

## **ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT SUMMARY**

**Project Name:** Maamba Collieries Power Generation Project  
**Country:** Zambia  
**Project Number:** P-ZM-F00-001

### **1. INTRODUCTION**

- 1.1 The objective of the project is to produce power while at the same time preventing pollution associated with self-burning low grade coal stockpiled for decades and in the project area. It entails the re-use of what has and would otherwise be left as waste in the project areas with insurmountable health risk due to smoke inhalation. Zambia's reliance on hydropower to meet current and future electricity demand faces some challenges ranging from increased economic development leading to growing demand for other water uses; the potential for increased water needs to address conservation goals in light of the potential impact of climate variability on water supply and evaporation and increased power demands requiring additional water for hydropower. Therefore diversification of Zambia's energy sources from 96% hydropower while at the same time controlling pollution and minimising health impacts due to spontaneous combustion will be beneficial to the country's needs in terms of energy reliability and ultimately development at large.
- 1.2 Maamba Collieries Limited (MCL) was incorporated in 1971 under the ownership of the Republic of Zambia through the Zambia Industrial and Mining Corporation (ZIMCO). The project area is located at Maamba Township in Sinazongwe district of Southern province which is about 350km from Lusaka, Zambia. MCL has operated under the current mining title since 1970. The mining title encompasses approximately 7,900 hectares located on the Siankondobo coalfield in the Gwembe Valley, in the Southern Province of Zambia.
- 1.3 The company is the largest producer of coal in Zambia with estimated coal reserves of 103 million tonnes of high grade coal and 70 million tonnes of low grade coal. MCL is operating an open cast coal mine with a production history of almost 40 years. The summary therefore includes the description of the process from mining to power generation; because the latter is the main objective of the project. Benefits and impacts of the project are highlighted indicating the proposed mitigation and existing gaps that require to be addressed prior to the Bank disbursing money. Project alternatives are entailed in section 5 and they outline options considered for the mining method, infrastructure location and technology issues where the preferred option was based on engineering, economic, environment and social considerations.

### **2. PROJECT DESCRIPTION AND JUSTIFICATION**

- 2.1 MCL lies within the Siankondobo coalfield comprised of karoo age sediments, exposed within the current Zambezi River valley. These coal bearing sediments stretch into neighbouring Zimbabwe. MCL extracts coal from the Gwembe coal formation which comprises lower Maamba sandstone overlain by carbonaceous mudstones. The project area is as indicated in Figure 1 Below.

2.2 MCL plans to revive coal mining and construct a thermal power plant that would be able to produce about 600 MW of power. The first phase will involve the start of the open-pit mining; construction of the coal handling and preparation plant (CHPP) for upgrading the quality of the run of mine (ROM) coal to suit customers. Other auxiliary infrastructure that will be constructed will include water reservoir, water pipeline from Lake Kariba to the water reservoir, and also the refurbishment of the engineering workshop.

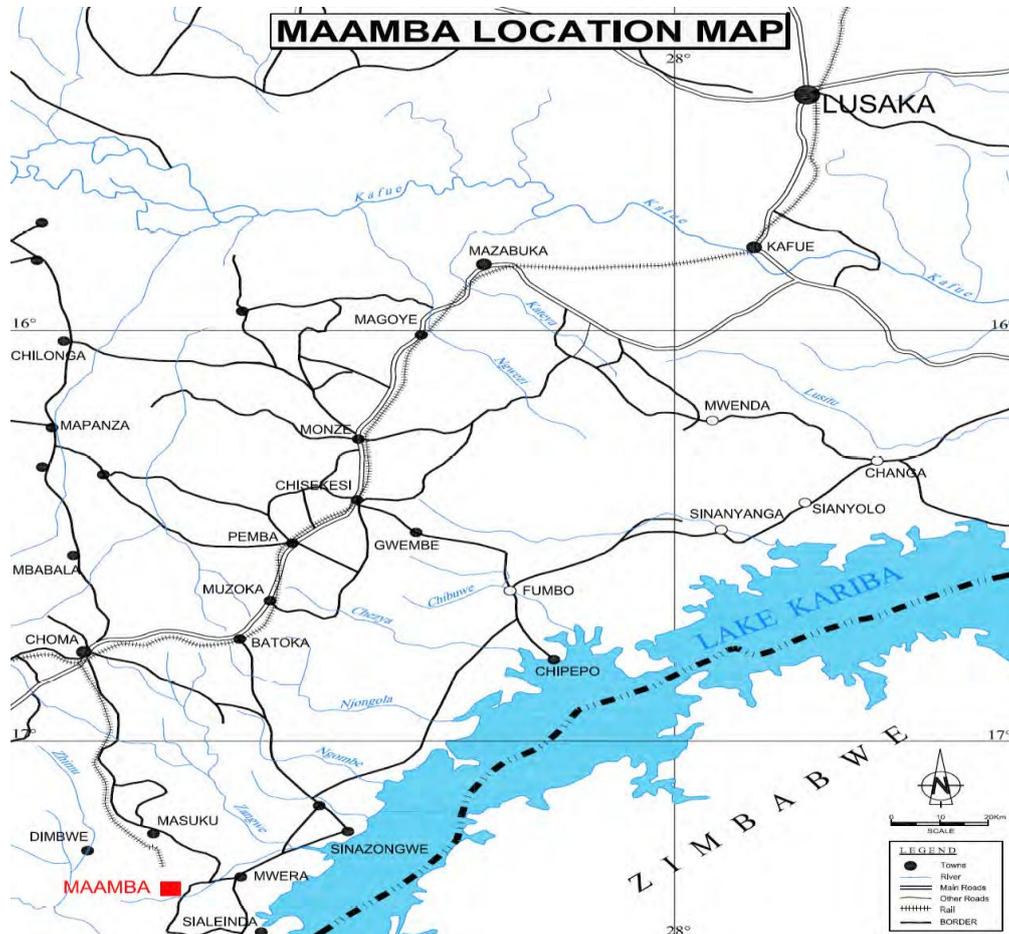


Figure 1: Project Area

2.3 The power plant construction will include construction of conveyors from the mine to the CHPP and power plant; and vice versa; construction of a 330 kV double circuit power transmission line from Maamba to Muzuma; refurbishment of the Aerial ropeway from Maamba to Masuku; refurbishment of the workshop and the magnetite processing plant; construction of lake water pump house at Kariba and pipe line to the raw water reservoir; construction of raw water & clarified water reservoirs.

2.4 The project will provide incremental generation capacity of 300 MW and increase reliability of electricity supply which will bring growth to the various industries. The project is also expected to lead to sustainable social development in the project areas with an increase in paid jobs, infrastructure development and community improvements in various areas such as health, education and recreation.

### 3. Policy, Legal and Administrative Framework

3.1 Various pieces of legislation related to environmental management and protection as well as protection of the public were applied in carrying out the ESIA. Legislation considered included

- The Environmental Management Act No. 12 of 2011 and its subsidiary regulations;
- The Mines and Minerals Development Act and subsidiary regulations;
- The Public Health Act
- The Energy Regulation Act
- The Land Act;
- The Explosives Act;
- The Town and Country Planning Act;
- The Forest Act;
- The Zambezi River Authority Act
- The Electricity Act; and
- The National Heritage and Conservation Commission Act.

#### 3.2 Environmental Management Act (EMA)

This is the principal legislation governing environmental management in Zambia. The Act provides for the continuation and renaming of the Environmental Council of Zambia (ECZ) as ZEMA. The Agency is mandated to ensure the sustainable management of natural resources and protection of the environment, and the prevention and control of pollution. In relation to this project, some of the functions of ZEMA are to review environmental impact assessment reports, and undertake environmental auditing and monitoring. The Act also provides for public participation in environmental decision-making and access to environmental information. In particular, section 29 of the Act states that *“A person shall not undertake any project that may have an effect on the environment without the written approval of the Agency, and except in accordance with any conditions imposed in that approval”*. The Act provides specific regulations and relevant ones within which the ESIA was conducted are the environmental impact assessment regulations.

#### 3.3 The Environmental Impact Assessment Regulations, SI 28 of 1997

The Environmental Impact Assessment (EIA) Regulations, Statutory Instrument 28 of 1997, Part II, under the Environmental Protection and Pollution Control Act of 1990 demands that before a developer commences implementing a project, an environmental impact statement (EIS) *be* prepared and submitted to the relevant regulatory authority for review and approval. The EIA regulations specifically require that a developer prepares and submits an EIS for:

- a) Any project set out in the Second Schedule, whether or not the developer is part of a previously approved project;
- b) Any alterations or extensions of any existing project which is set out in the Second Schedule; or
- c) Any project which is not specified in the Second Schedule, but for which the Council determines a project brief should be prepared.

#### 3.4 The Waste Management Regulations (SI 71 of 1993)

The management of non-hazardous waste – storage, transportation and disposal – will be done in accordance with the Waste Management regulations.

#### 3.5 The Air Pollution Control Regulations (SI 141 of 1996)

The Air Pollution Control Regulations give powers to ECZ to regulate emission of air pollutants into the atmosphere in order to safeguard the general health, safety or welfare of persons, animal life, plant life or property affected by the workers, industrial or business activities undertaken by an operator. In line with these regulations, open air burning of waste will not be permitted anywhere within the mine premises. Spontaneous burning of coal will be controlled in order to comply with these regulations.

#### 3.6 The Water Pollution Control Regulations (SI 72 of 1993)

These regulations govern the discharge of effluent into the aquatic environment. The regulations provide for the installation of appropriate pre-treatment facilities and ensuring that the discharged effluent conforms to the conditions and standards for chemical, biological and physical parameters contained in the table of standards for effluent and waste water, set out in the Third Schedule of the regulations.

#### 3.7 The Hazardous Waste Management Regulations (SI 125 of 2001)

Any used oil generated, asbestos waste or any waste exhibiting the following characteristics – toxicity, flammability, infectious, irritability, etc – will be handled in accordance with the hazardous waste management regulations.

#### 3.8 The Mines and Minerals Development Act, 2008

The Act provides for the control of mining activities with regard to environmental protection. MCL will ensure that environmental controls are put in place alongside safety and occupational health management measures.

#### 3.9 Pneumoconiosis Act

This Act (No. 13 of 1994) provides for the requirement for Certificates of Fitness for all mine employees that work in a restricted mine areas – working places where free silica in the respirable dust with particle size less than 5 microns is harmful to humans if inhaled over a period of time.

#### 3.10 The Town and Country Planning Act

The Act came into force in 1962 and provides for the appointment of planning authorities whose main responsibilities are the preparation, approval and revocation of development plans. It also provides for the control of development and subdivision of land. The Act does not however apply to Trust Land and land in Reserve and Mining Areas, which fall under regional plans. The Act has been referred to during the study to verify land ownership; number of people on the land; extent of the farmland affected and authorising officer at the time of obtaining land. Further demarcation of land and issuing of title deeds is done by the local authority.

#### 3.11 The Water Act

The Act regulates the use of public water including protection against pollution. The act has been referred to during the study to ensure that the impact on the quality of water during construction is minimised.

### 3.12 The Zambia Wildlife Act

The Act provides for the establishment, control and management of national parks. The proposed thermal power plant project will have a power transmission line that will pass on the edge of forest in Masuku Mission. Measures will be taken to ensure the safety of the animals and people. The act will also be referred to during the briefing of construction workers on wildlife conservation.

### 3.13 The National Heritage Conservation Commission (NHCC) Act

The act was referred to during the study to ensure that should there be any cultural, historical or national monuments discovered during construction, the NHCC will be notified.

### 3.14 The Forest Act

It provides for the establishment and management of National and Local forest conservation and protection of forests and trees, and licensing and sale of forest. During the study, personnel from the Forest Department at both the provincial and district level were consulted on the status of the Forest Reserves and how MCL could work within the Forest during and after the project.

### 3.15 The Zambezi River Authority Act, 1987

An Act to give effect to certain provisions of an interstate agreement relating to the utilisation of the Zambezi River concluded between the governments of the Republics of Zambia and Zimbabwe for the management of the Zambezi River. The Lake Kariba from which water will be abstracted is under the jurisdiction of the Zambezi River Authority.

### 3.16 Energy Legislation

The Department of Energy is responsible for the administration of the petroleum policy including pricing, storage and the oil pipeline, control and administration of electricity, production and processing of fossil fuels, and development of renewable energy resources. The Department also administers the Electricity Act, the Petroleum Act (No.13 of 1985), the Zambia-Tanzania Pipeline Act, the Energy Regulation Act, CAP 436 of 1995, the Rural Electrification Authority Act ( No. 20 of 2003) and the Zambezi River Authority Act. The development of the Power Plant therefore will have to be in line with the provisions of the Electricity Act that is administered by the Department of Energy. The Electricity Act (No. 15 of 1995) under CAP 433 of the Laws of Zambia is an Act established to regulate the generation, transmission, distribution and supply of electricity;

### 3.17 International Commitments Influencing Local Planning of Zambia

The Government of Zambia recognised and affirmed Agenda 21 and signed and is party to more than 30 international and regional conventions and protocols. They include

- Ramsar Convention
- Convention on International Trade in Endangered Species of Wild Flora and Fauna(CITES)
- Convention on Biological Diversity (CBD)
- The United Nations Framework Convention on Climate Change (UNFCCC)
- United Nations Convention to Combat Desertification (CCD)
- Convention on the Protection of World Cultural and National Heritage
- Convention on the Protection of Ozone Layer

- The Kyoto Protocol
- Basel Convention

The UNFCCC and its associated Kyoto Protocol are of particular relevance to the Power Plant. The UNFCCC sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognises shared climate resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The objective of the Kyoto Protocol is the “stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”. Although a developing country like Zambia is not required to reduce carbon emissions in terms of the protocol, there is still a common responsibility that all countries have to reduce emissions where possible.

### 3.18 African Development Bank’s ESAP

These environment and social assessment procedures among others call for screening of proposed projects to determine the type and extent of assessment required. A proposed project is classified as Category 1 if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. The Maamba project is classified as category one which requires a full ESIA and because it involves resettlement of some community members there is a RAP prepared as well. The AfDB’s disclosure requirement of 60 days for category 1 private sector projects is also complied with in addition to the stakeholder consultations that were part of the ESIA process.

## 4. DESCRIPTION OF THE PROJECT ENVIRONMENT

### 4.1 Climate:

The Southern Province of Zambia lies predominantly between the elevation of 1,200m asl (for areas on the plateau like Choma, Kalomo and Monze) and 500m amsl (for areas in the Gwembe valley like Siavonga, Sinazongwe and Maamba. The region has distinct dry (May to October) and wet (November to April) seasons. Rainfall mainly occurs in heavy thunderstorms producing typical precipitation events of 10 to 40 mm. Department of Meteorology indicated that the province used to get a lot of rainfall though now the amounts has reduced due to climate related issues and deforestation.

### 4.2 Local Rainfall, Temperature and Wind Data

In 2011, MCL installed a weather station at their mine offices. The total annual rainfall recorded at MCL mine office for November 2010 - August 2011 is 1,220.70 mm. Temperatures are defined by the two seasons, cool and dry (May to September) and warm and wet (October to April). Maximum recorded at MCL in November was 33.4°C and the lowest was 22.7 °C recorded in July. Mean monthly humidity in the project area range between 64.24 and 89.77%.

### 4.3 Air Quality

Spontaneous fires from the uncovered and loosely covered coal dust in disused overburden dumps, grassland and forest fires, charcoal burning and traditional slash and burn agriculture during the dry season generates smoke and dust and has caused a lot of pollution in the project area as shown in Figure 2 below. This air pollution hangs over the area and forms a distinctive haze especially when it’s cold. The haze layer is mainly visible from the air and worst during the coolest months (June and July) when temperature inversions tend to trap the smoke near ground level. The haze lasts until the

weather becomes hot in the months of August or September. Localised air quality deterioration is also associated with village domestic fires. The size of airborne particulate matter of interest in air pollution studies usually range from 50µm down wards. Respirable particles of less than 10µm are of special concern due to health hazard potential. Particulates between 10 µm and 2 µm are referred to as coarse particles (MP10) while those of less than 2 µm are termed fine particles (PM2.5). High levels of suspended particulate matter increase chances of respiratory diseases such as chronic bronchitis and asthma cases to the exposed population.



Figure 2: Spontaneous Combustion

Air quality monitoring was conducted at six locations in the project area from February 2011 until May 2011. The ranges of monitoring results are given below in ug/m<sup>3</sup> and the permitted figures in the same units are PM<sub>10</sub> = 70, NO<sub>x</sub> = 400, CO = 30 and SO<sub>2</sub> = 350.

Sampling Site	Total Suspended Solids	PM <sub>10</sub>	SO <sub>2</sub>	NO <sub>2</sub>	CO
Power Plant	95.8 – 108.4	35.5-45.5	220-243	370-560	6-12
Old Service Station	98.7-100	36.3-58	234-250	320-350	7-18
Air Strip Area	90.3-100	48.2-57.6	210-263	318-345	7-14
Izuma Block A	102.5-200	50.6-57.6	269-283	320-376	12-17
Sipumina Village	89.7-100	40-58.2	176-190	369-387	19-26
Montlev Town	57.4-64.8	27.5-37.2	129-153	222-246	6-12

The results show that most of the parameters are within permitted levels by ZEMA with the exception for the values of NO<sub>x</sub> during the months of February and April. This could be attributed to the fact that, during that period, there was a lot of smoke that was being generated from the spoil heaps. This, coupled with cloud and still environment, resulted in the reading being high.

#### 4.4 Topography

Maamba lies between 575 to 689m asl and located within Sinazongwe District, which covers 4,964 sq km. Most of it lies in the Zambezi rift valley with a hilly terrain and is about 30 km from Lake Kariba shore.

#### 4.5 Land Use and Land Class Evaluation

The majority of land cover is degraded disturbed woodland. The project area is affected by shifting cultivation practices, burning, and charcoal burning activities. A recent review of irrigable soils indicated that the area required for the mining lease tends to be rocky, with numerous bare back granite outcrops. As a result the mining lease is generally not suitable for large scale arable farming activities, including irrigation, even

though there is a lot of small scale agriculture activities' taking place especially along the flat land found along the streams in the surrounding areas. Maize fields are common in the area and cultivated for up to five years before planting a drought resistant crop such as sorghum, millet etc. Animal husbandry is limited to the keeping of goats, pigs, chickens, ducks and cattle. Mountains dominate the land so much that land for settlement is only found in isolated pockets. However, most of the habitable land is used for agriculture. There is no manufacturing or any other industry within the mining licence area, or within the larger area surrounding the project. Nearby urban areas include Sinazongwe and Choma. Traditionally, men control most of the land. They decide on the use of the land while women have limited say over what to do with the land.

#### 4.6 Hydrology

The elevations within Maamba vary. Some rivers and all the streams drain from the Zambezi escarpment. Along the side of these rivers and streams are rich floodplains of alluvial soils, which are cultivated by the local people. Two streams drains the project area i.e. Kazinze and Izuma streams. The Kanzinze River is the main surface water channel which flows through the mine area and then flow southwards to Lake Kariba. Izuma River is also another river which flows through the open pits and then joins the Kanzinze River in the south of the project area.

#### 4.7 Flora

Maamba basin forest comprises Riparian and Munga forest which seem to have regenerated. There are mainly tall grass and shrubs which are sparsely distributed. The tree species in the open pit are mainly those whose fruit are winged and dispersed by wind. The trees found growing on the site were multi-stemmed. This could be due to stresses exerted by the environment on the plants especially during the regenerative phase when soil moisture in the dry season can be quite constraining. The results show that there are 190 stems per hectare (SPH) in the whole assessed area.

According to the inventory results for Maamba, Mopane, *Brachystegia* and *Julbernardia* species are the most common species and these are the species that regenerate very quickly by seed and are generally suitable for poles. But then, these trees can be utilised for fuel wood and service provider (i.e. such as soil conservation, protection of streams from siltation, etc). The diameter and height analysis show that the forest structure of the assessed area of Maamba, defined by the height indicate that average height 6m, Average diameter is 13cm. Timber production therefore, has little potential.

#### 4.8 Fauna

There are birds in the area; a number of crocodiles were also sighted in the old dump sites. Clearing of woodlands to create farmland and settlements in the project area, coupled with increased human presence, has led to fragmentation of wildlife habitats. In the area most reptiles, with the exception of snakes, are rarely killed unless where human life is threatened. Human and wildlife conflicts are very few.

#### 4.9 Demography

The last Census of Population and Housing which was conducted in 2000 estimated the population of Zambia at 9.9 million and projected it to rise to 13.3 million in 2011. It was estimated that 4,946,298 were males while 4,939,293 were females. According to the Living Conditions Monitoring Survey (LCMS) of 2006, approximately 65% of the population live in rural areas, compared to 35% residing in the urban areas. According

to the 2006 LCMS, Zambia's population is generally young, with 66% aged 0 – 24 years. The working age population, 15 – 54 years old, constitute 51.2 % of the total population. The annual population growth rate was estimated to be at 2.4 percent. HIV and AIDS prevalence rate for the active population age group (15 – 49 years) is estimated at 14.5%. This high prevalence rate is said to have contributed to the reduction in the life expectancy to 48 year and 52 years for male and female respectively.

#### 4.9.1 Regional

The study area lies within Zambia's Southern Province which, according to the 2006 LCMS, had 12 percent of the total population. 78 percent of the people in Southern Province live in urban areas while 22 per cent are in rural areas.

#### 4.9.2 Local

The 2000 Census of Population and Housing estimated that Maamba had 1,821 households and a total population of 10,299 of which 49.47% were male.

#### 4.12 Economic and Social Situation

Coal mining is the dominant economic activity in the area. Maamba residents are mainly dependent on the coal mine for their survival. They either work for the mine or supply goods and services to the mine or to its employees. Diminishing activities at the mine has caused a lot of suffering for locals as there are few alternative opportunities for them. Some have ventured into subsistence crop and pastoral farming.

Most households in the area surrounding Maamba earn their living by keeping livestock, specifically cattle and goats, and fishing. The major crops grown are maize, cassava, sweet potatoes, sorghum, millet and vegetables. These crops are mainly grown for household consumption with a few sold within the communities and occasionally to Maamba and Choma. Apart from vegetable gardening that goes on throughout the year, most agricultural activities are seasonal; conducted during the rainy season.

#### 4.13 Health

Sinazongwe District has 14 health facilities, all of which are Rural Health Centres, apart from Maamba District Hospital. The most common diseases in the area are malaria fever, diarrhoea, and respiratory complications. HIV/AIDS is exacerbated by prostitution in the area. Girls are known to be sold into prostitution due to household poverty. Respiratory tract infections, because of the district's mining activities, have also been discovered to be a major health issue among the residents.

#### 4.14 Sanitation

Most houses in and near the mine area generally have good sanitation as they are connected to the MCL water and sewerage network. Nonetheless, the sanitation situation of households in communities described as villages is poor as there is no clean and safe water, waste disposal and other facilities which is the major cause of diarrhoea related illnesses. Villagers in some cases have to walk long distances to fetch water from wells and streams.

#### 4.15 Education

There are about 40 schools offering education from the first grade up to high school. Some of the rural places have no schools nearby hence the pupils have to walk long

distances to and from school which discourages some from attending school. There are no tertiary or vocation training institutions in the area.

#### 4.16 Recreation

Maamba has a number of good recreation facilities which include a golf course, football stadium (Kanzinze), pitches (mainly at schools), pubs etc. Most of these facilities were constructed during the time when the mine was fully operational, and have thus been dilapidated during the period that the mine has not been doing fine.

#### 4.17 Housing

Most of the houses in Maamba were constructed by MCL to accommodate its employees in the 1970s and are generally in a good conditions. These houses are made out of bricks with asbestos roofing. However most villages in areas near the mine are typical village houses with thatched roofs, mud walls or burnt bricks and serviced by pit-latrines,

#### 4.18 Mode of transportation in project area

For local transportation some use bicycles, donkeys and coach carts. The roads in the area are mainly gravel, except for the ones leading to the mine and service areas.

#### 4.19 Power and communication

Maamba and the surrounding areas are connected to the national grid through the Muzuma ZESCO sub-station. However, it is mainly those in mine, government and privately built brick houses that have access to power. The majority of the people in surrounding farms and villages rely on traditional sources of energy.

#### 4.20 Other public services

Maamba has other public facilities atypical of an urban area at smaller scale. There are banking facilities in the area (Zanaco) and some shops/market where trading takes place. People still have to travel to Choma for some of the items which are not found in Maamba. There is also a post office and a police post. Maamba Collieries Limited has engaged the services of Pre-Secure Security Company which provides security to the mine and its properties.

### **5. PROJECT ALTERNATIVES**

#### 5.1 The 'Do Nothing' Alternative

The 'do-nothing' alternative is the option of not developing the Maamba mine and not establishing a new coal-fired power station at Maamba. If the project does not go ahead, the environmental impacts of the area such as spontaneous combustion, acid mine drainage and unsightly environs will continue. In addition, not proceeding with the project will not avail Zambians, especially locals, of the needed job opportunities. Establishing the project will contribute significantly to the economic and social wellbeing of the area through job creation as well as to the nation's treasury through PAYE and other tax remittances. The project will also enhance the locals' technological and managerial capacity through skill transfer. Therefore, the 'do nothing' option has not been considered as being feasible.

#### 5.2 Selling Coal to Companies vs. Using Coal to Generate Electricity

The electricity demand due to increased industrial and economic development in Zambia is placing increasing pressure on existing power generation capacity. This has put pressure on the existing installed capacity to be able to meet the energy demands

into the future. If the company embarked on wholesale distribution of coal without adding value, the electricity demands will not be met in the short-term. Without the implementation of the power generation project, the electricity network will not be able to function at full capacity, and the greater power supply will be compromised in the near future.

In addition, mining of the coal with a lower calorific content will not be very economical as companies are interested in obtaining coal with a higher calorific value. The proposed power generation project will be designed to take coal of lower calorific value. This undertaking will therefore mitigate against spontaneous combustion as historically, coal of lower calorific value has been discarded or stockpiled.

### **5.3 Ash Disposal Alternatives**

The company has considered the possibility of disposing ash by the following methods:

- Land disposal
- Land filling back into mined out areas
- Using the ash for making bricks.

Land disposal will require a separate dump and additional land within the mine surface area. Using the ash to make bricks will require further financial and economic evaluation and marketability of the brick. MCL will use ashing back into the mined out areas of the pit before considering other options.

### **5.4 Analysis of Process and Emission Technology**

As a clean coal combustion technology, the Circulating Fluidized Bed (CFB) technology has been successfully used in boilers since 1980's around the world. The various types of solid fuel combustion systems historically available, such as stokers, pulverized fuel, and cyclone-fired boilers have distinct and specific advantages and disadvantages. A few of the disadvantages that are common to each of them in varying degrees are: Low residence time of material in the combustion zone (except stokers) requires high combustion temperatures to assure adequate combustion efficiency without excessive unburned carbon losses. High temperatures, usually more than 980°C, contribute to the formation of nitrogen oxides, which are environmentally objectionable. High combustion temperatures also dictate the use of post-combustion treatment scrubbers for removal of sulphur dioxide (SO<sub>2</sub>). When the combustion temperature is maintained between 815°C and 870°C, SO<sub>2</sub> removal can be accomplished by injecting limestone (CaCO<sub>3</sub>) directly into the furnace. The low ash fusion temperature of many solid fuels prevents use with conventional combustion systems because the higher combustion temperatures result in the formation of slag on boiler heat transfer surfaces. The need to overcome these difficulties when using low-grade, less expensive fuels has led to the development of fluidized bed combustion systems. Presently, there are two distinct types of fluidized bed boilers in commercial operation: bubbling bed and circulating bed.

#### **5.4.1 Bubbling Bed**

In the bubbling bed-type boiler, a layer of solid particles (mostly limestone, sand, ash and calcium sulphate) is contained on a grid near the bottom of the boiler. This layer is maintained in a turbulent state as low velocity air is forced into the bed from a plenum chamber beneath the grid. Fuel is added to this bed and combustion takes place. Normally, raw fuel in the bed does not exceed 2% of the total bed inventory. Velocity of combustion air is kept at a minimum, yet high enough to maintain turbulence in the bed. The combination of turbulent mixing and residence time

permits bubbling bed boilers to operate at a furnace temperature below 890°C. At this temperature, limestone is mixed with fuel in the furnace to achieve greater than 90% sulphur removal. Incomplete combustion results in the formation of carbon monoxide (CO) in the flue gas plus unburned carbon in the solid particles leaving the furnace. In a regular bubbling bed fluidized boiler, combustion efficiency can be up to 92% with the unburned carbon loss component typically in the 2% to 5% range. A good figure, but lower than that achieved by pulverized or cyclone-fired boilers. In addition, some fuels that are very low in volatile matter cannot be completely burned within the residence time in bubbling bed-type boilers.

#### **5.4.2 Circulating Fluidized Bed (CFB)**

The need to improve the fluidized bed combustion efficiency and to burn a much wider range of fuels has led to the development and application of the circulating fluidized bed (CFB) boiler. Limestone is used as sulphur sorbent and furnace temperature is maintained in the range of 815°C to 925°C by suitable heat absorbing surface. Advantages associated with CFB include fuel flexibility – The relatively low furnace temperatures are below the ash softening temperature for nearly all fuels. As a result, the furnace design is independent of ash characteristics, which allows a given furnace to handle a wide range of fuels. Low SO<sub>2</sub> emissions (95% removal) due to the use of limestone; low NO<sub>x</sub> Emissions; high combustion even with difficult-to-burn fuels. The unburned carbon loss component of the combustion efficiency is typically in the 1% to 2% range.

### **6. POTENTIAL IMPACTS AND MITIGATION/ENHANCEMENT MEASURES**

#### **6.1 Positive Impacts:**

The project will bring about positive impacts such as job creations in terms of both skilled and unskilled labour from the construction phase up to operation phase. Provision of employment contributes to raising the socio-economic well-being of the people and thereby reducing poverty levels. Management intends to employ local people unless the required expertise cannot be found locally. The operation of this project will contribute to enhancing the nation's economy through tax payments. The aesthetic value of the area will also be greatly improved since these will be modern structures and the eradication of smoke. A number of service suppliers will also earn income as they will be contracted to supply services such as food, transport, fuel, and extraction and blasting operations. The use of local contractors will increase their capability to carry out their work competently. There may also be an influx of skilled contractors to the area related to various fields of the economy. This will help to set up economic diversification.

#### **6.2 negative impacts:**

Impacts are addressed by mine components and these are:-

- i. Open pit;
- ii. Overburden Dump (OB) and ROM pad;
- iii. Coal handling and processing plant (CHPP);
- iv. Thermal Power Plant;
- v. Power line;
- vi. Water pipeline;
- vii. Engineering workshops, MPP and Aerial rope way
- viii. Materials handling and storage.

Impact during construction	Impact during Operation	Post	mitigation
<b>OPEN PIT COMPONENT</b>			
<p><b>Local Geology</b> The removal of the coal bearing ore using conventional open pit mining methods will permanently deplete the geological resource of the area. There is also a possibility of disturbing the hydro-geological regime of the area.</p> <p><b>Soil</b> Through surface run-off and wind erosion, coal laden dust may cause local contamination of surface soils as well as flora.</p> <p><b>Air Quality, Noise and Vibration</b> Drilling and blasting will cause localised vibrations and noise as well as dust emissions.</p> <p><b>Surface and Ground Water</b> The pumping and discharge of excess water from the open pit may contaminate and affect the quality of surface water into which it may be discharged. This water may have low pH by virtue of sulphur bearing rock formation and may also contain elevated amounts of suspended and dissolved solids and metals. Accidental spills and leaks of oils, fuels, lubricants and hydraulic fluids may contaminate surface water through surface runoff. The pumping water from the open pit may lower the water table in the vicinity of the mine site thereby lowering the amount of water available for domestic consumption in the water wells. Groundwater may be contaminated through infiltration from surface runoff laden with accidental spills and leaks of oils, fuels, lubricants and hydraulic fluids.</p> <p><b>Pit stability</b> Improper erosion, dewatered and storm water management coupled with inadequate mine design and mining as well as poor blasting methods may render the pit unstable. This scenario can be a safety hazards to employees working in the pit.</p> <p><b>Occupational health and safety</b> The windblown dust from the open pit may cause respiratory diseases. The use of haul trucks, front-end loaders and other machinery may pose safety risks for the workers. Poor storage and handling of explosives can cause severe harm to employees through improper handling. Pits left around the mine site can provide a breeding ground for mosquitoes and inevitably lead to high incidences of malaria. In addition, pits could pose a potential physical hazard of injury in the event of someone falling in especially for pits located close to working areas.</p>	<p><b>Landuse</b> The final void left in open pit will be allowed to flood when mine dewatering ceases at the end of the mining activities.</p> <p>Depending on the quality of the water, other land use activities such as recreation or providing water for the animals will be explored.</p> <p><b>Surface Water and Groundwater</b> The flooding of the open pit will result in the hydrological regime rebounding to baseline levels.</p> <p><b>Public Safety</b> Accessing the flooded pits unintentionally may result in drowning. The flooded water may be breeding grounds for mosquitoes.</p>	<p><b>Soil</b> To prevent contamination of water and land as a result of spillage of oil and fuel from storage and handling of fuel the storage area will be provided with impervious surfacing and containment.</p> <p><b>Air Quality, Noise and Vibration</b> Workers assigned to jobs with high prolonged exposure to highly pitched noise will be provided with personal protective gear such as ear plugs or muffles as appropriate. Equipment will be well serviced to improve efficiency and reduce friction of moving parts which may generate noise to limit noise levels to less than 85 dB. The blasting operation will be done by licensed employees, who are quite adept with handling and using of explosives. Adequate warning will be carried out before blasting. The major impact on air quality will be dust. Therefore, dust emission from access roads into and from the pit will be frequently suppressed with water.</p> <p><b>Surface and Ground Water</b> Storm water cut-off drains will be constructed around the perimeter of the open pits. Silt traps will be constructed across all channels draining open pit areas, to settle suspended solids from surface runoff prior to release to the environment. Except for emergency cases, servicing of machinery will not be done in the pits be carried out offsite in the Engineering Workshop. In the event that servicing or repairing happened in the pit, sumps will be used to contain oils and fuels so as to prevent surface and/or groundwater contamination. Portable toilets will be used for the disposal of sewage generated from the pits. Sewage disposal will be in stabilization ponds via the existing sewage reticulation system.</p> <p><b>Pit stability</b> Implement erosion and storm water management measures by constructing diversion channels around the perimeter of the open pits and grading of the perimeter haul road to divert storm water runoff and surface drainage away from the pit and its slopes. The pit will be dewatered to prevent build up and accumulation of water. Silt settled in the open pit sump during the wet season will be removed as necessary during the dry season by hydro or mechanical means to free up capacity for water to accumulate at the bottom of the pit. Cautious blasting will be practiced at pit limits to preserve the final pit wall. Regularly check and revise slope design as the pit is developed and additional data on the rock mass is collected.</p> <p><b>Occupational health and safety</b> Employees will be provided with adequate personal protective equipment. All workers will be trained in occupational health and safety and applicable protocols will be firmly enforced. All workers will be provided with personal protective equipment. An emergency response plan will be put in place to guide response and minimise effect in case of an emergency situation. Fire drills shall be held regularly and all pits shall be cordoned off with reflective material. Flammable materials shall be stored away from ignition sources. All heavy equipment and fuelling sites shall have approved and fully charged fire extinguishers installed.</p> <p><b>Local Geology</b> The voids left by the removal of the coal bearing will be backfilled by ash from the TPP. At cessation of mining operations, the pits will be allowed to flood as indicated the section below.</p> <p><b>Landuse</b> The open pit will be allowed to flood when mine dewatering ceases at the end of the mining activities. Depending on the quality of the water, other land use activities such as recreation or providing water for the animals will be explored.</p> <p><b>Public Safety</b> Accessing the flooded pits unintentionally may result in drowning. The flooded water may be breeding grounds for mosquitoes.</p>	

Impact during construction	Impact during Operation	Post	mitigation
<b>Overburden Dump (OB) and ROM pad</b>			
<p>During the operational phase, activities at the overburden dump will involve the movement and dumping of overburden material by haul trucks.</p> <p><b>Visual character</b> The dump will be visually noticeable and affect the natural topography of the area. This will affect the aesthetics of the area.</p> <p><b>Soil</b> There is potential of metals/salts leaching from the overburden into the ground thereby affecting the quality of soil. The surrounding soils may also be contaminated by surface runoff from the dump or dust blown off the overburden dump.</p> <p><b>Dump stability</b> Poor dump design as well as improper tipping of overburden material may render the dump unstable. In addition, erosion of materials from the surfaces of the dump can affect the integrity of the dump. Leaving the overburden material (has some coal bearing materials) exposed to the atmosphere without any inert soil to prevent spontaneous combustion can also destabilise the dump wall.</p> <p><b>Occupational health and safety</b> Dust and noise generated by operational equipment will pose occupational health concerns for the workers while inadvertent access to the coal stockpiles may raise safety concerns for mine workers.</p> <p><b>Air Quality, Noise and Vibration</b> The hauling and dumping of overburden may generate dust emissions and cause noise pollution. This may affect flora and fauna. Vehicular emissions may also cause localised air pollution. The overburden material if not adequately covered with inert soil and is left exposed to the atmosphere may result into spontaneous combustion releasing gases into the atmosphere.</p> <p><b>Surface and groundwater</b> Erosion of the sidewalls and upper surface of the overburden dump may contaminate surface runoff that will end up in local watercourses. The water quality in these water courses may be affected by suspended solids with elevated metal contents. If the overburden material contains significant levels of sulphides, Acid Mine Drainage (AMD) may occur. AMD may contaminate surface and groundwater. When the sulphur containing material is exposed to water and air, it forms sulphuric acid. The acidity of the runoff is problematic by itself, but it also dissolves metals like manganese, zinc and nickel, which then become part of the runoff. The resulting acidity and presence of metals in the runoff are directly toxic to aquatic life and render the water unfit for use.</p> <p><b>Flora</b> Dust blown from the overburden dump may be deposited on surrounding vegetation and may affect biological productivity.</p>	<p><b>Visual character</b> The dump will be visually noticeable and affect the natural topography of the area. This will affect the aesthetics of the area.</p> <p><b>Air Quality</b> Windblown erosion at the dump might cause localised air pollution. Spontaneous combustion at overburden dumps may be difficult to control if disposal methods were not adequate during the operational phase of the project.</p> <p><b>Surface Water</b> Erosion of the sidewalls and upper surface of the overburden dump may contaminate surface runoff that will end up in local watercourses. The water quality in these water courses may be affected by suspended solids with elevated metal contents.</p> <p><b>Groundwater</b> If the overburden material contains significant levels of sulphides, Acid Rock Drainage (ARD) may occur. ARD may</p>	<p><b>Visual character</b> Landscape intrusion as a result of dumping overburden material will be minimised by the planned progressive rehabilitation. This will involve covering the overburden with inert material to prevent spontaneous combustion and thereafter re-vegetating. The remote nature and topographic outlay of the mine obscures any aesthetic intrusion brought about by the dumping of overburden. Investigate ways of using the overburden for alternative uses such as road aggregate. In the event that no alternative use for the overburden is found, the OB dump will be re-vegetated with indigenous plant species.</p> <p><b>Air Quality, Noise and Vibration</b> Overburden material will be covered with inert material to prevent spontaneous combustion. Trucks will undergo regular maintenance to reduce exhaust emissions. Access tracks and cleared areas will be regularly watered down to reduce emissions of dust. In the event of excess dust being generated, personal protective equipment (dust masks) will be used. The following appropriate measures to reduce dust shall be employed:</p> <ul style="list-style-type: none"> <li>• Keeping disturbed areas to a minimum, and re-vegetating bare areas, as soon as possible;</li> <li>• Minimising vehicle movements and speed. A progressive planting of vegetation will be carried out while the dumped material will be compacted to prevent loose material from being blown off</li> </ul> <p><b>Surface Water</b> Perimeter drains and silt traps will be regularly inspected and maintained. Drains and silt traps will be cleaned before the start of each wet season. The dump walls will be re-vegetated. All coal on the ROM Pad will be processed and the area re-profiled and rehabilitated.</p> <p><b>Dump stability</b> As far as it is practicable to do so, heavily weathered materials and rock types prone to erosion will be identified and placed in central areas well away from dump walls. Conversely, more competent, less weathered materials will be used to construct the outer dump walls and to dress the slopes; Dumps will be of terrace construction i.e. there will be no end-tipping and dump construction will be regularly monitored to verify that it is as per design; Overburden material will be covered with inert soil to prevent spontaneous combustion an activity which can destabilise the dump wall. Re-vegetation of the dump walls and upper dump surfaces will be conducted progressively during the life of the mine to produce a sustainable vegetation cover, stabilise slopes, improve visual aesthetics and minimise post closure re-vegetation requirements.</p> <p><b>Groundwater</b> MCL will continue to monitor the quality of groundwater in the vicinity of the dump and in the event ARD is observed, appropriate measures will be put in place. MCL will endeavour to use all coal bearing materials at the dumps. The dumped material will be compacted to prevent loose material from being blown off.</p> <p><b>Flora</b> To prevent the emission and disposition of dust on vegetation on surrounding vegetation, will embark on re-vegetation of inactive areas of the dump surfaces.</p> <p><b>Occupational health and safety</b> In the event of excess dust being generated, personal protective equipment (dust masks) will be used. All workers will be trained in occupational health and safety and applicable protocols will be firmly enforced. All workers will be provided with personal protective equipment. An emergency response plan</p>	<p><b>Visual character</b> Landscape intrusion as a result of dumping overburden material will be minimised by the planned progressive rehabilitation. This will involve covering the overburden with inert material to prevent spontaneous combustion and thereafter re-vegetating. The remote nature and topographic outlay of the mine obscures any aesthetic intrusion brought about by the dumping of overburden. Investigate ways of using the overburden for alternative uses such as road aggregate. In the event that no alternative use for the overburden is found, the OB dump will be re-vegetated with indigenous plant species.</p> <p><b>Air Quality, Noise and Vibration</b> Overburden material will be covered with inert material to prevent spontaneous combustion. Trucks will undergo regular maintenance to reduce exhaust emissions. Access tracks and cleared areas will be regularly watered down to reduce emissions of dust. In the event of excess dust being generated, personal protective equipment (dust masks) will be used. The following appropriate measures to reduce dust shall be employed:</p> <ul style="list-style-type: none"> <li>• Keeping disturbed areas to a minimum, and re-vegetating bare areas, as soon as possible;</li> <li>• Minimising vehicle movements and speed. A progressive planting of vegetation will be carried out while the dumped material will be compacted to prevent loose material from being blown off</li> </ul> <p><b>Surface Water</b> Perimeter drains and silt traps will be regularly inspected and maintained. Drains and silt traps will be cleaned before the start of each wet season. The dump walls will be re-vegetated. All coal on the ROM Pad will be processed and the area re-profiled and rehabilitated.</p> <p><b>Dump stability</b> As far as it is practicable to do so, heavily weathered materials and rock types prone to erosion will be identified and placed in central areas well away from dump walls. Conversely, more competent, less weathered materials will be used to construct the outer dump walls and to dress the slopes; Dumps will be of terrace construction i.e. there will be no end-tipping and dump construction will be regularly monitored to verify that it is as per design; Overburden material will be covered with inert soil to prevent spontaneous combustion an activity which can destabilise the dump wall. Re-vegetation of the dump walls and upper dump surfaces will be conducted progressively during the life of the mine to produce a sustainable vegetation cover, stabilise slopes, improve visual aesthetics and minimise post closure re-vegetation requirements.</p> <p><b>Groundwater</b> MCL will continue to monitor the quality of groundwater in the vicinity of the dump and in the event ARD is observed, appropriate measures will be put in place. MCL will endeavour to use all coal bearing materials at the dumps. The dumped material will be compacted to prevent loose material from being blown off.</p> <p><b>Flora</b> To prevent the emission and disposition of dust on vegetation on surrounding vegetation, will embark on re-vegetation of inactive areas of the dump surfaces.</p> <p><b>Occupational health and safety</b> In the event of excess dust being generated, personal protective equipment (dust masks) will be used. All workers will be trained in occupational health and safety and applicable protocols will be firmly enforced. All workers will be provided with personal protective equipment. An emergency response plan</p>

Impact during construction	Impact during Operation	Post	mitigation
<b>Overburden Dump (OB) and ROM pad</b>			
<p><b>Occupational health and safety</b> The windblown dust from the dump may pose health hazards to workers. The use of haul trucks, front-end loaders and other machinery may pose safety risks for the workers. There are a number of operational activities that might pose physical hazards and safety concerns for the workers. These include pits, bush fires, potential hazards posed by handling of fuel, blasting, and use of drilling machinery and vehicles.</p> <p><b>Public Safety</b> Access to the dump may result in personal injury or loss of life.</p>	<p>infiltrate the ground and contaminate groundwater.</p> <p><b>Public Safety</b> Access to the dump may result in personal injury or loss of life.</p>	<p>will be put in place to guide response and minimise effect in case of an emergency situation. To reduce the incidence of malaria, any standing water will not be allowed to accumulate in ponds or pits. All containers and equipment where water can collect and provide breeding places will be removed.</p> <p><b>Public Safety</b> Warning signs will be erected around the mining site and the patrols will be regularly carried out to prevent the public from accessing the site. Warning signs will be in place to warn the public about the danger of accessing the mines. In addition, security patrols will be in place.</p>	

Impact during construction	Impact during Operation	Post	mitigation
<b>Coal handling and processing plant (CHPP);</b>			
<p><b>Landscape and visual character</b> Clearing has the potential to destabilise the existing natural ecosystems within the project area. Installation of structures and compacting using heavy machinery have the potential to change the natural landscape and may therefore have an impact on local aesthetics.</p> <p><b>Soil</b> Cleared areas will be exposed to adverse weather conditions such as rain and wind. The use of heavy equipment such as dumper trucks and front-end loaders, can compact and change the texture of the soil. This has the potential to leave the soil prone to erosion. Soil contamination may result from poor handling of petroleum products such as oil and diesel during dispensing as well as improper disposal of waste oils, hydraulic fluids, and empty oil drums.</p> <p><b>Surface and groundwater</b> The land where the construction of the wash plant will take place is bare and almost devoid of any vegetation. This scenario leaves the site prone to soil erosion resulting into the accumulation of solids and the discharge of the same into nearby surface water bodies. Years of lack of investment has also seen the area left without being rehabilitated and uncollected piles of coal slurry are common. The slurry ponds have not been emptied for a long time resulting into the discharge of overflow into the stream during the rainy season. Run off from these ponds have contributed to the acid mine drainage in a nearby stream. The stream is earmarked for diversion. Leaks from</p>	<p><b>Soil</b> Municipal solid waste as well as industrial waste will be generated throughout the project cycle. Unsound management practices of waste have potential to pollute land and water resources. If the coal discard from the wash plant is not properly disposed of, land pollution may occur alongside aesthetic impacts. There are a number of environmental impacts from generation of coal discard. First, the land where these wastes are dumped is no longer useable for other purposes. Second, the piles are flammable and susceptible to spontaneous combustion. Third, they are prone to erosion which is a major concern because the runoff and seepage from these piles is highly acidic. The company intends to use this discard to fill voids in mined out areas.</p> <p><b>Air quality</b> As a result of stockpiling of coal, dust will be generated and dispersed by the wind affecting a zone of up to 100m around the operation site. Emission of loose soil particles on cleared areas during strong winds may also affect the quality of the air in the immediate local environment. Air pollutants are also likely to emanate</p>	<p><b>Soil</b> Surface runoff from the ore stockpile areas may be contaminated which may infiltrate into soils and cause metal contamination in soil and plants.</p> <p><b>Aesthetics-</b> Mining structures if left unattended to at the end of operations or changed to other uses may be an aesthetic intrusion. Therefore, all structures and garbage shall be removed from the site. Drainages and sumps shall be refilled and the soil re-profiled.</p>	<p><b>Landscape and visual character</b> Rehabilitation activities such as soil re-profiling or ripping along the contours, mulching and in some cases re-vegetating using indigenous plant species will be practiced. Less well vegetated areas shall be preferred for work installations and the company will ensure that only the sites where construction will take place will be cleared. Landscaping and planting of flowers will be practiced to improve the appearance of the area near the offices. The remote nature and topographic outlay of the mine obscures any aesthetic intrusion brought about by the erection of buildings.</p> <p><b>Soil</b> Clearing of vegetation will be limited and planting of trees will be undertaken so as to provide a windshield against soil erosion. Mulching on destabilized soils will be practiced and sides of the drainage channels shall be planted with grass or stone pitched to prevent soil erosion. If the ground has been compacted by the use of heavy machinery or prolonged use, the site shall be ripped to loosen the soil. Care shall be taken when ripping or loosening not to create large furrows which may become erosion gullies. This will be avoided by ripping along the contour. Stockpiled soil and vegetation shall be spread over the site after activities have been completed. The site shall be monitored periodically and further work carried out, if required, to ensure success of the rehabilitation. Mulching will be carried out to accelerate seedling development and to reduce the chance of seed being washed away by rainfall and runoff. This practice can accelerate re-vegetation at higher-risk locations.</p> <p><b>Air quality</b> During construction, the sites with potential to generate dust will be sprayed with water to suppress dust. The Coal Handling portion of CHPP is an enclosed gallery thus minimising the dust. Adequate dust control systems like dust extraction and dust suppression systems will be provided at the coal handling and transfer system. In order to ensure a safe working environment and to</p>

Impact during construction	Impact during Operation	Post	mitigation
<b>Coal handling and processing plant (CHPP);</b>			
<p>storage tanks can contaminate surface and subsurface soils, rendering drinking water from aquifers non-potable.</p> <p><b>Air quality</b> During site clearing, dust will be generated and dispersed by the wind affecting a zone of up to 100m around the operation site. Emission of loose soil particles on cleared areas during strong winds may also affect the quality of the air in the immediate local environment. Air pollutants are also likely to emanate from vehicular emissions due to increased vehicular traffic flows. However, this is negligible and transient.</p> <p><b>Land use</b> The area surrounding the project site is a mining area and has been used for coal mining for decades. The proposed project will therefore not bring about any land use change but will however enhance the almost derelict site at Maamba. Construction of the project will however enhance the positive impacts because of the following:</p> <ol style="list-style-type: none"> <li>Stockpiled slurry material will be removed from site, resulting in the elimination of discharge of solids into nearby streams. The possibility of making coal briquettes from the coal slurry will be pursued.</li> <li>The entire area will be cleaned of old equipment and unwanted parts to pave way for the construction of the new wash plant.</li> <li>The areas not to be used for construction will be reprofiled to improve water retention.</li> <li>Drainage channels will be improved and settling ponds constructed to prevent the discharge of solids into the streams.</li> </ol> <p><b>Occupational health and safety</b> Occupation health hazards arise from the construction activities particularly the handling of heavy equipment and welding activities.</p> <p><b>Public safety</b> Inadvertent access to the site by the members of the public may result in personal injury or loss of life.</p>	<p>from vehicular emissions due to increased vehicular traffic flows. However, this is negligible and transient.</p> <p><b>Surface and groundwater</b> During the operational phase of the project, water will be needed particularly for washing of coal and watering down areas prone to wind erosion. Abstraction of water in large quantities from local sources may lead to temporal disturbance of the water aquifer. The surface run-off from coal stockpiles, may lead to acid mine drainage when the sulphur-bearing material is exposed to air and water. This lowering of pH can also lead to the dissolution of metals contained in the coal.</p> <p><b>Occupational health and safety</b> During the operational period, poor storage and handling of electricity, fuel and chemicals can cause severe harm to employees.</p> <ul style="list-style-type: none"> <li>Process Safety</li> <li>Fire and explosions</li> <li>Poor management of wastewater might lead to outbreaks of waterborne diseases</li> </ul> <p>Inhalation and dermal exposure to coal dust from transportation of raw materials as well as inhalation of dust from crushing operations may be a source of occupational hazards. The storage and handling of fuels and lubricants may also present a risk of fire and explosions. Physical hazards may include the potential for falls caused by slippery floors and stairs, and accidental collisions with internal transport such as trucks. Operators may also be exposed to noise from crushing facilities, and internal transport.</p>	<p><b>Surface and groundwater</b> At decommissioning and closure, piles of washed coal and coal slurry may be carried away with surface run off if the area will is left without rehabilitation. This may lead to siltation and sedimentation of nearby watercourses. The increase in turbidity is likely to have an impact on the quality of surface water.</p> <p><b>Public Safety</b> Access to the improperly decommissioned sites and structures may result in personal injury or loss of life.</p>	<p>reduce the emission of dust into the ambient atmosphere, dust extraction system in the CHPP, pulse jet/reverse jet type bag filter, fan duct, hood &amp; stack shall be provided to extract dust laden air from all the dust generating points. Dust suppression system with water spray by means of spray nozzles shall also be provided for some dust generation points as applicable, including dry ash unloading area.</p> <p><b>Land use</b> The project area will be entirely located in the MCL mining license area and the area surrounding the project site is a mining area that has been used for coal mining for decades. The proposed project will therefore not bring about any land use change but will however enhance the almost derelict site at Maamba.</p> <p><b>Surface and groundwater</b> Surface runoff will be routed to the settling ponds for retention and settling of suspended solids, and the clear water from there will be used for dust suppression in the coal stockpile area. During excessive rain, when the runoff is not expected to contain substantial amount of suspended solids after initial hours of heavy rains, the clean runoff will be directed to central monitoring basin for storage and further reuse. Mulching on destabilized soils will be practiced and sides of the drainage channels shall be planted with grass or stone pitched to prevent soil erosion. The open storm water drainage system shall be designed by utilizing a series of French drains around the roads and buildings.</p> <p><b>Occupational health and safety</b> All workers will be trained in occupational health and safety and applicable protocols will be firmly enforced. All workers will be provided with personal protective equipment. An emergency response plan will be put in place to guide response and minimise effect in case of an emergency situation. Fire drills shall be held regularly and flammable materials shall be stored away from ignition sources. All heavy equipment and fuelling sites shall have approved and fully charged fire extinguishers installed. An emergency response plan will be put in place to guide response and minimise effect in case of an emergency situation. Equipment will be well serviced to improve efficiency and reduce friction of moving parts which may generate noise to limit noise levels to less than 85 dB. A comprehensive fire detection and protection system will be put in place. Fire drills shall be held regularly and flammable materials shall be stored away from ignition sources. Warning signs will be erected around the mining site.</p> <p><b>Public Safety</b> The CHPP will be within the mine area which will not be allowed to be accessed by the public. The mine site will be fenced off to prevent unauthorised access until such a time that MSD and ZEMA declare the area safe.</p>

Construction Impacts	Impact during Operation	Post	mitigation
<b>Thermal Power Plant</b>			
<p><b>Landscape and visual character</b></p> <p>The clearing of the area to set up the plant has the potential to destabilise the existing natural ecosystems within the project area. The impact of this activity is very low considering that the project will be in a brown field that has experienced years of mining activity and place where the plant will be located is devoid of any vegetation. Installation of structures and compacting using heavy machinery has the potential to change the natural landscape and may therefore have an impact on local aesthetics. This impact is expected to be minimal as the hilly and isolated nature of the area obscures any aesthetic intrusion. The project will however improve the surrounding environs which have not been rehabilitated in a long time.</p> <p><b>Soil</b></p> <p>Cleared areas will be exposed to adverse weather conditions such as rain and wind and may be left prone to erosion. The use of heavy equipment such as dumper trucks and front-end loaders, can compact and change the texture of the soil. This has</p>	<p><b>Air quality</b></p> <p>The main emissions from coal combustion at thermal power plants are oxides of carbon, nitrogen oxides, Ozone (O3), sulphur dioxide (SO2), volatile organic compounds (VOC), and air-borne inorganic particles such as fly ash, and soot.</p> <p><b>NOx</b></p> <p>Most of the NOx is emitted as NO which is oxidised to NO2 in the atmosphere. Some of NO2 will be converted to NO3 in the presence of O2. NO3 is an essential ingredient of acid precipitation and photochemical smog. Acid rain can have impact on buildings/monuments, human health, agriculture, and surface water bodies. In addition, NO2 absorbs visible light and in high concentrations can contribute to a brownish discoloration of the atmosphere.</p> <p><b>SOx</b></p> <p>About 97 to 99% of SOx emitted from combustion sources is in the form of Sulphur Dioxide, the remainder is mostly sulphur trioxide (SO3), which in the presence of atmospheric water is transformed into Sulphuric Acid at higher concentrations, and can have deleterious effects on the respiratory system. In addition, SO2 is a phytotoxicant (toxic to vegetation).</p> <p><b>Particulate matter</b></p> <p>Incomplete and/or inefficient combustion processes of fossil fuel generate black carbon (soot) which may cause possible lung tissue irritation resulting from inhalation of soot particles. The generation of bottom ash may cause further disposal challenges.</p> <p><b>CO2</b></p> <p>Emission of carbon dioxide (CO2)</p>	<p><b>Soil</b></p> <p>Surface runoff from the coal stockpile areas may be contaminated which may infiltrate into soils and cause metal contamination in soil and plants. Mining structures if left unattended to at the end of operations or if not changed to other uses may be an aesthetic intrusion. Therefore, all structures and garbage shall be removed from the site. Drainages and sumps shall be refilled and the soil re-profiled.</p> <p><b>Surface and groundwater</b></p>	<p><b>Landscape and visual character</b></p> <p>Rehabilitation activities such as soil re-profiling or ripping along the contours, mulching and in some cases re-vegetating using indigenous plant species will be practiced. Less well vegetated areas shall be preferred for work installations and the company will ensure that only the sites where construction will take place will be cleared. Landscaping and planting of flowers will be practiced to improve the appearance of the area near the offices. The remote nature and topographic outlay of the mine obscures any aesthetic intrusion brought about by the erection of buildings. All structures will be dismantled and the area rehabilitated to almost baseline conditions.</p> <p><b>Soil</b></p> <p>Clearing of vegetation will be limited and planting of trees will be undertaken so as to provide a windshield against soil erosion. Mulching on destabilized soils will be practiced and sides of the drainage channels shall be planted with grass or stone pitched to prevent soil erosion. If the ground has been compacted by the use of heavy machinery or prolonged use, the site shall be ripped to loosen the soil. Rehabilitation activities such as soil re-profiling or ripping along the contours will be carried out. Mulching and in some cases re-vegetating using indigenous plant species will be practiced. Surface runoff will be routed to the settling ponds for retention and settling of suspended solids, and the clear water from there will be used for dust suppression in the coal stockpile area.</p> <p><b>Surface and groundwater</b></p> <p>Surface runoff will be routed to the settling ponds for retention and settling of suspended solids, and the clear water from there will be used for dust suppression in the coal stockpile area. During excessive rain, when the runoff is not expected to contain substantial amount of suspended solids after initial hours of heavy rains, the clean runoff will be directed to central monitoring basin for storage and further reuse. Mulching on destabilized soils to enhance re-vegetation will be practiced and sides of the drainage channels shall be planted with grass or stone pitched to prevent soil erosion. The open storm water drainage system shall be designed by utilizing a series of French drains around the roads and buildings. Effluent from the turbine and other areas handling oil and grease, which may contain traces of hydrocarbons, will be directed to the Oil/Water Separator where the oil will be pumped out periodically and trucked off site for use for other purposes such as heating the boilers. Wash water from other areas will be led to such separators or will be treated in separate plate separators. Wastewater shall not be discharged directly into a body of water. All effluents from water and plant drains, boiler blow down, and cooling tower blow down will be mixed in the central monitoring basin. A provision of dosing to adjust the pH of the treated water will be put in place and if the treated water quality in central monitoring basin is within the acceptable limit, the water will be used either for plant green belt development or for miscellaneous plant uses. The condenser cooling water system will consist of acid/Chemical dosing system for scale control/prevention, consisting of solution tanks, dosing pumps and associated piping. The cooling tower will include provision for drainage of all water contained in the distribution system and pond and access for de-sludging</p> <p><b>Air quality</b></p> <p>Haulage trucks will be regularly cleaned and maintained to reduce exhaust emissions. Access tracks and cleared areas will be regularly watered down to reduce emissions of dust. For the gaseous pollution, the company will install equipment that will reduce on the effect of the gaseous pollution on the environment. The Power plant is coal based Power plant, Particulate matter, SO2 and NOx are the major pollutants emitted due to burning of coal.</p> <p><b>Particulate matter</b></p> <p>Each steam generator will be provided with a high efficiency electrostatic precipitator (ESP). The ESP will remove dust or other finely divided particles (fly ash) from flue gases by charging the particles inductively with an electric field, then attracting them to highly charged collector plates, also known as precipitator. The function of the ESP system is to remove the particulate matter from the flue gases, so as to maintain the flue gas particulate emissions limit below the permitted level. ESP will be designed in such a way that the dust concentration level at outlet is maintained below 50 mg/ Nm3 with all fields in operation and 75 mg/Nm3 with one field out of service. Fly ash collection hoppers will be located beneath each</p>

Construction Impacts	Impact during Operation	Post	mitigation
<p>the potential to leave the soil prone to erosion. Soil contamination may result from poor handling of petroleum products such as oil and diesel during dispensing as well as improper disposal of waste oils, hydraulic fluids, and empty oil drums.</p> <p><b>Surface and groundwater</b></p> <p>The land where the construction of the thermal power plant will take place is bare and almost devoid of any vegetation. This scenario leaves the site prone to soil erosion resulting into the accumulation of solids and the discharge of the same into nearby surface water bodies. During this period, the already existing fuel tanks will be used for dispensing of fuels. However, the spills and leaks from the handling of fuels during the construction phase can contaminate surface and subsurface soils, rendering drinking water from aquifers non-potable.</p> <p><b>Air quality</b></p> <p>During site clearing, dust will be generated and dispersed by the wind affecting a zone of up to 100m around the operation site. Emission of loose soil particles on cleared areas during strong</p>	<p>from the burning of fossil fuels, coal in this case, has been linked to climate change. This is because the atmosphere traps more of the sun's heat from Earth's surface (the way heat is trapped in a greenhouse, hence the "greenhouse effect"). The greenhouse effect is predicted to result in global warming.</p> <p><b>Impact on soil</b></p> <p>One of the significant effects of thermal power stations is land requirement for ash disposal and hazardous elements percolation to ground water through ash disposal in ash ponds. If the bottom ash from the TPP is not properly disposed of, land pollution may occur and may also cause aesthetic effects.</p> <p><b>Noise pollution</b></p> <p>Some areas inside the plant will have noisy equipment such as crushers, belt conveyors, fans, pumps, milling plant, compressors, boiler, turbine, etc. The noise generated may be a nuisance to workers.</p> <p><b>Surface water and ground water releases</b></p> <p>Surface runoff from the storage areas of coal, limestone, bed ash and fly ash has potential to change the quality of the receiving surface water environment. Effluents from mixed bed units in the Demineralisation Plant, SG, Turbine and other areas, may contain traces of Oil and there may be some occasional variations in suspended solids and pH. This scenario raises the need to have the wastewater treated before discharge to meet effluent quality standards for wastewater as specified in the Wastewater Regulations (SI 72 of 1993).</p>	<p>At decommissioning and closure, piles of coal and ash may be carried away with surface run off if the area will be left without rehabilitation. This may lead to siltation and sedimentation of nearby watercourses. The increase in turbidity is likely to have an impact on the quality of surface water.</p> <p><b>Public Safety</b></p> <p>Access to the improperly decommissioned sites and structures may result in personal injury or loss of life.</p>	<p><b>Thermal Power Plant</b></p> <p>field. Fly ash will be collected by ESP hoppers of 8 hours storage capacity and removed periodically by pneumatic ash handling system to fly ash storage silos. On top of the fly ash silo, a bag filter vent unit will be mounted to filter exhaust air before leaving the same to atmosphere. The function of the Bed Ash Handling System is to extract ash from the steam generator furnace bed on a continuous or intermittent basis with the Boiler either on or off load. The hot furnace bottom ash will be adequately cooled by means of proprietary systems of the Steam Generator manufacturers and removed periodically by mechanical ash handling system to bed ash storage silos. On top of the bed ash silo, a bag filter vent unit will be mounted to filter exhaust air before leaving the same to atmosphere. A 150 m height RCC twin steel flues common multi-flue chimney will be installed for each 2 x 150 MW CFPP based on worst coal quality to vent out the exhaust flue gas after ESP. This will help with dispersing the air borne emissions over larger area and thus reducing the impact on the power plant on ground level concentrations. During retrieval of dry fly ash from silos, adequate water injection into the ash conditioner will be made to avoid spreading of dust.</p> <p><b>SO<sub>2</sub>, NO<sub>x</sub> and CO</b></p> <p>Particulate matter, SO<sub>2</sub> and NO<sub>x</sub> are the major pollutants emitted due to burning of coal. Sulphur dioxide emission from Boilers is due to burning of sulphur in the coal. Limitation of SO<sub>2</sub> emission will be accomplished by injecting limestone (CaCO<sub>3</sub>) directly into the furnace. The boiler will be designed in such a way that the SO<sub>2</sub> concentration level at outlet is maintained to meet World Bank norms. The most significant environmental effects on air quality will be generated from the TPP. The steam generator (boiler) of each unit will employ a Circulating Fluidized Bed Combustion (CFBC) technology. The CFBC technology has a high carbon burn out as it efficiently burns low grade, high ash coals while maintaining low emissions. The main environmental advantage of the CFBC technology is the removal of SO<sub>2</sub> (90-95%) and NO<sub>x</sub> levels in the combustion process without adding post combustion cleaning equipment. There are two major reasons fluidized bed boilers are cleaner, and superior to typical coal fired power plants:</p> <p>a) The tumbling action allows limestone to be mixed in with the coal since limestone is a "sulphur sponge" in that it absorbs sulphur pollutants. As coal burns in a fluidized bed boiler, it releases sulphur. But just as rapidly, the limestone tumbling around beside the coal captures the sulphur. A chemical reaction occurs, and the sulphur gases are changed into a dry powder that can be removed from the boiler. The resulting calcium-sulphate-based ashes are chemically stable and can be safely disposed of on land. This ash can be used as raw material for cement manufacturing, soil stabilization, concrete blocks, road base, structural fills, etc. The limestone calcines in the furnace to form calcium oxide (CaO) and then reacts with the SO<sub>2</sub> to form calcium sulphate, as follows:</p> $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ $\text{CaO} + \text{SO}_2 + \frac{1}{2} \text{O}_2 \rightarrow \text{CaSO}_4$ <p>b) The second reason a fluidized bed boiler burns cleaner is that with low temperature and staged combustion, the oxidation of fuel nitrogen is suppressed resulting in very low NO<sub>x</sub> emissions. The technology burns fuel at temperatures of 1,400 to 1,700 degrees F, well below the threshold where Nitrogen Oxides form (at approximately 2,500 degrees F, the nitrogen and oxygen atoms in the combustion air combine to form nitrogen oxide pollutants). The efficient combustion will ensure that CO and hydrocarbon emissions in the CFBC boiler are controlled.</p> <p><b>CO<sub>2</sub></b></p> <p>In order to reduce emission of CO<sub>2</sub> so as to reduce the contribution of CO<sub>2</sub> to global warming, management of MCL will consider the deployment of new technology for retrofitting of the coal plant through add-ons to the proposed plant to facilitate post-combustion carbon capture followed by long-term, large scale, sequestration, or increasing the thermal efficiency of the boilers to reduce greenhouse gas emissions per unit of power output. However, retrofit decision will be taken only after evaluation of numerous site-specific factors such as available space (space constraints may make carbon capture retrofit impossible, or limit the amount of capture that is possible) and access to increased water supply. Research and development is also required as CO<sub>2</sub> capture technology may influence other steps in the conversion process.</p> <p><b>Stack Emission Monitoring System</b></p>

Construction Impacts	Impact during Operation	Post	mitigation
<p>winds may also affect the quality of the air in the immediate local environment. Air pollutants are also likely to emanate from vehicular emissions due to increased vehicular traffic flows. However, this is negligible and transient. The use of heavy machinery coupled with welding operations is a potential source of noise. This impact will be limited to the TPP area which will only be accessed by employees.</p> <p><b>Land use</b> The project area will be entirely located in the MCL mining license area and the area surrounding the project site is a mining area that has been used for coal mining for decades. The proposed project will therefore not bring about any land use change but will however enhance the almost derelict site at Maamba.</p> <p><b>Occupational health and safety</b> Occupation health hazards may arise from construction activities particularly the handling of heavy equipment and welding activities.</p> <p><b>Public safety</b> Inadvertent access to the site by the members of the public may result in personal injury or loss of</p>	<p><b>Occupational health and safety</b> SO<sub>3</sub>, which in the presence of atmospheric water is transformed into Sulphuric Acid at higher concentrations, can have deleterious effects on the respiratory system. The generation of black carbon may cause possible lung tissue irritation resulting from inhalation of soot particles. The storage and handling of fuels and lubricants may also present a risk of fire and explosions. Physical hazards may include the potential for falls caused by slippery floors and stairs, and accidental collisions with internal transport such as trucks. Operators may also be exposed to noise from crushing facilities, and internal transport.</p>		<p align="center"><b>Thermal Power Plant</b></p> <p>In order to monitor the discharge of flue gases and provide controls, the chimney for venting of flue gases will be designed with on-line continuous Emission Monitoring System (CEMS) for monitoring of Opacity/Suspended Particulate Matter, SO<sub>x</sub> and NO<sub>x</sub> monitoring system, CO monitoring and Flue Gas Oxygen analyzers. CEMS will be complete with Flue gas sample extraction &amp; conditioning and analysing system, PC based Emission Monitoring Systems with Colour graphic LCD/TFT monitor, with keyboard, mouse along with Laser jet printer. A software link will be provided to hook up the Emission monitoring System to the Plant DCS.</p> <p><b>Ambient Air Quality Monitoring System</b> Analytical Instruments for Ambient Air Quality Monitoring will also be provided to check upon the ambient air quality around the Power Plant.</p> <p><b>Land use</b> The project area will be entirely located in the MCL mining license area and the area surrounding the project site is a mining area that has been used for coal mining for decades. The proposed project will therefore not bring about any land use change but will however enhance the almost derelict site at Maamba.</p> <p><b>Occupational health and safety</b> All workers will be trained in occupational health and safety and applicable protocols will be firmly enforced. All workers will be provided with personal protective equipment. An emergency response plan will be put in place to guide response and minimise effect in case of an emergency situation. Haulage trucks will be regularly cleaned and maintained to reduce exhaust emissions while access tracks and cleared areas will be regularly watered down to reduce emissions of dust. In the event of excess dust being generated, personal protective equipment (dust masks) will be used.</p> <p><b>Public safety</b> The mine site will be fenced off to prevent unauthorised access.</p> <p><b>Noise pollution</b> The fans of the draft system in the TPP will be with variable speed drive motors, blade pitch flow control, inlet silencers, acoustic insulation, inlet/outlet dampers and other miscellaneous accessories to reduce the impact of noise. Additionally, the plant will be located right inside the mine area and as such far away from the human habitation. During installation of the Power plant, no significant impact is envisaged as most of the construction equipment produce noise level below 90 dB(A). The noise generated is expected to be intermittent and of short duration. On site workers working in noise prone areas would be provided with earmuffs &amp; plugs. During operation the major noise generating sources are Steam Turbine Generators, Compressors, Coal crushers and Boiler Feed Water Pumps. Steam Turbine Generators would be provided with acoustic enclosures. Proper encasement of noise generating sources will be done to control the noise level. An integrated approach shall be taken to control noise emission which shall include but not be limited to:</p> <ol style="list-style-type: none"> <li>Design and layout of building to minimize transmission of noise, segregation of particular items of plant and to avoid reverberant areas.</li> <li>Specification of permissible noise levels for bought out items.</li> <li>Choice of materials for civil construction.</li> <li>Acoustic design of buildings.</li> <li>Use of lagging with attenuation properties on plant components.</li> <li>Muffling the drains and vents</li> <li>Green belt along the Power plant</li> </ol> <p>The plans for attenuation of the noise and air pollutant levels include design of plantations around the plant boundary, roadside, office buildings and stretches of open land. The vegetation for the attenuation of air pollution would be most needed in the areas where ground level concentrations of the pollutant are high. The proposed power plant being a coal based power plant, the particulates tend to settle immediately after release due to gravity settling. An area will be developed under greenbelt to improve aesthetics, control of dust and noise pollution covering all around the power plant</p>

Construction Impacts	Impact during Operation	Post	mitigation
<b>Thermal Power Plant</b>			
life.			complex as per Zambian / International standards.

Impact during construction	Operation	Post	mitigation
<b>Power line</b>			
<p><b>Landscape and visual character</b> Activities such as clearing using heavy machinery have potential to change the natural landscape and may therefore degrade areas of scenic beauty. Areas will need to be cleared for trenching where the water pipeline will subsequently be installed. This activity has the potential to destabilise the existing natural ecosystems within the project area. Installation of structures and compacting using heavy machinery has the potential to change the natural landscape and may therefore have an impact on local aesthetics.</p> <p><b>Local erosion</b> Cleared areas will be exposed to adverse weather conditions such as rain and wind. The cleared areas will therefore be prone to soil erosion and may lead to siltation and sedimentation of nearby watercourses. The increase in turbidity is likely to have an impact on the quality of surface water. In addition, the use of heavy equipment can compact and change the texture of the soil. This has the potential to leave the soil prone to erosion.</p> <p><b>Impact of hydrocarbons on soil</b> Soil contamination may result from poor handling of petroleum products such as oil and diesel during dispensing as well as improper disposal of waste oils, hydraulic fluids, and empty oil drums. Leaks from storage tank systems can contaminate surface and subsurface soils, rendering drinking water from aquifers non-potable. Storage and handling of fuel especially during transfer from one vessel to the other, can lead to spills. Such spills and leaks have a potential to contaminate the soil when mechanisms are not put in place to contain the leaks.</p> <p><b>Air quality</b> During site clearing, dust will be generated and dispersed by the wind affecting a zone of up to 100m around the operation site. Emission of loose soil particles on cleared areas during strong winds may also affect the quality of the air in the immediate local environment. Air pollutants are also likely to emanate from vehicular emissions due to increased vehicular traffic flows. However, this is negligible and transient.</p> <p><b>Impact of Noise</b> Generally, construction noise exceeding a noise level of 70 decibels (dB) has significant impacts on surrounding sensitive receptors within 50m of the construction site.</p> <p><b>Inconvenience to locals</b> Traffic congestion, air pollution, and inconvenience to pedestrians are potential problems in power line construction particularly if this is done near the residential areas.</p> <p><b>Impact of solid waste disposal on land</b> During the construction period, municipal solid waste such as kitchen waste, cans, plastic bottles, will be generated. Hazardous wastes will include waste oils, oil-contaminated soils and rugs. Unsound management practices of waste have potential to pollute land and water resources. The infiltration of leaked or spilled waste oils or leachate from decomposing waste may lead to the contamination of soil. The decomposing vegetative waste materials might produce foul smell and affect the quality of the surrounding air. Unintentional burning of waste may emit air polluting substances and cause a nuisance to nearby communities. Waste that is disposed of in an improper manner may be unsightly thereby affecting the visual characteristics of the area.</p> <p><b>Threat to traditional cultural and archaeological sites</b> The clearing activities may inadvertently destroy historical artefacts or sites with cultural and historical significance.</p> <p><b>Occupational health and safety</b> Occupational health hazards arise during the construction period may arise from the use of machinery and the handling and lifting of</p>	<p><b>Noise</b> The production of noise is inevitable during the maintenance of the line.</p> <p><b>Landscape and visual character</b> The existing natural ecosystems along the project area may be affected during the clearing of the area as a result of maintenance of the way leave.</p> <p><b>7.3.5.3 Closure Phase</b> At decommissioning and closure stage of the mine management will weigh the alternative options of disposing of the power line infrastructure.</p>		<p><b>Waste disposal</b> All solid wastes shall be removed from the site to an approved waste disposal site and no burying or burning of wastes shall be permitted. No littering will be permitted. Waste shall be stored in such a manner that it does not generate nuisances of odour and unsightly visual impact. For storage, solid waste will be located in covered, leak proof containers. All materials with use value such as scrap metal, wood paper, and plastic will be recycled or reused for other purposes or sold to other users. Hazardous waste such as waste oil and sludge will be handled differently; waste oil will be stored for sale to recyclers or those using the oil as a source of energy. The oil may also be used in MCL's boilers.</p> <p><b>Land use conflicts</b> Installations will be located on areas where other land use possibilities are low. The company will uphold best practice environmental management aimed at</p>

Impact during construction	Operation	Post	mitigation
<b>Power line</b>			
<p>heavy equipment. Interaction of construction workers with the nearby communities might lead to social change through transmission of diseases such as HIV/AIDS, STDs.</p> <p><b>Public safety</b> Inadvertent access to the site by the members of the public, particularly the trench before backfilling with soil, may result in personal injury.</p> <p><b>Transmission of STIs and HIV/AIDS</b> Project employees will have extra disposable income compared to unemployed residents within the project area. This sudden acquired affluence will translate itself into antisocial behaviour including excess consumption of beer and other social vices e.g. prostitution resulting in the spread of STIs and HIV/AIDS cases.</p>			<p>protecting the areas biodiversity.</p> <p><b>Public safety</b> Regular monitoring and awareness raising will be carried out to ensure that the way leave is observed by the locals and to ensure that encroachments do not occur.</p>

Impact during construction	Operational Impacts	Post	mitigation
<b>Water pipeline</b>			
<p><b>Landscape and visual character</b> Activities such as clearing using heavy machinery have potential to change the natural landscape and may therefore degrade areas of scenic beauty. This activity has the potential to destabilise the existing natural ecosystems within the project area. Installation of structures and compacting using heavy machinery has the potential to change the natural landscape and may therefore have an impact on local aesthetics.</p> <p><b>Ecological disturbance</b> Clearance of natural vegetation cover in the command area, for example, can affect the microclimate and expose the soil to erosion, leading to a loss of top soil and nutrient leaching. The removal of roots and vegetation disrupts the water cycle, increasing the rate at which water enters rivers and streams, thereby changing flow regimes and increasing siltation in the downstream zone. This is often to the detriment of fisheries and aquaculture activities.</p> <p><b>Local erosion</b> Cleared areas will be exposed to adverse weather conditions such as rain and wind. The cleared areas will therefore be prone to soil erosion and may lead to siltation and sedimentation of nearby watercourses. The increase in turbidity is likely to have an impact on</p>	<p><b>Ecological disturbance</b> The environmental effects of operation and maintenance of the proposed pipeline are considered to be low. A maintenance track (generally only light vehicles) will be required and the pipeline will be kept clear of large vegetation (trees and bushes). Grasses will be re-established along the route using native varieties.</p> <p><b>Soil</b> Municipal solid waste as well as industrial waste will be generated throughout the project cycle. Unsound management practices of waste have potential to pollute land and water resources.</p> <p><b>Surface water resources</b> The abstraction of water</p>	<p>At decommissioning and closure stage of the mine, management will weigh the option of handing over the water reticulation system to the provincial water utility company. This decision has the possibility of ensuring sustained water supply to the communities along the line as well as off take points along the line.</p>	<p><b>Ecological disturbance</b> Spreading of top soil on cleared areas, including replanting and regrowing of vegetation, will be implemented to minimize soil erosion and water pollution impacts. Measures such as enclosure of materials will be taken to prevent the spill of construction material during transportation, especially along the major highways. The following are other measures that will be put in place:</p> <p>a) Keeping disturbed areas to a minimum, and re-vegetating bare areas, as soon as possible; the forest alongside the Run of Way (ROW) will be left intact and preserved as an ecological habitat for faunal and floral plant species.</p> <p>b) Introduction of invasive plant species alien to the area will be monitored and the replanting exercise will involve only indigenous plant species.</p> <p>c) Emission of dust will be controlled by watering down the access road as well as the project site.</p> <p>d) Surface run-off from construction sites will be controlled and will not be allowed to flow into streams.</p> <p>e) Speed limit will be established and management will ensure that drivers do not exceed the set speed limit as the raised dust has potential to affect the well being of floral species.</p> <p><b>Impact on landscape and aesthetics</b></p> <p>a) Keeping disturbed areas to a minimum, and re-vegetating bare areas, as soon as possible;</p> <p>b) Scouring and re-profiling of disturbed land and undertaking replanting with appropriate indigenous plant species.</p> <p>c) Keeping the forest alongside the ROW undisturbed to provide soil stability and serve as wind break.</p> <p><b>Air pollution</b> Mitigation measures for generated dust include spraying water on dusty roads, covering of dust generation sources, maintaining moisture content in construction material, construction of containing walls to control muddy runoff, minimising on-site storage time of construction material, controlling the speed of vehicles and selecting transportation routes to minimize impacts on dust sensitive receptors, and timely restoration of disturbed land to minimize the adverse impacts on crops. To reduce the impact of air pollutants during the construction phase the following additional measures will be undertaken:</p>

Impact during construction	Operational Impacts	Post	mitigation
<b>Water pipeline</b>			
<p>the quality of surface water. In addition, the use of heavy equipment can compact and change the texture of the soil. This has the potential to leave the soil prone to erosion.</p> <p><b>Impact of hydrocarbons on soil</b> Fuels and oils will be required for use in construction vehicles during the construction phase, soil contamination may result from poor handling of petroleum products such as oil and diesel during dispensing as well as improper disposal of waste oils, hydraulic fluids, and empty oil drums. Leaks from storage tank systems can contaminate surface and subsurface soils, render drinking water from aquifers non-potable. Storage and handling of fuel especially during transfer from one vessel to the other, can lead to spills. Such spills and leaks have a potential to contaminate the soil when mechanisms are not put in place to contain the leaks.</p> <p><b>Surface and groundwater</b> Clearing of the area to pave way for the laying of the pipe may leave the site prone to soil erosion resulting into the accumulation of solids and the discharge of the same into nearby surface water bodies. During the construction stage, leaks and spills of hydrocarbons, from construction equipment, can contaminate surface and subsurface soils, rendering drinking water from aquifers non-potable.</p> <p><b>Air quality</b> The proposed construction sites are within or adjacent to farmlands, rivers, and residential areas. Dust generated and construction material stored on-site during the construction period could have short-term adverse impacts on the surrounding environment. During site clearing, dust will be generated and dispersed by the wind affecting a zone of up to 100m around the operation site. Emission of loose soil particles on cleared areas during strong winds may also affect the quality of the air in the immediate local environment. Air pollutants are also likely to emanate from vehicular emissions due to increased vehicular traffic flows. However, this is</p>	<p>from the lake may result into the reduction of an existing natural resource. Abstraction of water in large quantities from local sources may lead to temporal disturbance of the water aquifer.</p> <p><b>Sedimentation</b> Water pipeline installations can fail if the sediment load of the water supply is higher than the capacity of the water pipeline structures to transport sediment. Increased suspended sediment can cause problems at intake structures in the form of siltation as well as pump and filtration operation. In addition, degradation of the river bed is likely to threaten the structural integrity of hydraulic structures such as intakes and head-works.</p> <p><b>Occupational health and safety</b> In the event of water leaks, the resulting ponding of water along the pipe line may be breeding grounds for mosquitoes – malaria causing insects.</p>		<p>a) In the event of excess dust being generated, personal protective equipment (dust masks) will be used.</p> <p>b) Employ appropriate measures to reduce dust by keeping disturbed areas to a minimum, and re-vegetating bare areas, as soon as possible;</p> <p>c) Access tracks will be regularly watered down to reduce emissions of dust.</p> <p>d) Haulage trucks will be regularly cleaned and maintained to reduce exhaust emissions.</p> <p><b>Impacts associated with use of heavy machinery</b> Environmental protection measures in connection with construction operations are required as integral parts of the engineering contracts. Good practices such as dust reduction, provision of storm runoff detention ponds, controlled disposal of spoil material, and washing of trucks before leaving the construction site are some of the environmental protection measures to be adopted in the contract specifications.</p> <p><b>Noise pollution from construction vehicles</b> Major abatement measures include:</p> <p>a) Limiting construction to daytime only and no night-time construction using heavy machinery particularly near residential areas;</p> <p>b) No discretionary use of noisy machinery within 50m of residential areas;</p> <p>c) Good maintenance and proper operation of construction machinery to minimize noise generation;</p> <p>d) Installation of temporary sound barriers if necessary; and</p> <p>e) Selection of transport routes for large vehicles to avoid residential areas.</p> <p><b>Threat to traditional, cultural and archaeological sites</b> In order to maintain the social fabrics, construction workers will be obtained from among the locals unless the required skills cannot be found locally Inform NHCC in the event that relics of historical or archaeological value if found Consult with the locals on areas with traditional or cultural values that will need to be avoided.</p> <p><b>Impact of hydrocarbons on soil</b> To limit, contain, and manage the impact of spillages, dispensing points shall stand on an impervious surface. Except for minor or emergency cases, all repair and maintenance works shall be carried out in the workshop. Hazardous waste such as waste oil and sludge will be handled differently; waste oil will be stored for sale to recyclers or those using the oil as a source of energy while sludge will be ash blend and encapsulated before being disposed of.</p> <p><b>Local erosion</b> Disturbed areas shall be kept to a minimum by limiting cleared sites to the ROW while Mulching and replanting on destabilized soils will be practiced. Careful design will avoid the occurrence of erosion problems. Practices such as land levelling and the construction of field bunds, tends to reduce erosion. Following the completion of construction work, vegetation will be established around structures so that bare soil is not exposed to erosive forces. The construction sites will be leveled to ensure uniform topography. MCL will carry out progressive rehabilitation on disturbed areas. Topsoil stripping will be practiced and this will be stockpiled for use when rehabilitating ecologically disturbed site. When rehabilitating, the topsoil shall be re-spread and, where appropriate, the area re-vegetated with species consistent with the surrounding vegetation. Cutting of trees will be limited so as to provide a break against soil erosion. Slash material will be stockpiled at the edge of the clearing and utilized for reclamation of the site.</p>

Impact during construction	Operational Impacts	Post	mitigation
<b>Water pipeline</b>			
<p>negligible and transient.</p> <p><b>Impact of Noise</b> The use of heavy machinery is a potential source of noise. Noise and vibration are generated during construction by heavy construction machinery, including excavators, bulldozers, concrete mixers, and transportation vehicles. Generally, construction noise exceeding a noise level of 70 decibels (dB) has significant impacts on surrounding sensitive receptors within 50m of the construction site. Blasting activities may be employed to break up rocks; this may generate noise nuisances. Noise is a nuisance and may bring about annoyance, sleep disturbance and interference with communication.</p> <p><b>Inconvenience to locals</b> Traffic congestion, air pollution, and inconvenience to pedestrians are potential problems in water pipe laying, especially when using the open cut method proposed in the project.</p> <p><b>Interference with existing utilities</b> Project construction will interfere with existing underground utilities (water pipelines, and communication and power cables), and may result in temporary suspensions of service.</p> <p><b>Impact of solid waste disposal on land</b> During the construction period, municipal solid waste such as kitchen waste, cans, plastic bottles, will be generated. Hazardous wastes will include waste oils, oil-contaminated soils and rugs. Unsound management practices of waste have potential to pollute land and water resources. The infiltration of leaked or spilled waste oils or leachate from decomposing waste may lead to the contamination of soil. The decomposing vegetative waste materials might produce foul smell and affect the quality of the surrounding air. Unintentional burning of waste may emit air polluting substances and cause a nuisance to nearby communities. Waste that is disposed of in an improper manner may be unsightly thereby affecting the visual characteristics of the area.</p>			<p><b>Impact on water resources due to abstraction of water</b> During the construction phase water will be needed for various purposes including dust suppression and domestic use.</p> <p>a) Careful use of water resources will be put in place to reduce wastage arising from spills and leaks. Awareness will be created among the work force on the need to conserve water.</p> <p>b) Regular monitoring of the water pipe network for leaks will be undertaken.</p> <p>c) Reuse of water during the construction phase will be instigated. This includes use of dirty water for dust suppression.</p> <p><b>Inconvenience to locals</b> Mitigation measures will include regulating traffic at the road crossings, building interim roads, selecting transport routes to reduce disturbance to regular traffic, and reinstating the roads as soon as possible.</p> <p><b>Interference with existing utilities</b> Avoidance of other utilities will be carefully considered in project detail design and construction. Emergency measures will be in place to minimize adverse impacts. The survey carried out indicates that there are no telephone, water or sewerage lines in the area where the pipe will be laid. The construction of the water pipeline will avoid crossing of the railway line. In addition, in order not to disrupt transport services trenching across roads will be carried out just when the pipe will be connected and the road reinstated as soon as possible.</p> <p><b>Impact on rare or endangered species</b> There are no records of rare or endangered species living within the project areas. Project construction areas are not in designated natural reserves or scenic spots, and there are no sites with significant conservation values within the construction area.</p> <p><b>Land-use conflicts</b> In order to prevent land use conflicts, the project will avoid farms, utilities and communities. The existing land use activities will be carefully considered in project detail design and construction. The survey carried out indicates that there are no telephone, water or sewerage lines in the area where the pipe will be laid. The construction of the water pipeline will avoid crossing of the railway line. In addition, in order not to disrupt transport services trenching across roads will be carried out just when the pipe will be connected and the road reinstated as soon as possible.</p> <p><b>Impact of HIV/AIDS</b> Education and sensitization on the dangers of HIV/AIDS together with the promotion of self-protection, e.g. by use of condoms, will be the key intervention against the HIV/AIDS problem. The key message to be promoted will be that of abstinence from casual sex followed by use of condoms where abstinence has failed. To that effect talk about HIV/AIDS at the work place and in the community will be promoted too.</p> <p><b>Waste disposal</b> All solid wastes shall be removed from the site to an approved waste disposal site and no burying or burning of wastes shall be permitted. No littering will be permitted. Waste shall be stored in such a manner that it does not generate nuisances of odour and unsightly visual impact. For storage, solid waste will be located in covered, leak proof containers. All materials with use value such as scrap metal, wood paper, and plastic will be recycled or reused for other purposes or sold to other users. Hazardous waste such as waste oil and sludge will be handled differently; waste oil will be stored for sale to recyclers or those using the oil as a source of energy. The oil may also</p>

Impact during construction	Operational Impacts	Post	mitigation
<b>Water pipeline</b>			
<p><b>Threat to traditional cultural and archaeological sites</b> The clearing activities may inadvertently destroy historical artefacts or sites with cultural and historical significance.</p> <p><b>Loss of biodiversity</b> The clearing of vegetation along the project site and clearing of access routes is likely to affect the ecological value of the area. Some of these areas may be home to a diversity of plant and animal species.</p> <p><b>Pest introduction</b> Another threat to ecosystems and native flora and fauna is the introduction and spread of pest species. This introduction can happen as vehicles travel over distances particularly from weed infested areas to weed free areas. Pest plant species can displace native species, which in turn can impact on fauna habitat and food sources, thereby altering ecosystem function.</p> <p><b>Occupational health and safety</b> Occupational health hazards arise during the construction period may arise from the use of machinery and the handling and lifting of heavy equipment. Interaction of construction workers with the nearby communities might lead to social change through transmission of diseases such as HIV/AIDS, STDs.</p> <p><b>Public safety</b> Inadvertent access to the site by the members of the public, particularly the trench before backfilling with soil, may result in personal injury.</p> <p><b>Disruption of infrastructure or other services</b> Creating a trench may disrupt infrastructure such as water and sewerage, telephone, road or railway lines.</p> <p><b>Transmission of STIs and HIV/AIDS</b> Project employees will have extra disposable income compared to unemployed residents within the project area. This sudden acquired affluence will translate itself into antisocial behaviour including excess consumption of beer and other social vices e.g. prostitution resulting</p>			<p>be used in MCL's boilers.</p> <p><b>Land use conflicts</b> Installations will be located on areas where other land use possibilities are low. The company will uphold best practice environmental management aimed at protecting the areas biodiversity.</p> <p><b>Surface and ground water</b> Reuse of water during construction and operational phases will be instigated. This includes use of dirty water for dust suppression and watering of the lawns Careful use of water resources will be implemented to reduce wastage arising from spills and leaks. Awareness will be created among the work force on the need to conserve water. Regular monitoring of the water pipe network for leaks will be undertaken. Housekeeping measures shall be employed at the mine to ensure that leaking pipes are fixed as soon as practical while recycling and reuse options for wastewater shall be considered. Rain harvesting options will be explored and implemented.</p> <p><b>Impacts associated with pipe leaks</b> Major impacts from operation and maintenance of water pipelines are associated with repair and replacement activities when there are leaks or breaks on pipelines. A program will be established to detect leaks and replace old pipelines to minimize the risk of water supply interruption. A key component of the operation of the pipeline will be an ongoing integrity management program. With proper design and construction of the proposed water pipeline, leakage rates and risk of contamination during distribution will be decreased substantially.</p> <p><b>Pest introduction</b> <b>Pest introduction</b> It will be a requirement that for the life of the proposed project, a weed management plan will be formulated and implemented to prevent the spread of declared and environmental weeds along the proposed pipeline route.</p> <p><b>Impact of noise</b> The only noise generated during the operational phase of the pipeline will be that emanating from the pump stations. The pump stations will be isolated from residential areas and be surrounded by vegetated bunds. In addition the stations will have acoustic doors and vents to reduce noise.</p> <p><b>Sedimentation</b></p> <ol style="list-style-type: none"> <li>Install sediment excluders/extractors at the intake to minimise sediment entry.</li> <li>Keep cleared areas to a minimum to minimise soil erosion.</li> <li>Re-vegetate cleared areas on a regular basis.</li> <li>Construct contours to prevent surface run-off</li> </ol>

Impact during construction	Operational Impacts	Post	mitigation
<b>Water pipeline</b>			
in the spread of STIs and HIV/AIDS cases.			

Construction Impacts	Impact during Operation	Post	mitigation
<b>Engineering workshops, MPP and Aerial rope way</b>			
<p>The engineering workshops for both light and heavy duty vehicles are in place and no construction will be undertaken. However, refurbishment will be carried out and replace dilapidated parts of the workshops. Oily contaminated soil will be removed off-site and treated by spreading the soil on cleared land and exposing the contaminated soil to the atmosphere. This treatment process may be enhanced with the use of hydrocarbon digesters.</p>	<p><b>Soil</b> Spills and leaks of battery acid, fuel, oil, and greases may occur from workshop equipment and vehicles brought in for maintenance and may contaminate exposed surface soils. Wash water from the washing of vehicles may be contaminated with oil, metals and chemicals that may contaminate exposed surface soils through surface runoff.</p> <p><b>Surface and Ground Water</b> Spills and leaks of battery acid, fuel, oil, and grease may occur from workshop equipment and vehicles brought in for maintenance and may contaminate surface water through surface runoff. The seepage of contaminated water into the soil may contaminate the underlying aquifer. Particularly the handling and storage of oils and lubricants may cause contamination of groundwater through leaks and spills or improper storage. Overflow from oil-water separators if not scooped on a regular basis has potential to contaminate surface water bodies.</p> <p><b>Aesthetics</b> The refurbishment and painting of structures will affect the natural aesthetic value of the site. In addition, if sound housekeeping measures are not properly enforced within the workshops, that is, if equipment and new and old spare parts are not properly stored, the workshops may be rendered unsightly.</p> <p><b>Occupational Health and Safety</b> The handling of acid batteries, oils and fuel as well as machinery may pose health and safety concerns for the mine workshop workers.</p>	<p><b>Soil</b> If after the mine operational phase the site is not properly rehabilitated, soil contamination may continue to occur particularly from hydrocarbon contamination.</p> <p><b>Occupational health and safety</b> Improperly decommissioned buildings may be a source of health and safety concerns.</p>	<p><b>Air quality</b> Equipment will be well serviced to improve efficiency and reduce friction of moving parts which may generate noise to limit noise levels to less than 85 dB.</p> <p><b>Soil</b> Soil contaminated with hydrocarbons will be treated. Stockpiled soil and vegetation shall be spread over the site after activities have been completed. Rehabilitation activities such as soil re-profiling or ripping along the contours will be carried out. Mulching and in some cases re-vegetating using indigenous plant species will be practiced At the end of mining activities, workshops shall be dismantled and the area returned to its previous state as practicable. At decommissioning and closure stage, all structures and garbage shall be removed from the site.</p> <p><b>Waste disposal</b> Waste shall be stored in such a manner that it does not generate nuisances of odour and unsightly visual impact. For storage, solid waste will be located in covered, leak proof containers. All materials with use value such as scrap metal, wood paper, and plastic will be recycled or reused for other purposes or sold to other users. Hazardous waste such as waste oil and sludge will be handled differently; waste oil will be stored for sale to recyclers or those using the oil as a source of energy.</p> <p><b>Surface and Ground Water</b> The engineering workshops will have heavy equipment wash-bays equipped with impervious surfaces and containment to enable capture of all effluent from washing operations. Oil traps will be installed in the workshop drainage system to treat all effluent prior to release.</p> <p><b>Occupational Health and Safety</b> Adequate signage with reflective material and fire fighting equipment shall be provided at the filling station. All workers will be trained in occupational health and safety and applicable protocols will be firmly enforced. All workers will be provided with personal protective equipment. An emergency response plan will be put in place to guide response and minimise effect in case of an emergency situation. Fire drills shall be held regularly and flammable materials shall be stored away from ignition sources. All heavy equipment and fuelling sites shall have approved and fully charged fire extinguishers installed. All fuelling sites shall be designated and no smoking allowed near fuelling sites or while operating equipment.</p> <p><b>Aesthetics</b> All structures will be dismantled and the area rehabilitated to almost baseline conditions.</p>

Impacts in General	Mitigation
Some of the materials that will be handled and stored at the mine include coal (both	Materials Handling Storage <b>Soil</b>

<p>crushed and uncrushed), limestone (both crushed and uncrushed), fuel, ash (both fly and bottom ash), and magnetite. The handling and storage of these materials may pose some occupational health and environmental impacts.</p> <p><b>Soil</b> Soil contamination may result from poor handling of petroleum products such as oil and diesel during dispensing as well as improper disposal of waste oils, hydraulic fluids, and empty oil drums. Leaks from storage tanks can contaminate surface and subsurface soils, rendering drinking water from aquifers non-potable.</p> <p><b>Surface and groundwater</b> Spills and leaks of materials may contaminate surface water through surface runoff while the seepage of contaminated water into the soil may contaminate the underlying aquifer.</p> <p><b>Air quality</b> Storage of coal may cause localised air pollution and pollution of water courses from surface runoff.</p> <p><b>Occupational health and safety</b> Inhalation and dermal exposure to dust from storage and transportation of raw materials as well as inhalation of dust from crushing operations may be a source of occupational hazards. The storage and handling of fuels and lubricants may also present a risk of fire and explosions</p>	<p>The ash extracted from various hoppers will be collected in silos and disposed of by land filling in mined out areas.</p> <p><b>Surface and groundwater</b> To limit, contain, and manage the impact of spillages, fuel tanks/drums will be contained in a bund of sufficient capacity and will stand on an impervious surface. The storage area for petroleum products such as oil and diesel will have an impervious concrete surface to prevent leaks from contaminating surface and subsurface soils. All areas with potential to have oil leaks and spills shall be channelled to the oil-water separator to prevent discharge of hydrocarbons in the aquatic environment.</p> <p><b>Air quality</b> Before being supplied to the TPP, the extracted Thermal Grade coal, i.e. up to 60% ash, will be covered with non-coal bearing material to avoid spontaneous combustion.</p> <p><b>Occupational health and safety</b> The blasting operation will be done by licensed employees, who are quite adept with handling and using of explosives. Emergency spill kits shall be provided at the filling station and all spilled or leaked material shall be handled as hazardous waste. All workers will be trained in occupational health and safety and applicable protocols will be firmly enforced. All workers will be provided with personal protective equipment. An emergency response plan will be put in place to guide response and minimise effect in case of an emergency situation. Fire drills shall be held regularly and flammable materials shall be stored away from ignition sources. Warning signs will be erected around the mine site.</p>
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## **7. ENVIRONMENTAL HAZARD MANAGEMENT**

- 7.1 Environmental emergencies involve the release, or threatened release, of hazardous materials, chemicals, or oil to the soil, water, or air. Releases can be accidental, deliberate, or caused by natural disasters. Environmental emergencies are categorised as technological emergencies, human error emergencies and physical infrastructure emergencies. These emergencies could arise as a result of:
- Fire and/or explosion at the plant;
  - Equipment/infrastructure failure;
  - Flooding; and
  - Chemicals spills or discharge
- 7.2 Possible technological emergencies could result from failure of equipment or facilities, or could result from a process or system failure and they include:
- Failure by the fire arrestor, especially at the magazine for explosives or power lines;
  - Failure by the pollution control equipment particularly at the CHPP and TPP
  - Safety system failure;
  - Power failure; and
  - Emergency notification system failure.
- 7.3 All emergencies will be addressed in line with the emergency preparedness plan that will be kept updated by MCL and agreed to by the relevant authorities.

## **8. MONITORING PROGRAM**

- 8.1 MCL has been carrying out its own sampling of wastewater and surface run off. The company has an equipped laboratory that will be used for monitoring the quality of the effluent into the surface water. For quality control purposes, samples will also be submitted to an independent laboratory. MCL will put in place and implement an Environmental Monitoring Plan in fulfilment of the requirements of the Zambian environmental and mining legislation and as part of implementing good environmental practices. This monitoring exercise will cover surface water, groundwater, air emissions, noise pollution, erosion and habitat management. The environmental monitoring plan will be implemented by the SHEQ department. ZEMA will review monitoring reports and based on the results they may conduct their own audits.
- 8.2 Groundwater monitoring will be undertaken to record the quality of water discharged to the environment and to monitor compliance with effluent standards and permit limits. The boreholes will be located across the MCL site and will include such areas as the slag and tailings storage site, the fuel and concentrate storage area. Sampling stations will be regularly reviewed with regard to their suitability. At the beginning of the sampling campaign, the frequency will be on a quarterly basis.
- 8.3 MCL will put in place a noise monitoring programme throughout the phases of the project. Noise levels will initially be monitored over a continuous 24hr period to provide a more representative understanding of noise levels around the site. This will also lead to the identification of hazards posed by noise pollution. In such areas, employees will be required to have adequate ear muffers. Noise monitoring will cover a radius of 3km from the site.
- 8.4 A soil monitoring exercise will be undertaken to assess the chemical, biological and physical properties of the soil around the site particularly after accidental spills or disasters. Bearing in mind the fact that the soil has sulphate bearing materials, MCL will continue to monitor ARD particularly around overburden dumps. Based on the

results, recommendations for mitigating impacts will be provided. The samples collected will be assessed for various microbial development and chemical characteristics that will include pH and heavy metals. The most likely sites for soil sampling will be the overburden dump and ROM Pad, fuel storage areas and areas windward of the CHPP and TPP.

## 9. PUBLIC CONSULTATIONS AND PUBLIC DISCLOSURE

9.1 Comprehensive stakeholder consultations were conducted with the local authorities, the traditional leadership and the communities. Consultations culminated into the disclosure of the Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) reports were disclosed on the Zambia Environmental Management Agency (ZEMA) website as well as locally at the Sinazongwe District Council, the Civic Center and the palaces of traditional leaders. Moreover, the public hearing was conducted by the ZEMA on the 3<sup>rd</sup> of February 2012. Overall, communities were supportive of the project and did not voice any opposition although they expressed the following concerns:

Concerns raised	Responses
The community initially enquired about the nature of services available at the proposed site for resettlement, as they were uncertain as to level of improvement	Criteria for selection of the new relocation site will take into account important social facilities (including schools, health care facilities, churches, and transport facilities).
Security in terms of crime as a result of the mine activities;	MCL will be working closely with the Zambian police on security issues
Access to fields for crops for the affected people;	Land for crops will not be affected as a result of project activities. Construction activities will respect time of harvest to the extent possible and when this is not possible compensations will be paid for loss of crops.
Grazing land for animals for affected people	Project activities will not affect grazing land.
Shelter for livestock such as chickens, goats, pigs, sheep and cattle;	Auxiliary structures such as shelter for livestock will be compensated
Sufficient and good quality water supply is of great concern outside the mine area;	MCL has rehabilitated the water treatment plant and safe water will be provided to the communities outside the mine area as part of the Maamba Trust Fund activities
An influx of people will create competition for resources such as jobs.	Capacity-building and training activities will be offered to local communities as part of the Mamba Trust Fund activities

Concerns raised	Responses
Facilities available to the community including the state of the roads, drainage, disease outbreaks and limited access to clean water.	Major road rehabilitation, such as the Mamba- lake Kariba road will be undertaken as part in the framework of the overall project
Work opportunities associated with the project.	The project is expected to create up many unskilled jobs during construction activities. As for the operation of the mine, many jobs will be created directly and indirectly (repair shops, restaurants services, etc...

9.2 In accordance with the AfDB's environmental procedures for private sector operations, the ESIA and RAP will be posted on the Bank's website on June 7, 2013.

## 10. COMPLEMENTARY INITIATIVES

10.1 MCL has undertaken an extensive Corporate Social Responsibility (CSR) program as part of the Maamba Trust Fund. The program includes several activities, from small-scale infrastructures investments to capacity-building. These activities will be financed by a US\$ 3 contribution per ton of washed coal, although during the initial stages many of the activities will be directly financed by MCL. Specific activities of the Maamba Trust Fund are the following:

- **Water supply:** Maamba is maintaining the water reticulation system and supplying the treated water to the entire Maamba community at a nominal price (almost negligible). The facility will be handed over to SWACO (Southern Water and Sewage Corporation, Government of Zambia) in due course of time.
- **Sanitation:** MCL has provided garbage collection centers at 34 locations in Maamba Town and provided a common collection center with proper fencing and security. This facility will be handed over to the local council in due course of time.
- **Sewage ponds:** MCL has established sewage ponds for the benefit of the entire Maamba Community to help maintain the town clean and combat disease like malaria, etc.
- **Health:** MCL is developing a mobile health camps initiative in and around Maamba with the support of external medical professionals to diagnose diseases at an early stage.
- **Education:** MCL is supporting a pre-school and basic school (up to Grade 9) for children from the community and the mining employees with the objective of providing quality education at an affordable price with subsidized tuition fees. To date the school has 768 pupils out of whom 379 (49%) are girls. To further improve the skills of the students and quality of education, MCL is adding a science and computer laboratory to the school. In addition to the above, from the current academic year, to encourage and motivate the students MCL is offering the scholarship to the top 3 students.
- **Vocational Training:** With the view of enhancing employable skills, MCL is launching this year a two-year vocational training program offered to the youth in and around Maamba and Sinozongwe district. The program will train 25 students per

annum in 3 trades (automobile repair and maintenance, electrical and electromechanical trade).

- **Industrial Training:** MCL has launched an internship program for 4<sup>th</sup> and 5<sup>th</sup> year engineering students for a 45-day duration with free boarding and food.

## 11. CONCLUSION

- 11.1 The project will be beneficial to the environment in terms of air pollution minimisation while at the same time diversifying power sources for Zambia. An air quality modelling and management plan should be compiled and submitted to the bank for approval.
- 11.2 To ensure that the project is fully taking into account all environmental issues, there will be a detailed waste management plan especially for the ash produced during operation stage. The option of backfilling mined areas seemed to be the preferred option by MCL but will need to be proven to be safe for groundwater and soil.
- 11.3 While the ESIA mentioned the fact that the preferred power generation technology can be enhanced further by fitting carbon capture equipment, discussions during the mission showed that the exercise would be exorbitantly costly and as a result, the carbon balance study should be done as part of the rehabilitation plan where carbon sinks must be developed in line with the amount of carbon produced by the plant hence reaching an acceptable carbon balance.
- 11.4 The waste management plan with specific detail of all waste types and huge focus on ash management and their impact on the ground water and human health; the air quality management plan with details of sampling areas, equipment to be used and parameters to be tested together with the carbon balance plans must be submitted prior to first disbursement by the Bank. Coupled with the three plans will be submission of a comprehensive cost of the environmental and social management plan which can only be estimated with accuracy after the three issues have been catered for and a cumulative effects assessment study.

## 12. REFERENCES AND CONTACTS

### 12.1 References

- 2011 AMG Global Consultants Environmental Impact Statement Report for the mining operations and thermo-powered electricity generation plant projects.
- 2001 AfDB Environmental and Social Assessment Procedures

### 12.2 Contacts

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