. 8/2003

3.4.1 The Constitution of the Republic of Mozambique (2004)

The Constitution is the supreme law of the land and any act or conduct inconsistent with it is invalid and will have no force of law. The Constitution addresses matters relating to the environmental protection and quality of life in Articles 45, 81, 90, 98, 102 and 117. Article 90, which is part of Chapter V (Economic, social and cultural rights and duties) of Title III (Fundamental rights, duties and liberties), gives the people of Mozambique the right to live in a balanced environment free of contamination. It commits 'the State and local authorities, in collaboration with other appropriate partners, to adopt policies for the protection of the environment through appropriate waste management practice and care for the rational utilisation of all natural resources'.

3.4.2 Environmental Act (Law 20/97) of 1 of October 1997

Many of the requirements relating to the management of waste within Mozambique are documented in the Environment Act (Law 20/97 of 1 October 1997). This Act was one of the first regulatory tools developed by the Mozambican Government to ensure that waste does not pollute the natural environment or effect the social environment. The law provides a general framework for environmental protection, including the management of waste. The purpose of the Law is to, "*define the legal basis for the proper use and management of the environment and its elements in order to establish a system of sustainable development*" in the country.

According to the Environment Act (Law 20/97 of 1 October 1997), any waste and effluent related activity with a significant impact on the environment requires an environmental license. The Environment Act (EA) also states that the environmental license shall be subject to specific regulations on the process of EIA study (approved EIA decree No. 76/98 of 29 December 1998 as amended by Decree 42/2008).

The Environmental Law of 1997 imposes strict liability on persons who cause material damage to the environment. The State has the right to assess the damage, fix the amount of compensation and to take counter measures at the expense of the person causing the damage. In addition to the above, provided in Table 3.3 (below) are the sections of the Environmental Law of 1997 that are particularly relevant to waste management and the prevention of pollution of the environment in Mozambique.

Table 3.3: Sections of Mozambique's Environment Law that have relevance to the management of wastes within the country

Section #	Article #	Sub Article #	Stipulation
III: Environmental Pollution	**9: Prohibition against pollution**	**1**	The production, deposit in the soil or sub-soil, emission into water or the atmosphere of any toxic or pollution substance as well as the practice of any activities which accelerate the erosion, desertification, deforestation or any form of environmental degradation that are outside of the legally established limits is not permitted in the national territory.
		2	The importation into the national territory of toxic residues or wastes is expressly prohibited, except under the terms that would be established in specific legislation.
	10: Environmental Quality Standards	**2**	In the definition of the environmental quality standards, rules and time limits shall be established for agricultural and industrial processes including machinery and methods of transport to adopt the appropriate technology and procedures in order to neutralise or prevent the emission of polluting substances.
IV: Special Measures for Environmental Protection	**14: Erection of Infrastructures**	**1**	The erection of residential or other infrastructures and the deposit of waste and used materials which, by virtue of their size, nature or location, would provoke a significant negative impact on the environment are prohibited.
		2	The prohibition referred to in the previous number is applicable in particular to coastal zones, zones threatened by erosion and desertification, wetlands, environmental protection zones and other ecologically sensitive zones.
V: Prevention of Environmental	**18: Environmental Audits**	**1**	All activities which on the date this law enters into force are operating without the application of

Section #	Article #	Sub Article #	Stipulation
Damage			appropriate technologies or procedures and as a consequence, result or could result in damage to the environment shall be subjected to an environmental audit.
		2	The operators of the activities shall be responsible for the costs which result from the repair of environmental damage which may be determined by the audit.
VII: Exercise of Economic Activities	**26: Strict Liability**	**1**	Any person who causes material damage to the environment or who provokes the temporary or definitive standstill of economic activity as a result of the practice of especially dangerous activities, shall, regardless of intent and notwithstanding compliance with the law, be obligated to indemnify the injured parties.
		2	The government shall have the power and authority to evaluate the seriousness of the damage and to assess the amount of compensation. The amount of compensation shall be fixed by environmental expert testimony and proof.
		3	Whenever circumstances so require, the State shall take the necessary measures to prevent, contain or eliminate any grave damage to the environment. The State shall have the right to seek compensation for these costs incurred.

3.4.3 National Environmental Management Programme (NEMP), 1995

The Ministry for Co-ordination of Environmental Affairs (MICOA) approved a National Environmental Management Programme (NEMP) in 1995. This is a policy document outlining the priorities for environmental management and sustainable development in the Country. The underlying goal of Mozambique's environmental legislation is the protection of human and environmental health and, importantly, the legislation promotes the governing of *Polluter Pays Principle, Preventive and Corrective Action Principle,* and the *Precautionary Principle*.

3.4.4 Regulation on Environmental Quality Standards and Effluent Emission Decree No. 18/2004 of 2 June 2004 amended by the Decree No. 67/2010

The Regulation on Environmental Quality Standards and Effluent Emission (Decree No. 18/2004) establishes the environmental quality standards and permissible limits for effluent and emission discharge by industries. The purpose of these Regulations is to establish standards for environmental quality and effluent emissions, aiming at the control and maintenance of the admissible levels of concentration of pollutants in the environment. The provisions of these Regulations are applicable to all new public and private activities that may affect the environment directly or indirectly. Existing factories and processing plants have to adapt their equipment to ensure compliance within five years from the date of publication of the Regulations. Article 6 of the Regulations requires them to be reviewed (and updated) every five years, unless the obligations deriving from an international convention require more urgent action. The Regulations cover air quality (Chapter II), water quality (Chapter III), soil quality (Chapter IV), and noise (Chapter V). Contained in its annexes are Annexes IA and IB deals new standards of air quality, atmosphere polluting agents and parameters for carcinogenic Inorganic and Organic agents (as amended by Decree No 67 of 2010), Annex II - Emission standards for gaseous pollutants by Industries, Annex III – Standards of Emission of Liquid Effluents by Industries, Annex IV – Standards of Emission of Domestic Liquid Effluents, Annex V –lists potentially harmful chemical substances and Annex VI - Manual for Classification, Quantification, Interpretation of Laboratory Analysis of Soil and Water. According to the amendment regulations 67 of 2010, MT50 thousand to MT500 thousand is required as tax payment for emission of special permission. In addition, non-compliance with any

of the pollution standards set out in Decree No. 18/2004 as amended or failure to report exceedances is punishable with a fine of between MT1 million to MT10 million.

The specific permissible Mozambican discharge limits for various pollutants within a sewage effluent stream in comparison with those required by the IFC and AfDB sewage effluent standards are indicated in Appendix A, while those for mining liquid effluent are provided in Appendix B. Where there is a difference in the specific limits for a particular parameter, it is proposed that the most stringent be adopted.

3.4.5 Regulation on the process of Environmental Impact Assessment Decree No. 45/2004 as amended by Decree 42 of 2008

The regulation states that one of the key instruments for environmental management is the process of ESHIA, which aims to mitigate the negative impacts that certain projects of public and private sectors can cause the natural and socio-economic environment, by conducting environmental studies before the project starts. It defines the process of environmental impact assessment, environmental studies, required public participation process, the process of review studies, the draft decision process feasibility and environmental issue and license. It is applicable to all public and private activities with direct or indirect influence on the environmental components.

The proponent has the responsibility to ensure that the proposed activities and the ESHIA process conform to the requirements of this regulation. The proponent is obliged to request an environmental license and perform the ESHIA process in support of the application in accordance with this Regulation and an environmental license must be obtained from the MICOA. Environmental Licences for all activities are valid for a period of five years, renewable for an equal period and application for renewal has to be submitted at least 180 days before the licence expires (Amendment Decree 42 of 2008).

3.4.6 Regulation on the Environmental Audit process Decree No. 32/2003 of 12 August

The Regulation on the Environmental Audit Decree 32/2003 defines an environmental audit as a tool for objective and documented management and systematic assessment of the management system with relevant documentation in place to ensure the protection of the environment. It aims to assess the performance of operational processes and working with the environmental management plan, including environmental legal requirements enforced and approved for a particular project.

3.4.7 Regulation of Waste Management Decree No. 13/2006 of 15 June

The Regulation of Waste Management (Decree No. 13/2006) is applicable to all individuals or collective bodies, public or private, involved in waste management and its objective is the establishment of norms relative to generation, disposal on soil and underground, dumping into water or to the atmosphere, of any toxic or polluting substances, as well as the carrying out of polluting activities that accelerate degradation of the environment, with view to preventing or minimizing the negative impacts on human and environmental health.

The Article 9 of the Regulation of Waste Management (Decree 13/2006), requires the producers of waste to minimize the production of their waste and the details of how to achieve waste minimization should be documented by the company. In addition to that, the Environmental Law 20/97 imposes strict liability on people who contribute to environmental degradation. The government has the responsibility to determine the amount for compensation and the person causing environmental degradation is responsible to pay the amount needed to rehabilitate the affected environment. The provision does not relate to hazardous wastes only. On the other hand, according to, the General Guideline for EIA, proponents are obliged to present details of the wastes and their management in the EIA report.

3.4.8 Regulation on the Management of Bio-Medical Waste Decree No. 8/2003 of 18 February

Decree No. 8/2003 defines bio-medical wastes as those emanating from medical facilities including veterinaries, treatment and medical research facilities. The regulation is applicable to health institutions, industries and individuals who produce and manage the disposal of bio-medical waste. It establishes the rules applicable to the management of medical waste, serving to protect the health and safety of healthcare workers and the general public as well as to minimize the impact of bio-medical waste on the environment.

According to the Bio-medical waste Decree No. 8/2003, bio-medical waste can only be transported off-site by operators licensed by MICOA and large quantities of waste pharmaceuticals should be returned to suppliers. The licensing of medical waste transporters by MICOA is done in coordination with the Ministry of Health which is responsible for the training and capacity development of medical waste transporters.

3.5 Relevant International Standards and Guidelines

There are a number of International Conventions and Guidelines that are of relevance to the project because they have been ratified by the Government of Mozambique. These relevant guidelines and conventions are discussed below.

3.5.1 Stockholm Convention on Persistent Pollutant

Stockholm Convention on Persistent Organic Pollutants which was adopted in Mozambique in 2001 and ratified by the Resolution 56/2004 of 31 December, is an international environmental treaty that aims to eliminate or restrict the production and use of persistent organic pollutants (POPs). Key elements of the Convention include the requirement that developed countries provide new and additional financial resources and measures to eliminate production and use of intentionally produced POPs, eliminate unintentionally produced POPs where feasible, and manage and dispose of POPs wastes in an environmentally sound manner. Precaution is exercised throughout the Stockholm Convention, with specific references in the preamble, the objective and the provision on identifying new POPs.

3.5.2 Basel Convention

Mozambique is a signatory to the Basel Convention (acceded on the 13th of March, 1997), which is the Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal. This convention is highly relevant to the management of hazardous waste within Mozambique.

The main objectives of the Basel Convention are the reduction of the production of hazardous waste and the restriction of trans-boundary movement and disposal of such waste. It also aims to ensure that any trans-boundary movement and disposal of hazardous waste, when allowed, is strictly controlled and takes place in an environmentally sound and responsible way. Its scope of application covers a wide range of wastes defined as “hazardous wastes” based on their origin and/or composition and their characteristics (Article 1 and Annexes I, III, VIII and IX), as well as types of wastes defined as “other wastes” (household waste and incinerator ash; Article 1 and annex II).

In particular, the convention prohibits the trans-boundary movement of wastes and is applicable to wastes that belong to the following categories:

- Hazardous wastes that are subject to trans-boundary movement and they include
    a. Wastes that belong to any category contained in Annex I, unless they do not possess any of the characteristics contained in Annex III of the Convention; and

b. Wastes that are not covered under paragraph (a) but are defined as, or are considered to be, hazardous wastes by the legislation of Mozambique for export, import or transit.

- Wastes that belong to any category contained in Annex II that are subject to trans-boundary movement shall be "other wastes" for the purposes of this Convention.
- Wastes which, as a result of being radioactive, are subject to other international control systems, including international instruments, applying specifically to radioactive materials are excluded from the scope of this Convention.
- Wastes which derive from the normal operations of a ship, the discharge of which is covered by another international instrument, are excluded from the scope of this Convention.

For the purpose of this Convention, any trans-boundary (export and import) movement of the described wastes without due authorization by the relevant Mozambican authority is deemed illegal. It should be noted that the illegal trafficking of wastes also applies to damage due to an incident occurring during an authorized trans-boundary movement of hazardous wastes and their disposal. Decree No. 13/2006, of 15 June, Regulations on Waste Management, designates MICOA as the competent Mozambican authority for the approval of transport of hazardous waste. According to the Basel Convention Fact sheet of 2011, Mozambique has no legislation that restricts the export (including the transit) of hazardous wastes and other wastes for final disposal or recovery.

3.5.3 Bamako Convention

Mozambique is a signatory to the Bamako Convention (acceded on 5th February, 1999), which is the Convention on the ban of the import into Africa and the control of trans-boundary movement of hazardous wastes within Africa. The requirements of this Convention are similar to those of the Basel Convention.

Impetus for the Bamako Convention arose from the failure of the Basel Convention to prohibit trade of hazardous waste to less developed countries, and from the realization that many developed nations were exporting toxic wastes to Africa. Though the Bamako Convention uses a format and language similar to that of the Basel Convention, it is much stronger in prohibiting all imports of hazardous waste. Additionally, it does not make exceptions on certain hazardous wastes (like those for radioactive materials) made by the Basel Convention.

Article 9 (*Illegal Traffic*) of the Bamako Convention prohibits any trans-boundary movement of hazardous wastes under the following conditions:

- if carried out without notification, pursuant to the provisions of this Convention, to all States concerned; or
- if carried out without the consent, pursuant to the provisions of this Convention, of a State concerned; or
- if consent is obtained from States concerned through falsification, misrepresentation or fraud; or
- if it does not conform in a material way with the documents; or
- if it results in deliberate disposal of hazardous wastes in contravention of this Convention and of general principles of international law.

The Convention requires its signatories to introduce national legislation to criminalise and impose high punitive measures on all persons who have planned, carried out, or assisted in the illegal trans-boundary movement of hazardous wastes.

3.5.4 African Development Bank Guidelines for Mining Projects (1995)

All mining activities must adhere to the AfDB Environmental Guidelines for Mining Projects (1995). The guidelines stipulate the requirements for environmental impact assessments in order to identify all issues likely to result from mining projects. The guidelines list a number of issues to be

considered during the pre-implementation, operation and post mining phases for medium and large scale mining projects. These requirements are largely covered in the IFC Performance Standards discussed below. In addition, the document stipulates guideline limits for air and water pollutants as well as noise and vibrations. The AfDB prescribed guidelines limits for sanitary effluent, mine effluent and soil are provided in Appendices A, B and C.

3.5.5 IFC Performance Standards on Environmental and Social Sustainability (2012)

In 2005 the IFC, which is the private sector arm of the World Bank Group, embarked on an extensive review of its environmental assessment procedures and PS. A revised and slightly more rigorous and more clearly defined PS as well as its associated Guidance Notes were published in January 1, 2012. These PS (Box 1) usually form the back-bone of Environmental, Social & Health Impact Assessments (ESHIA) and environmental management for large projects in developing countries and can be used to identify and manage risk in proposed developments.

Box 1: IFC Performance Standards (January, 2012)

Performance Standard 1:	Assessment and Management of Environmental and Social Risks and Impacts
Performance Standard 2:	Labour and Working Conditions
Performance Standard 3:	Resource Efficiency and Pollution Prevention
Performance Standard 4:	Community Health, Safety, and Security
Performance Standard 5:	Land Acquisition and Involuntary Resettlement
Performance Standard 6:	Biodiversity Conservation and Sustainable Management of Living Natural Resource.
Performance Standard 7:	Indigenous Peoples
Performance Standard 8:	Cultural Heritage

Of specific relevance to this report is Performance Standard 3 (PS3) which deals with resource efficiency and pollution prevention. The primary objectives of PS3 are to:

- To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities.
- To promote more sustainable use of resources, including energy and water.
- To reduce project-related Greenhouse Gas emissions.

The primary requirement of PS3 is that technologies and practices that avoid or minimise detrimental impacts of pollution are applied throughout the lifecycle of the project.

In addition to the IFC PS, the General Environmental, Health and Safety Guidelines (2007) described below (section 3.5.3), and the Industry-Sector IFC EHS Guidelines for Mining (2007), which deal with pollution and human health issues associated with mining (section 3.5.4), are of equal relevance.

3.5.6 IFC General Environmental, Health and Safety Guidelines (2007)

The IFC General EHS Guidelines (2007) are technical reference documents with general and industry specific examples of Good International Industry Practice (GIIP) as defined in the IFC's PS3 on Resource Efficiency and Pollution Prevention. The IFC uses the EHS Guidelines as a technical source of information during project appraisal activities as described in the IFC's Environmental and Social Review Procedures (2006).

According to the General EHS Guidelines, facilities that generate and store wastes should practice the following:

- Establishing waste management priorities at the outset of activities based on an understanding of potential EHS risks and impacts and considering waste generation and its consequences;
- Establishing a waste management hierarchy that considers prevention, reduction, re-use, recovery, recycling, removal and finally disposal of wastes;
- Avoiding or minimizing the generation of waste materials, as far as practicable;
- Where waste generation cannot be avoided but has been minimized, recovering and reusing waste, and;
- Where waste cannot be recovered or reused, treating, destroying and disposing of it in an environmentally sound manner.

Section 1.3 of the IFC General EHS Guidelines (2007) provides specific recommendations related to the management of wastewater and includes indicative values for treated sanitary sewage discharges (Appendix A), while those for mining effluent are provided in IFC EHS Guidelines for Mining (2007) (Appendix B).

3.5.7 IFC EHS Guidelines for Mining (2007)

Whilst the IFC PS, of which some parts relate to all phases of a project's lifecycle - planning, design, construction, operation and decommissioning / closure – the IFC Industry Sector EHS Guidelines relate specifically to the construction and operational phases of specific projects. The purpose of these guidelines is to compliment the Performance Standards by providing more detailed guidance on the environmental and social impacts likely to be associated with specific industry sectors, as well as specific limits.

The Guidelines are therefore technical reference documents that recommend general industry-specific examples of GIIP, and they provide performance levels and measurable objectives for new and existing facilities, including specific targets by which GIIP may be achieved. These industry sector EHS guidelines are designed to be used together with the General EHS Guidelines (2007) document (described above), which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. The IFC Industry Sector EHS Guidelines that is of relevance to the proposed projects is the IFC EHS Guidelines for Mining (2007). This guideline is applicable to underground and open-pit mining, alluvial mining, solution mining, and marine dredging.

The EHS Guidelines for Mining is organised according to the following sections:

- Section 1.0 — Industry-Specific Impacts and Management
- Section 2.0 — Performance Indicators and Monitoring
- Section 3.0 — References and Additional Sources
- Annex A — General Description of Industry Activities

The management of wastes from mining operations is included in these guidelines.

3.6 Waste Management Infrastructure in Mozambique

Mozambique has a modern and progressive waste management system regulation. However, despite a clear political objective, many people still do not have access to adequate and proper waste management and sanitation infrastructure (BTI 2012). Search on the internet reveals minimal progress being made in the development of waste infrastructure in Maputo, while there is a general lack of waste management infrastructure throughout the rest of the country. According to a draft report by the United Nations (www.un.org), urban solid waste is managed informally. Typically, the final destination of solid waste in Mozambique consists of simple open air rubbish dumps. In these places, waste is burnt, buried and compacted, causing certain environmental and health concerns.

According to the draft UN report (no date), informal recycling of solid waste does take place and is often located at the disposal sites. Furthermore, recycling is more prevalent in the larger cities, due

to the quantities of waste available and the increased likelihood of finding a buyer for the material. Some of the recycled material, such as glass, plastic and metal, is sold locally but it is also transported to South Africa. In addition to this informal recycling, there is also evidence of the initiation of more formalised recycling operations in the larger cities of Maputo and Matola. An organization called Amor (the Mozambican Association of Recycling – see www.associacao-mocambicana-reciclagem.org) has been in operation since 2010 and focuses on using recycling initiatives for socio-economic upliftment. Such initiatives do, however, seem to be limited to the larger urban areas with no evidence of formalised recycling in rural areas.

Disposal of hazardous waste in Mozambique poses a challenge. According to the Basel Convention Country Fact sheet for Mozambique (2008), the Mavoco hazardous waste disposal facility near Maputo is the only licensed hazardous waste site in the country.

4 METHODOLOGY

4.1 Introduction

This assessment did not include a visit to the proposed project site. Instead, information regarding the process, expected waste volumes and properties of the wastes was obtained from client. In terms of rating of potential environmental waste impacts, the standard CES rating system was applied and the specific context of the proposed project was taken into consideration.

4.1.1 Waste characterisation methodology

Information regarding the process, expected waste volumes and properties of the wastes was obtained directly from the client. Additional information was obtained from relevant reference sources. A life cycle assessment approach with a limited spatial scope was used to identify all key waste streams associated with the proposed project. The assessment covered waste streams during the construction, operation and decommissioning phases excluding transportation of product to the port at Pemba and all port related activities.

For the purposes of this report, waste streams generated during the operational phase have been defined as either process wastes or non-process wastes. The former may be defined as any liquid or solid wastes generated directly as a result of the core process described in section 2.2.1, while non-process wastes refer to those wastes that are generated from auxiliary operations or services as described in section 2.2.2. It is likely that the process and non-process waste streams will include both hazardous and general (non-hazardous) wastes. Waste streams originating during the construction and decommissioning phases are also covered in this report. The differentiation of the various waste streams is indicated in Figure 4.1.

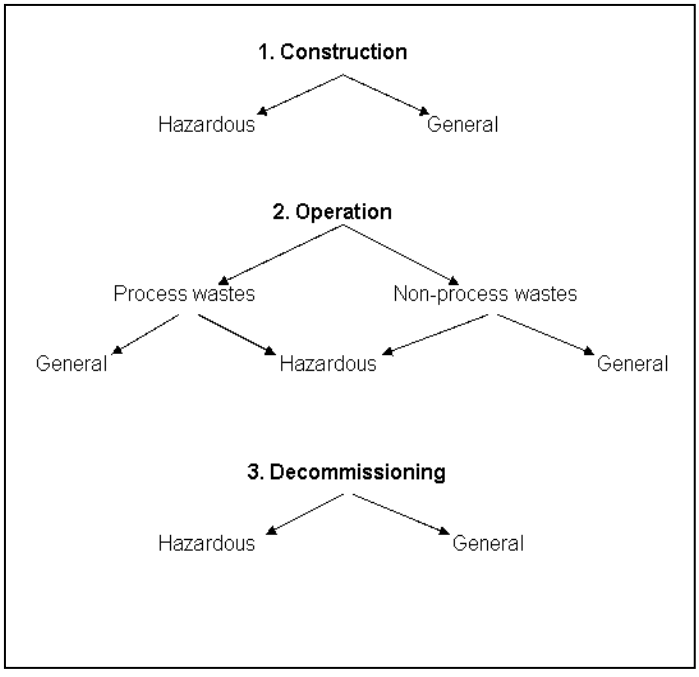

Figure 4.1: Differentiation of waste streams associated with a generic industrial development

A number of international guidelines provided useful information that was considered relevant to the project and included:

- Pollution Prevention and Abatement Handbook: General Environmental Guidelines (World Bank Group, 1998a)

- Pollution Prevention and Abatement Handbook: Management of Hazardous Wastes (World Bank Group, 1998b)
- Pollution Prevention and Abatement Handbook: Principles of Waste Avoidance and Utilization (World Bank Group, 1998c)
- The IFC General EHS Guidelines (2007).
- EHS Guidelines for Mining (2007)
- AfDB Guidelines for Mining Projects (1995)

In terms of rating of potential environmental impacts, the standard CES rating system was applied (Appendix D).

5 WASTE CLASSIFICATION AND QUANTIFICATION

5.1 Introduction

For the purposes of characterising the various waste streams likely to be produced over the entire life of the proposed facility, from construction through to decommissioning, the following section will be divided based on the key stages of the development including construction, operational and decommissioning phases.

5.2 Construction phase

It is expected that a significant quantity of solid waste and some sewage will be produced during the construction phase (Table 5.1) over a period of 8 to 12 months. To some extent, the quantity of waste (solid and liquid, including sewage), will depend on the duration of the construction phase i.e. the longer the construction phase, the greater the total quantity of waste likely to be generated.

5.2.1 Vegetation

Preparation for the construction phase will require clearing of existing vegetation from the site. Although the disposal route for cleared vegetation has not been specified, it has been assumed that the vegetation cleared from the land shall be disposed of by one or more different routes. These could include removal by local communities for construction, stockpiling and natural decomposition on-site wood chipping or burning. Usually, value added processes are preferred in the disposal of vegetation and the milling of felled trees in preference to chipping or mulching and is encouraged. However, chipping and mulching is preferred to on-site burning. On-site burning is usually permitted where it can be satisfactorily demonstrated that the requirement to mill and/or chip and mulch cleared vegetation would be an unreasonable imposition on the development. The loss of vegetation will need to be considered when calculating the overall greenhouse gas emissions for the project.

5.2.2 Solid wastes

In addition to the waste vegetation, waste streams likely to be produced during the construction phase will include both general (non-hazardous) and hazardous wastes and are expected to be similar in composition to the non-process wastes or co-products produced during the operational phase (see section 5.3 below). As such, the potential environmental impacts and mitigation measures will also be similar.

It is difficult to provide an estimate of the total quantity of non-process solid waste likely to be generated during this phase of the project. According to the World Bank Technical Paper No. 426 (Rushbrook and Pugh, 1999), the estimated rate of generation of domestic waste in developing countries is approximately 0.5kg per person per day, at an estimated density of 151kg/m^3. As such, a construction workforce of 300 to 500 individuals (maximum) could generate approximately 150 to 250kg of solid domestic waste per day, which equates to 1 to 1.7m^2 of solid waste generated per day. It is expected that this waste stream will be comprised predominantly of non-hazardous waste types including paper, plastic, cloth and some food waste. In addition, relatively insignificant quantities of hazardous wastes may be included in this waste stream, including batteries, empty containers for cleaning chemicals, fluorescent light tubes, pesticide aerosol cans, medical / clinic wastes etc. The construction and rehabilitation activities will also result in the generation of hazardous wastes including chemicals associated with machine and vehicle maintenance, oily rags and filters, empty containers for hazardous chemicals (paints, solvents, lubricants, herbicides, pesticides / herbicides) and electrical and electronic equipment. Non-hazardous wastes will be separated from hazardous wastes at source and all wastes will initially be stored on site in a dedicated area prior to safe disposal.

Based on information provided and as required by Article 9, Decree 13/2006 (Regulation of Waste Management), where possible, wastes will be separated for recycling and non-recyclable wastes should be disposed of at a general landfill. Considering the remote nature of the project site, it will be necessary to consider construction of such a facility at the mine site. This option is considered to be the best practicable environmental option (BPEO) over the medium- to long-term and is the preferred alternative when compared against the disposal at an existing landfill site given the remote location of the mine site and apparent challenges associated with management of solid wastes in Mozambique**.**

Regarding hazardous wastes, it would probably be possible to return used oils and lubricants to the suppliers or else have them recycled by approved agents within the country. The first aid station that will be located at the mine will most likely generate some medical waste that would need to be managed and disposed. Medical wastes typically associated with such a facility include small quantities materials described in Table 5.2. Much of the medical waste should be regarded as bio-hazardous and would therefore need to be disposed of by incineration, to render inactive, prior to its final disposal at the on-site landfill. Alternatively, the medical wastes should be transferred to the Balama Clinic, which is about 7km away, for proper disposal. The storage of medical waste should only be at the temporary hazardous waste storage facility. Regardless of what option that is adopted, all medical waste should be managed in accordance with the management procedure described in Annex 3 of the International Committee of the Red Cross (ICRC) Medical Waste Management (2011) and the requirements of the Mozambican legislation. Where there is a difference between these two sources of guidance, the most stringent should be applied.

Although the safe disposal of other types of hazardous wastes within the country is possible, the only available facility is the Mavoco landfill facility near Maputo, which is about 2 483,2 km away. Annex IX of the Regulation of Waste Management (Decree No. 13/2006) provides the basic norms and procedure for the transportation of hazardous wastes. It should be noted that in addition to the significant costs associated with transport of hazardous wastes over such long distances, the potential environmental, health and safety impacts associated with transportation of this material must also be considered. The most practical alternative is to treat by incinerating and or dispose of the hazardous waste in a dedicated and purpose-built cell in a new on-site landfill. The viability and acceptability of designing and constructing a dedicated cell for disposal of project-related hazardous wastes would need to be investigated, should this alternative be adopted. Alternatively, the transportation and export of hazardous wastes would need to comply with the requirements of the Bamako Conventions.

Irrespective of the disposal option, it will most likely be necessary to store at least small quantities of hazardous waste on site until the volumes are sufficient to warrant either off-site transportation or incineration. As such, it is advisable to construct a secure, bunded facility on the site for the temporary storage of hazardous wastes.

5.2.3 Sewage and wash water

Domestic sewage is characterised by a high concentration of nutrients, organic matter and a variety of pathogens. As such, it must be properly treated prior to discharge to avoid negative impacts to human and environmental health.

The construction workforce of approximately 300 to 500 individuals (at peak construction) will generate sewage and wash water that will need to be managed. Based on a low estimate of 0.025m^3 per person per day the total volume of domestic effluent requiring disposal during this phase will be 7.5 to 12.5m^3 per day. However, if a large proportion of the construction team are living on site and / or have access to bathing facilities then the volume of effluent requiring disposal could be closer to 0.2m^3 per person per day or a collective total volume of 60 to 100m^3/day. Sewage and other effluent from ablution facilities will be disposed by use of septic tanks. As the construction phase nears completion it may be an option to direct the sewage to a packaged sewage treatment plant and the treated effluent then sent to the process water dam from where it will be pumped to the process water tank to be used as recycled water for mineral processing. If

the treated sanitary effluent water is discharged onto the environment, it must meet national discharge standards and, preferably, the most stringent limits identified in Appendix A of this report.

The total quantity of effluent requiring disposal during the construction phase could be increased further by washing of equipment such as machinery and vehicles although the exact quantities produced by these activities cannot be determined. Wash water from vehicles frequently contains at least small quantities of hydrocarbons (oil, grease etc.) and, as such the washing of vehicles and machinery should be conducted only at permitted and well selected designated wash bay where wash water is collected and routed through a grease trap/oil-water separator prior to discharge.

5.2.4 Storm water

In addition to sewage and wash water, the storm water will also be generated during the construction phase. This discharge is discussed in greater detail in Section 5.3.2.

A summary of waste expected to be generated during the construction phase of the project is provided in Table 5.1 below.

Table 5.1: Summary of expected solid and liquid waste streams associated with the construction phase of the Syrah Resources Graphite project

Phase	Waste Type	Estimated Quantity	Management & Disposal
Construction	General (non-hazardous) solid waste	Unknown but at least 1 to 1.7m^3 (150 to 250kg/day) of solid domestic waste per day	As required by Article 9 of Decree 13/2006 (Regulation of Waste Management), Syrah Resources will embark on the separation of non-hazardous, hazardous and recyclable wastes at source. Where considered practical, recyclable wastes will be sent to approved agents for recycling and the remaining non-hazardous wastes will be disposed of in a landfill.
	Hazardous solid & liquid waste	Unknown but relatively limited	Separated at source from general wastes. Stored on site at a secure temporary hazardous waste storage facility with secondary containment and then sent to licensed hazardous waste disposal agents. Alternatively, it is proposed that hazardous waste is incinerated and or encapsulated before disposal at the on-site landfill site that has been designed to accept and effectively contain waste of this type.
	Sewage / domestic wash water	~60 to 100m^3/day	A packaged sewage treatment plant will be utilised and the treated effluent sent to the process water dam for recycling. Lined Ventilated Improved Pit (VIP) latrines would need to be considered for field operations, particularly near the mine pit.
	Machine and vehicle wash water	Variable	Contained and passed through oil-liquid separator prior final disposal at the process water dam.
	Storm water	Variable	Where possible, diverted around sources of contamination and then discharged to the environment. Where required, pre-treatment such as settling may be required.

5.3 Operational Phase

Waste generated during the Operation Phase will include process and non-process related waste streams.

5.3.1 Process wastes

Process related waste streams that will be associated with the Syrah Resources Graphite project include;

- Spillage of the ROM resulting from trucking of the material over a combined distance of 4 km may result in the heavy metal contamination of soil (Craig Vogt 2012);
- Process tailings from the thickener underflow are pumped out to the tailings dam. Chemical composition of the tailings slurry pose a potential source of surface and groundwater contamination;
- Waste rock (over-burden) from the east and west pits will be generated over the life time of the mine. This material has the potential to generate acid mine drainage.

Environmental impacts from graphite mills consist of air pollution including fine particulate exposure of workers and also soil contamination from powder spillages leading to heavy metals contaminations of soil. Issues relating to air pollution will be covered in the Air Quality report and will not be dealt with here.

Some rocks mined in quarries or mines may contain sulphides that convert to sulphates during mining and are soluble in contact with water. Such acid drainage waters can cause the release of heavy metals. Fossil materials such as coal and graphite containing carbonaceous matter, formed in a reducing medium, combined with iron sulphides (pyrite) result in the formation of acid mine drainage. The extent, to which ground and surface water quality will be affected during mining of the graphite deposit, will most probably be driven by possible acid rock drainage from the waste rock piles, tailings impoundments and from the exposed rock face. This process will be influenced by the percentage of sulphide minerals present, the particle size and oxygen ingression of the rocks.

Available information suggests that sulphide minerals (notably pyrite and chalcopyrite, sphalerite and pyrrhotite), is associated with quartz veins (Twigg Exploration, 2012) as well as intergrown with graphite (Ashley, 2012). Preliminary tests show the presence of 0.01% sulphur in the processed ore and sulphide levels in the discard are expected to range from 0.5 – 1% (Balama Scoping Report, 2012). It was also noted that some carbonate minerals are present in the host rocks, which could buffer acid generation. Further details confirming the acid mine drainage potentials of the site can be found in the Balama Graphite Geochemistry report (Digby Wells, 2014)

5.3.2 Non-process wastes

In addition to the waste streams originating directly from the graphite mining and processing, ancillary operations associated with the proposed project are likely to generate a variety of solid and liquid waste streams, both general (non-hazardous) and hazardous, that will require management. These waste streams will be generated during the construction, operational and decommissioning phases.

General (non-hazardous) solid wastes

All elements of the proposed development will contribute to the general waste stream from the facility. While it is possible to predict with some degree of certainty the types of waste that will be produced, it is extremely difficult to estimate the quantities of the different non-process general waste types.

During the operational phase, the proposed development will employ approximately 250 individuals once fully operational. The expected volume of solid waste generated by this workforce during the

operational phase will be slightly lower than those generated during the construction phase and will equate to 0.83m^3 /day (125kg/day) at an estimated density of 151kg/m^3.

In addition to the above, it is expected that the auxiliary services (administration, workshops, laboratories etc) of the proposed operations will generate general waste. This waste stream could therefore include vegetable / food waste, paper, cardboard, plastic, rubber, glass and a variety of synthetic compounds.

These wastes will be managed as described in Section 5.2.2 of this report.

Hazardous waste (solid and liquid)

Due to the nature of the proposed operation, it is likely that all of the ancillary services that produce general waste will also produce a range of hazardous liquid and solid wastes. A definition of hazardous waste is provided in Section 3.2 of this report and they normally exhibit properties including toxicity, corrosivity or flammability. Types of non-process hazardous wastes that may be associated with this development are described in Table 5.2. Based on information provided by the client, there will not be any sources of radioactive waste generated by the operation.

Table 5.2: Typical non-process hazardous waste (solid and liquid) likely to be produced during the operational phase of a generic industrial development

Service / area	Typical hazardous wastes
Packaged sewage treatment plant	Sewage sludge.
First aid stations	Sharps (needles & blades), bandages, expired medication, gloves, biological waste
Workshops / maintenance activities	Chemical containers, solvents, paints, hydrocarbon products including waste lubricating oil, oily rags and vehicle parts and machinery, batteries, hydrocarbon-contaminated absorbent material used to clean up spills
Administration	Electronic equipment, fluorescent tubing, solvent-based cleaning agents, pesticide cans
Canteen / kitchen	Used cooking oil
Vehicle wash bay and bunded fuel and waste storage areas	Wastewater containing hydrocarbons, fertilizer and pesticides

Although it is not possible to accurately quantify all of the non-process hazardous wastes until the facility is operational, it is expected that the quantities will be low during the operational phase.

In terms of the management of hazardous waste streams it would be considered BPEO to adopt a waste management hierarchy whereby the production of these wastes is prevented or minimised as far as possible. Where these wastes are produced they should be recycled wherever practical. In terms of the *Precautionary Principle* which underpins the NEMP (1995) (described in Section 3.4.3), all wastes should be considered hazardous unless proven otherwise. It is essential to separate hazardous and general wastes and correctly label all wastes. Unknown wastes must be regarded as hazardous and managed and disposed as such. The challenges and options for disposal of hazardous wastes are discussed in Section 5.2.2.

Certain hazardous waste types are considered to require specific consideration and are discussed below.

Sewage

During the operational phase, the proposed facility will not have access to the municipal sewage reticulation network and will thus have to rely on the use of, most likely, a packaged sewage treatment plant to cater for the sewage emanating from the facilities. Based on a workforce of 250 individuals, it is unlikely that the total volume of sewage requiring disposal will exceed $50m^3$/ day (assuming that $0.2m^3$ of effluent is generated per person per day). The presence of hazardous chemical contaminants is unlikely when the domestic sewage is not combined with industrial effluents, machine wash water or with effluent from the laboratory, which should be prohibited. The treatment and disposal of sewage has been described in section 5.2.3 above.

Occasionally, sludge from the septic tanks and the sewage treatment package plant may have to be removed and this material, which should be regarded as hazardous due to the potential pathogen content, must be disposed of in accordance with the EHS Guidelines for Water and Sanitation (2007). Within the urban context the sewage sludge could be transferred to a municipal treatment plant for final treatment to a permissible quality for disposal. However, in the current context, this is not practical. As such, the sludge would need to be stabilized by drying in purpose-build beds or composting. The latter requires mixing the sludge with additional sources of carbon such as sawdust, straw or wood chips in the presence of oxygen to enable the indigenous bacteria to digest both the sludge and the added carbon source. The stabilized sludge can then be dried and either disposed at the proposed landfill or alternatively, applied as a soil conditioner during rehabilitation of the mine, provided that levels of toxic constituents is sufficiently low. If soil application is adopted, soil contamination should be avoided and the soil standard prescribed by the AfDB (Appendix C) should be adhered to.

Medical wastes

As described in section 5.2.2 there are two potential disposal options for medical waste. One is to transport this material to the Balama regional clinic for safe disposal. Another would be to incinerate the material on site to render it harmless and then dispose of it at the on-site landfill. Both options of medical waste management should be in accordance with the management procedure described in Annex 3 of the ICRC Medical Waste Management (2011).

Laboratory and other process reagent wastes

A project of this nature is also likely to require a laboratory for product quality control and a liquid reagent area for the storage of reagents such as paraffin and flocculants. Such facilities are likely to generate small quantities of both general and hazardous waste, in liquid, solid and gaseous forms. The laboratory wastes, including hazardous wastes, will require safe disposal and options for disposal of hazardous waste from this development are discussed in Section 5.2.2. Separation and correct labelling of laboratory waste is essential as is correct temporary storage. Laboratory effluents (including rinse water) must not be routed to the packaged sewage treatment plant as these waste chemicals can result in the operational failure of the plant. Instead, chemical wastes may be stored in labelled containers that are sealed and disposed as hazardous waste, while rinse water should be routed to a lined evaporation pond.

Storm water, wash water and other runoff

It is important to consider the potential environmental impacts associated with storm water and other run-off. This will include run-off from the stockpiles, waste rock dump and mine pit. The primary threat posed by storm water is that as it has the ability to pick up contaminants, including hydrocarbons, heavy metals, pesticides and nutrients as it moves across a project area. If not managed correctly, these contaminants may then be transported, via the storm water, into areas where they could pose a threat to human and environmental health.

The exact quantity of contaminated water requiring careful management and treatment prior to release from the site is likely to be highly variable and largely dependent on seasonal rainfall. Storm and machine wash water should be kept separate from the sewage. This would need to be addressed in the design of the storm water system for the site which should take into consideration the use of sealed manhole covers.

Table 5.3 provides a summary of non-process wastes likely to be associated with the project.

Table 5.3: Summary of non-process solid and liquid waste streams associated with the operational phase of the Syrah Resources Graphite project

Waste Type	Estimated Quantity	Management & Disposal
General (non-hazardous) solid waste	Variable	Separated at source from hazardous wastes. Recycle where possible and dispose of remaining waste at a landfill.
Hazardous solid & liquid waste	Variable but limited	Separated at source from general wastes. Stored on site at a temporary hazardous waste storage facility with secondary containment until exported for safe disposal. Alternatively, the hazardous waste is incinerated and or encapsulated before disposal at the on-site landfill site that has been designed to accept and effectively contain waste of this type.
Sewage / wash water	$50m^3$/ day	Sewage generated from the facilities will be treated at the packaged sewage treatment plant. Sewage from other facility areas, such as mine site, will probably be treated via septic tank systems or VIPs.
Medical waste	Variable but limited	The medical waste generated will be collected and sent to the Balama Clinic for disposal. Alternatively, the medical waste will be incinerated on-site. The medical waste should be managed in accordance with the ICRC Medical Waste management requirement (2011).
Storm water	Variable and expected to be high, especially during the raining season	The storm water will be managed according to procedures that would be described in the Storm water Management Plan.
Vehicle wash water	Variable but potentially high	All water from vehicle wash bays will pass through an oil-water separator prior to discharge at the process water dam.
Laboratory waste	Variable but limited	Laboratory wastes effluent will be separated from the sewage lines. Temporary storage of these wastes will be in a secure facility with secondary containment. As far as possible, these wastes will then be returned to the supplier or, if not possible, then disposed of with other hazardous waste.

5.4 Decommissioning Phase

The plant operation is expected to last for a period of approximately 50 years. This will result in both general (non-hazardous) and hazardous waste that will require disposal. At this early stage it is not possible to accurately predict the exact nature and quantities of wastes produced during decommissioning although non-hazardous wastes will most likely include rubble, piping, metal, plastic, glass etc. Hazardous wastes could include any materials, including tanks and pipes that

have been used to store or transport hydrocarbons. The quantity and management options would need to be accurately assessed prior to decommissioning.

6 ASSESSMENT OF POTENTIAL ENVIRONMENTAL IMPACTS

6.1 Introduction

This chapter deals with waste related impacts that were identified as a result of the Syrah Balama Graphite project. These include all process and non-process related waste streams, including waste generated from all ancillary facilities.

Issues 1 to 4 below are process waste-related issues resulting from a graphite mining and processing. Issues 5 to 7 are non-process related wastes issues, while issue 8 is a non-process related cumulative waste issue. The impact rating scales used can be found in Appendix D.

6.2 Impacts associated with process wastes

6.2.1 Issue 1: Disposal of waste rock and tailings

Tailings and waste rock will be generated from the graphite mine throughout the life of the mine.

Impact 1.1: Health and safety of employees and local communities

Cause and comment

The TSF will be designed by an independent globally recognised expert in tailings dam design and will be managed according to best practice. However, the communities of Nquide, Ntete, Maputo and Pirira are within the footprint of the project site, with Pirira located close to the West Pit. In the highly unlikely event of a TSF failure, unstable tailings material could pose a risk to members of nearby communities. In addition, there is also a chance of small scale instability events on the slopes of the rock dumps which may result in injury to employees working at the dumps. However, these risks would normally be managed along with other routine occupational health and safety risks.

Significance statement

A long term impact may occur within the study area and due to the potential for harm to individuals, including possible fatalities the severity of the impact is regarded as high. Without mitigation, significance will be **HIGH** and with mitigation, this could be reduced to **LOW** significance.

Mitigation measures

- The management of waste rock and tailings will conform to the requirements of the IFC's EHS Guidelines for Mining (IFC, 2007);
- Develop practices in terms of design and operation to prevent sediment run-off, inclusive of cut-off drains.
- As above, as far as practical, the waste rock dump and TSF must be sited in a location such that in the event of failure, pollution of soil and water as well as physical risk to communities is minimised;
- The integrity of the waste rock dump and tailings facility must be inspected regularly by suitably qualified personnel throughout the life of the mine;
- Access to the TSF and waste rock dump should be restricted as far as practical and all local communities should be informed of the potential risks associated with these facilities through site notices and community meetings.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Issue 1: Disposal of waste rock and tailings						
Impact 1.1: Health and safety of employees and local communities						
Long Term	Localized	May Occur	High	**HIGH**	Slight	**LOW**

6.2.2 Issue 2: Spillage of Run of Mine while Trucking

Impact 2.1: Disruption of ecological function

Cause and comments

The transportation of extracted ore by trucking to the processing facility is anticipated to result in the some spillage of the ore materials on land. The ore material contains heavy metals that would be dispersed during transportation. Over time, this would accumulate resulting in the heavy metal contamination of soil (http://medbib.com/Graphite). Spilled material could also result in increased turbidity of water bodies and smother plants.

Significance statement

Heavy metals have the tendency to accumulate within living organisms and can interfere with normal physiological processes leading to disruption of ecosystems. The disruption of ecosystems by heavy metals was determined to be Localized. Without mitigation the significance was considered **MODERATE** and with mitigation it was considered to be **LOW**.

Mitigation measures

- Avoid overloading the trucks with ore;
- Clean-up significant spillages, as soon as possible;

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Issue 2: Spillage of Run Of Mine						
Impact 2.1: Disruption of ecological functions						
Long term	Localized	May occur	*Moderate*	MODERATE	*Slight*	**LOW**

6.2.3 Issue 3: Storage of effluent in the process water pond

The Process Water Pond will serve as the collection point for the decant water from the tails, regrind mill and overflows. This effluent water is anticipated to contain some levels of process feed. The effluent water in the Process Water Pond will be diluted with water make-up from the environment and re-circulated to the plant raw water system for crusher dust suppression, reagent mixing, flocculant make-up, and to the plant water supply system.

It is anticipated that the re-circulated water in the Process Water Pond will contain at least low concentrations of heavy metals and frothers. Over time, the re-circulation and evaporation may result in an increase in the concentration of the abovementioned compounds. The presence of a large pond containing process water containing potentially harmful substances could pose a threat to environmental contamination, particularly if the pond was to overflow after a period of heavy rainfall.

Impact 3.1: Pollution of soil and water resources

Cause and comment

In the event that the pond overflows or is otherwise compromised, the accidental release of stored process water and associated sediment, could lead to pollution of water resources and soil and an increase in the turbidity of nearby water bodies. The potential consequences of increased turbidity include reduced light penetration and growth of aquatic plants. This could have subsequent, long-term negative impacts on local ecosystems and human health.

Significance Statement

The impact of the pond water released into the ecosystem without mitigation was considered to be very severe with a **MODERATE** significance and with mitigation it was considered to be **LOW** with a slight severity.

Impact 3.2: Risk to Health and Safety of Employees

Cause and comment

Water from the TSF will be captured in a pond prior to blending with the input process water to the plant. The presence of a large pond containing process water which contains potentially harmful substances will pose a threat to the health and safety of employees. Access to the pond by individuals who are not able to swim may result in drowning.

Significance Statement

It is possible that without mitigation, an employee could fall into the TSF/pond and drown. As such, the impact to human health and safety without mitigation was considered to be *very severe* with a **HIGH** significance. The likelihood of the impact occurring could be reduced through implementation of mitigation measures. With mitigation, the overall significance of the impact is expected to be **LOW**.

Mitigation measures

- The TSF and process water storage pond will be fenced off and the gate locked at all times to limit unauthorised access;
- As drowning from falling into the water is a heightened risk employees should wear a floatation device when working within the fenced off area. In addition, flotation devices will be readily available around the facility;
- Incorporate water body risks into the Health & Safety induction training;
- Conduct periodic inspections of the integrity of the TSF and Process Water Pond by an independent and suitably qualified and experienced engineer;
- Ensure the operation of all facilities containing water maintains sufficient freeboard to ensure that the ponds do not overflow;
- Monitor the quality of the stored process water so that in the event of accidental discharge, the contaminants released into the environment are known.
- Place warning notices and “do not enter” signage around such facilities.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Issue 3: Storage of water in the Process Water Pond						
Impact 3.1: Pollution of soil and water resources						
Without mitigation					**With mitigation**	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Medium Term	Localized	Unlikely	Very Severe	MODERATE	Severe	**LOW**
Impact 3.2: Risk to health and safety of employees						
Without mitigation					**With mitigation**	
Medium Term	Localized	Unlikely	Severe	HIGH	Slight	**LOW**

6.2.4 Issue 4: Disposal of potentially hazardous process chemicals

Impact 4.1: Risk to health and safety of employees

Cause and comment

Certain of the bulk chemicals used in the process such as paraffin as flotation agent and associated wastes are classified as hazardous (SANS 10234:2008). They will be managed according to the IFC's General EHS Guidelines (2007).

Significance Statement

The storage of process-related hazardous chemicals (paraffin) and associated wastes constitutes a risk to the safety of employees but this risk can be reduced relatively easily through operational procedures. With and without mitigation it was deemed to be of **MODERATE** and **VERY HIGH** significance, respectively.

Mitigation measures

- The TSF and process water storage pond will be fenced off and the gate locked at all times to limit unauthorised access;
- Flotation devices will be readily available around the facility;
- The Health & Safety induction training should incorporate these risks;
- The integrity of the TSF must be inspected regularly by an independent and suitably qualified and experienced engineer;
- The operation of the facility must ensure sufficient freeboard to ensure that the pond does not overflow;
- The quality of the stored process water should be monitored so that in the event of accidental discharge, the contaminants released into the environment are known.
- Warning notices should be placed around such facilities.

Impact 4.2: Pollution of water resources and soil

Cause and comment

The release of hazardous chemicals such as paraffin to the environment will result in the pollution of soil and water resources (including surface and ground water), which are used by local communities in the proximity of the project area. Pollution may arise from the accidental release of stored chemicals or uncontrolled storage and disposal of empty chemical containers.

Significance Statement

The negative impacts, including death of fauna and flora and, potentially humans, may be long term. With and without mitigation it was deemed to be of **MODERATE** and **VERY HIGH** significance, respectively.

Mitigation measures

- All chemicals used on site must be stored and disposed of according to the legislation and international BPEO;
- Chemicals must be stored in secure, bunded designated areas;
- Material Safety Data Sheets (MSDS) must be readily available for all chemicals at the point of storage and use;
- An Operational Procudure - Hazardous Chemical Management must be developed for the facility and must include detailed spill response procedures;
- Chemicals that may react in a dangerous manner should not be stored within the same bunded area;
- 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;
- An Emergency Preparedness and Response Operating Procedure must be developed for the facility;
- Any facility for the bulk storage of flammable liquids, including fuels, must be designed and operated according to best practice;
- All hazardous chemicals of a volume equal to or greater than 250 litres must be stored in a bunded facility that complies with the legislative requirement and good practice;
- An Operational Procedure - Waste Management must be developed for the facility which includes measures to ensure that all chemical wastes and empty chemical containers are managed and disposed of according to the requirements of legislation and best practice.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Issue 4: Disposal of potentially hazardous chemicals						
Impact 4.1: Risk to health and safety of employees						
Long Term	Localized	May occur	Severe	VERY HIGH	Slight	**MODERATE**
Impact 4.2: Pollution of water resources and soil						
Long Term	Localized	May occur	Severe	VERY HIGH	Slight	**MODERATE**

6.3 Impacts associated with non-process wastes

In addition to the waste streams originating directly from the process, there are likely to be a number of other general and hazardous waste streams associated with the project that will require management. These waste streams will be generated during the construction, operation and decommissioning phases. There is likely to be a large variety and quantity of non-process solid and liquid wastes associated with the proposed development. While the project proponent plans to recycle a large proportion of these, temporary storage may still be required. Where a single issue is potentially associated with more than one impact and where significance ratings and mitigation measures are similar, these have been discussed together.

6.3.1 Issue 5: Management of non-process general and hazardous wastes (Construction, Operation and Decommissioning)

Impact 5.1: Pollution of land and water

Cause and comment

Inappropriate storage of wastes, particularly those exhibiting harmful properties (i.e. hazardous wastes), can result in the contamination of land and water resources. As a result of rainfall events, leachate may be formed as water percolates through the solid waste, and this leachate may contain nutrients and a variety of toxic compounds, including metals. As such, it could result in the contamination of water and land. In extreme cases, release of large quantities of nutrients to a water body can result in eutrophication. The presence of certain toxic compounds in water as a result of pollution by wastes may have significant long-term negative impacts on the aquatic ecosystems and render the water unsuitable for certain applications including human consumption.

Mitigation measures (General wastes)

- Manage wastesaccording to the requirements of Mozambican legislation and, preferably, the requirements of the IFC General EHS Guidelines (2007);
- General wastes that cannot be reused or recycled should be stored temporarily in a dedicated area and then transported regularly to the proposed landfill for disposal;
- The proposed general landfill site must be sited, designed and operated to international standards in order to isolate the wastes and prevent environmental contamination, particularly groundwater contamination (EHS Guidelines for Waste Management Facilities 2007 and EPA 2000) and must be licenced by the developer early in the construction phase. Until such time as this 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;
- It will be essential to implement a ground water monitoring system in the vicinity of the constructed landfill site in order to detect any changes to the quality of sub-surface water;
- Cover bins for temporary storage of waste that are located outdoors should be covered to prevent ingress of water and access by animals;
- Develop a comprehensive Integrated Waste Management Plan should be developed for the site and it should include Key Performance Indicators (KPIs) against which the management of wastes can be audited;
- Inform employees, contractors and visitors to the site must be informed of correct waste management procedures, including separation of general and hazardous waste at source;
- Locate waste storage and disposal areas must be located at least 100m from surface water resources or important drainage lines.

Mitigation measures (Hazardous wastes)

- Cover the management of hazardous wastes within the Integrated Waste Management Plan for the facility;
- Prior to safe disposal, all hazardous wastes will be temporarily stored at the temporary hazardous waste storage facility. This facility should be designed to include secondary containment lined and covered to protect the contents from weather (sunlight and rain). If wastes are corrosive, the base of the storage facility should be lined with an acid-resistant coating;
- Return where possible, empty containers for hazardous chemicals to suppliers. Where empty containers for hazardous chemicals (hydrocarbons, pesticides, laboratory chemicals, degreasing agents etc.) cannot be returned to the suppliers, they must be triple-rinsed, punctured and stored in a secure area until such time as they can be disposed of safely. Rinse water may not be discharged directly to the environment;

- Dispose of empty pesticide containers according to the Food and Agricultural Organisation's Guidelines on Management Options for Empty Pesticide Containers (Food and Agriculture Organisation (FAO) 2008);
- A hydrocarbon management Operating Procedure should be designed and implemented. Copies of this document should be made available at designated facilities where hydrocarbons are used or stored. The purpose of this procedure is to provide for the proper storage and handling of hydrocarbons, including waste hydrocarbons, on site and hence prevent any form of contamination;
- Remove and dispose of soil contaminated with hydrocarbon at a soil bioremediation facility on site or else disposed of as hazardous waste;
- MSDS for all chemicals must be readily available on site and the precautions stipulated in these must be adhered to at all times. Staff to be trained on the correct management of bunded facilities, including the discharge of collected liquids;
- Spill kits must be readily available at strategic points throughout the site and staff must be trained on the correct use of these kits;
- No hazardous wastes should be disposed of into drains as this may impact negatively on the performance of the septic tanks;
- There are two potential disposal options for medical waste which must be managed according to the management procedure described in Annex 3 of the ICRC Medical Waste Management (2011) and the requirements of the Mozambican legislation. The first would be to transport this material to the Balama regional clinic for safe disposal. The second would be to incinerate the material on site to render it harmless and then dispose of it at the on-site landfill.

Significance statement

Impacts associated with the management of general (non-hazardous) solid waste may occur and the impacts are potentially long-term. The extent of the impacts (excluding potential impacts to water resources which are assumed to be covered in the Surface Water specialist report) are likely to be limited to the *study area*. Without mitigation the impacts will definitely occur and should *probably* be regarded as ***moderately severe.*** With the recommended mitigation the severity could be reduced to ***slight***. The overall significance of the impact without mitigation would be MODERATE but with mitigation would be LOW.

Based on the most likely nature of non-process hazardous wastes, impacts may occur and, due to the potential for certain hazardous substances to accumulate in the environment, are potentially permanent. Due to potential transport of these substances into water, their impact may be of significance to the district. Without mitigation the impacts will definitely occur and would probably be regarded as ***very severe*** and of VERY HIGH significance. However, with mitigation the severity could be reduced to ***moderate*** and the overall significance of the impact would be MODERATE.

Without mitigation					**With mitigation**	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
ISSUE 5: Management of non-process general and hazardous wastes (All phases)						
Impact 5.1: Pollution of land and water						
General (Non-hazardous) wastes						
Long term	*Study area*	Probable	*Moderately Severe*	MODERATE	*Slight*	**LOW**
Hazardous wastes						
Permanent	*District*	Probable	*Very Severe*	VERY HIGH	*Moderate*	**MODERATE**

Impact 5.2: Nuisance impact (Production of odours, visual impact and attraction of pest and vermin)

Cause and comment

The uncontrolled storage of solid waste, in particular food waste, can attract vermin and pests including rodents, birds and flies. These vermin / pests may pose a nuisance to adjacent communities of Nquide, Ntete, Maputo and Pirira and may act as vectors for disease. The uncontrolled storage of solid waste can result in the release of unpleasant odours which may be regarded as a nuisance to adjacent land-users, particularly that down-wind of the material. Odorous compounds are also released from relatively well-managed solid waste disposal facilities. The presence of large quantities of litter around the facility or at the proposed landfill may constitute a visual impact to employees and local communities.

Mitigation measures

Refer to mitigation measures for Impact 5.1 (above).

Significance statement

Nuisance impacts associated with the management of solid waste will *probably* occur and the impacts are potentially long-term but limited to the *study area*. Without mitigation the impacts should *probably* be regarded as *moderately severe* but with mitigation the severity could be reduced to *slight*. The overall significance of the impact without mitigation would be **MODERATE** but with mitigation would be **LOW**.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Impact 5.2: Nuisance impact (Production of odours, visual impact and attraction of pest and vermin)						
Long-term	District	Probable	*Moderately severe*	MODERATE	*Slight*	**LOW**

6.3.2 Issue 6: Disposal of domestic wastewater and sewage sludge (Construction, Operation and Decommissioning)

Impact 6.1: Pollution of soil and water

Cause and comment

Domestic sewage is characterised by a high concentration of nutrients, high organic matter and a variety of pathogens. As such, it must be properly treated prior to discharge to the environment to avoid negative impacts to human health and the environment. If untreated sewage is discharged to the environment, the high nutrient concentration could lead to eutrophication of surface water resources and subsequent disruption of ecological function within the aquatic environment. The sewage sludge from sanitary treatment facilities would have to be removed periodically. The sludge would have to be treated and disposed of as described in section 5.3.2. Sewage sludge also contains high concentrations of nutrients and may have a similar impact on water resources if not stored and disposed of in a manner that minimises the likelihood of migration of contaminants from the sludge to water resources.

Mitigation measures

- Domestic wash water and sewage will be diverted to the septic tanks or packaged sewage treatment plants for treatment. Discharge from these facilities will meet discharge standards prior to release into the process water pond. Sewage sludge from these facilities will be managed as described in the EHS Guidelines for Water and Sanitation (2007). This includes to stabilize by drying in purpose-built beds or composting. The stabilized sludge can then be dried and either disposed at the proposed landfill or alternatively, applied as a soil conditioner during rehabilitation of the mine, provided that levels of toxic constituents is sufficiently low. If soil application is adopted, soil contamination will be avoided and the soil standard prescribed by the AfDB (African Development Bank, 1995) will be adhered to.
- Pre-treat oil and grease containing effluents from canteens with a grease trap prior to discharge into sewage treatment facilities;
- If possible Chemical toilets will not be used during the construction period unless the contents can be disposed of in a manner that does not pose a threat to the environment. Instead, alternatives such as VIPs, composting toilets or similar will be considered as preferred alternatives;
- If VIPs are used, they must be lined, maintained and sited in a way that minimises the risk of contamination of surface and sub-surface water resources;
- All sewage treatment facilities should be well maintained. To this end, at least one employee on site must be trained to maintain the system(s);
- The performance of the sewage treatment systems must be monitored regularly. Where a system is found to performing poorly, the cause of the poor performance must be investigated timeously and remediation measures put in place to restore performance;
- In the event that sludge must be removed from the system(s), it must be disposed in a manner that minimises potential risk to human health and the environment and should comply with the National legislation;
- The environmental monitoring programme for the facility must incorporate monitoring points that are able to detect a negative impact on the environment associated with the discharge of treated sewage.

Significance statement

Environmental impacts associated with the disposal of sewage will definitely occur. As the proposed project will be operational for approximately ~50 years, impacts associated with the release of untreated effluent and poor sludge management are potentially long-term and may affect the *study area.* Without mitigation the impacts on soil and water would probably be *moderately severe* and of **MODERATE** significance. However, with implementation of the recommended mitigation measures the severity of the impacts would be *slight* and of **LOW** significance.

Without mitigation					**With mitigation**	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
ISSUE 6: Disposal of domestic wastewater and sewage sludge (All phases)						
Impact 6.1: Pollution of soil and water						
Long-term	*Study area*	Probable	*Moderately severe*	MODERATE	*Slight*	**LOW**

Impact 6.2: Health impacts to employees and communities

Cause and comment

Sewage and sewage sludge is normally characterised by high concentrations of pathogenic microorganisms (viruses and bacteria) and helminths. Exposure to untreated effluent, either directly or through contaminated water resources, can result in the spread of numerous diseases including cholera.

Mitigation measures

Refer to mitigation measures for Impact 6.1 above. In addition, the following mitigation measures are applicable:

- Any employees tasked with management of sewage and sanitation systems will be vaccinated against key diseases associated with these waste streams.

Significance statement

Pathogenic microorganisms are commonly found in untreated sewage and release of these organisms to water bodies used for irrigation, drinking, recreation or fishing can result in the spread of disease such as cholera. The health impacts associated with the release of untreated sewage effluent and poor sludge management are potentially long-term and may affect the *district.* Without mitigation the associated health impacts would probably be *severe* and of **HIGH** significance. However, with implementation of the recommended mitigation measures the impacts would be of *slight* severity and of **LOW** significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Impact 6.2: Health impacts to employees and communities						
Long-term	District	Probable	*Severe*	MODERATE	*Slight*	**LOW**

Impact 6.3: Nuisance impacts (odour and flies)

Cause and comment

Raw sewage, sewage sludge and sewage treatment facilities are frequently associated with the release of unpleasant odours and may attract large numbers of insect pests such as flies. The persistent odours and presence of insect pests would most likely be regarded as a nuisance to employees and local community members. If sewage is managed correctly, the level of these nuisance factors can normally be reduced significantly.

Mitigation measures

Refer to mitigation measures for Impact 6.1 above.

Significance statement

The management of sewage will definitely be associated with odours and insect pests and, due to the influence of wind, the impact on any one receptor would probably be short-term. The treatment plant will, however be relatively small and so the impact is likely to be confined to the *study area*. There are also currently no communities in the immediately vicinity of the mine. Without mitigation the impacts would probably be *Moderately Severe* and of **MODERATE** significance. However, with implementation of the recommended mitigation measures the impacts would probably be of *slight* severity and of **LOW** significance.

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Impact 6.3: Nuisance impacts (odour and flies)						
Short-term	Study area	Probable	Moderately *Severe*	MODERATE	*Slight*	**LOW**

6.3.3 Issue 7: Disposal of run-off / storm water

Impact 7.1: Pollution of land and water

Cause and comment

Run-off water is likely to be generated on site as a result of the high rainfall, washing of machinery (including vehicles) and, possibly, dust suppression activities. As this water migrates across the site it has the potential to pick up various pollutants such as hydrocarbons and small solid particles. Furthermore, the run-off from machine washing activities is also likely to contain hydrocarbons. If this water is discharged without treatment, chemicals (hydrocarbons, pesticides etc.) and sediment could be transported into surface and sub-surface water bodies, resulting in ecological disruption.

Mitigation measures

- The management of all run-off must comply, as a minimum, with the requirements of Mozambican legislation but preferably with the requirements of the IFC's General EHS Guidelines (2007);
- Develop a Storm Water Management Plan for the mine and incorporate measures to divert clean storm water away from stockpiles, waste storage and disposal areas and other operation areas;
- Aim to reduce contact between storm water and hazardous chemicals. This will be considered during the planning of the storm water drainage system for the mine facilities;
- In terms of minimising discharge of pollutants and run-off quantity requiring treatment, all storm water run-off must be properly segregating and clean water run-off diverted to prevent it mixing with water containing a high solids content, to minimize the volume of water to be treated prior to release;
- Run-off from machine wash areas will pass through an oil trap. Other run-off water will pass through a sediment trap to remove the majority of suspended solids prior to discharge to the environment. All settled material will be disposed of at the landfill; and
- The quality of all liquid waste streams discharged from the site, including storm water, must be monitored regularly to ensure compliance with the requirements of relevant legislation and standards.

Significance statement

Impacts associated with the disposal of run-off may occur and the impacts are possibly Long-term and, considering the relatively dry climate, impacts may be of significance to the *study area*. Without mitigation the impacts should be regarded as *moderately severe* but with mitigation the severity could be reduced to *slight*. The overall significance of the impact without mitigation would be **MODERATE** but with mitigation would be **LOW**.

Without mitigation					**With mitigation**	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
ISSUE 7: Disposal of run-off / storm water						
Impact 7.1: Pollution of land and water						
Long-term	*Study area*	Possible	Moderately *Severe*	MODERATE	*Slight*	**LOW**

6.4 Cumulative impacts

6.4.1 Issue 8: Regional waste profiles and community awareness

In addition to consideration of direct impacts associated with the production of waste streams by the proposed development, it is also necessary to consider the cumulative impacts which may manifest as a consequence of multiple large-scale commercial developments within the region. With respect to waste management, key considerations are the change in the profile of waste streams produced by local communities and awareness of local community members about the management wastes. Each of these is discussed in more detail below.

Impact 8.1: Local knowledge of waste management practices

Cause and comment

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 of the need for and BPEO regarding management of waste streams is expected to be limited. While a limited knowledge of waste management may not pose a significant risk while communities subsist largely off agriculture and 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 the waste profile change 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 non-biodegradable materials and even small quantities of hazardous wastes (e.g. batteries).

It is expected that a significant proportion of the employees at the developer's mine 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 at such operations, these local community members will be trained on 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.

Mitigation measures

- Train all employees on the importance of proper management of waste streams and sanitation;
- Consider options to facilitate improved management of solid waste in local communities. This may include allowing local communities to dispose of their solid wastes at the new landfill facility or training local communities on composting techniques. This may be incorporated into an urbanisation plan for the area.
- Consider involving local communities in waste recycling initiatives if these are considered practical within the context of the project.

Significance statement

The development of a knowledge and appreciation of the need for sound waste management amongst employees, and subsequent informal dissemination of this knowledge into local communities may ultimately, together with the provision of waste management infrastructure such as formal temporary storage areas or a landfill (perhaps through an urbanisation plan), result in an improved management of waste streams within the local communities. As one of the positive impacts would be an enhanced local knowledge, the impact may be considered permanent. Without mitigation the impact would possibly be considered to be *slightly beneficial* and of LOW significance. However, with mitigation, the impact could be considered *beneficial* and of MODERATE positive significance.

Impact 8.2: Change to waste profiles in the local communities

Cause and comment

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.

Mitigation measures

- The mine could assist in the facilitation the development of an urbanisation plan for the local communities;
- Consider options to facilitate improved management of solid waste in local communities. This may include allowing local communities to dispose of their solid wastes at the new landfill facility, training local communities on composting techniques or investigating and, if considered feasible, supporting recycling initiatives.

Significance statement

The impact would probably be of MODERATE negative significance without mitigation and LOW negative with mitigation.

Without mitigation					**With mitigation**	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
ISSUE 8: Regional waste profiles and community awareness						
Impact 8.1: Local knowledge of waste management practices						
Permanent	*District*	Definite	Slightly beneficial	LOW (+ve)	*Beneficial*	**MODERATE (+ve)**
Impact 8.2: Change to waste profiles in the local communities						
Permanent	*District*	Definite	Slightly beneficial	**MODERATE**	*Slight*	**LOW**

7 CONCLUSION AND RECOMMENDATIONS

A review of relevant legislation and policy documents suggested that waste management in Mozambique is still in its infancy. Waste management infrastructure for the safe management of wastes 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.

Based on the available project description and supplementary information sourced from a variety of sources, it was possible to assess the likely impacts associated with the management of waste streams from the proposed Syrah Resources Graphite project in Mozambique.

A total of 15 impacts were identified (Table 7.1) and of these, with mitigation, 11 were considered to be of LOW negative significance and three of MODERATE negative significance. One impact was considered beneficial and of Moderate significance with mitigation. However, due to the potential long-term nature of waste-related impacts, it is essential that the developer adhere to national legislative requirements and international BPEO with regards the management of all waste streams. While a number of specific mitigation measures have been included in the document, further detailed guidance on the management of key waste streams is provided in the documents referenced in this report.

Table 7.1: Summary of the wastes related environmental impacts for the Syrah Resources Graphite project

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
ISSUE 1: Disposal of waste rock and tailings						
Impact 1.1: Health and safety of employees and local communities						
Long Term	Localized	May Occur	High	**HIGH**	Slight	**LOW**
ISSUE 2: Spillage of Run Of Mine						
Impact 2.1: Disruption of ecological functions						
Long term	Localized	May occur	*Moderate*	**MODERATE**	*Slight*	**LOW**
ISSUE 3: Storage of water in the Process Water Pond						
Impact 3.1: Pollution of soil and water resources						
Without mitigation					**With mitigation**	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Medium Term	Localized	Unlikely	Very Severe	**MODERATE**	Very Severe	**LOW**
Impact 3.2: Risk to health and safety of employees						
Without mitigation					**With mitigation**	
Medium Term	Localized	Unlikely	Severe	**HIGH**	Slight	**LOW**
ISSUE 4: Disposal of potentially hazardous chemicals						
Impact 4.1: Risk to health and safety of employees						
Long Term	Localized	May occur	Severe	**VERY HIGH**	Slight	**MODERATE**
Impact 4.2: Pollution of water resources and soil						
Long Term	Localized	May occur	Severe	**VERY HIGH**	Slight	**MODERATE**
ISSUE 5: Management of non-process general and hazardous wastes (All phases)						
Impact 5.1: Pollution of land and water						
General (Non-hazardous) wastes						

Without mitigation					With mitigation	
Temporal scale	**Spatial scale**	**Certainty**	**Severity**	**Significance**	**Severity**	**Significance**
Long term	*Study area*	Probable	*Moderately Severe*	**MODERATE**	*Slight*	**LOW**
Hazardous wastes						
Permanent	*District*	Probable	*Very Severe*	**VERY HIGH**	*Moderate*	**MODERATE**
Impact 5.2: Nuisance impact (Production of odours, visual impact and attraction of pest and vermin)						
Long-term	District	Probable	*Moderately severe*	**MODERATE**	*Slight*	**LOW**
ISSUE 6: Disposal of domestic wastewater and sewage sludge (All phases)						
Impact 6.1: Pollution of soil and water						
Long-term	*Study area*	Probable	*Moderately severe*	**MODERATE**	*Slight*	**LOW**
Impact 6.2: Health impacts to employees and communities						
Long-term	District	Probable	*Severe*	**MODERATE**	*Slight*	**LOW**
Impact 6.3: Nuisance impacts (odour and flies)						
Short-term	Study area	Probable	Moderately *Severe*	**MODERATE**	*Slight*	**LOW**
ISSUE 7: Disposal of run-off / storm water						
Impact 7.1: Pollution of land and water						
Long-term	*Study area*	Possible	Moderately *Severe*	**MODERATE**	*Slight*	**LOW**
ISSUE 8: Regional waste profiles and community awareness						
Impact 8.1: Local knowledge of waste management practices						
Permanent	*District*	Definite	Slightly beneficial	**LOW (+ve)**	*Beneficial*	**MODERATE (+ve)**
Impact 8.2: Change to waste profiles in the local communities						
Permanent	*District*	Definite	Slightly beneficial	**MODERATE**	*Slight*	**LOW**

It is recommended that:

i. All waste streams should be managed according to the waste management hierarchy and according to Decree 13/2006, of 15 July: Regulation of Waste Management. This specifies that wherever possible, production of wastes should be prevented or minimised at source.

ii. Where prevention or further minimization is not possible, wastes should be re-used, recycled and then disposed of responsibly so as to minimise impacts to the environment. Further guidance on the management of waste streams is provided in the IFC General EHS Guidelines (2007) and the IFC EHS Guidelines for Mining (2007).

iii. In the event that there are no national standards available, the proponent must comply with internationally recognised standards developed by international organisations such as the IFC. In the case where there are several standards available for use, the proponent must provide justification for the choice of use, other than the use of the most stringent.

iv. Due to the remote location of the project site and relevant legislation, it is recommended that the proponent establish a non-hazardous waste disposal facility on the site.

v. Practical options will need to be considered 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.

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World Bank Technical Paper No. 426

APPENDIX A: SANITARY EFFLUENT STANDARDS

Pollutant/Measure	Units	MICOA	IFC Gen. EHS	AfDB	Most Stringent
Colour	Present / Absent	1:20 dilution	-	-	Absence
Smell	Present / Absent	1:20 dilution	-	-	Absence
Total Suspended Solids	mg/l	60	50	-	50
pH	S.U.	6-9	6-9	-	6-9
COD	mg/l	150	125	100	100
BOD	mg/l	-	30	50	30
Oil and Grease	mg/l	-	10	-	10
Total Nitrogen	mg/l	15	10	15	10
Total Phosphorus	mg/l	10*y*	2	2	2
Total Coliform bacteria	MPN*b*/100ml		400*a*	400*q*	400
Temperature increase	^{o}C	35°*z*	-	-	35^{o}

a: Not applicable to centralized, municipal, wastewater treatment systems which are included in EHS Guidelines for Water and Sanitation
b: MPN = Most Probable Number
y: 3 mg/l in sensitive zones
z: Increase at the receiving medium
q: Water used for irrigation

APPENDIX B: MINE EFFLUENT STANDARDS

Pollutant/Measure	Units	MICOA	AfDB	IFC Gen. EHS	Most Stringent
Aluminium	mg/l	1.5	-	-	1.5
Ammonia	mg/l	0.4	-	-	0.4
Arsenic	mg/l	0.05	-	0.1	0.05
Berelium	mg/l	1.5	-	-	1.5
BOD	mg/l	<5	50	50	<5
Boron	mg/l	5	-	-	5
Cadmium	mg/l	0.005	0.1	0.05	0.005
Chromium (Total)	mg/l	-	1	-	1
Chromium (VI)	mg/l	0.05	-	0.1	0.05
COD	mg/l	-	100	150	100
Copper	mg/l	0.05	1	0.3	0.05
Cyanide	mg/l	0.005	-	1	0.005
Cyanide (Free)	mg/l	-	-	0.1	0.1
Cyanide (Total)	mg/l	-	0.5	-	0.5
Cyanide WAD	mg/l	-	-	0.5	0.5
dissolved oxygen	mg/l	≤ 6	-	-	≤ 6
Floating material	Present / Absent	Absent	-	-	Absent
Fluorides	mg/l	1.4	-	-	1.4
Iron (Total)	mg/l	0.3	-	2	0.3
Lead	mg/l	0.01	0.5	0.2	0.01
Manganese	mg/l	0.1	-	-	0.1
Mercury	mg/l	0.0001	0.01	0.002	0.0001
Nickel	mg/l	0.1	5	0.5	0.1
Nitrate	mg/l	10	-	-	10
Nitrite	mg/l	1	-	-	1
Nitrogen	mg/l	-	15	-	15
Oil and Grease	Present / Absent	Absent	20	10	Absent
pH	S.U.	6.5 - 8.5	6 - 9	6 - 9	6 - 9
Phenols	mg/l	0.001	-	0.5	0.001
Phosphorous	mg/l	-	2	-	2
Residual chlorine	mg/l	0.01	-	-	0.01
Selenium	mg/l	0.01	-	-	0.01
Silver	mg/l	0.005		-	
Substances that react with methylene blue	mg/l	0.5	-	-	0.5
Sulphite like hydrogen disulphide	mg/l	0.002	-	-	0.002
Temperature	° C	-	-	<3° differential	<3° differential
Tin	mg/l	2	-	-	2
Total Suspended Solids	mg/l	-	-	50	50

Pollutant/Measure	Units	MICOA	AfDB	IFC Gen. EHS	Most Stringent
Uranium	mg/l	0.5	-	-	0.5
Zinc	mg/l	0.01	-	0.5	0.01

APPENDIX C: SOIL STANDARD

Pollutant/Measure	Units	AfDB		
		A	B	C
Cadmium	mg/kg	-	5	20
Chromium	mg/kg	-	250	800
Copper	mg/kg	-	100	500
Lead	mg/kg	-	150	600
Mercury	mg/kg	-	2	10
Nickel	mg/kg	-	100	500
Zinc	mg/kg	-	500	3000
Bromine	mg/kg	20	50	300
Cyanides (total free)	mg/kg	1	10	100
Fluorides	mg/kg	-	400	2000
Sulphide	mg/kg	2	20	200
Benzene	mg/kg	0.05	0.5	5
Ethylbenzene	mg/kg	0.05	0.5	50
Toluene	mg/kg	0.05	3	30
Xylene	mg/kg	0.05	5	50
Phenols	mg/kg	0.05	1	10
Total hydrocarbons	mg/kg	-	7	70

A: Reference value, no pollutant
B: Value for further investigations
C: Value for remedial action

APPENDIX D: CES IMPACT RATING SCALES

Specialists are required to provide the reports in a specific layout and structure, so that a uniform specialist report volume can be produced. To ensure a direct comparison between various specialist studies, standard rating scales have been defined for assessing and quantifying the identified impacts. This is necessary since impacts have a number of parameters that need to be assessed.

To ensure a direct comparison between various specialist studies, standard rating scales have been defined for assessing and quantifying the identified impacts. This is necessary since impacts have a number of parameters that need to be assessed.

Five factors need to be considered when assessing the significance of impacts, namely:

1. Relationship of the impact to **temporal** scales - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.

2. Relationship of the impact to **spatial** scales - the spatial scale defines the physical extent of the impact.

3. The severity of the impact - the **severity/beneficial** scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on a particular affected system (for ecological impacts) or a particular affected party.

   The severity of impacts can be evaluated with and without mitigation in order to demonstrate how serious the impact is when nothing is done about it. The word 'mitigation' means not just 'compensation', but also the ideas of containment and remedy. For beneficial impacts, optimization means anything that can enhance the benefits. However, mitigation or optimization must be practical, technically feasible and economically viable.

4. The **likelihood** of the impact occurring - the likelihood of impacts taking place as a result of project actions differs between potential impacts. There is no doubt that some impacts would occur (e.g. loss of vegetation), but other impacts are not as likely to occur (e.g. vehicle accident), and may or may not result from the proposed development. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.

Each criterion is rated according to Table D-1 and Table D-2 to determine the overall **significance** of an activity. Firstly, the criterion is considered in two categories, viz. effect of the activity and the likelihood of the impact (Table D-1). The significance of the effect and likelihood are then read off the matrix presented in Table D-2, to determine the overall significance of the impact. The overall significance is either negative or positive.

The ***environmental significance*** scale is an attempt to evaluate the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological or social, or both. The evaluation of the significance of an impact 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

Cumulative Impacts affect the significance ranking of an impact because it considers the impact in terms of both on-site and off-site sources. For example, the noise generated by an activity (on-site) may result in a value which is within the World Bank Noise Standards for residential areas. Activities in the surrounding area may also create noise, resulting in levels also within the World Bank Standards. If both on-site and off-site activities take place simultaneously, the total noise

level at the specified receptor may exceed the World Bank Standards. For this reason it is important to consider impacts in terms of their cumulative nature.

Seasonality

Although seasonality is not considered in the ranking of the significance, if may influence the evaluation during various times of year. As seasonality will only influence certain impacts, it will only be considered for these, with management measures being imposed accordingly (i.e. dust suppression measures being implemented during the dry season).

Prioritisation

The evaluation of the impacts, as described above is used to prioritise which impacts require mitigation measures.

Negative impacts that are ranked as being of "**VERY HIGH**" and "**HIGH**" significance will be investigated further to determine how the impact can be minimised or what alternative activities or mitigation measures can be implemented. These impacts may also assist decision makers i.e. lots of **HIGH** negative impacts may bring about a negative decision.

For impacts identified as having a negative impact of "**MODERATE**" significance, it is standard practice to investigate alternate activities and/or mitigation measures. The most effective and practical mitigations measures will then be proposed.

For impacts ranked as "**LOW**" significance, no investigations or alternatives will be considered. Possible management measures will be investigated to ensure that the impacts remain of low significance.

Table D-1: Ranking of Evaluation Criteria

EFFECT	**Temporal scale**		
	Short term	Less than 5 years	
	Medium term	Between 5 and 20 years	
	Long term	Between 20 and 40 years (a generation) and from a human perspective almost permanent.	
	Permanent	Over 40 years and resulting in a permanent and lasting change that will always be there	
	Spatial Scale		
	Household	At localised scale and a few hectares in extent. This scale applies to a person or persons in and around the study area.	
	Localised	This scale applies to the project footprint.	
	Study area	The area directly affected by the proposed site and its immediate environs (mine lease area).	
	Traditional Authority Areas	Determined by local administration.	
	District	District	
	National	Country level	
	International	International level	
	Severity		**Benefit**
	Slight / Slightly Beneficial	Slight impacts on the affected system(s) or party(ies)	Slightly beneficial to the affected system(s) or party(ies)
	Moderate / Moderately Beneficial	Moderate impacts on the affected system(s) or party(ies)	An impact of real benefit to the affected system(s) or party(ies)
	Severe / Beneficial	Severe impacts on the affected system(s) or party(ies)	A substantial benefit to the affected system(s) or party(ies)
	Very Severe / Very Beneficial	Very severe change to the affected system(s) or party(ies)	A very substantial benefit to the affected system(s) or party(ies)
LIKELIHOOD	**Likelihood**		
	Unlikely	The likelihood of these impacts occurring is slight	
	May Occur	The likelihood of these impacts occurring is possible	
	Probable	The likelihood of these impacts occurring is probable	
	Definite	The likelihood is that this impact will definitely occur	

In certain cases it may not be possible to determine the severity of an impact thus it may be determined: Don't know/Can't know

Table D-2: Description of Environmental Significance Ratings

Significance	Description	Score
Low	Acceptable impact 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 either positive or negative medium to short term effects on the social and/or natural environment.	
Moderate	An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment.	
High	A serious impact, if not mitigated, may prevent the implementation of the project (if it is a negative impact). These impacts would be considered by society as constituting a major and usually a long-term change to the (natural &/or social) environment and result in severe effects or beneficial effects.	
Very High	A very serious impact which, if negative, may be sufficient by itself to prevent 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.	

Example of how to use the CES Environmental Impact Rating Methodology when writing up the impacts

CES are recommending the write up method outlined below as a way of reducing the amount of descriptive writing normally required. This is based on using the impact rating methodology CES has adopted and made available to you.

Impact 1: Contamination of surface and groundwater

Cause and Comment

It is estimated that as many as 150 construction workers will be employed on site. These workers will generate sanitary waste which needs to be carefully managed and properly disposed of.
(Note to consultants: this statement can be longer and can include data (and tables etc) that will justify the impact ratings provided in the impact table below).

Mitigation and Management

Chemical toilets could be used on the construction site and these would need to be emptied periodically and the waste disposed of at a municipal sewage treatment facility. If one conservatively assumes a volume of 50L of wash water and sewage per individual during a work shift then the total volume of effluent requiring disposal could be ~17m^3 per day.

Significance Statement

Impact	Effect			Risk or Likelihood	Total Score	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact			
Without Mitigation	Short term	Study Area	Moderate	Definite	**MODERATE**	
With Mitigation	Short term	Localised	Slight	Unlikely	**LOW BENEFICIAL**	