# ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) STUDY REPORT

## PROPOSED GOLD MINING AND LEACHING PLANT

**LOCATION**

Plot Nos. Nandi/Chemase/974 and Nandi/Legemet/224 in Chemase-Chemilil Ward, Kibisem Sub – Location, Chemase Location, Tinderet Sub-County, Nandi County

Latitude 0.03093500 S and Longitude 35.02344500 E

**Proponent:**

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**Prepared for submission to the National Environment Management Authority (NEMA) by:**

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**July 2021**

## CERTIFICATION

This is to certify that an Environmental and Social Impact Assessment (ESIA) Study Report has been carried out for the Proposed Gold Mining and Leaching Plant on Plot Nos. Nandi/Chemase/974 and Nandi/Legemet/224 in Chemase-Chemilil Ward, Kibisem Sub-Location, Chemase Location, Tinderet Sub-County, Nandi County. The study was carried out by NEMA registered EIA/EA experts in accordance with Environmental Management and Co-ordination Act (EMCA), 1999 (Amendment 2015) and the Environmental (Impact Assessment and Audit) Regulations, 2003 (Amendment 2019). The experts also compiled this report. We the undersigned hereby certify that the information and particulars given in this report are correct as at the time the assessment was conducted.

FOR THE CONSULTANTS, ENVERTEK AFRICA CONSULT LIMITED

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FOR THE PROPONENT; NANDI CHEMASE MINING COMPANY

Name: **Abraham Keitany**  _____
Signature Date

Position: _____

Mobile phone No(s): _____

# LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| % | Percentage |
| BQs | Bills of Quantities |
| Cap. | Refers to 'chapter' in the Laws of Kenya |
| CBO(s) | Community Based Organization(s) |
| CIP | Carbon in Pulp |
| CIL | Carbon in Leach |
| CO | Carbon-monoxide |
| $CO_2$ | Carbon-dioxide |
| Dba | Decibels (a unit of measuring sound) |
| EA | Environmental Audit |
| ESIA | Environmental and Social Impact Assessment |
| EMCA | Environmental Management and Coordination Act |
| EMP | Environmental Management and Monitoring Plan |
| ft | Foot/feet (a unit of measuring length) |
| GDA | Gold Dressing Agent |
| GOK | Government of Kenya |
| Ha | Hectares (a unit of measuring land area) |
| hr(s) | Hour(s) (A unit of measuring time) |
| KCB | Kenya Commercial Bank |
| KEBS | Kenya Bureau of Standard |
| KFS | Kenya Forest Service |
| Km | Kilometer(s) (a unit of measuring distance) |
| KShs. | Kenya shilling(s) (a unit of measuring currency in Kenya) |
| KWS | Kenya Wildlife Service |
| LVSWSB | Lake Victoria South Water Services Board |
| m | Metre(s) (a unit of measuring length) |
| $m^3$ | Cubic metre(s) (a unit of measuring volume) |
| mm | Millimeter(s) (a unit of measuring length) |
| NCLR | National Council for Law Reporting |
| NEMA | National Environment Management Authority |
| NMK | National Museums of Kenya |
| $^o$ | Degrees (A unit of measuring latitudes and longitudes) |
| $^oC$ | Degrees Celsius |
| OSHA | Occupational Health and Safety Act |
| P. O. | Post Office |
| PPE | Personal Protective Equipment |
| PVC | Polyvinyl chloride |
| Reg. No. | Registration number |
| spp | Species |
| TOR | Terms of Reference |
| WRA | Water Resources Authority |
| YIWP | Youth International Water Project |

## DEFINITIONS OF OPERATIONAL TERMS

**Authority:** Refers to NEMA established under section 7 of the Environmental Management and Co-ordination Act, 1999, (Amendment 2015).

**Decommissioning**: This is the permanent withdrawal from a site or close down of a facility for restoration.

**Developer/Proponent**: Means a person proposing or executing a project which is subjected to an ESIA or undertaking an activity specified in the second schedule of Environmental Management and Co-ordination Act, 1999, (Amendment 2015).

**EA:** The systematic, documented, periodic and objective evaluation of how well environmental organization, management and equipment are performing in conservation or preservation of the environment.

**ESIA:** A systematic evaluation of activities and processes of an upcoming project/facility to determine how far these activities and programs conform to the approved environmental management plan of that specific project and sound environmental management practices.

**EMP:** Means all details of project activities, impacts, mitigation measure, time, schedule, costs, impact or activities, including monitoring and environmental audit during implementation and decommissioning phase of a project.

**Environment:** Physical factors of surroundings of human beings including land, water, atmosphere, climate, sound, odour, taste, the biological factors of animals and plants and social factor of aesthetics, culture and includes both the natural and the built environment.

**Gangue:** The commercially worthless material that surrounds, or is closely mixed with a wanted mineral in an ore deposit

**Leaching:** Process of extracting gold from tailings through GDA process. The gold is extracted from slurry of crushed gold ore tailings, water, and Gold Dressing Agent.

**Mineral:** A naturally occurring inorganic solid with a crystalline structure and a definite range of chemical formula

**Mitigation:** Measures which include engineering works, technology improvement management ways and means of minimizing negative aspects, including socio-economic and cultural losses suffered by communities and individuals, whilst enhancing positive aspects of the project.

**Ore:** A concentration of minerals in a rock that is high enough to be economically extracted for use

**Overburden:** The waste rock or materials overlying an ore or mineral body that are displaced during mining without being processed

**Scoping:** Is the process of determining the content and extent of the matters which should be covered in the environmental information to be submitted to a competent authority for projects which are subject to ESIA.

**Screening:** It is a coarse analysis of the possible impacts of an action with a view to identifying those impacts which are worthy of detailed study for a project to be considered for an ESIA process or not.

**Slurry:** The thick pulp made from a solution of crushed tailings, and treated with GDA, mixed with caustic soda lime and hydrogen peroxide.

**Standards:** Means the limit of discharge or emission established under the Act or under Regulations.

**Tailings**: Remnant low grade ore left behind as waste after gold has been extracted from grade high ore.

# EXECUTIVE SUMMARY

This document is an Environmental and Social Impact Assessment (ESIA) Study Report for the Proposed Gold Mining and Leaching Plant on Plot Nos. Nandi/Chemase/974 and Nandi/Legemet/224 in Chemase-Chemilil Ward, Kibisem Sub – Location, Chemase Location, Tinderet Sub-County, Nandi County. This study report is prepared in accordance with Section 58 to Section 67 and Section 138 of the Environmental Management and Coordination Act (EMCA), 1999; Amendment 2015, (Cap. 387) that require all projects listed under the second schedule of the Act to undertake environmental assessments and submit it to NEMA for approval and licensing before commencement. The subsidiary legislation to the Act, the Environmental (Impact Assessment and Audit) Regulations, 2003, (Amendment 2019), provides the framework for carrying out EIAs and EAs in Kenya by NEMA licensed experts. Environmental and Social Impact Assessments (ESIAs) should be followed by Annual Environmental Audits (EAs) beginning 12 months from the date of commissioning of operations in order to determine the projects' compliance with regulations and set standards. The purpose of ESIA study is to identify potential positive and negative environmental impacts associated with the proposed projects and thus provide recommendations on how to take advantage of the positive impacts on one hand and how to mitigate the negative environmental impacts on the other. The proposed site is neighboured by homesteads, access roads and farms. The project proponent, consulted the National Environment Management Authority (NEMA) registered experts to conduct an Environmental Impact Assessment (EIA) study for the proposed projects and prepare an ESIA study report for submission to the Authority. The project intends to extract gold from unrefined tailings. The process involves using a series of tanks where crushed ores or flotation concentrate are dipped into GDA solution. The solution is chemically treated in open tanks under atmospheric pressure conditions to extract gold granules from the tailings. The ESIA study report team carried out the assessment using a combination of methods including ground survey and interviews with the neighbours, project management and other interested people and parties including the area residents. From the public consultation process it was evident that the project has sufficient public support. Existing literature on statutory and other requirements was also reviewed. During the assessment, various Acts and Regulations were reviewed to gather information which would help in preparing this project report. Alternatives to the proposed project, site and technologies were analyzed based on a cost and benefit criteria; environmental impacts, social acceptability, economics (including productivity of land-use) and included proposed development alternatives. Potential beneficial and adverse environmental and social impacts associated with the proposed project were identified and discussed. The main positive contribution of the proposed project is to extract gold from the tailings. Other benefits include: capital into the economy, revenue to the government, increased demand for raw materials, creation of employment opportunities, optimal use of land and development in the area. A summary of these potential impacts and a brief description of their mitigation measures has been provided (Table I). The project study report complies with the requirements of the Environmental Management and Co-ordination Act, (EMCA), 1999 (Amendment 2015) and takes into consideration the County Government of Nandi (CGN) by-laws and the applicable international standards. At the end of the report, there is an Environmental Management and Monitoring Plan (EMP) which ensures that environmental impacts are identified and mitigated during all phases of the project. The study report concludes that if all the suggested mitigation measures and the above recommendations are put in place and if the proposed EMP is followed, the proposed project will not adversely impact on the environment.

**Table I: Summary of potential negative environmental impacts**

| Potential adverse environmental impact | Proposed mitigation measures |
|---|---|
| Chemical contamination (Gold Dressing Agent) | • Handle the GDA solution carefully to prevent accidental spillage.<br>• The process should be restricted to specific places at the site and be avoided in residential areas. These sites should be at least 100 m from the nearest residential areas.<br>• Recycle water left after the process appropriately to prevent accumulation of contaminants in the environment.<br>• The developer must seek for appropriate licensing from appropriate authorities such as CGN, The Pharmacy and Poisons Board and the Department of Mining.<br>• Only qualified and recommended persons to handle the GDA solution |
| Air pollution (vapours, exhaust emissions and dust) | • Dispose appropriately the tailings and other wastes regularly to prevent them from accumulating at the site.<br>• Provide workers in areas concentrated with exhaust emissions, dust and fumes with nose masks covering the mouth and the nose; and goggles to protect the eyes.<br>• Run and service/maintain machinery and vehicles regularly according to the manufacturer's instructions in order to ensure efficiency in working.<br>• Use appropriate fuel that is free from adulteration.<br>• Sprinkle water on all dust-active areas to suppress dust and/or pave or apply non-toxic soil stabilizers on all unpaved access roads and parking areas.<br>• Sprinkle water to earthen and dusty ground before sweeping to prevent dust production.<br>• Supervise activities at the site especially burning and sweeping.<br>• Regularly check and clean or repair areas perceived to be sources of air pollution such as manholes.<br>• Advice workers to adhere to instruction for use of air polluting agents. For instance "DO NOT USE IN CONFINED PLACES", "DO NOT INHALE FUMES" etc.<br>• Advice workers and stall operators to ensure indoor ventilation by opening windows and using exhaust fans to allow good air circulation into and out of the stalls and offices.<br>• Where possible cover all trucks hauling loose material including the gold ore with tarpaulin and/or requiring these trucks to maintain at least two feet of freeboard. |
| Risk of release of associated gases | • Use lime to maintain the pH of the slurry at between 11 to 12 values<br>• Ensure that barren slurry from which gold has been extracted is certified as having less than 0.1% of chemical solution before its reused to make interlocking bricks |
| Noise and vibrations | • Posting notices at the sites to inform people of the activities, time and day.<br>• Planning the construction work to take place only during the day when the neighbours are also at work and maintaining reasonable working hours of not more than 8 hours within any 24-hours working duration so as to reduce the number of complaints concerning noise from the workers and neighbours. Workers will work in shifts.<br>• Providing ear protective devices to workers and visitors in noisy |

| Potential adverse environmental impact | Proposed mitigation measures |
|---|---|
| | environments to prevent high frequency noise emitted by the high frequency machines.<br>• Fitting crushing rooms with sound proof materials<br>• Employ modern machines that produce less noise or ones fitted with silencers |
| Storm water flow | • Design and construct curbs and channels to direct water to the lower areas.<br>• Design the storm drainage system in such a way that the storm does not mix with the waste water.<br>• Consult the neighbours and land owners on the lower side neighbourhood of the site to ensure that all storm drains leaving the site to the valley does not become a nuisance to them or interfere with activities therein those areas.<br>• Keep open all drainage lines and built no obstructions within them to prevent stagnation of water that could lead to development of breeding grounds for disease causing vectors such as mosquitoes, rats, cockroaches and lice and other vermin.<br>• Install gutters and tanks to harvest and store rain water from the buildings in order to reduce run-off.<br>• Plant papyrus reeds in the valley part of the site that receives run-off from the site in order to trap contaminants from the plant. |
| Solid wastes | • People in the area use the tailings for smearing and decorating houses since they have attractive colours. This is mostly done just before Christmas season.<br>• Tailings can be added in the farm especially where root crops are grown since they are believed to provide favourable conditions for fattening of the roots.<br>• Tailings can be used to make bricks.<br>• Provide bins for separate collection of wastes into appropriate sorts such as recyclable and non-recyclable for each room, each corridor and each common room. These bins should be labeled.<br>• Put in place an efficient, regular and appropriate waste collection and disposal scheme that will prevent the accumulation of wastes at collection areas.<br>• Where possible material considered as waste may be re-used or recycled or be given to who may consider them useful for others uses.<br>• Advice workers and business people to order materials according to needs to reduce waste.<br>• Maintain and repair equipment rather than replacing it to reduce waste. |
| Water usage | • Provide polite notices to conserve water at the site.<br>• Always recycle water used in the leaching tanks.<br>• Maximize on rain water harvesting for domestic purposes. |

| Potential adverse environmental impact | Proposed mitigation measures |
|---|---|
| Safety, health and hygiene | • Provide workers with appropriate PPE such as aprons, ear muffs, nose masks and gloves<br>• Train workers or self in emergency management<br>• Install and safeguard machinery, equipment, PPE, appliances and tools appropriately and carry out regular maintenance services in accordance with their manufacturer's safety data information<br>• Maintain First Aid Kits at the site in easily accessible areas<br>• Employ security personnel that will be at the facility for all hours of the day<br>• Install and use exhaust fans and lighting systems in areas natural ventilation and lighting are not enough<br>• Store and use all materials as outlined on their manufacturers' data safety labels<br>• Make distinctions in all stores in such a way that non-food or poisonous materials are not stored together or mixed with food<br>• Separate outdoor washrooms based on gender into ladies and gents and provide them with lockable doors |

# TABLE OF CONTENTS

**CERTIFICATION** ..... **ii**
**LIST OF ABBREVIATIONS AND ACRONYMS** ..... **iii**
**DEFINITIONS OF OPERATIONAL TERMS** ..... **iv**
**EXECUTIVE SUMMARY** ..... **v**
**TABLE OF CONTENTS** ..... **ix**
**LIST OF TABLES** ..... **xii**
**LIST OF PLATES** ..... **xii**
**1 INTRODUCTION** ..... **13**
1.1 Background to the proposed project ..... 13
1.2 Rationale for the EIA process ..... 13
1.2.1 Purpose of the EIA ..... 13
1.2.2 Objectives of the EIA ..... 14
1.2.3 Terms of Reference (TOR) and scope for the EIA ..... 14
1.2.4 Assessment methodology and limitations ..... 15
**2 BASELINE INFORMATION OF THE PROPOSED PROJECT AREA** ..... **16**
2.1 Introduction ..... 16
2.1 The physical environment ..... 20
2.1.1 Topography and altitude ..... 20
2.1.2 Drainage and hydrology ..... 20
2.1.3 Soils and geology ..... 20
2.1.4 Climate ..... 20
2.1.5 Air quality ..... 21
2.2 Socio-economic information ..... 21
2.2.1 Population ..... 21
2.2.2 Employment trends in the neighbourhood ..... 21
2.2.3 Land use patterns ..... 21
2.2.4 Physical and social infrastructure ..... 21
2.2.6 Business activities ..... 22
2.2.7 Agriculture ..... 22
2.3 Ecological environment ..... 22
**3 PROPOSED PROJECT DESCRIPTION** ..... **23**
3.1 Projects design and components ..... 23
3.1.1 Mining ..... 23
3.2 Material input in mining and processing gold ..... 23
3.2.1 Mining of the gold ore ..... 23
3.2.2 Crushing the mined ore ..... 23
3.2.3 Sieving of dirt and impurities ..... 23
3.2.4 Transporting ..... 24
3.2.5 Crushing ..... 24
3.2.6 Milling ..... 24
3.2.7 Gravity Circuit ..... 24
3.2.8 Thickening ..... 24
3.2.9 CIL/CIP-Carbon in Pulp Leaching ..... 24
3.2.10 Tailings ..... 25

3.2.11 Refining ..... 25
3.3 Description of the proposed project activities ..... 25
3.4 Facilities, utilities, amenities and services facilitating activities at the site ..... 26
3.5 Chemical Formula ..... 26
3.5.1 Gold Dressing Agent (GDA) ..... 26
3.5.2 The chemical reaction ..... 26
3.5.3 Mechanism of gold dissolving in alkaline thiourea ..... 27
3.5.4 Product Advantages ..... 27
3.5.5 Operating Instruction ..... 27
**4 RELEVANT LEGISLATIVE AND REGULATORY FRAMEWORK ..... 33**
4.1 Introduction ..... 33
4.2 National Policy Framework ..... 33
4.2.1 Sessional Paper No. 6 of 1999 on Environment and Development ..... 33
4.2.2 National Environmental Policy, 2012 ..... 33
4.3 Institutional and Administrative Framework for the Management of the Environment ..... 34
4.3.1 National Environmental Management Authority (NEMA) ..... 34
4.3.2 Environmental Liaison Units in Other Institutions with Environmental Management Mandates in Kenya ..... 34
4.4 Nandi County Development Plans and Laws ..... 34
4.4.1 Nandi County CIDP II (2018 – 2022) ..... 34
4.5 National Laws, Regulations, Codes and Policies with Environmental Relevance ..... 35
4.5.1 The Constitution of Kenya, 2010 ..... 35
4.5.2 Environmental Management and Coordination Act, 1999 (Cap. 387), amended 2015 ..... 35
4.5.3 Environmental Management and Coordination (Waste Management) Regulations, 2006 36
4.5.4 Environmental Management and Coordination (Noise and Excessive Vibration, and Pollution Control) Regulations, 2008 ..... 36
4.5.5 Mining Act, 2016 ..... 37
4.5.6 Work Injury Compensation Benefit Act (WIBA), 2007 ..... 38
4.5.7 Occupational Safety and Health Act (OSHA), 2007 ..... 38
4.5.8 Public Health Act, 1986 (Cap. 242) Revised 2012 ..... 38
4.5.9 County Governments Act, 2012 ..... 39
4.5.10 Mining Act 2016 No 12 of 2016 ..... 40
4.5.11 Financial Provisions under the Mining Act 2016 ..... 40
4.5.12 Restoration of Derelict Land after mining Under the Mining Act 2016 ..... 40
4.5.13 Physical and Land Use Planning Act, 2019 ..... 41
4.5.14 Traffic Act (Cap. 403) ..... 41
4.5.15 Penal Code (Cap. 63) ..... 41
4.6 International framework ..... 41
4.6.1 World Commission on Environment and Development (1987) ..... 41
4.6.2 IFC Performance Standards on Environmental and Social Sustainability, 2012 ..... 42
4.6.3 Rio Declaration on Environment and Development (1992) ..... 42
**5 ANALYSIS OF PROPOSED PROJECT ALTERNATIVES ..... 43**
5.1 Introduction ..... 43
5.2 Conclusion ..... 46
**6 POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES ..... 47**
6.1 Introduction ..... 47
6.2 Potential adverse impacts during the establishment phase ..... 47

6.2.1 Impacts on vegetation, water and soil....47
6.2.2 Extraction and/or usage of materials....48
6.2.3 Safety at the construction sites....48
6.3 Impacts cutting across phases....49
6.3.1 Air pollution from associated chemical reaction....49
6.3.2 Air pollution (vapours, exhaust emissions and dust)....49
6.3.3 Noise and vibrations....50
6.3.4 Storm water flow....51
6.3.5 Fire....51
6.3.6 Waste water and sanitary facilities....52
6.3.7 Solid wastes....52
6.3.8 Increased traffic flow....53
6.3.9 Water usage....54
6.3.10 Use of energy (electricity and fuel)....54
6.4 Impacts related to occupational and public health and safety....55
6.4.1 Assessment....55
6.4.2 Mitigation....55
6.5 The decommissioning plan....56
6.6 Potential positive impacts....57
**7 PUBLIC PARTICIPATION....58**
7.1 Introduction....58
7.2 Findings....58
**8 ENVIRONMENTAL MANAGEMENT AND MONITORING....60**
8.1 Environmental management....60
8.2 Environmental monitoring and audits and record keeping....60
**9 RECOMMENDATIONS AND CONCLUSION....67**
9.1 Recommendations....67
9.2 Conclusion....67
**REFERENCES....68**
**APPENDICES....69**

## LIST OF TABLES

Table I: Summary of potential negative environmental impacts ..... vi
Table 1.1: Summary of the proposed project ..... 13
Table 5.1: Proposed alternatives for the proposed project ..... 44
Table 8.1: Proposed EMP for the proposed project ..... 61
Table 8.2: Proposed EMP for the decommissioning phase ..... 65

## LIST OF PLATES

Plate 2.1: Fallow land and residential houses to the West of the proposed ..... 18
Plate 2.2: Access road to the proposed site ..... 18
Plate 2.3: Proposed mines in the background and an electricity step down transformer at the proposed site ..... 19
Plate 2.4: Access road and The Nandi Escarpment in the background ..... 19
Plate 7.1: Village elder addressing the community during public consultation forum ..... 59
Plate 7.2: Community members during the public consultation forum ..... 59

# 1 INTRODUCTION

## 1.1 Background to the proposed project

This document is an Environmental and Social Impact Assessment (ESIA) study report for the Proposed Gold Mining and Leaching Plant on Plot Nos. Nandi/Chemase/974 and Nandi/Legemet/224 in Chemase - Chemilil Ward, Kibisem Sub-Location, Chemase Location, Tinderet Sub-County, Nandi County. Below is a summary of the proposed project.

**Table 1.1: Summary of the proposed project**

| Item | Description |
|---|---|
| Project name | Proposed Gold Mining and Leaching Plant |
| Location | Plot Nos. Nandi/Chemase/974 and Nandi/Legemet/224 in Chemase-Chemilil Ward, Kibisem Sub-Location, Chemase Location, Tinderet Sub-County, Nandi County |
| Nature of development | Gold mining and leaching |
| Objective | To extract gold from tailings by use of leaching process |
| Proponent | Nandi Chemase Mining Company |
| License area | The area cover the 9 acres of land leased to the proponent |
| Land ownership | The land has been leased to Nandi Chemase Mining Company for 20 years by Mr. Cheseret Arap Korir |
| Land Size | 9 Acres |

## 1.2 Rationale for the ESIA Study process

### 1.2.1 Purpose of the ESIA Study Report

The proposed project is categorized as a High-Risk Project under the Legal Notice No. 31, Legislative Supplement No. 16 published in the Kenya Gazette Supplement No. 62 on 30th April, 2019 i.e. Amendment of the Second Schedule which lists the projects to undergo EIA [Section 58 (1) of EMCA, 1999 (Cap. 387) (Amendment 2015)]. The project can be described as Mining and other related activities including – precious metals; [Sub-section 3. (6) (a)] Furthermore, the proposed project's beneficial and adverse environmental impacts cannot be underestimated. The project requires an ESIA study report carried out for it before it is implemented subject to Section 58 of the Act and Part VI, Section 31 (3) (a) (i) and (ii), of its legislative supplement, the Environmental (Impact Assessment and Audit) Regulations, 2003 (Amendment 2019). These require all upcoming projects to have environmental assessments carried out for them before they are executed. The ESIA study provides baseline information upon which subsequent environmental assessments are based. It also addresses mitigation options for potential impacts. The main purpose of an ESIA study report is therefore to assist the Proponent, NEMA and all other stakeholders in understanding the potential environmental consequences of the proposed project and thus provide a basis for making informed decisions on the project.

The proposed project has close linkage to the current government development priorities, which includes Vision 2030, with Mining as the 7th pillar. The economic pillar of this development agenda aims at uplifting the status of community members. Mineral exploration and eventually mining activities can transform the economic welfare in the area. Manufacturing; and Affordable Healthcare are

covered. The proposed project has demonstrated alignment with environmental sound development global, national and county level strategic goals.

### 1.2.2 Objectives of the ESIA Study

The following are the main objectives:

a) To comply with EMCA, 1999 (Cap. 387), Amendment 2015;
b) To identify and assess the likely negative and positive environmental impacts that would arise with the implementation of the proposed project;
c) To identify and plan for measures for the mitigation of the identified impacts; and
d) To provide a basis for decision-making to reviewers, the Authority and all other stake-holders.

### 1.2.3 Terms of Reference (TOR) and scope for the ESIA Study Report

The assessment is expected to meet the objectives of ESIA Study in order to ensure sustainable development. Hence, TOR outlining the expectations of the ESIA Study were documented by the Proponent and the ESIA team in accordance with the requirements of the Environmental (Impact Assessment and Audit) Regulations, 2003, (Amendment 2019) in order to lay a basis for the assessment. The proponent and the ESIA team did the following in order to achieve the TOR for this assessment:

a) Generated environmental baseline conditions of the project area.
b) Described the proposed project by giving clear accounts of its location; design; construction and operational activities; material usage; products and by-products including wastes to be generated in all phases and the methods of their disposal; and likely environmental changes.
c) Obtained views and opinions of the interested and affected persons by undertaking public consultations by means of administration of questionnaires to neighbours, business operators and area residents in the vicinity of the proposed project. A public meeting (*baraza)* was held for the proposed project.
d) Reviewed legislation and regulations relevant to the proposed project and showed their relevance to the proposed project.
e) Described and analyzed alternatives to the proposed project in relation the project site, design, technologies, processes and the reasons for preferring the proposed alternative.
f) Established key areas of environmental, health and safety concerns focusing on both the positive and negative effects in relation to how they affect the biophysical, social, economic and cultural components of the environment.
g) Analyzed impacts and recommended mitigation and enhancement measures for the adverse and positive impacts respectively. The analysis of potential impacts related to the location; design; applicable technologies; and construction and operation activities of the proposed project.
h) Generated comprehensive environmental management and monitoring plans for the proposed project covering all its phases. The plans form a basis upon which all mitigation/enhancement measures will be carried out and specify the parties (organizations or individuals) responsible for the implementation of mitigation/enhancement measures and the schedule for their implementation and indicate the parameters to be monitored, frequency of monitoring, indicators of performance, parties responsible for monitoring and the associated costs.

i) Generated a comprehensive ESIA study report in accordance with the Environmental (Impact Assessment and Audit) Regulations, 2003 (Amendment 2019) and submitted the study report and necessary soft and hard copies to the Authority for further instructions and/or approval.

### 1.2.4 Assessment methodology and limitations

This assessment was carried out in November 2020 in accordance with the procedures and protocols in the Environmental (Impact Assessment and Audit) Regulations, 2003 (Amendment 2019). The assessment involved:

a) Extensive site tours to physically inspect and document existing facilities at the site and natural and socio-economic features of importance;
b) Environmental screening to determine the necessity and level of the ESIA study process;
c) Interviews with the interested and affected persons including the project management team and neighbouring residents and business operators among other groups in the neighbourhood regarding the proposed project; and
d) Desktop studies for documentary review on the nature of the activities of the proposed project, proposed project related documents, plans, designs, policy and legislative frameworks as well as the environmental setting of the area amongst other things.

The main limitation to the assessment is that some of the information was compiled based on responses of the owner and the stakeholders involved. There are difficulties in verification of some of this kind of information. The consultant has evaluated information obtained within the limits of the established scope of work.

# 2 BASELINE INFORMATION OF THE PROPOSED PROJECT AREA

## 2.1 Introduction

In this chapter, emphasis is placed on describing proposed project area and its neighbourhood in terms of resources, vegetation, land-use patterns, socio-economic activities, population, topography, climate and geology among others so as to provide information from which the potential impacts of the proposed project can be predicted. The proposed site is found in Chemasse - Chemilil Ward, Kibisem Sub-Location, Chemasse Location in Tinderet Sub-County, Nandi County. Gold mining in Western Kenya dates back to 1892 when deposits of the precious metal were discovered at Lolgorian, along the Nyanza-Rift Valley border. Kibigori mines at the foot of the Nandi Hills were in operation in 1950s. Gold deposits exists within Chemase in Tinderet Sub-county. As more gold deposits were discovered in the region, foreign companies such as Karebe Gold Mining Company has been undertaking mining operations since 2008 and are believed to have minted billions of shillings from the mines, though their lease period has expired. For a long time since the exit of these companies, the quest for gold has been in the hands of area residents and other artisanal and small-scale miners who practice it on small-scale. However, their quest is hindered by many challenges including:

a) Limited access to the deposits;
b) Legal set-ups;
c) Inadequate financial and technical requirements; and
d) Exploitation by middlemen.

In addition, miners exploit the marginal deposits in harsh and dangerous conditions. Needless to say, child labour is involved as most of them are trying to escape poverty and unemployment which are serious problems in the area. Though there are relatively higher returns for the gold miners, the processes of mining and purification result into considerable impacts on the environment and the health of the miners as poisonous elements such mercury and cyanide are sometimes used.

At the time of the assessment, the construction and operations of the proposed project had not started. It is important to note that the gold mine is a few meters away from where the tailings are and will be transported by conveyor belt. Structures at the site will include; leaching tanks, a laboratory, a raw water reserve tank, a barren tank and a solution tank decker, a stone crusher, buildings to offer spaces for offices and workers residents. Details of the project is provided on the attached approved plans.

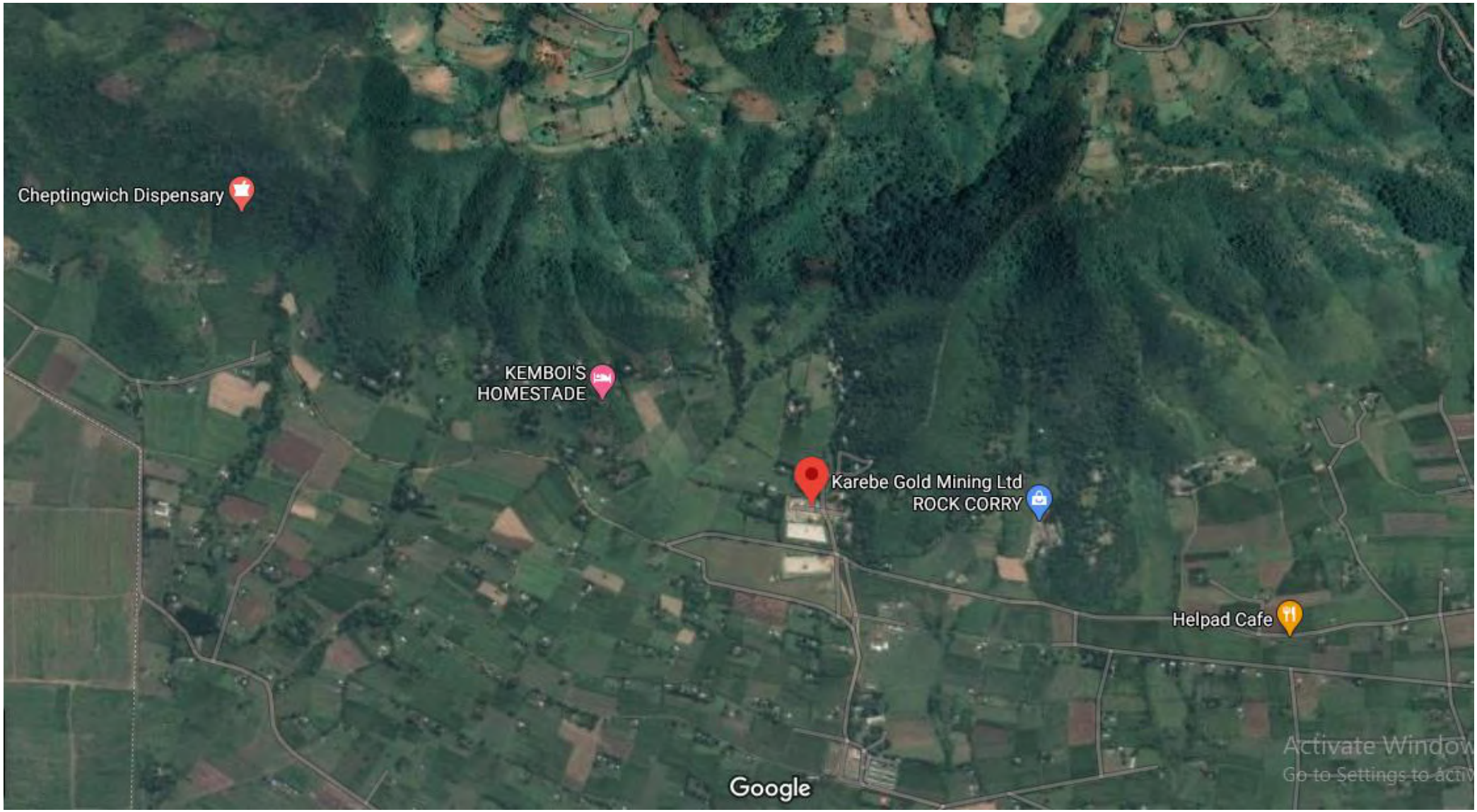



**Figure 2.1: The location of the proposed project site**

Source: Google (2020)

**Plate 2.1: Fallow land and residential houses to the West of the proposed site**

**Plate 2.2: Access road to the proposed site**

**Plate 2.3: Proposed mines in the background and an electricity step down transformer at the proposed site**

**Plate 2.4: Access road and The Nandi Escarpment in the background**

The immediate neighbourhood of the proposed site consists of The Nandi Hills, The Nandi Escarpment, homesteads, fallow lands and undeveloped pieces of land. Other things in the outer neighbourhood within the site's vicinity include an access road farms under food crops.

## 2.1 The physical environment

### 2.1.1 Topography and altitude

Nandi County is divided into five distinct physiographic features: the Rolling Hills to the West: the Kapsabet Plateau (part of the Uasin Gishu Plateau); the Weeded Highlands and the Foothills of Tinderet Volcanic Mass in the Southeast; the Kingwal Swamp in the Baraton – Chepterit area and the dissected Nyando Escarpment at the southern border. The county lies at an altitude ranging between 1300 M and 2,500 M above sea level. The county borders Kakamega County to the Northwest, Uasin Gishu County to the North and East, Kericho County to the Southeast, Kisumu County to the Southwest and Vihiga County to the West. The county occupies an area of 2,884 $Km^2$ with maximum distance of 90 Km from North to South and 75 Km from east to west. The county has six constituencies: Tindiret, Aldai, Nandi Hills, Chesumei, Emgwen and Mosop.

### 2.1.2 Drainage and hydrology

The county has seven major rivers, namely Anapingetuny, Kapchorua, Kimondi, Yala, Mokong, Kabutie and Clare. All these rivers originate from the county except Rivers Anapingetuny and Kimondi. There are also other permanent streams spread all over the county, but with concentration in central and southern divisions of Aldai, Tinderet, Nandi Hills, Kilibwoni, Kaptumo and Kapsabet. These rivers have enough water for livestock and human and industrial activities in the county. The proposed road crosses River Mokong. The water colour in streams and rivers varies from dark brown during the rainy seasons and during the day to colourless during the night. The brown colour is due to contamination by siltation during the rainy season and human activities during the day.

### 2.1.3 Soils and geology

Generally Nandi County is endowed with good soils suitable for cultivation of diverse crops. Seven major soil types can be identified. Soils found on the mountains and major scarps have developed from basement system, especially granite. They are shallow and excessively drained and range from red friable clay loams to sandy clay loams. In some areas, they appear as rock outcrops. These soils are found in Songhor in Tindiret, the Nyando Escarpment and Lelmokwo in Chesumei.

### 2.1.4 Climate

The county experiences a cool and moderately wet climate. Below is a description of the climate of the county.

#### 2.1.4.1 Rainfall

It receives an average rainfall of between 1,200 mm and 2,000 mm per annum. The long rains start in early March and continue up to the end of June, while the short rains usually fall from mid-September to the end of November. A dry spell is normally experienced between December and March but there is no single month in which the district records nil rainfall.

#### 2.1.4.2 Temperatures

Temperatures range from 14 $^0$C to 32 $^0$C depending on the month of the year. The mean maximum varies from 22 $^o$C in July/August to 27 $^o$C - 28 $^o$C in March. Diurnal temperature variations are minimal.

#### 2.1.4.3 Smog and cloud formation

Smog is common during the rainy season. This is mostly associated with the development of towering cumulus and cumulonimbus clouds.

#### 2.1.4.4 Wind patterns

A significant feature of the climate is the frequency with which the wind comes from the Northeast and to a somewhat lesser degree from the Southeast. These are the Northeast and Southeast Monsoons respectively which blow very steadily but without high intensity. Both wind run and mean wind speed are at a maximum in December. Winds also remain high during January, February and March which coincides with the period of higher potential evaporation.

### 2.1.5 Air quality

Generally, gaseous emissions are below the visible limits except that total suspended particulates (TSP) are high in the air. This is attributed to use of automobiles such as vehicles and generators and burning activities taking place in farms, hotels and in homes.

## 2.2 Socio-economic information

### 2.2.1 Population

The county's population was about 996,677 people with a density of 261 people per $Km^2$ (Census 2019) with an annual growth of 3.7 %. Tinderet Sub-county where the proposed project is has a population of 134,805 with a density of 244 people per $Km^2$. The human concentration is high in Kapsabet, Aldai and Nandi Hills. The current population expected to be over 760,000 people.

### 2.2.2 Employment trends in the neighbourhood

There are a number of business activities, tea factories and learning institutions. These provide major sources of employment to most people in the county and its neighbourhood.

### 2.2.3 Land use patterns

There is a variety of land use patterns within the county. Apart from residential settlements there are farm lands with different agricultural crops, including food crops such as maize and cash crops like: tea, sunflower, sugarcane and coffee among others. Livestock keeping is also done immensely within the area. The road network is uniformly distributed throughout the county, except in the hilly areas of Tinderet Division to the South and the forest areas to the west and north-western parts of the county, which are not well linked to the rest of the county. Other rural access roads serve as an important link ways but become impassable when it rains heavily

### 2.2.4 Physical and social infrastructure

Electricity is supplied by the Kenya Power. However, some institutions have opted to the installation of back- up generators to supplement the Kenya Power supply especially in times of power black-outs. Water in the area is supplied by Young International Water Project (YIWP). Water is trapped on the slopes of Nandi Hills and flows in pipes to homes by gravity. Most homes, offices and business

premises have access to this piped water. However some people rely on protected springs for water for their domestic and commercial use. Other sources of water include protected springs especially in the rural areas and harvested rain water. The area is served by traffic mainly on Chavakali – Kapsabet – Eldoret Road and Kapsabet – Nandi Hills Road, Kisumu – Mamboleo – Miwani – Muhoroni road and other access roads that connect rural areas to the major roads. However, these feeder roads are dry weather roads and most become impassable during the rainy seasons and dusty during the dry season. Communication is excellent for mobile reception from Safaricom, Airtel, Telkom networks and for landline from Telkom Kenya.

### 2.2.5 Hospitals and schools

People in the area access private, public hospitals and clinics that are found in the area. Chemase Location is home to Kibisem Health Center. The residents in the area can also access medical referral services at Nandi County Referral Hospital in Kapsabet town and Moi Teaching and Referral Hospital in Eldoret Town. All these health facilities are accessible for the proposed site. There are a number of learning institutions in the area including Kamuny Primary and Kamuny Secondary schools. Nandi County has its headquarters at Kapsabet Town which is also a home to most learning institutions such Kapsabet Boys High School, Chepterit Girls High School and Baraton University among others.

### 2.2.6 Business activities

Many business operations are concentrated in urban areas and along the roads. Business entrepreneurs licensed in the formal sector include catering, retail, motor vehicle repairs, wholesale, manufacturing, welding, bar and restaurant, distribution, bakeries and export-import activities. The informal sector is widespread in the county and it contributes considerably to the growth of the area's economy. However, the sector requires intensive promotion since it uses affordable and readily available technology and is among the sectors, which offer most of the employment opportunities within the urban areas.

### 2.2.7 Agriculture

Farming forms the main source of livelihood in the county. The main crops grown are maize, beans, tea, sweet potatoes and vegetables. Of the main food crops, maize and beans are the most important staples while among the cash crops; tea is the most important. Animals kept include poultry, cow, sheep and goats. Farming is mainly concentrated and is extensively practiced in the rural areas of the county.

## 2.3 Ecological environment

There are neither wildlife sanctuaries nor rare, endangered and endemic species at or within a radius of 3 Km from the proposed project sites. The ecology of the project area is however very rich in flora and fauna diversity and is typical of modified equatorial-type vegetation. There are 6 No. gazetted forest reserves in Nandi County covering a total area of about 54,487.4 Ha. The largest reserves are North Nandi Forest, North Tinderet Forest and South Nandi Forest. The area has both exotic and indigenous vegetation. Trees in homesteads are used mainly for shade, boundary demarcation, fencing, production of fruits, timber, fuel wood and for ornamental purposes. These trees include *Eucalyptus* spp, *Markhamia lutea, Cupressus lusitanica, Bischovia javonica, Spathodea nilotica, Croton megalocarpus*, *Pinus* sp, *Persea americana, Syzygium guminii* and *Eryobotria japonica*. Shrubs include *Lantana camara, Tethonia diversifolia* and *Solanum incanum.*

# 3 PROPOSED PROJECT DESCRIPTION

## 3.1 Projects design and components

### 3.1.1 Mining

Underground operations will be carried out using conventional underground Resue mining and deep shaft mining methods suitable for narrow vein mining. Resue mining is a method of mining that allows split face firing within stops to allow waste and ore to be mined separately, allowing dilution to be minimized. The proponent will operate a raising and wincing system and typical stopping techniques when mining. Ore will be mined through drilling and blasting. The pit and part of the tunnel were made by the foreign companies that operated in the area during the precolonial and colonial period. The Proponent's activities include searching gold through this tunnel by digging it further. It is from this tunnel that the gold ore is extracted. The tunnel is made horizontally from the pit at 50 m depth.

## 3.2 Material input in mining and processing gold

Usage of materials has both beneficial and adverse impacts on the environment. Both on-site and off-site impacts are anticipated from extraction, acquisition and usage material. The most common of these impacts are income circulation in the economy, creation of employment opportunities, off-site depletion of materials, land degradation, pollution, excessive demand on materials and health hazards.

### 3.2.1 Mining of the gold ore

Gold mining is done manually. Men enter the pit from which they enter the tunnels in search for quartz, the ore that contains gold. A pulley system is used to help the people easily get into and out of the pit. One person sits in a container that is supported by a rope on the pulley system and is assisted by another person who controls the pulley from top of the pit to slowly get into and out of the pit. They extract the ore using simple tools such as chisels and shovels and load the ore in metallic containers for ease of transportation from the underground. The gold ore is then packed into sacks and then transported to the crushers.

### 3.2.2 Crushing the mined ore

Big particles of the gold ore are broken down with a mallet to sizeable pieces before they are taken to a crusher. The amount of the mineral in the mined ore differs. Sometimes the rock that is extracted contains no gold at all. The crushed particles are put into the crusher and ground into fine powder that can easily be processed to extract the precious metal.

### 3.2.3 Sieving of dirt and impurities

The fine dust from the crusher is taken for sieving where the powder is mixed with water to make a slurry that is put on sieves elevated on inclined bench-like supports. The sieves allow the dirt to be removed by drawing them with jugs leaving behind an impure gold that drops into metallic pans. The dirt is collected in shallow wells that are dug at the site.

### 3.2.4 Transporting

Mined ore will be loaded into hoppers, which will run on a rail system to a mining shafts. The ore will be tipped into ore shoots/boxes from which it will be loaded into skips, which will hoist the ore to surface. Mined ore will be delivered by tractors and trailers to the main ore bin, from which it travels on conveyors to a series of gyro and jaw crushers.

### 3.2.5 Crushing

The ore will be withdrawn from the ore and crushed by a gyro crusher and a series of three jaw crushers. After each crusher, material is fed over a vibrating screen; large particles are returned for re-crushing, and fine material that passes through the screens progresses towards the next crusher and eventually on to the mill feed bin.

### 3.2.6 Milling

The ore will be fed from the crushing line into the ball mill where it will be ground with steel balls. Inlet dilution water will be added to the mill feed chute to control mill slurry density. The ball mill will then discharge the resultant slurry via a trammel screen to the gravity concentrator. Any material not collected in the concentrator will be pumped to a cyclone at the head of the CIP plant and treated with GDA.

### 3.2.7 Gravity Circuit

Ore particles will be subjected to a force of 60 gravities in a fluidization process in a Knelson Concentrator. When the concentration cycle is complete, concentrates will be flushed from the cone into the concentrate launder through a patented multi-port.

### 3.2.8 Thickening

The tails will empty to a tank and process water will be added before being pumped to 100mm cyclone. The cyclone will classify the mill product into two fractions. The overflow fraction will then be directed to a trash removal screen and then to a high thickener. The underflow fraction will be controlled manually by opening or closing the thickener drain valve to attain the desired pulp density. The thickened pulp will be pumped to the No 1 Carbon in Leach (CIL) tank.

### 3.2.9 CIL/CIP-Carbon in Pulp Leaching

GDA solution will be added into the No1. CIL tank. To assist in the leaching process, hydrogen peroxide will be added. Slurry overflows from the mechanically agitated leach tank through six mechanically agitated CIL tanks to ensure complete dissolution as a complex GDA solution and adsorption onto activated carbon. Carbon recovered on the screen will be delivered to a bulk bag for re-use. Tailings discharging from the tailings linear will gravitate to the tailings section.

### 3.2.10 Tailings

Tailing slurry passing through the CIL tailings screen gravitates via pipes to the tailings dam in the immediate vicinity of the plant. Water on the tailings dam gravitates via a penstock into a return water pond from which return water is pumped to the plant for re-use.

### 3.2.11 Refining

Concentrates from the Knelson concentrator and elutions extracted from the pregnant carbon are further refined.
The project components are 3 No. leaching tanks (Each tank will be 4.8 meters in width and 2.3 meters in height), a general house that will have a chemical store, a laboratory, and column chambers, a solution tank deck, a raw water reserve tank and a barren mixing tank.

## 3.3 Description of the proposed project activities

Gold dressing by use of Gold Dressing Agent is a hydrometallurgical technique for extracting gold from low grade ore by converting the gold to a soluble coordination complex. Water is added to the tailings to produce a slurry. The process will involve bleaching gold tailings using tank leaching process. In the process, tailings are loaded into the tanks, once full the tanks are flooded with a leaching solution in this case GDA. The solution drains from the tank, and is either recycled back into the tanks or pumped to the next step of the recovery process. The leach units are either cyclical or rectangular containers (drums, barrels, tanks or vats), usually very big and made of wood or concrete, lined with material resistant to the leaching media. This process works by exposing the surface of the finely crushed ore to the GDA solution. Once exposed to the gold, the solution binds with ions in the gold that allows them to separate out into solution and then be screened for collection.

It is well-known that the introduction of more oxygen speeds up the leaching process but it is not often done in a mill out of cost concerns. Different elements in the ore itself can wreak havoc on the process and significantly hurt the effectiveness of the process. The process is sequential to maximize the contact time between the ore and the reagent. In such a series the leachate collected from one tank is added to another tank with fresher tailings. The tanks are equipped with agitators to keep the solids in suspension and improve the solid to liquid to gas contact. Agitation is further assisted by the use of tank baffles to increase the efficiency and prevent centrifuging of slurries in circular tanks. Five steps will be involved in this process;

i. **Step One:** This step will involve mixing the tailings with GDA solution. Hydrogen peroxide will be used as a catalyst in the process. Use of lime (caustic soda) will be considered in order to make the GDA solution less toxic by improving the pH.

ii. **Step Two:** At this stage, the slurry will be left to flow by gravity to each of the 10 tanks.

iii. **Step Three:** The slurry is then compressed and directed to the carbon house and column. It is in the carbon house and column that the gold granules are segregated from the slurry. The carbon is used to separate gold from the slurry.

iv. **Step Four:** The slurry is further directed to the barren tank. At this stage, fresh water is pumped into the barren tank by two motorized fresh water pumps and the slurry is further pushed into the raised 10,000 liter tank for recycling.

v. **Step Five:** From the 10,000 liter tank, the slurry is once again recycled and flows by gravity once again into the leach tanks. The proponent intends to be replacing slurry after every one month.

## 3.4 Facilities, utilities, amenities and services facilitating activities at the site

a) Most equipment and machinery are diesel-powered. These include the generator, the ore crusher and the compressor. Other equipment such as the pulley system, the chisels and the shovels are manually-driven. There is minimal usage of electricity and electricity for this purpose is obtained from a diesel-powered generator. Electricity is mostly used in lighting the workshop and in running the water pump.
b) Water for use in gold leasing processing is tapped from the Nandi Hills and conveyed in pipes by gravity to the site. Potable water for use by the workers is drawn from a nearby protected spring that is also used by the community. Pure/fresh water that is used in the final gold purification process to dissolve salts from the gold is purchased from laboratories.
c) There are several pit latrines at the site for all the workers. Most of the casual workers are drawn from the area.

## 3.5 Chemical Formula

### 3.5.1 Gold Dressing Agent (GDA)

Currently, more than 85% of gold-ore dressing enterprises all over the world use sodium cyanide for gold extraction. As sodium cyanide is a kind of virulent and dangerous chemical, environmental pollution, malignant poisoning as well as different kinds of events with social feat sometimes occur during the processes of transportation, safekeeping and use. Sodium cyanide causes fear among competent authorities or citizens living around the production base. The use of sodium cyanide has been banned in many countries and regions in the world. Competent authorities, gold mining enterprises or citizens living around the production base are all looking forward to an environmental protection ore-dressing product which can replace the sodium cyanide in gold mining to deal with the detriment brought to human living environment by development of the gold-metallurgy industry. Due to this issue, Gold Dressing Agent (GDA) has been invented and supplied as a possible substitute.

GDA is an eco-friendly gold leaching reagent that can replace sodium cyanide without changing the original equipment and cyanide process. It can be used directly for gold ore beneficiation and refining. Compared with the traditional leaching agent, it can achieve targets of green and environmental protection with no severe accidents.

### 3.5.2 The chemical reaction

The following are the composition of GDA

1) Sodium hydroxide – pH modifier
2) Sodium silicate – Depressant
3) Thiourea – Leaching agent

The dissolution of gold by thiourea involves the formation of single cationic species of gold by thiourea in an acid medium according to the reaction;

$$AUO + 2C(NH_2)_2 \text{`} \longrightarrow AU\{CS(NH_2)_2\}_2^+ + e^- \text{ (Gold thiourea complex)}$$

During the ion exchange process, this single cation gold species (gold thiourea complex) is exchanged for the cationic groups on the resin.

The general ion exchange reaction is represented as:

$RN.H+ + AU[CS(NH_2)_2]_2^+ \longleftrightarrow RN.AU\ [CS(NH_2)_2]_2^+ + H^+$

### 3.5.3 Mechanism of gold dissolving in alkaline thiourea

Reaction mechanism of gold dissolving in alkaline thiourea solution was studied by electro-chemical methods; such as cyclic voltammetry, chronopotentiometry, acimpedence, linear sweep voltammetry.

In alkaline thiourea solution, gold dissolving mechanism undergoes the following courses;

Adsorption of thiourea on electrode surfaces, charge transfer from gold atom to thiourea molecules, AU $[SC(NH_2)_2]_2^+$ ads receiving thiourea molecules and forming stable + AU $[CS(NH_2)_2]_2^+$, and then AU $[SC(NH_2)_2]_2^+$ diffusing away from the electrode surface to solution.

### 3.5.4 Product Advantages

- High-tech products: It is the world's first high-tech products to replace sodium cyanide for gold beneficiation.
- Low toxicity and environmental protection: the product is non-combustible, non-explosive, non-oxidant risk, non-radioactive, low-toxic, belongs to ordinary chemical product which are environmentally safe
- Stable performance: it can reduce the interference of harmful substances such as arsenic and sulfur.
- Strong applicability: it is suitable for heap leaching, pool leaching and Carbon in Pulp (CIP) process of oxidized gold and silver ore. The scale can be large or small, and it is more suitable for large-scale heap leaching.
- High leaching rate: it can leach the gold ions effectively and can achieve faster with higher recovery rate than using sodium cyanide.
- Faster recycling: compared with using sodium cyanide, the heaping process is shorter and the recovery is faster.
- Lower cost: it can reduce costs such as purchasing, transportation, warehousing, storage, usage, safety and environmental protection facilities.
- Easy to use: the production process is consistent with the condition that have been used in the past while using GDA, which makes it easy to adopt and promote.
- Easy to transport: it is an ordinary cargo and can be transported by air, sea, road or rail.

### 3.5.5 Operating Instruction

**Ingredients:** Sodium oxide, nitrogen, ammonium, calcium, iron

**Usage:** While being used, the non-cyanide gold extraction reagent must be agitated with alkaline water at normal temperature ($23^o$), and then dissolved in a slurry to do gold leaching. In the process of heap leaching, pool leaching and CIP production of oxidized gold ore, the process is as same as the process

of using sodium cyanide. The pregnant solution and the lean solution in production can be reused, and the most stable material in pregnant solution gold leaching is activated carbon. The leaching effect of gold is best when the ambient temperature is above 10 °C.

**Alkalinity:** It generally uses lime and caustic soda to adjust and maintain the PH value to 10 ~ 12. After the raw ore is piled up or into the pool, it should return water to adjust the alkalinity to PH value 11±1.

**Dosage:** The dosage is about 0.5 to 1.0 parts per thousand (500-1000 g of ton of ore). The property, grade and pH of the ore affect the dosage. The actual dosage can be calculated according to the concentration of the solution.

**Dosing method:** It can be used after being fully dissolved in water at normal temperature (usually the dissolution in flowing water or after sufficient agitation would be accelerated) continuously flush the non-cyanide gold extraction reagent into the medicine pool (lean solution pool) or put it into the medicine tank to dissolve. If it is a heap leaching process, dosing and spraying can be carried out simultaneously.

**Effects of use and precaution**

Inhalation of a small amount of dust will not cause significant harm to human body, excessive inhalation or long-term inhalation of dust can cause respiratory system mild irritation and lead to lung injury. The site of production, storage and use should be kept ventilation, during the process of production and use should use dust mask to avoid excessive inhalation of dust.

Direct contact should be avoided to prevent physical damage. Skin contact with this product does not affect health, but will stimulate the broken skin causing inflammation. In view of good industrial hygiene, any chemical contact should be kept to a minimum and good personal protection. The product is expected a harmful can not to Ingestion. Ingestion will irritation the mouth and digestive tract, after ingestion will have vomiting, fever, abdominal pain, loss of appetite.

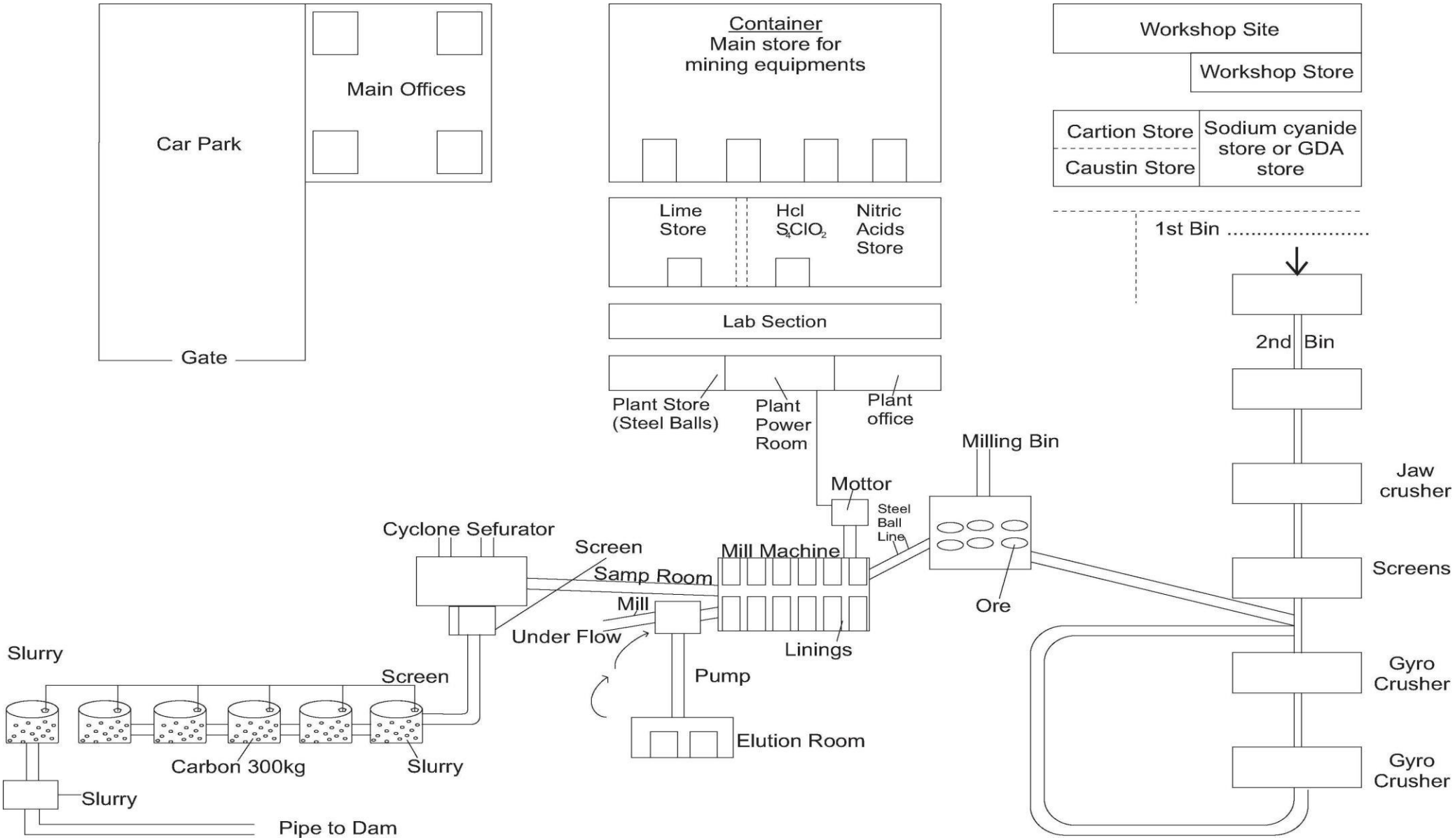
Generally it is not hazardous in normal handling, however good laboratory practices should always be used. Avoid long term exposure to skin or by inhalation. Inhalation: Inhaled, should move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen, get medical help. Skin Contact: Take off contaminated clothing, and use a lot of clean water and soap and other anti-pollution products thoroughly clean. If infection of wound and cause injury should seek medical treatment in time. Eye Contact: Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids .Get medical aid. Swallow: A small amount of water into the mouth rinse with water, excessive eating vomit after drink enough water, milk or egg white, and timely seek medical help.

When a small amount of leakage occurs, clean the spill directly into the package bag or other processing containers. Large leak: When a large leak occurs, should be isolate the leakage area, restrict staff and livestock access. Processing personnel wear protective equipment to recycle the spill to the related packaging container. With a shovel to put the material into a convenient waste disposal container. To complete the water cleaning polluted surface, and to allow the evacuation of the health system.

Use of the product should pay attention to the operation personnel protection measures, wear goggles, masks and gloves. When processing pay attention to personal hygiene, do not eat, drink or smoke. In handling process pay attention to the protection of the packaging is not damaged, as far as possible to avoid dust, to avoid the operator excessive inhalation Storage: This product is non-flammable, strong stability, and has no strict requirements on the storage conditions, and can be stored in a cool, ventilated and dry place according to the general goods. Don't store with acidic product.

This product reacting with a strong acid will produce harmful gases, prohibited the use or storage together with strong acid. The product itself is relatively stable, usually does not decompose. However, in the case of high temperature or with the reaction of reactive chemicals may be decomposed to produce harmful substances.

Normal use is harmless for water organisms and water environment. The possibility of short-term degradation of harmful products is not high. In the process of production and use, avoid the waste piled up in the drinking water source. Disposal must be done as per the NEMA regulations.


Car Park
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Gate
Container
Main store for mining equipments
Lime Store
Hcl
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Nitric Acids Store
Lab Section
Plant Store (Steel Balls)
Plant Power Room
Plant office
Workshop Site
Workshop Store
Cartion Store
Caustin Store
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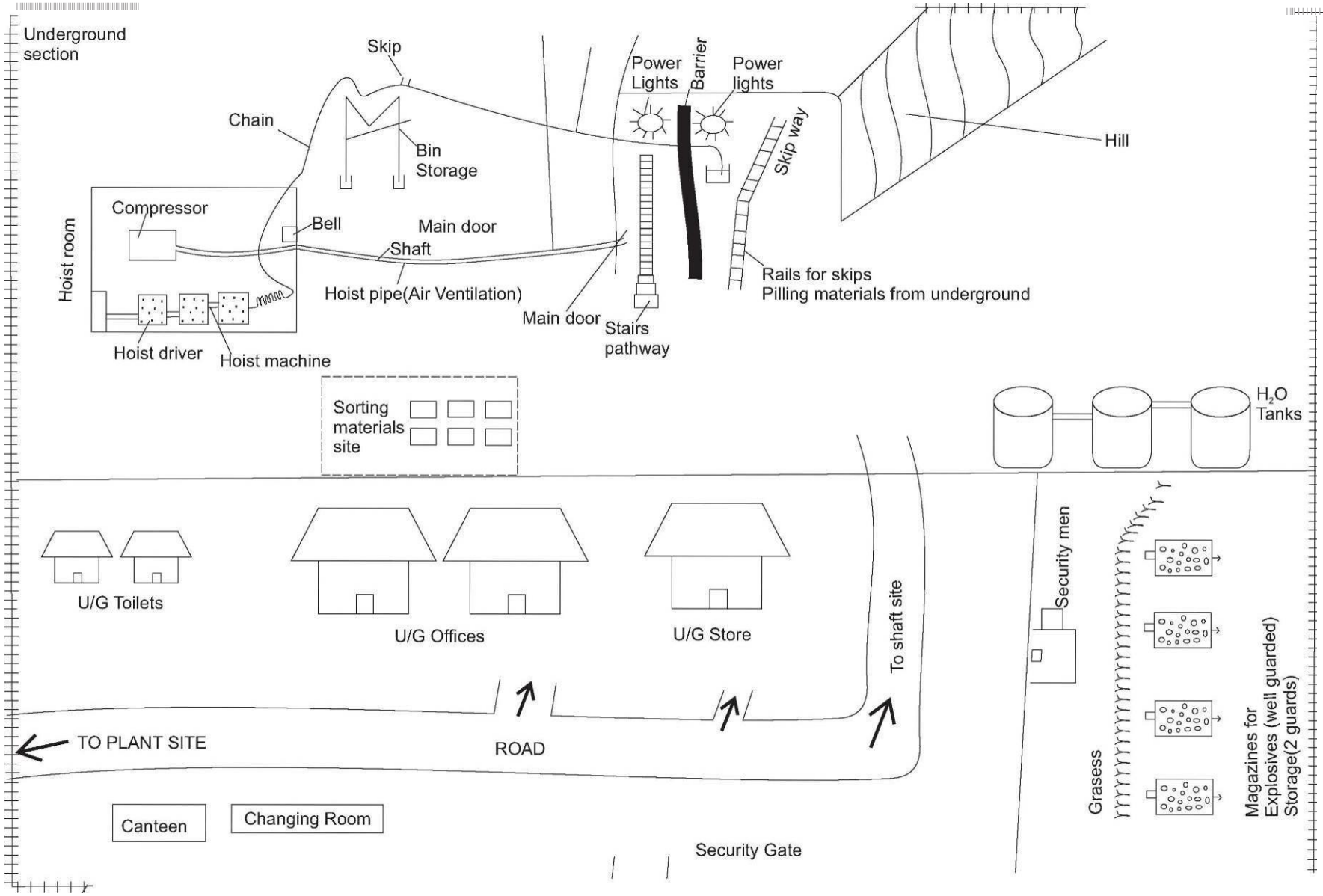
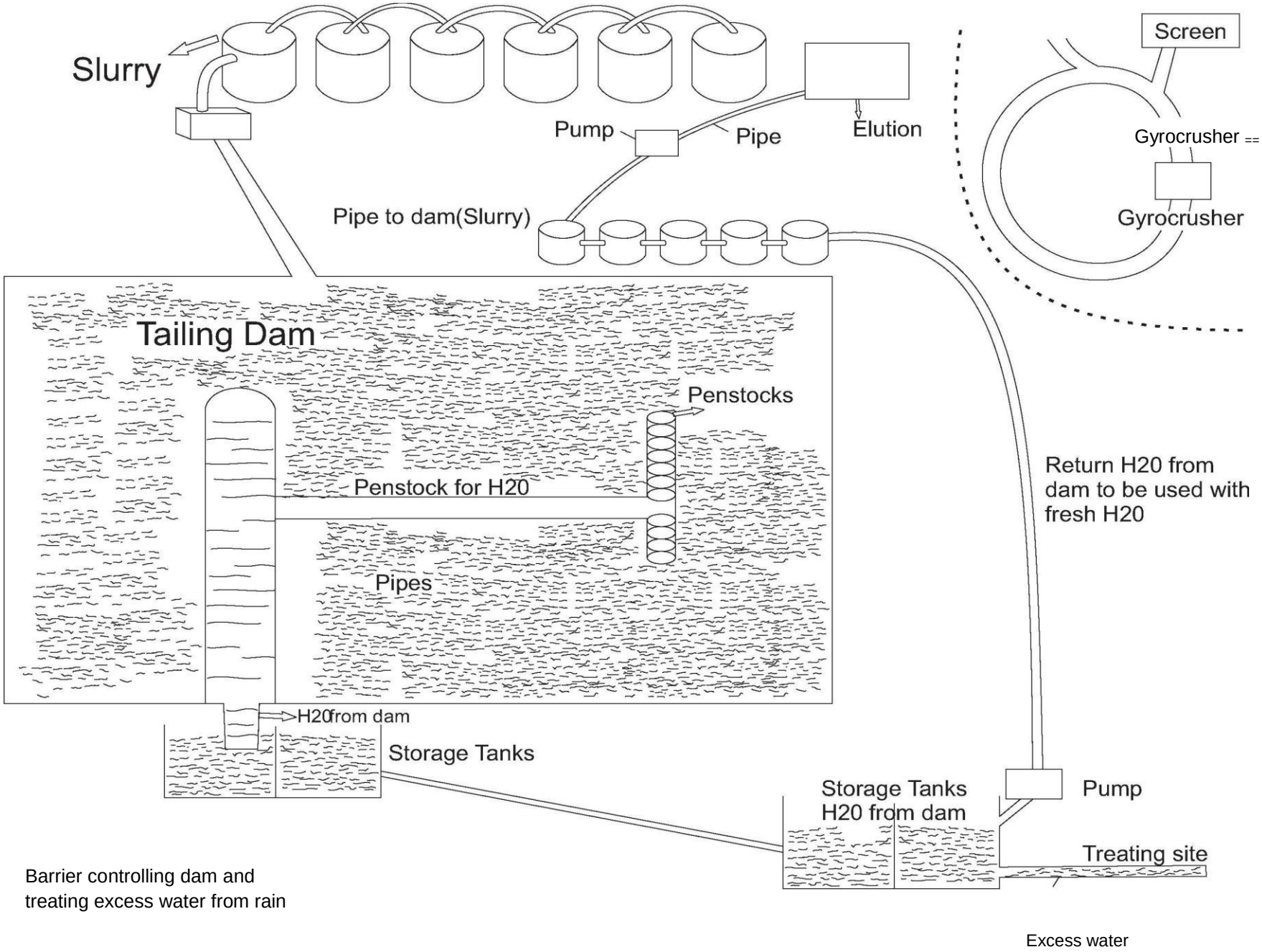

Underground section
Skip
Chain
Bin Storage
Power Lights
Barrier
Power lights
Skip way
Hill
Compressor
Bell
Main door
Shaft
Hoist room
Hoist pipe(Air Ventilation)
Main door
Stairs pathway
Rails for skips
Pilling materials from underground
Hoist driver
Hoist machine
Sorting materials site
H2O Tanks
U/G Toilets
U/G Offices
U/G Store
To shaft site
Security men
Grasess
Magazines for Explosives (well guarded) Storage(2 guards)
TO PLANT SITE
ROAD
Canteen
Changing Room
Security Gate


Slurry
Pump
Pipe
Elution
Screen
Gyrocrusher
Gyrocrusher
Pipe to dam(Slurry)
Tailing Dam
Penstocks
Penstock for H20
Pipes
Return H20 from dam to be used with fresh H20
H20from dam
Storage Tanks
Storage Tanks H20 from dam
Pump
Treating site
Barrier controlling dam and treating excess water from rain
Excess water

# 4 RELEVANT LEGISLATIVE AND REGULATORY FRAMEWORK

## 4.1 Introduction

There is need to take care of the environment in order to ensure survival of human beings. The law has intervened to ensure that human beings are considerate, cautious and careful in their dealings with the environment. The laws governing the environment in Kenya include the Constitution of Kenya, 2010; national policies, EMCA, 1999 (Cap. 387), Amendment 2015 and its subsidiary legislations; and other Kenyan and multilateral environmental laws. EMCA, 1999 (Cap. 387), Amendment 2015 was developed to harmonize and co-ordinate environmental management issues in Kenya by providing for the establishment of an appropriate legal and institutional framework for the management of the environment. The institution is the National Environment Management Authority (NEMA). The Act covers all aspects of the environment. Kenya is a signatory to some international legislation. Some of these are relevant to this project and were reviewed for the purpose of writing this report. Environmental management issues are addressed differently in several legal statutes, but the main objective in all of them is sustainability. It is however noted that wherever any of the laws contradict each other, EMCA, 1999 (Cap. 387), Amendment 2015 prevails.

## 4.2 National Policy Framework

According to the Kenya National Environment Action Plan (NEAP), 1994, GOK recognized the negative impacts on ecosystems emanating from economic and social development programmes that disregarded environmental sustainability. This led to establishment of appropriate environmental policies and legal guidelines as well as harmonization of those that were existing at the time. NEAP introduced environmental assessments in the country culminating into the enactment of the Policy on Environment and Development under the Sessional Paper No. 6 of 1999. An EIA is a legal requirement in Kenya for all development projects listed in the 2$^{nd}$ schedule of EMCA 1999 (Cap. 387), Amendment 2015. The Policy on Environment and Development presents broad categories of development issues that require a sustainable approach. Among the specific goals of the policy are:

a) To incorporate environmental management and economic development as integral aspects of the process of sustainable development; and
b) To encourage sustainable utilization of resources and ecosystems for the benefit of the present generations, while maintaining their potential to meet the needs of the biosphere and future dependents.

### 4.2.1 Sessional Paper No. 6 of 1999 on Environment and Development

The policy paper emphasizes that ESIA study report must be undertaken by the developers as an integral part of a project preparation. It also proposes for periodic environmental auditing to investigate if developer is fully mitigating the impacts identified in the assessment report.

Relevance: The carrying out of this ESIA study and the preparation of this study report is in compliance with this paper.

### 4.2.2 National Environmental Policy, 2012

Integration of environmental conservation and economic activities in the development process is a key policy statement in this policy paper.

Relevance: Throughout the proposed project life cycle, the Proponent will conserve the environment. Conservation measures will include restoration of degraded environments while economic activities will include CSR initiatives that will be implemented by the proponent for the benefit of the community.

## 4.3 Institutional and Administrative Framework for the Management of the Environment

### 4.3.1 National Environmental Management Authority (NEMA)

EMCA, 1999 (Cap. 387), Amendment 2015 provides for establishment of NEMA as the principal agency responsible for coordination, monitoring and supervision of environmental issues in Kenya. NEMA too has a cross-sectorial mandate to oversee the conduct of environmental assessments and audits through issuance of guidelines, regulations and registration of environmental practitioners. It reviews and approves reports for environmental assessments and audits in consultation with any relevant lead agencies. NEMA's enforces environmental legislations through the Department of Compliance and Enforcement which is responsible for ensuring that projects comply with the various environmental regulations and standards. NEMA has appointed environmental inspectors whose powers and duties are listed out under section 117 of EMCA, 1999 (Cap. 387), Amendment 2015. The environmental inspector may also issue an improvement notice requiring an operator to cease any activity deleterious to the environment which is contrary to the Act. NEMA has power, to prosecute environmental offenders and offences committed under the Act and may earn the offender fines and prison sentences. NEMA works with the county environment departments and committees at the county level in undertaking inspection, monitoring and compliance enforcement.

Relevance: NEMA will review and approve this ESIA study report. County environment officers represent NEMA at the county level and are responsible for monitoring environmental protection or regulatory compliance at the county level. In this regard, Nandi County NEMA office is expected to monitor regulatory compliance of the proposed project throughout its life cycle.

### 4.3.2 Environmental Liaison Units in Other Institutions with Environmental Management Mandates in Kenya

NEMA is linked to sectorial lead agencies, private organizations and educational institutions through their environmental liaison units. These institutions include county environment departments, parastatals, learning institutions, NGOs and CBOs among others and are charged with implementation of environmental programmes and integration of environmental concerns in sectorial policies, plans and programs. Consequently, they monitor investment programmes at their respective sectorial levels.

Relevance: Relevant environmental liaison units are stakeholders in the proposed project and will have input into the ESIA study process. These include the State Department of Mining, Ministry of Lands and county environment department amongst others.

## 4.4 Nandi County Development Plans and Laws

### 4.4.1 Nandi County CIDP II (2018 – 2022)

Nandi County CIDP II (2018 – 2022) is a plan that was prepared through a consultative process by Nandi County as a guide development over a five-year period beginning 2018 and ending 2022.

Relevance: The proposed project is in line with the CIDP and also a Vision 2030 flagship project of improving creating employment opportunities.

## 4.5 National Laws, Regulations, Codes and Policies with Environmental Relevance

### 4.5.1 The Constitution of Kenya, 2010

This is the sovereign law in Kenya. The constitution acknowledges the people of Kenya's respect for the environment which is our heritage in its preamble. It also points out our determination to sustain it for the benefit of future generations. This is sustainability of the environment. Environmental provisions are included in:

- Cap. 4 on Rights and Fundamental Freedoms
- Cap. 5 on Environment and Natural Resources
- Cap. 10 on Judicial Authority and Legal System
- Fourth Schedule on Distribution of functions between National and County Governments
- Fifth Schedule on Legislation to be enacted by Parliament

Chapter 5, Part 2 has the following provisions on Environment and Natural Resources

- Article 69 – Obligations in respect of the environment
- Article 70 – Enforcement of environmental rights
- Article 72 – Legislation relating to the environment

Article 42 states that, "Every person has a right to a clean and healthy environment, which includes the right to:

a) Have the environment protected for the benefit of the present & future generations through legislative & other measures, particularly those contemplated in Article 69; and
b) Have the obligations relating to the environment fulfilled under Article 70

Relevance: This is the sovereign law in Kenya and points out our determination to sustain the environment it for the benefit of future generations. The Proponent must be committed to protecting the environment throughout the project life cycle.

### 4.5.2 Environmental Management and Coordination Act, 1999 (Cap. 387), Amendment 2015

It is a requirement that all projects listed under the second schedule of the Act undertake an environmental assessment and submit a report to NEMA for licensing before commencement. The subsidiary legislation to the Act, the Environmental (Impact Assessment and Audit) Regulations, 2003, Amendment 2016, provides the framework for carrying out ESIAs and EAs in Kenya by NEMA licensed experts. ESIAs should be followed by EAs which should be carried out to annually to determine the projects' compliance with environmental regulations.

Section 3 (1) of the Act states that, "Every person in Kenya is entitled to a clean and healthy environment in accordance with the Constitution and relevant laws and has the duty to safeguard and enhance the environment".

Section 58 (1) of the Act states that, "Notwithstanding any approval, permit or license granted under this Act or any other law in force in Kenya, any person, being a proponent of a project, shall before any

financing, commencing, proceeding with, carrying out, executing or conducting or causing to be financed, commenced, proceeded with, carried out, executed or conducted by another person any undertaking specified in the Second Schedule to this Act, submit a project report to the Authority, in the prescribed form, giving the prescribed information and which shall be accompanied by the prescribed fee". This fee is determined by the Authority and currently there is no EIA application fee.

Section 68 (3) states that, "The owner of the premises or the operator of a project for which an environmental impact assessment study report has been made shall keep accurate records and make annual reports to the Authority describing how far the project conforms in operation with the statements made in the environmental impact assessment study report submitted under section 58 (2)."

Relevance: The Proponent is carrying out this ESIA study in order to comply with sections 58 to 67 and 138 of the Act. The Proponent will put in place the stated management measures and will keep records of environmental issues, relevant licenses and permits and shall avail them to the Authority when necessary to prove compliance. The Proponent will be held responsible for any other matter in contravention of this Act.

### 4.5.3 Environmental Management and Coordination (Waste Management) Regulations, 2006

According to part II of the regulations, a generator of waste should:

a) *Not dispose of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle;*
b) *Collect, segregate and dispose or cause to be disposed-off such waste in the manner provided for under these Regulations; and*
c) *Ensure that the waste is transferred to a person who is licensed to transport and dispose-off such waste in a designated waste disposal facility.*

Relevance: All wastes from the proposed activities will be managed in accordance with the procedures outlined in this report or as may be advised by the public health office and/ or other authorities. The Proponent and contractor(s) will be held responsible for any environmental damage or nuisance resulting from wastes from the proposed project and site and for any other matter in contravention of these regulations.

### 4.5.4 Environmental Management and Coordination (Noise and Excessive Vibration, and Pollution Control) Regulations, 2008

These regulations prohibits under Section 3 (1) the causing of loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. Noise levels as provided for in the First Schedule of these regulations are presented in Table 4.1 below.

**Table 4.1: Maximum permissible intrusive noise levels**

| Zone | | Sound Level Limits db(A) *(Leq, 14h)* | | Noise Rating Level (NR) *(Leq, 14h)* | |
|---|---|---|---|---|---|
| | | Day | Night | Day | Night |
| A | Silent Zone | 40 | 35 | 30 | 25 |
| B | Places of Worship | 40 | 35 | 30 | 25 |
| C | Residential: Indoor | 45 | 35 | 35 | 25 |
| Outdoor | | 50 | 35 | 40 | 25 |
| D | Mixed Residential (with some commercial and places of entertainment) | 55 | 35 | 50 | 25 |
| E | Commercial | 60 | 35 | 55 | 25 |

Source: First Schedule of the Environmental Management and Coordination (Noise and Excessive Vibration, and Pollution Control) Regulations, 2008

According to these regulations, Day means the time between 0601 hours and 2000 hours while night the time between 2001 hours and 0600 hours.

Relevance: In compliance with these regulations:

a) There will be no noisy exploration activities at night without relevant permit;
b) Ear muffs will be provided to workers in places with high noise concentrations;
c) Regular maintenance/ repair of contractor's vehicles and machinery will be enforced in order to minimize noise;
d) Any maintenance of construction vehicles and machinery will be carried out in an appropriately designed yard;
e) All noise to be produced as a result of the proposed project activities will be managed as outlined in this report or provided by authorities in control of noise; and
f) The Proponent will be held responsible for any environmental nuisance resulting from noise pollution at the proposed site and for any other matter in contravention of these regulations.
g) Noise permits will be obtained from the County as necessary

### 4.5.5 Mining Act, 2016

The Mining Act was enacted during May 2016, prior to which the industry was regulated by the Mining Act 1940 Cap 306, Trade in Unwrought Mineral Act Cap 309 and the Diamond Industry Protection Act Cap 310 (GoK, 2016 a). Regulations pertaining to the repealed acts remain in force until revoked. In part III under general principles it states that a person shall not search for, prospect or mine mineral, mineral deposit or tailings in Kenya unless that person has been granted a permit or license in accordance with this Act. The Act states that the holder of a permit or license under this Act shall use the land in accordance with the terms of the permit or license and will ensure the following:

a) Sustainable use of land through restoration of abandoned mines and quarries;
b) The seepage of toxic waste into streams, rivers, lakes and wetlands is avoided;
c) Disposal of any toxic waste is done in the approved areas only;
d) Blasting and all works that cause massive vibration is properly carried out and muffled with the EMCA, 1999 (Cap. 387), Amendment 2015; and

e) Upon completion of prospecting or mining, the land in question is restored to its original status or to an acceptable and reasonable condition as close as possible to its original state.

Relevance: The Proponent has been granted a Prospecting License (PL) from the Ministry of Petroleum and Mining. The Proponent will rehabilitate the affected areas after gold exploration activities.

### 4.5.6 Work Injury Compensation Benefit Act (WIBA), 2007

This Act provides for compensation for employees on work related injuries and diseases contacted in the course of employment and for connected purposes. The Act includes compulsory insurance for employees. The Act defines an employee as any worker on contract of service with employer.

Relevance: The Proponent and contractor(s) will insure the staff at the sites. Compensation will be undertaken for any employee in cases of injury or disease in line with working.

### 4.5.7 Occupational Safety and Health Act (OSHA), 2007

This Act provides for the safety, health and welfare of workers and all persons lawfully present at workplaces where any person is at work, whether temporarily or permanently. Part II of the Act on General Duties states the following Duties of Occupiers according to:

- Section 6 (1) that, "Every occupier shall ensure the safety, health and welfare at work of all persons working in his workplace".
- Section 6 (2) (b), "Arrangements for ensuring safety and absence of risks to health in connection with the use, handling, storage and transport of articles and substances".
- Section 6 (2) (c), "The provision of such information, instruction, training and supervision as is necessary to ensure the safety and health at work of every person employed".

Part VI, Sections 47 to 54 on Health General Provisions requires work places to be kept clean, properly ventilated, have enough lighting, have floors properly drained, and have sanitary conveniences.

Relevance: The contractor(s) and the Proponent will ensure the safety and health of those to be employed at the site in all its phases. They will also be held responsible for any other matter in contravention of this Act. The EMP provided advises the Proponent and the contractor(s) on safety and health aspects, potential impacts, personnel responsible for implementation and monitoring, frequency of monitoring, and estimated cost, as a basic guideline for the management of health and Safety issues.

### 4.5.8 Public Health Act, 1986 (Cap. 242) Revised 2012

Part IX of the Act on Sanitation and Housing, Section 115 prohibits nuisance by stating that, "No person shall cause a nuisance or shall suffer to exist on any land or premises owned or occupied by him or of which he is in charge any nuisance or other condition liable to be injurious or dangerous to health."

Section 118 (b) – (e), (h), (p) and (s) defines nuisance in that order as:

- Any dwelling or premises or part thereof which is or are of such construction or in such a state or so situated or so dirty or so verminous as to be, in the opinion of the medical

officer of health, injurious or dangerous to health, or which is or are liable to favour the spread of any infectious disease;

- Any street, road or any part thereof, any stream, pool, ditch, gutter, watercourse, sink, water-tank, cistern, water-closet, earth-closet, privy, urinal, cesspool, soak-away pit, septic tank, cesspit, soil-pipe, waste-pipe, drain, sewer, garbage receptacle, dust-bin, dung-pit, refuse-pit, slop-tank, ash-pit or manure heap so foul or in such a state or so situated or constructed as in the opinion of the medical officer of health to be offensive or to be injurious or dangerous to health;
- Any well or other source of water supply or any cistern or other receptacle for water, whether public or private, the water from which is used or is likely to be used by man for drinking or domestic purposes or in connection with any dairy or milk shop, or in connection with the manufacture or preparation of any article of food intended for human consumption, which is in the opinion of the medical officer of health polluted or otherwise liable to render any such water injurious or dangerous to health;
- Any noxious matter, or waste water, flowing or discharged from any premises, wherever situated, into any public street, or into the gutter or side channel of any street, or into any nullah or watercourse, irrigation channel or bed thereof not approved for the reception of such discharge;
- Any accumulation or deposit of refuse, offal, manure or other matter whatsoever which is offensive or which is injurious or dangerous to health;
- Any accumulation of stones, timber or other material if such in the opinion of the medical officer of health is likely to harbour rats or other vermin;
- Any premises in such a state or condition and any building so constructed as to be likely to harbour rats;
- Any dwelling or premises which is so overcrowded as to be injurious or dangerous to the health of the inmates, or is dilapidated or defective in lighting or ventilation, or is not provided with or is so situated that it cannot be provided with sanitary accommodation to the satisfaction of the medical officer of health;
- Any public or other building which is so situated, constructed, used or kept as to be unsafe, or injurious or dangerous to health;
- Any occupied dwelling for which such a proper, sufficient and wholesome water supply is not available within a reasonable distance as under the circumstances it is possible to obtain;
- Any area of land kept or permitted to remain in such a state as to be offensive, or liable to cause any infectious communicable or preventable disease or injury or danger to health; and
- Any act, omission or thing which is, or may be, dangerous to life, or injurious to health.

Relevance: The Proponent will carry out the drilling for periods that are agreed upon with the neighbours and within the provisions of the law.

### 4.5.9 County Governments Act, Amendment 2020

This Act gives effect to chapter eleven of the Constitution of Kenya to provide for county governments powers, functions and responsibilities to deliver services and for connected purposes.

Relevance: The proposed site is found in Nandi County. The Proponent will abide by all laws, rules, regulations, guidelines and requirements by the CGN. The contractor(s) and the Proponent will be held responsible for any other matter in contravention of this Act.

### 4.5.10 Mining Act 2016 No 12 of 2016

This act was enacted to replace the mining act cap 306 which was last revised in 2012. In part III under general principles it states that a person shall not search for, prospect or mine mineral, mineral deposit or tailings in Kenya unless that person has been granted a permit or license in accordance with this Act. (1) a person or company may apply for a mining license in the prescribed form and accompanied by the prescribed fee.(2) An application for a mining license under subsection (I) shall be in the prescribed form and addressed to the Cabinet Secretary and shall provide the following information

a) The mineral or minerals in respect of which the license is sought;
b) The area in respect of which the license is sought;
c) A proposed programme of mining operations that outlines the mine forecasts and operations plans including the options for minerals beneficiations in the prescribed form;
d) A feasibility study;
e) A statement regarding the mineral or minerals in the area of land over which the license is sought including details of all known minerals as well as probable mineral reserves;
f) A statement of the financial and technical resources available to the applicant to carry out the proposed mining operations and to comply with conditions of the license;
g) A plan giving particulars of the applicant's proposals with respect to the procurement of local goods and services;
h) Proof of submission and approval of an environmental and social impact assessment report and environmental management plan for the term of the mining license to the National Environment Management authority; and
i) A plan giving particulars of the applicant's proposals with respect to social responsible investments for the local community.

### 4.5.11 Financial Provisions under the Mining Act 2016

In part xii of the mining act, it outlines the required financial provisions under article 182. (1) it states that an applicant or a holder of a mineral right, a mineral dealer's license; or a diamond dealer's license, shall pay such fees or charges and at such time as may be prescribed by notice in the Gazette. The prescribed fees may include;

i) Application filing fees
ii) Report filing fees
iii) Fees for access to geological data
iv) Fees for access to public register

It also states that the prescribed charges may include annual charges payable upon grant of the relevant mineral right, mineral dealer's permit or diamond dealer's license. Further, the prescribed charges shall be payable annually for the duration of the mineral right, mineral dealer's permit or diamond dealer's permit or diamond dealer's license. This article also states that all fees and charges payable under this Act shall be demanded and recovered in the same manner as a civil debt.

### 4.5.12 Restoration of Derelict Land after mining Under the Mining Act 2016

The holder of a permit or license under this Act shall use the land in accordance with the terms of the permit or license and shall ensure the following:

i) Sustainable use of land through restoration of abandoned mines and quarries;
ii) The seepage of toxic waste into streams, rivers, lakes and wetlands is avoided;

iii) Disposal of any toxic waste is done in the approved areas only;
iv) Blasting and all works that cause massive vibration is properly carried out and muffled with the Environmental Management and Coordination Act; and
v) Upon completion of prospecting or mining, the land in question shall be restored to its original status or to an acceptable and reasonable condition as close as possible to its original state.

### 4.5.13 Physical and Land Use Planning Act, 2019

This Act makes specific provisions for physical and land use planning. Section 25 (b) of the Act states that, "A local physical development plan shall consist of such maps and description as may be necessary to indicate the manner in which the land in the area may be used".

Relevance: The proposed license area is mostly in a rural setting and the Proponent will be held responsible for any matter in contravention of this Act and in breaking regulations by the Physical Planning Department of Nandi County.

### 4.5.14 Traffic Act (Cap. 403)

This is an Act of Parliament to consolidate the laws relating to traffic on the roads. Section 66 A (1) of the Act protects the occupational safety and health of drivers by stating that, "*No person shall drive a public service vehicle or a commercial vehicle for more than a total of eight hours in any period of twenty-four hours".* All drivers who will drive vehicles to be used in the proposed project in all its phases shall operate in shifts of not more than 8 hours in any period of 24 hours.

Relevance: The contractor(s) and the Proponent will ensure that all drivers on the project comply with all traffic rules.

### 4.5.15 Penal Code (Cap. 63)

The Penal Code's chapter on "Offences against Health and Conveniences" strictly prohibits the release of foul air into the environment, which affects the health of other persons.

Relevance: All wastes from the proposed project activities will be managed in accordance with the procedures outlined in this report or as may be advised by the public health office and/ or other authorities. The Proponent and the contractor(s) will provide appropriate solid and liquid waste handling facilities for the proposed project throughout its project life cycle and will be held responsible for any environmental damage or nuisance resulting from wastes from the proposed project and site and for any other matter in contravention of this Code.

## 4.6 International framework

### 4.6.1 World Commission on Environment and Development (1987)

This commission commonly referred to as "the Brundtland Commission" focuses on the environmental aspects of development, with particular, the emphasis on sustainable development that produces no lasting damage to the biosphere and to particular ecosystems.

Relevance: The Proponent and the contractor(s) will put in place mitigation measures outlined in this report and as will be advised through improvement orders in order to protect people and the environment from undue harm.

### 4.6.2 IFC Performance Standards on Environmental and Social Sustainability, 2012

The objective of the World Bank's Performance Standards on Environmental and Social Sustainability is to prevent and mitigate undue harm to people and their environment in the development process. The Proponent has carried out this ESIA study report in compliance with Performance Standard 1 (Assessment and Management of Environmental and Social Risks and Impacts). Performance Standard 5 relates to Land Acquisition and Involuntary Resettlement and recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use the land.

Relevance: The proposed project activities will be implemented in accordance with the management practices outlined in this report. No persons or activities will be permanently displaced in order to pave way for the proposed exploration activities.

### 4.6.3 Rio Declaration on Environment and Development (1992)

Principle No. 10 of the declaration underscored that, “Environmental issues are best handled with participation of all concerned citizens at all the relevant levels.

Relevance: The Proponent has and will continue to encourage and facilitate public participation for the proposed project activities. The public comments must be treated with utmost relevance.

# 5 ANALYSIS OF PROPOSED PROJECT ALTERNATIVES

## 5.1 Introduction

The purpose of this section is to examine feasible alternatives to the proposed project. The benefits of the proposed project will be considered against any potential environmental cost. The general principle involved in identifying alternative option(s) to a proposed development is to ensure that the option chosen results in optimal social, environmental and capital benefits not only for the developer, but also for the environment and stakeholders in the area. This section is critical in consideration of an ideal or near-ideal project with minimal environmental disturbance. The alternatives to the inputs and technologies are;

i) Thiourea
ii) Thiocyanate
iii) Halogens/Halides
iv) Bisulphide
v) Ammonia
vi) Use of lime based cyanide for leaching

**Table 5.1: Proposed alternative inputs for the proposed project**

| Alternative | Advantages | Disadvantages |
|---|---|---|
| Cyanide | • Cost effective<br>• Easy to apply | • The pH of the slurry with cyanide must be maintained between 11 and 12<br>• Can release HCN if the pH falls below 11.HCN is extremely toxic especially for aquatic life<br>• Highly toxic especially to aquatic life<br>• Its use has been banned |
| Thiourea | • Proven technology<br>• Ready Available<br>• Suitable for refractory ores<br>• Consumption can be reduced by redox control<br>• Fast rate of gold dissolution | • Recyclable only to limited extent due to instability<br>• Detoxification costs would be considerable<br>• Difficult to control process parameters<br>• Limited applicability<br>• It is a known carcinogenic |
| Thiosulphate | • Ready Available<br>• Suitable for refractory/ preg -robbing ores not amenable to cyadination<br>• Good leaching performance 99%<br>• Like cyanide, thiosulphate leaching is an alkaline process (usually operated in the pH 8 to 10 range) so there are no concerns with corrosion and materials used in construction, and the process can be applied to heaps and dumps, or to stirred tanks.<br>• It can yield substantially better recovery than cyanide.<br>• It has great potential to reduce the impact on the environment compared to the cyadination process.<br>• The main chemical components of the leaching process (ammonium thiosulphate and ammonium sulphate) are common fertilizers, which opens up the additional possibility of using mine tailings solutions in agricultural applications, in regions of the world where the local infrastructure and environmental regulations are favorable. | • Recyclable only to limited extent due to instability<br>• Detoxification costs would be considerable<br>• Difficult to control the process<br>• Limited thiosulphate leaching is a sensitive process that requires both dependent and independent optimization of each of the chemical components of the leach reaction, as well as physical parameters such as pulp density and temperature, in order to maximize gold recovery and minimize reagent losses. |
| Thiocyanate | • Can operate over a wide pH range<br>• Partly recyclable | • Availability limited<br>• No large scale applications known |

| | | |
|---|---|---|
| | | • Detoxification costs would be considerable<br>• Higher temperatures required |
| Halogens/ Halides | • Readily available<br>• Leach performance is good<br>• Proven technology in refining gold<br>• Suitable for most ore types | • Requires oxidant. (often of halide)<br>• Handling and control difficult |
| Bisulphide | The availability and reasonable price of bisulphide and its sources indicate reasonable extraction economics | • Long retention times and closed system, that would probably be required, would mean high capital investment costs for such a leach plant.<br>• The operating costs considering detoxification, however, would be very high, because a high chemical oxygen demand would again be necessary<br>• Compared to cyanide, bisulphide does not offer any major technical advantages nor does it have such favorable lethal toxicity and ecotoxicity data to warrant a more favorable classification with regard to safe handling or environmental damage in the case of a spillage |
| Ammonia | • Availability<br>• Recyclable<br>• Could be suitable for refractory ores | • No large scale applications known<br>• Not detoxiafiable, must be recycled<br>• Requires high temperatures and pressures for acceptable leach performance |

## 5.2 Conclusion

From the alternatives mentioned above, the developer is advised to combine the following project alternatives:

i) Use thiosulphate in the process. It has great potential to reduce the negative impact on the environment compared to the cyanidation process
ii) Ensure the project is located at least 100 meters from the nearest residential houses
iii) Treat cyanide solution with lime to make it less toxic
iv) The developer should plant trees and other vegetation around the project site. This would assist to naturally detoxify any toxic waste that may be washed by runoff.

# 6 POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

## 6.1 Introduction

The environmental baseline information collected and the project characteristics discussed form the basis for impact identification and evaluation. Assessment of impacts depends on the nature and magnitude of the activities being undertaken as well as the type of environmental control measures that are envisaged as part of the project proposal. The impacts that are expected to arise from the proposed project could either be termed as positive or negative, direct or indirect, short-term or long-term, temporary or permanent depending on their nature, area of coverage and their duration in the environment. Impacts have been identified and discussed in all phases of the proposed project cycle; establishment, operational and decommissioning.

## 6.2 Potential adverse impacts during the establishment phase

During the construction phase, the main impacts will be related to vegetation, water and soil and on extraction and/or usage of materials.

### 6.2.1 Impacts on vegetation, water and soil

#### 6.2.1.1 Assessment

The impacts on vegetation and soil were born from removal and disturbance of vegetation, movement of people and machinery, excavation and compaction. These impacts are localized but could spread depending on how the project is managed. The effects of these impacts are discussed below.

##### 6.2.1.1.1 Removal and disturbance of flora

Some of the plants that were present at the site were cleared in order to pave way for the construction of the leaching plant. Movement of vehicles, machines and people on vegetation will result in additional damage to plants because pressure will be exerted on the plants by the heavy vehicles, machines and people and will interfere with biological processes in the plants and could also lead to death of the plants. In addition, with the removal and/or death of fauna:

a) There is loss of valuable food and shelter for arthropods and other small animals whose life is depended on these plants for shelter and food leading to their eventual death and/or displacement.
b) Soil erosion and siltation are aggravated.
c) Habitats of some animals are altered and/or destroyed.

##### 6.2.1.1.2 Excavation

Excavation just like clearance of vegetation alters and/or destroys habitats of organisms. It also results into loose soil which is prone to both water and wind erosion. Eroded soil silts water bodies and can flood downstream areas. Loosening of soil interferes with soil structure. Most of the excavated soil will be utilized at the site to adjust levels where necessary. However, if excess soil is not properly disposed, it results into nuisance as a solid waste, dust and silt.

#### 6.2.1.1.3 Compaction

As vehicles, machines and people move on ground, soil is compacted. Compaction has the undesired effect of hindering air and water penetration beneath the soil surface and thus limiting aerobic processes of soil-dwelling organisms which lowers soil productivity. When water penetration into the soil is interfered with, surface run-off during the rains is enhanced resulting in soil erosion and siltation. Compaction become significant if land used for cultivation is used for movement of vehicles. From the assessment, no agricultural pieces of land are used as access roads.

### 6.2.1.2 Mitigation

There was no encroachment into road reserves and other private or public properties at the time the site was being established. The project area is properly demarcated and the construction works and associated activities are restricted to the demarcated area. In addition to this, the proponent is advised to:

(a) Re-establish vegetation in some parts of the site through implementation of a well-designed landscaping programme by planting of appropriate plants.
(b) Rip-off areas within and outside the site where compaction will have adversely affected to allow aeration of soil and ease infiltration of water into the soil.
(c) Use excess soil especially the tailings in filling road potholes or hollow areas at the site among many other uses.

## 6.2.2 Extraction and/or usage of materials

### 6.2.2.1 Assessment

The proposed project will require significant amounts of materials including structural support posts and poles, cement, sand and gravel among others. Fuel will be consumed indirectly through machines. The overall environmental impacts become significant if the amounts required are so large. Many construction materials are components of natural resources and their extraction has an effect of depleting land resources alongside subsequent off-site degradation of the environment.

### 6.2.2.2 Mitigation

(a) The project and material requirements will be evaluated and quantified to ensure that the design optimizes the use of materials.
(b) Proper planning of transportation of materials will ensure that products of fossil fuels (diesel and petrol) are not excessively consumed.

## 6.2.3 Safety at the construction sites

Approved and licensed specialists will be contracted to be in charge of specialized operations at the construction sites. These specialists shall put the following in place in order to ensure safety at the site:

(a) Fence the construction site with iron sheets supported on wooden posts to ensure privacy and security and to reduce interference with activities in the neighbourhood.
(b) Supervise all specialty works at the site.
(c) Adopt proper working procedures when handling tasks and when working with machines and equipment.

(d) Keep all passages clear at all times.
(e) All workers must wear appropriate PPE.
(f) Put in place an appropriate emergency response plan including having emergency telephone numbers (such as ambulance, fire tender and police) properly displayed at places where everybody at the site can see them.
(g) Support all structures under construction.
(h) Remove all soil, boulders and other heavy materials from the edges of excavations.
(i) Remove and dispose all wastes in designated areas whenever they are produced.

## 6.3 Impacts cutting across phases

The following impacts will adversely affect the environment in two or all of the project phases.

### 6.3.1 Air pollution from associated chemical reaction

#### 6.3.1.1 Assessment

Due to the chemical processes going on the pH of the slurry is likely to go down thus affecting the leaching process. The pH should be maintained at between at the values of 11 and 12. If the pH falls below 11, there is the danger of the associated chemical reactions where gases are being released.

#### 6.3.1.2 Mitigation

a) Use lime to maintain the slurry pH at between 11 and 12 values
b) All the employees to wear PPE including masks, helmets overcoats and appropriate foot ware
c) Ensure the tanks are well maintained to prevent leakage of the slurry which may emit foul smell

### 6.3.2 Air pollution (vapours, exhaust emissions and dust)

#### 6.3.2.1 Assessment

Air quality pollutants range from bad odours to toxic hazards and include smells of rotting organic/food wastes, sewer emissions, tobacco smoke and allergens such as moulds. Air pollution from dust is also a common problem in gold processing sites. These dust emissions result from the loading and offloading the tailings. Vehicles especially coming in and out of the site also pose a risk of dust production and exhaust emission. Exposure to gold and soil dust results in silicosis, respiratory disorders, chest problems and many other diseases (Alpers, 2000).

#### 6.3.2.2 Mitigation

The machinery and equipment at the site are repaired when they break in order to increase working efficiency. In addition:

a) Dispose the tailings and other wastes regularly to prevent them from accumulating at the site.
b) Provide workers in areas concentrated with exhaust emissions, dust and fumes with nose masks covering the mouth and the nose; and goggles to protect the eyes.
c) Run and service/maintain machinery and vehicles regularly according to the manufacturer's instructions in order to ensure efficiency in working.
d) Use appropriate fuel that is free from adulteration.

e) Sprinkle water on all dust-active areas to suppress dust and/or pave or apply non-toxic soil stabilizers on all unpaved access roads and parking areas.
f) Sprinkle water to earthen and dusty ground before sweeping to prevent dust production.
g) Supervise activities at the site especially burning and sweeping.
h) Regularly check and clean or repair areas perceived to be sources of air pollution such as manholes.
i) Advice workers to adhere to instruction for use of air polluting agents. For instance "DO NOT USE IN CONFINED PLACES", "DO NOT INHALE FUMES" etc.
j) Advice workers to ensure indoor ventilation by opening windows and using exhaust fans to allow good air circulation into and out of the stalls and offices.
k) Where possible cover all trucks hauling loose material including the gold tailings with tarpaulin and/or requiring these trucks to maintain at least two feet of freeboard.

### 6.3.3 Noise and vibrations

#### 6.3.3.1 Assessment

Noise has an impact on the life and health of people whether within or outside any surrounding. Exposure to noise pollution above 60 dBA (can be transmitted to over 20 m away) can affect mood and quality of sleep and can result in stress. Such noise can also result in auditory fatigue (buzzing and ringing in the ear). Exposure to levels beyond 90 dBA (can be transmitted to over 30 m away) represents a hazard to hearing which can also result in moderate to severe deafness. Noise also interferes with communication and is itself a nuisance and therefore lowers working morale. The main sources of noise at the leaching plant are the generator, the compressor and the vehicular movements. The generator, the compressor and the vehicular movements also produce vibrations. Noise and vibrations are considered significant if the project results in a substantial temporary or permanent increase in ambient levels in the project vicinity especially above levels existing without the project; and exposure of persons to the noise and vibrations. Vibrations can weaken adjacent buildings resulting into cracking of their walls. Construction noise and vibrations are short-term impacts. During the operation phase, noise will not be a major concern due to the nature of the facility unless when carrying out repair works.

#### 6.3.3.2 Mitigation

a) Minimize noise at the sites and in the surrounding areas by:

    i) Sensitizing drivers and machine operators to switch off their engines while they are not in use especially when offloading and loading materials and to avoid hooting especially when passing near noise-sensitive areas such as health facilities, educational institutions, worship places and residential areas among other noise-restricted areas;
    ii) Placing some noisy equipment such as generators in sound-proof rooms or in enclosures to minimize ambient noise; and
    iii) Properly servicing and tuning construction machinery such as generators and other heavy duty equipment to reduce noise generation.
    iv) Avoid unnecessary ignition and usage of the generator, the compressor and vehicles.

b) Minimize the impacts of temporary construction noise and vibration by:

i) Posting notices at the sites to inform people of the activities, time and day.
ii) Planning the construction work to take place only during the day when the neighbours are also at work and maintaining reasonable working hours of not more than 8 hours within any 24-hours working duration so as to reduce the number of complaints concerning noise from the workers and neighbours. Workers will work in shifts.
iii) Providing ear protective devices to workers and visitors in noisy environments to prevent high frequency noise emitted by the high frequency machines.

### 6.3.4 Storm water flow

#### 6.3.4.1 Assessment

The roofs of the buildings and the compacted working ground often lead to increased volume and velocity of storm flowing across the site due to the increase in the sealed surfaces area. Sealing of the ground surface inhibits percolation and consequent infiltration. The increased storm flow can damage existing storm drainage lines. It can also cause overflows that can cause damage to adjacent structures or facilities and can also cause soil erosion. The water may also end up stagnating in hollow places at the site and hence creating conducive breeding areas for mosquitoes and other water based vectors leading to transmission of human diseases like malaria and cholera. Run-off over gold processing plant often carry with it materials contaminated with chemicals used in gold extraction.

#### 6.3.4.2 Mitigation

(a) Design and construct curbs and channels to direct water to the lower areas.
(b) Design the storm drainage system in such a way that the storm does not mix with the waste water and sewerage system.
(c) Consult the neighbours and land owners on the lower side neighbourhood of the site to ensure that all storm drains leaving the site to the valley does not become a nuisance to them or interfere with activities therein those areas.
(d) Keep open all drainage lines and built no obstructions within them to prevent stagnation of water that could lead to development of breeding grounds for disease causing vectors such as mosquitoes, rats, cockroaches and lice and other vermin.
(e) Install gutters and tanks to harvest and store rain water from the buildings in order to reduce run-off.

### 6.3.5 Fire

#### 6.3.5.1 Assessment

Fire is a reality at the site due to use of machines and presence of open cooking by business people. If appropriate measures are not put in place, a fire outbreak can occur and cause great damage to property and even lead to death. Possible source of fires may include:

(a) Lightening;
(b) Leaking methane gas and fumes;
(c) Leaving flammable material near fire points;
(d) Careless disposal of lighting match sticks or cigarette stabs; and
(e) Poor handling of electrical appliances which may also lead to shocks, electrocution and damage to electrical appliances.

#### 6.3.5.2 Mitigation

(a) Declare places with flammable materials as "NO SMOKING ZONES" and display conspicuous notices of the same.
(b) Install fire extinguishers at strategic locations such as flammable material storage areas within and outside the office and stalls. All these must be available at the site at all times.
(c) Regularly inspect the fire-fighting equipment as will be advised by the fire officer.
(d) Clearly mark "FIRE EXIT" points from the site and ensure that they are visible.
(e) Create space for use by emergency management vehicles.
(f) Establish and mark a "FIRE ASSEMBLY POINT" at a strategic outdoor point at the site.
(g) Weather-proof all lighting and power points at the site.
(h) Install electricity and fire suppression equipment through a competent and licensed personnel and properly handle, store and use fuel and electricity.
(i) Keep the compound clean and free from fire hazards and flammable litter and avoid naked fires and burning things in the open fire near flammable material.
(j) Regularly repair and maintain all equipment.
(k) Allow only purposeful and controlled burning at the site.
(l) Regular train personnel concerning emergencies including those involving fire out-breaks.
(m) Subject to availability of resources install fire alarms that have smoke sensors.

### 6.3.6 Waste water and sanitary facilities

#### 6.3.6.1 Assessment

A lot of waste water is expected to come from the leaching tanks. Water used in in the tanks drops on the ground and percolates in. There are pit latrines for use by the workers and visitors. Accidental flooding of the sewerage system can flush into the storm water drainage system thereby creating biological hazards. Sewage and waste water have associated problems when they leak into the environment. Such problems include poor sanitation, nuisance and associated diarrhea diseases. Poor surface drain management or large amounts of effluents may lead to blockage of drains which in turn could result in flooding and unsanitary conditions.

#### 6.3.6.2 Mitigation

(a) Construct more pit latrines. Construct disludgeable pit latrines. Upon filling or whenever it will near filling, the proponent will contract an exhauster service provider to empty the pit latrines for appropriate disposal of the wastes.
(b) Clean sanitary facilities and sinks every day.
(c) Construct a soak pit for the discharge of waste water.
(d) Carry out regular inspections on the sewerage and waste water drainage systems to detect and repair breakages order to minimize risks of flushing that causes pollution and nuisance.

### 6.3.7 Solid wastes

#### 6.3.7.1 Assessment

Mine tailings constitute one of the sources of solid waste at the site. Part of the tailings result from the process of leaching of the crushed ore. The residue which is usually in form of a thick liquid is left on the ground to dry and can always be recycled back into the process of extracting gold. Other solid

wastes include: household wastes such as food/kitchen waste, used paper wrapping, plastic wrapping and plastic bags; organic wastes such as vegetable and fruit matter and peelings; purchase packaging materials; old printed documents such as newspapers; plastics bags and bottles; metallic tins, jar lids and soft drinks cans; glass bottles, jars and flasks; clothing materials; used sanitary towels and baby diapers; and dead fluorescent tubes and bulbs. Below are some of the effects of these solid wastes:

(a) Some of these wastes are hazardous.
(b) Some waste materials especially the plastic/polythene are not biodegradable hence may cause long-term injurious effects to the environment.
(c) Solid wastes can be injurious to the environment through blockage of drainage systems, choking of water bodies and negative impacts on animal health or be a potential source of disease pathogens or form breeding grounds for: disease causing vectors such as mosquitoes; rats; cockroaches and lice and other vermin leading to increase in incidence of associated diseases.

#### 6.3.7.2 Mitigation

(a) People in the area use the tailings for smearing and decorating houses since they have attractive golden-like colours. This is mostly done just before Christmas season.
(b) The tailings can be added in the farm especially where root crops are grown since they are believed to provide favourable conditions for fattening of the roots.
(c) Tailings can be used to make bricks.
(d) Provide bins for separate collection of wastes into appropriate sorts such as recyclable and non-recyclable for each room, each corridor and each common room. These bins should be labeled.
(e) Put in place an efficient, regular and appropriate waste collection and disposal scheme that will prevent the accumulation of wastes at collection areas.
(f) Where possible material considered as waste may be re-used or recycled or be given to who may consider them useful for others uses.
(g) Advice workers and business people to order materials according to needs to reduce waste.
(h) Maintain and repair equipment rather than replacing it to reduce waste.

### 6.3.8 Increased traffic flow

#### 6.3.8.1 Assessment

There is influx of traffic to and from the site. These include vehicles facilitating activities and operations at the site, people seeking employment opportunities, workers, managers, environmental inspectors and suppliers of foodstuffs to the workers. Though vehicle traffic is not a major concern, it can cause congestion on the roads which may subsequently results in accidents.

#### 6.3.8.2 Mitigation

(a) Place clear signage at the gate to alert drivers to look out for entering and/or exiting vehicles.
(b) Provide space for use by emergency management vehicles.
(c) Provide for adequate space at the turning point at the gate to give drivers enough room to maneuver into and out of the project site.

### 6.3.9 Water usage

#### 6.3.9.1 Assessment

Water for use in gold leaching is tapped form Nandi hills and conveyed to the site by use of pipes and help of gravity. Potable water for use by the workers and the business people is drawn from a nearby protected spring that is also used by the community. Pure/fresh water that is used in the final gold purification process to dissolve salts from the gold is purchased from laboratories.

#### 6.3.9.2 Mitigation

(a) Provide polite notices to conserve water at the site.
(b) Used water should be RECYCLED BACK into the leaching tanks. However, if such water has to be used for domestic purposes, it has to be treated after approval for abstraction by WRA.
(c) Maximize on rain water harvesting for domestic purposes.

### 6.3.10 Use of energy (electricity and fuel)

#### 6.3.10.1 Assessment

Electricity is required to run the facility and for lighting purposes. Fuel is required to run the generators and the compressors. Since electric and fuel in Kenya are generated mainly through natural resources, namely water and geothermal resources, increased use of electricity have adverse impacts on the sustainability of these resources. Improper handling of electricity may lead to shocks, electrocution and damage to electrical appliances. On the other hand, fuels are usually inflammable and could result into fires. Leaks and spills of fuels may lead to explosions and fires leading to destruction of property injuries and deaths.

#### 6.3.10.2 Mitigation

(a) Possible options for minimization of energy include:

    i) Consider installing alternative energy sources such as solar panels and automatic generators.
    ii) Use of energy efficient night-time lighting only at the site.
    iii) Use electricity and fuel only for the intended purposes.
    iv) Switch off all energy using equipment when they are not in use.
    v) Regularly check the working of energy-using equipment to ensure that there are no faults that could lead to high energy consumption.

(b) Control of fires and explosions is important in energy-use and management so as to: reduce damage on property, avoid injuries and accidents and protect electrical appliances and lives. In this case:

    i) Weather-proof all lighting and power points located outside the proposed building; and
    ii) Ensure proper handling, storage and use of fuel and electricity.

(c) Monitor electricity consumption by:

    i) Installing separate meters for each building; and

ii) Checking the electricity meters at least once per month to ensure that they are working properly.

## 6.4 Impacts related to occupational and public health and safety

### 6.4.1 Assessment

There are three main types of occupational health and safety hazards that may be of concern. These are physical, chemical and biological. Potential physical hazards will include noise and accidents resulting from land subsidence, misuse of explosives, lack of knowledge and training on safety in the leaching process and use of poorly maintained equipment. Chemical hazards will involve exposure to harmful gases and chemicals by inhalation, ingestion and skin contact. Biological hazards involve exposure to pathogenic organisms which may cause diseases. Specific areas of concern include:

(a) Fire hazards
(b) Noise and vibrations
(c) Congestion
(d) Accidents including cuts, pricks and bruises; electrocution from naked electrical cables; and suffocation from gas accumulation or lack of oxygen in confined spaces. Accidents could result from lack of supervision and job training, improper handling of machinery and hand tools and inappropriate carrying out of tasks.
(e) Poor sanitation resulting from presence of potential environmental pollutants at the site including waste water, decomposing solid wastes, dust and exhaust emissions and used chemicals and equipment.

### 6.4.2 Mitigation

Approved and licensed specialists will be contracted to be in charge of specialized operations at the site. Mitigation options to most of the occupational health and safety impacts: noise and vibrations; fires and dust and exhaust emissions have been discussed. Additional mitigation measures to other impacts are listed below.

(a) Secure the site with appropriate fencing for protection; provision of privacy; reduction of cases of trespass and theft; and for control of entry by straying animals and therefore avoid conflicts between people at the site and the people in the neighbourhood.
(b) Post notices at the site informing the public of activities at the site and the need to be aware of potentially dangerous things and spots at the site including open pits.
(c) Provide hazard notifications, signage and warnings to warn the persons on potential consequences of their actions.
(d) Supervise all specialty works at the site.
(e) Remove all soil, boulders and other heavy materials from the edges of the pit.
(f) Keep all passages clear at all times.
(g) Provide appropriate PPE including masks, goggles, scarfs, boots and overalls among other protective clothing as spelt out under section 101 (1) of OSHA, 2007 to all workers and sensitize them to use them whenever they are in environments that warrant the use of such PPE especially in all situations where the body and skin are potentially exposed to hazards such as chemicals, harmful dusts, highly infectious wastes, sharp objects, burns and extreme temperature and/or when working in areas that present threatening experiences.

(h) Have fully equipped First Aid Kits at the site at all times and ensure that trained first aid personnel are available to handle any incidents due to pollution at site. A typical First Aid Kit contains a first aid manual and is equipped with sterile adhesive bandages, safety pins, cleansing agent/soap, latex gloves; sterile gauze pads triangular bandages, non-prescription drugs, scissors, tweezers and antiseptic amongst others. First aid can assist in containing blood loss among other emergency occurrences before medical attention is given.
(i) Adopt proper working procedures and when working with chemicals, machines and equipment.
(j) Ensure that trained first aid personnel are available on site at all times to handle emergencies.
(k) Put in place an appropriate emergency response plan including having emergency contacts (such as ambulance, fire tender and police) conspicuously displayed.
(l) Dispose wastes from the site regularly and ensure high standards of cleanliness of all waste collection and disposal facilities.
(m) Rehabilitate areas within and outside the proposed site that will have been directly and indirectly adversely affected by the activities at the site through spillages of pollutants and those that will have been destroyed in other ways.
(n) Ensure adequate potable water supply for high standards of sanitation that keeps to the minimum chances of disease outbreaks.
(o) Control waterborne diseases by ensuring sanitation at the site as outlined in this report and by regularly conducting chemical and bacteriological quality of the water to ascertain its suitability for consumption and treating water before drinking using approved home-based treatment methods such as filtration using life-straw, boiling and use of chemicals such as water guard.
(p) Ensure presence of sanitary facilities by adding pit latrines or outdoor toilets that can be emptied.
(q) Always keep sanitary facilities and waste disposal facilities clean.
(r) Frequently undertake workers through refresher trainings in order to make them have a basic understanding of the tasks under them, the hazards involved, and how to manage them.
(s) Ensure employee welfare including provision of free or subsidized medical attendance if injured on work, making provisions for leaves and offs, and operation of shorter-shift period for workers in highly polluted working areas.
(t) Conduct regular maintenance of the proposed site and facilities therein to increase the life of the proposed structures making them safe for working.
(u) Clean all spilt hazardous materials using an appropriate disinfectant.

## 6.5 The decommissioning plan

Gold mining and leaching is a temporary activity. Just like the initial mining activities that were established by the colonialists came to an end, this process is also likely to come to an end. The proposed activities can come to an end after depletion of tailing deposits or if the proponent decides to move to another site. The facility can also close if the operations become unprofitable. At the closure of the operations, the proponent is required by law under the Mining Act, 2016 to ensure that the site will not pose a threat to the health and safety of the environment at that time and in future. At this point, the site can be repurposed into another use or restored to its previous status. The process of closure will adhere to the following steps: shut-down where the number of employees will be reduced gradually; decommissioning where equipment is removed and disposed and structures demolished; rehabilitation; and monitoring (post-closure). If the facility is decommissioned without any mitigation measures, the following are likely:

(a) The site might become a safety hazard due to the presence of a deep open pit and structures.
(b) There will be massive loss of livelihoods due to the end of jobs at the site.
(c) Similarly, the hollows at the site especially the ponds might accumulate water and become breeding grounds for water-based disease causing and spreading organisms.

The following will be adhered to during decommissioning:

(a) A decommissioning report will be prepared and submitted to NEMA at least three months before decommissioning takes place.
(b) Remove and clean all equipment and sell them or re-use them elsewhere and demolish all structures that will have been established at the site by the proponent.
(c) Remove any hazardous materials, reshape the land, restore the top soil and plant native plants at the site.
(d) The use of the site or the structures may be changed to other appropriate uses after renovation, rehabilitation and some structural changes have taken place. This uses include museums or education centre, an attraction site, a recreation site and a fish farm among others.
(e) The decommissioning and alternative land-use options will be facilitated by appropriate professional personnel incorporating environmental experts; planners; public works officers and public health officers among others.
(f) The government must ensure right from the right the license is issued that the proponent has resources for rehabilitation of the site.
(g) Ensure long-term care and monitoring of the site in order to contain any unremoved structures to ensure that they don't endanger the lives of the people.
(h) Mitigation for decommissioning phase impacts will follow general guidelines discussed in the decommissioning report.

## 6.6 Potential positive impacts

(a) Gold: The proposed project will be a source of gold. Gold is a precious and expensive metal.
(b) Creation of employment opportunities: It is estimated that the proposed project will employ many people in the area. This will either be directly or indirectly. These include the workers at the leaching plant most of who will come from the area; the site manager; gold dealers; and operators of other businesses. The income to be earned will be used for the betterment of peoples' lives and families thus improving their living standards.
(c) Demand for materials: This includes bricks, chemicals, acids and food supplies. The supply of these materials translates into boosting both the local and national economy. The multiplier' effect of this project also translates into increased revenue to the county and national governments in terms of tax and other service charges.
(d) Capital into the economy: The proposed project will inject some capital into the economy.
(e) Improved aesthetics: Spill-off developments include improvement in the general aesthetic of the area. This will add to improved development of the local area.

# 7 PUBLIC PARTICIPATION

## 7.1 Introduction

Members of the public are supposed to participate and get involved in decision making process concerning development projects because they affect them. Reference is made to Section 17 of the Environmental (Impact Assessment and Audit) Regulations, 2003, which states that the proponent shall in consultation with the authority, seek the views of persons who may be affected by the projects. The role of public consultation and involvement in ESIA study report process is to assure the quality, comprehensiveness and effectiveness of the assessment and ensure that the public views are adequately taken into consideration in decision making process. This public participation was conducted by organizing a public *baraza* and administration of questionnaires to the neighbours of the proposed site and residents in the area.

## 7.2 Findings

The people interviewed greatly appreciated that the proponent had given them a chance to participate in the decision making process concerning the proposed project. Most members of the public interviewed were positive about the project. Below are some of the major positive comments from the members of the public.

a) Boost to local business: The people were happy that the proposed project will bring new residents who will serve as customers to local businesses especially groceries and *boda boda* (motor cyclists).
b) Employment opportunities: Members of the community were happy that the project would partly solve the problems of unemployment. Members urged that the proponent should consider residents for some of the employment opportunities at the site.
c) Development in the area: The people were happy that the proposed project is a major development in the area and therefore will enhance land value in the area. They commended that the proposed development will open the area to other new developments in the area and increase business performance due to increased demand for local products.
d) Security: Neighbours of the proposed project site were optimistic that the establishment and lighting of the proposed project would lead to improved security situation in the area.

These comments can be verified from the public participation comment sheets are attached on this report.

**Plate 7.1: Village elder addressing the community during public consultation forum**

**Plate 7.2: Community members during the public consultation forum**

# 8 ENVIRONMENTAL MANAGEMENT AND MONITORING

## 8.1 Environmental management

This section is intended to provide a concise structure of actions with specific priority levels for the management of the environment in all phases of the proposed project. Environmental management is best achieved by preparation and implementation of an EMP. The plan ensures that environmental impacts are identified and mitigated by outlining corresponding management strategies that need to be implemented to mitigate potential adverse environmental impacts and assigns responsibility for the implementation of the mitigation measures. All costs are estimates and may change in time and space. As project commencement and scheduling plans are developed and changed, components of the EMP might require amending. The EMP is generally prepared to ensure that the components of proposed project are operated in accordance with the design, standards, and regulations. If the proposed development is implemented without any environmental management options the total project impact will be on the appreciably adverse side. However, if the environmental management strategies discussed in the EMP are fully implemented, the adverse impact of the project would be reduced and there will be an overall improvement in the environment.

## 8.2 Environmental monitoring and audits and record keeping

Environmental monitoring and audits are conducted to establish if project implementation has complied with established environmental management standards. Environmental audits (EAs) are conducted annually beginning twelve months from the date of commissioning of the project to ensure that identified potential negative impacts are mitigated. EA reports are submitted to the Authority in accordance with Section 68 (3) of the EMCA, 1999 (Cap. 387). Environmental monitoring is best achieved by keeping proper records of the progress of the facility. Some of the records to be kept include:

a) Staff health records;
b) List of materials according to approved classification schedule;
c) Emergency management procedures such as fire response plans;
d) Staff training records in environmental issues and periodic review notes; and
e) Records of violations and notification of authorities' correspondence in relation to the environment.

**Table 8.1: Proposed EMP for the proposed project**

| Area of concern | Recommended measures | Responsible party | Approximate cost (Kshs.) |
|---|---|---|---|
| **Removal of vegetation, excavation and compaction** | | | |
| • Interference with plant and animal life<br>• Change in aesthetic characteristics of the site | Demarcate the project area to be affected by the construction works to prevent the effects from spilling over into other areas | Proponent and contractor | – |
| | Fence the demarcated area appropriately in accordance with the requirements of the Mining Act of 2016 for hoarding of such facilities | Contractor | Covered in cost of construction |
| | Re-establish vegetation through by creating grass verges along the fence and establishing potted plants | Proponent | 20,000 |
| **Use of GDA to leach gold tailings** | | | |
| Risk of leakage or spills of GDA slurry during leaching | • Seal the leaching tanks with impervious material to reduce possibility of leakage of GDA chemicals during the leaching process | Proponent | 100,000 |
| **Solid wastes** | | | |
| • Environmental contamination<br>• Nuisance<br>• Health hazard | Collect and appropriately dispose all waste generated during construction activities and must be accumulated at the point of generation and disposed off as appropriate through an integrated solid waste management system that comprises of recycling, re-use, combustion, decomposition of organic matter and sanitary land filling in order to prevent accumulation at the site | Proponent | Covered in cost of construction |
| | Proper disposal of tailing in a manner approved by the inspector or use the tailings to make bricks | | |
| **Noise and vibration** | | | |
| • Hearing problems<br>• Damage to the ears | Keep all machinery e.g. generators, compressors and crushers in good condition to reduce noise generation<br>Install silencers and acquire permits to emit license from the CGK | Machine operators | Cost vary with service extent |
| | Construct a housing enclosure for generators and other noise-generating equipment if available | Proponent and Site manager | Covered in cost of construction |
| | Advice all machine operators to switch them off when they are not in use | Site manager | – |
| | Provide workers in noisy areas with ear muffs | Site manager | 500 per worker |
| **Dust and exhaust emissions** | | | |

| Area of concern | Recommended measures | Responsible party | Approximate cost (Kshs.) |
|---|---|---|---|
| • Health hazard<br>• Visual obscurity | Sprinkle water on all dust-active areas to suppress dust and/or pave or apply non-toxic soil stabilizers on all unpaved access roads and parking areas /Use a wet milling operation and employ water to control dust from crushing and grinding | Site manager | 100 per day |
| | Provide workers in dust and/or exhaust concentrated areas with nose masks<br>Minimize atmospheric emissions | Site manager | 200 per worker |
| | Properly service, maintain and tune all equipment and machinery to minimize exhaust emission<br>Dust control devices should be installed like electrostatic precipitator, cyclones, scrubbers etc. | Site manager and all machine operators | Cost vary with service extend |
| **Water usage** | | | |
| • Over-extraction of water resources<br>• Conflicts over water-use<br>• Increased demand on water resources<br>• Wastage of water | Manage and account for all water sources in the mine area by installing meters to monitor water consumption | Contractor and proponent | Water works rates apply |
| | Recycle and re-use water and use water wisely by ensuring that taps are not running when not in use | Contractor and all workers | – |
| | Conduct regular checks, inspections and maintenance of pipes and storage containers and tanks to fix leakages | Site manager and all workers | Cost vary with damage extent |
| Water shortage | Construct or install bigger storage facilities ponds to be able to cope with potential stresses in supply | Contractor and proponent | 30,000 |
| | Construct settling ponds for the waste water, with pumps that re-route the cleared water back into the process. | | |
| **Waste water and sewerage and sanitary conveniences** | | | |
| • Sanitary inconveniences<br>• Poor sanitation | Provide lockable washrooms for the workers and separate them based on gender into ladies and gents | Proponent and contractor | Done |
| | Properly use and clean sanitary facilities daily | Site manager and all workers | 100 per day |
| | Dispose chemical contaminated wastes tailings into the lined pond to prevent chemical solutions from entering the environment | | |
| | Plant a belt of reeds around the leaching facility. Reeds are known to naturally detoxify wastes | | |
| **Increased traffic flow** | | | |
| Risks of accidents | Regularly service vehicles to ensure that they are in good condition | All drivers | Cost vary with damage extent |

| Area of concern | Recommended measures | Responsible party | Approximate cost (Kshs.) |
|---|---|---|---|
| | Place prominent signage alerting the presence of the site and a parking area | Site manager and proponent | 1,000 |
| | Provide enough space at the gate to allow vehicles to get in and out of the site easily | Contractor | – |
| **Energy consumption** | | | |
| Over consumption of electricity | Install meters to monitor energy consumption and clearly mark distribution board switches to indicate respective circuits | Site manager and proponent | Kenya Power rates apply) |
| | Switch off electrical appliances including lights when they are not in use | Site manager and all workers | – |
| Damage to electrical appliances | Weather-proof all lighting and power points to ensure there are no live electrical wires are exposed | Site manager and proponent | Covered in cost of construction |
| Power black-outs | Install alternative energy sources such as solar panels and automatic generators not only for power back-up but also to reduce dependency on electricity | Proponent and Site manager | 100,000 per solar panel and 35,000 per generator |
| **Fires** | | | |
| • Injuries and deaths<br>• Destruction of property | Prominently display 'NO SMOKING' signs at the site especially in areas where flammable materials are stored or used and emergency telephone numbers (such as ambulance, fire tenders and police) where everybody at the site can see them | Site manager | 1,000 |
| | Regularly train personnel in relation to emergencies (Do this at least once for every employee during the mining period) | Site manager and all workers | 5,000 per trainee |
| **Safety, health, hygiene and sanitary conveniences** | | | |
| • Food contamination<br>• Accidents<br>• Sanitary conveniences | Provide workers with appropriate PPE such as aprons, ear muffs, nose masks and gloves | Site manager | Price vary with respective PPE |
| | Train workers in emergency management at least once before the leaching process starts | Site manager | 50,000 per group/session |
| | Install and safeguard machinery, equipment, PPE, appliances and tools appropriately and carry out regular maintenance services in accordance with their manufacturer's safety data information | Contractor | Cost vary with service extent |
| | Maintain First Aid Kits at the site in easily accessible areas | Contractor | 1,500 per kit |
| | Indicate dangerous spots and actions at the site | Contractor | – |

| Area of concern | Recommended measures | Responsible party | Approximate cost (Kshs.) |
|---|---|---|---|
| **Compliance with legislations** | | | |
| Non-compliance with legislations | Register the site with the Mines and Geology department in accordance with Mining Act requirements | Proponent | 0.5 % of the project cost |
| | Document and keep records of all environmental and health matters in accordance with Section 68 (3) of EMCA, 1999 and OSHA, 2007 | Contractor | 500 per month |

**Table 8.2: Proposed EMP for the decommissioning phase**

| Area of concern | Recommended measures | Responsible party | Approximate cost (Kshs.) |
|---|---|---|---|
| **Impacts to the aesthetic characteristics of the site** | | | |
| Change in aesthetic characteristics of the site | Demarcate the project area to be affected by the demolition works and hoard the area appropriately in accordance with NCA requirements to prevent impacts from spreading to other areas | Proponent and contractor | – |
| | Re-establish vegetation through implementation of a well-designed landscaping programme and rehabilitate the site | Proponent | 20,000 |
| **Solid wastes** | | | |
| • Environmental contamination<br>• Nuisance<br>• Health hazard | Collect and dispose all solid wastes from the site through an integrated waste management system that comprises of recycling, re-use, combustion, decomposition of organic matter and sanitary land filling in order to prevent accumulation at the site | Contractor | 10,000 |
| **Noise** | | | |
| • Hearing problems<br>• Damage to the ears | Keep all machinery in good condition to reduce noise generation | Machine operators | Cost vary with service extent |
| | Advice drivers to avoid hooting vehicles unnecessarily and when passing through noise-sensitive areas such as religious places, learning areas and hospitals and all machine operators to switch them off when they are not in use | Contractor | – |
| | Provide workers in noisy areas with ear muffs | Contractor | 500 per worker |
| **Dust and exhaust emissions** | | | |
| • Health hazard<br>• Visual obscurity | Sprinkle water on all dust-active areas to suppress dust | Contactor | 100 per day |
| | Provide workers in dust and/or exhaust concentrated areas with nose masks | Contractor | 500 per worker |
| | Properly service, maintain and tune all equipment and machinery to minimize exhaust emission | Contractor and all machine operators | Cost vary with service extend |
| **Waste water and sewerage and sanitary conveniences** | | | |
| • Sanitary inconveniences<br>• Poor sanitation | Properly use and clean sanitary facilities daily | Site manager and all workers | 300 per day |
| **Interference with traffic flow** | | | |
| Risks of accidents | Regularly service vehicles to ensure that they are in good condition | All drivers | Cost vary with damage extent |

| Area of concern | Recommended measures | Responsible party | Approximate cost (Kshs.) |
|---|---|---|---|
| | Place prominent signage on the road alerting the presence of the site and a parking area | Contractor and proponent | 1,000 |
| **Fires** | | | |
| • Injuries and deaths<br>• Destruction of property | The safety of the workers should surpass all other objectives in the decommissioning of the project | Contractor | – |
| **Safety, health and hygiene** | | | |
| • Food contamination<br>• Accidents<br>• Sanitary conveniences | Provide workers with appropriate PPE such as aprons, ear muffs, nose masks and gloves | Contractor | Price vary with PPE |
| | Prominently display 'NO SMOKING' signs, indicate dangerous spots at the site and conspicuously display contacts of emergency service providers such as ambulance, fire tenders and police | Contractor | 1,000 |
| | Make distinctions in all stores in such a way that non-food or poisonous materials are not stored together or mixed with food | Contractors and all specialty supervisors | – |
| | Train workers in emergency management at least once during the decommissioning period | Contractor | 50,000 per group |
| | Install, store, use, maintain and safeguard machinery, equipment, PPE, tools and appliances appropriately in accordance with their manufacturer's safety data information | Contractor | Cost vary with service extent |
| | Maintain First Aid Kits at the site in easily accessible areas | Contractor | 1,500 per kit |
| **Compliance with legislations** | | | |
| Non-compliance with legislation | Conduct an environmental assessment and prepare a decommissioning report for application of a decommissioning permit from NEMA | Site manager and proponent | 40,000 |
| | Document and keep records of all environmental and health matters in accordance with Section 68 (3) of EMCA, 1999 (Cap. 387) and OSHA, 2007 | Site manager | 500 |

# 9 RECOMMENDATIONS AND CONCLUSION

## 9.1 Recommendations

a) Promote the local economy by purchasing materials from sources within the area.
b) Keep records and important documents at the site to assist in self-auditing.
c) Properly manage water and drainage channels at the site in order to improve the quality of sanitation around it.
d) Develop an Environmental Policy stating commitment, intentions and principles of action with respect to the environment including compliance with relevant environmental regulations. This is to form a basis upon which the management of the facility is to set its environmental objectives and targets as in the environmental management plan.
e) Implement and follow the EMP.
f) The proponent is advised to maintain good relations with area residents and especially their immediate neighbours in order to make them live in harmony with the community. This includes purchasing locally produced food stuffs and other locally produced products in order to enhance local development in the area and considering the area residents when offering job opportunities at the site.
g) For security purposes, the proponent can insure the premises as per statutory requirements (comprehensive, third party and workman's compensation policies).

## 9.2 Conclusion

The proposed development will have numerous positive impacts as has been outlined in this report. The likely negative environmental impacts can be mitigated with the options provided for in this report. The report concludes that if all the suggested mitigation measures and the above recommendations are put in place and if the proposed EMP is followed, the proposed project will not adversely impact on the environment. From the foregoing, it is clear that since the proposed project has actively involved the key neighbourhood stakeholders who did not object the development it has sufficient public support and if it is implemented with the proposed mitigation measures, adverse environmental impacts will be mitigated.

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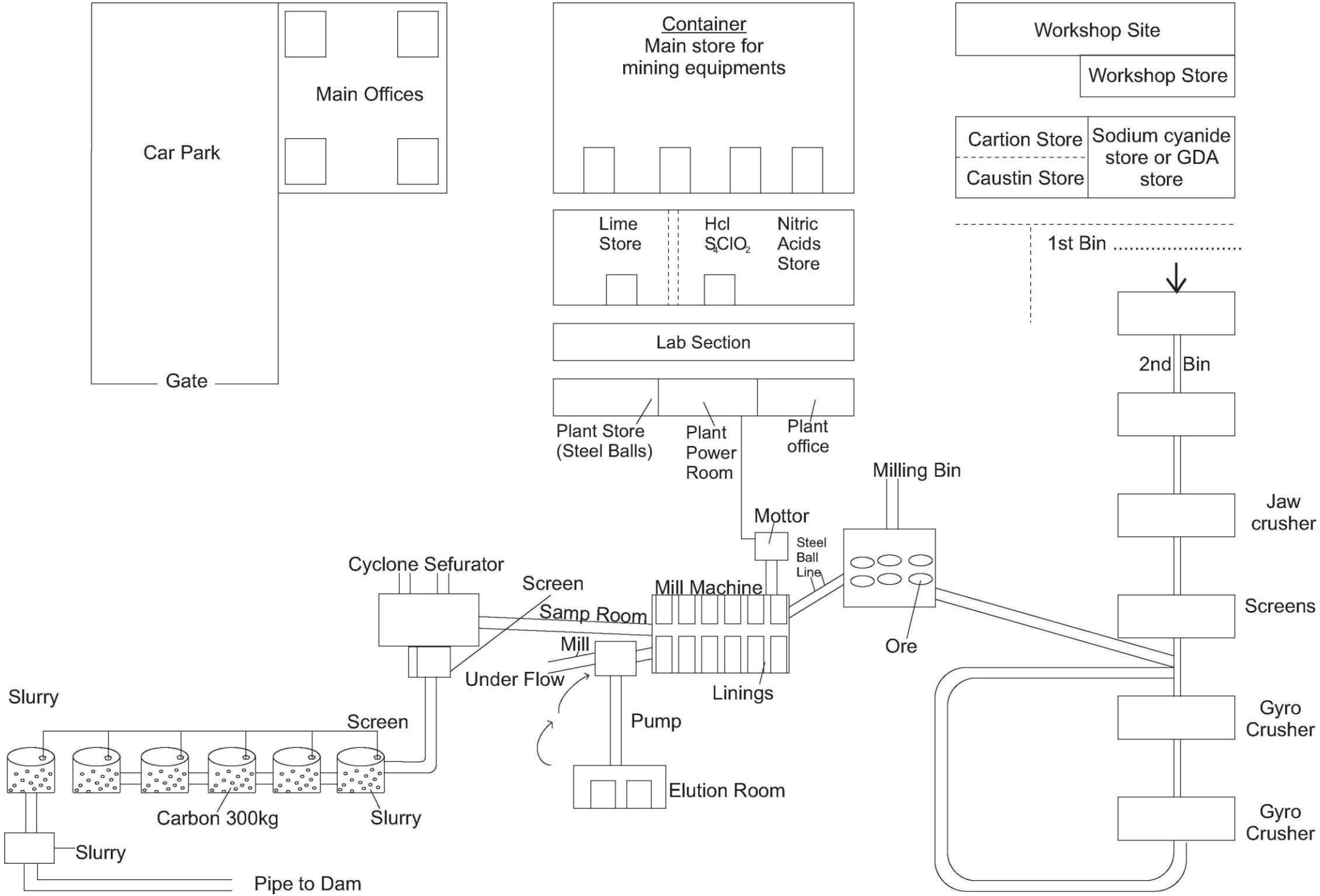
# APPENDICES

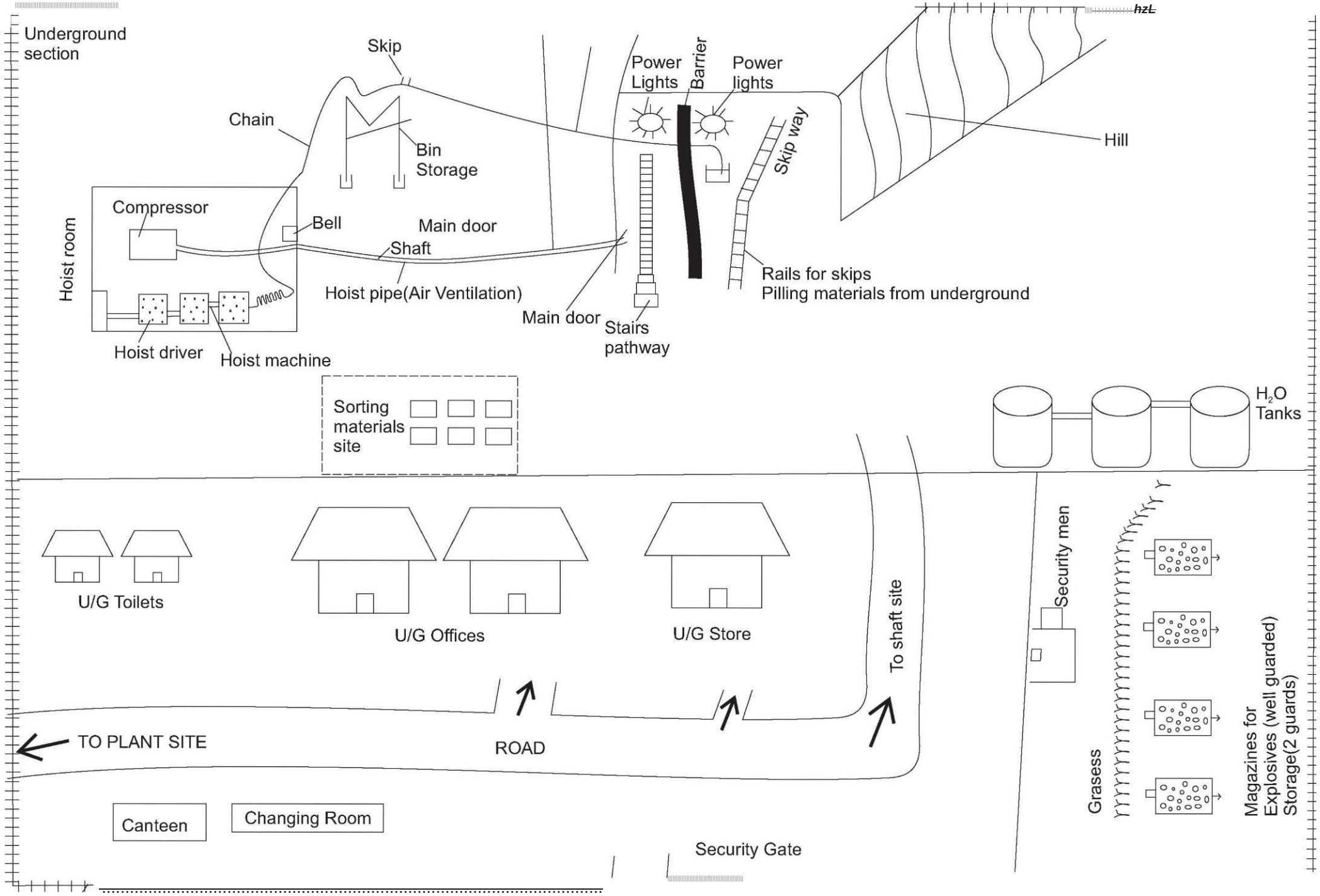
Copy of Lease agreement

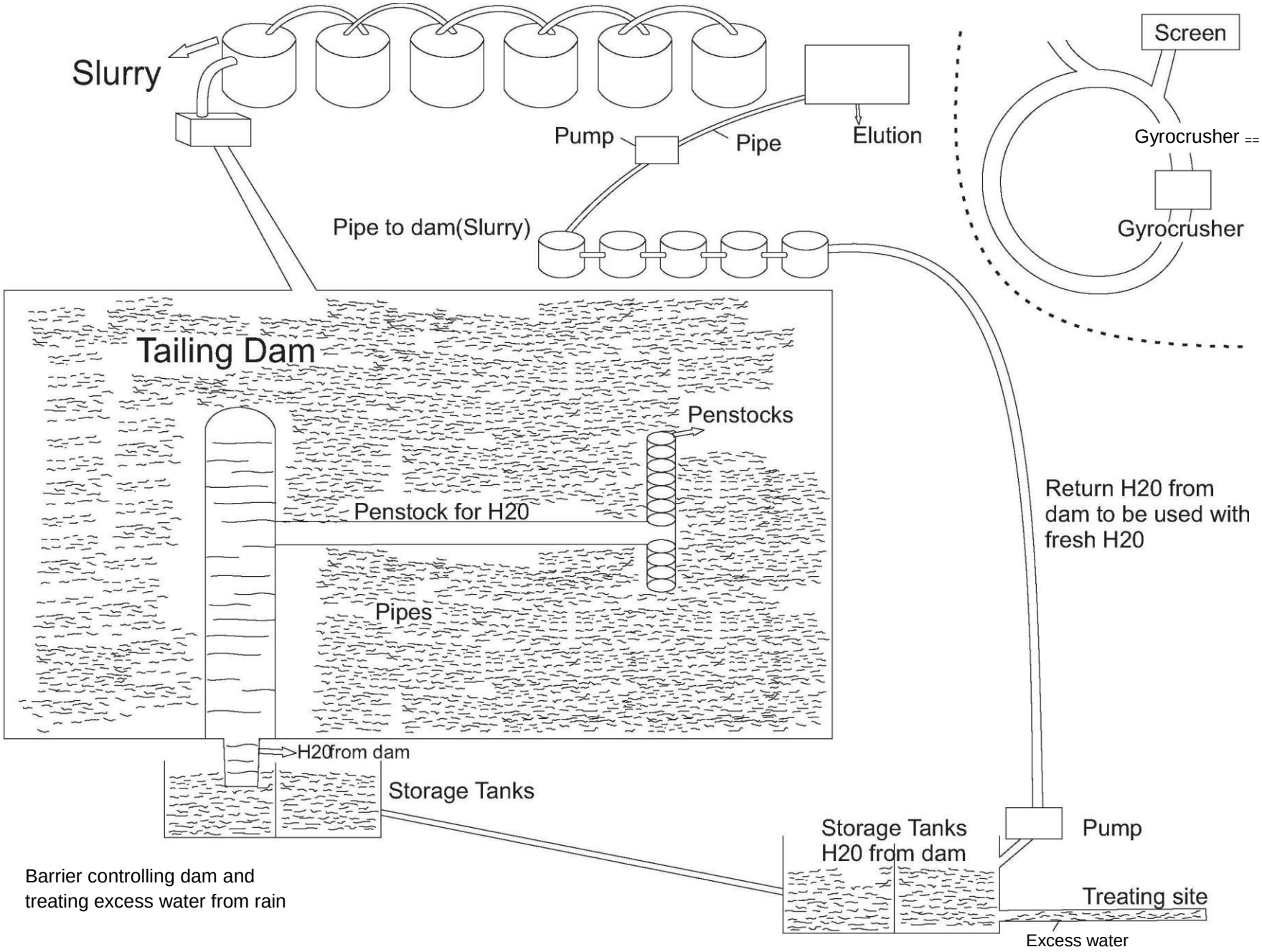
Public Consultative forum minutes

Copy of current NEMA EIA/EA expert license

Site layout and design of the plant and chemical specifications


Car Park
Main Offices
Gate
Container
Main store for mining equipments
Lime Store
Hcl
$S_4ClO_2$
Nitric Acids Store
Lab Section
Plant Store (Steel Balls)
Plant Power Room
Plant office
Workshop Site
Workshop Store
Cartion Store
Caustin Store
Sodium cyanide store or GDA store
1st Bin .....
2nd Bin
Jaw crusher
Screens
Gyro Crusher
Gyro Crusher
Milling Bin
Mottor
Steel Ball Line
Ore
Cyclone Sefurator
Screen
Samp Room
Mill Machine
Mill
Under Flow
Linings
Pump
Elution Room
Slurry
Screen
Carbon 300kg
Slurry
Slurry
Pipe to Dam


Underground section
Skip
Chain
Bin Storage
Power Lights
Barrier
Power lights
Skip way
Hill
Compressor
Bell
Main door
Shaft
Hoist room
Hoist pipe(Air Ventilation)
Main door
Stairs pathway
Rails for skips
Pilling materials from underground
Hoist driver
Hoist machine
Sorting materials site
H2O Tanks
U/G Toilets
U/G Offices
U/G Store
To shaft site
Security men
TO PLANT SITE
ROAD
Grasess
Magazines for Explosives (well guarded) Storage(2 guards)
Canteen
Changing Room
Security Gate

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Barrier controlling dam and treating excess water from rain

**Notes on Mining and Purification Underground processes (referring to the flow diagram above)**

1. Surveillance is done by surveyors.
2. Area is made safe for operations including pumping water out.
3. Samples taken, building stabilised or raised to control risks.
4. Drillers then drill and sample out high good materials/ore/reeps
5. Blasting is then done.
6. Lashers then remove what is already blasted and move it to the store/pilling for easy transportation
7. Hoist driver signals to remove the materials using skip by a rail road.
8. Materials are then stored in a bin for a tractor collection to the plant site.
   - The low grade are dumped away
   - Medium grade are sorted at sorting plant site
   - High grade are moved direct for crushing
9. A generator is needed for backup in case of power failure for operation especially (compressor) for air ventilation inside the mine shaft.
10. Magazines are manned well day and night - 2 guards day and 2 nights
11. Licensed transporters of explosives, blusters etc are used

**Chemicals**

1. Lime is added to the system through inlet of the mill 0.5kg/500g/15mins depending on colour tested by PH paper
2. Steel balls are added to the system through inlet of the mill 2.2 - 2.3 kg x 2 (4.4 - 4.6 kg)/Hr depending on mode of crushing materials in the mill. The more time taken to fill wheelbarrow from mill the lesser steel balls put, and vise versa.
3. Sodium Cyanide (NaCN) is put 0.5kg / 15mins intervals until the milling machines is shut down. It is added starting with the first CIP tank.
4. Hydrogen Peroxide ($H_2O_2$) is added to 1st C.I.P tank at intervals of 200ml/15 mins till the machine shuts down
5. Before the start of milling, the following is done to all C.I.P tanks, first to the last;
   i. NaCN - 1kg (addition)
   ii. $H_2O_2$ - 200 ml (addition)
   iii. 1 L of materials from C.I.P tank taken to the laboratory
6. Specific Gravity (SG) determined for samples taken after every hour, for purpose of calculating tonnages and detecting any non.conformity
8. Flushing of concentration - cleared after every intervals of45mins - 1hr frequently during milling for the separation of Gold

9. C.I.P tanks are drained at the end of every mouth for elution.

10. Best samples are taken by 1m stick at intervals of every 30 mins at mill inlet to determine the tonnage milled