ENVIRONMENTAL IMPACT ASSESSMENT REPORT

AFRICAN INKALAMO MINING COMPANY LIMITED

RARE EARTH MINERAL PROJECT

PREPARED BY MVC CONSULTING ENGINEERS

JUNE 2024

TRANSMISSION NOTE

MVC Consulting Limited was appointed by African Inkalamo Mining Limited to assess the environmental impacts which are likely to arise from the Rare Earth Mineral Project. The Project which will be located at Nkombwa Hill is planned to produce 0.75 Million tonnes of Rare Earth Mineral per annum. The results of these studies are reported here in the format of an Environmental Impact Statement (EIS) in accordance with the requirement of part III of the Environmental Impact Assessment Regulations of 1997 and schedule 2 of the Mines and Minerals (Environmental) Regulations 1997.

HUA GUO DONG
Country Director

MBITA CHIFUNDA
Lead Consultant

EXECUTIVE SUMMARY

Overview

African Inkalamo Mining Company Limited (AIMCL), a Zambian registered private limited company, holds the mining rights over the 1850.3 Ha Large-Scale Prospecting Licence Number 21442-HQ-LEL tenement, located in Chief Katyetye Chiefdom, 50Km east of Isoka District, Muchinga Province. The project area is uninhabited with the nearest settlement located about 4km away i.e. Chilonga area. There are no activities in the project area, apart from some exploration works, hence this is a greenfield project.

Project objectives

The objectives of the project are to exploit the Rare Earth Elements orebody using open pit mining method. This will be achieved by:

- Opening up the new open pit for accessing the orebody using the mining machinery and materials (excavators, loaders, bull dozers, explosives etc.)
- Hauling of ore to processing facilities and waste to the waste rock dump
- Processing of the ore by crushing, milling, floating to produce Rare Earth Oxides concentrates
- Building of other auxiliary facilities

Capital cost

The implementation of the project would require an estimated capital cost of about USD$ 5.0 million, which would go towards the construction of the infrastructures such as Rare Earth Minerals processing facilities, mine site offices, workshop for repair of the mining equipment etc. Other facilities to be constructed include fuel storage facility, pollution control facilities and storage facilities for raw materials.

Capacity / Output

Due diligence studies for the licence area estimated the Mineral Resources at 16 million tonnes at an average grade of 1.6%TREO. The Mineral Reserves have been estimated to be 9.1 million tonnes at an average of 1.28%TREO. The ore occurs very close to the surface, naturally, it will be mined using the open-pit mining method.

A mining throughput of 750,000 mtpa was adopted for this project, giving a pit life of just over 25 years based on the initial estimations. African Inkalamo will produce a rare earth oxide concentrate.

The Project will create employment opportunities that are expected to pick to 400 during the construction phase while operational phase will create about 150 employment opportunities.

Scope of the EIS

This Environmental Impact Statement (EIS) was prepared in accordance with the requirements of the Environmental Management Act No. 12 of 2011 read together with Environmental Impact Assessment Regulations No. 28 of 1997. It summarizes policy, legal and administrative frameworks within which the assessment was carried out; gives a brief description of the project and the project site; analysis of the site's physical, biological, human, environmental, social issues and anticipated changes at project implementation. Potential impact, mitigation measures and an impact management plan, which African Inkalamo is committed to implement, are also included.

The study addresses issues surrounding the following aspects of the environment:

- Air quality
- Noise;
- Solid waste management and management of other waste during all project phases;
- Landscape and Aesthetics;
- Water quality and potential sources of pollution;
- Occupational health and safety;
- Traffic management and safety
- Land use;
- Soil
- Flora and Fauna;
- Social, Cultural and Economic environment;
- Public health issues including waste management and vector control.

Alternative

The following project alternatives were considered

- Project Need
- Site
- Mining Method
- Power Supply
- Processing Technology
- Fuel
- Waste disposal
- Raw materials

From the analysis of these alternatives it was concluded the social and economic benefits of the prospects of developing the mine in the area using the best available technology outweighs other options.

Baseline conditions

To describe the existing environment appropriate standard methodologies were used. These included undertaking inventory of physical and biological environments, conducting interviews with stakeholders and reviewing of relevant literature. Information on names of geographical features were checked from the maps and confirmed by interviewing the project proponents who were conversant with the area and specific details.

The inventory of the existing physical and biological environment such as vegetation in the proposed project site focused on quality, quantity, density, and distribution. The mapping of the existing surrounding environment was undertaken to map out the surroundings of the project areas in order to determine the location of the proposed development in relation to any existing neighbouring developments. In doing so, the existing environment was categorized into physical, social and biological environments.

The proposed site is devoid of any settlement. The climate around the project site characterized by three distinct seasons in the year: the warm-wet season, stretching from November through April; cool-dry cold season from May to August with the mean temperatures varying between 14^{o}C and 30^{o}C. The area receives an annual rainfall in the range of 900mm to 1500mm with a mean annual rainfall of 800 mm.

Dominated by prevailing easterly winds during the dry season with fresh winds experienced in the months of July and August. The rains experience light variable winds predominantly northerlies and north-easterlies in January and February. Mean wind speed ranges from 4.0m/s to 9.0m/s.

The general geology of the area is dominated by the Nkombwa Hill which was originally mapped as limestone in the early 1930 with further investigations in the 1950 it was recognized as carbonatite plug. The plug is elliptical in plan measuring some 1000m by 1500m and rise some 300m above the surround countryside which is underlain by the basement of gneiss, schist, amphibolite, and quartzite.

The terrain of the project site is generally gentle approximately only 0.14% from the highest ground radiating outward and mainly towards the northwest, but also towards the southwest and northeast.

The general atmospheric air quality and noise conditions of the project area are normal and typical of a non-industrial area.

During the bio-physical baseline characterisation, notable conspicuous indigenous tree species spotted included the Southern Miombo woodland of the project area is dominated by Combretum collinum Diplorhynchus condylocarpon, Piliostigma thonningii and Dichrostachys cinerea. Other tree species which were in abundance/relatively large numbers included; Securidaca Longepedunculata, Piliostigma thonningii, Ziziphus abyssinica, Strychnos spinosa, Acacia tortilis subsp. heteracantha, Flacourtia indica, Senna petersiana and Dichrostachys cinerea. Those that were in small numbers included; Terminalia sericea, Pericopsis angolensis, Euphorbia ingens, Borassus aethiopum, Erythrina abyssinica, Kigelia Africana, Markhamia obtusifolia, Kigelia Africana and Ficus sycomorus.

No endangered flora or fauna species were seen. None of the IUCN Red List of threatened fauna species was recorded at the project site.

Potential Socio and Environmental Impacts

Like any mining venture, the development of the African Inkalamo Rare Earth Elements project will result in positive and negative impacts such as the extensive physical disturbance of the land, which for the most part would be permanent. These physical environmental impacts include open-pit mining operations, construction of waste rock dumps, plant site, and tailings storage facility. Other environmental and social risks from the project will include, air, water and land pollution during the different stages of the planned activities.
The main anticipated issues will include:

Positive impacts

- Employment generation and poverty alleviation
- Impacts on the local and National Economy
- Boost to the construction sector

Negative impacts

Construction Phase

Environmental issues likely to be of concern during the construction phase of the project include:

- Soil contamination;
- Air pollution;
- Noise pollution and also vibration;

- Change of landscape
- Water pollution;
- Traffic and road safety;
- HIV/AIDs
- Occupational Health and Safety issues;
- Waste management from construction works;
- Local/national economy, employment generation and multiplier effect.

Operational/Life Phase

- Environmental impacts over the life of the project could include:
- Noise and vibration;
- Loss pf flora and fauna
- Water pollution
- Soil contamination
- Increased traffic and associated noise and air pollution;
- Waste generation
- HIV/AIDS
- Occupational Health and Safety issues

Environmental Management and Monitoring

African Inkalamo Mining Company Limited is committed to adhering to industry best practice and to all regulatory frameworks in ensuring that its mining project has minimal public health or safety risks and environmental impacts.

The study has proposed an Environmental Management and Monitoring Plan (EMP) to address the management of the identified impacts associated with the project. The plan consists of implementing the following: -

- Implementing the Impact Mitigation Plan;
- Monitoring the implementation of the EMP; and
- Institutional Framework for Monitoring, Reporting and Supervision of EMP.

Environmental monitoring and enforcement are stated along with the output from such monitoring activities. Monitoring responsibilities are specified for the responsible authorities and African Inkalamo Mining Company Limited.

Key parameters to monitor during operation of the project will include:

- Noise
- Water
- Biodiversity
- soil
- Dust
- Traffic and safety;
- Solid waste storage, collection and disposal

Recommendations

The proposed project is feasible considering the proposed management commitments. The positive impacts clearly outweigh the negatives as can be seen in the impacts evaluation. The project, therefore, has great potential in up lifting the wellbeing of the general project area through job creation supplemented by AIMCL corporate social responsibility programs.

SIGNATURE PAGE

We the undersigned hereby declare that the information contained in this report is true and correct to the best of our knowledge:

Project proponents

Mr. Hua Guo Dong……
Director – African Inkalamo Mining Company Ltd

Environmental Team

Mr. Mbita Chifunda .....
Environmental Impact Assessment (EIA) and Public Consultation Coordinator

Ms. Bernadette Chitalu Kanchule …….....
Social & Economic Expert

Ms. Mirriam Nachilembi .....…….....
Ecologist/Natural Resources Expert

Mr Mutakwa Sikazwe .....
Civil/Hydrology & Hydrogeologist Expert

Mr Stalin Sichinga .....
Soil & Agriculture Analysis Expert

Mr Kelvin Diteta .....
Environmental Management/Impact Analysis Expert

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ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
AIMCL	African Inkalamo Mining Company Ltd
amsl	Above mean sea level
BSI	British Standards Institute
CSO	Central Statistical Office
Dbh	Diameter at Breast Height
D.C	Direct Current
EIA	Environmental Impact Assessment
ELF	Extremely Low Frequency
EMC	Electro – Magnetic Capability
EMP	Environmental Management Plan
EPB	Environmental Project Brief
ERB	Energy Regulation Board
ERP	Emergency Response Plan
ITC	Isoka Town Council
ITCZ	Inter-Tropical Convergence Zone
IFC	International Finance Corporation
IUCN	International Union for the Conservation of Nature
Km	Kilometre
NGO	Non-Government Organisation
NTU	Nephelometer Turbidity Unit
MW	Megawatts
OHS	Occupational Health and Safety
pH	Acidity or Alkaline
REA	Rural Electrification Authority
RTU	Remote Terminal Unit
SAPP	Southern African Power Pool
SE	Southeast
SHE	Safety Health and Environment
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
USEPA	United States Environment Protection Agency
WHO	World Health Organisation
°C	Degrees Celsius
dB	decibels
g/l	grams per litre
ha	hectare
kg/m^3	kilograms per cubic metre
$L_{A90.T}$ Index	The A weighted noise level exceeded for 90% of the period.
m	metre
m/s^2	metres per squared second
m/sec	metres per second
m^2	squared metre
m^3	cubic metre
m^3/h	cubic metres per hour
mg/kg	milligrams per kilogram
mg/l	milligrams per litre
mm	millimetres
Nm^3/h	Normal cubic metres per hour
µm	micron
ZEMA	Zambia Environmental Management Agency

1.0 INTRODUCTION

Zambia is endowed with a lot of natural resources, most of which have not been exploited due to a number of factors, thus limiting its development prospects. Mineral resources are still in abundance, especially in Muchinga Province and thus, mining has remained the backbone of the Zambian economy. The country's favourable economic environment implemented over the last two decades have attracted both domestic and international investment into mining and other sectors which have contributed to economic growth. More investments are needed for the country to attain its objectives outlined in the Seven National Development Plan.

African Inkalamo Mining Company Limited (AIMCL), a private limited company, has identified the potential of the mining sector and thus acquired mining rights over the Large-Scale Prospecting Licence Number 21442-HQ-LEL tenement, which was granted in November 2020. The tenement is located in Isoka District of Muchinga Province of the Republic of Zambia. The project area lies in Lualuzi area located about 50Km east of Isoka District and covering an area of approximately 1850.3 Ha. The general geology of the area is dominated by the Nkombwa Hill which was originally mapped as limestone in the early 1930 with further investigations in the 1950 it was recognized as carbonatite plug. The plug is elliptical in plan measuring some 1000m by 1500m and rise some 300m above the surround countryside which is underlain by the basement of gneiss, schist, amphibolite, and quartzite.

AIMCL started due diligence/exploration related operations in the licence area in March 2023 and undertook an extensive validation of the works that were done by previous owners of the licence. Drill holes were done to ascertain the quality of the mineralisation. Due to positive results from the due diligence/exploration activities, AIMCL would like to proceed with the project which will involve the mining of Rare Earth Element ore.

Due diligence/exploration studies for the licence area estimated the Mineral Resources at 16.5 million tonnes at an average grade of 1.16%Rear Earth Oxides (TREO). The Mineral Reserves have been estimated to be 9.1 million tonnes at an average of 1.28% TREO. The ore occurs very close to the surface, naturally, it will be mined using the open-pit mining method.

A mining throughput of 750,000 mtpa REE was adopted for this project, giving a pit life of just over 25 years based on the initial estimations. African Inkalamo will produce Rare Earth Oxides concentrate.

The project works are anticipated to progress to full scale by third quarter of 2024 once all the statutory clearances are obtained i.e. the development of the mine, ore crushing and transfer facilities, Rare Earth Element processing plant, waste rock and overburden dumps and all related infrastructure. To comply with the requirements of the Environmental Management Act, 2011, a full Environmental Impact Assessment

was undertaken and this report presents the findings of the assessments and the proposed redress mechanisms.

1.2 Project Developer

African Inkalamo Mining Company Ltd is a Zambian Registered Company, whose shareholders are involved in various business projects. The Project Developer is not involved in any mining but because of the need to diversify their operations, the Directors decided to venture into mining. The company has since employed experienced personnel in explorations, mining and management.

To deliver superior returns to shareholders over time, African Inkalamo Mining Company Ltd intends to take a long term and responsible approach to the Group's business. This means concentrating on the development ore bodies into large, first class, long life and efficient operations, capable of sustaining competitive advantage through business cycles. AIMCL is currently working on finalising the feasibility study on its Tin Project in Zambia. The details of the developer are summarised below in tables 1.1,1.2 and 1.3.

Table 1.1 Directors of African Inkalamo Mining Company Ltd

Designation/Title	Name	Nationality	Passport	Address
Director	Pingwei Wang	Chinese	EA3692330	1 ZCCZ, Chambishi, Kalulushi, Copperbelt Province, Zambia
Director	WANG CHAOLE	Chinese	EG4269733	1 ZCCZ, Chambishi, Kalulushi, Copperbelt Province, Zambia
Director	Yuan Li	Chinese	EC9267396	1 ZCCZ, Chambishi, Kalulushi, Copperbelt Province, Zambia

Table 1.2 Shareholders for African Inkalamo Mining Company Ltd

Name	Percentage of Shareholding
Sinomine Hong Kong Rare Earth Resources Co Ltd	99%
Sinomine Resource Geological Engineering Company Limited	1%

Table 1.3 Contact Details

Name	Contact Details
Mr. Tang	1 ZCCZ, Chambishi, Kalulushi, Copperbelt Province, Zambia
Project Manager	0967483618
Email Address	1062286186@qq.com

1.3 Rationale and Objectives of the Project

African Inkalamo Mining Company Limited would like to contribute to Zambia's realisation of her development goals through the exploitation of Rare Earth Element reserves in Isoka District. The area, where the project is located, has had little or no development since independence despite being endowed with a variety of resources. The opening of the mine in the area will create opportunities for locals in terms of employment and businesses whose incomes will contribute to other ventures and eventual uplifting of the lives of the people in the area. The taxes, levies and other fees that AIMCL will pay coupled with its Corporate Social Responsibilities (CSR) activities will also contribute to the development of the region and the country.

The objectives of the project are to exploit the Rare Earth Elements orebody using open pit mining method. This will be achieved by:

- Opening up the new open pit for accessing the orebody using the mining machinery and materials (excavators, loaders, bull dozers, explosives etc.)
- Hauling of ore to processing facilities and waste to the waste rock dump
- Processing of the ore by crushing, washing and floating it to produce improved Rare Earth Elements concentrate
- Building of other auxiliary facilities

The implementation of the project would thus mean construction of the infrastructures such as Rare Earth Elements processing facilities, mine site offices, workshop for repair of the mining equipment etc. Other facilities to be constructed include fuel storage facility, pollution control facilities and storage facilities for raw materials.

The projected mine life is over 25 years and capital costs are estimated at about USD$5.0 million. The Project will create employment opportunities that are expected to pick to 400 during the construction phase while operational phase will create about 150 employment opportunities.

1.4 Objectives of the Environmental Impact Assessment

The main objectives of this Environmental Impact Assessment were:

- To identify the likely impacts of the project within the project area and beyond;
- To provide estimates of the severity of the development on the target group; and

- To gain insight into which impacts are significant and available opportunities to avoid or to minimize their impacts.

This EIA was conducted in accordance with the requirements of the Environmental Management Act No. 12 of 2011 read together with Environmental Impact Assessment Regulations No. 28 of 1997. The EIS summarizes policy, legal and administrative frameworks within which the assessment was carried out; gives a brief description of the project and the project site; analysis of the site's physical, biological, human, environmental, social issues and anticipated changes at project implementation. Potential impact, mitigation measures and an impact management plan are also presented.

The compilation of the environmental and social impact assessment for the Rare Earth Elements Mine Project started in July 2023 and was completed in May 2024. The EIA Team from MVC Consulting Engineers that compiled the report on behalf of African Inkalamo Mining Company Ltd is given in Table 1.4.

Table 1.4: Environmental Impact Assessment Team

#	Position	Name
1	Environmental Consultant (Team Leader)	Mr. Mbita Chifunda
2	Social and Economic Consultant	Ms. Bernadette Kanchule
3	Soil & Agricultural Consultant	Mr. Stalin Sichinga
4	Civil/Hydrology & Hydrogeological Expert	Mr. Mutakwa Sikazwe
5	Ecologist / Natural Resource Specialist	Ms. Mirriam Nachilembi
6	Environmental Management/Impact Analysis specialist	Mr. Kelvin Diteta

1.5 Approach to the Study

1.5.1 Scope of Work

In compliance with legislative requirements, the EIA process comprised two key phases:

- Terms of Reference – this phase develops the framework and proposed methodology for the assessment of environmental and social impacts. The ToR phase includes a presentation of the proposed project, proposed EIA process and the public consultation process; and

- Environmental Impact Assessment – this phase builds on from the ToR and entails the commencement of the EIA to assess the issues of the ToR. The EIA culminates with the development of a Draft EIA report which is presented

to the public for review and discussion through a public meeting. The EIA is then finalized and submitted to the ZEMA and MSD for approval (the decision-making phase).

The full scope of work and core issues considered when conducting the EIA are as stated in the TORs for this assignment attached as Appendix 1

1.5.2 Study Methods

I. Desk Study

The desk study was conducted to collect available data including project briefs, satellite imagery, relevant site reports, records and materials. A preliminary review of these datasets was done in order to set foundation for pre-planning phase.

II. Reconnaissance site visit

A reconnaissance site visit was undertaken to the project site to provide an idea on the local bio-physical and socio-economic conditions. Consultations were made with the stakeholders in the project area in Lualuzi and Isoka District.

III. Fieldwork Planning

The study team used the scoping data and additional information collected to plan a more detailed field assessment of the biophysical and socio-economic aspects, the project design and to facilitate a basis for elaboration of impacts and determine mitigation.

IV. Stakeholder Consultation

Visits were conducted to relevant government and other institutions to collect information and undertake interviews. Public consultation and information disclosure activities were also conducted in the project area.

V. Field Data Collection

Necessary field studies were conducted, as supplements to previous studies and to fulfil special requirements of the TORs. The field studies, baseline descriptions and impact assessments were also conducted.

VI. Data Analysis and Interpretation

Information on the ecological conditions of the site and surroundings was also obtained from published information and records. Records and information compiled from previous studies on soils, vegetation and terrain were accessed and existing maps were obtained. This valuable information was used to identify and map the bio-physical sensitivities and determine the mitigation measures on expected impacts.

Findings and recommendations in reports of consultations previously held with local stakeholder communities and earlier surveys, have also given important input to this EIA study. Baseline and field data were analysed using standard methods as follows:

- A review of the current policy and regulatory framework was done. Relevant environmental legislation and regulations that would apply to this project were collected from relevant stakeholders and considered;
- A temporal analysis of baseline and field data on climate was applied to determine rainfall patterns, temperature regimes, humidity and sunshine levels;
- Due to non-availability of detailed studies on air quality, the portable Pylon air sampler was used to sample the air within the project area in order to determine the baseline status of the project site;
- Similarly, available national level geological and hydro geological studies and maps were assessed and correlated to the project site. The baseline data were supplemented with field survey data analysis on hydrology & hydrogeology with specific consideration to quality of surface and ground water;
- Topographic, land use, land cover and landscape data were assessed;
- Available baseline data on land tenure was considered and correlated with underlying poverty conditions;
- Due to non-availability of detailed studies on noise and vibration, a sound level meter was used to obtain the baseline noise levels of the project site;
- Field survey for archaeological and cultural environment, fauna and flora were also conducted; and
- Available baseline data on socio-cultural and economic setup was supplemented with field data collection.

VII. Environmental Impact Statement Preparation

The EIA Team used the ZEMA guidelines in preparing the EIS report.

2.0 POLICY AND REGULATORY FRAMEWORK

2.1 National Legislative Framework

African Inkalamo Mining Company is committed to responsible environmental management during all the stages of the project, starting from construction to commissioning, operation, closure and post-closure monitoring and therefore will adhere to all relevant national legislation and guidelines.

The following are some national legislations relevant to the proposed Tin mining project to be undertaken by AIMCL:

2.1.1 Environmental Management Act, 2011 [No. 12 of 2011]

Provisions	This is the Principal Act governing and regulating environmental issues in Zambia. Its main functions include the protection of the environment and control of pollution. The Act provides specific regulations for discharge, collection, storage, transportation and disposal of gaseous, liquid and solid waste. In particular, it provides for the health and welfare of people, animals, plants and the environment.
Relevance	The proposed mining activities for Rare Earth Elements falls under the project category requiring the preparation of an Environmental Impact Assessment.
Compliance	This Environmental Impact Assessment was prepared in compliance with the provisions of this Act. AIMCL shall, in accordance with this Act, engage a solid waste management company, avoid water pollution and air pollution during all phases of the project. The developer shall also avoid unnecessary cutting of trees in order to protect and conserve the environment.

The subsidiary Statutory Instruments (S.I.s) of the EMA that are relevant to the project are the following:

2.1.1.1 Environmental Impact Assessment Regulations, S.I. No. 28 of 1997

Provisions	The regulations state that a developer shall not implement a project for which an Environmental Project Brief or an Environmental Impact Statement is required under the regulations, unless an Environmental Project Brief or an Environmental Impact Assessment has been concluded in accordance with the Regulations and the Agency has issued a Decision Letter.
Relevance	Being a project of this magnitude (mining of Rare Earth Elements), it falls under the project category requiring the preparation of the Environmental Impact Assessment Report.

Compliance	AIMCL prepared this Environmental Impact Assessment Report in compliance with the provisions of this Statutory Instruments before commencing the mining work.

2.1.1.2 Environmental Management (Licensing) Regulations, SI 112 of 2013 (Part 3)

Provisions	This SI is meant to regulate primarily transportation of waste and operation of disposal sites. ZEMA regulates these activities through the licensing of transporters of waste and operators of disposal sites; the licenses are accompanied by conditions.
Relevance	The Project Proponent will be generating waste during their operation activities. This Act regulates the generation of solid waste management up to the point of disposal.
Compliance	The management of both none hazardous waste – storage, transportation and disposal – will be done in accordance with the Waste Management regulations.

2.1.1.3 Environmental Management (Licensing) Regulations, SI 112 of 2013 (Part 2)

Provisions	The Air Pollution Control Regulations give powers to ZEMA to regulate emission of air pollutants into the atmosphere in order to safeguard the general health, safety or welfare of persons, animal life, plant life or property affected by the workers, industrial or business activities undertaken by an operator.
Relevance	operation of the mine may necessitate the production of dust during the works. This Act regulates amount of dust that can be generated at any one time. During operation, there is possibility of releasing dust into the atmosphere thus compromising the quality of the air in the vicinity of the Project.
Compliance	In line with these regulations, dust generated during the works will be reduced by consistently sprinkling with water.

2.1.3 The Environmental Management (Licensing) Regulations, SI 112 of 2013 (Part 2)

Provisions	These regulations govern the discharge of effluent into the aquatic

	environment. The regulations provide for the installation of appropriate pre-treatment facilities and ensuring that the discharged effluent conforms to the conditions and standards for chemical, biological and physical parameters.
Relevance	The regulation is relevant in that the project being developed has potential, to contaminate the environment and the groundwater if the effluent from the working area is not properly managed.
Compliance	Any materials, liquids or solids with potential to contaminate the effluent will be monitored to ensure contamination does not occur. AIMCL will endeavour to comply with the chemical, physical and biological parameters in the above SI.

2.1.4 Environmental Management (Licensing) Regulations, SI 112 of 2013 (Part 4) (Hazardous Waste)

Provisions	provides for licensing of solid hazardous waste transportation and operating/owning of a hazardous waste disposal site. The Project will generate waste oils from operations and some other minor wastes. These materials will require management as per regulations. Therefore, licenses to dispose of wastes deemed hazardous will be required.
Relevance	The regulation is relevant in that the project activities being proposed have the potential to contaminate the environment through oil spills from the machinery at the site and also workshop.
Compliance	Any used oil generated will be handled in accordance with the hazardous waste management regulations. AIMCL will endeavour to ensure no spills of oil occur at the site.

2.1.5 Other Applicable Zambian Legislations

2.1.5.1 Mines and Minerals Development, 2015 [No. 11 of 2015] CAP 213

Provisions	An Act to revise the law relating to the exploration for, mining and processing of, minerals; provide for safety, health and environmental protection in mining operations; provide for the establishment of the Mining Appeals Tribunal; repeal and replace the Mines and Minerals Development Act, 2008; and provide for matters connected with, or incidental to, the foregoing. ▪ Statutory Instrument No 29 of 1997 – Mines and Minerals (Environmental) Regulations – provides the framework for conducting and reviewing environmental impact assessment for the mining sector. Further to that, it provides regulations

	for auditing project implementation. ▪ Statutory Instrument No 102 of 1998 – Mines and Minerals Environmental Protection Fund Regulations – provides the mechanism of setting up and operating the Environmental Protection Fund. Thus, the mine will have to contribute to the fund so that if the mine owners left or abandoned the project, funds could be used to clean up the environment.
Relevance	The core focus of the project is mining, therefore African Inkalamo Mining Company Limited will manage the project in accordance with the provisions of this Act
Compliance	African Inkalamo Mining Company Limited will manage the project in compliance with the provisions of the Act and subsidiary legislation. Mineral royalty taxes will also be paid in accordance with CAP 213 of the Laws of Zambia

Other applicable Zambian Legislations include but are not limited to those outlined in the Table 2.1 below. Regulations have not yet been developed in Zambia for most of these Acts.

Table 2.1 Other Applicable Zambian Legislation

Institution of Legislation	Act	Provisions	Relevance	Compliance
Water	Water Resources Management Act, 2011 [No 21 of 2011]	Provides for the management of water resources within Zambia.	The project will manage all nearby water resources in line with the legal requirements outlined in Section 60.	The company will apply for any permits relevant under Part IX, Section 69 of this legislation
Energy	The Petroleum Act,1995 [No. 8 of 1995]	The areas of the Petroleum Act of relevance to this project are regulations for the conveyance and storage of petroleum, inflammable oil and liquids e. g. paraffin.	Petroleum product will be handled in line with the provisions of the Act at this project.	All necessary approvals related to storage and transportation as required in Section 4 and 15 respectively will be obtained to avoid being non-compliant
Health	The Pneumoconiosis Act, 1994 [No. 13 of 1994]	Provides for the requirement for Certificates of Fitness for all mine employees that work in restricted mine areas – working places where free REE in the respirable dust with particle size less than 5 microns is harmful to humans if inhaled over a period of time.	All workers employed will undergo Pneumoconiosis assessments, in accordance with Sections 40 to 43, before and during the duration of employment.	The company will ensure that people that employed, are medically fit and have necessary documentations that allows them to operate in the mine.
	The Occupational Safety and Health Act, 2010 [36 of 2010]	Provides for preventing work-related injuries, illnesses, and death by issuing and enforcing workplace health and safety standards. Hundreds of OSHA safety standards, covering everything from first aid to fire protection, apply to most federal and private workplaces. OSHA allows employees to question unsafe conditions, request inspections, and file lawsuits to correct unsafe conditions without retaliation.	AIMCL will put in place measures to ensure that workers are adequately protected from injury at the work place in accordance with Part IV, Part V and Part VI of the regulations.	AIMCL will ensure that measures and policies are put in place that prevents accidents as outlined in Section 17

Institution of Legislation	Act	Provisions	Relevance	Compliance
Radiation	Ionising Radiation Protection Act, 2005 [No. 16 of 2005]	Provides for the protection of the public, workers and the environment from hazards arising from the use of devices or materials capable of producing ionising radiation	Some of the materials that African Inkalamo Mining Company will use that would fall in the categories outlined in the regulations will be managed according to this law and obtain all the necessary licences as outlined in Part IV	AIMCL will ensure that radioactive materials are used and kept in a manner that complies with this regulation
Explosives	Explosives Act (No 10 of 1974)	Provides for the handling, storage and general management of explosives used for blasting in the mining industry.	Explosives will be managed in line with the provisions of Section 18 of the Act at this project.	AIMCL will ensure that explosives are kept in a manner that complies with this regulation
Employment	Minimum Wages and Conditions of Employment Act (CAP. 276) (Statutory Instruments (SI) No. 2 & 3)	Establishes minimum guidelines for remuneration of an employee in Zambia.	AIMCL will employ people to work on this project in line with the Employment and social insurance laws of the land.	AIMCL will ensure that remuneration is according to the laid down Section 9 of the regulations
	The Employment Act Cap 268	Provide for the employment of persons on contracts of service and for the form of and enforcement of contracts of service, appointment of officers of the Labour Department and for the conferring of powers on such officers and upon medical officers and protection of wages of employees as well as control of employment agencies		AIMCL will ensure that all the necessary measures are put in place in compliance with Parts III to Part IX of this legislation
	Workers' Compensation Act (No 10 of 1999)	Provides for the establishment and administration of a Fund for the compensation of Workers disabled by accidents to, or diseases contracted by, such Workers in the course of their		AIMCL will ensure that all workers are registered with

Institution of Legislation	Act	Provisions	Relevance	Compliance
		employment, and for the payment of compensation to dependants of Workers who die as a result of such accidents or diseases.		Workmen's Compensation and monthly contributions are paid promptly, in accordance with the provisions of Part IV to Part VIII.
	National Pension Scheme Act, 1996 [No. 40 of 1996]	The Act provides for the establishment of the pensions scheme and the payment of pensions. Section 12 of the NPS Act defines who a contributing employer is and this includes any person, association, Institution, Firm registered as a tax payer with a tax payer with a contract of service with an employee		AIMCL will contribute to the pension scheme in accordance with Sections 12 to 15 of the Act
Taxes and Investment	Income Tax Act, 1997 [No. 3 of 1997] CAP 323	The Act governs Income tax in Zambia. Income tax is tax on profits made by Limited Companies, Partnerships and Self-Employed individuals as well as on emoluments earned by employees.	National legislation requires all companies operating in the Republic to comply with regulations on taxes. AIMCL will operate within the taxation and investment laws of the land	AIMCL will pay all taxes on its incomes and PAYE in accordance with Part III, IV, VI and VIII of the Act
	Value Added Tax Act, 2015 [No. 17 of 2015] CAP 331	An Act to impose a tax on the supply of goods and services in Zambia and the. importation of goods into Zambia.		AIMCL will ensure that VAT is paid on all taxable supplies in accordance with Part V and that all its contractors are registered accordingly
	Zambia Development Agency Act No 11 of 2006	Provides for the encouragement of private sectors investment in different sectors of the economy.		AIMCL will ensure that all the necessary measures are taken in compliance with this regulation, particularly Part 10 on licences, permits and certificates of registration.

Institution of Legislation	Act	Provisions	Relevance	Compliance
	Investment Act of 1998	Provides a legal framework for investment in Zambia. The Act relates to the environment by encouraging investment that is not detriment to the environment.		AIMCL will ensure that all the necessary measures are taken in compliance with this regulation, specifically sections 8 to17 on Investment Certificates and Section 26 on income tax on mining
Country, Town and Local Planning	Urban and Regional Planning, 2015 [No. 3 of 2015]	Provides for the appointment of planning authorities whose main responsibilities are the preparation, approval and revocation of development plans. It also provides for the control of development and subdivision of land.	The project will be implemented and operated in line with the planning laws of Zambia.	AIMCL will ensure that all the necessary measures are taken in compliance with Part VI of this regulation.
	The Local Government Act, No 13 of 2010	Provides for the establishment of Councils or Districts, the functions of local authorities and the local government system. Some of these functions relate to pollution control and the protection of the environment in general.		AIMCL will ensure that all the necessary measures are taken in compliance with this regulation.
Heritage and Conservation	National Heritage Conservation Commission Act (No. 23 of 1989) and National Heritage Conservation Commission Amendment Act (No. 13 of 1994)	Provides for the establishment of the National Heritage Commission responsible for the conservation, restoration, rehabilitation, reconstruction, adaptive use and good management of heritage conservation.	AIMCL will immediately inform the NHCC if any artefact were found during the project execution in accordance with Section 42.	AIMCL will ensure that all the necessary measures are taken in compliance with Section 41 of this regulation.

2.1.6 Forestry Act, 2015 [No. 4 of 2015]

Provisions	An Act to provide for the establishment and declaration of National Forests, Local Forests, joint forest management areas, botanical reserves, private forests and community forests; provide for the conservation and use of forests and trees for the sustainable management of forests ecosystems and biological diversity; establish the implementation of the United Nations Framework Convention on Climate Change, Convention on International Trade in Endangered Species of Wild Flora and Fauna, the Convention on Wetlands of International Importance, especially as Water Fowl Habitat, the Convention on Biological Diversity, the Convention to Combat Desertification in those Countries experiencing Serious Drought and/or Desertification, particularly in Africa and any other relevant international agreement to which Zambia is a party; repeal and replace the Forests Act of 1999; and provide for matters connected with, or incidental to, the foregoing.
Relevance	Though the Project site is outside a protected forestry area; minimal loss of vegetation will occur during the implementation of the Project because of the area where the mining will be conducted.
Compliance	AIMCL will ensure that all the necessary measures are taken in compliance with Section 86 of this regulation

2.1.7 Fisheries Act, 2011

Provisions	An Act to provide for the sustainable development of fisheries and a precautionary approach in fisheries management, conservation, utilisation and development; establish fisheries management areas and fisheries management committees; provide for the regulation of commercial fishing and aquaculture; establish the Fisheries and Aquaculture Development Fund; repeal and replace the Fisheries Act, 1974; and provide for matters connected with, or incidental to, the foregoing.
Relevance	The Act, particularly Section 1 and 17, is relevant to the project because there are streams near the project site and if no measures are put in place to protect it, it would end up being polluted.
Compliance	AIMCL will ensure that in its operations, care is taken to protect the streams nearby and also to ensure that the operations of the mine do not in any way affect the well-being of the streams.

2.1.8 Road Traffic Act, 2002 [No. 11 of 2002]

Provisions	The Act provides for a system of road safety and traffic management; licensing and registration of drivers and motor vehicles
Relevance	The Act is relevant to the project in that transport will be used to both ferry workers and also transport materials to and from the project site.
Compliance	AIMCL will ensure that all mine vehicles are registered and also insured at all times and all drivers will be required to have appropriate licenses for them to be eligible to be employed as drivers.

2.1.9 Zambia Wildlife Act, 2015 [No. 14 of 2015]

Provisions	The Act provides for the establishment, control and management of National Parks, bird and wildlife sanctuaries and for the conservation and enhancement of wildlife eco-systems, biological diversity and objects of aesthetic, pre-historic, historical, geological, archaeological and scientific interest in National Parks
Relevance	The Act is relevant to the project because the project area is in the vicinity of the West Lunga National Park and associated Game Management Area
Compliance	African Inkalamo Mining Company will comply with the provisions of the Act and ensure that its contractors and employees comply with Part III and IV

2.1.10 Institutional Framework

A number of institutions will have a regulatory and monitoring role directly or indirectly under their respective pieces of legislation. However, the following will be key institutions whose requirements will need to be complied with in accordance with the stated legislation.

- Geological Survey Department
- Mines Safety Department
- Zambia Environmental Management Agency
- Ministry of Labour and Social Security
- Isoka District Council
- Ministry of Health

African Inkalamo Mining Company will ensure compliance with institutional provisions and guidelines issued by the above institutions in the process of implementing the project.

2.2 International Agreements and Regional Conventions

Zambia has ratified more than twenty global and regional environmental conventions and treaties, which guide the country's environmental policy making, legislation and sustainable management of national resources. African Inkalamo Mining Company made reference to some of these international guidelines in the preparation of this Environmental Impact Statement. The company intends to adhere to international best practice on the guidelines during the planning, implementation / operation and closure of the project as it interacts with, the natural environment and interested and affected parties.

The most pertinent to the project are discussed in more detail below.:

	Convention / Treaty	
1	**Convention on Biological Diversity (ratified in 1993):**	The objectives of Zambia's National Biodiversity Action Plans include ensuring the conservation of a full range of Zambia's natural ecosystems through a network of protected areas, development and implementation of strategies for conservation of biodiversity, sustainable use and management of biological resources. Biological resources of significant conservation value that will be identified during Project implementation will be conserved and protected within the Mine Surface rights area.
2	**Convention on Wetlands of International Importance especially as waterfowl habitat (1975)**	The Convention aims at promoting conservation and sustainable use of wetlands and their resources for the benefit of the present and future generations. The Project development and implementation would need to be undertaken in a way that should not compromise the ecological character of the marshlands but should instead contribute to their maintenance and enhancement.
3	**Convention concerning the Protection of the World Cultural and National Heritage (1972)**	The Convention aims at ensuring the identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage. Cultural and natural heritage sites that may be identified during the proposed Project implementation will be protected and conserved in accordance with the provisions of the Convention to which Zambia is party to
4	**United Nations Framework Convention on Climate Change (1992)**	The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty (currently the only international climate policy venue with broad legitimacy, due in part to its virtually universal membership) negotiated at the United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit, held in Rio de Janeiro. The objective of the treaty is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". This is important to the project in that AIMCL should endeavour to ke7ep the Green House Gas emission to the minimum.
5	**Convention on the Trans-Boundary Movement of Hazardous Wastes**	The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, usually known as the Basel Convention, is an international treaty that was designed to reduce the movements of hazardous waste

	Convention / Treaty	
		between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries (LDCs). It does not, however, address the movement of radioactive waste. The Convention is also intended to minimize the amount and toxicity of wastes generated, to ensure their environmentally sound management as closely as possible to the source of generation, and to assist LDCs in environmentally sound management of the hazardous and other wastes they generate
6	**Convention on Biological Diversity, 5 June 1992;**	The Convention on Biological Diversity (CBD), known informally as the Biodiversity Convention, is a multilateral treaty. The Convention has three main goals: I. conservation of biological diversity (or biodiversity); II. sustainable use of its components; and III. fair and equitable sharing of benefits arising from genetic resources In other words, its objective is to develop national strategies for the conservation and sustainable use of biological diversity. It is often seen as the key document regarding sustainable development. The convention is applicable to the project in that as the company implements its project, it needs to ensure that strategies are put in place that protects biological diversity.
7	**United Nations Convention to Combat Desertification (UNCCD), adopted 1997**	The United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa (UNCCD) is a Convention to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements.
8	**Convention on the Protection of World Cultural and Natural Heritage ratified 1975**	The Convention concerning the Protection of the World Cultural and Natural Heritage entered into force on 17 December 1975, three months after the date of the deposit of the twentieth instrument of ratification, acceptance or accession, pursuant to its article 33
9	**Montreal Protocol, 1985**	The protocol is aimed at ensuring measures to protect the ozone layer.
10	***Ramsar (wetlands) Convention***	The broad aims of this convention are to stem the loss and to promote wise use of all wetlands. The convention addresses one of the most important issues in Southern Africa, namely the conservation of the countries water supplies, for both the use of the natural and the human environments.
11	***The Kyoto Protocol***	Treaty to further reduce greenhouse gas emissions by enhancing the national programs of developed countries aimed at this goal and by establishing percentage reduction targets for the developed countries

2.3 Public Consultations

Focus Group engagement meetings were organised in line with the provisions of Regulations No. 8 of the Environmental Impact Assessment Regulations 2007. Public Consultations were held at Lualizi with the local people, traditional leaders and civic leaders to consider in preparing the Terms of Reference (TORs) for submission to

the Zambia Environmental Management Authority (ZEMA) and to determine the scope of work to be done in the conduct of the EIA. Apart from the scoping meeting meetings, disclosure meetings were also held in the project area to provide the results of the EIA and get the views of the people.

Prior notice for the Public Consultation with the community was given through the community leadership, announcements at Churches and schools and also through the adverts in the Daily Mail Newspaper. Relevant government departments, non-governmental organisations and the general public were invited to attend. At the meetings, the project description, potential environmental and socio-economic impacts, mitigation measures and benefits were presented to the stakeholders for their feedback. The meetings also provided an opportunity for capturing any other relevant issues for inclusion in project EIS document.

3.0 PROJECT DESCRIPTION

3.1 Project Location

The proposed Rare Earth Element Mine Project by African Inkalamo Mining Company is located in Chilonga Village under Chief Katyetye's Chiefdom. The area is about 50Km east of Isoka District (by road) in Muchinga Province as indicated in Figures 3.1 and Maps in Appendix 2. The African Inkalamo Mining Company prospecting licence area covers about 1850.3 Ha (which will be converted to mining license). About 400 Ha of the licence area will be used by the proposed project.

The nearest land marks to the project area with respective coordinates are outlined in Table 3.1 below. The African Inkalamo Mining Company tenement is located in area of active exploration activities for various minerals. The project site is bordered by large scale and small scale exploration Licenses as well as artisanal mining licenses respectively according to the Zambia Mining Cadastre Map.

The site is near the Lualizi area, approximately 50 km east of Isoka town, 15 km off the Isoka-Muyombe (D790). The turnoff to the proposed project site is about 50km from Isoka town as one drives towards Muyombe.

Table 3.1: Distances and Coordinates of Nearby Land Marks

Point	Distance to Project Site		Coordinates
Isoka - Nakonde Road/Muyombe Road Junction	41.4 km (following the route from Isoka – Nakonde Road/Muyombe Road Junction) to Mine site		32º 40′ 13″E 10º 08′ 52″S
Katyetye Road/Muyombe Road (D290} Junction	28 km from the Mine Site		32º 45′ 38″ 10º 15′ 58″
Katyetye Road/Mine Site Turn-Off (Junction)	5 km to the Mine Site		32º 48′ 26″E 10º 09′ 15″S

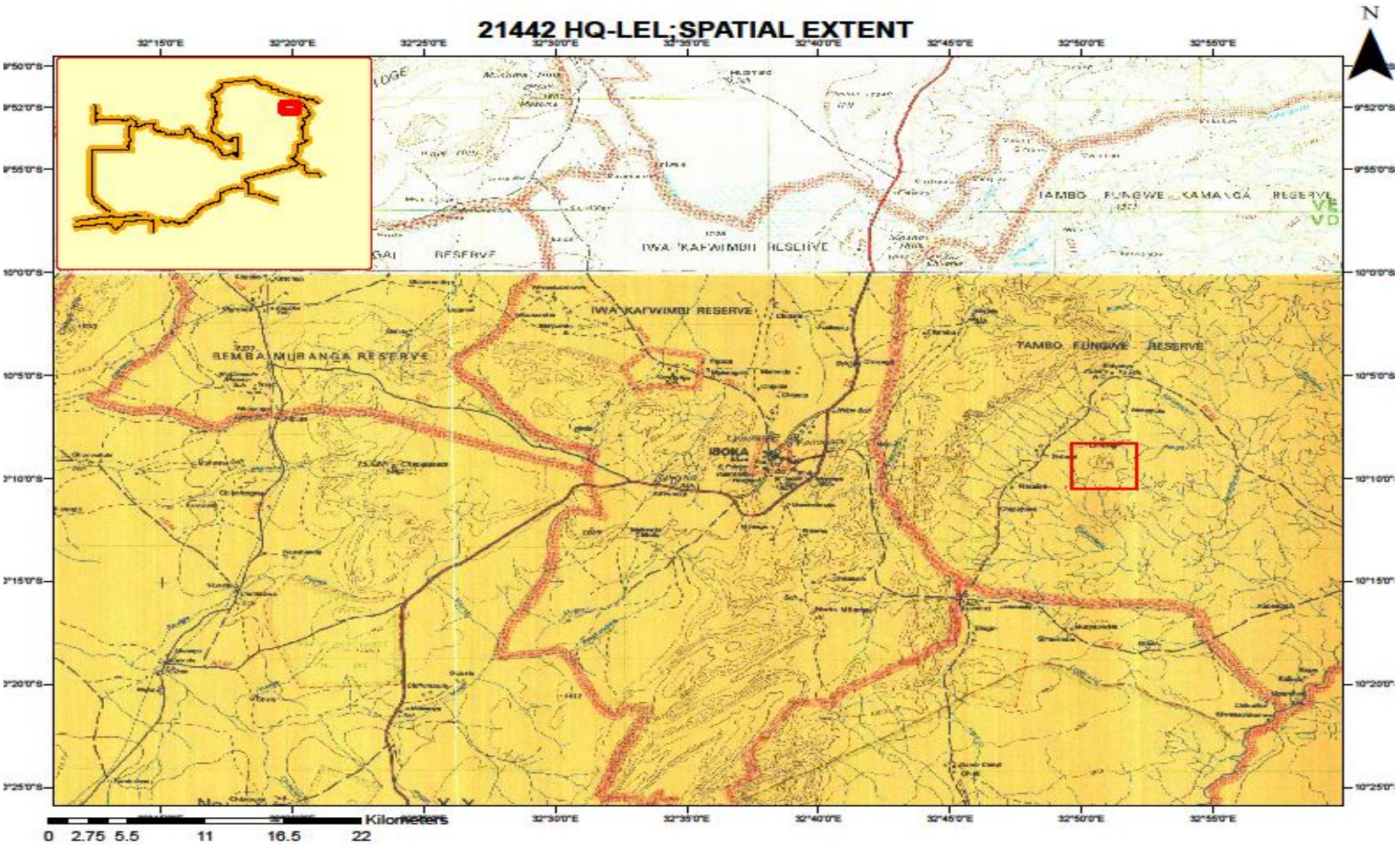


Figure 3.1 showing the Location of the Project Site

3.2 Nature of the Project

3.2.1 Overview

The African Inkalamo Mining Company Project is a greenfield project as the project area is a located on a dormant piece of land where no formal land use activities have been taking place. Previous owners of exploration licence for the area did not undertake any developments, hence African Inkalamo Mining Company Limited will be the first one to develop the area. The only activities that have been reported are the exploration works that were undertaken by previous license holders and some isolated artisanal/illegal mining activities that left some trenches and excavations.

It is envisioned that the open pit mine its associated facilities will be set up in Lualuzi area. The mining of Rare Earth Elements will be conducted using hydraulic excavators, bulldozers, dump trucks and loaders to mine the ore. Where hard rock is encountered, drilling and blasting methods of mining will be employed. The ore will then be transported from the open pit area to the mineral processing plant where it will be crushed, after which it will then be milled before being further processed to produce concentrates.

3.2.2 Production and ancillary facilities

The Project will contain the following principal production facilities, laid out as shown in Figure 3.2:

- Open Pit Mining Operations
- Waste Rock Dumps (WRD)
- Ore crushing station including coarse-crushing and fine-crushing workshops, ore transfer system and ROM pad
- Processing Plant area
- Tailings Storage Facility (TSF)

And the following ancillary facilities:

- Mine camp infrastructure: mine site administration office
- Engineering workshops
- Water supply facilities
- Power supply facilities
- Flood protection and drainage system
- Waste management, which includes hazardous, non-hazardous and medical waste
- Materials Handling and Storage, with explosives magazine

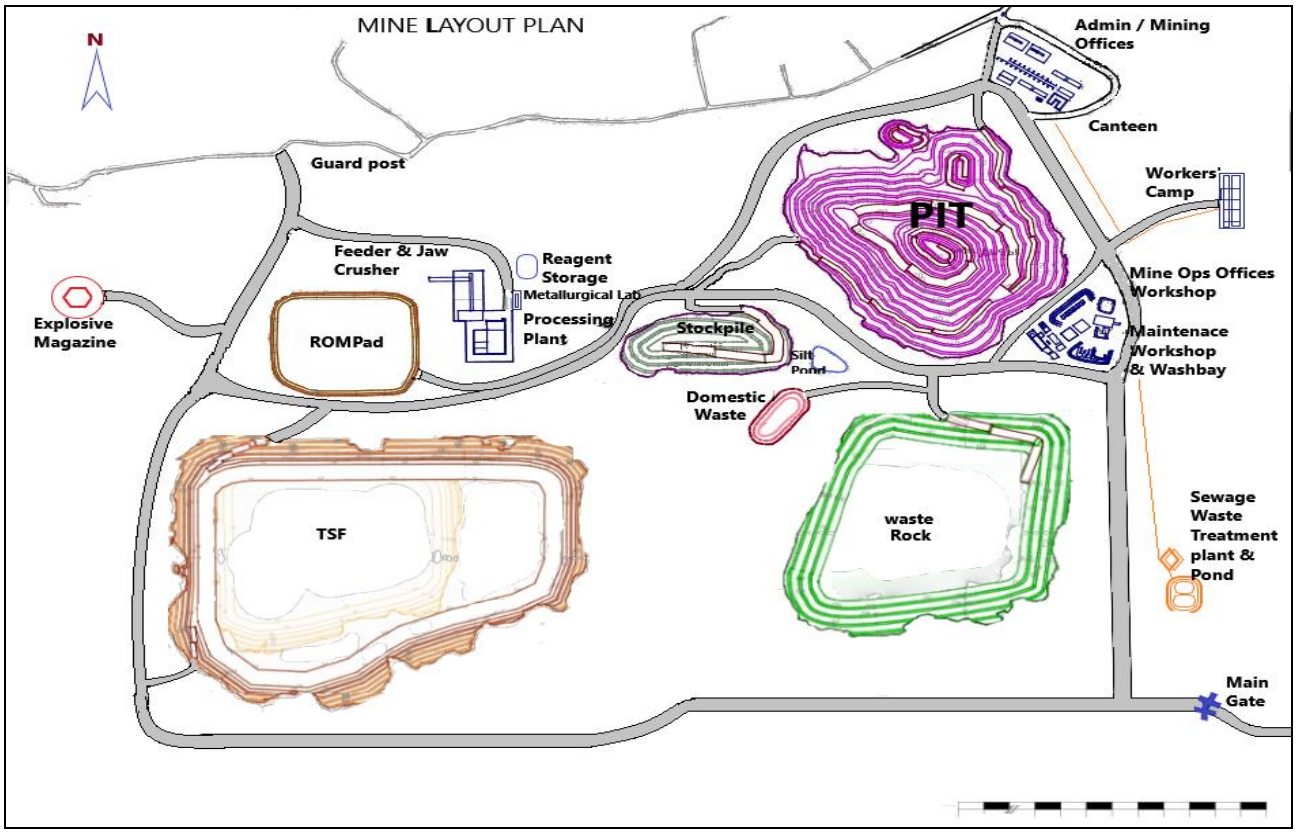


Figure 3.2: Mine Layout Plan

3.2.3 Rare Earth Elements Ore Reserves

The current estimated Mineral Resources for the African Inkalamo Mining Company Limited Licence 21442-HQ-LEL is **16.5 million tonnes** at an average grade of **1.16%** Rear Earth Oxides (REO). The Mineral Reserves have been estimated to be 9.1 million tonnes at an average of 1.28% Rare Earth Oxides (TREO). The ore occurs very close to the surface, naturally, it will be mined using the open-pit mining method.

A mining throughput of 750,000 mtpa was adopted for this project, giving a pit life of just over 25 years based on the initial estimations. African Inkalamo will produce Rare Earth Oxides concentrates.

Table 3.2 Showing the Summary of Mineral Reserves

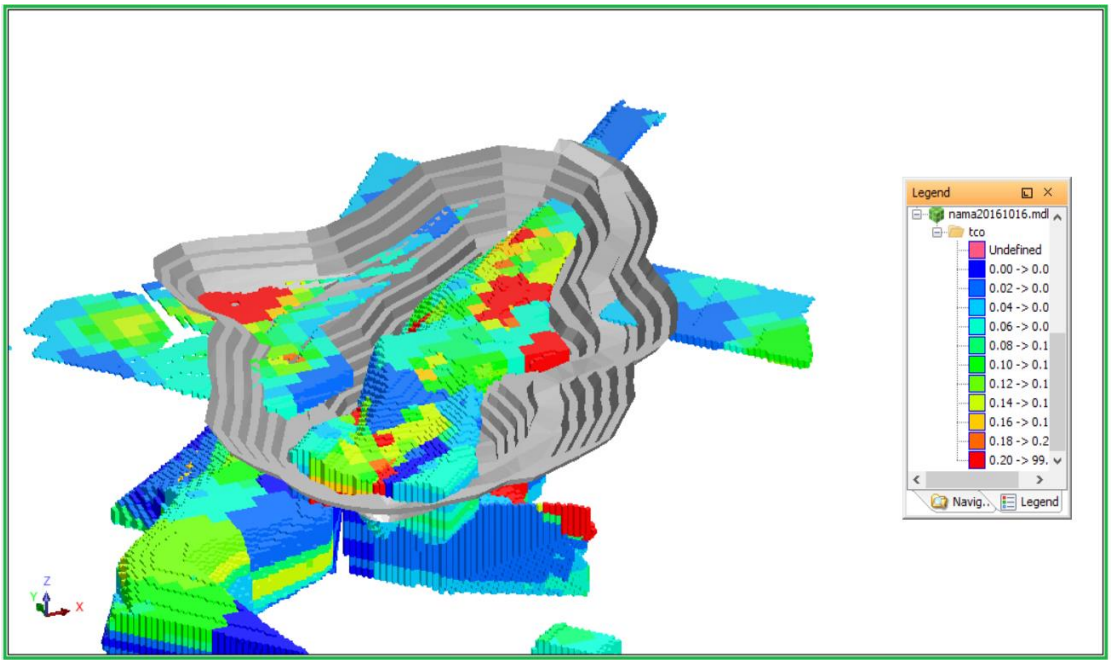
Category	Tonnage (Mt)	TREO (%)	TREO (t)
Proven Mineral Reserves	9.1	1.28%	116,480
Probable Mineral Reserves	7.4	1.11	82,140
Total Reserves	16.5	1.16	191,400

3.2.4 Mining

Rare Earth Element ore will be mined from the open pit (Nkombwa Hill). The mining method that will be used for the open pit is the conventional selective open pit mining, where deposits are delineated through benching and drilling of the deposits.

Like any other mineral ore, the ore will be blasted by explosives to fragment the insitu rock prior to excavation. The maximum mined depth below surface will be approximately 60m i.e. after depleting the Nkombwa Hill materials. The overall stripping ratio (overburden/ore) is approximately 2:3. The design pit wall slope angles vary between 50° in extremely weathered rocks to 75° in fresh rock. Bench heights are planned at 5m with nominal 4.0m to 4.5m wide berms. The final slope angle will vary between 30^{o} to 43.1^{o}. The gradient adopted for the ramp is 10^{o}. Storm water cut-off drains constructed alongside the pit perimeter haul roads will prevent surface runoff flowing into the pit. The designed pit is 1.5km along strike and 500m across strike and 120m dip from an average topographic elevation of 1325m a.m.s.l, as illustrated in Figure 3.3.

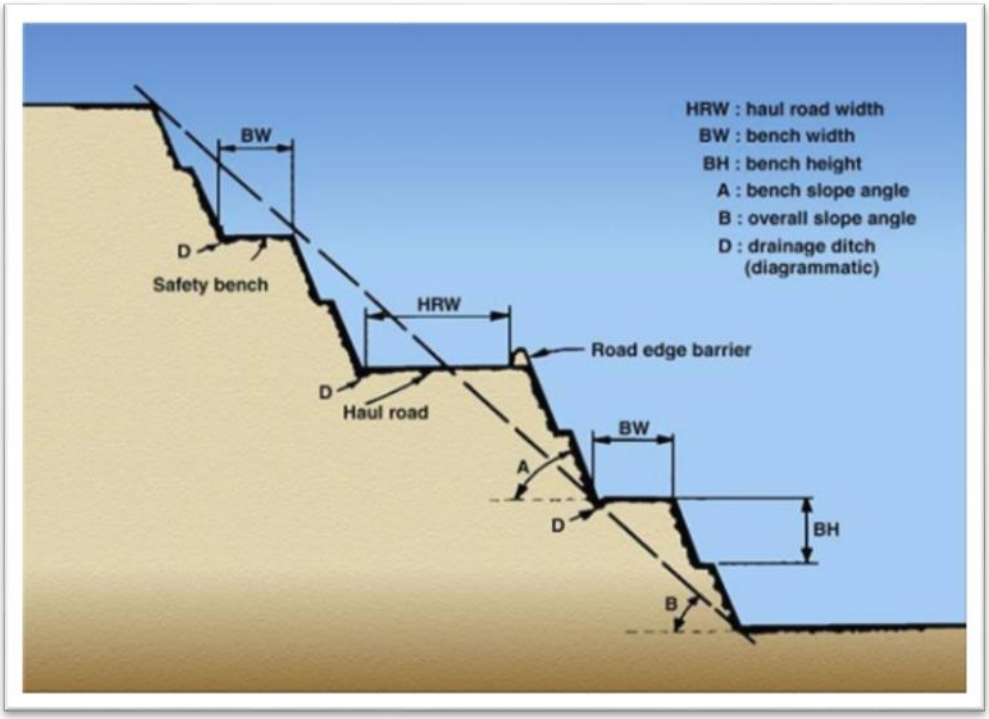
Figure 3.3 Open pit outline



De-pressurisation of the pit slopes to permit safe mining will be achieved by a combination of in-pit pumping and vertical dewatering wells positioned behind

the pit rim. The blasted material will be in the form of big boulders, ranging from a centimetre to meters in size. The material will then be excavated using Front – end Loaders into haul trucks. The haul trucks will transport the mined ore either directly to the Primary Crusher or the Run-Off Mine (ROM) Pad for storage.

Figure 3.4: Schematic Outline of the Open Pit



3.2.4.1 Production Sequence

Exploration activities have so far shown that the mineralisation extends beyond the open pit to the extent that sufficient mineralisation can be identified to produce a mineable resource. Due to ongoing work, both in the field and on the block model, no attempt has been made to finalize the resource. The resource drilling model used for the study, suggests a resource of some 16.5 million tonnes at an average Rare Earth Element grade of 1.16% (TREO).

The resource translates into a potential mineable reserve of 9.1 million tonnes at an in-situ grade of 1.28% TREO. It was considered that open pit mining method would be most appropriate for the mining operations. The mine layout was designed such that future extensions, either along strike and at depth, or both, would not be prevented or precluded. Mining throughput of 750,000 mtpa of TREO was adopted for this study giving a pit life of just over 25 years based on the initial estimations. Ongoing exploration activity and resource

development studies are considered to have the potential to extend the mine life to more than 25 years and further work is expected to increase the mine life beyond that. The area considered for this is just a quarter of the licence area.

Waste Rock Dump

Overburden materials generated from mining the open pit will be dumped at the associated waste dump which will be established before operations commence. The waste dump will be operated with an overall slope angle of approximately 35º. It will be constructed in 10 m lifts with 5m wide berms and an inter-berm slope angle of approximately 40º. The dump design will ensure long-term slope stability and prevent erosion.

It should however be noted that the plan for the open pit operations are to use in pit dumping once enough space has been established for same mining. This way, the ultimate void that will be created at end of mine life will be small and thus presenting reduced costs at closure.

During operations, slope runoff from the sides and on the upper surface of the dump will be intercepted in toe and perimeter drains respectively and settled in sedimentation ponds before being pumped to the natural environment.

The top of the dump will be engineered to slope down to the north during construction of the final lift. This will facilitate post closure collection of runoff from the dump into the decommissioned mine pit and subsequent release of water into natural environment.

The proposed schedule or sequence has indicated that certain critical items of equipment will dictate project progress. The autogenous/ball mill is one such major items and the project schedule will be determined by the availability of such units, either new or second-hand.

3.2.4.2 Mine Life and Mine Production

Pit optimisation studies conducted during the study indicate an optimum mine life of 25 years at an ore production rate of 750,000 Mtpa at average insitu grade of 1.28%TREO. Average overburden stripping will be 2.089 Mtpa giving a total material movement of over 15.84 Mt for the life of the mine. As mentioned earlier, this mine life will be extended by conducting exploration activities.

3.2.4.3 Mine Products and Planned Annual Production

African Inkalamo Mining Company will produce Rear Earth Elements Oxides concentrate. The planned annual production and quality of Rare Earth Elements Oxides is shown in the Tables 3.8 below.

Table 3.8: Table Showing Average Annual Production of Rare Earth Element Mineral

Material	Totals
Ore Tonnes @ 1.28% TREO	750,000 tons

3.2.5 Process and technology

Nkombwa Hill is a rare earth elements deposit in the eastern region of Isoka District. It comprises mostly carbonaceous gangue minerals and rare earths associated with oxides. Minor amounts of sulphide minerals are also present. The purpose of the concentrator plant or “front end” is to produce a rare earth oxide concentrate, which is to be treated in a subsequent hydrometallurgical plant.

Flotation of oxide minerals is typically more difficult to achieve than flotation of sulphide minerals, and a defining characteristic of this project has been to develop a flotation circuit and reagent suite that effectively float the rare earth oxides from the other oxidic gangue. The key in achieving flotation recovery lies in the combination of fine grinding, high-intensity conditioning, elevated temperature, and the correct reagent suite and dosages.

Continuous flotation test work drove the development of the process design, and the current flotation circuit has been proven to produce good recoveries and concentrate grades.

The crushing circuit consists of a primary jaw crusher and secondary and tertiary cone crushers. Primary and secondary screens are used to optimise the size of the crushers. The crushed product will be milled in a ball mill in a closed circuit with a primary cyclone cluster. The cyclone overflow will then be ground in stirred media mills and classified before being pumped to the flotation circuit.

The flotation circuit will start with sulphide pre-float rougher and cleaner cells to remove sulphide minerals ahead of the main rare earth oxide flotation. Pre-float tails will then be conditioned and fed into rare earth oxide roughers and scavengers. The rougher and scavenger concentrate will then be treated in cleaner cells, and the cleaner concentrate ultimately will report to the concentrate thickener. The thickener underflow will be filtered and sent to the hydrometallurgical plant for further processing. The cleaner tails will be treated in cleaner scavenger cells, and the concentrate will be recycled to the rougher scavenger feed. The rougher, scavenger and cleaner scavenger tails will report to the tailings thickener and will then be pumped to a TSF.

The hydrometallurgical plant will receive the flotation concentrate from the flotation plant and will treat it with an up-front gangue leach to dissolve the acid-consuming gangue minerals with dilute acid. Gangue leach liquor s purified to precipitate impurities, filtered, and dosed with calcium chloride and

sulphuric acid to regenerate hydrochloric acid and produce solid gypsum for possible sale.

Gangue leach residue will be contacted with concentrated NaOH solution at a high temperature in order to convert insoluble rare earth minerals into soluble rare earth hydroxides in the caustic conversion. The caustic conversion residue will proceed to cerium oxidation, where the slurry will be sparged with air to oxidise cerium and render it insoluble in the subsequent rare earth leach. The caustic conversion solution will be evaporated to reconcentrate it and then undergoe a causticisation process to regenerate sodium hydroxide for reuse in the process.

Cerium oxidation residue will be thickened and filtered before being fed into a more severe rare earth leach with hydrochloric acid. The leach residue will be thickened and filtered before being repulped in the hydrometallurgical tails neutralisation area, and then combined with flotation and other hydrometallurgical tails streams to be sent to the TSF. Rare earth leach liquor will be purified of heavy metals and radionuclides before being precipitated as a mixed rare earth carbonate product.

3.2.5.1 Rare Earth Elements Processing

The material to be handled will be disseminated ore, which will be mined by Open Pit methods. From studies conducted, the design head grade is 1.16% TREO, which allows for some fluctuations in feed grade.

After mining, REE ores will then be crushed and ground to appropriate sizes. The basic function of the crushing circuit will be to reduce the run-off-mine (ROM) ore to a size suitable for feeding to the grinding circuit and will be achieved through the use of primary crushers. The product size from the crushing plant is determined by the size of the feed to the grinding circuit. The crushed ore will be transported to stockpiles by separate overland conveying systems. Ore will be recovered from the crushed ore stockpiles by the use of variable speed apron feeders. After crushing, the material will then be transferred to the grinding circuit before it can be transferred for further processing using flotation and leaching methods.

Should air quality become an issue as a result of the crushers, appropriate dust suppression equipment shall be considered.

After mining, the REE ores will be processed to produce a concentrate with high TREO contents by-using flotation and leaching methods with which about 70% TREO concentrate will be produced. This concentration of the rare earth ore oxides is expected to be achieved using simple flotation, gravity and magnetic processes and leaching processes as confirmed by the metallurgical test works. Test works have shown that 60% TREO recovery, with a mass pull factor of 10% to achieve grades of 70% TREO.

Crushing

ROM ore will be delivered to the plant by haul trucks which will tip the ore directly into the ROM bin. Material will be withdrawn via an apron feeder and vibrating grizzly arrangement to feed the primary jaw crusher. A rock breaker will be installed in the ROM bin area to break any oversize material that could become stuck in the primary crusher. The primary crusher product will be discharged onto the primary crusher product conveyor. An overhead magnet installed on the conveyor will remove any

tramp steel. A belt weightometer installed on the primary crushing product conveyor controls the circuit feed tonnage by varying the speed of the ROM bin reclaim apron feeder.

The primary crusher product is conveyed to the secondary screen, which removes the target size material from the feed to the secondary cone crusher. The screen oversize is fed to the secondary crusher via a bin and pan feeder arrangement. The screen undersize joins the secondary crusher product and tertiary crusher product and is conveyed to the tertiary screen.

The tertiary screen oversize is fed into the tertiary cone crusher via a bin and pan feeder, and the tertiary screen undersize is conveyed to the ball mill feed bin. The tertiary crusher product is combined with the secondary screen undersize and secondary crusher product and conveyed to the tertiary screen to be classified once more in a recirculating loop.

The ball mill feed bin provides a process de-coupling between crushing and milling, and it also provides an 8 h surge capacity to allow for the lower availability in the crusher circuit. The mill feed bin overflows onto an emergency stockpile; the mill feed bin overflow can then be reclaimed with front-end loaders (FELs) and returned to the mill feed conveyor. The mill feed bin discharges onto the mill feed conveyor via a belt feeder.

A weightometer installed on the ball mill feed conveyor is used to control the mill circuit feed by varying the speed of the mill feed bin discharge belt feeder. The mill feed conveyor weightometer is used for metallurgical accounting purposes.

Conveyor skirting and dust enclosures, together with dust extraction systems, are included in the design as a means of containing the dust produced by the crushing circuit.

Ball Milling

The milling circuit will comprise a ball mill operating in a closed circuit with a classification cyclone. Fresh feed to the ball milling circuit consists of crushed ore that is milled down prior to further grinding in the fine grinding circuit. Process water is fed at a ratio of the mill feed tonnage required to obtain the target in-mill solids density and is also added at a controlled rate to the mill discharge sump to achieve the set cyclone feed solids density.

Milled slurry overflows from the mill through the trommel screen to remove scats, and into the mill discharge sump. Scats are collected in a bunker and removed periodically using an FEL.

Mill discharge slurry is pumped to a cluster of hydrocyclones for classification. The cyclone overflow gravitates to the fine grinding circuit for further processing while the cyclone underflow gravitates back to the ball mill feed chute.

Steel grinding media are added into the mill feed chute by means of a magnet, hoist and kibble system. The media level in the mill is determined by measuring the mill power draw, and fresh media is added when the power draw decreases below a set limit.

Spillage in the area is contained by a concrete bunded area with a sloped floor to direct spillage to the mill feed side spillage sump, equipped with a vertical spindle pump to return the spillage to the mill discharge sump.

Fine Grinding
The product from the ball mill circuit gravitates to the regrind mill feed sump for ultra-fine grinding, which comprises several regrind mills operating in a closed circuit with a classification cyclone. The regrind mills use ceramic grinding media and stirrers to further decrease the size of the flotation feed slurry.
The cyclone underflow flows to a splitter box to feed four regrind mills operating in parallel, with one additional mill on standby. The product from the regrind mills reports back to the circuit feed sump to be classified once more in a recirculating loop.

The cyclone overflow gravitates to the flotation feed sampler, which comprises a two-in-one sampling system. The cyclone overflow material is passed through a trash screen, which separates out undesirable material, such as wood chips, to a skip. The screened underflow material gravitates to the pre-float rougher surge tank for further processing.

Flotation
The cyclone overflow from the fine grinding circuit reports to the flotation circuit of the concentrator.

The flotation circuit consists of rougher and cleaner sulphide pre-flotation, total rare earth oxide (TREO) rougher flotation, TREO scavenger flotation, TREO cleaner flotation, and TREO cleaner scavenger flotation. All cells are tank cells with forced-draft air systems.

Automatic head sampling consists of a feed box, launder, and a two-in-one sampling system (primary cross-cut sampler and vezin sampler) and provides flotation feed samples at regular intervals for metallurgical accounting purposes.

An on-line stream analyser will be provided on the key feed, concentrate and tailings streams for process control purposes.

Pre-Flotation Rougher Flotation
The cyclone overflow material from the fine grinding cyclone cluster reports to the pre-float surge tank, where it is diluted with process water to the desired solids density for froth flotation. The diluted slurry is pumped, at a controlled rate and density, from the surge tank to an overflow conditioning tank, where collector and frother reagents are added. The reagents are dosed at the dosage rates required for optimal flotation performance. The conditioned slurry overflows by gravity to the first of four cells in series in the flotation bank. Blower air is provided via the low-pressure air reticulation system.

The concentrate from the cells gravitates into the pre-float rougher flotation concentrate sump, from where it is pumped to pre-float cleaner flotation. Spray water is provided at the concentrate launder of each cell to assist with washing down the froth and to improve flow.

Tailings gravitate to the pre-float rougher flotation tailings tank, from where they are pumped to the TREO rougher flotation.

Pressure pipe samplers are installed on the pre-float rougher flotation feed and tailings pump discharge lines, providing sample material to the automatic on-line stream analyser for plant control. Recirculating streams from the on-line stream analyser are directed back to the prefloat rougher flotation and rougher flotation feed surge tanks.

Spillage in the pre-float rougher flotation bunded area reports to the pre-float rougher flotation surge tank.

Pre-Flotation Cleaner Flotation
The pre-flotation cleaner flotation circuit is fed directly with pumped pre-float rougher concentrate material. This section comprises two cells in series. Blower air is provided via the low-pressure air reticulation system.

The concentrate from the cells gravitates into the pre-float cleaner concentrate sump, from where it is pumped to scavenger flotation. Spray water is provided at the concentrate launder of each cell to assist with washing down the froth and to prevent/minimise gangue material recovery or entrainment to the concentrate.

Tailings gravitate to the pre-float cleaner tailings tank, from where they are pumped to the TREO rougher flotation.
Pressure pipe samplers are installed on the pre-float cleaner concentrate and tailings discharge lines, providing sample material to the automatic on-line stream analyser for plant control. Concentrate and tailings return material from the on-line stream analyser are directed back to the scavenger flotation and rougher flotation feed surge tanks, respectively.

Spillage in the pre-float cleaner flotation bunded area reports to the first cell in the circuit.

TREO Rougher Flotation
The TREO rougher flotation circuit receives tailings material from the pre-float rougher and cleaner circuits via the rougher flotation surge tank. Steam is sparged into the surge tank to heat the slurry to the target temperature for downstream processing. The slurry is pumped, at a controlled rate and density, from the surge tank to a series of three overflow conditioning tanks, where further steam is sparged along with M4P, M7, caustic soda, collector, and frother. The reagents are dosed at the rates required for optimal flotation performance. The conditioned slurry overflows by gravity to the first of four cells in series in the flotation bank.

The flotation feed pumps from the surge tank control the level in the conditioning tanks and the feed rate to the flotation cells. Blower air is provided via the low-pressure air reticulation system.

The concentrate from the cells gravitates into the TREO rougher concentrate sump, from where it is pumped to cleaner flotation. Spray water is provided at the concentrate launder of each cell to assist with washing down the froth and to improve flow.

Tailings gravitate to the TREO rougher tailings tank, from where they are pumped to the scavenger flotation circuit, with the option of being bypassed to tailings thickening.

Pressure pipe samplers are installed on the rougher flotation concentrate and tailings discharge lines, providing sample material to the automatic on-line stream analyser for plant control. Concentrate and tailings return material from the on-line stream analyser are directed back to the cleaner and scavenger feed surge tanks, respectively.

Spillage in the rougher flotation bunded area reports to the rougher flotation surge tank.

TREO Scavenger Flotation
The TREO scavenger flotation circuit receives TREO rougher tailings and cleaner scavenger concentrate via the scavenger flotation surge tank. Steam is sparged into the surge tank to heat the slurry to the target temperature for downstream processing. The slurry is pumped, at a controlled rate and density, from the surge tank to a series of two overflow conditioning tanks ahead of flotation, where further steam is sparged along with M7, collector, and frother. The reagents are dosed at the dosage rates required for optimal flotation performance. The conditioned slurry overflows by gravity to the first of two cells in series in the flotation bank.

The flotation feed pumps from the surge tank control the level in the conditioning tanks and the feed rate to the flotation cells. Blower air is provided via the low-pressure air reticulation system.

The concentrate from the cells gravitates into the scavenger concentrate sump, from where it is pumped to cleaner flotation, with the option of being bypassed to concentrate thickening. Spray water is provided at the concentrate launder of each cell to assist with washing down the froth and to improve flow.

Tailings gravitate to the scavenger tailings tank, from where they are combined with cleaner scavenger tailings and pre-float cleaner concentrate and pumped to the tailings thickening circuit.
Pressure pipe samplers are installed on the scavenger flotation concentrate and the combined tailings discharge lines, providing sample material to the automatic on-line stream analyser for plant control. Rejects material from the on-line stream analyser is directed back to the scavenger feed surge tank.

Spillage in the scavenger flotation bunded area reports to the scavenger flotation surge tank.

TREO Cleaner Flotation
The TREO cleaner flotation cells receive as feed the concentrate streams from the rougher flotation and scavenger flotation circuits via the cleaner flotation surge tank. Steam is sparged into the surge tank to heat the slurry to the target temperature for downstream processing. The slurry is pumped, at a controlled rate and density, from the surge tank to a series of two overflow conditioning tanks ahead of flotation, where additional steam is sparged along with collector and frother reagents. The reagents are dosed at the dosage rates required for optimal flotation performance. The conditioned slurry overflows by gravity to the first of four cells in series in the flotation bank.

The flotation feed pumps from the surge tank control the level in the conditioning tanks and the feed rate to the flotation cells. Blower air is provided via the low-pressure air reticulation system.

The concentrate from the cells gravitates into the cleaner flotation concentrate sump, from where it is pumped to concentrate thickening. Spray water is provided at the concentrate launder of each cell to assist with washing down the froth and to prevent/minimise gangue material recovery or entrainment to the concentrate.
Tailings gravitate to the cleaner flotation tailings tank, from where they are pumped to the cleaner scavenger flotation circuit, with the option of being bypassed to the cleaner scavenger circuit.

Pressure pipe samplers are installed on the cleaner flotation concentrate and tailings discharge lines, providing sample material to the automatic on-line stream analyser for plant control. Concentrate and tailings rejects material from the on-line stream

analyser is directed back to the cleaner feed surge tank and scavenger feed surge tank, respectively.

Spillage in the cleaner flotation bunded area reports to the cleaner flotation surge tank when required.

TREO Cleaner Scavenger Flotation
The cleaner flotation tailings material is pumped to the cleaner scavenger flotation surge tank ahead of the cleaner scavenger flotation. Steam is sparged into the surge tank to heat the slurry to the target temperature for downstream processing, and collector reagent is dosed at the required dosage rate. The conditioned slurry overflows by gravity to the first of three cells in series in the flotation bank.

The flotation feed pumps from the surge tank control the level in the conditioning tanks and the feed rate to the flotation cells. Blower air is provided via the low-pressure air reticulation system.

The concentrate from the cells collects in overflow boxes and flows gravimetrically to the cleaner scavenger flotation concentrate sump to be pumped to the feed surge tank on the scavenger flotation circuit. Spray water is provided at the concentrate launder of each cell to assist with washing down the froth and to prevent/minimise gangue material recovery or entrainment to the concentrate.

Tailings from the cleaner scavenger circuit collect in the cleaner scavenger flotation tailings sump, from where they are pumped to the scavenger flotation tailings tank along with pre flotation concentrate to feed the tailings thickener.

A pressure pipe sampler is installed on the discharge line from the cleaner scavenger flotation tailings pumps. The sample reports to the automatic on-line stream analyser for plant control. Rejects from the on-line stream analyser are directed to the scavenger flotation area surge tank.

Spillage in the cleaner scavenger flotation bunded area is pumped via a spillage pump to the cleaner scavenger flotation surge tank when required.

Concentrate Thickening
The cleaner flotation concentrate slurry is pumped to the concentrate thickener for dewatering ahead of filtration. Scavenger flotation concentrate may also be bypassed intermittently to the concentrate thickener when required.

The concentrate slurry to the thickener is mixed with diluted flocculant in the feed well of the thickener to aid settling. The thickener underflow is pumped to the concentrate filter feed tank.

Clear thickener overflow water gravitates to the concentrate thickener overflow tank, from where it is pumped to the process water pond via the heat exchanger.

The thickener feed passes through an automatic sampling system consisting of a stilling box, launder, and primary cross-cut and secondary vezin samplers. The final flotation tailings metallurgical accounting sample is taken at regular intervals at this point. Rejects from the secondary sampler, with by-passed sampler feed, are directed back to the concentrate thickener feed tank.

Spillage in the concentrate thickening area is contained in a bunded area and pumped back to the thickener using the spillage pump.

Concentrate Filtration
The concentrate thickener underflow material is pumped to the agitated filter feed tank for surge storage capacity ahead of the filters. The two duty concentrate filters are operated in a parallel, staggered cycling arrangement to match downstream processing in the hydrometallurgical plant.

The thickened concentrate material is further dewatered by a pressing action between the cloth surfaces of the filter press and forms the filter cake. After a completed filter cycle, the concentrate filter cake is discharged onto the concentrate filter transfer and discharge conveyors, which offload the filter cake either to the emergency stockpile during process upset conditions or to the conveyor feeding the hydrometallurgical plant for repulping and further downstream processing.

The cloth wash water tank pumps raw water to the filters for cloth cleaning.

The filtrate gravitates to the filtrate tank and is pumped back to the concentrate thickening tank.

A weightometer is fitted onto the filter discharge conveyors for metal accounting of the final concentrate from the plant.

Tailings Thickening
The tailings thickener receives feed slurry from the combined flotation tailings sump in the scavenger flotation circuit for dewatering ahead of disposal in the TSF. Rougher tailings may also be bypassed intermittently to the tailings thickener when required.

The tailings slurry to the thickener is mixed with diluted flocculant in the feed well of the thickener to aid settling. The thickener underflow material is pumped to the agitated final tailings tank, from where it is pumped to the TSF. A dedicated system consisting of a tank and pumps for supplying high-pressure gland seal water for the tailings disposal pumps is provided.

Clear thickener overflow water gravitates to the tailings thickener overflow tank, from where it is pumped to the process water pond via the heat exchanger. The thickener feed passes through an automatic sampling system consisting of a stilling box, launder, and primary cross-cut and secondary vezin samplers. The final flotation tailings metallurgical accounting samples are taken at regular intervals at this point. Rejects from the secondary sampler, with bypassed sampler feed, are directed back to the tailings thickener feed tank.

Spillage in the tailings thickening area is contained in a bunded area and pumped back to the thickener using the spillage pump.

Tailings Storage and Return Water
Thickened tailings from the tailings thickener underflow are pumped to the TSF, along with the hydrometallurgical plant final tailings. Water from the settled tailings is siphoned off and pumped via return water pumps to the TSF return water pond. The return water pumps pump water from the TSF return water pond to the process water pond for use in the plant process water circuit.

3.2.5.2 Tailings Storage Facility
The tailings produced during the flotation process of the Rare Earth Elements will be directed to the tailings and effluent treatment tank. The solution in this

tank will be treated and neutralised and pumped to the TSF. The TSF will occupy an area of approximately 10Ha.

The conceptual design of the TSF has been done and is attached to this report. The location of the TSF is shown in Figure 3.2 and design drawings of the TSF are shown in Figure 3.5.

The TSF has been designed as a paddock-type containment facility with a perimeter compacted earth fill wall, compacted clayey fine tailings liner; decant system and perimeter toe drain. The tailings slurry will be neutralised in the tailings and effluent treatment tank at pH 6 to 8 and slurry will be pumped to the TSF.

The current design is for a disposal facility (including future expansion) that can accommodate 12 Mt of tailings at a deposition rate of 60,000 t/month over a project life of 25 years. The detail design, when undertaken, will take into account the latest tonnages and production rates expected by the project team.

The area to the south and west of the facility will be available for future expansion. Initially deposition will be behind the earth fill wall, and future lifts will be constructed with coarse tailings borrowed from the head of the beach. Supernatant water will be returned to the process water tank at the processing plant by a submersible pontoon pump. There will be no gravity decant or piping through the TSF wall.

A toe drain and blanket rain will return seepage through a pipe and manhole network to a collector sump from where it will be returned to the TSF. Catchment paddocks along the perimeter of the TSF will collect silt and run-off from the sides of the TSF.

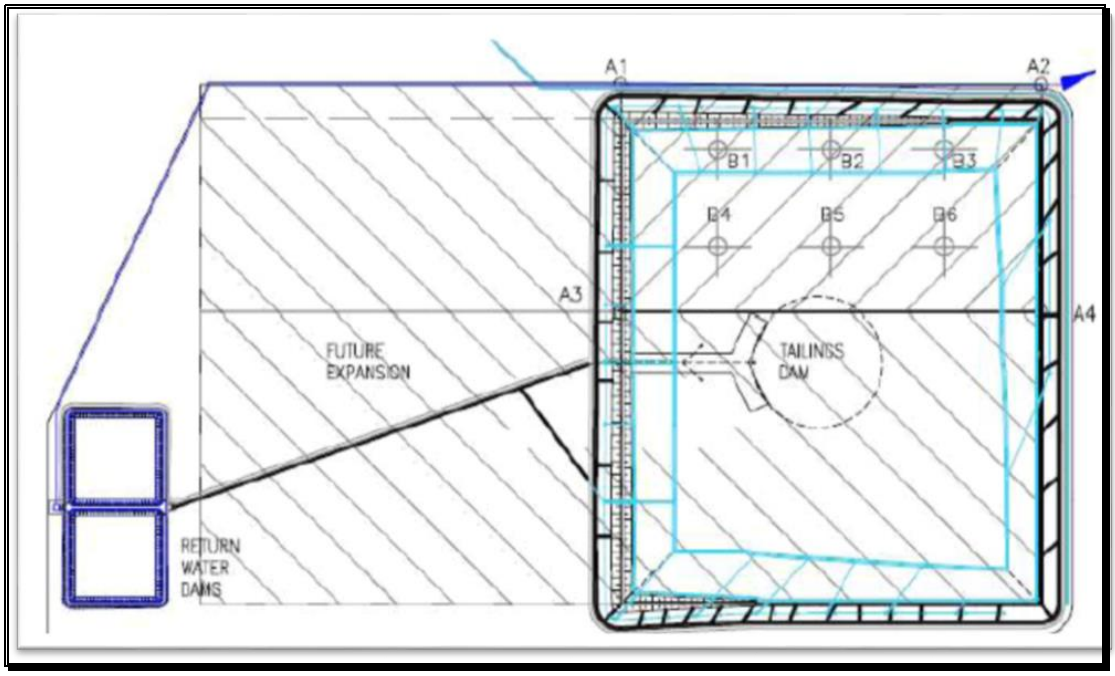
No stability problems are anticipated and research of seismic records for the region has shown that there are low levels of seismic risk in the area. The TSF will be designed to handle the 1 in 100-year storm event. There will be no discharge from inside the TSF direct to the mine site drainage system.

3.2.6 Site Drainage

Note that the Project area is generally flat and there are seasonal streams close to the project site. Because of this, there will be need to control the water from flowing all over the mine site especially during the rainy season. To this effect, during periods of rain, there will be some surface runoff, open channel flow and standing water in low areas. Nominal grading and ditching will be adequate to maintain a well-drained site.

Finish grade on the project site will be constructed to provide positive drainage away from structures. A system of ditches will route runoff around the project site and the ore stockpile. This routing will also be done for the waste rock dump site. This way, it will be done so as to prevent the direct flow of water into the river system. This way, water will be allowed to pass through a sedimentation pond before flowing into the river system.

Figure 3.5 Design of the Tailings Dam



3.2.7 Other Mine Infrastructure

3.2.7.1 Mine Access

Access to the project area is via a dirt road branching from the road to Muyombe. Stretches of this road are in poor conditions and thus have to be improved before it can be used to transport inputs and outputs to and from the mine site. Drainage ditches and culverts will be placed in accordance with the site drainage requirements. Site haul roads will be 8m wide and constructed to meet the requirements of haul trucks. Other roads on site will be 6m wide.

The entire site will be surrounded with a 1.8m high range fence in order to keep free range animals and intruders out of the mine site. Access to the mine-site will be restricted to one access main gate, which will include a gatehouse manned 24 hours/day. Furthermore, a 2m high chain link security fence will be erected around the explosive storage area.

3.2.7.2 Power Supply and Electrical Distribution

Power will be provided using an appropriate generator that will be installed on site and will be operated using diesel fuel. The power supply will require an overhead pole line from the genset and will terminate at the various destination points.

Apart from thermal power using the Gen set, the company will also have power supplied by Zesco to the site. This will be done by connecting the site to grid from Isoka District.

3.2.7.3 Ancillary structures

3.2.7.3.1 Workshop/Warehouse

The workshop will be a prefabricated concrete building with spread footing design. The workshop will include two indoor mobile equipment repair bays equipped with an overhead travelling crane, a small vehicle repair bay and one outdoor wash bay equipped with high pressure water monitors and a sloped concrete pad leading to an oil/water separator.

Building facility to include a machine shop, high pressure water and steam cleaning equipment, lubricant distribution pumps, electrical/instrumentation work areas and a tool crib. Offices for warehouse, maintenance and planning personnel will be provided.

3.2.7.3.2 Fuel Storage and Distribution

Diesel fuel will be delivered to the site by tanker truck. Diesel fuel requirements for the mining equipment and ancillary facilities will be supplied from a diesel fuel storage tank to be located at the mine site. Diesel fuel distribution will be limited to loading and unloading facilities and metering equipment at the diesel fuel tank. The details for the fuel storage facility are attached as appendix.

Lubricants will be delivered to the site in drums. The drums will be stored in a secure area. The lubricants will be distributed to hose reels in the truck shop service bay with barrel pumps.

The warehouse will be located adjacent to the truck shop. The structure will include personnel access doors, and interior office area, manually operated service door and interior shelving. An outdoor secure storage area surrounded by a chain link fence will be included located between the warehouse and workshop.

3.2.7.3.3 Administration Building

The administration building will be of a single-storey prefabricated panel construction. The panel construction is considered the least expensive alternative as these buildings can be efficiently transported to site in containers and assembled on a prepared concrete slab quickly and efficiently.

The administration building will include general areas for engineering, geology and administration personnel and offices for the Mine manager, plant superintendent, administration superintendent, chief geologist, chief engineer and security chief, etc.

3.2.7.3.4 Communication

Communication at the mine will be done by the use of radios. Please note that AIMCL will approach mobile providers so that they can connect the site to the mobile network. This way, the company will help in ensuring that the project is opened up in terms of mobile communication.

3.2.7.3.5 Water Sources

Groundwater supply from the production wells is envisioned for process water as well as for human consumption. The groundwater will be pumped from the borehole to supply water for the mine project. A pump house and storage facility for water will thus be constructed at the place.

3.2.7.3.6 Waste and Sewage Collection and Treatment

Office and domestic waste will be deposited in bins, then taken to a custom-made site where they will be collected by waste management trucks for disposal at designated site within the license area (please refer to the site layout plan). The dump will be made between the TSF and the waste rock

dump. Only non-hazardous waste will be dumped at the site. The site will be fenced off and security provided. Operations will be such that when waste is dumped, it will be crushed before being covered with soil.
African Inkalamo Mining Company will install an Integrated Bio-Reactor (IBR) at its project site to treat the waste water. An IBR is a unique modification of the activated sludge process in which the clarifier is placed within the aeration tank. The above-ground design reduces system footprint and saves on costs associated with excavating and constructing traditional concrete basins (please refer to picture below).

Composed of aerobic, anaerobic, and clarification zones, the IBR is designed to treat typical municipal wastewater. The operation and maintenance of the IBR is simple, as the system's only moving mechanical parts are the aeration blowers, which drive air into the reactor.

The treatment systems are designed to remove all the waste water from the septic tank, then with the unique “ACCELERATED OXYGENATION” technology, produces water which is as CLEAR as drinking water. This water is ODOURLESS and SAFE for re-use in garden as irrigation, for ponds or outlet to storm water drainage or streams.

The Bio-Filter African Inkalamo Mining Company will install facilitates all the chemical and biological reactions needed to clean and disinfect the waste water for re-use, and very low maintenance and running costs are a key feature of the systems operation.

3.2.7.3.6 Miscellaneous Site Buildings

A main gatehouse will be located at the entrance to the plant-site. This building will be a simple single-storey block work structure. The explosives storage magazine will be of block work construction and will be located away from where the operations will be taking place.

The other buildings will be construction phase accommodation or temporary site based accommodation for construction employees.

3.2.7.3.7 Consumables and Reagents

The explosive types and detonators to be used in fragmenting the waste and ore are:-

- Emulsions;
- High Explosion Boosters; and
- Non-electric detonators (NONEL, EXEL etc.)

All explosives will be stored in a secure bulk explosives storage building (Magazine) within the licence area in accordance with explosive regulations.

Reagents to be used in the process plant include frothers, collectors, promoters, lime, flocculent and steel balls. Water is also added to the process plant.

The additions are listed below:

- No additions are made in the crushing section;
- SAG mills - water and steel balls;
- Ball mills - water, steel balls and collectors;
- Tailings thickener section - water and flocculent; and
- No additions while the tailings are pumped to the storage facility or in the tailings dam.

All reagents will be kept in specially designated areas.

Delivery of these reagents will be by road from a proprietary supplier of these products, and only limited volumes will be kept on site due to the ready availability of delivery services. All reagents will be stored in accordance with the necessary legislation and the material safety descriptions provided by the manufacturer. No chemicals, or chemical residues, will be allowed to leave the site from the process route unless it has been adequately treated so as to render it harmless to fauna, flora and the environment in general.

3.2.8 Employment

The overriding philosophy and policy for manpower engagement at all levels is that of employing the correct level of skills and experience required to operate the mining complex efficiently. From brief reviews, and even in the current world shortage, the engagement of suitable skills and experience is not considered to be a major issue*. It is estimated that 400 workers will be engaged during construction and 150 personnel during operation i.e. direct employees.* The mining activity will be done through contract mining. This will enable the company to avoid large capital outlay at the start of its operation. However, to ensure that the works are correctly done, the contractor will be supervised by African Inkalamo Mining Company personnel.

Whilst the philosophy commences with engaging personnel from the local community and immediate surroundings, it is acknowledged that this will not be possible or feasible in all cases. It is expected that the majority of unskilled

positions will be filled from the local labour supply. At the same time, training programmes will be put in place for some of the semi-skilled positions such as plant operators and mining-fleet operators.

After the potential to fill positions from local community sources has been reviewed, the next stage will be to source the required skills from within Zambia in general. It is expected that within Zambia the majority of employees and skills will be found. There may be a few exceptions where specialist skills are required that cannot be sourced from within Zambia and for such cases, it will be necessary to look outside Zambia.

Table 3.9: Projected Human Resource

Category	Employees (Operations)	Employees (Construction)
Directors	4	
Administration	8	
Finance	4	
Quality Management	9	
Security Department	60	
Production (Processing Plant)	20	
Engineering Department	10	25
Mining	15	
Materials Management	5	
Sales/Marketing	5	
Construction (locals)		125
Expatriates	10	50
TOTAL	150	400

3.2.9 Employee Accommodation and Transport to the Mine Site

African Inkalamo Mining Company Ltd has made a plan by deciding to provide transport to workers. The transport will pick up the workers from Isoka, Lualuzi and the surrounding villages. Workers will be paid housing allowances so that they can find their own accommodation. The living camp will be used to accommodate the workers that will be employed from outside the project site but will not be allowed to have the families there.

3.2.10 Project Costs

The projected mine life for the project is over 25 years and capital costs are estimated at about ***USD$5 million.***

3.2.11 Storage of chemicals and reagents

Chemicals will be stored in a way that complies with all hazardous chemical reagent laws and guidelines (MSDS), including separation of incompatible chemicals, correct storage, locks, spillage bunds, roofed enclosures to minimise potential for spillage of chemicals to enter the environment.

Apart from bulk chemicals, chemical reagents will be stored in an enclosed storage building. This storage area will have 24-hour security to offer restriction of entrance. Reagent storage areas will be equipped with bund walls and provided with drain pumps to ensure spills are properly contained. Safety showers will be provided at all reagent storage areas to ensure employee safety. Plans and layouts for this building will be finalised in the final mine design.

3.2.12 Preventative and emergency measures

Surface runoff (uncontaminated) will be kept separate from contaminated plant runoff and process water. Clean run-off from the process plant will be collected in the perimeter storm drain and discharged to surface waters. All process spills and wash water will be returned to the process. Water from equipment wash bays at the workshop will be passed through oil sumps to remove oil and then sent to the process water storage pond.

Non-hazardous chemicals and reagents used in the process will be stored under roof or in a shed equipped with a concrete floor and containment wall to prevent any spillages causing soil, surface or groundwater contamination. There will be no releases of gases to the atmosphere but regular monitoring of air quality around and within the process plant will be carried out. All parameters will comply with air quality standards.

Air monitoring will be carried out to prevent build-up of gases, prevent releases of high levels of dust from the process plant and ensure a safe working environment. Safety breathing equipment will be located in all key areas where exposure to gases may occur. In the case of accidental spillages, the incident will be reported to the shift manager and the immediate remediation measures will be undertaken to neutralise the spill and prevent the spread of contamination. Contaminated soil or water will be disposed of appropriately according to methods detailed on the material safety data sheets (MSDSs).

Mine workers will be supplied with MSDSs to inform them about the chemicals they will be in contact with and the appropriate handling and storage practices to prevent accidents. Equipment cut-off switches will be inserted on key machinery (such as conveyors) where necessary to shut down equipment in the case of an emergency. Firefighting equipment will be available in key areas and extinguishers and signs placed in strategic areas of the process plant, offices and workshop areas. Only fully trained personnel will be operating each section and in the handling of reagents.

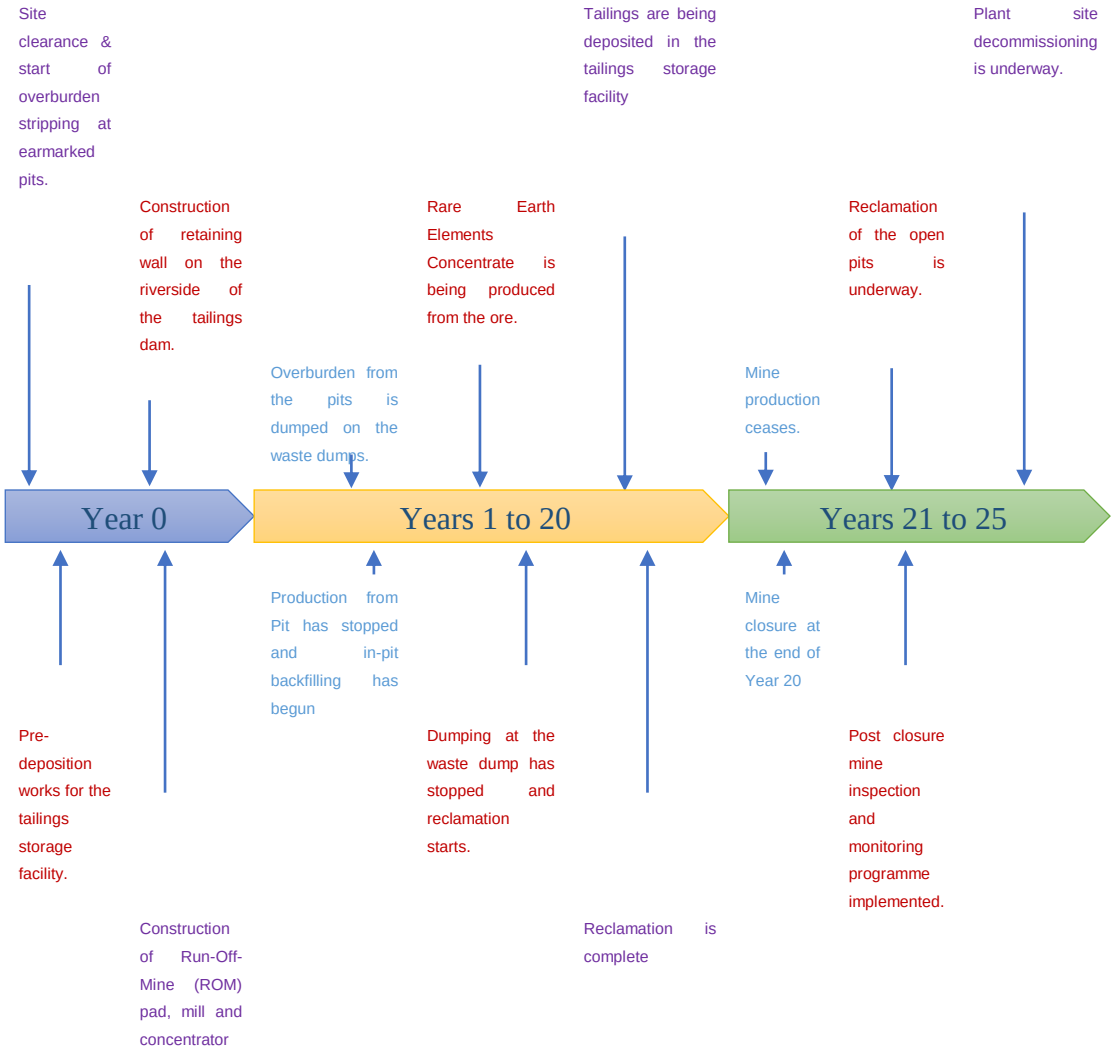
3.3 Project Main Activities

The schedule of activities to be undertaken in setting up, operation and closure of the project are summarised in Figure 3.6 and outlined in the sub sections below.

3.3.1 Site Preparation Phase

Being a greenfield project, construction and commissioning of the project will involve the clearing of the site in preparation for the construction activities to be conducted. The clearing will involve the removal of vegetation to pave way for the construction of project facilities. As mentioned earlier, the project will involve construction of processing plant for Rare Earth Elements. Apart from the main plant, other facilities to be constructed include a crusher, mine site offices, laboratory office, engineering workshop to carter for both heavy and light vehicle repairs at the mine site, store rooms, security checkpoint to control and monitor activities at the mine site, weigh bridge, change house, tailings storage facility and fuel storage facility.

Figure 3.6: Schedule of Main Activities - Year 0 to Closure in Year 25



3.3.2 Construction Phase Activities

Construction activities will generally comprise of land clearing, digging and earthworks to prepare foundations, compacting of foundations, setting of concrete footing/basements, fabrications and installation of fuel storage tanks, setting and erection of block walls, partitioning, roofing, painting and installation of fittings.

Other infrastructure to be constructed will include water pump house and treatment and storage facilities. Apart from materials specifically mentioned above other materials to be used in construction will comprise of laterite, river and building sand, crushed stones, steel bars and pipes, concrete blocks/burnt clay bricks, paint, planks, nails, wires, wire gauze, roofing sheets and fittings. Others will include pumps, meters, valves etc.

Equipment and tools to be used will include bulldozers/excavators, tippers, concrete mixers, wheelbarrows, shovels, picks, axes, hoes, compaction rollers and lifting devices. The raw materials will generally be sourced locally through competitive bidding. To this effect, African Inkalamo Mining Company will request suppliers of these materials to have clearance from ZEMA (where applicable) so that the environment is protected.

Other major construction works will be covered under plant construction works. One of the Key projects which will be undertaken by the plant is that of installation of the pollution control devices. Installation of pollution control devices (sump within the plant and also sedimentation ponds) will also be undertaken and it will have a major impact on the project environment in that there will be significant reduction in the levels of effluent and gas pollution arising from plant operations. A boundary security fence will also be constructed around the Processing Plant.

3.3.3 Operation Phase Activities

The operational phase will involve mining and processing of the Rare Earth Elements ore. The production of Rare Earth Elements Oxides will include mining Rare Earth Elements ore, crushing, milling, processing the ore into concentrates.

Rare Earth Elements ore will be mined from the open pit as indicated in (Figure 3.2). The mining method that will be used to mine the ore from open pit is the conventional open pit mining method. Like any other mineral ore, the ore will be blasted by explosives to fragment the insitu rock prior to excavation.

The blasted material will be in the form of big boulders, ranging from a centimetre to meters in size. The material will then be excavated using Loaders into trucks. The trucks will transport the mined ore either directly to the Primary Crusher or the Run-Off Mine (ROM) Pad for storage.

3.3.4 Decommissioning and Closure Phase

The activities that will be carried out during the decommissioning of the mine will include the decommissioning and removal of the equipment from the mine, renovation of mine offices and the re-vegetation of the entire African Inkalamo Mining Company mining project area. The offices will not be demolished but rehabilitated so that they can be used for some other alternatives project by nearby communities.

The removal of all other buildings and foundations will occur during mine decommissioning and precisely the plant site will be rehabilitated so that any contamination (e.g. soils, scrap metals, spilled chemicals, oils and fuel) that could have occurred during the life of the mine should not impact on the surface water, groundwater and flora after closure.

Closure will also cause the cessation of activities on the waste rock dump. The top of the dump will be engineered in such a way as to slope to one direction toward a natural drainage during construction of the final lift. This will facilitate post-closure collection of runoff from the dump into the natural drainage.

The TSF will be stabilised and re-vegetated with tolerant and hardy species, such as *Acacia polycantha, Acacia sieberana, Albizia adianthifolia, Peltophorum africanum*, and *Dichrostachys cinere*.

4.0 PROJECT ALTERNATIVES

The EIA regulations require the EIA process to include the consideration of reasonable and feasible alternatives for a project. Therefore, a number of possible proposals or alternatives for accomplishing the project objectives were identified and investigated by African Inkalamo Mining Company.

All reasonable and feasible technology alternatives were considered when assessing a variety of alternatives for the mining methods, processing methods, power supply, water supply, waste rock dumps, tailings storage facility and process plant. African Inkalamo Mining Company used and has committed to use industry best practice was used when determining which processes to use, as well as feasible financial considerations. A summary of the alternatives for the proposed Rare Earth Elements mine project is shown in Table 4.1 below.

Table 4.1: Summary of alternative analysis

#	Alternatives	Description
1	**No Project Option**	Development of the African Inkalamo Mining Company Rare Earth Elements project will result in extensive physical disturbance of the land, which for the most part is permanent. These physical environmental impacts include open-pit mining operations, construction of waste rock dumps, plant site, and tailings storage facility. However, if well managed and appropriate reclamation measures implemented, these mine components will have minimal public health or safety risks and no long-term effects on adjacent watercourses or groundwater resources. If the African Inkalamo Mining Company Rare Earth Elements mine project does not proceed, there will be no disturbance of the environment. However, the no project option must be weighed up against the loss of a multi-million-dollar long-term investment for the African Inkalamo Mining Company area, Muchinga Province, and the whole Zambian economy. African Inkalamo Mining Company Limited will employ hundreds of people (directly and indirectly) during the life of the mine. There will be numerous knock-on effects for the local and regional communities. Additional jobs will be created in service industries in the nearby towns where there is little development. AIMCL is committed to local employment, the use of local contractors and the promotion of independent sustainable economic development in the African Inkalamo Mining Company area. The no project option will be a major setback for regional and national economic development.
2	**Site**	There are no site alternatives, since the mineral deposit is located within the project area. Other areas with minerals are already owned by other companies. Location of the various mine components was limited due to the location of the ore deposit. Therefore, design of the mine site was carried out with economic feasibility and physical location in mind.
3	**Products**	Geological assessment of the mineralisation of the area showed that Rare Earth Elements are the only minerals that occur in economical quantities hence AIMCL settled for processing the material.
4	**Technology**	New technologies and greener technologies are continually being developed and African Inkalamo Mining Company has considered to install and use state-of-the-art technologies in an effort to make opencast and overall mining operations more efficient

#	Alternatives	Description
5	**Design Methods**	The African Inkalamo Mining Company Mine Project ore deposit is near the surface and the most economic extraction method is open pit mining. No other method is feasible. The plant layout is also designed to ensure the sustainable use of space
6	**Waste Rock Dumps**	The waste rock dumps are located to the south of the mining zone because of the proximity to the open pits, proposed dumps, the distance away from domestic activities, and the lack of mineralisation.
7	**Processing Facilities**	Various alternatives were considered during the compilation of the EIA report. Some of the options that were considered included: • The issue of processing the Rare Earth Elements ore and produce the concentrate which could be treated at another mine; and • Considering the mining of the ore and have it processed somewhere else On considering the first option i.e. the processing of the ore to produce the concentrate and have it further processed into finished product at another facility. This however was adopted owing to the fact that massive capital is required. As such, the option was considered because the ore that will be mined African Inkalamo Mining Company site are oxide materials. For the second option, the alternative could not be feasible owing to the fact that all the materials that would be transported for processing at an offsite would be too much.

#	Alternatives	Description
8	**Tailings Storage Facility**	The site identified for the TSF is generally a flat land with enough space for possible expansion. *Conventional Slurry Disposal* The most common method of tailings storage, worldwide, is slurry disposal, either into valley storage or paddock storage. The tailings, once discharged, beach and then settle and release the associated water for recovery and pumping back to the plant. Depending on the style of the storage, an annual rate of rise of less than 2 m/year is recommended to ensure that the tailings can consolidate and drain to form stable mass behind the embankments. Typically, only around 30% of the water which is delivered to the storage with the tailings can be recovered for return to the plant. *Thickened Tailings* Tailings can generally be thickened to above 70% by using conventional thickeners. At this density, the tailings will usually beach to a slope of around 2-3%. This slope allows the tailings to be discharged from a single elevated point to form a large self-draining cone. Water is released from toe of the slope and allowed to flow to a downstream collection point. The method is commonly called Central Thickened Discharge or CTD. The advantage of the method is that less water is lost from the system and hence less make-up water is required. In most cases, a lower Stage 1 embankment is required, and hence the capital cost of the storage should be less. However, if the tailings pulp density is too high, positive displacement pumps may be required to deliver the tailings, increasing both capital and operating costs. In some instances, CTD can lead to environmental problems largely due to the ever expanding footprint of the cone of tailings. The water released from the tailings passes over natural ground, which if permeable, can allow seepage to occur into the underlying groundwater. Dusting can also occur from the large surface area of the cone. *Paste Disposal* In recent times, high density or paste tailings storage has been used in several countries, however the method has not gained wide acceptance because of the costs involved in thickening the tailings, and then pumping the pulp to the tailings storage. Paste density (% solids) is usually above 85%. Positive placement pumps, and high pressure pipelines, are required to deliver the tailings to the tailings storage. Typically, the capital and operating costs of such systems are 20-30% above conventional pumping systems. Another problem with paste disposal is the management of the pulp once discharged into the storage. Due to the high viscosity, the pulp does not easily flow away from the discharge points, and this result in the need to regularly move the discharge points. In some cases, multiple points are used to spread the pulp over a wider area. One advantage of paste disposal is that considerably less water is delivered to the storage with the tailings and hence the overall water losses are reduced. This usually means that the amount of plant make-up water required is less that for a conventional storage.

#	Alternatives	Description
		Dry Disposal There are several projects around the world where the tailings are thickened and filtered before being dry stacked. Typical moisture contents are in the region of 15-18%. The advantages of dry disposal include: no embankments required, very low overall water losses, low environmental impacts (zero seepage losses), low closure costs. The disadvantages include: possible high capital and operating costs for the filter system, high transport costs for the filtered tailings (modern computer controlled conveyor stacking systems can reduce these costs), dusting from the dry stack and instability during the wet season. Dry stacking is rarely used, largely because of the high capital and operating costs. However, at a site where the available land is tight, dry stacking may be applicable. Developing capital and operating costs for this option will require extensive tailings test work.

The baseline assessments and subsequent assessment of impacts have identified and provided a number of incremental alternatives which are presented in the form of mitigation measures in later sections.

5.0 ENVIRONMENTAL BASELINE STUDY

The African Inkalamo Mining Company baseline study was conducted over a 3-month period beginning in July 2023 and finishing in September 2023. Data was collected over this period to examine seasonal and temporal changes in site conditions.

The baseline study area chosen for physical and ecological data collection is mainly that area which is in the direct zone of influence of the mine, its process facilities and infrastructure. Physical and ecological data was also collected on the local watercourse downstream of the immediate project area.

Scope of Work

The scope of work for the African Inkalamo Mining Company Mine Project baseline study included:

- A desk study of all available information on the project area;
- Visits to Government Departments, Non-Governmental Organisations and other relevant authorities;
- An investigation/assessment of environmental baseline conditions including: -
    I. Climate
    II. Air quality
    III. Geology
    IV. Hydrology
    V. Hydrogeology
    VI. Topography
    VII. Soils
    VIII. Land use and land tenure
    IX. Built Environment
    X. Noise and vibration
    XI. Fauna
    XII. Avifauna (Birds)
    XIII. Flora
    XIV. Archaeological and cultural environment
    XV. Social-economic set up

5.1 Climate

The climate of the area is controlled largely by the north-south migration of the Inter Tropical Convergence Zone (ITCZ) with seasons. The ITCZ migrates between the equator and the Tropic of Capricorn (23º S) between November and February. In winter, it is located over the northern tropics. The summer rains are brought by the southward migration of the ITCZ, and are characterised by thunderstorms, which are occasionally severe, with excessive lightning and sometimes hail.

The climate of Isoka and the project surrounding areas is clearly divided into two seasons of cold-dry and hot-rain seasons of about 6months each. Records on climate, particularly rainfall figures have been in existence since 1906. July is the coldest month of the year, with minimum temperatures of around 4°C and highest temperatures of about 28°C.

The hot season usually begin in September before the onset of the rains in November. The average relative humidity ranges from 47% in September to 85% in December and January. Relative humidity starts decreasing in April when rains end, and again start increasing in October just before the rainy season.

Mean annual rainfall is around 1, 386mm most of which falls within the period from November to March. Rainfall is fairly reliable from one year to the other, as Isoka falls within a high rainfall area of the country. Most rain is associated with thunderstorms which occur mainly during the afternoons and early evening.

Table 5.1: Mean monthly and annual rainfall Isoka).

Rainfall Monthly Mean (mm) & Standard Deviation (mm):

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Monthly Mean (mm)	3.1	26.0	124.3	276.9	285.0	237.6	186.6	44.7	4.1	0	0	0
Min	0	0	30	117	145	143	0	0	0	0	0	0
Max	21	118	315	491	548	511	319	199	53	0	0	0

Annual mean: 1386 mm

Table 5.2: Mean, Minimum and Maximum monthly temperature (Isoka)..

Monthly Temperature (°C) Mean, Minimum and Maximum and Mean

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean (°C)	20.0	20.3	20.6	19.0	17.5	15.6	16.5	18.9	21.8	23.8	23.7	20.0
Min (°C)	15.4	15.1	15.5	11.8	4.1	3.8	6.1	9.4	12.9	15.5	16.7	15.0
Max (°C)	37.9	28.4	27.4	26.5	28.1	25.5	25.7	27.7	29.8	31.4	31.5	27.9

The wind direction is mainly in the south-east to north-west direction. Rain season winds are more variable, usually with a northern inclination. Strongest winds are mostly from the northwest direction. The wind speeds normally drop to calm at night, though may be broken by squalls of up to 20knots.

Sunshine is abundant during the dry season when long spells of sunny weather occur with only short periods of cloud cover. During the rainy season the periods of sunshine are reduced to around four hours per day.

The mean annual periods of sunlight fluctuate from 2600 hours to a maximum of 2700 hours over the past 20 years. Frosts are unlikely to exceed 3 to 5 days per annum, even in areas most liable to low minimum temperatures owing to nocturnal air drainage and will occur only in May and August, causing severe damage to fruit trees planted in low lying areas near dambos.

5.2 Air quality

The study on the baseline air quality status in the vicinity of the proposed project is essential and a primary requirement for assessing the impacts on the air - especially that the African Inkalamo Mining Company Mine project might pollute the ambient air.

No air quality data is available for the project area. Field observations indicate that the general air quality in the area is good. However, seasonal variation as well as localized and temporal deterioration in air quality does occur.

In May 2024, MVC implemented the air quality survey for the project area. This was done so as to determine the current air quality conditions before the implementation of the mine project.

The size of airborne particulate matter of interest in air pollution studies usually range from 50µm down wards. Respirable particles of less than 10µm are of special concern due to health hazard potential. Particulates between 10 µm and 2 µm are referred to as coarse particles (PM_{10}) while those of size less than 2 µm are termed fine particles ($PM_{2.5}$). High levels of suspended particulate matter increase chances of respiratory diseases such as chronic bronchitis and asthma cases to the exposed population.

The air quality measurements, as part of baseline study, were carried out at three locations in the month of May 2024 within and near the mine area (Table 5.3). The portable Pylon air sampler as shown in the plate below was used to sample the air for 60 minutes at the rate of 2000 cm^3 per minute. The particulate matter PM_{10} were trapped using pre-weighed Whatman Nuclepore Track- Etch Membrane filters and the ambient gases were absorbed in potassium tetra-chloromercurate (TCM) and palladium chloride solutions and quantitatively analyzed using a UV- Shimidzu spectrophotometer for sulphur oxides, nitrogen oxides and carbon monoxide.

The results for air particulate matter are expressed as mass concentration in microgram (µg) per cubic meter (m^3) of air sampled while the results for absorbed gases are gas mass concentration in microgram (µg) per cubic meter (m^3) of the absorbing solution.

Figure 5.1. Ambient Air Sampling

Table 5.3: Air Quality Measurements

Date	Location	TSP[1] (µg/m³)	PM_{10}[2] (µg/m³)	$PM_{2.5}$[3] (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	CO (mg/m³)	Pb (µg/m³)
19/05/24	Nazareth	11.2	3.1	1.1	<0.2	0.3	<0.2	<0.1
19/05/24	Camp Site	6.3	2.8	0.8	<0.2	0.5	<0.2	<0.1
19/05/24	Sabuni	8.6	2.3	0.9	<0.2	0.4	<0.2	<0.1
19/05/24	Malemula	9.4	2.5	1.3	<0.2	0.41	<0.2	<0.1

It is seen from the air quality results in Table 5.3 that all the concentration levels of pollutants were within the prescribed Zambian guideline limits listed in Table 5.4. The observed pollution load of Total Suspended Particles (TSP) and the Respirable Particles (PM_{10}) is attributed to the vehicular movement on the dirt road leading to various places through Lualuzi Village. Current road traffic volumes are low for most times at 3 pick-up vehicles per day. As the project site is located in the rural set up with minimal ongoing human activities the levels of SO_2, NO_2 and CO are low compared to the Zambian standard.

Table 5.4: Zambian Guideline Limits for Ambient Air Pollutants

Parameter	Reference time (Average)		Guideline limit
Sulphur dioxide (SO_2)	10 minutes		**500 µg/m³**
	1 hour		**350 µg/m³**
Sulphur dioxide (SO_2) in combination with Total Suspended Particles (TSP) and PM_{10}	SO2	24 hours	**125 µg/m³**
		6 months	**50 µg/m³**
	TSP	24 hours	**120 µg/m³**
		6 months	**50 µg/m³**
	PM_{10}	24 hours	**70 µg/m³**
Respirable particulate matter PM_{10}	PM_{10}	24 hours	**70 µg/m³**
Respirable particulate matter $PM_{2.5}$	$PM_{2.5}$	12 months	**15 µg/m³**
Oxide of nitrogen (NO_X) as nitrogen dioxide (NO_2)	1 hour		**400 µg/m³**
	24 hours		**150 µg/m³**
Carbon Monoxide (CO)	15 minutes		**100 mg/m³**
	30 minutes		**60 mg/m³**
	1 hour		**30 mg/m³**
	8 hours		**10 mg/m³**
Ambient Lead (Pb)	3 months		**1.5µg/m³**
	12 months		**1.0µg/m³**
Dust fall	30 days	Residential & light commercial areas	**250mg/m²/day**
		Non-residential & light commercial areas	**500 mg/m²/day**

[1] TSP = Total Suspended Particles, particles with diameter less than 45 micrometres(µm),
[2] PM_{10} = Respirable Suspended Particulate Matter, particles with less than 10 micrometres(µm)
[3] PM_{10} = Respirable Suspended Particulate Matter, particles with less than 10 micrometres(µm)

Ozone	**8 hours**	**120 µg/m³**

5.3 Geological Setting

The general geology of the area is dominated by the Nkombwa Hill which was originally mapped as limestone in the early 1930 with further investigations in the 1950 it was recognized as carbonatite plug. The plug is elliptical in plan measuring some 1000m by 1500m and rise some 300m above the surround countryside which is underlain by the basement of gneiss, schist, amphibolite, and quartzite.

The intrusive complex is approximately 1.5km x 1.0km in size and consists of five main types of carbonatites. These are dolomite carbonatite, ankerite /siderite carbonatite, veined carbonatite, phlogopite carbonatite and silicified carbonatite. The Silicified carbonatite exposures are found at the highest levels of the complex. The Nkombwa Hill carbonatite is a composite ring complex whereby the units generally dip steeply to the southeast

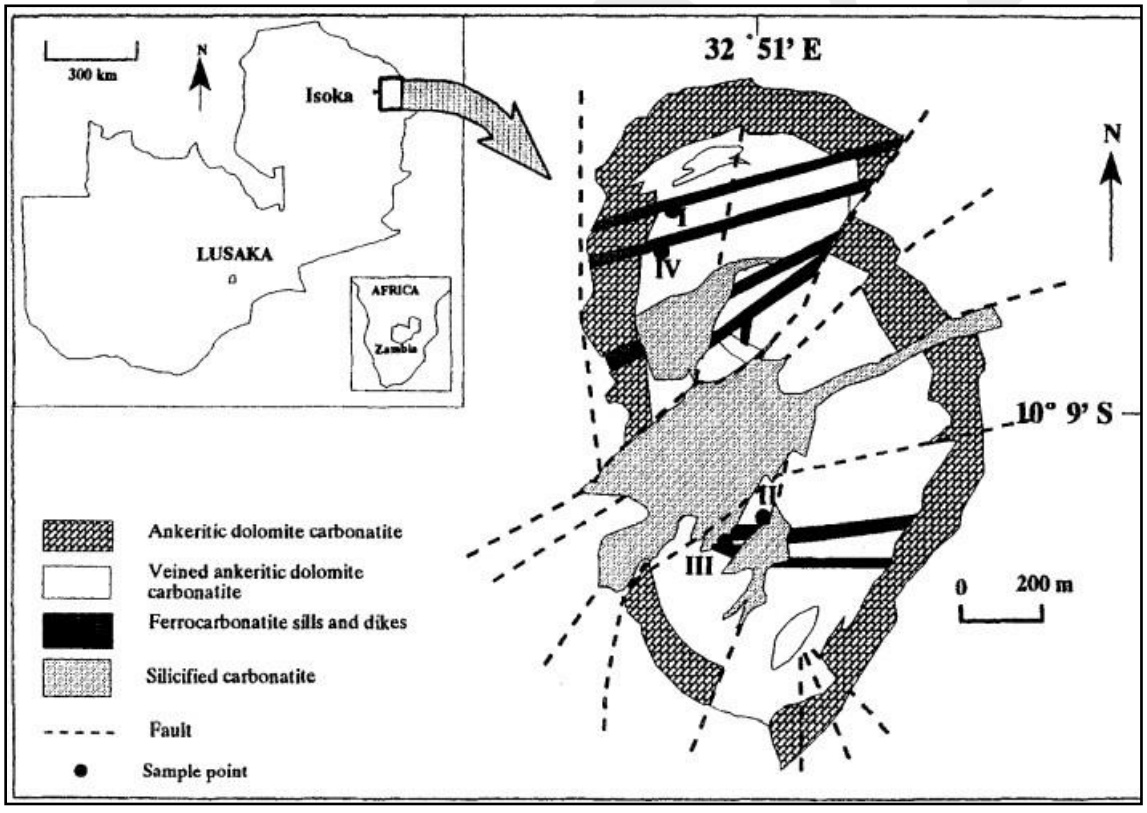


Figure 5.2 showing the Regional Geology of the Area

The Nkombwa Hill Rare Earth Project is located on northwest of the hill as illustrated in Figure 4. The general strike on in the area is North-East trending zones which dip steeply 70° to 80° to the Southeast.

5.3.1. Mineralisation

Rare Earth Mineralization at Nkombwa Hill Rare Earth Project comprise the family of Lanthanides on the periodic table of elements and are separated into light rare earths - Lanthanum (La), Cerium (Ce), Praseodymium (Pr), Neodymium (Nd), and Samarium (Sm) – and the less common heavy rare earths such as Yttrium,

Europium, Terbium and Gadolinium. The major REE-bearing minerals at Nkombwa Hill belong to the light REE group, and are bastnäsite, monazite and pyrochlore with minor daqingshanite-(Ce), rare-earth bearing isokite, strontian apatite, strontianite and other rare earth carbonates. REE"s reported from the carbonatite by Roan Selection Trust, Leeds University and others include Cerium, Lanthanum, Neodymium, Praseodymium and Gadolinium.

Within the carbonatite complex, bastnäsite - (Ce,La)CO3F, has been identified as an abundant mineral in xenoliths hosted by late-stage ferro - carbonatite sills and dykes (Touret, Leeds University, 1991).

Bastnäsite-(Ce) occurs as fibrous yellow crystals, about 1 µm in size, replacing monazite and in association with baryte, in a matrix of dolomite. In common with bastnäsite-(Ce) from other locations, the bastnäsite-(Ce) of Nkombwa Hill contains up to 70% light rare-earth oxides. However, Nkombwa Hill bastnäsite-(Ce) is relatively deficient in La and enriched in Pr and Nd. Cerium oxide assay results ranging from 0.78 to 9.28% CeO2 were recorded from five samples of drill core obtained by Roan Selection Trust Ltd in 1968-69. Individual rock chip samples from various workers in the 1980s yielded 2.5% Ce, 3.3% La and 0.6% Nd, 7.1% Ce, 7.2% La and 1.1% Nd and 5.6% Ce, 5.5% La and 2.3% Nd.

5.3.2 Hydrology

There are many streams within the Project area. These streams are mostly seasonal. The Panga stream is one of the main tributaries of the Luangwa River. The Panga stream and other streams drains into the Luangwa River, in the easterly direction.

5.3.3 Water quality

MVC initiated a ground and surface water monitoring programme in the study area. The locations of the monitoring points are shown in Figure 5.3, while the results of the surface and ground water monitoring are shown in Tables 5.4.

Sampling was conducted in accordance with internationally accepted sampling procedures for the collection and storage of surface water samples for chemical, physical and bacteriological analysis. Samples were analysed at The University of Zambia Environmental Engineering laboratory, in Lusaka, Zambia.

Sampling Frequency

Samples were collected during the site visit in May 2024 to determine the baseline environmental conditions of the Panga Stream. Full suite chemical, physical and bacteriological analyses were performed on the water samples collected.

Analytical Parameters

Surface water sampling and subsequent analysis provides the basis on which to evaluate any future environmental monitoring, which may be initiated as a result of any accidental spills or problems encountered during project operations, which may impact on project surface watercourses. During MVC's sampling exercise; the physical, chemical and bacteriological parameters that were tested included: -

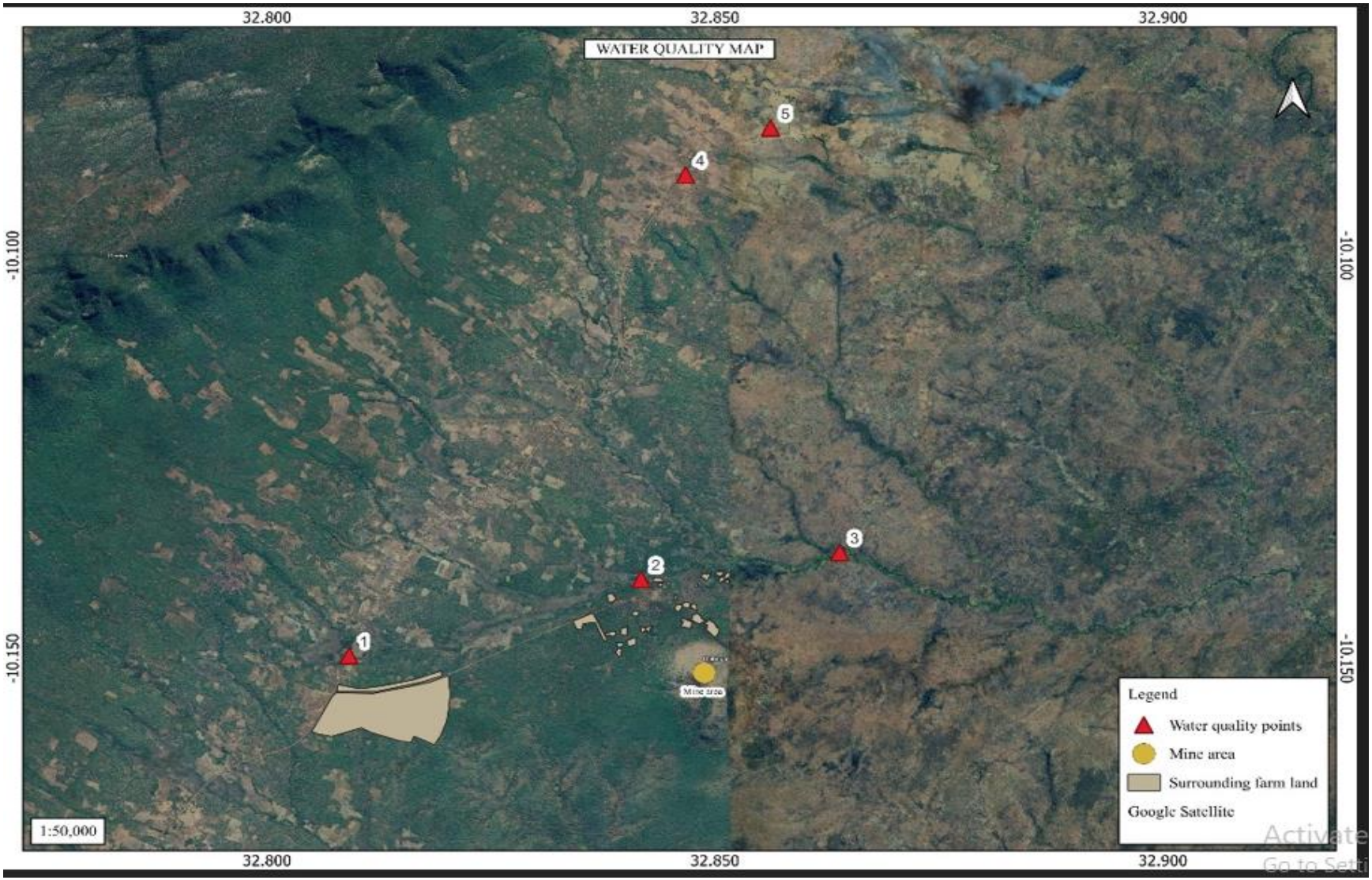


Figure 5.3 showing the sampling points

- pH
- Conductivity
- Turbidity
- Total Dissolved Solids (TDS)
- Total Suspended Solids (TSS)
- Colour

Total and dissolved metals tested included: -

- Lead
- Arsenic
- Manganese
- Mercury
- Nickel
- Selenium
- Copper
- Zinc
- Iron
- Gold

Sampling Results

The results show that the surface water in the project area is of good quality. All baseline concentrations analysed are compliant with Zambian drinking water standards except the concentration for Turbidity, Manganese, Total and Faecal coliforms which are above the limits at all the three sampling points.

Table 5.4: Baseline Laboratory Data: Surface water Quality Values, May 2024

	MAY 2024				
Parameter	**AIML/SWS01**	**AIML/SWS02**	**AIML/SWS03**	**ZABS**	**WHO STANDARD**
pH	6.81	6.84	6.3	6.5 – 8.0	
Turbidity (NTU)	104.20	95.90	97.12	5	
Conductivity (mMhos/cm)	228	236	229	1,500	
TSS (mg/l)	11.2	9.2	8.6		
TDS (mg/l)	115	118	115	1,000	
Sulphates (mg/l)	17.992	18.024	17.956	400	
Fluorides (mg/l)	0.14	0.12	0.13	1.5	
Chlorides (mg/l)	15.0	14.8	15.2	250	
Sodium (mg/l)	2.15	2.04	2.11	200	
Potassium (mg/l)	6.56	6.58	6.49		
Total Hardness (mg/l)	60	59	62	500	
Nitrates (as NO_3-Nmg/l)	<0.0001	<0.0001	<0.0001	10.00	
Total Phosphates (mg/l)	0.01479	0.01296	0.01752		
Cyanides (mg/l)	<0.0002	<0.0002	<0.0002		

Calcium (mg/l)	18.02	17.99	16.94	200	
Arsenic (mg/l)	<0.0002	<0.0002	<0.0002	0.01	
Barium (mg/l)	<0.01	<0.01	<0.01	0.7	
Boron (mg/l)	<0.04	<0.04	<0.04		
Hydrocarbons (mg/l)	<0.005	<0.005	<0.005		
Cadmium (mg/l)	<0.0002	<0.0002	<0.0002	0.003	
Cobalt (mg/l)	<0.0001	<0.0001	<0.0001	0.5	
Chromium (mg/l)	<0.01	<0.01	<0.01	0.05	
Copper (mg/l)	<0.003	<0.003	<0.003	1.0	
Iron (mg/l)	0.2100	0.2720	0.2100	0.3	
Mercury (mg/l)	<0.0002	<0.0002	<0.0002	0.001	
Manganese (mg/l)	0.2876	0.2942	0.2666	0.1	
Magnesium (mg/l)	7.283	7.1100	6.9562	150	
Molybdenum (mg/l)	<0.005	<0.005	<0.005		
Nickel (mg/l)	<0.001	<0.001	<0.001		
Lead (mg/l)	<0.01	<0.01	<0.01	0.01	
Zinc (mg/l)	0.01010	0.01220	0.01132	3	
Selenium	<0.0003	<0.0003	<0.0003	0.01	
Vanadium (mg/l)	<0.0001	<0.0001	<0.0001		
Nitrites (as NO_2 – Nmg/l)	<0.0001	<0.0001	<0.0001	1.0	
Ammonia (as NH4 – Nmg/l)	<0.0001	<0.0001	<0.0001		
Bacteriological Results					
Total Coliforms (#/100ml)	56	64	58	20	
Faecal Coliforms (#/100ml)	22	36	25	0	

5.3.4 Hydrogeology

It has been determined that the water table in the vicinity of the project area is approximately between 15m and 20 m below ground level.

There is no major water bearing structure visible or intersected around the project area. The ore breccia and the inferred fault associated with the breccia might carry larger volumes of groundwater at greater depth.

The results show that the groundwater in the project area is of good quality. All baseline concentrations analysed are compliant with Zambian drinking water standards except the concentration for Turbidity and Manganese, which are above the limits at all the three sampling points.

Table 5.5: Baseline Laboratory Data: Ground Water Quality Values, May 2024

	May 2024		
Parameter	**AIML/GWS01**	**AIML/GWS02**	**ZABS**
pH	6.88	6.84	6.5 – 8.0
Turbidity (NTU)	96.00	101.0	5
Conductivity (mMhos/cm)	230	242	1,500

TSS (mg/l)	8.8	12.2	
TDS (mg/l)	116	121	1,000
Sulphates (mg/l)	19.600	18.046	400
Fluorides (mg/l)	0.13	0.14	1.5
Chlorides (mg/l)	13.9	14.0	250
Sodium (mg/l)	2.22	2.17	200
Potassium (mg/l)	9.96	7.12	
Total Hardness (mg/l)	76	73	500
Nitrates (as NO_3-Nmg/l)	<0.0001	<0.0001	10.00
Total Phosphates (mg/l)	0.0124	0.01456	
Cyanides (mg/l)	<0.0002	<0.0002	
Calcium (mg/l)	18.26	16.94	200
Arsenic (mg/l)	<0.0002	<0.0002	0.01
Barium (mg/l)	<0.01	<0.01	0.7
Boron (mg/l)	<0.04	<0.04	
Hydrocarbons (mg/l)	<0.005	<0.005	
Cadmium (mg/l)	<0.0002	<0.0002	0.003
Cobalt (mg/l)	<0.0001	<0.0001	0.5
Chromium (mg/l)	<0.01	<0.01	0.05
Copper (mg/l)	<0.003	<0.003	1.0
Iron (mg/l)	0.1964	0.2440	0.3
Mercury (mg/l)	<0.0002	<0.0002	0.001
Manganese (mg/l)	0.2923	0.3003	0.1
Magnesium (mg/l)	6.94	4.100	150
Molybdenum (mg/l)	<0.005	<0.005	
Nickel (mg/l)	<0.001	<0.001	
Lead (mg/l)	<0.01	<0.01	0.01
Zinc (mg/l)	0.0112	0.01242	3
Selenium	<0.0003	<0.0003	0.01
Vanadium (mg/l)	<0.0001	<0.0001	
Nitrites (as NO_2 – Nmg/l)	<0.0001	<0.0001	1.0
Ammonia (as NH4 – Nmg/l)	<0.0001	<0.0001	
Bacteriological Results			
Total Coliforms (#/100ml)	0	0	20
Faecal Coliforms (#/100ml)	0	0	0

Water Use

Hand pumps and wells are constructed at regular intervals in populated areas along the linear settlement. A well and hand pump are usually available at each interval. In more sparsely settled areas they are dispersed at approximately 1km intervals. Hand pumps and wells are not available in more remote areas far away from the roads and natural water sources are used here. During cultivation and harvest of fields in remote areas, the population rely on natural water sources for domestic/drinking water.

5.3.5 Topography

Field observations together with topographical maps and satellite data have been used to define the topography and landscape of the study area. The topography of the project area is characterised by a generally flat land incised by the seasonal streams flowing in the Easterly direction to the Luangwa River.

5.3.6 Soils

As can be observed from the soil map, Figure 5.8, the project area is characterised by three soil types, Ferralsols (North-West, 15%), Acrisols (South, 50% of Site) and (North-East, 35%) Cambisols:

Table 5.6: Soil Types found in project site

Soil Type	Characteristics
1. Ferralsols:	Ferralsols represents the classical, deeply weathered, red or yellow soils of the humid tropics. Ferralsols have good physical properties but are chemically poor. Their low natural fertility and tendency to 'fix' phosphates are serious limitations. Many Ferralsols are used for shifting cultivation. Liming and full fertilization are required for sustainable sedentary agriculture. Fertilizer selection and the mode/timing of fertilizer application determine to a great extent the success of agriculture on Ferralsols. Slow-release (rock) phosphate applied at a rate of several tons per hectare eliminates phosphorous deficiency for a number of years. For a quick fix, much more soluble Super Phosphate is used, needed in much smaller quantities, especially if placed in the direct vicinity of the roots .
2. Acrisols:	Acrisols are most extensive on acid rock weathering, notably in strongly weathered clays, which are undergoing further degradation. A general paucity of plant nutrients, aluminium toxicity, strong phosphorous sorption4, slaking/crusting and high susceptibility to erosion imposes severe restrictions on arable land uses. Large areas of Acrisols are used for subsistence farming, partly in a system of shifting cultivation. By and large, Acrisols are not very productive soils; they perform best under undemanding, acidity‐tolerant crops such as pineapple, cashew, oil palm or rubber. Acrisols are suitable for production of rain–fed and irrigated crops only after liming and full fertilization. Rotation of annual crops with improved pasture maintains the organic matter.
3. Cambisols:	Cambisols have a wide variety of agricultural uses; however, climate topography shallowness, stoniness, or low base status may pose restrictions on land use.By and large, Cambisols make good agricultural land and are intensively used. The Eutric Cambisols of the Temperate Zone are among the most productive soils on earth. Dystric and Ferralic Cambisols in the humid tropics are poor in nutrients but still richer than associated Acrisols or Ferralsols. And they have greater cation exchange capacity.

Sampling

Soil sampling points were selected according to the probable location of planned surface facilities such as the tailings storage facility and plant area, all of which are likely to have long-term future impacts on soil quality. Baseline values of main toxic elements such as lead, arsenic and mercury are therefore needed to provide a comparison with any future soil study conducted to evaluate soil contamination in the vicinity of the mine and processing facilities.

Sample Analysis

Soil samples were collected (May 2024) at each of the augured positions. The results are shown in Table 5.7. The results indicate that the main toxic elements (lead (Pb), arsenic (As) and Mercury (Hg) are not present at levels that would be considered detrimental to plants and human health. The results also indicate slightly acid to neutral pH, which is typical of the natural soils in the project area.

Table 5.7: Soil Analysis Results

Element	Location	Tailings	Plant	Fuel Storage
pH		4.6	3.8	4.1
Al	µg/g	830	720	719
As	µg/g	<1	<1	<1
Ba	µg/g	<10	<10	<10
Be	µg/g	<5	<5	<5
Ca	µg/g	<10	<10	<10
Cd	µg/g	<10	<10	<10

Co	µg/g	6	8	11
Cr	µg/g	20	30	23
Cu	µg/g	8	11	10
Hg	µg/g	<1	<1	<1
Mg	µg/g	5	9	11
Mn	µg/g	9	11	7
Mo	µg/g	<10	<10	<10
Ni	µg/g	2	7	4
Pb	µg/g	11	13	6
Se	µg/g	<1	<1	<1
V	µg/g	<10	<10	<10
Zn	µg/g	4	11	10
Total S	%	<0.1	<0.1	<0.1
SO_4^{2-}	%	0.18	<0.1	<0.1

5.3.7 Land use and land tenure

Land Use

The majority of land cover in the licence area is indigenous forests with few patches of degraded grassland. The area was a hive ofillegal artisanal mining activities before African Inkalamo Mining Company acquired the licence area and secured the place.

Land Classification

Regional land classification based on United States Department of Agriculture (USDA) standards indicates medium to low potential for sustainable development. This classification is mainly based on regional soil classification, extremely weathered and iron rich soils characteristic of the area. These soils are nutrient deficient and have poor water retention abilities, though they are easily worked.

Land tenure

Zambia has a dual land tenure system. The 2 systems are customary tenure and leasehold tenure. Section 7 of the Lands Act 1995 recognises the existence of customary tenure in Zambia. Chiefs are expected to Grant Consent whenever customary land is offered to be converted to leasehold tenure.

The land where the project area lies is administered under customary law in Chief Katyetye's Chiefdom. African Inkalamo Mining Company Limited has obtained the Chief's consent to undertake the project in the Chiefdom (See Appendix).

5.3.8 Built Environment

The licence area is in a rural setting with no built-up structures in it. The nearest settlement areas, which are predominantly rural, are villages located at about 3 -4km away.

Most of the houses in these villages are typically grass-thatched with mud walls, though some have corrugated iron-sheets with burnt brick walls. Public buildings, schools and health centers, are the other structures made out of burnt bricks with corrugated iron sheet roofing. The Lualuzi road is the main gravel road that connects the villages with other graded roads and footpaths. The main rivers and streams have small bridges for one vehicle to cross at a time.

5.3.9 Noise and vibration

There is no historical data on noise for Project area. Due to its location and the absence of active industry nearby, current noise levels are associated with social activities in the villages and also traffic along the road that passes through the camp site.

Noise from traffic is generally low as very few vehicles pass through the area. Even when the vehicle is passing through, the noise rapidly drops as the vehicle moves further away from the roadside.

From the ambient noise level measurement, the noise levels ranges from 30 to 62.3 dB (A). The readings depend on the activities taking place at the time of measurement. Higher readings were recorded when there were social activities from the village. For other places, the noise level is basically within the acceptable limit of 35 dB (A).

It can also be recognised that despite the lower readings, the project site is located far from villages. With the coming of the mine project, its envisaged that there will be increased noise levels especially during the construction stage. During this stage, the company will endeavour to employ measures that will work on reducing the levels and also provide the workers with ear plugs.

Measurement of sound pleasure levels and variation over time were made using Sound Meter (Figure 4.4), to provide sound pressure measurements more representative of human hearing. Before taking measurements with the sound meter, a series of quick checks and considerations were performed and noted, such as making sure that the sound meter was calibrated and that new batteries were in place. The calibration of sound meter was done using a Quest Sound Meter Calibrator.

In order to maintain accurate calibration over time, the calibration was checked and the meter was slightly adjusted where necessary before and after each use.

Figure 5.4: Sound Meter

In order to measure an average sound level emanating from a particular case, the meter averaging time was extended to equal the period of interest **T,** which in our case was taken in intervals of seconds or minutes. This gave the equivalent

continuous sound pressure level ***(Leq)*** which is the level of that steady sound which, over the same interval of time, contained the same total energy (or dose) as the fluctuating sound.

The Results of the sampling are reflected in Table 5.8.

Table 5.8: Noise Sample Measurements

Sampling points	Sampling duration (minutes)	Noise level dB(A)
Camp site	10	30
Nazareth Village	10	29.3
Sabuni Village	10	28.2
Malamula Village	10	27.5

5.3.10 Fauna

The project area is virtually depleted of fauna, especially wild animals. The only exception is the presence of a good number of birds in the area. A list of sighted birds has been included, although this is not conclusive in itself.

Smaller forest mammals, e.g. duiker and bush pig, still survive within the Project area. Large mammals, such as buffalo, roan antelope, sable antelope, Lichtenstein's hartebeest, impala, eland and elephant are now either regionally extinct or heavily diminished due to uncontrolled poaching.

Faunal Habitats

There are a number of habitats utilized by the surviving fauna. These include: Miombo woodland, Degraded Miombo Woodland, Riparian Forest, Wetlands (freshwater lakes, dambos and marshes), Streams and Rivers, Rock Outcrops and Termite nests.

Terrestrial Fauna

Amphibians

- 84 amphibians have been recorded from Zambia.
- No detailed amphibian surveys have previously been undertaken in the project area.
- Most were wide-ranging species, others had a marginal distribution in the region
- No Zambian amphibians have become extinct
- No scientific data is available to document trends in amphibian populations in Zambia.

- No endemic or threatened amphibians occur in the region
- No alien amphibian species occur in Zambia.

Reptiles

- 146 reptiles, including 8 chelonians, 62 lizards, 74 snakes and 2 crocodiles, have been recorded for Zambia.
- 39 species were recorded from the project area, including 2 chelonians, 12 lizards and 24 snakes.
- Many are wide-ranging, and tolerant of disturbed areas.
- They include a number of venomous species (Gaboon Viper, Puff Adder, Rhombic Night Adder, Boomslang, Twig snake, Black Tree Snake, Black-necked spitting cobra, Günther's
- Garter Snake, Bibron's Burrowing Asp, etc, of which the Puff adder was the commonest snake encountered during the surveys.
- Important discoveries included:
  - The second and third records of the Black Tree Snake (*Thrasops jacksonii*) in Zambia.
  - The fourth Zambian record of the fossorial Striped two-headed Snake
  - (*Chilorhinophis gerardii*).
  - The Tree Agama (*Acanthocercus s*p.) in the region is an undescribed species, but it is not endemic to the region, neither is it considered threatened.
- No alien reptile species are known to have become established in Zambia.
- No species recorded in the project area are included in the IUCN Red List 2010.
- A number of species in the region are involved in international trade and listed on CITES Appendix II, e.g. chameleons, crocodiles, pythons, tortoises and monitor lizards, but none are exploited for trade locally.
- No species are strictly endemic to the region, although a number are endemic to southcentral Africa.

Mammals

- Over 160 mammal species are known from Zambia
- Bats dominate the mammal fauna in the region, and over 30 species have been recorded in the region.
- The historical large mammal fauna of the region is now largely extirpated, with only small populations of duiker and bushbuck remaining in less-disturbed habitats in the general region.

- Populations of medium-sized mammals, e.g. mongoose, civet, porcupine, monkey, etc., are also greatly reduced.
- No detailed small mammal survey was undertaken, although specimens and records were collected opportunistically.
- Alien mammals in the region include feral domestic cats and dogs and introduced rodent pests.

Sensitive Habitats for the Terrestrial Fauna

Amphibian diversity was greatest in streams running through gallery forest, dambo grasslands and temporary pools in Miombo woodland. The current spatial coverage of reserves in the area adequately protects amphibian species diversity.

Reptile diversity was greatest in miombo woodland, gallery forest and dambo grasslands. Rock outcrops were poorly populated by reptiles in the region. The importance of termite nests as refugia is likely, but unconfirmed. The current spatial coverage of reserves in the area adequately protects reptile species diversity.

Avian diversity was greatest in gallery forest, miombo woodland and dambo grasslands. The current spatial coverage of reserves in the area adequately protects avian diversity, although the selective logging of hardwood for charcoal results in the loss of old trees for hole-breeding species (hornbills, barbets, etc).

Mammal diversity is greatly reduced. Important habitats for sensitive mammal species include gallery forest and forest streams. The clearing of miombo woodland and gallery forest threatens dormouse, tree-roosting bats, squirrels, anomalures (scaly-tailed flying squirrels), monkeys and tree pangolin.

Use of fauna

Mammals

The areas used for hunting are reported to be of the same quality for hunting all year round and there is no reported season of preference.

Reptiles and Amphibians

Tortoises and terrapins are usually eaten during the rainy season. This is important as this season is when most households report to have gone hungry. Therefore, this source of food is an important substitute to the agricultural crops and other natural food sources available at the end of the rainy season and throughout the dry season.

Insects

Caterpillars are reported by key informants to appear in March throughout the Miombo woodland. It is during this time when trees are cut down to harvest the full-grown caterpillars. In April/May the caterpillars are reported to drop off the trees and form a cocoon just below the surface of the soil.

They are also collected during this time and are supposedly better to eat but more difficult to find. Caterpillars can be available all the way until November depending on

the weather patterns of the particular year. After the first rains in October and November people collect caterpillars from the forest.

Honeybees

Honey is higher quality and more abundant during the dry season but is also collected during the rainy season.

The flowering of *Brachystegia* species contributes to the flow of honey between October and December across the country. This provides farmers with cash at the start of the planting season to pay for agricultural inputs, and school fees. A second honey flow occurs in May and June in areas with plenty of *Julbernardia* and *Marquesia*. In June the honey obtained is sweeter compared to that harvested in October to December, and the honeycombs are reddish in colour, while the honeycombs of the May and June season are mostly light in colour.

Areas suitable for keeping bees are riverbanks, and where there are high *Brachystegia glaberrima* trees. *Julbernadia globiflora*, and *Brachystegia* are the best nectar producing trees. Other species that are suitable are *Brachystegia spiciformis* and *Zanthoxylum chalybeum*. However farmed honey hives are placed in any type of tree, with the bark of the *Brachystegia boehmii, musamba*,*mutondo*, and *manga* trees being used to form the cylindrical hives while the bark of the *mupunda* tree is used to close the ends of the cylindrical hives. These barks are chosen for their durability, and for the ease in which they can be prised from the tree and moulded into the strong container (billet) in which the bees are encouraged to build their hives. Small incisions or carvings are made in these billets to create places where bees will nest. According to the botanical specialist team the bark selected to form the hive is usually of the species *Isoberlinia paniculata*.

Termite mounds

With mounting population growth in the area, use of termite mounds for brick-making is likely to increase and become less sustainable. Demand for locally baked clay bricks is likely to increase significantly, placing pressure on termites and encouraging brick-makers to travel further into the woodland looking for this source of brick-making sand. Large termite mounds can take decades to be constructed and as such take a long time to rejuvenate. Termites are an important part of the Miombo Woodland ecosystem.

5.3.11 Avifauna (Birds)[4]

Zambia has a rich avifauna and new records continue to be reported. Over 550 species have been recorded from the Northwest province. The faunal surveys, supplemented with additional records of mine personnel, have recorded 248 species in the region.

- Birds characteristic of miombo woodland and dambo grasslands were the main components.
- No threatened birds were observed in the project area or greater region during the faunal survey.

[4] http://datazone.birdlife.org/userfiles/file/IBAs/AfricaCntryPDFs/Zambia.pdf

- No birds are strictly endemic to the region.
- Rare and Uncommon birds recorded on the project area included:
  - Margaret's Batis (*Batis margaritae*), endemic to miombo woodlands of southern central Africa.
  - Purple-throated Cuckoo-shrike (*Campephaga quiscalina*), a forest species with scattered records around the Congo Basin.

Bird life in the African Inkalamo Mining Company is abundant, with numerous bird species being observed in the bush. Numerous birds were heard in the trees during the field surveys but due to the density of the area many of them were not able to be identified because they couldn't be seen.

Table 5.9: Lists the Bird Species Observed in the African Inkalamo Mining Company

COMMON NAME	SCIENTIFIC NAME
Ground Hornbill	*Bucorvus leadbeateri*
Blackeyed Bulbul	*Pycnonotus barbatus*
Lilac Breasted Roller	*Coracias caudate*
Kurrichane Thrush	*Turdus libonyana*
Scarletchested Sunbird	*Nectarinia senegalensis*
Spotted Flycatcher	*Muscicapa striata*
Heuglin's Robin	*Cossypha heuglini*
Gymnogene	*Polyboroides typus*
Pennantwinged Nightjar	*Macrodipteryx vexillarius*
Tropical Boubou	*Laniarius aethiopicus*
Blue-Grey Flycatcher	*Muscicapa caerulescens*
Emeraldspotted Dove	*Turtur chalcospilos*
Red Throated Twinspot	*Hypargos niveoguttatus*
Grey Hornbill	*Tockus nasutus*
Yellowbilled Hornbill	*Tockus flavirostris*
Hadeda Ibis	*Bostrychia hagedash*
Natal Francolin	*Francolinus natalensis*
Swainson's Francolin	*Francolinus swainsonii*
Rock Pigeon	*Columba guinea*
Hamerkop	*Scopus umbretta*
Greater Honeyguide	*Indicator indicator*
African Skimmer	*Rynchops flavirostris*
Owl	strigiformes

Uses of Avifauna

Birds and eggs are usually eaten during the rainy season. This is important as this is the season when most households report to have gone hungry. Therefore, this source of food is an important addition/substitute to the agricultural crops and other natural food sources available at the end of the rainy season and throughout the dry season.

5.3.12 Natural Vegetation / Flora

The African Inkalamo Mining Company Rare Earth Elements deposit lies in the Central Zambezian Miombo Woodland (Figure 5.5), an ecological type that covers much of central and northern Zambia, south-eastern DRC, western Malawi, Tanzania and parts of Burundi and north-eastern Angola. This ecological type is characterised by broadleaf deciduous woodland and savannas interspersed with grassland, semi-aquatic vegetation and areas of evergreen groundwater forest.

The vegetation type in the project area is predominantly wet Miombo woodland of Zambezian origin. The natural Miombo woodland is characterised by a two-stage vegetation cover with a 12 to 15 m high open or semi-open canopy. The most common tree species are *Brachystegia, Isoberlina, Julbernadia* and the genre *Marquesia*. The dominant species is *Marquesia marcroura*. This tree's dominance is due to its resistance to fire. M. marcroura is well established in terms of number of stems per unit area, size classes, diameter and height, and forms the major part of the canopy structure. Other tree species found in the Miombo woodland include *Pericopsis angolensis, Combretum molle, Strychnos cocculoides, Afzelia quanzensis, Erythrophleum guineense, Lonchocarpus capassa, Uapaca kirkiana, anisophlea bohemii, and Diploryncus condylocarpon*.

The Miombo under-storey vegetation is a dense cover of indigenous grasses and shrubs. Common shrubs include *Securidaca longipendiculata*, several Rhus species, *Ochna pulchraus* and *Harugana madagascariensis*.

None of the endangered species are found within the proposed mining area.

Table 5.10: Common species found in the project area

SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME	COMMON NAME
Acacia polyacantha subsp. Campylacantha	White Thorn / Hook Thorn	*Acacia sieberiana*	Paperbark Thorn
Albizia versicolor	Muchacha	*Amblygonocarpus andongensis*	Scotsmans-Rattle

Annona senegalensis	Wild Custard-Apple	*Arundinaria alpina*	Mountain Bamboo
Baphia massaiensis	Sand Camwood	*Brachystegia boehmii*	Prince of Wales Feathers / Mufuti
Brachystegia bussei		*Brachystegia longifolia*	Msamba
Brachystegia spiciformis	Musasa	*Clerodendrum myricoides*	Cats-Whiskers
Combretum zeyheri	Large Fruited Bushwillow	*Combretum molle*	Velvet Bushwillow
Dichrostachys cinerca	Sickle-Bush	*Cussonia spicata*	Kiepersol
Erythrophleum africanum	Ordeal Tree	*Engleraphytum magalismontanum*	Stem-Fruit
Ficus sycomorus	Common Cluster Fig	*Faurea sp. (F. speciosa)*	Broad-Leaved Beechwood
Gardenia volkensii	Bushveld Gardenia	*Flacourtia Indica*	Governors Plum
Kigelia africana	Sausage Tree	*Julbernardia globiflora*	Munondo
Peltophorum africanum	African-Wattle	*Parinari curatellifolia*	Mobola Plum
Uapaca kirkiana	Wild Loquat / Msuku	*Piliostigma thonningii*	Camel's Foot / Msekese Tree
Xerophyta retinervis	Bobbejaanstert	*Xeroderris stuhlmannii*	Wing Bean / Pod
Ziziphus mucronata	Buffalo Thorn	*Ximenia americana*	Sour Plum

More than 50% of the Miombo Woodland within the concession is still fully or partially intact, with a range of disturbances from large areas relatively undisturbed (intact structure, function and composition) through to large areas that are highly disturbed with high levels of vegetation clearing and cultivation (structure, function and composition highly modified). The most important sources of disturbance within this vegetation community are:

- Anthropogenic clearing of vegetation for habitation, charcoal, timber and crop cultivation;
- Livestock grazing; and
- Seasonal burning during winter.

The level of degradation differs from low to medium depending on the area of the concession. Areas adjacent to villages, roads, pathways and commonly used routes (such as to mine areas and fields near rivers) tend to be more degraded than areas far from villages. As a result of the implementation of the project, about 40 ha of land will be affected. Of this, the total woodland to be affected is 10 ha.

Red Data Species

The Red Data Species List is a list of species that have been identified as requiring protection due to their population's status in a particular country. The list takes into account species of importance from a biological and cultural perspective. Species are assigned a status that indicates the level of protection required. The Red Data Species List is administered by the IUCN.

No red data species were identified in the study area.

5.3.13 Aquatic Flora and Fauna

Note that though the Project area has several streams, these streams are seasonal and at the time of conducting the baseline study, the streams had no water. Because of this, the aquatic study was not done to understand the fish and other organisms which could be president in the streams.

5.3.14 Archaeological and cultural environment

No sites of archaeological and / or cultural interest were observed within the African Inkalamo Mining Company Project area during the reconnaissance site visit nor was there any mention of such during consultations with community members. The main ccultural practices of the Lambya speaking people found in the region around the project area are described under Section 6.5 on Cultural and Political Review.

6.0 SOCIAL, CULTURAL AND ECONOMIC SITUATION

The socioeconomic study was done in accordance with the Zambian legislation [Statutory Instrument Number 28 of 1997 on Environmental Impact Assessment, EIA], which requires that an assessment of the social and economic impact of the project should be undertaken during the ESIA. This is done to determine the environmental and social impacts and assist in determining the possible mitigation measures to reduce these impacts.

6.1 Objectives and Scope of the Study

The overall objective of the social and economic study was to delineate the possible impacts that may arise from the proposed Rare Earth Elements mine with a view to aiding African Inkalamo Mining Company Limited institute measures aimed at mitigating the likely negative impacts on communities and the surrounding environment.

The specific objectives of the study were:

- To assess the prevailing social and economic conditions of communities living within and around the project area;
- To explore the possible impacts of the Rare Earth Elements mine on the social and economic conditions of communities during all phases of the project
- To recommend feasible measures that would be implemented by African Inkalamo Mining Company Limited to mitigate the negative impacts.

6.2 Scope of the study

The scope of the study involved the following aspects:

- Identifying the number of households which might be affected by way of loss of homesteads, farming land and other sources of livelihood as a result of the Rare Earth Elements mine;
- Assessing the nature of properties and livelihood activities that the affected households own and are involved in;
- Assessing existing public social services such as schools, health centres etc. were and means of transportation in the area;
- Conducting surveys in form of interviews, focus group discussions and meetings with both the directly and indirectly affected stakeholders to get their concerns and suggestions on the possible effects of the proposed Rare Earth Elements mine; and
- Recommending, using the findings of the above, measures that will require to be put in place to mitigate the negative environmental, social and economic impacts.

Both secondary and primary data were collected for the socio-economic baseline study and impact assessment. Primary data was collected through interviews (Plate 6.1 and 6.2) and meetings with relevant stakeholders (community and civic leaders).

Figure 6.1 : Public consultation meeting at Nazareth

The list of people contacted is attached in the Appendix at the back of this report. Secondary data on the other hand was collected from various reports from different sources including previous study reports commissioned by African Inkalamo Mining Company Limited on the proposed mine and surrounding areas.

6.3 Study Limitations

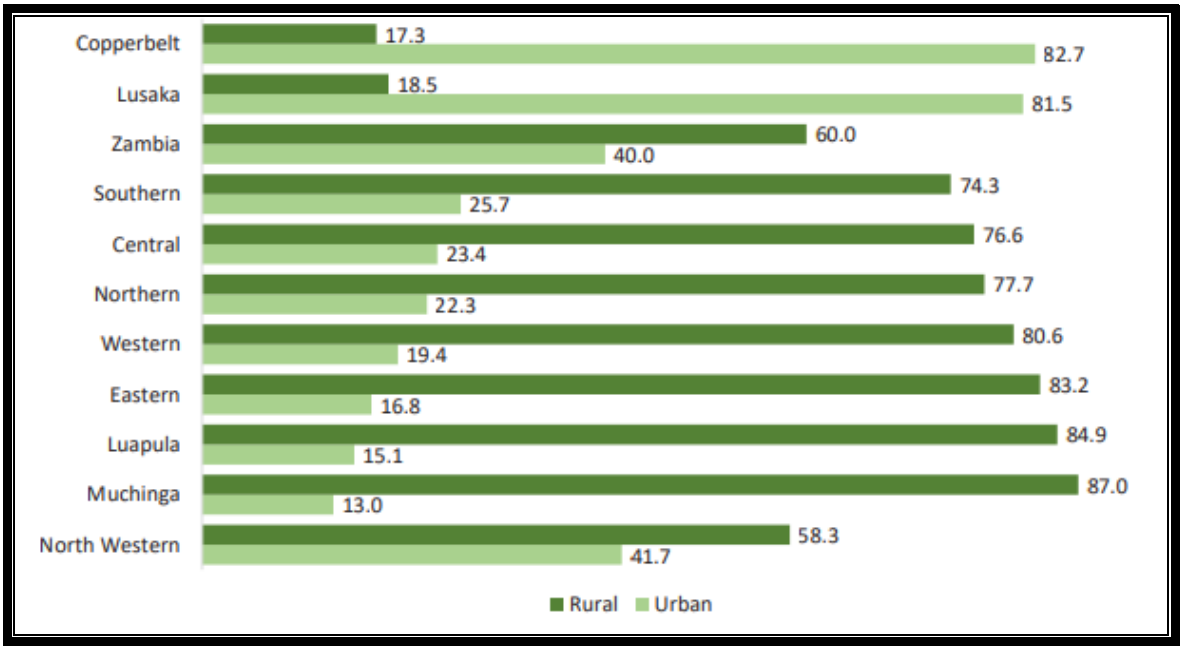
This study mainly focused on the social and economic implications the project would have on the people that live near the project area, even if the benefits would go beyond. The limited information provided on the proposed project also made it difficult to appreciate the wide implications of the project. It is our view that a detailed study of the broader impacts of the project should be undertaken once the project has been implemented after some years.

6.4 Demographic Composition of the Project Area

National

The official available demographic estimates are from the Census of Population and Housing which was conducted in 2022. According to 2022 census results, the population of Zambia was estimated at 19.6 million. Muchinga Province had the lowest population of 918,296 of which 87% were in rural areas and 13% were in urban (Table 6.1).

Figure 6.1: Percent Distribution by Rural and Urban, Zambia 2022



Source: CSO 2022 CENSUS OF POPULATION AND HOUSING – Preliminary Report

Table 6.1: Population Size by Constituency and Sex, Muchinga Province 2010 - 2022

Constituency	2010 Population			2022 Population		
	Male	Female	Total	Male	Female	Total
Muchinga Province						
Chinsali	42,915	43,808	86,723	73,557	75,440	148,997
Isoka	35,314	36,875	72,189	55,054	56,545	111,599
Kanchibiya	40,538	41,613	82,151	46,225	46,827	93,052
Mfuwe	20,051	20,626	40,677	27,802	27,953	55,755
Mafinga	32,035	33,934	65,969	49,630	52,903	102,533
Mpika	39,678	40,873	80,551	73,396	75,667	149,063
Nakonde	58,874	60,834	119,708	87,644	91,144	178,788
Shiwang'andu	29,611	30,184	59,795	39,292	39,217	78,509
Total	**299,016**	**308,747**	**607,763**	**452,600**	**465,696**	**918,296**

Regional

The study area lies within Isoka District of Muchinga Province. The population of Isoka was estimated at 111,599 in 2022. About 55,054 were male, while 56,545 were female. The population growth rate for the District was about 3. 7%/year [2010 → 2022].

Table 6.2: Average Annual Population Growth Rate by District and Sex, Muchinga Province 2010 – 2022

Province	2010 Population			2022 Population			Average Annual Population Growth Rate 2010-2022		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Chinsali	42,915	43,808	86,723	73,557	75,440	148,997	4.6	4.6	4.6
Isoka	35,314	36,875	72,189	55,054	56,545	111,599	3.8	3.6	3.7
Kanchibiya	40,538	41,613	82,151	46,225	46,827	93,052	1.1	1.0	1.0
Lavushimanda	20,051	20,626	40,677	27,802	27,953	55,755	2.8	2.6	2.7
Mafinga	32,035	33,934	65,969	49,630	52,903	102,533	3.7	3.8	3.7
Mpika	39,678	40,873	80,551	73,396	75,667	149,063	5.3	5.3	5.3
Nakonde	58,874	60,834	119,708	87,644	91,144	178,788	3.4	3.4	3.4
Shiwangandu	29,611	30,184	59,795	39,292	39,217	78,509	2.4	2.2	2.3
Total	**299,016**	**308,747**	**607,763**	**452,600**	**465,696**	**918,296**	**3.5**	**3.5**	**3.5**

Local

The project area is located in Nkombwa Ward which has a population of about 6,875 with a density of 2.943/Km^2. About 3,384 are males while 3,491 are female. According to the population distribution of the Ward, 61 of the population are 19 years old and below.

6.5 Social, Cultural and Political review

6.5.1 Cultural and traditional administration

Isoka district has two area chiefs, Kafwimbi and Katyetye. The main ethnic language in Isoka is Winamwanga which stands at 80 percent with English, Wiwa, Nyika, Bemba, Tumbuka and others sharing the rest. The Project area falls under Chief Katyetye.

The area under a sub-chief (Headman) is further divided into small areas managed by group leaders. Each group leader has a system of community section heads who report to the group leaders (and then to the sub-chief/headman and finally to the Chief to bring the chief up to date about developments in the village). Each group of houses has a community based committee leader who reports to the community section head, also keeping him informed about developments in the village. Finally, each house has a head of the household who is responsible for the overall wellbeing of its family members.

Chief Katyetye of Katyetye Royal Establishment is the tradition leader under whose authority the communities in the project area lies. Under him are the traditional headmen who preside over the affairs of the villages in the Chiefdom. The local community members are predominantly Winamwanga. The traditional ceremony commemorated in the Chiefdom is Chizumba Nsonje Traditional ceremony celebrated in July.

6.5.2 Civic administration

The proposed project is in Isoka District. The administration of the district is vested in the Office of the District Commissioner, established by the Government in 1999 as part of the decentralization process. The office coordinates the functions of all developmental agencies in a local district as well as harmonizing the functions of Central Government and those of Local Government. All development agencies working in the district are members of the District Development Coordinating Committee (DDCC) that is chaired by the District Commissioner.

Isoka is the only constituency in Isoka and has 14 wards which includes among others Nkombwa itself, Mpunga, Itukuta, Kantenshya, Kapililonga, Kasoka, Luangwa, Milongo, Sasamwenje etc. The constituencies are further subdivided into wards. The constituencies and wards are headed by elected Members of Parliament (MPs) and Councillors respectively.

The Local Authority is a semi-autonomous institution operating as agents of Central Government. The Local Authority provides a forum for local representation of the public by electing their local representatives, the Councillors. The Local Authority is responsible to the Ministry of Local Government and Rural Development (MLGRD).

Plate showing the Isoka Civic Centre

6.6 Economic and Social Situation

6.6.1 Agriculture

The population in the area is primarily a rural population depending on subsistence agriculture, small-scale agricultural activities.

The major crops grown are maize, cassava, groundnuts, beans, rice, sweet potatoes, sorghum, millet and vegetables. These crops are mainly grown for household consumption with a few sold within the communities and occasionally to Isoka. Apart from vegetable gardening that goes on throughout the year, most agricultural activities are seasonal; conducted during the rainy season.

Some households in the area keep goats, pigs, sheep, and free-range chickens which are mainly kept as assets with a few sold or consumed at household level. Cattle are also kept in the traditional sector where grazing is on communal land and at night they are confined in kraals.

Plate showing Animmals grazing near villages

6.6.3 Mining

Mining is becoming prominent in Muchinga Province. It might become the largest employer in this region due to the minerals discovered recently. There are a number of prospecting and mining projects in the area, though it should be pointed out that there is a fair distance between these prospecting areas and mines and the African Inkalamo Mining Company area. There is a rise in the incidences of illegal mining activities.

6.7 Social amenities and Infrastructure

6.7.1 Housing

The communities around the proposed mine project area are predominantly rural and they are located far from public amenities. Most of the houses are glass-thatched with mud walls or burnt bricks with corrugated iron-sheets serviced by pit-latrines, see Plate below.

Plate showing Typical House in Community
near the Project Area

Plate showing Typical House in Community
near the Project Area

6.7.2 Health

The health facility close to the project is at Katyetye Rural Health centre. Apart from this, another Rural Health Post I currently being constructed at Nazareth as shown in the plate below. The most common diseases in the area are malaria fever, diarrhoea, and respiratory complications. HIV and AIDS prevalence in Isoka is at 6.9%. The Rural Health Centre is stocked with the necessary drugs for these diseases but if there is an emergency, patients are referred to Isoka General Hospital.

The main challenges facing the provision of effective health care services in the area are poor roads and long distances making attendance difficult for many people. The centres face poor staffing levels, inadequate funding and unreliable transport.

Plate showing Katyetye Rural Health Centre

Plate showing the Health Post being constructed at Nazareth

Plate showing Isoka General Hospital

6.7.3 Sanitation

The sanitation situation of households in communities described as rural is relatively poor as there is no clean and safe water, waste disposal and other facilities which is the major cause of diarrhoea related illnesses. About 82.2% of the population has no access to improved sanitation in Isoka. These communities draw water from wells, boreholes, streams and dambos in the rain season.

Plate showing typical Borehole Found in the Project area

6.7.4 Education

Isoka District has 11 Secondary Schools, 53 Primary Schools and 18 Community Schools. The district also has one tertiary institution, namely, Isoka Trades. For the Project area, it has Schools which offer education services to the residents.

The schools in the project area carters for grades 1 to grade 9. The schools are Nazareth Primary School and Katyetye Primary School. These schools face challenges of not having enough structures for classrooms and teachers' staff houses. Apart from infrastructure, the schools face the challenge of not having enough desks for the pupils.

Plate showing Katyetye Primary School near the Project Area

6.7.5 Transportation

The communities complained that the lack of infrastructure, such as a proper road, has greatly hindered development in the area. The delivery of agricultural inputs and outputs, to and from the area is difficult as the roads are in very bad conditions.

Plate showing Typical road used by communities near project area

The roads need to be upgraded as they are literally impassable during or immediately after the rainy season. The main modes of transportation in the area are bicycles, motorbikes, canter trucks, vans and private buses (Figure 6.9).

Plate showing Main modes of transport around the project area

Plate showing the typical Transport mode in the Project area

6.7.7 Power and Communication

There is no electricity supply to the area; hence, people rely on the traditional sources of energy, charcoal and firewood. Radio and TV reception are very poor in the area. Mobile telephone signals are also very weak in most parts of the area. In some places, villagers have to get on top of anthills to be able to catch the signal.

6.7.8 Trading and Other public services

There are a number of private shops and groceries in Katyetye village and other nearby villages providing household second hand clothing, assorted goods and foodstuffs. There are no demarcated market areas but people who don't have shops sell their merchandise mainly along the roads and open spaces. There is no post office or banks in the Project area. Most people in the area are unbanked and rely on mobile money for sending and receiving money.

Plate showing the Store near the Project Area

Plate showing Recreation facility near project area

6.7.9 Recreation

The most common type of recreation in the communities around the project area is consumption of alcohol (mainly chibuku, a brown thick local beer made from roasted maize grain) which is sold at taverns.

6.7.10 Poverty and vulnerability

A primary assessment of poverty and vulnerability is beyond the scope of a socio-economic analysis of an ESIA, hence only secondary data can be used to describe these parameters. The level of disaggregation of official statistics is only done up to district level.

It is estimated that about 65% of the population in Isoka District are poor and about 70% in Nkombwa ward are poor. 20 percent in the Ward are severely poor. The severely poor are always vulnerable. Apart from those identified as poor using money metric measurements, the official definition of the vulnerable in Zambia include groups such as:

- Orphans, street children, other at-risk children;
- female-headed households, particularly widows;
- households with disabled or ill individuals (including HIV/AIDS related illnesses), or recent deaths;
- the “incapacitated poor,” identified as those “living in severe and chronic poverty and
- without members to carry out productive work”

These groups of people are present in communities around the project area and would need to be ascertained and prioritised for any livelihood uplifting interventions such as social cash transfers.

6.7.10 Resettlement

The project site is located about 3 – 4 km from the nearest village. For this reason, no one will be resettled as a result of the project activities. However, AIMCL commits to resettle anyone who might require to be resettled in the future should the circumstances change. It should however be noted that there about 13 families who conduct their farming activities near Nkombwa Hill. These families, will be compensated for the loss of farm land. The agreements for the affected are attached.

6.7.11 Security

The area also lacks a Police Post with the nearest being in Isoka. This lack of security services has resulted in a number of illegal mining activities. AIMCL will secure its licence area by erecting a barrier on the access road.

6.7.12 Religious Practices and Beliefs

From a general survey of the area, it is estimated that over 80% of local people embrace the Christian faith. A number of churches have been established, sometimes located less than 1km apart along the Lualizi - Katyetye road i.e. RD 316. It is quite evident that religion is an important aspect of peoples' lives and therefore the Church is a very important institution in these communities. Christian religions and traditional philosophies co-exist, and witchcraft is a common belief. A survey of churches in the project area revealed fourteen denominations. These included:

i. United Methodist Church;
ii. Roman Catholic Church;
iii. Covenant Church;
iv. Seventh Day Adventist Church;
v. Jehovah's Witnesses; and
vi. Pentecostal Church.

6.7.13 Livelihoods

An indication of the livelihoods of people living in the project area is given by the rural seasonal calendar. The calendar is dominated by farming activities highlighting the fact that local peoples' lives are strongly influenced by agriculture and agriculture related activities. See Table below.

Table 6.3 Rural Calendar in the Project Area (Agricultural Cycle)

Month	Farming Activities
January - March (Wet Season)	Plant pumpkins and sweet potatoes. Picking of various types of mushroom found in the area. Weeding of fields. Sweet potato harvesting, sunflower, soya beans, and beans harvesting and first green maize cobs.
April - July (Cool, Dry Season)	'Scaring' Birds. Harvesting of maize. Women cut thatch grass. Houses are built or repaired.
August - September (Cool, Dry Season)	Preparation of River Gardens for green vegetables.

October - December (Hot, Wet Season)	Clearing bush and lopping trees for the Chitemene farming system. Ploughing fields. Cassava, Maize, Sorghum, Millet and Groundnuts are planted. Picking of mushrooms (including Bandele and Bakulumbwe) and wild fruits like Masuku and Fungo (*Uapaca Kirkina* and *Anisophyllea Boehmii*)

The major economic activities in the Project area include subsistence farming and other, non-farming activities. Accordingly, livelihood strategies can be grouped into: -

1. Natural resource based.
2. Non-natural resource based.

The different livelihood strategies are presented in Table 6.4.

Table 6.4 Livelihood Strategies in Project Area

Livelihood Strategies (economic activities)	
Natural Resource Based	**Non-Natural Resource Based**
• Subsistence agriculture • Market gardening • Charcoal production • Fishing • Mushroom collection / selling • Basket weaving and crafts • Traditional healing	• Market or roadside vending • Beer brewing (*Imbote* gin) • *Munkoyo* brewing (maize or sorghum based beverage) • Petty trading in *Tuntemba* (roadside kiosks) • Blacksmithing / tinsmith • Livestock rearing
•	•

7.0 ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS

Identification of potential project environmental and socioeconomic impacts is based on the detailed mine design of the African Inkalamo Mining Company's Mine Project, while Project Description, the Environmental Baseline Study and industry experience. Management actions proposed to mitigate project impacts are based on best industry practice but adapted where appropriate to satisfy Zambian environmental and social conditions.

Environmental impacts are addressed by mine components. These are:-

1. Open pits;
2. Waste rock dumps;
3. Plant area, ROM pad and processing facilities; including
   - Ore crushing and transfer;
   - Concentrator;
4. Tailings storage facility (TSF);
5. Plant area workshop;
6. Transport infrastructure;
7. Waste management, including
   - Industrial waste;
   - Hazardous waste; and
   - Medical waste.
8. Materials handling and storage; including
   - Mine stores; and
   - Fuel.
9. Construction activities (contractors), including
   - Materials handling and storage;
   - Site preparation; and
   - Construction.
10. Socioeconomic impacts

The key environmental aspects/issues and associated impacts relate to each mine component and the pre-mining, operational and post closure phase where appropriate. They have been characterised using both qualitative assessment and quantitative evaluation where relevant data is available. The criterion used to characterise the environmental impacts is explained in Table 7.1.

Table 7.1: Criterion and Terms used to describe Potential Environmental Impacts

Item No.	Impact Criterion	Description	Criterion Classification	
			Term	Description
1.	Positive or Negative Impact	Will the impact have a positive or negative effect on the environment?	Positive	A positive impact.
			Negative	A negative impact.
2.	Intensity or Amplitude of Impact?	What is the likely level of impact with regard to physical disturbance; sensitivity; vulnerability; uniqueness or rarity of component?	Very High	Very high level of impact.
			High	High level of impact.
			Moderate	Moderate level of impact.
			Low	Low level of impact.
3.	Extent of Impact?	What is the geographical extent of the impact?	Project Area	Impact will affect the immediate mine area.
			Regional	Impact will affect entire province.
4.	Duration of Impact?	What is the likely duration or time over which the impact will occur / be felt?	Short-term	Impact will cease once activity stops.
			Medium-term	Impact will continue for the lifetime of the mine.
			Long-term	Impact will continue beyond decommissioning of the mine.
			Permanent	Impact will be permanent and irreversible.
5.	Timing of Impact?	At what point in time will the impact occur / be felt?	Construction	Impact will occur at the start of construction phase.
			During Operations	Impact will occur within the lifetime of the mine.
			Post Closure	Impact will occur after the decommissioning of the mine.
6.	Frequency of Impact?	What is the likely frequency of occurrence?	Continuous	Impact will be continuous.
			Frequent	Impact will occur frequently.
			Infrequent	Impact will occur infrequently.
			Occasional	Impact will occur occasionally.
7.	Likelihood of Impact occurring?	What are the likelihood / certainty associated with a potential impact?	Unlikely	Impact is unlikely to occur.
			Possible	Impact may possibly occur.
			Probable	Impact is likely to occur.
			Certain	Impact is certain to occur.
8.	Value of Affected Component?	What are the value / importance of the affected component to the people potentially affected?	High	Value / importance of affected component are high.
			Moderate	Value / importance of affected component are moderate.
			Low	Value / importance of affected component are low.
9.	Risk to Human Population	What is the likely level of risk for the safety and well being of the affected people?	High	High risk to human population from impact.
			Moderate	Moderate risk to human population from impact.
			Low	Low risk to human population from impact.
10.	Cumulative 'Knock On'	(a) What other environmental physical /	Surface Water	Surface water is also likely to be affected.

Item No.	Impact Criterion	Description	Criterion Classification	
			Term	Description
	Effect of Impact?	biological components are affected by the impact?	Groundwater	Groundwater is also likely to be affected.
			Air	Air is also likely to be affected.
			Soils	Soil is also likely to be affected.
			Flora & Fauna	Vegetation is also likely to be affected.
			None	None of the above is likely to be affected.
		(b) What other key social / economic components are affected by the impact?	Economy (R)	Regional (including local) economy is also likely to be affected.
			Economy (L)	Local economy is also likely to be affected.
			Culture	Culture is also likely to be affected.
			Health	Long-term health is also likely to be affected.
			None	None of the above is likely to be affected.

Project environmental aspects, potential environmental impacts and impact characterisation are presented in Table 7.3 at the back of this EIS Report. A total of 265 environmental impacts have been identified. Of these, 249 are classified as negative and 16 are classified as positive. It should be noted that a classification of negative does not necessarily imply a long-term adverse effect on the environment. It may well indicate an irreversible change to the physical environment from original conditions. In some cases, these irreversible changes can result in favourable long-term effects.

Potential positive impacts relate to social aspects, such as the diversification of jobs in the nearby villages, use of a local workforce and contractors, expansion of the local economy through diversification, improvement in electricity supply due to mine requirements and improvement of health for the workforce and local population.

Negative impacts generally relate to the possible physical disturbance of the land, surface and groundwater contamination, air pollution, soil contamination, noise, public and worker safety, plant spills and accidental releases, handling spills and issues related to waste management and sewage treatment/disposal. These potential environmental impacts, with the exception of permanent changes to the physical landscape resulting from open pits, tailings storage facility and

waste rock dump, can be prevented or successfully mitigated against by the implementation of a sound environmental management plans.

7.1 Open Pit

The open pit will cover a large surface area. A number of indigenous Miombo woodland will be cleared from the open pit footprint and its immediate surrounds. Topsoil will be removed from these areas and stored for later use in site rehabilitation.

7.1.1 Construction Phase

The activities to be carried out during the construction phase of the open pits include site clearance (removal of vegetation and topsoil) and pre-stripping for the mine. Vegetation will be lost over the area and along access roads. The soil removed from the peripheral areas of both open pits only will be stockpiled for future site rehabilitation works. All timber removed from the area, unless usable for construction, will be made available to the public for collection from site. Site clearance work will be undertaken using front-end-loaders, graders and haul trucks. Some pre-stripping will be undertaken during the mine construction phase using hydraulic excavators and dump trucks. The associated impacts of the construction phase of the open pit is detailed in the Environmental Impact Assessment Table (Table 6.3) and summarised in Table 6.2 below.

Landscape and Visual Character

Landscape and visual character of the area will be affected by the removal of vegetation to clear for the pits. This impact will be noticeable from the air but will be effectively screened at ground level by the remaining woodland and the local topography. This is a permanent impact.

Soil

Top soil removed from the peripheral areas of the pits and along pit access roads will be stockpiled and used in future re-vegetation schemes on the mine. Contamination of soil may occur from the spillage of oils and lubricants during construction activities.

Land use

The existing land uses, such as subsistence agriculture and settlement, will be lost when site clearance of the open pit areas occurs. This will affect the income of local population.

Air Quality, Noise and Vibration

Construction equipment will impact on local air quality (vehicle exhaust emissions and dust generation) and cause local noise and vibration disturbances. This impact will be screened by remaining vegetation and the local topography.

Surface and Ground Water

Surface water may be impacted on by the removal of vegetation during site clearance, by exposure of soils to the erosive potential of surface runoff. Siltation may occur in the rivers and streams. Clearance of the watershed vegetation may affect the evaporative and transmissive routes of water through the catchment areas of local watercourses which may eventually affect flow discharges in the watercourses. The accidental spillage of hydraulic fluid, oils and fuel from construction equipment and vehicles may contaminate surface runoff which flows into the local watercourses. This may then impact on users downstream of the mine site.

Groundwater may be contaminated from the residue of spilled oil, fuel and hydraulic fluids through infiltration of surface runoff.

Flora and Fauna

Vegetation will be removed during site clearance for the construction of the open pits. This will result in the loss of sustainable forest and the permanent loss of habitats. The Miombo woodland offers a source of income to local community and some plants may be used for medicinal purposes. These species will be lost from the area during site clearance. The construction vehicles and equipment may disturb animals and birds. The movement of construction equipment and vehicles along access roads and the open pits may generate dust that is deposited on surrounding vegetation which may cause a small reduction in biological productivity. No rare or endangered species were identified in the project area.

Archaeology

Any archaeological artefacts or existing cultural sites may be destroyed during construction. The baseline study did not identify any sites of interest during site visits making this impact unlikely.

7.1.2 Operational Phase

The operational phase at the African Inkalamo Mining Company Limitedopen pits will involve the removal of waste rock and ore (approximately 64 million tonnes over 7 years). The associated environmental impacts of open pit operations are outlined below.

Local Geology

The mining in the open pits will remove 64 million tonnes of ore and waste rock. The removal of these rocks results in the depletion of the geological resource of the area. This is a permanent impact. There are also potential temporary impacts on the hydro-geological regime over the life of mine.

Soil

Metals and dust may contaminate surface soils in the vicinity of the open pits through transport of ore, dust blow and water erosion. The contamination in the soils may also impact on flora and fauna due to biological uptake routes starting with the plant root system.

Air Quality, Noise and Vibration

Rock blasting may cause localised deteriorations in air quality and noise and vibration disturbances. Haul trucks and heavy plant equipment movement across the mine, open pit blasting and ore handling may generate fugitive dust along dirt roads. These activities may also result in increased noise levels and vibrations. The resulting air pollution, noise and vibration may affect people living or farming close to the mine and the fauna of the Miombo woodland surrounding the mine site.

Surface Water

The open pit water may contain high amounts of suspended and dissolved solids and metals (Co, Pb, Zn, Mn, Al). This water may contaminate the surface water possibly affecting downstream water users and aquatic flora and fauna. The discharge of excess mine water into the local watercourses may affect the quality of surface water.

Groundwater

Pit dewatering may lower the water table in the vicinity of the mine site. The lowering of the water table may directly affect the amount of water arising in the water wells sunk in the area for domestic consumption.

Accidental spills of oils, fuels, lubricants and hydraulic fluids may contaminate surface runoff which may contaminate groundwater through infiltration through soils.

Flora and Fauna

Blasting, ore handling and transport activities in the open pit may scare away small animals and birds.

Incident/Public Safety

The open pits and related activities (ore movement by haul trucks and front-end loaders) are dangerous to mine workers and the local public, i.e. members of the public will not be allowed into area covered by mining activities.

7.1.3 Post-closure Phase

At closure, all open pit equipment will be removed, mine dewatering will cease and the open pits will be allowed to flood. The impacts associated with the closure and post closure of the open pits are summarised below.

Landuse

The open pit will flood when mine dewatering ceases at the end of the mining activities. The pit will then provide water bodies that can be used as local resource (dependent on the water quality) for fishing, an aquatic nature reserve and/or irrigation for local farming activities.

Surface Water and Groundwater

The flooding of the open pit will result in the hydrological regime rebounding to baseline levels.

The quality of the groundwater in the flooded open pits will depend on the level of exposure of sulphide rocks to air (oxygen), remaining geology and any remnants of contaminating waste from open pit operations. Oxidation and reduction of sulphide minerals can lead to the formation of acid rock drainage, which will lead to acidification of the open pit artificial lakes. This is unlikely because the presence of sulphide minerals that are potentially acid generating is low, the neutralization capacity of the geology and the pits will be flooded thereby inhibiting oxidation of sulphide minerals.

Incidents/Public Safety

Inadvertent access to the flooded pits may result in drowning or health issues associated with contact to contaminated water.

7.2 Tailings Storage Facility

7.2.1 Construction Phase

The activities to be carried out during the construction phase of the tailings storage facility (TSF) include site clearance to pave way for the TSF extension. Some vegetation will be lost and topsoil will be removed from TSF extension footprint and stored for later use in re-vegetating the side walls of the TSF. Construction of the earthfill starter wall will be undertaken using front-end loaders, graders and haulage trucks. Decant towers and pipes will be installed to drain the water from the dam. A pump station will be constructed to return this water to the process plant.

All timber removed from the area, unless useable by the mine, will be made available to the public for collection from site. The associated impacts of the construction phase of the TSF are detailed in the Environmental Impact Assessment Table (Table 7.3) and are summarised below.

Landscape and Visual Character

Landscape and visual characteristic of the area will be affected by the removal of vegetation and the construction of the earth-fill starter wall. This impact will be noticeable from the air but will be effectively screened by remaining woodland and the local topography.

Soil

Impacts on the soil will occur due to removal of the topsoil during construction activities. Soil contamination may occur due to accidental spillages of oil and fuel from heavy equipment used during the construction phase.

Landuse

The existing land uses, such as agriculture, will be lost when site clearance of the TSF occurs. This will affect the income of the local population in the area.

Air Quality, Noise and Vibrations

Construction equipment may impact on local air quality (vehicle exhaust emissions and dust generation) and cause local noise and vibration disturbances.

Surface and Groundwater

The removal of vegetation during site clearance will expose soils and runoff may contaminate surface water. Siltation may occur in neraby streams and the Panga River.

Clearance of the watershed vegetation may affect the evaporative and transmissive routes of water through the catchment areas of local watercourses eventually affecting flow discharges in watercourses.

The accidental spillage of hydraulic fluid, oils and fuel from construction equipment and vehicles could contaminate surface runoff which flows into the Local River.

Groundwater may be contaminated from the residue of spilled oil, fuel and hydraulic fluids through infiltration of surface runoff.

Flora and Fauna

Vegetation will be removed during site clearance in the construction of the TSF. This will result in the loss of sustainable forest and the permanent loss of habitats. The Miombo woodland offers a source of income and traditional medicines. These species will be lost from this area during site clearance.

The construction vehicles and equipment may disturb animals, insects and birds.

Dust may be generated during the movement of construction equipment and vehicles along access roads and on the TSF which may lead to dust deposition on the surrounding vegetation. No rare or endangered species were identified in the project

Archaeology

Any archaeological artefacts or existing cultural sites may be destroyed during construction. The baseline study did not identify any sites of interest making this impact unlikely.

7.2.2 Operational Phase

Tailings from the process plant will be thickened to 55% solids by weight in the process plant and then pumped to the TSF. Approximately 800 million tonnes of tailings per annum will be deposited in the facility. Resultant impacts of the operational phase are summarised below.

Soil

A breach of the TSF delivery pipeline from the process plant may spill tailings and contaminate the soils. This may impact on the surface water quality and flora in the vicinity of the spill. Contamination of soils may occur from dust blown off the TSF.

Air Quality

Air contamination may occur during the dry season due to dust generated from exposed tailings surfaces. The dust may be deposited around the TSF impacting on flora and fauna and the surrounding soil (depending on wind direction).

Surface Water

Surface runoff may be contaminated through erosion of the dam wall. The TSF decant water and contaminated surface runoff may contain elevated levels of suspended solids and element concentrations, including but not limited to Al, Co, Cu, Fe and Mg. Contamination of the surface water may impact on the soil quality, on downstream users of water from the contaminated watercourse and the aquatic environment. The release of solids to the river could affect the river flow and cause local flooding.

Dam failure may release tailings and supernatant into surface water environments and have large impacts on aquatic flora and fauna, structure of surface watercourses and downstream water users. Dam failure is unlikely to occur with regular inspections and conservative nature of the dam design. Adherence to safe dam operating procedures provided by the designers of the TSF will also render the chances of dam failure very remote.

Groundwater

Local contamination of groundwater may occur resulting from acid rock drainage (ARD) and seepage of the acidic water through the base of the TSF. This seepage may contain elevated concentrations of dissolved metals. However, geochemical test work carried out on the tailings shows that the conditions in the TSF are non-acidic so ARD is unlikely to be generated.

Groundwater contamination may also occur due to seepage through the base of the TSF containing elevated concentrations of elements, in particular Al, Co, Cu, Fe and Mg. This is unlikely to occur because the local clay liner will act as the geomembrane for the facility.

Flora and Fauna

The dust blown from exposed tailings surfaces may deposit on surrounding vegetation and soils. This may lead to decreased biological productivity and may impact on surface water after the rainfalls.

Incident/Public Safety

Dam wall failure as a result of overtopping or breach of the dam wall, erosion, liquefaction or inadequate drainage will present a safety impact on the local populations downstream of the TSF. Supernatant and tailings may be washed downstream and flood local watercourses. This would impact on the surface water, groundwater, soils, flora and fauna of the project area. Drowning may occur if uncontrolled access to the TSF is allowed.

Aesthetics

The TSF will protrude above the natural surface topography and surrounding Miombo woodland. This will cause a visual impact to the surrounding community.

7.2.3 Post-closure Phase

The TSF will be stabilised and re-vegetated with tolerant and hardy species, such as *Acacia polycantha, Acacia sieberana, Albizia adianthifolia, Peltophorum africanum,* and *Dichrostachys cinere*. The potential post closure impacts of the TSF are summarised below.

Air Quality

Dust blow from non-vegetated areas on the TSF will affect local air quality. The dust could impact on the surrounding vegetation and local population downwind of the TSF (dominant wind direction is towards the northeast).

Surface Water

Erosion of the dam wall may result in contamination of local stream with solids and metals. Contamination of the surface water will have cumulative effects on the soil quality close to the river and the aquatic environment. The release of solids to the river could also affect the river flow and cause local flooding. This event will be unlikely due to the construction of properly designed, engineered and constructed retaining walls.

Groundwater

The seepage of acidic solutions from the TSF containing dissolved metals could contaminate groundwater in the vicinity of the mine site. This is unlikely to occur due to the non-acid forming nature of the tailing and nature of the underlying geomembrane (compacted local clay).

7.3 Waste Rock Dump

7.3.1 Construction Phase

The activities to be carried out during the construction phase of the waste rock dump include clearance of vegetation which on the proposed site and surroundings.. Construction work of the dump will be undertaken using Dozers, graders and haulage trucks. The associated impacts of the construction phase of the waste rock dump are detailed in the Environmental Impact Assessment Table (Table 7.3) and are summarised below.

Landscape and Visual Character

Landscape and visual characteristic of the area will be affected by the removal of vegetation and waste to construct the dump. This impact will be noticeable from the air but will be effectively screened at ground level by the remaining woodland and the local topography.

Soil

The removal of the topsoil (present in some areas at the peripheral of the dump) during construction activities may impact on the soil quality. Soil contamination may occur due to accidental spillages of oil and fuel from heavy equipment and construction vehicles.

Land use

No useful land for the local population is present at the proposed dump sites. This will have no impact on the income of the local population.

Air Quality, Noise and Vibration

Construction equipment may impact on local air quality (vehicle exhaust emissions and dust generation) and cause local noise and vibration disturbances. This impact will be screened by remaining vegetation and the local topography.

Surface and Groundwater

Exposed soils from the removal of vegetation may contaminate surface water. Siltation may occur in the Local Stream. Clearance of the vegetation will affect the evaporative and transmissive routes of water through the catchment areas of local watercourses eventually affecting flow discharges in watercourses.

The accidental spillage of hydraulic fluid, oils and fuel from construction equipment and vehicles could contaminate surface runoff which flows into the Local watercourse. This may have negative impacts on the aquatic life and on people living downstream of Local River.

Groundwater may be contaminated from the residue of spilled oil, fuel and hydraulic fluids through infiltration of surface runoff.

Flora and Fauna

Vegetation will be removed during site clearance. This will result in the loss of sustainable forest and the permanent loss of habitats. The Miombo woodland offers a source of income and traditional medicines. These species will be lost during site clearance. The construction vehicles and equipment will frighten away animals and birds. The movement of construction equipment and vehicles along access roads and the waste rock dump will lead to dust deposition on plants which may cause a small reduction in biological productivity. No rare or endangered species were identified in the project area.

Archaeology

Any archaeological artefacts or existing cultural sites, which include cemeteries, relic sites and rock engravings, may be destroyed during construction. The baseline study did not identify any sites of interest in the location of the waste rock dump making this impact unlikely.

7.3.2 Operational Phase

Activities during the operational phase in the waste rock dump will involve the movement and dumping of waste rock by haul trucks. Potential impacts related to the operational phase of the waste rock dump are summarised below.

Soil

Dust blown off the waste rock dump may contaminate the surrounding soils. This may impact on surface water quality and flora.

Air Quality, Noise and Vibration

Noise and vibrations from the movement of haul trucks along access roads and around the waste rock dumps may impact on the fauna and local inhabitants of the area. Dust may be generated by movement of vehicles and wind erosion which may cause localised deteriorations in air quality.

Localised air pollution by exhaust fumes may occur from vehicles working in and around the waste rock dumps. These impacts may affect the local population, flora and fauna, soils and the workers in the area.

Surface Water

Erosion of the sidewalls and upper surface of the dump may contaminate surface runoff that will end up in local watercourses. Suspended solids with elevated metal contents may affect the water quality and the aquatic environment.

Surface water could become contaminated by the influx of contaminated groundwater. This may affect aquatic flora and fauna.

Groundwater

Acid Rock Drainage (ARD) may occur if the waste rocks contain significant levels of sulphide mineralisation. The resulting acidic solution containing dissolved metals may seep through the base of the dump and locally contaminate groundwater. Surface water and soils may be impacted if ARD seepage occurs through the toe of the dump. Geochemical characterisation and ARD testwork

conducted during this study indicated that ARD is unlikely to occur in the mine waste rock dump.

Flora and Fauna

Dust blown from the waste rock dump may be deposited on surrounding vegetation and may decrease biological productivity. Cumulative impacts could also occur on the soils and surface water.

Aesthetics

The profile of the waste rock dump will be above the natural surface topography and Miombo woodland. This will result in the negative visual impact to the surrounding community.

Incident/Public Safety

Access by local people into operational areas may result in personal injury or loss of life.

7.3.3 Post-closure Phase

Post closure will cause the cessation of activities on the waste rock dump. Impacts that are associated with this phase are summarised below.

Air Quality

Erosion of exposed surfaces on the waste rock dump walls by wind may lead to localised and temporary deteriorations in air quality. This may impact on soils and local population downwind of the waste rock dump.

Surface and Groundwater Quality

Surface and groundwater contamination may occur from erosion of the waste rock dump walls. Surface runoff and infiltrating water may contain elevated concentrations of metals and suspended solids which may impact on the aquatic flora and fauna. ARD from the waste rock dump may seep into groundwater and deteriorate groundwater quality. The conditions in the waste rock dump are unlikely to lead to ARD due to the high acid neutralising capacity of waste rock and the compacted local clay which acts as the geomembrane for the facility.

Aesthetics

The profile of the waste rock dump will be above the natural surface topography and Miombo woodland. This will cause visual impact on the communities near the facility.

Incident/Public Safety

Access by local people into operational areas may result in personal injury or loss of life.

7.4 ROM Pad and Processing Facility

7.4.1 Construction Phase

The activities to be carried out during the construction phase of the Run off Mine (ROM) Pad and processing facility include site clearance and re-profiling. Vegetation will be removed wherever necessary over the area. Topsoil will be removed and stockpiled where it is practicable to do so. Construction work will be undertaken using front-end loaders, graders and haulage trucks. All timber removed from the area and not used during the construction period will be made available to the public for collection from site. The associated impacts of the construction phase of the ROM Pad and processing facility are detailed in the Environmental Impact Assessment Table (Table 7.3) and are summarised below.

Landscape and Visual Character

Landscape and visual characteristic of the area will be affected by the removal of vegetation and levelling of the site. This impact will be noticeable from the air but will be effectively screened at ground level by remaining woodland.

Soil

Impacts on the soil may occur due to removal of the topsoil during construction activities. This may impact on the future land use of the ROM Pad and processing facility. Soil contamination may occur due to accidental spillages of oil and fuel from heavy equipment used during the construction phase.

Land use

The existing land uses, such as agriculture and charcoal burning, will be permanently lost during construction activities. This will affect the income of the local population in the area.

Air Quality, Noise and Vibration

Construction equipment may impact on local air quality (vehicle exhaust emissions and dust generation) and cause local noise and vibration disturbances. This impact will be screened by remaining vegetation.

Surface and Groundwater

Exposure of the surface soils during construction may lead to erosion of soils by water and this could lead to surface water contamination and siltation in the Local River.

Clearance of the watershed vegetation may affect the evaporative and transmissive routes of water through the catchment of the Local River eventually affecting flow discharge in the watercourse.

The accidental spillage of hydraulic fluid, oils and fuel from construction equipment and vehicles could contaminate surface runoff which flows into the Local River.

Groundwater may be contaminated from the residue of spilled oil, fuel and hydraulic fluids through infiltration of surface runoff.

Flora and Fauna

Vegetation will be removed during site clearance resulting in the loss of sustainable forest and permanent loss of animal habitats. The Miombo woodland offers a source of income and traditional medicines, which may be lost in this area during site clearance.

The construction vehicles and equipment may frighten away animals and birds. The movement of construction equipment and vehicles along access roads and the ROM Pad and processing facility may generate dust and may lead to dust deposition on surrounding vegetation. This may result in a reduction in biological

productivity on Flora. No rare or endangered species were identified in the project area.

Archaeology

The loss or damage of archaeological artefacts and cultural sites may occur during construction activities. No archaeological artefacts and cultural sites were identified in the area

7.4.2 Operational Phase

During the operational phase activities will include the crushing and milling of ores, movement of ore around the process plant on conveyors, flash flotation, rougher and cleaner flotation and tailings disposal. The impacts that may occur are summarised below.

Soil

Poor handling, storage and transport of chemicals and reagents may lead to spillages which may contaminate exposed soils. Breakdowns of process plant equipment will occur occasionally and spillages of oil and lubricants may contaminate soils. Accidental spills of tailings from leaks in the tailings delivery pipeline may contaminate soil. Contamination of soils may occur due to the blowing of dust from the crushing and grinding circuits, ore stockpiles and conveyors. Contaminated soils may impact on surface water, flora and fauna.

Air Quality, Noise and Vibration

Noise and vibrations will be persistent in the process plant area which will be operational all day. Noise will be generated by dozers, haul trucks and operational equipment in and around the process plant and ROM Pad. Airborne dust will be generated from the crushing and grinding circuits, the conveyors and the ore stockpiles. Airborne dust contamination will occur from the concentrate stockpiles. These impacts may affect workers, soils, flora and fauna.

Surface Water

Dust and silt present on the ROM Pad and around the process plant may contaminate surface runoff with dissolved metals and suspended solids.

In the process plant accidental spillages from process equipment, thickeners, agitators and burst pipes may occur as well as spillages of chemicals and reagents caused by inadequate storage, handling and transport techniques. Equipment failure may lead to spillage of process liquids. These spillages may contaminate surface runoff and lead to contamination of surface watercourses.

Wash activities of plant equipment occur on a regular basis and wash water may be contaminated with suspended solids, oils, lubricants and fuels. Wash water released into drains leading to watercourse may contaminate surface water.

Tailings will be pumped from the process plant via pipelines. Spillage may occur if pipes leak which may become incorporated into surface runoff in the process plant. Process effluent may contaminate surface water if not treated prior to release to surface waters or accidental spills occur.

The impacts on surface water may affect aquatic flora and fauna, groundwater, soils and downstream water users.

Groundwater

Groundwater contamination may occur through infiltration of spills of chemicals and reagents through the soil profile. Seepages from process water ponds may contaminate groundwater with dissolved metals such as Cu, Co, Al, Zn and Mg. Spillages of contaminated mine water or process water may contaminate groundwater.

General Releases

Concentrates will be stockpiled after flotation and will be transported off the site via trucks. The exposure of concentrate to the natural weather conditions (wind, rain etc) may lead to contamination of soils, groundwater and surface water.

General Safety

There are safety concerns for mine workers who will be working in the ROM Pad and processing facilities. They will be around large dangerous operational equipment in a noisy and confined environment.

7.4.3 Post-Closure Phase

The potential impacts that may occur on the site of the ROM Pad and processing facility after decommissioning are summarised below.

Soil

Surface runoff off the stockpile areas (ore and concentrate) and the ROM Pad and processing facility may be contaminated and may infiltrate into soils and cause heavy metal contamination. This may affect flora and fauna on and off the site.

Surface and Groundwater

Surface runoff from the decommissioned ROM Pad and processing facilities may be contaminated and may lead to contamination of surface watercourses, and the infiltration through soils may contaminate groundwater. These impacts may affect soils, downstream water users and aquatic flora and fauna.

Incident/Public Safety

General public safety may be impacted on by the inadequate decommissioning of old mining buildings (collapse and falling objects).

7.5 Ore Stockpiles

7.5.1 Construction Phase

Only small ore stockpiles to act as an emergency buffer supply of a few hours have been planned for this operation. The activities to be carried out during the construction phase of the ore stockpiles include site clearance (removal of vegetation and topsoil) around the stockpiles and along access roads. Construction work will be undertaken using front end loaders, graders and haulage trucks. The soil removed from the stockpile area will be stored for future re-vegetation use where feasible. All timber removed from the area may be used during construction, and any excess will be made available to the public for collection from site. The associated impacts of the construction phase of the

stockpile areas are detailed in the Environmental Impact Assessment Table 7.2 and summarised below.

Table 7.2: Summary of Main Environmental Impacts and Mitigation Measures

Environmental Impact		**Associate Effect**	**Mitigation Measures**
Direct Impact (Main)	**Sub-Impact**	**Results**	
Vegetation Clearing	Indigenous timber	Loss of area designated for forest, and loss of potential income due to early felling of timber	AIMCL to adequately compensate affected parties for loss of timber resources.
		Loss of habitat for animals	As much vegetation will be retained as possible
			AIMCL and Forest Department will discuss options for timber extracted during construction works
	Soil erosion	Loss of productive land resulting from the reduction in vegetative cover	As much vegetation will be retained as possible.
		Increased siltation of project watercourses	Cleaning of equipment and vehicles will only conducted in designate wash-bays fitted with silt traps.
		Increased surface runoff due to reduced vegetative cover, resulting in increased surface water volumes in watercourses and therefore stream erosion	Vegetation will be retained if possible. Trees to be cut at stump level to allow regeneration of stumps and roots.
	Loss of Habitat	Removal of vegetation will reduce the amount of habitat available for certain animal species	As much vegetation will be retained as possible.
Risk of Injury or death due to inadvertent access to electrical equipment or accidents during construction		Increased risk to residents along the power line and substation during construction and operation	Restrict access to electrical equipment, ensure security and display warning signs in line with AIMCL operational procedures
			Ensure safety procedures are followed by AIMCL employees and contractors.
Noise and air pollution arising from construction vehicles	Disturbance to local residents	Noise disturbances	Ensure all vehicles are regularly maintained and work is restricted to daylight hours, when noise impacts are less disrupting
		Dust and exhaust emissions generated by construction vehicles causing deteriorations in air quality	Ensure all vehicles are regularly maintained and use dust suppression along access roads if necessary

Environmental Impact		Associate Effect	Mitigation Measures
Direct Impact (Main)	**Sub-Impact**	**Results**	
	Disturbances to animals	Disruption to normal animal activities	Ensure all vehicles are regularly maintained and work is restricted to daylight hours, when noise impacts are less disrupting
Accidental spills of oils and lubricants	Pollution of soil, surface water and groundwater	Contamination of water supplies used by humans and animals	Impermeable systems will be constructed around transformers
		Contamination of soils which may be used for agricultural purposes	A spills procedure to be developed by AIMCL to clean up and collect any spill of oil or fuel
			Regular maintenance of vehicle fleet to reduce the likelihood of any spill
			Re-fuelling to be conducted at designated areas fitted with impermeable surfacing and oil traps.
Temporary camps	Pollution of surface water and or soil due to inadequate disposal of human waste	May pose a danger to local water users	Portable sanitation devices will be used and human waste removed off site once construction has finished.
	Clearing of vegetation for camps	Loss of habitat for animals due to clearing of vegetation	As much vegetation around temporary camps will be retained as possible. Areas not required after construction will be re-vegetated
Waste management		Inadequate waste management leading to contamination of the environment	Waste to be separated in to different classes for re-use recycling or appropriate disposal
			Hazardous waste will be handled and disposed of appropriately.
Soil loss		Removal of soil during construction works	Ensure soil is stockpiled for future use and used to re-profile and rehabilitate closed affected areas
Archaeological		Loss of sites or artefacts of cultural or archaeological importance	Ensure that in the result of any find the area is cordoned off and the matter referred to the National heritage commission for advice
Social / Economic Impact		**Associate Effect**	**Mitigation Measures**
Direct Impact (Main)	**Sub-Impact**	**Results**	
Loss of Agricultural Land		Loss of agricultural land	Compensation and or land swap
Public Health		Increases in the incidence of HIV/AIDS and TB due to increased access and number of people in the area	AIMCL HIV/AIDS awareness campaign extended to areas around the mine area.
Disruption of economic activities		Changes in agricultural practices	Provide agricultural assistance to affected people if any

Environmental Impact		Associate Effect	Mitigation Measures
Direct Impact (Main)	**Sub-Impact**	**Results**	
		Loss of fruit trees	Adequately compensate for trees lost or acquire new fruit trees from Forestry Dept Nurseries.
Risk of Injury or death due to inadvertent access to electrical equipment or accidents during construction		Increased risk to residents along the power line and substation during construction and operation	Restrict access to electrical equipment, ensure security and display warning signs in line with AIMCL operational procedures
			Ensure safety procedures are followed by all AIMCL employees and contractors.
Access road improvement		Spread of diseases	AIMCL HIV/AIDS awareness campaign extended to areas around the project area and off-site investments (access route and power line).
		Illegal farming and settlement increases	Regular patrols along the wayleave will be conducted by AIMCL to discourage illegal settlements & agriculture along the wayleave, safeguarding public health

7.6 Social and Economic Impacts

7.6.1 Positive Social and Economic Impacts

The African Inkalamo Mining Company Limited Tin Mine Project would have far reaching positive social and economic impacts. Some of these impacts would include:

- **Employment opportunities**

  Long term employment opportunities would be created for skilled and unskilled workers during the construction and operation phases of the mine and off-site investments such as the upgrading and maintenance of the access road;

- **Business opportunities**

  Business opportunities would be created for locals and contractors who will be supplying the mines with a variety of goods and services. This

would have a multiplier effect on local economies as demand for other goods and services would be boosted;

- **Revenues**
  Revenues for local authorities and government from fees, levies and taxes would be increased;

- **Skills training**
  Locals who would be working for the mine would gain from skills training opportunities that would arise as a result of their working for the mine;

- **Accessibility**
  Accessibility to the area would be improved with the upgrading of the access road to the mine which communities could use for other economic benefits to the area;

- **Social Investment**
  Improved social and economic conditions of local communities through African Inkalamo Mining Company's corporate social responsibility programmes.

African Inkalamo Mining Company Limited would work at maximising the benefits to local communities who are the owners of the resources.

7.6.2 Negative Social and Economic Impacts

The perceived negative socio-economic impacts of the project are summarised below.

- **Displacement / Loss of rights to land**
  Currently, no households may be relocated to places further away from the mine or may lose their properties. This is because the project site.

- **Employment**
  Some jobs may go to people who are not locals due to the fact that not all skills can be found in the area.

- **Influx of people from outside / public health**

  The influx of people from outside, who would be looking for jobs would cause a burden on public services such as health centres and thus lead to an increase in some diseases.

- **Open pits**

  It is feared that open pits and water drained from the pits would act as bleeding ground for mosquitoes which might lead to increased incidences of malaria.

Safety, Health, Environmental, and physical

It is feared that increased flow of traffic and human activities would generate a lot of noise and air pollution in the area. Air pollution in the area would affect people's life styles and cause a number of respiratory tract infections. On the other hand, the chemicals and fuels from the mine would affect ground and surface water which people and animals in the area rely on; which would lead to diseases and hence put a burden on the health system.

8.0 ENVIRONMENTAL MANAGEMENT PLAN

African Inkalamo Mining Company Limited's Environmental Management Plan (EMP) for its proposed Mine Project is structured as follows: -

- Environmental Management;
- Occupational Health and Safety;
- Social Management
- Mine Site Decommissioning and Rehabilitation; and
- Mine Reclamation Costs.

Implementation of the Environmental Management Plan (EMP) will be the responsibility of the Environmental Officer (EO). The EO will report to the Project Manager. A Social Liaison Officer will communicate African Inkalamo Mining Company Limited's environmental policies to the local community through an ongoing public consultation process. This person will report to the Project Manager of African Inkalamo Mining Company Limited.

The EMP is presented in Table 8.1. The plan in Table 8.1 follows the layout of Table 7.3 in Chapter 7 (Environmental and Socioeconomic Impact) and is subdivided into construction and operational phases as appropriate. The plan specifies: -

- What needs to be managed? (Environmental Issue);
- Why does it need to be managed? (Environmental Impact);
- How should it be managed? (Management Action); and
- Person to manage.

A total of 200 management actions were identified. Provisional timings for the implementation of the management actions are also given in Table 7.3. The EMP is structured to facilitate environmental auditing of operations.

The African Inkalamo Mining Company Mine will have the following closure objectives, as per each mine component are:

- Stopping of dewatering of the open pits to allow for flooding to take place at the end of the project. The pit slopes will be stable and groundwater quality will not be compromised.
- Profiling of the dam surface and layering with soil to encourage re-vegetation programs. Closure of the decant and evaporation of supernatant after five years from closure
- Decommissioning of the plant, dismantling of buildings and removal of foundations. Removal of scrap metal and used oils etc. Re-profiling and re-vegetation of the site after five years from closure.
- Processing of sulphide stockpile. Re-profiling and re-vegetation of the site after five years from closure.
- Dismantling of buildings and removal of foundations. Removal of office waste. Re-profiling and re-vegetation of the site after five years from closure.
- Evaporation of remnant water, removal of contaminated solids to a waste disposal location offsite after five years from closure.

8.1 Mitigation Measures relating to Vibrations and Noise

There are varying levels of noise throughout the site and so measures to control noise impacts are site specific. The timing during the mining project is also indicated.

8.1.1 Open Pit

Operational Phase

Mining equipment such as compressors, haul trucks, loaders and dozers will increase the mine site noise levels. The current daytime noise levels of ≅ 40 dB reflect the rural setting. The operation of mine equipment will be noticeable to people living near to the mine exclusion zone but is unlikely to be a nuisance. The mine will purchase equipment with low noise levels and where necessary, African Inkalamo Mining Company Limited may ask a supplier to deliver equipment fitted with noise abatement devices.

8.1.2 Waste Rock Dump

Operational Phase

The waste rock dump will be located near the open pits and will not be near streams. It is unlikely that noise and vibration generated from the operation and movement of heavy equipment will be a nuisance to nearby communities. However, a complaints register will be set up and if necessary, 24-hour noise monitoring will be conducted and the results used to develop appropriate mitigation measures.

8.1.3 ROM Pad and Processing Facilities

Operational Phase

If necessary, 24-hour noise monitoring will be conducted at the crusher plant and the results used to develop appropriate mitigation measures. Workers will wear noise protection (ear plugs or muffs) at the grinding section, the crushing plant and around operational conveyors. The plant will undergo regular maintenance to ensure the machinery is in good working order and minimum noise levels are being produced. Where it is practical and feasible to do so, African Inkalamo Mining Company Limited will install sound-insulation, noise attenuation devices and control rooms to decrease the average noise level exposure in normal work areas.

8.2 Mitigation Measures relating to Atmospheric Emissions

The potential sources of air emissions are:-

- Dust emissions from the crushing plant (possible respirable dust generation) and dust blow from various locations across the mine site i.e. the mine waste rock dump, TSF, ore stockpile and mine haul roads; and

- Exhaust fumes from the operation of haul trucks and other heavy mining equipment.

It is unlikely that there will be other gases emitted from the mine process plant other than those stated above. The likely gas emissions are difficult to quantify.

8.2.1 Open Pit

Operational Phase

African Inkalamo Mining Company Limited will conduct routine spraying of haul roads to suppress the dust generated by the movement of haul trucks and other heavy equipment.

It is unlikely that blasting operations will have a noticeable impact on air quality beyond the pit boundary because of the low frequency and short duration of blasting. The exclusion zone around the mine site will not be populated and so it is unlikely that there will be any impact on the local populations due to deteriorations in the air quality during blasting. Nevertheless, a complaints register will be set up to determine if dust blow is an issue of concern.

Visual assessment of dust emissions will be conducted and if observations indicate that dust is a nuisance, a monitoring programme will be designed to quantify dust levels and develop mitigation measures.

8.2.2 Waste Rock Dump

Operational Phase

The generation of airborne dust from the movement of trucks and other heavy equipment will be suppressed by routine spraying of haul roads with water.

8.2.3 ROM Pad and Processing Facilities

Operational Phase

The release of airborne dust from the ROM Pad and ore stockpiles will be suppressed by regular spraying with water from water carts. Water sprinkler systems will be installed in the crusher plant and at bulk ore transfer points to suppress dust.

Air quality monitoring equipment will be installed in critical areas to assess the performance of dust suppression systems. Dust monitoring will be conducted in strategic working areas for respirable dust, rare earth element, cobalt and lead dust to evaluate dust exposure levels to workers. Workers in dust areas will wear dust masks. Failure in doing so will result in action taken against the erring individual by African Inkalamo Mining Company Limited.

8.2.4 Tailings Storage Facility

Operational Phase

To minimise dust generation, the wetted area of the tailings beach will be maximised during the dry season and if necessary water sprinkled on the TSF surface. Dust generation will be visually assessed during operations and if necessary, dust levels will be monitored. A dust complaints register will be kept at the mine.

8.2.5 Transport Infrastructure

Operational Phase

The generation of dust by heavy equipment and vehicles will be prevented by frequent water spraying on all mine access roads (to and from mine and access road to the Lualuzi Road which is the main gateway Isoka).

8.3 Mitigation measures relating to risks of degrading and polluting Water

The measures that will be carried out to prevent the degradation and pollution of natural waters are discussed below in relation to mine components and timing of impact during the project.

8.3.1 Open Pit

Operational Phase

Baseline information indicates that the surface water in the area is of good. During the operational phase it is envisaged that all water pumped from the pit will be used in the process plant operations. Should there be a need to discharge from the open pit the water will be settled in the settling ponds prior to discharge into the water tanks or watercourses. The settling ponds will be regularly de-silted and the sediment collected will be put through the processing plant if grade of REE is above cut-off grade or placed on the waste rock dump if below cut-off grade.

The raw water and process water storage tanks will receive mine water, return water from the TSF, and make up raw water to provide a total daily requirement ranging approximately from 2500 to 3000m^3/day.

Storm water run-off from around the open pits will be collected in perimeter drains that connect to the mine site drainage system and discharged into water storage facilities or directly into the Local streams.

The open pit workshop will be equipped with dedicated wash-bay areas that have impermeable surfaces, containment and oil traps. The treated effluent will be discharged into the mine site drainage system. The oil traps will be regularly checked and cleaned to prevent any overflows. The oil trap supernatant will be sold to the used oil dealers. Oil trap residue will be stored in drums in designated areas with impermeable surfaces and Bundwall to wait for disposal at a designated approved hazardous waste disposal site.

All open pit equipment using hydraulic fluid, oil, fuel or any other substance that has the potential to contaminate surface water, groundwater or soil will be subject to a preventative maintenance programme.

An Emergency Response Plan (ERP) will be developed by African Inkalamo Mining Company Limited specifying the procedures to be followed in the event of a fuel or oil spill. The plan will designate responsibilities, describe notification procedures, list the response actions and clean-up equipment and define the clean-up objectives.

It is expected that pit dewatering may lower the groundwater level in the vicinity of the open pit. The indication at present is for limited groundwater movement within the area of the proposed open pit. There are domestic boreholes within 1 km of the proposed open pits and the temporary lowering of the groundwater level over the life of the project is not expected to noticeably affect the amount of water available to the residents of the area. However, African Inkalamo Mining Company Limited will regularly monitor water levels in the boreholes to check this situation

Post Closure Phase

Pit dewatering will cease at the end of project year 6. The pit will be allowed to flood naturally by groundwater inflow and direct precipitation. This will create a new surface water resource for the surrounding area that could be used for sustainable land uses, such as irrigation for local farming, water supply and an aquatic nature preserve or a fish pond.

The water in the pits will be monitored as part of the mine's post closure environmental monitoring programme in order to evaluate water quality so that actions can be implemented in the event of significant water contamination.

8.3.2 Waste Rock Dump

Operational Phase

Surface run-off from the mine dump will be channelled to the sedimentation pond to settle solids before release into either water storage facilities or nearby

streams. The sedimentation pond discharge will be monitored to ensure compliance with Zambian effluent discharge standards.

Geo-chemical characterisation test work was conducted on representative samples of waste rock from the African Inkalamo Mining Company site to assess the Acid Rock Drainage (ARD) risk potential. The USEPA 1310a Extraction Leach Procedure was used to assess the risk associated with the mine waste.

The leach test results indicate that the African Inkalamo Mining Company mine waste rock is of negligible risk concerning ARD. There is little mobilisation of heavy metals into solution from the waste rock characterised at the mine.

8.3.3 ROM Pad, Crushing Plant and Transfer Facilities

Construction Phase

Perimeter storm drains will be constructed around the crushing plant, ROM pad and ore stockpiles to intercept surface run-off. These drains will connect with the main mine drain and run-off will pass through the settling ponds to settle the solids.

Operational Phase

The run-off from the ROM pad and ore stockpiles will be collected in drains and directed to settling ponds where solids will settle down. Clear water will be discharged to the main mine drains discharging to either water storage facilities or the local streams. The drains and settling ponds will be regularly maintained and cleaned out. Solids will be removed and dumped at the waste rock dump.

8.3.4 Flotation Plant

Operational Phase

Contamination of surface and groundwater may occur from contact between process spills, concentrate, tailings, wash water and storm water resulting in the carryover of spills into the plant site drainage system. Measures to protect surface water quality will include: -

- An impermeable (concrete) drainage system will be constructed around the flotation plant. All process plant spills will be collected in this drainage system connected to sumps and returned to the process;

- The wash water from washing down and maintenance activities will be collected in the internal plant drain and re-circulated into the plant for treatment. This water will be kept separate from storm water run-off; and

- Storm water drains will be of sufficient capacity, and kept clean and clear of debris to prevent overflow of the drains into processing areas.

The process water ponds will be of good water quality and no groundwater contamination is likely from any seepage under the process ponds. Consideration may be given to lining the process ponds in order to prevent loss of process water.

Raw water consumption will be controlled, optimised and efficiently used in the process plant. All process plant raw water inputs and effluent outputs will be identified and monitored and the data used to update the plant and site water balance. African Inkalamo Mining Company Limited will implement a preventative maintenance program to maintain and repair any leaking water pipelines and will continually review the plant site water balance and implement strategies to reduce water usage.

Contamination of water may occur due to accidental spills of oil, chemicals, reagents, tailings and equipment failure. To mitigate these potential impacts: -

- Oil traps will be installed around machinery in the mill to capture spills. The oil traps will be regularly serviced and cleaned. Oily residues will be stored in drums in awaiting collection by an approved used oil recycling company;

- Chemical off-loading bays will be equipped with an impervious floor surface and containment to recover spillages and prevent ingress into the site drainage system.

- An inventory control program will be designed to track and document movement of process chemicals and reagents through storage facilities. Regular inspections of storage and containment areas will be conducted;

- A preventative maintenance program will be implemented for all plant equipment, process infrastructure, drains and containment areas. This will involve regular inspection of all equipment to prevent spillage due to equipment failures;

- Chemical and reagent spills or leaks will be collected in sumps and returned to the process for correct disposal. Spill containment areas will be regularly cleaned to maintain storage capacity;

- Spilled materials will be removed and the area cleaned up as soon as possible;

- In addition to monitoring drainage from the process plant, African Inkalamo Mining Company Limited will install standpipe piezometers in boreholes to monitor groundwater levels and quality in the vicinity of the process plant; and

- In the event of a spill, spill response procedures and measures described in the Spillage Response Plan (currently being developed by African Inkalamo Mining Company Limited) will be followed.

8.3.5 Tailings Storage Facility

The design will be in such a way that TSF tailings will not be washed into the Local streams. In addition to this work there will be additional measures put in place to prevent any further erosion into the Local streams system:

- Construct storm water diversion drains to intercept slope side run-off and direct these drainage flows into a common drain and discharge directly into the Local streams after settling the solids;

- Backfilling of erosion gullies in the dam with tailings;

- Re-profiling the upper surface of the TSF such that precipitation flows to and collects in the centre of the dump. The dam will have adequate freeboard to withstand any storm event.

Construction Phase

The dam will be constructed so that it can store the tailings which will be produced over the life of the mine. Storm water cut-off drains will be constructed to prevent soil erosion and possible contamination of surface water during pre-deposition works at the TSF. The drainage water will flow into the settlement ponds and then drain into local streams.

Operational Phase

Tailings slurry will be transported from the process plant to the TSF in a pipeline at pH 6 to 8.

During the dry season there will be no drainage from the TSF. In the wet season, rainwater collecting on the upper surface of the TSF will be decanted to a sump and pumped to the plant where it will be recycled as process water. Therefore, the use of pumped water from the open pit to be used in the process will be reduced and will be diverted to the sedimentation ponds for subsequent discharge into the local streams.

Run-off from the perimeter earth fill wall will be intercepted in the toe drain and discharged to surface waters. The TSF operations should have no impact on the Local streams or other watercourses in the area.

Seepage of supernatant moisture and rainwater through the base of the TSF during the wet season is unlikely to have any discernible impact on groundwater quality in the immediate vicinity of the mine. Mine dewatering will create a potential hydraulic gradient towards the open pits, situated within 3km radius southeast of the TSF. Groundwater quality will be monitored in the open pit and from boreholes equipped with standpipe piezometers. These boreholes will be drilled around the TSF and between the TSF and the open pit.

The risk of contamination of surface water from tailings spills or leaks from the tailings delivery pipeline will be minimised by regular monitoring of the pipeline. In the unlikely event of any spill, the tailings will be removed and returned to the TSF.

8.3.6 Mine Workshops

Operational Phase

African Inkalamo Mining Company Limited will implement measures to prevent the contamination of surface run-off from the mine workshop area.

The washing of mobile equipment and machine parts will be carried out in wash bays equipped with impervious flooring and spillage containment. The wash bay drainage will pass through oil traps and then clean water will be released to the site drainage system. The oil traps will be inspected regularly to monitor condition and performance. Oil residue will be collected and stored in drums in a designated area, awaiting removal by a recycling company. Sludge in the oil traps will be treated and disposed of as a hazardous material at an approved site. If no appropriate site is found a bio-remediation system will be developed on site. This system will involve the mixing of waste oil with saw dust and organic material in order to encourage the natural breakdown of oil.

Oil traps will be installed in drains at all oil handling and storage areas in order to capture all oily residues. This will prevent the carryover of oil by storm water into the mine site drainage system.

Workshops will be regularly inspected to enforce for handling of spills and housekeeping. This will form part of a preventative maintenance program to monitor potential sources of contamination.

8.4 Mitigation measures and rehabilitation of degraded soils

8.4.1 Open Pit

Operational Phase

Topsoil removed during construction from peripheral areas of the open pit will be stored in a designated area adjacent to the waste rock dump (nearest to the project infrastructure) for use in future re-vegetation.

Soil contamination will be minimised by ensuring that the service; maintenance and repair of vehicles and equipment is only carried out in areas designed for such activity i.e. mine workshops. The movement of any in-pit mobile fuel tankers and possibly mobile electrical substations will adhere to specified procedures to prevent the contamination of soils from accidents involving oil and fuel.

8.4.2 Mine Workshops

Operational Phase

Any topsoil removed from the mine workshop site will be stockpiled in a designated area for future re-vegetation. Inadequate handling and storage of new and/or used oil may result in soil contamination. To prevent this occurring, new and used oil will be stored in accordance with African Inkalamo Mining Company Limited's Materials Handling Procedure (under development). The key measures are:-

- Oil will only be stored and handled in designated areas;
- Drains in areas where oil is stored and handled will be equipped with oil traps;
- Oil handling and storage areas will be equipped with impervious surfaces; containment, impact and fire protection and protection against the sun and rain; and
- Waste oil will be recycled and quantities of stored oil will be kept to a minimum.

The oil handling and storage areas will undergo regular inspections, which will determine service, maintenance and repair requirements.

All electrical transformers will be fitted on impervious surfacing with bund walls, in order to contain any transformer oil spills. The bund walls will be fitted with a valve to allow the collection of waste water and oil for appropriate disposal. No transformer oil containing PCB's will be used on site.

The workshop personnel (management, engineers, mechanics and operators) will receive training on oil handling and disposal. The programme will focus on environmental awareness, safe-handling procedures, spill reporting and spillage response/action.

Inadequate handling and storage of new and/or used batteries may result in soil contamination. To prevent this occurring, new and used oil will be stored in accordance with African Inkalamo Mining Company Limited's Materials Handling Procedure. The key measures are:-

- Batteries will only be stored and handled in designated areas;

- Battery storage areas will be equipped with impervious flooring, containment, impact and fire protection and protection against the sun and rain;

- All spills will be treated as contaminated waste; and

Used batteries will be stored in a designated area awaiting collection by recycling company and the quantity of them in storage will be minimised.

In the event of an oil or battery acid spill, the procedures outlined in the African Inkalamo Mining Company Limited Emergency Response Plan (ERP) will be followed. The ERP measures to be effected include:-

- The key personnel to be notified;

- The location of any emergency equipment that will need to be used;

- Corrective actions – oil spills will be cleaned up using sawdust as an absorbent;

- Rehabilitation requirements; and

- Correct handling and disposal of any contaminated waste (soil).

8.4.3 Mine Waste Rock Dump

Waste Rock Dump Pre-mining Phase

No rare or endangered species of flora or fauna were identified in the project area during the baseline study. A survey of fauna in the area indicated that only small mammals, reptiles, fish, birds and insects are present. Population pressure and uncontrolled hunting has destroyed or caused the larger mammals that were once present in the area to move away.

Public Safety

African Inkalamo Mining Company Limited will inform the public concerning the dangers of entering into areas of mining operations through public consultation, liaison with local community leaders and erection of warning signs. Mine security will remove intruders from the mine site.

Archaeology

A ‘walk over’ of the site and discussions with the local community and African Inkalamo Mining Company Limited employees during the baseline study revealed that no archaeological or cultural sites exist within the area of the waste rock dump.

Operational Phase

Surface Water

Details of surface water protection measures are outlined below.

Dump Stability

To maintain the stability of the waste rock dump and prevent erosion, African Inkalamo Mining Company Limited will incorporate the following procedures: -

- A strategy of dumping weathered waste rock in central dump areas and using more competent waste rock for construction of the outer walls. The more competent waste will also be used to dress dump slopes;

- The waste rock dump will be designed according to best industry practice with an overall slope angle of 35°. The dump will be constructed in 10m lifts with 5m wide berms and an inter-berm slope angle of 42°. The waste rock dump will attain maximum height of 40 metres;

- The dump will be of terrace construction;

- The dump construction will be regularly checked to ensure that it is as per design; and

- Perimeter drains and a sedimentation pond will be constructed to control/manage surface run-off. The drains and sedimentation ponds will be regularly inspected and cleared of solids and debris before the start of each wet season.

African Inkalamo Mining Company Limited will progressively rehabilitate the sidewalls of the waste rock dump over the life of mine with appropriate indigenous vegetation to prevent erosion and rehabilitate the upper surface of the dump at closure in year 6 of operations.

Aesthetics

The waste rock dump will be approximately 1 km from the main dirt road which links the area with Lualuzi Road. The dump will attain a maximum height of 40m.

Post-closure Phase

The physical condition of the waste rock dump and the quality of dump surface run-off will be monitored as part of the post-closure environmental monitoring plan.

8.4.4 Tailings Storage Facility (TSF*)*

Construction Phase

The mitigation measures for site clearance at the TSF extension site are the same as those described for the waste rock dump, ROM pad and process plant.

Operational Phase

Details of surface water protection measures for the TSF are outlined below.

Incidents and Public Safety

Failure of the TSF could occur due to over-topping of the dam wall or erosion of the perimeter earth fill wall. To prevent failure of the TSF, African Inkalamo Mining Company Limited will operate the TSF according to the procedures outlined in the designer's Safe Operating Manual. As a minimum, the following measures will be implemented: -

- Rainfall will not be allowed to accumulate on the upper surface of the TSF. Rainwater will be decanted and used as process water in the plant;

- In the event of a 1:100-year storm, excess water will be retained in the TSF and subsequently discharged via the decant;

- The dam wall, toe drain, filter drain outlets, freeboard, decant structure and beach above decant pipe will be inspected weekly by a competent person and an inspection record kept on site;

- In an emergency, procedures outlined in the Emergency Response Plan will be followed; and

- To ensure public safety, signs and a fence will be erected around the TSF to warn the public of the dangers associated with the TSF.

Aesthetics

The TSF will attain a maximum crest height of 30-35m. The side slopes will be progressively re-vegetated to blend in with the surrounding Miombo woodland. It is unlikely that the TSF will impact the natural topography of the area.

Post-closure Phase

Unless a use of the tailings can be found (reprocessing), the upper surface of the TSF will be profiled and re-vegetated at closure. The decant will be sealed. Annual evaporation exceeds annual rainfall by approximately 700mm at the project site. Rainfall accumulating atop the dam will either evaporate or infiltrate the soil. Slope run-off will be intercepted in the perimeter drain and discharged into the Local streams. No post closure environmental impacts are expected.

8.4.5 Open Pits

Operational Phase

Surface Water / Groundwater and Soils

Details of surface water protection measures for the Open Pits are outlined below.

Pit Stability

Storm water and erosion management measures will include the construction of diversion channels around the perimeter of the open pit and profiling of the haul roads to redirect storm water run-off away from the pit and slopes. The pit will be dewatered to prevent the build-up and accumulation of water. These measures in addition to ongoing review of pit slope design and best blasting practices at final pit limits will minimise the risk of pit wall failure.

Waste Generation

Waste that is generated from the repair, maintenance and service of open pit equipment will be handled, stored and disposed of according to African Inkalamo Mining Company Limited waste management plan.

Public Safety

The public will be informed of the dangers of entering into areas of mining operations through public consultation, liaison with local community leaders and signposting. Mine security officers will remove intruders from operational areas.

Post-closure Phase

The following management actions are proposed for the open pit post-closure phase.

Pit Wall Stability

Final pit walls will be designed with adequate factors of safety to ensure long-term pit stability. The pit perimeter will be profiled to prevent surface run-off flowing into the pit or saturating the pit wall. Pit wall stability will be monitored as part of the mine's post closure environmental monitoring programme.

Public Safety

Warning signs and fencing will be erected around the mine site and on approach roads to the mine to warn the public of the danger of falling into the pit and/or drowning.

8.4.6 ROM Pad and Processing Facilities

Construction Phase

Site Clearance

The footprint of the ROM Pad and process plant is very small in relation to the other mine components, being approximately 26,936 m^2. The mitigation measures are the same as those proposed for site clearance at the waste rock dump.

Public Safety

African Inkalamo Mining Company Limited will inform the public concerning the dangers of entering into construction areas through public consultation, liaison with local community leaders and erection of warning signs.

Management of Contractors

Environmental management requirements will be included in all contracts between the contractor and African Inkalamo Mining Company Limited in order to effectively manage contractors and prevent any unnecessary environmental degradation. The principal contractor will submit a Construction Environmental Management Plan to African Inkalamo Mining Company Limited for approval by the Project Manager. The contractors will be monitored and audited against the agreed upon environmental requirements in their contract. An induction course on safety, health and environment will have to be attended by the principal contractor, employees and sub-contractors before they can enter the site.

Operational Phase

Public Safety

African Inkalamo Mining Company Limited will inform the public of the dangers of entering areas of operations and erect warning signs.

8.4.7 Transport Infrastructure

Operational phase

Accidental Spills/Releases

The contamination of soil, air and/or water resulting from the spill of tailings filter cake, chemicals and reagents, acid, fuel, oil and concentrate will be minimised. African Inkalamo Mining Company Limited will implement procedures for the transport of hazardous materials to, from, in and around the mine site. These procedures include but are not limited to: -

- Documentation and inventory control through a chain of custody;
- Emergency response training for all African Inkalamo Mining Company Limited employees and contractor employees;
- Tracking and notification of shipment location and condition;

- Carrying of on-board emergency equipment;

- Use of designated transport routes only;

- Vehicle road worthiness checks and implementation of a preventative maintenance programme; and

- Random and unannounced en route safety inspections.

All outside contractors will adopt these procedures, which will be incorporated into all contract agreements.

An escort vehicle will accompany explosives trucks and all vehicles will be flagged.

Tarpaulins will cover open top bulk transport trucks in order to prevent spills resulting from the exposure of concentrate to rain and/or wind.

Mine transport infrastructure including roads, bridges, culverts and traffic signs will be subject to a preventative maintenance programme to ensure that they are kept in a good condition. This will reduce the number of road accidents, which could potentially result in soil or water contamination.

8.4.8 Materials Handling and Storage

Mine Stores

Operational Phase

Acid Storage Tanks

The acid storage tanks will be above ground types. The tanks will be installed in banded concrete walls whose capacity will be twice that of the tanks. This will be done to ensure that in case of leakage, the banded wall is able to contain all the acids that would leak from the tanks. The tank capacity that will be installed will be about 100 ,000 to 200,000 litres' capacity. Apart from these features, other features include:

- The tanks being supplied with fire retardant and ultra violet resistant additives as per specific requirements.
- The tanks being designed for pressure and vacuum conditions.

- The tanks being supplied with double wall construction.
- The tanks will be designed and supplied for above and underground applications.
- The tanks will have thermoplastic welded joints with conductive layer.
- Vertical cylindrical, horizontal cylindrical and with require type of end closures.
- Supplied along with additional accessories like ladder, handrail, platform, level indicators, leg supports and saddle supports.

Accidental Releases/Spills

The risk of a fuel spill occurring will be minimised by equipping all the fuel storage areas with statutory bunding containment (of 110% storage capacity) and concrete surfaces. Procedures outlined in the mine's Spillage Response Plan will be followed in the case of significant fuel spills. These procedures include but are not limited to the clean-up action to be taken, the clean-up materials to be used and the appropriate disposal practices for contaminated soil and clean-up materials used. All spills will be dealt with in accordance with the African Inkalamo Mining Company Limited's Spillage Prevention, Control and Clean-up Plan.

African Inkalamo Mining Company Limited has no plans for any subsurface fuel storage tanks on the mine site. Spills of oils, greases and chemicals during handling and storage will be immediately cleaned up following the procedures outlined in the Spills Prevention, Control and Clean-up Plan. Training will be given to employees handling oils, reagents and chemicals that will focus on potential risks, safe handling procedures, safety precautions, first aid, emergency response and appropriate disposal practices.

Hazardous Substances

Material Safety Data Sheets (MSDSs) will be obtained by African Inkalamo Mining Company Limited for all the chemicals used on the site. These sheets will specify hazards, compatibility with other substances and specific handling, storage or disposal requirements. The end users will have copies of the relevant

MSDSs and receive training on the hazardous substances used in their area of operations.

Handling

African Inkalamo Mining Company will:

- provide safety data sheets (kept in a hazardous substance register) to employees and others who may be exposed to chemicals at the workplace;
- ensure containers containing chemicals are correctly labelled;
- ensure that the contents of any pipework or process vessels containing chemicals are adequately identified;
- assess the risk of injury or harm to people resulting from the use of chemicals;
- prevent exposure by means other than personal protective clothing or equipment as far as practicable;
- where it is not practicable to adequately reduce the risk without personal protective clothing or equipment, provide such clothing and equipment and ensure there are systems in place for its safe use and maintenance;
- provide sufficient information, training and supervision to employees to allow them to use chemicals safely; and
- plan and train for emergencies such as fire, spills and poisoning.

Very small quantities of chemicals, even as little as the size of an aspirin tablet when ingested or inhaled could be lethal. It does not matter whether you are part of a large operation using tonnes of chemicals or just using a few grams in a small workshop.

For this reason, African Inkalamo Mining Company will ensure that any employee who works in a place where chemicals are used or stored:

- prevent accidents by following the proper procedures for safe handling, storage and disposal;
- be able to recognise the early signs and symptoms of chemicals poisoning; and
- be prepared for an emergency by learning the correct first-aid treatment.

African Inkalamo Mining Company will always avoid poisoning by preventing chemicals from entering the body. Entry to the body can be from:

- breathing chemicals gas or dust;
- swallowing chemicals solids or liquids; or

- absorption of chemicals solutions through the skin.

Effects may occur within seconds to minutes following inhalation and could be delayed several hours following skin absorption. To avoid breathing in chemicals gas or dust, African Inkalamo Mining Company will:

- ensure chemicals is stored in a closed container;
- keep workplaces and stores dry and well ventilated;
- ensure that acid chemicals cannot accidentally come in contact with chemicals;
- do not smoke or keep cigarettes in areas where chemicals is used or stored;
- use the appropriate respirator;
- wash and dry the respirator after each use and seal it in a clean plastic bag; and
- do not store the respirator in areas where chemicals is used or stored.

Chemicals Handling

African Inkalamo Mining Company will:

- provide safety data sheets (kept in a hazardous substance register) to employees and others who may be exposed to chemicals at the workplace;
- ensure containers containing chemicals are correctly labelled;
- ensure that the contents of any pipework or process vessels containing chemicals are adequately identified;
- assess the risk of injury or harm to people resulting from the use of chemicals;
- prevent exposure by means other than personal protective clothing or equipment as far as practicable;
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- do not smoke or keep cigarettes in areas where chemicals is used or stored;
- use the appropriate respirator;
- wash and dry the respirator after each use and seal it in a clean plastic bag; and
- do not store the respirator in areas where chemicals is used or stored.

8.4.9 Fuel Handling and Storage

Operational Phase

Accidental Release/Spills

Regular inspections of surface fuel storage tanks will be carried out in order to minimise the risk of contamination of soils and water through handling or leak/rupture of a fuel tank. In addition, monthly reconciliation of fuel stocks will be undertaken in order to detect any fuel loses.

Drainage from fuel storage and handling areas will be isolated from the mine site drainage system and passed through an oil trap prior to release. Oil traps will be regularly monitored and cleaned and drains will be kept clear.

8.5 Waste Management

Operational Phase

Industrial Waste Generation

Significant quantities of scrap metal and empty containers will be generated. These should be sold or recycled to minimise the amount stored at the mine. All the industrial waste will be disposed of according to African Inkalamo Mining Company Limited's Waste Management Policy and Scrap Sales Procedures. The waste will be stored in secure areas. The materials will be sorted to facilitate reuse/recycling. Scrap metal dealers and used equipment dealers will be encouraged to remove waste materials. Reusable materials such as empty drums, used conveyor belts and timber will be reused by the mine, sold or given away. Used tyres will be painted by the mine and used to mark the edges of roads, bends, operational areas and accident black spots.

Waste Separation

General waste generated onsite (wood, plastic and organic waste) will be separated on site. Three different coloured and labelled bins will be provided in appropriate areas.

Waste will be re-used where possible on or off site i.e. organic waste composted and wood waste re-used for construction or conversion into sawdust for oil spill absorption.

Waste that cannot be re-used or recycled will be disposed of on the designated waste site.

Hazardous Waste Generation

Hazardous waste such as oils and grease will be stored in a secure area. The area will be covered, have a concrete floor and 110% containment capacity. Sawdust that is used to clean up oil and grease spills will be contained in a secure area and mixed with a small amount of organic material and soil in order to encourage the bio-remediation of the contaminated sawdust. The success of the bio-remediation system will be reviewed annually through an annual hydrocarbon monitoring campaign. Non-compatible hazardous waste will be stored at separate sites. Used oil will be sold to a recycling company and greases returned to supplier or incinerated according to approved disposal practices.

8.6 Occupational Health and Safety Plan

African Inkalamo Mining Company Limited will implement internationally accepted occupational health and safety standards and procedures throughout its operations. This will create a safe workplace thereby protecting its employees from accidents and sickness. The key measures involved are described in the following sections.

8.6.1 Workplace Air Quality and Temperature

In addition to the air monitoring outlined above, good ventilation will be provided in the workplace. The condition of protective respiratory equipment and air quality monitoring equipment will be routinely checked and maintained, as well as any warning systems.

Protective respiratory equipment will be provided and worn by all employees when exposed to welding fumes, solvents and other substances present in the workplace. Respiratory protection will be worn at all times in dusty environments and when air monitoring data indicates that respiratory protection is required. Dust masks will be issued to all employees working in areas where particulates (inert or nuisance dusts) may exceed the statutory limit of 10 mg/m^3 i.e. crusher plant and concentrate storage areas.

OHS officers will conduct routine inspections to ensure the appropriate respiratory protection equipment is in good working condition and being used correctly.

8.6.2 Workplace Noise

All plant equipment (belonging to the mine and contractor) will undergo routine maintenance to ensure it is in good working order and to minimise noise levels.

Where it is practical and feasible to do so, African Inkalamo Mining Company Limited will install sound-insulation and control rooms to decrease the average noise level exposure in normal work areas.

African Inkalamo Mining Company Limited will adopt the international standard of 82 decibels (dB) for exposure of its employees to noise over an 8-hour shift. Employees will wear the appropriate ear protection provided in workplaces where noise levels exceed 82 dB.

Safety officers will monitor noise levels and the use of protective equipment to ensure the appropriate and correct use of the protective equipment by employees.

8.6.3 Working in Confined Spaces

Entering into confined spaces such as tanks, vessels, sumps and excavations to carry out inspection, repair and/or maintenance can expose workers to the danger of toxic, flammable or explosive gases, or lack of oxygen. These spaces must be tested for the presence of gases or lack of oxygen and adequate ventilation provided before and during occupancy. Employees working in confined spaces, which may become contaminated or deficient in air, must wear appropriate air-supplied respirators. Suitably equipped observers will be stationed outside of confined spaces to provide emergency assistance if required to people working inside.

8.6.4 Handling and Storage of Hazardous Material

All hazardous (reactive, radioactive, corrosive and toxic) materials or substances will be stored in appropriate and clearly labelled containers or vessels. Fire protection systems and secondary containment will be provided to the storage area to prevent fires or the release of hazardous materials to the environment.

The storage and handling of hazardous materials will be carried in accordance with the Zambia Mining Regulations and African Inkalamo Mining Company Limited's Materials Handling Procedures (currently under development).

8.6.5 Employee Health - General

African Inkalamo Mining Company Limited will provide an onsite ambulance to deal with mining emergencies. The mine will help the current medical facility in the area to be equipped with medical material, medicines and vaccines and be adequately staffed.

Pre-employment and regular medical examinations will be carried out on all mine employees. As a minimum, the baseline medical examination would include the following: -

- A short medical history of the employee and his family history;
- Full occupational history of the employee;
- Signature of the employee to state that the above information is accurate and correct;
- Examination of:-
    - Weight;
    - Height;
    - Blood pressure;
    - Pulse;
    - Urine test;
    - Eye Test (Snellen Chart);

- Chest X-ray (large 35 cm x 43 cm) indicating date and name of employee on X-ray plate;
- Audiometry test - physical and visual inspection of both ears;
- Lung function; and
- Cardio-respiratory examination (general physical examination).

This examination will be performed at a government bureau in Kitwe.

African Inkalamo Mining Company Limited will provide well-equipped sanitary facilities for its employees. Workers will be encouraged to wash or shower frequently, particularly those employees exposed to dust, chemicals or pathogens.

Workers in areas of high temperature and/or humidity will be allowed to take frequent breaks away from these areas.

African Inkalamo Mining Company Limited will strive to reduce the risk of malaria by spraying offices and workshops as well as surrounding communities and providing insecticide treated nets.

Employees will also be informed and counselled with regard to HIV/AIDS to reduce the further spread of the disease.

The Medical Officer (MO) will keep a record of employee medical examinations, specific surveillance records and medical history.

8.6.6 Employee Safety - General

The general safety of employees while at work will be the responsibility of African Inkalamo Mining Company Limited, except in cases where the employee was acting in a negligent and dangerous manner.

Conveyors and similar machinery will be provided with emergency stop buttons to prevent accidents. Guards will be fitted to all drive belts, pulley, gears and other moving parts to protect workers. Raised platforms, walkways, gantries,

scaffolds, stairways and ramps will be equipped with handrails and non-slip surfaces. All electrical equipment will be grounded, well insulated and conform to applicable codes. Plant site piping will be colour coded for acid, water, compressed air, process solution etc.

Mine employees will be provided with appropriate personal protective equipment as demanded by their activities, e.g.; hard hats, safety boots, overalls, ear and eye protection, dust masks and gloves as appropriate.

The Mining Explosives Regulations governing the safe storage, handling and transport of explosives to, in and around the mine will be strictly enforced. Only qualified and certified personnel will be allowed to carry out blasting operations.

Hazard signs will be erected or posted around the plant and mine site to warn employees and contractors of potential dangers.

Contact telephone numbers of persons and services to be notified in the event of an emergency will be posted on all notice boards.

8.6.7 Employee Training

Employees will receive specific training from accident prevention and safety officers concerning the hazards precautions and procedures for the safe storage, handling, transport and use of potentially harmful materials that are relevant to each employee's job task and work area. Training on offer will include key information from the Material Safety Data Sheets (MSDSs) for potentially harmful material and substances. Employees will also receive training regarding safety, health and environmental matters including accident prevention, safe lifting practices, correct use of MSDSs, safe chemical handling practices, and proper control and maintenance of equipment and facilities. This will aid in the prevention of accidents or chemical spills.

Training will also be given on emergency response systems and procedures including the location and proper use of emergency equipment, use of personal protective equipment, procedures for raising the alarm and notifying emergency

response teams, and the proper response actions for each foreseeable emergency situation. Daily safety and environment briefings including inspections of personal protective equipment will be conducted by relevant supervisors or shift controllers.

A safety and environmental induction will be carried out for new employees and for any person arriving on site after a break exceeding two weeks or any contractor commencing work on site. The safety induction will cover; the use of personal protective devices, dangerous areas, appropriate conduct, emergency response procedures and waste management. The induction will be compulsory for all persons entering the site to do work.

8.6.8 Emergency Fire and Rescue Services

The African Inkalamo Mining Company Mine Project is relatively remote from urban centres equipped with a firefighting service, the nearest being Isoka (approximately 50km by road). As such the mine will be unable to call on municipal fire services in the event of a fire or other emergency. African Inkalamo Mining Company mine will therefore be equipped with its own fire tender (water cart equipped with pump and water canon). A volunteer mine rescue team will be established to assist in firefighting and emergency rescue services. This team will be provided with specialist training.

8.6.9 Health and Safety Records

In addition to the medical records kept by the Medical Officer, the Project Manager through appointed Environmental Officer will maintain records of all significant environmental matters, including but not limited to accidents, monitoring data, occupational illnesses, spills, fires and other emergencies. This data will be used to evaluate and improve the efficiency and effectiveness of the environmental health and safety programmes.

Health and safety statistics will be reported on at African Inkalamo Mining Company Limited Management Meetings and included in annual mine environmental reports.

8.6.10 Emergency Measures

African Inkalamo Mining Company Limited will develop an emergency management plan which will outline emergency measures to be undertaken in the event of a major loss incident such as (but not limited to); open pit wall failure, fire, or tailings dam failure.

The Emergency Action Plan (EAP) will detail: -

- Immediate actions to be undertaken;
- Evacuation and/or containment measures; and
- Contact details for persons responsible for implementing emergency measures.

The emergency measures will be communicated to all relevant employees and the EAP will be posted at strategic working areas such as change houses and safety briefing rooms.

8.7 Social Management Plan

African Inkalamo Mining Company Limited's Socio-economic and Culture plan has been detailed below. The main objectives of the plan are: -

- To preferentially maximise the use of local and provincial employment opportunities, wherever possible and economically feasible;

- To encourage the economic expansion and diversification in African Inkalamo Mining Company through the provision of aid to third parties and to encourage diversification away from the mining sector;

- To implement the corporate Occupational Health and Safety Policy and strive to ensure that all African Inkalamo Mining Company Limited employees are aware of the policy and their role within this policy;

- To ensure that the any relocation of people is carried out to World Bank Standards and that the relocated population are satisfied with the process; and

- To explain African Inkalamo Mining Company Limited's environmental policies to the local population through public consultation and feedback throughout the project.

The African Inkalamo Mining Company Mine Project is projected to operate for 25 years and will employ approximately 400 employees during construction and 150 employees during operation. The implementation of social policies that provide financial aid to the local population will occur when the mine is fully operational and a profit is being generated. The socio-economic and cultural objectives are described in detail below.

8.7.1 Maximising Local Economic and Employment Opportunities

African Inkalamo Mining Company Limited will maximise local employment during the mining project by implementing a strategic program that will focus on the employment of people from the mine area and nearby villages, and will only look further afield in Zambia due to the lack of mining skills in the local area. The company is an 'equal opportunity' employer and the best applicant for the position will be employed. The local population will be given priority with regard to employment, dependent on experience and qualifications.

African Inkalamo Mining Company Limited will develop an engagement strategy for contractors such that local contractors are employed where practicable in preference to foreign contractors, dependant on their ability to carry out the necessary work. This will improve the competency and capacity of local contractors to carry out large scale operations.

African Inkalamo Mining Company Limited will develop safety standards and guidelines to which employees and contractors are expected to adhere. The OHS Plan will incorporate an HIV/AIDS awareness campaign.

African Inkalamo Mining Company Limited will develop a retrenchment campaign for its employees and counselling will be provided for those employees experiencing a retrenchment. This will aim to promote sustainable livelihoods and promote employee mental and physical health during retrenchment.

8.7.2 Local and Regional Economic Growth

African Inkalamo Mining Company Limited will implement a local procurement strategy that will support local business development where cost effective and practicable. The distribution of information through the African Inkalamo Mining Company Limited information office on African Inkalamo Mining Company site will provide details for carrying out business with the company for supplies and contracts. This will provide opportunities for employment and business entrepreneurship within the area.

African Inkalamo Mining Company Limited will require the provision of a consistent electricity supply in order to carry out operations and it is planned for either the mine to connect to the national grid, though initially it is planned to use a diesel generator. This may encourage the electricity supplier to extend their supply power lines to the rest of the community.

8.7.3 Social Policy

African Inkalamo Mining Company Limited will implement its Social policy (under development) with all employees and contractors. The responsibility for the success of this policy is with all mine employees and contractors and implementation of this policy will be monitored by the senior management at regular intervals.

8.7.4 Land Use and Settlement

African Inkalamo Mining Company Limited will apply for the delineation of the mine site as an excluded zone and, for safety reasons, will fence off the mine boundaries to prevent inadvertent access to the site. African Inkalamo Mining Company Limited will liaise with the local population and form pathways around the exclusion zone for their access. African Inkalamo Mining Company Limited will monitor the fence line to ensure no unauthorised access takes place. This is mainly a requirement for the health and safety of the local population since there

will be numerous safety hazards, such as open pits and mine machinery, which could seriously injure any unauthorised person.

The settlement of the local population in the exclusion zone will be prohibited for safety reasons and access will be denied to persons entering the mine for reasons other than business or as a mine employee. This will be communicated to the local population through public consultation and signs will be posted along the fence in Lambya and English.

African Inkalamo Mining Company Limited will engage with the local communities to encourage the protection and planting of trees under a natural resources management scheme. This will involve the prevention and discouragement of further unnecessary deforestation in accordance with African Inkalamo Mining Company Limited's Corporate Environmental Policy.

African Inkalamo Mining Company Limited will ensure that all mine hazards, such as the waste rock dump, open pits, Workshop etc., are clearly signposted onsite, even within the restricted zone for the safety of mine personnel and visitors to site. African Inkalamo Mining Company Limited will raise awareness amongst the local population about the dangers of mining activities through public consultation.

African Inkalamo Mining Company Limited will inform its employees and the public about the dangers of mine water streams (effluent, process water etc.). Signs in local languages will give details of the hazards and health issues related to water streams on site and locate areas where potential drowning may occur. The aim is to prevent the use of mine water by the public and mine employees.

8.7.5 Health Plan

African Inkalamo Mining Company Limited will provide basic medical supplies to the health Centre at Lualuzi in order to use this clinic for the basic health provisions for mine employees.

African Inkalamo Mining Company Limited will provide basic healthcare and sanitation for its employees. The mine will assist the health centre. Change house facilities will be provided onsite to ensure all employees are able to change into work clothes at the commencement of their shift and to be able to clean-up and change into non-work clothes after shifts.

The implementation of an HIV/AIDS program to reduce and prevent the spread of AIDS will be carried out onsite. Malaria rollback programs will be implemented and African Inkalamo Mining Company Limited will spray the mine site and surrounding communities.

9.0 ENVIRONMENTAL MONITORING PLAN

African Inkalamo Mining Company Limited will put in place and implement an Environmental Monitoring Plan in fulfilment of the requirements of the Zambian environmental and mining legislation and as part of implementing good environmental practices. This monitoring exercise will cover the following aspects:

- Surface water
- Groundwater
- Air emissions
- Noise pollution
- Erosion
- Habitat management

The SHE department of the African Inkalamo Mining Company Limited will implement the environmental monitoring plan which is outlined below.

9.1 Surface Water Monitoring

Surface Water/Effluent Discharge Monitoring Sites

African Inkalamo Mining Company Limited will monitor the quality of surface water and effluent streams at a number of locations across the mine site. Sampling will be conducted according to internationally accepted standards. The location of the monitoring sites is described in Table 9.1.

Table 9.1: Description of African Inkalamo Mining Company LimitedSurface Water and Effluent Monitoring Sites

Monitoring Site	Location of Monitoring Sites
SW1	Along Panga River just before the Project area
SW 2	Along Panga River, just north of the Camp site
SW 3	Down stream of Panga River

African Inkalamo Mining Company Limited will review the location and appropriateness of the surface water and effluent monitoring sites after 6 months of mining operations, and make any necessary changes.

Monitoring Frequency and Analytical Parameters

Surface water sampling and monitoring at SW1, SW3, SW4 and SW8 will start one month before the commencement of project site clearance/construction work to monitor the impact on the local watercourses. Sampling at the XX remaining monitoring sites will begin one month before the commissioning of the process plant. The proposed monitoring frequency and sample analyses at each site, is given in Table 9.2.

Table 9.2: Water & Effluent Monitoring Sites - Sampling Frequency & Analytical Parameters

Monitoring Site	Water Type	Sampling Frequency	Analytical Parameters
SW 1	Surface Water	Monthly	pH, EC, TSS, TDS, SO_4, Al, Cu, Co, Fe, Pb & Na.
		Quarterly	As, Ca, Cr, Hg, Mg, Mn, Mo, Ni, Pb, Se & Zn
SW 2	Mine Effluent	Monthly	pH, EC, TSS, TDS, Cu, Co & organics
		Quarterly	As, Cr, Fe, Hg, Mn, Ni, Pb & Se
SW 3	Surface Water	Monthly	pH, EC, TSS, TDS, SO_4, Al, Cu, Co, Fe, Pb & Na.
		Quarterly	Al, As, Cr, Hg, Mg, Mn, Ni, Pb, Se & Zn
		Quarterly	As, Ca, Cr, Hg, Mg, Mn, Na, Ni & Zn

NB. TDS = Total Dissolved Solids, TSS = Total Suspended Solids, EC = Electrical Conductivity

Full suite analyses will be conducted quarterly on water / effluent samples collected at monitoring sites SW1, SW2, SW3.

Analytical Laboratory & Quality Assurance / Quality Control Analyses

The mine analytical laboratory will be equipped to analyse for the parameters specified above. Surface water QA/QC analysis will consist of 10% duplicate sample analyses as well as the analysis of reference and spiked samples. In addition 5% of the samples will be sent to an independent accredited laboratory for further QA/QC analysis.

Compliance with Statutory Limits and Other Relevant Standards

The Zambian Statutory Limits for effluent discharged to surface waters (key parameters) are summarised in Table 9.3. Where the World Bank guideline for discharge to surface waters is lower than the Zambian statutory limit the World Bank guideline is shown in brackets. For these parameters African Inkalamo

Mining Company Limited is committed to complying with the World Bank guideline.

Table 9.3: Zambian Statutory Limits & Relevant WB Guidelines/ USEPA Limits

Parameter	Statutory Limit / Proposed Standard	Parameter	Statutory Limit / Proposed Standard
PH	6.0 - 9.0	**Lead - Pb**	0.5 (0.1)
EC	4,300	**Chromium - Cr**	0.1
TSS	100 (50)	**Mercury - Hg**	0.002
TDS	3,000	**Arsenic - As**	0.05
Magnesium - Mg	500	**Antimony - Sb**	0.5
Chloride - Cl	800	**Selenium - Se**	0.02
Sulphate - SO_4	1,500	**Boron - B**	0.5
Nitrates - NO_3-N	50	**Fluoride - F**	2.0
Ammonium - NH_3-N	10	**Molybdenum - M**	5.0
Iron - Fe	2.0	**Silver - Ag**	0.1
Copper - Cu	1.5 (0.5)	**Barium - Ba**	0.5
Zinc - Zn	10 (2.0)	**Thallium - Tl**	0.5
Nickel - Ni	0.5	**Vanadium - V**	1.0
Cobalt - Co	1.0	**Tin - Sn**	2.0
Aluminium - Al	2.5	**Uranium - U**	4.0
Manganese - Mn	1.0	**Radium 226 - Ra**	1.11
Cadmium - Cd	0.5 (0.1)		

NB. All values are in mg/l except Ph and EC $\mu S/cm$

African Inkalamo Mining Company Limited will submit a monitoring report to the Mines Safety Department (MSD) and Zambia Environmental Management Agency (ZEMA) for its Licensed Effluent Discharge monitoring sites every 6 months from the start of licensed activities in accordance with the Water Pollution Control Regulations, 1993.

Field Water Quality Measurement

Field measurements of pH and electrical conductivity (EC) will be conducted concurrently with water sampling for comparison with laboratory results. Field water temperature measurements will also be taken.

Flow Rate Measurement

Settled runoff from the walls of overburden dump pumped into the local Stream via monitoring site SW2 and open pit drainage water pumped into settling pond will be measured using flow meters or estimated from pump speeds.

An appropriate method will be used to measure seepage (if any) issuing from the toe of TSF west wall (wall facing the watercourse). Seepage flow is expected to be low due to low permeability of the TSF dam wall.

Flow rate measurement will be conducted concurrently with water/effluent sampling. Flow rate data will be used to calculate stream loadings (metals and suspended solids) and update the site water model and plant water balance.

9.2 Groundwater Monitoring

Groundwater Monitoring Boreholes

Groundwater contamination is most likely to occur as a result of infiltration/seepage of process spills and leaks from the process plant into sub soils and seepage through the base of the tailings storage facility.

In order to monitor groundwater quality in the vicinity of the plant area, African Inkalamo Mining Company Limited will install groundwater monitoring boreholes near the process plant, TSF, workshops and open pits. The monitoring wells will be equipped with standpipe piezometers. Groundwater samples will be collected monthly, commencing one month before process plant commissioning. Water levels in the boreholes will also be monitored monthly.

Analytical Parameters

The groundwater parameters to be analysed for are pH, EC, TDS, TSS, SO_4, Fe, Cu, Co, Mn and As.

Analytical Laboratory & Quality Assurance / Quality Control Analysis

The mine analytical laboratory will be equipped to analyse for all of the parameters specified above. Groundwater QA/QC analysis will consist of 10% duplicate sample analyses as well as the analysis of reference and spiked samples. In addition, 5% of the samples will be sent to an independent accredited laboratory for further QA/QC analysis.

Compliance with Statutory Limits

There are currently no Zambian Statutory Limits regulating the quality of groundwater. However, the environmental regulations do require African

Inkalamo Mining Company Limited to notify the Mines Safety Department (MSD) and Zambia Environmental Management Agency (ZEMA) of any mine pollution. In this regard, African Inkalamo Mining Company Limited will use the baseline groundwater quality data as a benchmark against which the quality of groundwater in and around the mine will be assessed.

Groundwater quality data will be submitted to the ZEMA quarterly. African Inkalamo Mining Company Limited will notify the ZEMA immediately of any significant or sudden deterioration in groundwater quality.

Water Management Plan

No waste water treatment will be undertaken, unless final effluent monitoring evaluates a need to do so.

9.3 Air Monitoring

An air monitoring programme will be undertaken to prevent, mitigate or reduce impacts of air emissions to human health and the environment in compliance with the air quality standards. The programme will be developed with the following in mind:

- Regulatory standards
- Existing ambient air quality
- Source of emissions
- Wind speed and direction
- Location of sensitive receptors

Gas and dust monitoring will be conducted in January, April, July and October each year at the crushing plant, stockpiles, process plant, TSF and waste rock dump (inside the mine perimeter) and 1km north, south, east and west of the process plant (outside the mine perimeter). Monitoring will also be done at sensitive areas i.e. settlement areas near the project site (Lualuzi village). Recording of the test methods used, results of testwork and the corrective measures undertaken will be recorded in a register. The monitoring programme will be reviewed after 12 months. African Inkalamo Mining Company Limited expects to comply with all of the above air quality standards.

African Inkalamo Mining Company Limited does not expect to release any emissions requiring permits for release into the atmosphere. If the mining scope changes to include the smelter or any activities requiring release permit, then African Inkalamo Mining Company Limited will submit applications to the authorities for the relevant permits. They will also submit air quality reports as required by the Zambia Environmental Management Agency and report any abnormal emissions.

Regular visual assessment of dust emissions from the TSF and open pit blasting will be conducted to ensure that the anticipated negligible impact of dust from these areas is accurate.

Parameters to be Monitored

Three forms of emissions will be monitored – gaseous, dust particulate emissions and nuisance dust.

- Sulfur dioxide
- Oxides of nitrogen
- Particulate matter

Air Quality Standards

The standards in the *Air Pollution Control (Licensing and Emissions Standards)* will be used as yardstick of performance.

Table 9.4: Guideline Limits for Ambient air Pollutants

Parameter	Reference Time		Guideline Limit
1. Sulphur dioxide (SO_2)		10 minutes	500□g/m^3
		1 hour	350□g/m^3
2. Sulphur dioxide (SO_2) in combination with Total Suspended Particles (TSP)*[1)] and PM_{10}	SO_2	24 hour	125□g/m3
		6 months	50 □g/m^3
	TSP	24 hours	120 □g/m^3
		6 months	50 □g/m^3
	PM_{10}	24 hours	70□g/m^3
3. Respirable particulate	PM_{10}	24 hours	70□g/m^3
4. Oxides of nitrogen (NO_X) as nitrogen dioxide (NO_2)		1 hour	400 □g/m^3
		24 hours	150□g/m^3
5. Carbon monoxide (CO)		15 minutes	100 mg/m^3
		30 minutes	60 mg/m^3
		1 hour	30 mg/m^3

Parameter	Reference Time	Guideline Limit
	8 hours	10 mg/m^3
6. Ambient Lead (Pb)	3 months	1.5 µg/m^3
	12 months	1.0 µg/m^3
7. Dust fall	30 days	7.5 tonnes/km^2

9.4 Noise Monitoring

Continuous and permanent noise will be present in working areas of the process plant (grinding and crushing sections). In these areas workers will be instructed to wear ear protective equipment and will be allowed to take frequent breaks.

A monthly noise monitoring program will be initiated at strategic work areas (areas likely to exceed 82 dB) when plant operation begins. All areas that exceed or are within 10db of the limit will be designated as noisy areas. These areas will be sign posted and workers will only be allowed to work in them if they wear appropriate hearing protection.

Noise and vibrations will be high during blasting but sessions will be restricted to once a day and notices on boards at entrance gates to the mine site and specific areas will announce time and location of blasting every day. If possible, people living in areas with potential of flying rocks from blasting activities will be evacuated.

There will not be any residential dwellings or schools on the mine site. However, African Inkalamo Mining Company Limited will carry out a once off noise monitoring session at the different locations near residential areas, clinic and schools during blasting to quantify the amount of noise impacting at these locations.

9.5 Soil Monitoring

A soil monitoring exercise will be undertaken to assess the chemical, biological and physical properties of the soil around the site particularly after accidental spills or disasters. Based on the results, recommendations for mitigating impacts will be provided.

The samples collected will be assessed for various microbial development and chemical characteristics that will include pH and heavy metals.

The most likely sites for soil sampling will be the concentrate stockpile, slag and tailings storage facility and fuel storage areas.

10.0 POST CLOSURE MITIGATION AND REHABILITATION MEASURES

African Inkalamo Mining Company Limited will implement a mine site reclamation plan at closure. The plan will focus on the reclamation of the tailings storage facility (TSF), ROM Pad, ore stockpile areas, process plant and workshop. The main objectives of the plan will be to:-

- Promote alternative economic activities in the area that are sustainable in the future;

- Ensure the safety of surrounding communities through public consultation and the erection of warning signs.

- Return the land to conditions capable of supporting the former land use (woodland and agriculture), or where this is not practical, or feasible, an alternative sustainable land use; and

- Prevent potential significant adverse effects on adjacent water resources, being groundwater and surface water.

10.1 Mine Reclamation Plan

10.1.1 Open Pit

The African Inkalamo Mining Company Mine Project open pit will cover an area of 40,000 sq. m (approximately 4 hectares) and will have a maximum depth of 120 m at closure. Mine dewatering will stop and the pit will flood to a depth of approximately 10 to 15m below surface (pre-mining pit water level).
Whilst in the post closure phase, the open pit may have several potential uses, which will be dependent upon the many safety aspects associated with closed mine open pits, it is unlikely that they will be permitted due to the inherent danger associated with closed pits. The main likely outcome is that the water from the pit will be available for agricultural irrigation.

The final outcome for the use of the pit will be dependent upon a full risk analysis bearing in mind that whilst the final pit slopes may be designed for long-term stability there is no guarantee that failure in the future will not occur. There will be limited post-closure monitoring on the slope stabilities of the pit.

10.1.2 Waste Rock Dumps

The waste rock dumps will be profiled to provide safe stable slopes and will be re-habilitated with some topsoil replacement and re-vegetation.

10.1.3 ROM Pad, Ore Stockpiles, Process Plant and Workshops

All ore on the ROM Pad and transient ore stockpiles will be processed. The area will be re-profiled to establish the natural drainage pattern.

The following plant and equipment dismantling and disposal practices will be applied to the crusher plant, mill, process plant and workshops, provided there are no requirements for them from the local businesses, other mining companies, or government agencies:-

1. Removal of all brick buildings;
2. Breaking out and removal of all concrete foundations;
3. Removal of steel frames;
4. Demolish reinforced concrete structures and dispose of on site;
5. Remove HDPE liners and backfill all process ponds;
6. Remove electrical equipment, pumps, motors, and other fixed equipment;
7. Remove all fuel storage tanks;
8. Cut up and remove all steel tanks and vessels;
9. Remove all pipelines;

10. Dig up and remove all below ground electricity cables;

11. Remove conveyor belting;

12. Remove all mechanical equipment;

13. Materials handling areas will be cleared of all raw materials;

14. General site clean-up;

15. Site levelling and profiling to re-establish the natural drainage pattern across the site; and

16. Re-distribution of the stockpiled soils and re-vegetation of the site with indigenous grasses and trees.

Concrete foundations will be retained for use as foundations for future buildings if required.

Septic tanks will be emptied and the sludge will be treated to render it harmless and it may be used in the re-vegetation process.

Scrap metals and equipment will be sorted and sold. The company will remove, or otherwise dispose of, all equipment and materials that cannot be reused, recycled or sold, to an approved non-hazardous disposal site.

10.1.4 Tailings Storage Facility

At closure the upper surface will be re-profiled and re-vegetated. Stockpiled organic matter and soil from the initial site clearance will be spread over the storage facility in order to promote the growth of indigenous trees, shrubs and grasses transplanted from the mine nursery. Advice will be sought from a competent person regarding the species and diversity of vegetation to be established on the TSF. These trees will likely need to have high tolerance to dry and high sulphate conditions such as *Acacia polycantha, A. sieberana, Albizia adianthifolia, Peltophorum africanum,* and *Dichrostachys cinere*. The decant for the tailings dam will be sealed.

The TSF outer slope angles of approximately 18° will be resistant to erosion when re-vegetated. Slope run-off from the closed TSF is not expected to impact the nearby surface water.

Testwork carried out indicates that the tailings have a very low net acid producing potential and low sulphide content and as a result the tailings have been classified as low risk concerning ARD. The natural clay liner at the base of the TSF will prevent seepage from the TSF. No post closure impact on groundwater is expected.

A full review of the stability of the tailings dam and additional measures to be undertaken in order to safely close the tailings dam will be carried out by competent external person(s) and a detailed tailings closure plan will be developed by the company a year before operations are scheduled to cease.

10.1.5 Transport Infrastructure

Transport infrastructure such as site access roads, bridges and drainage channels will be removed, ripped and re-vegetated if the farmer or local community do not want them to be retained. This will be evaluated at the appropriate pre-closure time through the company's ongoing consultation program.

10.1.6 Settlement Pond and Mine Site Drainage Systems.

After cessation of mine operations, all settling pond silt will be tested for contamination. The results of this test work will indicate the measures needed to stabilise the silt to avoid additional contamination of the surface and groundwater. The settling ponds will be re-profiled with the addition of waste rock, previously stripped topsoil and organic matter and re-vegetated.

10.1.7 Re-vegetation

For the purposes of re-vegetation, stripped soil and organic material will be stockpiled for future use during site preparation. A nursery of young trees will be established on site within 3 years of operations for the concurrent and progressive re-vegetation of closed stable areas. The nursery will consist of species endemic to the local area and some colonizer species which are tolerant

to dry conditions likely to be experienced at the tailings dam. In general the stages of re-vegetation will be:-

- Development of the Nursery;
- Site stabilisation and profiling;
- Site contamination assessment in order to evaluate conditions needed for re-vegetation;
- Addition of stripped soil, fertiliser and organic material;
- Planting or transplanting of seedlings from the nursery (under the supervision of a competent forester);
- Post planting care (watering, and fertilising); and
- Final site inspection to clarify if the re-vegetation is successful.

The areas to be re-vegetated post closure include:-

i. Waste rock dump;
ii. Tailings dam;
iii. Ore stockpiles;
iv. Settlement ponds;
v. Drainage channels;
vi. Closed areas of the plant; and
vii. Roads, and areas underlying removed infrastructure.

The time table for successful re-vegetation of all relevant areas of the project area is 5 years post closure.

10.1.8 Contaminated Soil

A soil survey will be conducted at closure to identify any areas of inorganic and/or organic soil contamination. The soil survey will involve a programme of test pitting to a depth of 500mm, soil sampling and analysis. The number and location of test pits will be based on a site walkover/inspection at closure to identify potentially contaminated soils. A deeper soil inspection may be necessary at specific hotspots (pollution sources) depending on the findings of the near surface soil survey.

Inorganic soil contamination including rare earth element, nickel, cobalt and sulphate will be treated on-site using neutralisation methods to reduce the concentration of contaminants in the soil solution. This may be achieved by adding lime to stabilise the soil pH between 5.3 and 6.5, the application of organic matter (decaying vegetation) and/or incorporation of organic materials to the soil.

Localised soil contamination resulting from the accidental spill of diesel and oil will be treated by the removal of contaminated soil from affected areas to an appropriate disposal facility or to the bio-remediation site.

Soil contaminated with chemicals, reagents or oils will be removed to an approved hazardous waste disposal site.

The ROM pad, ore stockpiles and process plant site will be re-vegetated following the removal of any remaining ore, process plant dismantling, removal from site of all equipment and materials, treatment or removal of contaminated soil (if any) and re-profiling of the area to re-establish natural drainage patterns. A soil improvement program will be carried out using stockpiled organic matter and topsoil, prepared organic mulches and fertilizer. Indigenous plants, shrubs and trees will be transplanted from a nursery area.

The dismantling and removal from site of all buildings, sewage systems, workshops, fuel storage facilities, electrical and mechanical equipment and materials will be carried out, unless they can be put towards a sustainable use. The mine drainage sedimentation ponds will be cleaned (if necessary) and backfilled.

10.1.9 Public Safety

All hazardous areas will be sign posted and fenced off if necessary and the public informed of the associated dangers of inadvertent mine site access after closure through the company’s ongoing public consultation program.

11.0 POST CLOSURE MINE SITE INSPECTION, ENVIRONMENTAL MONITORING AND REPORTING

The Company will implement a programme of post closure environmental inspection and monitoring to assess the success of mine reclamation and verify that the various components of the closed mine are not adversely impacting adjacent watercourses and groundwater, and do not pose a potential health risk and/or danger to the public. An independent consultant will conduct the site inspection and environmental monitoring.

The Company proposes that post closure environmental inspection and monitoring be conducted bi-annually for the first 2 years to establish seasonal variations. Bi-annual site visits will be made in October (before the rains) and in April (at the end of the rains). Final inspection and monitoring will be conducted 5 years after mine closure. The findings of this inspection will determine whether or not any further post closure site inspection is necessary.

11.1 Post Closure Environmental Inspection

Post closure environmental inspections will focus on:-

- Pit wall instability;
- Erosion on the waste rock dump sidewalls and upper surfaces;
- Erosion at the TSF;
- Success of establishing an indigenous vegetation cover on the TSF, process plant site, ROM pad and ore stockpile areas;
- Any activity by the general public or persons unknown that may adversely affect the stability of disused mine structures, pose a danger to the community or possibly result in environmental degradation; and
- The condition of site access roads, bridges and culverts.

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

11.2 Post-closure Environmental Monitoring

Post-closure environmental monitoring will include the following tasks:-

- Surface water sampling across the mine site; and
- Groundwater sampling at the plant area, TSF and workshop.

Surface water samples will be collected at the following sites: -

1. Drainage from the former process plant area;
2. Drainage from the former ROM Pad;
3. The flooded Builders Mining Corporation Limited open-pits;
4. Drainage from the waste rock dump;
5. Drainage from the TSF;
6. Drainage from the workshop and former ore stockpile area; and
7. Panga Stream

The surface water samples will be submitted to an independent accredited laboratory and analysed for the key parameters pH, EC, TSS, TDS, SO_4, Cu and Co.

Groundwater samples will be collected from the 6 piezometer boreholes located at the disused TSF, former process plant and workshop. The groundwater samples will be submitted to an independent accredited laboratory and analysed for the key parameters pH, EC, TDS, SO_4, Cu and Co.

11.3 Post-closure Environmental Reporting

The consultant will produce an annual post-closure environmental monitoring report at the end of years 2 and 4 and a final post closure environmental report at the start of year 5. These post closure environmental reports will be submitted to the ZEMA and MSD and made available to all stakeholders. The reports will present the findings of the mine site inspections/walkovers and the results of the environmental monitoring programme. Where reclamation activities have not obtained the desired result, the consultant will make recommendations on what additional reclamation work is required to achieve full reclamation. Any areas of concern will be highlighted. The reports will include a post closure photographic record of mine reclamation.

No significant post closure environmental issues are anticipated. Environmental inspections and monitoring should cease in year 5, subject to approval from the ZEMA.

12.0 DECOMMISSIONING AND CLOSURE PLAN

A preliminary African Inkalamo Mining Company Limited Decommissioning and Closure Plan has been prepared together with an estimate of the costs of implementation. These costs will form the basis for the calculation of the financial guarantee.

Two years prior to closure, a detailed final closure plan will be submitted to the Ministry of Mines and Mineral Development in Lusaka.

The mine site will be progressively rehabilitated throughout the life of the mine as areas become available. A more detailed closure plan with costs will be produced during the detailed design and construction phase i.e. pre-production during 2024/25. This closure plan will be reviewed and updated every 6 months. The preliminary and final closure plans will satisfy the requirements of the Zambian Environmental Regulations and World Bank procedures and guidelines where appropriate.

The overall objectives of the mine Decommissioning and Closure plan are to:

- Protect future health and safety;
- Minimize or prevent environmental degradation, either physical or chemical;
- Return the land to the pre-mining land use (sustainable woodland) or an acceptable alternative; and
- Minimize any adverse socio-economic impacts.

These will be considered under the following site conditions; physical stability, chemical stability and land use.

12.1 Physical Stability

Mine structures that remain after closure e.g. tailings storage facility, waste rock dump and open pit should be physically stable such that they do not pose a hazard to public health and safety as a result of failure or gradual degradation.

These structures should not erode and/or release solids into the environment during storm events or due to the long-term effect of natural forces.

12.2 Chemical Stability

The infiltration or run-off from the mine site or waste storage facilities should not endanger public health and safety or result in the pollution of surface or groundwater, or non-compliance with Zambian statutory limits or World Bank guidelines concerning the quality of effluent discharged to the environment. All mine waste materials stored on site should be chemically stable.

12.3 Land Use

After closure, the mine site should be compatible with the surrounding land, to the extent that it is both practicable and economical to do so.

Open Pits

The open pit will be designed with stable final pit slopes. During the operating life of the mine, a perimeter bund wall will be constructed around the perimeter of the pit to prevent inadvertent access. At closure, all mining and dewatering equipment, and materials will be removed and the pit will be allowed to flood by natural groundwater inflows and precipitation. The access ramp to the pit will be blocked with waste rock to prevent access by motor vehicles. Pictorial signs in English and local languages will be erected along the pit perimeter bund to warn the public of the dangers of entering the pit.

At closure the mine infrastructure providing water supply to the community i.e. water reservoir, pumps, pipeline and water storage tank will be handed over to the local authorities. Post closure, the pit water is expected to be of good quality and suitable for water supply to community, irrigation, aquaculture or recreation.

Waste Rock Dump

The waste rock dump will be made in such a way that It will be of stable terrace construction to an overall slope angle of 35 degrees with 10m lifts, 5m wide berms and inter-berm slope angles of 42 degrees (i.e. angle of natural repose).

The results of geochemical characterization, mild leach testing and acid base accounting test work performed on mine waste indicates a low risk of acid rock drainage occurrence. The dump will be constructed to ensure that any potentially acid forming (PAF) waste is encapsulated within non-acid forming (NAF).

The dumps will be progressively re-vegetated over the life of mine using borrowed topsoil and indigenous grasses and trees. The upper surface of the dump will be re-vegetated at closure using agricultural methods i.e. discing, application of lime/fertilizer and planting of indigenous grasses and trees. If necessary, the dump will be irrigated during the dry season with water from the open pit.

Tailings Storage Facility

The current tailings storage facility will be rehabilitated to prevent erosion and contain tailings by constant wetting the surface and building a retaining wall on the west side of the dam respectively. The planned extension on the TSF will be constructed according to specifications provided by ZEMA waste management consultant or African Inkalamo Mining Company Limited independent consultants and be of stable design. At closure all decant structures will be sealed, and pipelines, equipment and materials will be removed. The supernatant pool will be allowed to evaporate. Future precipitation will collect in paddocks on the upper surface of the TSF and infiltrate the tailings and/or evaporate.

The results of geochemical characterization, mild leach testing and acid base accounting test work performed on samples of final concentrator tailings indicates the tailings to be non-acid forming (NAF).

The side walls of the TSF will be progressively rehabilitated over the life of mine in order to establish a sustainable indigenous vegetation cover and minimize erosion. The upper surface of the TSF will be re-vegetated at closure using agricultural methods i.e. discing, application of lime/fertilizer and planting of indigenous grasses and trees.

Plant Infrastructure and Buildings

At closure, the crusher and ore transfer section, mill and concentrator, associated steel and brick structures and foundations will be dismantled to 500 mm below ground level. Saleable items such as crushers, mills and flotation equipment etc will be sold at market values. Redundant equipment will be sold as scrap or otherwise disposed of in an approved manner.

Equipment such as mining fleet, other mobile plant, pumps, motors, valves pipes, transformers, electric cables, containers etc will be dismantled and/or removed to a secure storage area awaiting relocation to another mine site or sale to the local community, businesses and scrap metal dealers.

Certain of the mine buildings and plant structures (after removal of process plant and decontamination) could be adapted for sustainable use including small business enterprise, light industry and/or warehouse use. These buildings include offices, stores, workshops assay laboratory etc. The local community, businesses and government agencies will be consulted in this regard prior to closure. The Decommissioning and Closure Plan with Costs assumes that the whole mine site is dismantled and removed.

Potentially hazardous chemicals and substances onsite at closure will be sold, recycled or disposed of in an approved hazardous waste disposal site.

A soil contamination study will be conducted at closure. Contaminated soils will be rehabilitated on site or removed and disposed of off-site at an approved hazardous waste disposal site.
Finally, the plant site will be levelled and re-profiled with stockpiled soil.

13.0 ENVIRONMENTAL PROTECTION COSTS

The following costs have been estimated to implement the Decommissioning and Closure Plan discussed in Chapter 12. Two years prior to closure, a detailed and final cost analysis of protecting the environment will be submitted to the Zambia Environmental Management Agency and to the Mine Safety Department.

These estimated costs will form the basis for the calculation of the Environmental Protection Fund as provided for by Statutory Instrument No 102 of 1998 – Mines and Minerals Environmental Protection Fund Regulations.

13.1 Estimated Cost of Mine Site Reclamation Tasks

Open Pit Decommissioning and Closure Cost

Open pit decommissioning activities and costs are presented in Table 13.1. The total open pit decommissioning cost estimate is US$43,000.

Table 13.1: Open Pit Decommissioning Cost

Activity/Task	*Cost US$*
Removal of dewatering pumps	$7,000
Removal of dewatering pipeline	$5,000
Removal of electrical equipment and cables	$8,000
Removal of scrap materials	$5,000
Blocking of pit ramp to prevent unauthorised access	$1,000
Backfilling and profiling of sedimentation ponds	$14,000
Erection of danger signs around open pit	$3,000
Total	US$43,000

Process Plant, Workshop and Re-fuelling Station

The African Inkalamo Mining Company Limited process plant, workshop and re-fuelling station dismantling and disposal costs are summarised in Table 13.2 and estimated to be US$246,000. This figure does not take into account any revenue generated from the sale of scrap materials and equipment, which will offset decommissioning costs.

Table 13.2: Process Plant, Workshop and Re-fuelling Station Closure Costs

Item No.	Mine Component	Decommissioning Cost US$
1.	Ore crushing and transfer section	$32,000
2.	Mill	$28,000
3.	Flotation plant	$100,000
4.	Heavy equipment workshop	$20,000
5.	Mechanical and electrical workshops	$15,000
6.	Fuel storage area	$7,000
7.	Stores and offices	$14,000
8.	Other plant/infrastructure/cables/equipment	$30,000
Total		US$246.000

A soil contamination survey will be carried out after the process plant has been dismantled and disposed of. A sum of US$25,000 is included in the decommissioning and closure cost for the soil contamination study and removal or in-situ treatment of contaminated soils (if any).

The estimated unit rate for grading and re-profiling the plant site to re-establish natural drainage is US$5,000/ha. This cost is based on local earthworks rates of US$2.50/$m^3$ and an average re-profiling depth of 200mm. The estimated cost of process plant site grading and re-profiling is US$5,000/ha x 2.6 ha = US$13,000.

Tailings Disposal Facility

The main decommissioning activities and costs associated with the TSF are presented in Table 13.3. The total decommissioning cost estimate is US$81,920.

Table 13.3: TSF Decommissioning Cost

Activity/Task	*Cost US$*
Removal of tailings delivery pipelines	25,000
Removal of return water pipeline	20,000
Seal TSF decant towers and pipes	36,920
Total Cost	US$81,920

Mine Site Re-vegetation Cost

The estimated cost to re-vegetate the mine site based on local input prices and labour rates is US$450/ha for the tailings dam and US$233/ha for the plant site and dumps. The cost breakdown is given in Table 13.4.

Table 13.4: Mine Site Re-vegetation Costs per Hectare

Agricultural Activity	Tailings Storage Facility	Plant Site and Dumps
Discing	$15	$15
Spreading fertilizer	$6	$6
Spreading limestone	$13	$13
Limestone cost	$200	$66
Fertilizer cost	$166	$83
Plant native species	$50	$50
Total cost per hectare	US$450/ha	US$233/ha

The total mine site re-vegetation cost estimate is US$73610. Re-vegetation costs by mine component are summarised in Table 13.5.

Table 13.5: Mine Site Re-vegetation Costs

Mine Component	Area (ha)	Unit Rate (US$)	Re-vegetation Cost (US$)
Waste rock dump	42.3	233	9,856
ROM pad and ore stockpiles	6.26	233	1,459
Process plant site	140.0	233	32,620
Tailings storage facility TSF	66	450	29,675
Total Re-vegetation Cost			US$73,610

Mine site re-vegetation should be completed within 3 years post closure.

General Site Clean-up

A sum of US$20,000 has been included in the mine decommissioning and rehabilitation cost estimate for general site clean up.

Total Decommissioning and Closure Cost

The decommissioning and rehabilitation cost for the African Inkalamo Mining Company Limited mine site is estimated at US$502,530. A sum of US$100,500 (20% of decommissioning and closure cost) has been added for supervision of

decommissioning and closure activities by an external consultant. This brings the total cost to US$603,030 (Table 13.6).

Table 13.6: Total African Inkalamo Mining Company LimitedMine Site Decommissioning & Closure Cost

Item No.	Mine Component	Cost US$
1.	Open Pits	$43,000
2.	Process Plant, workshop and re-fuelling station	$246,000
3.	Soil Contamination Survey	$25,000
4.	Re-Profiling Plant Site	$13,000
5.	Tailings Storage Facility	$81,920
6.	Mine site Re-vegetation.	$73,610
7.	General site clean-up	$20,000
Sub Total		$502,530
20% external management of closure		$100,500
Total Decommissioning and Rehabilitation Cost		US$603,030

13.2 Post-closure Site Inspection and Environmental Monitoring Costs

The African Inkalamo Mining Company Limited Mine site post closure inspection and environmental monitoring cost is estimated to be US$36,980. The cost breakdown for these activities is given in Table 13.7.

Table 13.7: Post Closure Inspection and Environmental Monitoring Cost

Item No.	Post-closure Environmental Activity	Qty	Unit	Rate US$	Cost US$
1.	Site Inspections Mine site inspection to be carried out by independent consultant	12	days	$720	$8,640
	Consultant's accommodation and transport	12	days	$120	$1,440
Sub Total					$10,080

2.	Environmental Monitoring Technician to collect water samples Water sampling consumables Analysis of water samples Technician's transport and accommodation	 12 - 45 12	 days - -. days	 $350 $500 $120 $200	 $4,200 $500 $5,400 $2,400
Sub Total					$12,500
3.	Post-closure Environmental Reporting Preparation of 2 annual and final post closure environmental monitoring reports by independent consultant	20	days	$720	$14,400
Sub Total					$14,400
Total Post Closure Environmental Inspection and Monitoring Cost					US$36,980

African Inkalamo Mining Company Limited have allocated some US$1.5m for decommissioning and closure throughout the project. This will cover any cost increases and contingencies not yet identified.

13.3 Emergency Response Plan

The emergency response plan (ERP) is a supplement to the EMP and it seeks to address the adverse effects accruing from the project implementation requiring immediate attention. The plan is simply a summary of the approach and procedure to be taken in an event that the envisaged emergency incident occurs. It also specifies responsibility. This summary is presented in table 13.2 below.

Table 13.2: Emergency Response Plan

#	Anticipated Emergency	Source	Remedial Measures	Responsibility
1	Used oils and fuel spillages	Vehicles and fuel based machinery e.g. Drill Rig and Vehicles	In an event of accidental spills of oils or fuels, the area affected shall immediately be cleaned up.	Machine operators
			The incidence will then be reported to the site manager to assess the scale and level of clean up made. If determined inadequate by site manager, he/she will recommend to team members for further clean up and the incidence will be documented	Supervised by Site Manager
2	Animal-Human Conflict	The area is endowed with some wildlife which can be dangerous such as snakes and crocodiles	Team members shall be instructed on best practices when they encounter dangerous animals	All members of the team

3	Fire	Anthropogenic activities e.g. Smoking, Cooking	In an event that fire breaks out, fire extinguishers shall be kept in an open and easy to access area with use instructions clearly indicated. Members of the team shall be instructed on fire handling practices in this sensitive environment.	All members of the team
4	Occupational Health and Safety related emergencies	Operation of machinery and other equipments that has potential to cause injury to persons.	The fully stocked First Aid Kit will be kept in an easily accessed area and all team members will receive basic first aid training. In an event that the injury is assessed to require professional medical attention, an evacuation vehicle will be kept hand at all times throughout the prospection period.	All Team Members, Supervised by Site Manager

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