MOMBASA CEMENT LTD (ATHI RIVER UNIT)

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MOMBASA

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PROPOSED EXPANSION OF MOMBASA CEMENT ATHI RIVER CEMENT GRINDING PLANT

GPS COORDINATES: 01° 26’ 001”S and 036° 57’ 795”E

ENVIRONMENTAL IMPACT ASSESSMENT STUDY REPORT

Compiled by:

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October 2017

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Signed:

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Submitted by:

HASMUKH K. PATEL

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Director

On behalf of

Mombasa Cement Limited

EXECUTIVE SUMMARY

This report presents finding of an environmental impact assessment study carried out for the proposed expansion of Mombasa Cement Limited Athi River Unit. The EIA was carried out as provided for in the Environmental Management and Coordination Act, 1999 (Amended) 2015 and the Environmental (Impact Assessment and Audit) Regulations 2003. Other relevant national legislations that were reviewed include, The Environmental Management and Coordination (Water Quality) Regulations, 2006, the Environmental Management and Coordination (Waste Management) Regulations, 2006, the Environmental Management and Coordination (Air Quality) Regulations, 2014, the Public Health Act Cap 242, the Occupational Safety and Health Act 2007, the Employment Act 2007, the Work Injuries Benefit Act 2007, the Physical Planning Act 1996, Cap. 286 and the Standards Act Cap 496.

Current facilities at MCL Athi River

The existing MCL Athi River unit consists of two cement grinding mills complete with support infrastructure. The existing support infrastructure include two cement silos, one clinker stock pile, raw material storage sheds, central control room, quality control laboratories, staff canteen, two administrative blocks, borehole, water storage tanks, reverse osmosis water treatment plant, worship facilities for Christians, Muslims and Hindu, lorry parking yard, workshops, stores and garage among other facilities. The existing MCL Athi River Unit has undertaken two environmental impact assessment study reports and obtained two environmental impact assessment licenses.

The proposed expansion

The proposed expansion aim to increase cement production capacity of Mombasa Cement Athi River Unit by 4,300 tons per day. The scope of the expansion will cover construction of 1 new cement grinding mill, raw material storage two cement storage silos, a cement packaging plant and bulk cement loading.

Project Location

The proposed expansion of MCL Athi River unit will be within the compound of the existing MCL Athi River Unit. The existing unit is located in Machakos County, Athi River Sub-County, on plot No. I.R 63766/4. The global position system (GPS) for the Athi River unit is 01° 26' 001"S and 036° 57' 795"E

Potential positive impacts

It is envisaged that implementation of the proposed expansion may result in positive impacts. Some of the envisaged positive impacts may include:

- ✓ Increased mining of minerals used in cement production
- ✓ Increase in cement production in Kenya
- ✓ Reduction in cement imports
- ✓ Increase in Cement exports
- ✓ Employment opportunities
- ✓ Support of local businesses
- ✓ Increased revenue to government

Potential negative impacts

Potential negative impacts that may result from the implementation of the proposed expansion of the Mombasa Cement Limited Athi River Unit may include: -

- ✓ Dust emission
- ✓ Noise disturbance
- ✓ Occupational injuries and accidents
- ✓ Waste generation

Proposed mitigation measures

Potential negative impacts	Proposed mitigation measures
Cement dust emission and pollution	✓ Install bag filters that employ Pulse-Jet Dust system to remove cement dust from the production line. ✓ Proper maintenance of the de-dusting systems to be done as per manufacturer's specifications. ✓ Provision of appropriate Personal Protective Equipment to workers exposed to dust. ✓ Workers to be trained on the importance of making proper use of personal protective equipment provided. ✓ Workers to undergo pre-employment and periodic medical surveillance tests by a designated medical practitioner. ✓ Air quality monitoring to be undertaken as stipulated in the Environmental Management and Coordination (Air Quality) Regulations, 2014. ✓ Sprinkling of water in unpaved open areas to arrest fugitive dust.
Noise disturbance and pollution	✓ Assess the noise risks by identifying noise hazards. ✓ Plan & put in place technical & organizational noise control measures ✓ Use Noise barriers and attenuators ✓ Ensure appropriate engineering controls are used to minimize noise generation from plant and equipment.

Potential negative impacts	Proposed mitigation measures
	✓ Ensure timely equipment service and maintenance as per manufacturer's specification ✓ Protect employees by providing them with an appropriate hearing protection such as ear plugs and ear mufflers ✓ Undertake periodic noise monitoring ✓ Workers to undergo pre-employment and periodic audiometric test by a designated medical practitioner.
Occupational injuries and accidents	✓ Workers working at height and in confined areas to be provided with appropriate working equipment and appropriate personal protective equipment. ✓ Appropriate emergency exits to be provided for safe exits from confined places. ✓ Good housekeeping practices to eliminate potential hazards. ✓ Appropriate training of employees in occupational safety and health and their individual obligations. ✓ Use personal protective equipment ✓ Minimizing the work time required in high temperature environments, confined places by implementing shorter shifts at these locations to minimize fatigue that could result to injuries and or accidents. ✓ Implementing specific personal protection safety procedures in the workplace to avoid potential exposure to conditions that could result to injuries and or accidents.

Potential negative impacts	Proposed mitigation measures
	✓ Engineering methods to reduce noise levels by modifying, enclosing and dampening noise sources. ✓ Lifting of heavy materials and equipment to be done by forklift and or cranes no manual lifting of heavy equipment and materials. ✓ Ensure all rotating plant and equipment parts have appropriate guards.
Waste generation	✓ Applying manufacturing process that convert materials efficiently, providing higher product output yields, including modification of design of the production process, operating conditions, and process controls. ✓ Instituting good housekeeping and operating practices, including inventory control to reduce the amount of waste resulting from materials that are out-of-date, off specification, contaminated, damaged, or excess to plant needs.

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1. BACKGROUND INFORMATION

1.1 Introduction

This is an Environmental Impact Assessment Study Report for the proposed expansion of Mombasa Cement Limited (MCL) Athi River Unit. The expansion will involve construction of a new cement mill complete with support infrastructure. The EIA Study Report was carried out and prepared in compliance to and as provided for in section 58 (1) of the Environmental Management and Coordination Act, 1999 (Amended) 2015 and Regulation 7 of the Environmental Impact Assessment and Audit Regulations 2003.

1.1.1 Project definition

The proposed expansion of Mombasa Cement Limited Athi River Unit will involve construction of a new cement mill complete with support infrastructure. The components of the expansion will include construction of 1 new cement grinding mill, raw material storage i.e. godowns and clinker stock pile, two cement storage silos, a cement packaging plant and bulk cement loading.

1.1.2 Proposed project location

The proposed expansion of MCL Athi River unit will be within the compound of the existing MCL Athi River Unit. The existing unit is located in Machakos County, Athi River Sub-County, on plot No. I.R 63766/4, this parcel of land is about 20.23 acres and is sandwiched between Bamburi Road and new Mombasa Road just before the Namanga – Mombasa interchange. Figure 1 is a view of the proposed project location from Google Earth while plate 1 is a section of the proposed project site. The global position system (GPS) for the Athi River unit is 01° 26’ 001”S and 036° 57’ 795”E. Appendix 1 gives land documents.

1.1.3 Project proponent

Mombasa Cement Limited, a private company incorporated with limited liabilities in the Republic of Kenya is the project proponent. The company holds a certificate of incorporation number C. 106734 date eleventh November two thousand and three and personal identification number certificate P051159492Z dated second June 2004. Appendix 2 is copy of the certificate of incorporation and copy of personal identification number certificate

1.1.4 Project objective and scope

The objective of the proposed expansion of Mombasa Cement Athi River Unit is to increase the cement production capacity by 4,300 tons per day. The scope of the expansion will cover construction of 1 new cement grinding mill, raw material storage i.e. godowns and clinker stock pile, two cement storage silos, a cement packaging plant and bulk cement loading. Appendix 3 is the proposed layout plan.

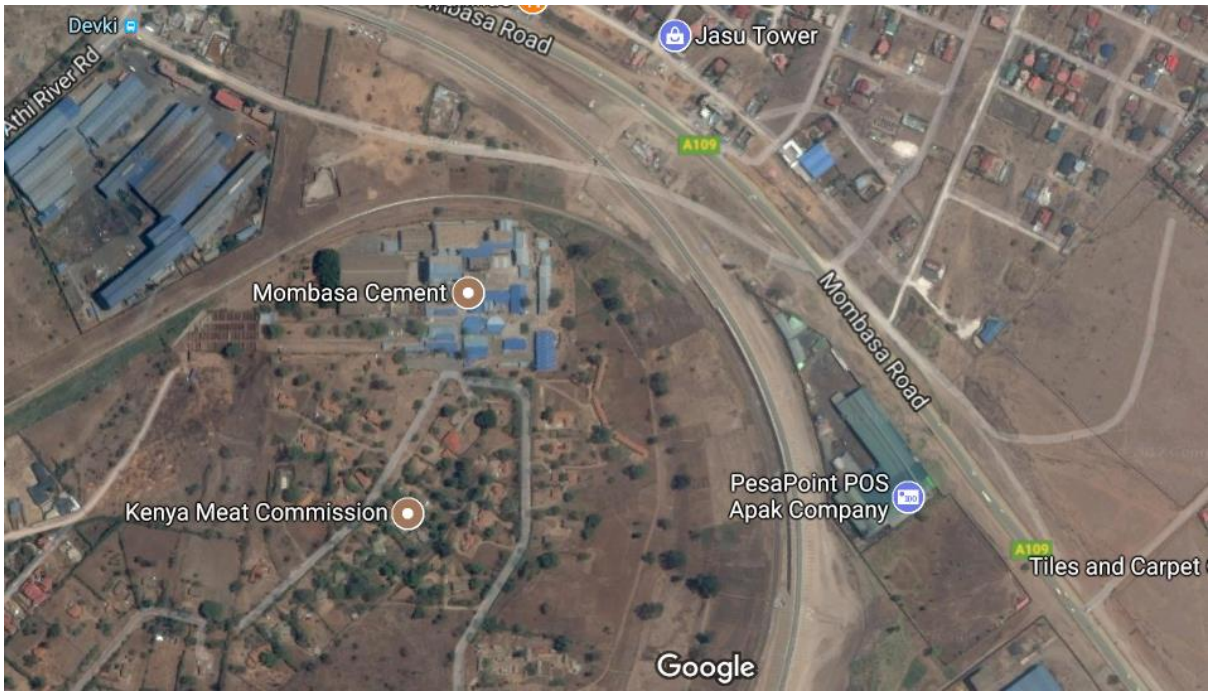

Figure 1: Location of the proposed project site as viewed from Google Earth

Plate 1: A view of a section of the proposed project site

1.1.5 The Existing MCL Athi River Unit

The existing MCL Athi River unit consists of two cement grinding mills complete with support infrastructure (plate 2). The existing support infrastructure include two cement silos, one clinker stock pile, raw material storage sheds, central control room, quality control laboratories, staff canteen, two administrative blocks, borehole, water storage tanks, reverse osmosis water treatment plant, worship facilities for Christians, Muslims and Hindu, lorry parking yard, workshops, stores and garage among other facilities. The existing MCL Athi River Unit has undertaken two environmental impact assessment study reports and obtained two environmental impact assessment licenses (appendix 4)

Plate 2: A section of the existing cement grinding mill and silo

1.1.6 Cement manufacturing Companies in Kenya

There are seven operational cement manufacturing plants in Kenya; four of the plants are both at the Kenya Coast and Athi River Machakos County two are located at Athi River Machakos County and the other at Kitengela Kajiado County. Table 1 summarizes the cement plants, their location and cement brands.

Table 1: Table of cement manufacturing companies in Kenya and their location

Company	location	Brand
Mombasa Cement Limited	Vipingo , Kilifi County and Athi River Machakos County	Nyumba
Athi River Mining	Kalolen Kilifi County i, Athi River Machakos County	Rhino Cement

Bamburi Cement	Bamburi Mombasa County , and Athi River Machakos County	Bamburi Cement
East Africa Portland Cement	Athi River Machakos County	Blue Triangle
National Cement	Athi River-Lukenya Machakos County	Simba Cement
Savannah Cement	Kitengela, Kajiado County	Savannah Cement
Karsen Ramji & Sons Limited (Ndovu Cement)	Athi River, Machakos County	Ndovu Cement

1.2 Environmental impact assessment

Broadly environmental impact assessment (EIA) refers to the need 'to identify and predict the impact on the environment and on man's health and wellbeing of legislative proposals, policies, programmes, projects and operational procedures, and to interpret and communicate information about the impacts'(Munn 1979). UNECE (1991) defines EIA as 'an assessment of the impacts of planned activity on the environment', IAIA (2009) on the other hand defines EIA as 'the process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of proposed development proposals prior to major decision being taken and commitments made'. Glasson *et.al* (2012) defines EIA as 'a systematic process that examines the environmental consequences of development actions in advance'. EIA is thus a vital tool that aid formulation of development actions, decision making, an instrument for sustainable development and vehicle for stakeholder consultation and participation (Glasson *et.al* 2012).

1.2.1 An aid to decision making

EIA is an aid to decision-making. For the decision maker, for example, a local authority, it provides a systematic examination of the environmental implications of a proposed action, and sometimes alternatives, before a decision is taken. The EIA can be considered by the decision-maker along with other documentation related to the planned activity. EIA is normally wider in scope and less quantitative than other techniques, such as cost-benefit analysis (CBA).It is not a substitute for decision making, but it does help to clarify some of the trade-offs associated with a proposed development action, which should lead to more informed and structured decision-making. The EIA process has a potential, not always taken

up, to be a basis for negotiation between the developer, public interest groups and the planning regulator. This can lead to outcome that balances well the interests of the development action and the environment.

1.2.2 An aid to the formulation of development actions

Developers may see the EIA process as another set of hurdles to jump before they can proceed with their various activities; the process can be seen as yet another costly and time-consuming activity in the development consent process. However, EIA can be of great benefit to them, since it can provide a framework for considering location and design issues and environmental issues in parallel. It can be an aid to the formulation of development actions, indicating areas where a project can be modified to minimize or eliminate all together its adverse impacts on the environment. The consideration of environmental impacts early in the planning life of a development can lead to more environmentally sensitive development; to improved relations between the developer, the planning authority and the local communities; to a smoother development consent process, and sometimes to a worthwhile financial return on the extra expenditure incurred. O'Riordan (1990) links such concepts of negotiation and redesign to the important environmental themes of 'green consumerism' and 'green capitalism'. The growing demand by consumers to goods that do no environmental damage, plus a growing market for clean technologies, is generating a response from developers. EIA can be the signal to the developer of potential conflict; wise developers may use the process to negotiate 'environmental gain' solutions, which may eliminate or offset negative environmental impacts, reduce local opposition and avoid costly public inquiries. This can be seen in the wider and contemporary context of corporate social responsibility (CSR) being increasingly practiced by major businesses (Crane et al.2008)

1.2.3 A vehicle for stakeholder consultation and participation

Development actions may have wide-ranging impacts on the environment, affecting many different groups in society. There is increasing emphasis by government at many levels on the importance of consultation and participation by key stakeholders in the planning and development of projects. EIA can be a very useful vehicle for engaging with communities and stakeholders, helping those potentially affected by a proposed development to be much better informed and to be more fully involved in the planning and development process.

1.2.4 An instrument for sustainable

Existing environmentally harmful developments have to be managed as best as they can. In extreme cases, they may be closed down, but they can still leave residual environmental problems for decades to come. It would be much better to mitigate the harmful effects in advance, at the planning stage, or in some cases avoid the particular development together. This of course leads on to the fundamental role of EIA as an instrument for sustainable development-a role some writers have drawn attention to as one often more hidden than it should be when EIA effectiveness is being assessed (Jay et al.2007).

1.2 Terms of Reference

Terms of reference for the EIA study report were developed and presented to NEMA for approval. Appendix 5 is the approval of the ToR by NEMA.

1.2.1 EIA Experts

The Team of Experts who undertook the environmental impact assessment study are James Morumbasi Mong'oni a registered EIA/EA Lead Expert a licensed Safety Advisor and authorized Inspector of pressure vessels and lifting equipment, Philip Manyi Omenge EIA/EA Lead Expert, Natural resources management scientist and rural development specialist, Beatrice Minoo Nguti EIA/EA Associate Expert and Jonathana Katana Yeri, Soil, Water and Environmental Engineer, EIA/EA Associate Expert, appendix 6 is copy of registration certificates and practicing licences of the experts.

Table 2: Team of specialist

Name	Profession / Designation	Education Background
James Morumbasi Mong'oni(BSc, (Eng), MSc.; MBA)	EIA/EA Lead Expert Reg. No 0357, Occupational Safety and Health (OSH) Practitioner Trainer in Occupational Safety and Health in the	- MSc. Occupational Safety and Health, - Master Business Administration (MBA), - Bachelor of Science in Mechanical Engineering, BSc(Mech Eng) - Postgraduate Certificate in

Name	Profession / Designation	Education Background
	workplace OSH Risk Assessment Expert Fire safety Auditor Authorized Plant Inspector (Pressure Vessels and Lifting Appliances)	Occupational safety and Health Risk Assessment - Postgraduate certificate in Environmental Impact Assessment - Postgraduate Certificate on Advanced Information Processing, - Postgraduate Certificate in Occupational Safety and Health
Philip Manyi Omenge (BSc.; MSc., PhD –on-going)	EIA/EA Lead Expert, Reg. No. 1559; Natural Resources Management Scientist/Rural Development specialist and resource based conflict management specialist	- PhD (on-going) in Natural Resources and Peace, Egerton University, Njoro. Research topic **"Evaluation of the Effectiveness of Environmental and Social Impact Assessment in conflict identification and prevention for renewable energy projects in Kenya"** - MSc. (with dissertation) Rural Development Studies, SLU, Uppsala, Sweden - BSc. (Hons), Natural Resources Management, Egerton University - Cert. Environmental Audit; KNCPC, Nairobi - Certificate of Achievement, Grade Merite: AuthorAID Proposal Writing and Research Writing

Name	Profession / Designation	Education Background
		Online Course. INASP, a UK-based international development charity working with a global network of partners to improve access, production and use of research information and knowledge. - Postgraduate Training Certificate (3ECT) in 'Science and Leadership for Transforming Institutions' The Research School for Society, Landscape and Land Use at the Swedish University of Agricultural Sciences, Sweden and the University of Dar Es Salam, Tanzania
Beatrice Minoo Nguti (B.A)	EIA/EA Associate Expert Reg. No 1848	- BA (Hons) Geography & History - Cert, in Environmental Impact Assessment
Jonnathan Katana Yeri (BSc.)	EIA/EA Associate Expert Reg. No. 7890, Soil, Water & Environmental Engineer	- BSc. Soil, Water & Environmental Engineering, - Certificate in Office Automation

1.3 Background to cement

Cement is a fine grained material which when mixed with water form a paste which is capable of hardening and binding solid materials together. Cement is a binder, a substance that sets and hardens independently, and can bind other materials together. Cement used in construction is characterized as hydraulic or non-hydraulic. Hydraulic cements (*e.g.*, Portland cement) harden because of hydration chemical reactions that occur independently of the mixture's water content; they can harden even underwater or when constantly exposed to wet

weather. The chemical reaction that results when the anhydrous cement powder is mixed with water produces hydrates that are not water-soluble. Non-hydraulic cements (*e.g.*, lime and gypsum plaster) must be kept dry in order to retain their strength. The most important use of cement is the production of mortar and concrete the bonding of natural or artificial aggregates to form a strong building material that is durable in the face of normal environmental effects.

1.3.1 Types of cement blends

Cement is made by heating limestone (calcium carbonate), with small quantities of other materials (such as clay) to 1450 °C in a kiln, in a process known as calcination, whereby a molecule of carbon dioxide is liberated from the calcium carbonate to form calcium oxide, or quicklime, which is then blended with the other materials that have been included in the mix . The resulting hard substance, called 'clinker', is then ground with a small amount of gypsum into a powder to make 'Ordinary Portland Cement', the most commonly used type of cement (often referred to as OPC).

1.3.1.1 Portland cement blends

Portland cement blends are often available as inter-ground mixtures from cement manufacturers, but similar formulations are often also mixed from the ground components at the concrete mixing plant.

Portland blast furnace cement contains up to 70 % ground granulated blast furnace slag, with the rest Portland clinker and a little gypsum. All compositions produce high ultimate strength, but as slag content is increased, early strength is reduced, while sulfate resistance increases and heat evolution diminishes. Used as an economic alternative to Portland sulfate-resisting and low-heat cements.

Portland flyash cement contains up to 30 % fly ash. The fly ash is pozzolanic, so that ultimate strength is maintained. Because fly ash addition allows lower concrete water content, early strength can also be maintained. Where good quality cheap fly ash is available, this can be an economic alternative to ordinary Portland cement.

Portland pozzolan cement includes fly ash cement, since fly ash is a pozzolan, but also includes cements made from other natural or artificial pozzolans.

Portland silica fume cement. Addition of silica fume can yield exceptionally high strengths, and cements containing 5-20 % silica fume are occasionally produced. However, silica fume is more usually added to Portland cement at the concrete mixer.

Masonry cements are complex proprietary formulations containing Portland clinker and a number of other ingredients that may include limestone, hydrated lime, air entrainers, retarders, water proofers and coloring agents. They are formulated to yield workable mortars that allow rapid and consistent masonry work.

Expansive cements contain, in addition to Portland clinker, expansive clinkers (usually sulfoaluminate clinkers), and are designed to offset the effects of drying shrinkage that is normally encountered with hydraulic cements.

White blended cements may be made using white clinker and white supplementary materials such as high-purity metakaolin.

Colored cements are used for decorative purposes. In some standards, the addition of pigments to produce "colored Portland cement" is allowed. In other standards (e.g. ASTM), pigments are not allowed constituents of Portland cement, and colored cements are sold as "blended hydraulic cements".

Very finely ground cements are made from mixtures of cement with sand or with slag or other pozzolan type minerals that are extremely finely ground together. Such cements can have the same physical characteristics as normal cement but with 50% less cement particularly due to their increased surface area for the chemical reaction. Even with intensive grinding they can use up to 50% less energy to fabricate than ordinary Portland cements.

1.3.1.2 Non-Portland hydraulic cements

Pozzolan-lime cements. These mixtures develop strength slowly, but their ultimate strength can be very high. The hydration products that produce strength are essentially the same as those produced by Portland cement.

Slag-lime cements. They are similar to pozzolan lime cements in their properties. Only granulated slag (i.e. water-quenched, glassy slag) is effective as a cement component.

Supersulfated cements. These contain about 80% ground granulated blast furnace slag, 15 % gypsum or anhydrite and a little Portland clinker or lime as an activator. They produce strength by formation of ettringite, with strength growth similar to a slow Portland cement. They exhibit good resistance to aggressive agents, including sulfate.

Calcium aluminate cements are hydraulic cements made primarily from limestone and bauxite. The active ingredients are monocalcium aluminate $CaAl_2O_4$ ($CaO \cdot Al_2O_3$ or CA in Cement chemist notation) and mayenite $Ca_{12}Al_{14}O_{33}$ ($12\ CaO \cdot 7\ Al_2O_3$, or $C_{12}A_7$ in CCN). Strength forms by hydration to calcium aluminate hydrates. They are well-adapted for use in refractory (high-temperature resistant) concretes, e.g. for furnace linings.

Calcium sulfoaluminate cements are made from clinkers that include ye'elimite ($Ca_4(AlO_2)_6SO_4$ or $C_4A_3\bar{S}$ in Cement chemist's notation) as a primary phase. They are used in expansive cements, in ultra-high early strength cements, and in "low-energy" cements. Hydration produces ettringite, and specialized physical properties (such as expansion or rapid reaction) are obtained by adjustment of the availability of calcium and sulfate ions.

"Natural" cements correspond to certain cements of the pre-Portland era, produced by burning argillaceous limestones at moderate temperatures. The level of clay components in the limestone (around 30-35 %) is such that large amounts of belite (the low-early strength, high-late strength mineral in Portland cement) are formed without the formation of excessive amounts of free lime. As with any natural material, such cements have highly variable properties.

Geopolymer cements are made from mixtures of water-soluble alkali metal silicates and aluminosilicate mineral powders such as fly ash and metakaolin.

2. NATIONAL POLICY AND LEGISLATIVE FRAMEWORK

2.1 Relevant National Policies

2.1.1 National Environment Policy, 2013

The policy document was prepared with the goal of bettering the quality of life for present and future generations through sustainable management and use of the environment and natural resources. The document underscores the importance and contribution of environment and natural resources to the local and national economy, people's livelihoods and the provision of environmental services such as watershed protection and carbon sequestration. It also reviews the status of environment in Kenya and highlights the key environmental issues and challenges. It identifies Kenya's critical ecosystems and natural resources and proposes measures to enhance conservation and management of ecosystems and sustainable use of natural resources.

The policy document also deals with emerging issues that require environmental stewardship. The issues covered include natural capital and valuation, trade and environment, tourism, consumption and production patterns, industrialisation, infrastructural development, management of chemicals, human settlements, energy use, climate change, emergency preparedness and disaster management, gender, invasive alien species. It addresses a wide range of issues relating to environmental quality and health. The areas covered include air quality, water and sanitation, waste management, radiation, toxic and hazardous substances, noise, HIV and AIDS and environmental diseases. The document also provides a framework for environmental research, education and monitoring. It deals with environmental governance and underscores the importance of legal reforms, institutional linkages including partnerships, regional and international cooperation, human resource development and capacity building and funding mechanism for the sector. It also outlines strategies and actions that will ensure effective implementation of the Policy and the Environmental Management and Coordination Act.

2.1.2 Kenya National Youth Policy

The National Youth Policy is aimed at ensuring that the youth play their role, alongside adults, in the development of the country. The policy goal of the youth policy is to promote

youth participation in community and civic affairs and to ensure that youth programmes are youth centred. The policy proposes guidelines and strategies that can be used to facilitate participation of the youth in national development. The policy also spells out the strategic areas that must be addressed in order for Kenya's young people to effectively play their role in nation building. These are: Employment creation, health, education and training, sports and recreation, the environment, art and culture, the media and participation and empowerment. The youth are classified into priority target groups to make it easier to tackle challenges unique to each group. The priority groups are: Youth with disability, street youth, and youth infected with Aids, female youth, and unemployed youth and out of school youth.

2.3.3 Kenya Gender Policy

This gender policy seeks to contribute to strengthening in the gender equality work in the Ministry of East African Community (EAC), Labour and Social Protection, by giving due attention to gender considerations and promote equity and equality between women and men, girls and boys. In more specific terms, the policy seeks to:

- ✓ Increase coverage, effectiveness and efficiency of interventions
- ✓ Promote equity and equality of women and men, throughout their life cycle and ensure that interventions do not promote inequitable gender roles and relations
- ✓ Provide quantitative and qualitative information on the influence of gender on diverse sectorial issues
- ✓ Support line ministries and state corporations on how to undertake gender responsive planning, implementation and evaluation of policies, programmes and projects
- ✓ Provide capacity building supported by knowledge sharing and research on gender issues

2.3.4 KNBS Economic Survey Report 2017

The Economic Survey is an annual publication of the Kenya National Bureau of Statistics (KNBS). It presents socio-economic highlights of the economy for the last five years. The report forms an important source of input into the budgeting, planning, monitoring and policy formulation processes. On Employment and Earnings, the report indicates that in 2016, the economy generated a total of 832.9 thousand new jobs of which 85.6 thousand were in the modern sector while 747.3 thousand were in the informal sector. Wage employment in the private sector increased by 3.3 per cent from 1,759.6 thousand persons in 2015 to 1,817.2

thousand persons in 2016. Within the public sector, wage employment increased from 718.4 thousand persons in 2015 to 737.1 thousand persons in 2016. Nominal wage earnings increased by 9.1 per cent from KSh 1,509.1 billion in 2015 to KSh 1,647.1 billion in 2016. Total wage payments in the public sector increased by 9.1 per cent from KSh 461.7 billion in 2015 to KSh 503.5 billion in 2016. The share of County Governments wage payments to the total public sector was 19.1 per cent in 2016. Wage payments in the private sector increased by 9.2 per cent to KSh 1,143.6 billion in 2016. Annual average wage earnings grew by 5.9 per cent to KSh 644,837.7 in 2016. Annual inflation decelerated from 6.6 per cent in 2015 to 6.3 per cent in 2016 largely due to reduced costs of petroleum products and tight monetary policies

2.2 Legislative Framework

The following legislations reviewed were identified to be relevant to the proposed project

- ✓ The Constitution of Kenya, 2010
- ✓ The Environmental Management and Coordination Act (EMCA),1999 amended in 2015
- ✓ The Environmental (Impact Assessment and Audit) Regulations,2003
- ✓ The Environmental Management and Coordination (Water Quality)Regulations,2006
- ✓ The Environmental Management and Coordination (Waste Management) Regulations, 2006
- ✓ Environmental Management and Coordination (Air Quality) Regulations, 2014
- ✓ The Public Health Act Cap 242
- ✓ The Occupational Safety and Health Act 2007
- ✓ Employment Act 2007
- ✓ Work Injuries Benefit Act 2007
- ✓ The Physical Planning Act 1996, Cap. 286
- ✓ The Standards Act Cap 496

2.2.1 The Constitution of Kenya, 2010

The Constitution of Kenya 2010 acts as the overarching legal framework for matters on environment. It recognizes the environment as part of the country's heritage, and which must be safeguarded for future generations. It provides for the right to a clean and healthy environment for every person in Article 42, obligating the state to enact legislation to protect

that right as well as to establish systems of environmental impact assessment, environmental audit and monitoring of the environment in Article 69.

Article 69 imposes on the State, other obligations including, to:

- Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits;
- Encourage public participation in the management, protection and conservation of the environment;
- Eliminate processes and activities that are likely to endanger the environment; and
- Utilize the environment and natural resources for the benefit of the people of Kenya.

Article 69 (2) similarly poses a conservation obligation on parties such as the Tasa Pharma Limited. The proponent is thus obligated to cooperate with State organs and other persons to protect and conserve the environment.

2.2.2 The Environmental Management and Coordination Act of 1999 (Amended) 2015

EMCA, 1999 and its 2015 Amendment provides a legal and institutional framework for the protection and conservation of the environment (in line with Article 42 of the constitution), as well as providing the necessary mechanism to monitor that, which include environmental impact assessment, environmental auditing and monitoring as prescribed by Article 69 of the Constitution.

In Section 58 (1) of EMCA 1999 (Amended) 2015, the Act requires that "Notwithstanding any approval, permit or license granted under this Act or any other law in force in Kenya, any person, being a proponent of a project, shall, before financing, commencing, proceeding with, carrying out, executing or conducting or causing to be financed, commenced, proceeded with, carried out, executed or conducted by another person any undertaking specified in the Second Schedule to this Act, submit a project report to the Authority, in the prescribed form, giving the prescribed information and which shall be accompanied by the prescribed fee". The project report should be conducted or prepared by individual experts or a firm of experts authorized by NEMA, which maintains a register of all experts authorized to carry out

environmental impact assessment studies and reports as Section 58(5) stipulates. The report shall be accompanied by the prescribed fee.

The proponent therefore by engaging the expert, undertakes this project report in fulfillment of the above requirement.

Section 60 of EMCA gives power to NEMA to require lead agencies to comment on an EIA Report. Considering the nature of the Project, NEMA may require relevant bodies/agencies such as the ministry of health, lands and planning under Nairobi County government to comment on the EIA Report.

Amended Section 59 (1) states that upon receipt of an environmental impact assessment study report from any proponent under section 58(2), the Authority shall cause to be published in the Gazette, in at least two newspapers circulating in the area or proposed area of the project and over the radio". The public notice provides the following information:-

(i) A brief description of the project;

(ii) The place where the project shall be carried out;

(iii) The place where the EIA Report may be inspected; and

(iv) A time limit not exceeding sixty (60) days for the submission of oral or written comments on the EIA Report.

Part VII on environmental audit and monitoring empowers NEMA to enter any premises for purposes of monitoring whether ongoing project activities conform to the statements made in EIA study report. The proponent is required to submit annual audit reports to NEMA, describing how far the project conforms in operation with the statements made in the EIA report.

2.2.3 Environmental Management and Coordination (Air Quality) Regulations, 2014

The objective of these Regulations is to provide for prevention, control and abatement of air pollution to ensure clean and healthy ambient air. The general prohibitions state that no person shall cause the emission of air pollutants listed under First Schedule (Priority air pollutants) to exceed the ambient air quality levels as required stipulated under the provisions

of the Seventh Schedule (Emission limits for controlled and non-controlled facilities) and Second Schedule (Ambient air quality tolerance limits).

The proponent will be guided by provisions of this act, during operation phase. Air quality monitoring will be guided by the standards stipulated thereof.

2.2.4 The public health Act cap 242

Relevant key areas of the law are:

- Section 10, 11, 12, and 13 for regulating the maintenance, repair and inspection of drains, latrines, cesspool or septic tanks
- Section 28, 29, and 30 which give requirements for the construction of drains in connection with buildings and
- Section 115 prohibiting nuisances that may cause injury or health hazards

2.2.5 Occupational Health and Safety act 2007

2.2.5.1 Part II-General duties of the occupiers

In section 6(i), it is stated that the occupier shall ensure the safety, health and welfare at work of all persons working in his work place

Without prejudice to the generally of an occupier's duty under sub-section 1 above, the duties of the occupier include:-

- The provision and maintenance of plant and systems and procedures of work that are safe and without risk to the health
- Arrangements for ensuring safety and absence of risk to health and connection with the use ,handling, storage and transport of articles and substances
- The provision of such information, instruction, training and supervision as it is necessary to ensure he safety and health at work of every person employed
- The maintenance of any workplace under the occupier's control, in a condition that is safe and without risks to health and provision and maintenance of means of access to and aggress from it that are safe and without such risks to health

- The provision and maintenance of a working environment for every person that is employed that is safe, without risks to health, and adequate as regards facilities and arrangements for the employees welfare at work;
- Inform all persons employed of:-
  - ✓ Any risks from new technologies; and
  - ✓ Imminent danger; and
- Ensuring that every person employed participates in an application and review of safety and health measures

Every occupier shall carry appropriate risk assessments in relation to the safety and health of persons employed and adopt preventive and protective measures to ensure that under all conditions of their intent use without risk to health and comply with the requirements of safety and health provisions

The occupier shall send a copy of a report of Risk Assessment carried out under this section to the area occupational safety and health officer and shall take (occupier) immediate steps to stop any operative or activity where there is an imminent and serious danger to safety and health and evacuate all persons employed as appropriate

2.2.5.2 Duty to prepare a safety and health policy statement

In section 7(i) (a) and (b),it is established that except in such cases that as may be prescribed, it is the duty of every occupier to:-

- Prepare and ,as often as may be appropriate ,revise a written statement of his general policy with respect to the safety and health at work of his employees and the organization and arrangements for the time being in force for carrying out the policy; and
- To bring the statement and any revision of it to the notice of all of his employees

2.2.5.3 Discrimination against employee

Subsection(1) of section (8) states that the occupier shall not dismiss an employee, injure the employee or discriminate against or disadvantage an employee in respect of the employee's

employment, or after the employees position to the detriment of the employee by reason only that the employee:-

- Makes a complaint about a matter which the employee considers is not safe or is a risk to his health;
- Is a matter of a safety and a health committee established pursuant of his Act; or
- Exercises any of his functions as a member of the safety and health committee

2.2.5.4 Safety and health committee

Section (9) (1) illustrates that the occupier shall establish a safety and a health committee at the workplace in accordance with the regulations prescribed by the minister if:-

- There are twenty or more persons employed at the work place; or
- The Director directs the establishment of such a committee at any other workplace

2.2.5.5 Duty not to charge employees for things done or provided

Section (10)(1) states that an employer shall not make any deduction from an employee's remuneration or levy, or permit to be levied on any of his employees any charge in respect of anything done or provided in pursuance of this Act or any regulation made thereunder

2.2.5.6 Safety and health audits

Section (11)(1) of the Occupational Safety and Health Act 2007 outlines that the occupier of a workplace shall cause a thorough safety and health audit o0f his workplace to be carried out at least once in every period of twelve months by a safety and health advisor, who shall issue a report of such an audit containing g the prescribed particulars to the occupier on payment of a prescribed fee and shall send a copy of the report to the Director The audit report referred above shall be preserved and kept available for inspection by the Occupational safety and health Officer

2.2.6.7 Duties of self-employed person

Every self-employed person shall

- Take all necessary precautions to ensure his own safety and health and that of any other person in his work place or within the environs of his workplace

- All times use appropriate systems at work, preventive and control measures and where not feasible, use suitable personal protective appliances and clothing required under this Act
- Comply with any safety and health rules, regulations instructions and procedures issued under this Act;
- Report to the director;-
  - ✓ Any situation which he has reason to believe would present imminent danger or hazard and which he cannot correct, and
  - ✓ Any incidence or injury that arises in the course of or in connection with his works, as required under this Act

2.2.5.8 Duties of employee

Every employee shall, while at workplace:-

- Ensure his own safety and health and that of other persons who may be affected by his Acts or omissions
- Cooperate with his employer or any other person in he discharge of any duty or requirement imposed on the employer or that other person by this act or any regulation made hereunder
- At all times, wear or use any protective equipment or clothing provided by the employer for the purpose of preventing risks to his safety and health;
- Comply with the safety and health procedures, requirements and instructions given by a person having authority over him for his own of other person's safety
- Report to the supervisor any incidence or injury that arises in the cause of or in connection with his work; and
- With regard to any duty or equipment imposed on his employer or any other relevant statutory provision, cooperate with the employer or other person to enable that or requirement to be performed or complied with

2.2.5.9 Duties of designers, manufacturers, importers etc. with regard to articles and substances for use at work

Section (20)(1) illustrates that a person who designs ,manufactures, imports or supplies any articles for use at work shall:-

- Ensure that the article is so designed and constructed as to be safe and without risks to health when properly used;
- Carry out, or arrange for the caring out of such testing and examination as may be necessary to ensure that the article is safe and without risk to health when properly used
- Take such steps as are necessary to ensure that there is available, in connection with the use of the article at work, adequate information about the use for which is designed and has been tested and about any conditions necessary to ensure that, when put to that use, it will be safe and without risks to health.

2.2.5.10 Notice of accidents and dangerous occurrences

Section (21)(1) stipulates that an employer or self-employed person shall notify the area Occupational Safety and Health Officer of any accident, dangerous occurrence, or occupational poisoning which has occurred at work place

Where an accident in the workplace causes the death of a person there in, the employer or self-employed person shall;

- Inform the area occupational safety and health officer within twenty-four hours of the occurrence of the accidence; and
- Send a written notice of the accident in the prescribed form to the area occupational safety and health officer, within seven days of the occurrence of the accident

Where an accident in the workplace causes non-fatal injuries to the person therein ,the employer shall send to the area occupational safety and health officer, a written notice of the accident in the prescribed form within seven days of the occurrence of the accident and

In case of death due to a workplace accident, non-fatal injuries arising from a workplace accident, an occupational disease or a dangerous occurrence at the workplace ,involving a

self-employed person incapable of submitting notification, such notification shall be submitted to the area occupational safety and health officer

2.2.5.11 Health general provisions

Under section 47(1) it is established that every workplace shall be kept in a clean state and free from effluvia arising from any drain ,sanitary convenience or nuisance, and without prejudice to the generality of sub-section(1):-

- Accumulations of dirt and refuse shall be removed daily by a suitable method from the floors and benches of workrooms, and from a staircases and staircases
- The floor of every workroom shall be cleaned at least once in every week by washing or, if it is effective and suitable, by sweeping or by any other method;
- All inside wall partitions ,and all ceilings or tops of rooms ,and all walls, sides and tops of passages and staircases, shall;-
- Where they have a smooth impervious surface, at least once in every period of twelve months, be washed with hot water and soap or cleaned other suitable method;
- Where they are kept painted with oil paint or varnished, be repainted or varnished at least once in every period of five years, or such other period as the director may deem necessary, and at least once in every period of twelve months be washed with hot water and soap or cleaned by other suitable method and
- In other cases, be kept whitewashed or colour washed and the white washing or colour washing shall be repeated at least once in every period of twelve months.

2.2.6 The Environmental Management and Coordination (Water Quality) Regulations 2006

The regulation protects all water sources .Relevant features of this regulation as far as this environmental impact assessment is concerned include:-

- Every person shall refrain from any act which will directly or indirectly cause pollution and it shall be immaterial whether or not the water source was polluted before the enactment of these regulations
- No person shall throw or cause to flow into or near a water source any liquid, solid or gaseous substance or deposit any such substance as to cause pollution

- Discharge of effluent from sewer must be licensed according to the act
- Water abstraction must only be done after approval of an Environmental Impact Assessment study

The regulations also set out rules to be followed for effluent discharge to the environment

2.2.7 The Environmental Management and Coordination (Waste Management) Regulations 2006

Relevant parts of this regulation include:-

- Prohibition of any waste disposal on a public highway, street, road, recreational area or in any public place except in designated waste receptacle
- All waste generated to be collected, segregate and dispose such waste in a ,manner provided for under these regulations
- All waste generators to minimize waste generated by adopting cleaner production methods
- All waste transporters to be licensed according to the Act
- All vehicles used to transport waste to be labeled in such a manner as may be directed by the authority
- Collection and transportation of the waste to be done in such a manner not to cause scattering of the waste
- The vehicle and equipment for waste transportation to be in such a manner not to cause scattering or flowing out of the waste; and
- The vehicles for transportation and other means of conveyance of waste to follow he scheduled routes approved by the authority from the point of collection to the disposal site

2.2.8 Employment act 2007

2.2.8.1 General Principal

The act constitutes minimum terms and conditions of employment of an employee and any agreement to relinquish vary or armed the terms set shall be null or void. The act stipulates that no person shall use or assist any other person, in using forced labor. Clause 5 of the Act

states that it shall be the duty of the minister, Labor Officer, the National Labor Court and the subordinate labor courts to; promote equality of opportunity in employment in order to eliminate discrimination in employment, promote and guarantee equality of opportunity for a person who, is a migrant worker or a member of the family of the migrant worker lawfully within Kenya

No employer shall discriminate directly or indirectly, against an employee or prospective employee or harass an employee or prospective employee on the following grounds, race, color, sex, language, religion, political or other opinion, nationality, ethnic or social origin, disability, pregnancy, mental status or HIV status

An employer shall pay his employees equal remuneration for work of equal value.

2.2.8.2 Part IV Rights and duties of employment

The provisions of this part and part VI constitute basic minimum and conditions of contract of service. The employer shall regulate the hours of work of each employee in accordance with provisions of this Act and any other written law. Subsection (2) of section 27 states that an employee shall be entitled to at least one rest day in every period of seven days. An employee shall be entitled to not less than twenty-one working days or leave after every twelve consecutive months

2.2.8.3 Maternity leave

Section twenty nine of the act stipulates that a female employee shall be entitled to three months maternity leave with full pay. The Act further states that no female employee shall forfeit her annual leave entitlement on account of having taken her maternity leave

2.2.8.4 Section 37 (conversion of casual employment to term contract)

Where a casual employee works for a period of a number of continuous working days which amount in the aggregate to the equivalent of not less than one month; or performs work which cannot reasonably be expected to be completed within a period, or a number of working days amounting in aggregate to equivalent of three months or more. The contract of service of the casual employee shall be deemed to be one where wages are paid monthly. In calculating wedges and the continuous working days ,a casual employee shall be deemed to

be entitled to one paid res day after a continuous six days working period and such rest day or public holiday which falls during the period under consideration shall be counted as part of continuous working days

2.2.9 Work injuries benefit Act 2007

2.2.9.1 Obligations of employers

Section7 of the Act stipulates that every employer shall obtain and maintain an insurance policy which an Insurer approved by the Minister in respect of any liability hat the employer may incur under this Act to any of his employees.

2.2.9.2 Registration of employer

Every employer carrying on business in Kenya shall within the prescribed period and in the prescribed manner register with the Director of Occupational Health and Safety Services and any other information as the Director may require Subsection 4 of section 8 of the Act states that where an employer carries on business in more than one workplace, or carries out more than one class of business, the Director may require the employer to register separately in respect of each place or class of business

2.2.9.3 Employer to keep record

Section 9 states that an employer shall:

Keep a register or other record of the earnings and other prescribed particulars of all employees and produce the same upon demand by the director of inspection. Such records shall be retained for at least six years after the date of the last entry

2.2.9.4 Right to compensation

An employee who is involved in the accident resulting in the employees' disablement or death is subject to the provisions of this Act, and entitled to the benefits provided for under the Act. Section 3 of se4ction 10 of the Act however states that no employer shall be entitled to compensation if an accident, not resulting to serious disablement or death, is caused by the deliberate and wilful misconduct of the employee

Section 12 of the Act stipulates if an employee is injured in an occupational accident or contracts an occupational disease while the employee, with the consent of the employer is engaged in any organized first aid, ambulance or rescue work, or firefighting or other emergency services, the accident or disease is for the purpose of this Act, deemed to have arisen out of an in the cause of the employee's employment

2.2.9.5 Reporting of accidents

A written or verbal notice of any accident shall be given by or on behalf of the employee concerned to the employer and a copy to the Director of occupational health and Safety within twenty-four hours of its occurrence in case of fatal accident

2.2.9.6 Lapse of right to benefits

A right to benefits in accordance with this Act shall lapse if the accident is not reported to the employer within twelve months after the date of such accident. However, it shall not be bar to compensation if it is proved that the employer had knowledge of the accident from any other source. Section 30 of the Act states that compensation for permanent disablement shall be calculated on the basis of ninety six months earnings subject to a minimum and maximum amounts determined by the minister after con siltation with the board. In case of a fatal accident, compensation shall be paid to the dependents of the employee in accordance with the set provisions in the third schedule. The employer shall further be liable to pay reasonable expenses for the funeral of the deceased employee subject to a maximum amount determined by the minister, after consultation with the National Council for Occupational Health and Safety. The first schedule of the Act gives the minimum degree of disablement for various body parts while the second schedule gives a list of work description and the associated occupational disease

2.2.10 Labor Instructions Act 2007

The Act establishes the National Labor Board whose functions will be to advice the minister on;

- All matters concerning employment and labor
- Legislation affecting employment and labor
- Any matter relating to labour relations and trade unionism

- Labor inspection service
- Reported strikes and lockouts
- Labor market information and indices etc.

The board shall in consultation with the minister, establish

- ✓ Work permit committee
- ✓ National Manpower Development Committee
- ✓ Trade Dispute Committee
- ✓ Productivity committee and such other committees or panel as are necessary for the performance of board's functions

Section 34 of the Act stipulates that an authorized officer may either alone or in the presence o0f another person, enter any premises or place where persons are, or may be employed for the purpose of performing his duties as specified under the Act

The labor officer may, for the purpose of monitoring or enforcing compliance with any law require the production or wages sheets or other employment records kept by an employer, enter inspect and examine all latrines and other sanitary arrangements or water supply, inspect and examine all food provided or appearing to be provided for employees, and take samples thereof in duplicate, in the presence of the employer or the employer's representative which samples shall be sealed and one sample so sealed shall be left with the employer, order that all buildings and premises where employees are housed or employed be kept in a clean and sanitary condition

Section 37 of the Act states that the medical officer shall exercise the powers conferred upon the labour officer and in addition;

- Order an employee who, in his opinion is sick and for whom the conditions prevailing at the place of employment are not conducive to rapid recovery of his health to proceed to hospital and in that case and in that case the employer shall at the earliest opportunity and at his own expense send the employee to the place of work to a hospital, as the case may be

- Condemn any food provided for employees which, in the opinion of the medical officer ,is unfit for human consumption, and all food condemned shall be destroyed forthwith in the presence of the medical officer
- Order at the expense of the employer, such variety of food for an employee as he may deem necessary
- Inspect all drugs and medicine provided for the use of employees.

2.2.11 The Physical Planning Act 1996, Cap. 286

The Physical Planning Act has provisions to control development and use of land in particular areas, especially where a project may involve subdivisions or amalgamation of land parcels, or located in an area otherwise reserved for other uses. It aims at guiding the development in the whole country irrespective of the land tenure limitations. Section 30 (1) of the Act stipulates that no person shall carry out development within the area of a local authority without a development permission granted by the local authority under section. Section 29 of this Act provides for development control. It empowers the local authority to prohibit or control the use and development of land and buildings in the interests of proper and orderly development of its area. Section 36 states that a local authority may if deem necessary require a submission of EIA report together with development application if they feel the project has some injurious effects on the environment.

2.2.12 The Standards Act Cap 496

This Act promotes the standardisation of the specification of commodities, and provides for the standardisation of commodities and codes of practice to ensure public health and safety. It establishes the Kenya Bureau of Standards (KBS) and defines its functions as related to:

- Promotion of standardization in industry and commerce; and
- Making arrangements or provision of facilities for the testing and calibration of precision instruments, gauges and scientific apparatus, for the determination of their degree of accuracy by comparison with standards approved by the Minister on the recommendation of the Council, and for the issue of certificates in regard thereto.

This means the Proponent has to ensure all materials and equipment in use during assembling as well as operation of the facility adheres to the highest standards and do not pose any

human health and safety risk.

3. BACKGROUND TO MACHAKOS COUNTY

3.1. Location and Size

Machakos County is strategically located as it borders seven Counties. To the North it is bordered by Embu, Muranga and Kiambu Counties, to the West Nairobi and Kajiado Counties, to the South Makueni County and to the East Kitui County. See Map 1 below. In terms of latitude and longitude it lies between latitudes 0º45´South and 1º31´South and longitudes 36º45´East and 37º45´East.

Figure 2:Geographical Location of Machakos County in Kenya

Source: Machakos County Integrated Development Plan 2015

The County covers an area of 6208.2 Km² with Machakos covering 925.2 Km², Kangundo covers 177.2 Km², Kathiani covering 207.1 Km², Athi River covers 843.2 Km², Yatta covering 1,057.3 Km², Masinga covering 1,402.8 Km², Matungulu covering 577.5 Km² and Mwala covering 1,017.9 Km².

Given the foregoing coverage it is apparent that Masinga, Yatta, Mwala and Machakos have the biggest area coverage respectively while Kangundo, Kathiani and Matungulu have the lowest coverage respectively. However to take note is the fact that the area coverage of the Sub-County does not necessarily determine the population density. For instance Kangundo, Kathiani and Matungulu have lowest area coverage while they have the highest population density of the Sub-Counties in the County. Mwala, Yatta, Masinga have a big area coverage yet they are not as densely populated as compared to Kangundo, Kathiani and Matungulu.

3.2. Physiographic and Natural Conditions

3.2.1. Physical & Topographic Features

Machakos County has very unique physical and topographical features. Hills and a small plateau rising to 1800-2100m above sea level constitute the Central part of the County. To the West, the County has a large plateau elevated to about 1700m which sloping towards the South-East. The County rises from 790 to 1594 m above sea level. In the North West the County has stand-alone hills.

The soils are well drained shallow, dark red clay soils particularly in the plains. However the vegetation across the entire County depends on the altitude of any given area/location. The rainfall distribution in the County depends on the topography of the areas. Since some areas of the County are arid while others have hills and volcanic soils and other areas are plains, the rainfall is widely distributed. For instance the plains receive less amounts of rainfall as such the dominant vegetation is grasslands and some sparse acacia trees. The areas within the County are predominately plains include Mutituni, Mwala, Mua, Iveti Hills and Kathiani.

3.2.2. Ecological Conditions

Machakos County is the home for Yatta plateau which is situated within the Yatta Sub-County which Sub-County has a land mass of 1,057 Km² thus the second biggest Sub-County. This County has numerous hills which include Iveti, Lukenya, Komarock, Kavila

Koli, Ithanga, Mavoloni, Kangonde, Kamuthamba, Nzii, and Ekalakala. River Tana and River Athi are the two permanent rivers within Machakos County. They are also the main sources of water, however we also have the Masinga dam within Masinga Sub-County which is the largest Sub-County with a land mass of 1,402.8 Km².

3.2.3. Climatic Conditions

Generally the annual rainfall of the County is unevenly distributed and unreliable. The average rainfall is between 500 mm and 1300 mm. The short rains are expected in October and December while the long rains are expected in March to May. The highland areas within the County such as Mua, Iveti and Kangundo receive an average of 1000mm while the lowland areas receive about 500mm; ideally the rainfall within the County is influenced by the latitude. In terms of temperature, July is the coldest month while October and March are the warmest. Temperature varies between 18^0C and 29˚C throughout the year. Since the County does not experience rain throughout the year it then means that there are months that experience dry spells. These months are mainly February to March and August to September.

3.3. Administrative Units

The total land mass of Machakos County is divided into eight sub-counties/ constituencies, namely ; Mavoko, Kathiani, Machakos, Matungulu, Yatta, Masinga, Mwala, and Kangundo. These eight sub-counties/ constituencies are further subdivided into twenty two divisions, seventy five locations and two hundred and thirty nine sub locations respectively as shown in the in Table 2.

Table 3: Area and Administrative Units by Sub-County

Sub-County/Constituency	Area (KM^2)	Divisions	No. of Locations	No. of Sub-Locations	2009 (Census)	
					Population	Density (KM^2)
Machakos	925.2	2	13	39	125,940	90
Kangundo	177.2	3	9	25	147,579	140
Kathiani	207.1	1	4	21	94,367	532
Athi River	843.2	4	7	14	124,736	216
Yatta	1,057.3	3	8	23	104,217	503
Masinga	1,402.8	2	9	29	139,502	165
Matungulu	577.5	3	10	30	199,211	215
Mwala	1,017.9	4	15	58	163,032	160
TOTAL	**6,208.2**	**22**	**75**	**239**	**1,098,584**	**177**

Source: Machakos County Government Integrated Development Plant 2015

A comparison of the data in the above table, tells a story about Machakos County. It is apparent that Masinga is the Sub-County with the largest area coverage. However it is not the Sub-County with the highest number of divisions, locations and sub locations. To note also is the fact that it does not have the highest population. Mwala Sub-County is the third largest Sub-County however it is the Sub-County with the largest number of divisions, locations, sub locations, though it is the second in terms of population. Though Matungulu is the 6th in terms of area coverage, it has three divisions, ten locations, thirty sub locations but it is the Sub County with the largest population. An interpretation of the foregoing data means that the equitable distribution of resources shall be guided by the area coverage and population.

3.4. Demographic Features

3.4.1. Population Size

According to the 2009 Kenya Population and Housing census the total population of the County is 1,098,584. It is projected to increase to 1,166,516 in 2012, 1,238,649 in 2015 and 1,315,244 in 2017. This increase suggests that population will be increasing by 2%.

The population as reflected below is an indication of the social and public amenities that are necessary in each Sub-County to provide sufficiently for the needs of the entire populations. Sub-Counties like Machakos that have the highest population requires more social and public amenities than Kangundo Sub-County would require. Considering the population growth projections, It is pertinent to note that the social and public amenities must increase concurrently with the population growth. See Table 3.

Table 4: Population and Density Distribution by Constituency/Sub County

Constituency/ Sub-County	2009 (Census)		2012 (Projections)		2015 (Projections)		2017 (Projections)	
	Population	Density (Km^2)	Population	Density (Km^2)	Population	Density (Km^2)	Population	Density (Km^2)
Masinga	125,940	90	133,728	95	141,997	101	147,691	160
Yatta	147,579	140	156,705	148	166,395	157	173,384	978
Kangundo	94,367	532	100,202	565	106,398	600	110,867	535
Matungulu	124,736	216	132,449	229	140,639	244	146,546	174

Kathiani	104,217	503	110,661	535	117,504	568	122,439	116
Mavoko	139,502	165	148,128	176	175,288	187	163,894	117
Machakos Town	199,211	215	211,530	229	224,610	243	234,044	405
Mwala	163,032	160	173,133	170	183,818	181	191,538	188
Total	**1,098,584**	**177**	**1,166,516**	**188**	**1,238,649**	**200**	**1,290,672**	**208**

Source: Machakos County Integrated Development Plan 2015

3.5. Human Development Approach

According to the United Nations Development Programme, one of the measures of human development would be the Human Development Index. This index encompasses statistics such as life expectancy at birth, an education index (calculated using mean years of schooling and expected years of schooling), and gross national income per capita. Though this index does not capture every aspect that contributes to human capability, it is a standardized way of quantifying human capability across nations and communities. Aspects that could be left out of the calculations include incomes that are unable to be quantified, such as staying at home to raise children or bartering goods/services, as well as individuals' perceptions of their own wellbeing. Other measures of human development include the Human Poverty Index (HPI), Gender Related Development Index and the Global Empowerment Measure. To note also are the six basic pillars of human development which include; equity, sustainability, productivity, empowerment, cooperation and security.

In view of the foregoing, the human development approach as a measure of economic development has its advantages and disadvantages. However it still gives statistics that can be used in understanding the background of a County. Development is ultimately best measured by its impact on individual lives. To promote human development, the County shall put in place policies which cut across the six pillars of human development referred to above. Since human development as defined by the United Nations Development Programme is a process of enlarging people's choices, the County will take cognizance of the three essential choices that people make. These three choices include; living a long and healthy life, to acquire better knowledge and to have access to the resources needed for a decent standard of living.

3.6. Political Units

Machakos County is divided into eight Sub Counties/ Constituencies which are further broken down into Forty (40) County Assembly Wards as illustrated in table 4 below.

Table 5: County's Electoral Wards and Areas by Constituency/Sub County

Constituency/Sub County	County Assembly Wards	Area (Km^2)
Machakos Town	7	925.2
Kangundo	4	177.2
Kathiani	4	207.1
Mavoko	4	843.2
Yatta	5	1,057.30
Masinga	5	1,402.80
Matungulu	5	577.5
Mwala	6	1,017.90
Total	40	6,208.20

Source: Machakos County Integrated Development Plan 2015

From the above table it is apparent that Machakos Constituency/Sub County has the highest number of County assembly wards however Masinga Sub County/ Constituency covers the largest area. This can be attributed to the fact that the population per km2 is higher in Machakos than it is in Masinga. It can also be attributed to the fact that Machakos is a commercial hub and headquarter of the County.

3.7. Infrastructure and Access

3.7.1. Road, Rail Network, Ports and Airports, Airstrips and Jetties

The County has a total road network of 12152.5 Km of which 375 Km is bitumen surface, 10,628Km is gravel surface, and 1149.5 Km is earth surface. Some are good roads including the Nairobi - Mombasa road, Machakos - Kitui road, Machakos-Wote road and Nairobi-Kangundo road. Since majority of the roads within the County are earth and inaccessible during the rainy season; the County has prioritized the upgrading of the roads within the County.

3.7.2. Posts and Telecommunications

The mobile network coverage within the County is of 85 per cent of the total area. However, areas such as Kibauni and Yathui in Mwala, and Kalama in Machakos have a poor network

coverage. The number of land line connection is 327 and its use is on the decline particularly because the use of internet as the main source of communication is on the rise and with the availability of fibre optic then the reliance on the landlines is on the decrease. There are 14 post offices and 20 sub-post offices which are fairly distributed within the County. Radio ownership is 96 per cent which is attributed to low cost of purchase and maintenance while Television coverage is 58 per cent.

3.7.3 Financial Institutions

Because of the fact that Machakos County has very many commercial activities, numerous banks and microfinance institutions have been attracted. Currently there are about ten (10) commercial banks and fourteen (14) microfinance institutions with branches well distributed across the County. These banks and microfinance institutions include, Kenya Commercial Bank, Equity Bank, Cooperative Bank, Barclays Bank, Standard Chartered Bank, KREP Bank, National Bank of Kenya, Faulu Kenya, Kenya Women Finance Trust Kenya, Post Bank, Family Bank, Small and micro enterprise programme (SMEP), three village banksand several SACCOS which include; Harambee Sacco, Hazina Sacco and Universal Traders Sacco.

3.7.4. Education Institutions

The County has 1,736 Early Childhood Development (ECD) centres, 688 primary schools and 190 secondary schools. The introduction of the free primary education increase the enrolment of children into primary school. This has led to a strain on the infrastructure of the primary schools particularly the classrooms, toilets and laboratories. Though primary education, secondary education and universities has not been devolved to the County government, the County is keen on cooperation with the National government to ensure that the infrastructure mentioned above takes into account the growing enrolment rates. Since the ECD and the village polytechnics have been devolved, the County government has set aside a budget to ensure that the number and quality of ECD centres increases.

The County has one medical training institution (MTC) located in Machakos town and two private universities Daystar University and Scotts Christian University which are situated in Mavoko and Machakos Town constituencies respectively. Other universities such as Nairobi University, Kenyatta University, Nazarene University St. Pauls University and Jomo

Kenyatta University of Agriculture and Technology have also opened various campuses in the County. Most of the campuses are situated in Machakos town. The institutions have created opportunities for the youth to acquire skills and knowledge.

3.7.5. Energy Access

Masinga dam is one of the seven forks dams which produces hydroelectricity for the National Electricity Grid and it is located within the County. The connection to the national grid across the County is commendable since, 77 per cent of all trading centres have power. Though connection to individual homes is low and there is need for up scaling the rural electrification programme, the County is keen on cooperating with the Rural Electrifications Authority to ensure that there is energy access across the County. The department responsible for energy has also set aside a budget with respect to the distribution of power across the County. To note also is the fact that following the investment conference held on 15th and 16th of May 2013, many investors have shown an interest in the energy sector. In particular investors have shown an interest in the generation of wind energy, solar energy and mini hydros. Following the interests expressed by the investors the County is keen on partnering with the investors so as to see an increase in the availability of energy across the County. The County takes cognizance of the fact that energy plays a very fundamental role in the cost of production of any product which is a key determinant as to whether an investor will set up an industry within the County or not.

Wood, paraffin, charcoal, solar, gas and electricity are the main sources of energy across the County. Though wood is the main source of cooking energy accounting for 81.6 per cent, while the main source of lighting energy is paraffin accounting for 88.1 per cent. From the foregoing it is apparent that diminishing forest coverage within the County can be attributed to the high use of wood as the main source of fuel. The photo below is a cross section of Masinga Dam Hydro-electricity power station.

3.7.6. Markets and Urban Centres

The main urban centres in the County are Machakos, Kangundo-Tala, Athi River, Kathiani Masii and Matuu, however the major urban centres are Machakos and Athi River. Other trading centres include Mlolongo, Kyumbi, Mwala, Mbiuni, Kaewa, Mitaboni and Kithimani

among others. For purposes of categorizing markets, the County Finance Act has identified seven (7) urban centres and twenty three (23) peri-urban centres.

3.7.7. Housing

Houses in the County are both permanent and semi-permanent. 59.2 per cent of all the homes have brick/block walls, 23.9 per cent stone walled and 12.3 per cent mud / wood walls. Other houses have 1.5 per cent, 2.7 per cent wood wall and corrugated walls respectively. The highest number of houses has earth floor which accounts for 62.4 per cent, others have cement floors accounting for 46.6 per cent. Only 0.4 per cent of the housing have floor tiles. The main roofing materials in the County is corrugated iron sheets which represents 82 per cent of the total houses. Other houses are roofed using grass, tiles, concrete and asbestos sheets which accounts for 14.5 per cent, 1 per cent, 1.2 per cent and 0.5 per cent respectively.

3.8. Land and Land use

Land has aesthetic, cultural and traditional values and is a vital factor of production in the economy. Land in the County is broadly used for Forest, Government Reserve, Townships, Game Reserves, Agriculture, Ranches, Industrialization, mining and livestock keeping. The absence of the national land use policy has led to the proliferation of informal settlement, inadequate infrastructure services, congestion environmental degradation, unplanned urban centres, pressure on agricultural land and conflicts.

3.8.1 Mean Holding Size

Out of the 6,028 Km2 covered by the County, approximately 3,720.2 Km2 is arable land while approximately 2,436 Km2 is non-arable land and approximately 124 Km2 is under water mass. Masinga Sub County has the highest water mass since it is the home of Masinga dam and the Seven Folks dam.

3.8.2. Percentage of Land with Title Deeds

According to the available data, the proportion of land with title deeds stands at 28.5per cent with the most affected area without title deeds issued being Athi River, Machakos and Kathiani. The impact of the lack of title deeds in these areas has resulted in the reduced investments despite the investment potentials vested in these areas.

3.8.3. Incidence of Landlessness

The incidence of landlessness has resulted from the influx of people into the County in search of job opportunities. This is prevalence in the urban areas like Machakos Town, Mavoko, Mlolongo and Athiriver. The County is keen to ensure that this issue is dealt with.

3.9. Education and Literacy

3.9.1. Pre-School Education

The County has a total population of 155,230 children falling within the age group of 3 to 5 (pre-school). This consists of 78,478 males and 76,752 females. There are 1736 ECD centres and 2287 ECD teachers in the County. The County has an enrolment rate of 43.1 per cent and 41.1 per cent for boys and girls in ECD. The transition rate is 45 per cent. There is need for strategies to ensure that enrolment and transition rates improve to more than 70 per cent.

3.9.2. Primary Education

There are 688 primary schools in the County. The enrolment rate is 85 per cent for both girls and boys in primary schools which can be attributed to the introduction of free primary education. The transition rate from primary school to secondary school is 57 per cent. Infrastructure in schools has also improved through devolved funds e.g. Constituency/Sub County Development Fund (CDF). However, the County still needs to invest in the provision of additional education facilities because of the increasing school going population.

3.9.3. Literacy

The literacy level in the County is relatively high with those who are able to read and write representing 82.3 per cent. Other statistics on literacy are as follows: 12.2 per cent of the total population is not able to read; 91.8 per cent of the total population is able to write while 7.6 per cent cannot write. The high literacy rates are as a result of continued investment in the education sector and there is need for more investment to ensure the literacy levels gets to 100 per cent.

3.9.4. Secondary Education

There are 190 secondary schools both private and public in the County. The enrolment rate in secondary schools is 76 per cent and the transition rate to tertiary is 54 per cent. The number of teachers in the County stands at 1,895 and the teacher/pupil ratio is 1:51.

3.9.5. Tertiary Education

The County has three fully fledged universities, Machakos Technical University, Daystar University, and Scott Christian University located in Mavoko and Machakos constituencies respectively. There are other several university colleges located in the major markets. There is one public medical training college and one teacher training college.

3.10. Employment and Other Sources of Income

3.10.1. Wage Earners

From the statistics that are available with respect to employment and other sources of income, it is apparent that the wage earners are few because of the low number of formal employment opportunities within the County. However these employment opportunities will increase upon the construction of the New Machakos City and the commencement of the Investment Program once launched. Currently the wage employment constitutes of only 11 per cent of the total number of people who can be employed. Most of the wage earners are casual labourers working in the construction industry and the farms.

3.10.2. Self Employed

Due to the scarcity of formal jobs, most residents living in the rural areas within the County engage in agricultural activities some in terms of small scale farming or large scale farming, while those living in the urban centre engage in small businesses. The national government has to date sought to enhance self-employment and has put in place the Youth Fund, UWEZO fund and Women Funds has given out soft loans to the youth and women groups and other self-help groups to assist them in starting small businesses.

3.10.3 Labour Force

The population of the people willing and able to work stands at 654,967 which is 56.15 per cent of the total County population. With the steady growth of the labour force, there will be a major challenge of creating employment opportunities in the County.

3.10.4 Unemployment Levels

The unemployment rate in the County is high at approximately 52 per cent. There is a mismatch between the population growth which is estimated at 2 per cent, and the rate of job creation. This situation is likely to cause discontent in the County as most those unemployed are youth, who are likely to engage in unproductive behaviour. The high rate of unemployment is attributed to low absorption rate in the agriculture and commercial sectors and preference for white colour jobs by the youth.

3.11. Mining

3.11.1. On-going Activities

The County is well endowed with mineral resources that are a valuable input to the building and construction industries. The large deposits of sand, limestone and granite have attracted all the major cement factories in Kenya including Bamburi, East Africa Portland, Mombasa Cement, Simba Cement and Savanna to Athi River where these minerals are found. The photo below shows the cement manufacturing plant of Mombasa Cement in Athi River.

3.12. Industry

The County has a number of manufacturing industries mostly in Mavoko Constituency/Sub County. They include Mabati Rolling Mills, Kenya Meat Commission, Agrichem & Tools Ltd, Athi River Steel plant, EAPCC, Bamburi Cement, Mombasa Cement, Savannah Cement, Simba Cement, Primarosa , Kenya Meat Commission (K.M.C) among others. They provide ready market for the large mineral deposits such as limestone, ballast and sand found in the County. The number of industries is bound to increase drastically because of the New Machakos City which will be set up as well as the Investment Program that will be launched in the course of the year.

3.12. Water and Sanitation

3.12.1. Water Resources

Water resources in the County are under pressure from agricultural chemicals and urban and industrial wastes, as well as from use for hydroelectric power. The County has two permanent rivers namely Athi and Tana. Tana River is mainly used for hydroelectricity generation while Athi River is used for domestic and industrial uses. There are also several dams that serve as water resources and springs which are found in the hilly areas. Underground water sources supplement surface water sources.

3.12.2. Water Supply Schemes

There are established water supply schemes in every sub-County of the County. There are three water supply schemes in the County, Kayata in Matungulu, Yatta, and Kabaa in Mwala. There are various community management committees in various water catchments areas in the County. They help in protection of water catchments areas.

3.12.3. Water Sources

The main water sources are rivers, dams and boreholes. The average distance to the nearest water source in the County is 5Km. Fetching of water is mainly done by women especially in the rural areas who end up spending so much of man-hours on this activity.

3.12.4 Sanitation

The County has only two sewer lines; in Athi River and Machakos. Machakos is partially connected to the sewer systems. Parts of Kariobangi and Mjini are not connected and as high as 78.3 per cent of households use pit latrines. Other households use covered pit latrines, uncovered pit latrines, VIP latrine and flush toilets accounting for 47.8 per cent, 30.5 per cent, 6.2 per cent and 5.9 per cent use respectively. Garbage disposal in the County is mainly by farm garden which accounts for 48.4 per cent. Communities use other means such as local authority, private firms, garbage pit and burning and public garbage heaps.

3.13. Environment and Climate Change

3.13.1. Major Contributors to Environmental Degradation

Environmental degradation across the entire world is a major concern. The County is not exempted from this degradation. This is particularly so because the County is the main supplier of sand. It is also the home of most of the cement factories that supply cement across the entire county, East African region and COMESA. This obviously has a negative impact on the environment particularly the quality of water because of the emissions and discharges from these industries. In addition to the foregoing, most of the locals use firewood and charcoal as the source of fuel. This has led to deforestation in various areas thus leading to expansive soil erosion. The most affected areas are Kibauni forest, Yathui, and Muumandu hills.

3.13.2. Effects of Environmental Degradation

The effects of environmental degradation are felt across the globe. As mentioned above, Machakos County has had its share of degradation. For example, sand harvesting has resulted in the drying up of some of the rivers. This has caused the surrounding communities to encounter water supply scarcity because of the substantial reduction of the water. An example of such a river is Thwake. Most of the factories and industries within the County have a tendency of polluting water bodies within their vicinity. In addition there are treatment ponds at Kariobangi that have polluted Mitheu and Iliyini Rivers. Other environment issues of concern in the County include; the mushrooming of slums and the destruction of forests/catchment's areas particularly due to farming on the slopes.

3.13.3. Climate Change and Its Effects in the County

Climate change threatens to adversely affect economic growth in the County and endangers it from becoming a prosperous County with a high quality of life for all its citizens. The cummulative impacts of climate change have the potential to reverse much of the progress made towards the attainment of the Millennium Development Goals (MDGs) and Vision 2030. The effect of the climate change has been increased periods of drought, erratic rainfalls and increase in temperatures which have led to low agricultural productivity.

3.13.4. Climate Change Mitigation Measures and Adaptation Strategies

The County has taken cognizance of the fact that climate change impacts have to be mitigated as such various strategies to address this issue have to be adapted. In view of this, the County will launch several tree planting programmes. The County will also put in place sand harvesting regulation. The County will also put in place sensitization programs across the entire County to sensitize residents on the measure and strategies' that the County has adapted to mitigate climate change.

4. BACKGROUND TO CEMENT MILLS AND CEMENT SILOS

4.1 Cement mills

A cement mill is the equipment used to grind the hard, nodular clinker from the cement kiln into the fine grey powder that is cement. There are basically 4 types of cement mills:

4.1.1 Ball Mill

This is the most predominant. It is essentially a large rotating drum containing grinding media-normally steel balls. As the drum rotates, the motion of the balls crushes the clinker. The drum rotates approximately once every couple of seconds. The drum is generally divided into two or three chambers, with different size grinding media. As the clinker particles are ground down, smaller media are more efficient at reducing the particle size still further. Grinding systems are either "open circuit" or "closed circuit." In an open circuit system, the feed rate of incoming clinker is adjusted to achieve the desired fineness of the product. In a closed circuit system, coarse particles are separated from the finer product and returned for further grinding. Gypsum is inter-ground with the clinker in order to control the setting properties of the cement. This type of Mill often operates with roller press for pre-grinding or in combined grinding;

Ball milling has several advantages over other systems:

- The cost of installation and grinding medium is low;
- It is suitable for both batch and continuous operation,
- Similarly it is suitable for open as well as closed circuit grinding; and
- It is applicable for materials of all degrees of hardness.

The demerits of this type of Mill include;

- Clinker grinding uses a lot of energy
- The higher amount of energy used makes the cement become hot-this can result in the gypsum becoming dehydrated, with potentially undesirable results.

4.1.2 Vertical Roller Mill (VRM)

In terms of grinding of raw materials, fuels and cement, grinding ball mills are now considered to be out-dated technology, especially when considering their electricity consumption. While the specific energy consumption of standard ball mills has been improved with the development of high efficiency separators, a major technological step was achieved with the development of the Vertical Roller Mill (VRM). The VRM is now considered by many companies as standard and tested technology for milling in cement plants. VRMs present a compact and efficient grinding method. Roller mills employ a mix of compression and shearing, using 2-4 grinding rollers carried on hinged arms riding on a horizontal grinding table. The feed material is ground on the rotating table by rollers that are pressed down using spring or hydraulic pressure. The material is forced off the table by centrifugal force, where it is then swept up into an airstream to an internal classifier immediately above. Material that is too coarse is returned to the table for additional grinding while material that is fine enough is collected as product. Hot gas is used for drying during the grinding process when required.

The compact design of a VRM allows it to dry, grind, and classify, all within one piece of equipment and all in a relatively compact space. VRM technology allows power consumption savings, consistent product quality and process simplification. This type of mill has gained popularity in last decade due to lower energy consumption & higher capacity.

The benefits of the vertical roller mill are;

- They are smaller footprints
- Can be erected on site which avoids logistical issues.
- Low wear rate
- More grinding capacity (approx. 20–25% more) than ball mill
- Lower power consumption (KWh/Ton) than ball mill

Its limitations are that;

- It is complex system
- Maintenance requirement are higher
- Higher overall cost

4.1.3 Horizontal Mill (HM)

The HRM consists of a tube shell, supported by slide shoes, that rotates at a hypercritical speed. Inside the shell, a hydraulic roller exerts a pressure on the grinding bed, often causing material to become attached to the inner face of the shell by hypercritical shell speed. Scrapers are employed to remove this material, which then falls onto a diverting system, which pushes the material against the shell face for regrinding and adjusts the motion of this material inside the mill. The material is ground several times before leaving the mill and being classified by a dynamic separator. The horizontal mills have relatively low power consumption however maintenance costs are high.

4.1.4 Roller Press (RP)

This is a more recent choice especially after the advent of the V-separator & improved roller life, offers the lowest energy consumption but even few plants in service. These consist of a pair of rollers set 8-30 mm apart and counter-rotating with surface speed around 0.9 - 1.8 m/s. The bearings of the rollers are designed to deliver a pressure of 50 MPa or more. The bed of material drawn between the rollers emerges as a slab-like agglomeration of highly fractured particles.

Like the VRM and the HRM, roller press systems are also based on the particle bed compression principle of energy saving. High pressure roller press systems for finish grinding employ a static V-separator to first separate the fine fraction from the feed. The course fraction is fed in to the roller press itself and the fine fraction is fed into a dynamic separator to separate out the final product. The coarse fraction is fed back to the roller press. The two rollers of the roller press pressurise the coarse material to break up the particles. One advantage of this milling system is that the return of the coarse material from the static separator is performed by a bucket elevator instead of less energy efficient pneumatic conveying (as is done internally in a VRM). The energy efficiency of this process is

comparatively high. Systems have been designed, including a de-agglomerator and separator that will deliver material of cement fineness.

However, particle size distribution is again a problem, and roll presses are now increasingly popular as a "pre-grind" process, with the cement finished in a single chamber ball mill. This gives good cement performance, and reduces energy consumption by 20-40% compared with a standard ball mill system.

4.2 Cement silos

A silo is a structure for storing bulk materials. Silos are more commonly used for bulk storage of grain, coal, cement, carbon black, woodchips, food products and sawdust. For the storage of cement, usually various silos are required. However new silo designs allow the storage of more than one type of cement in the same silo. Nowadays for cement storage the silo configurations listed below are used.

There are four types of cement storages:

4.2.1 Single Cell Silo with Discharge Hopper (SCSDH)

This is a cement storage silo with a single compartment and whose cement dispenser mechanism is a discharge hopper. In this type of silo, the homogeneity of stored powdered bulk materials is not well achieved.

4.2.2 Single Cell Silo with Central Cone (SCSCC)

Intensive development during the last few decades in the field of silo technology has produced pneumatic emptying and blending systems which provide reliable storage and good homogenization of the powdered bulk materials.

4.2.3 Multi-Cell Silo (MCS)

Changes in the production of binders and fillers, for example by grinding the mixing components separately or utilizing waste materials, fly ash, etc., have had an effect on silo technology, the preparation of the bulk materials and ultimately the dispatch technology. The concentration of storage, blending and dispatch for a greatly increased number of bulk materials, inter-ground additives and mixed products has eventually led to the concept of a multi-compartment, high capacity silo system with integral positive mixer and dispatch

station. The multi-compartment silo comprises individual storage units that can be very flexibly designed. This silo is therefore also ideal for convenient storage of widely differing binding agents using a common out-loading system.

4.2.4 Dome Silo with Central Cone (DSCC)

With the progressively increasing size of the production units in the cement industry there has been a corresponding increase in size of the silo units for storing the cement. Silos with large diameters and with very high individual storage capacities must be capable of efficient and trouble-free emptying. The dome-shaped central cone silo is today's answer to this task. Several discharge gates placed at the circumference of the silo opened one after the other make the cement flow downwards near the outer shell. This system allows recovery of more than 99% of the stored material.

5. BACKGROUND TO RAW MATERIALS TO BE USED

Raw materials that will be used for the production of cement will be pozzolana, gypsum and clinker.

5.1 Pozzolana

Pozzolana, also known as pozzolanic ash (*pulvis puteolanus* in Latin), is a siliceous or siliceous and aluminous material which reacts with calcium hydroxide in the presence of water at room temperature (pozzolanic reaction). The designation pozzolana is derived from one of the primary deposits of volcanic ash used by the Romans in Italy, at Pozzuoli. Nowadays the definition of pozzolana encompasses any volcanic material (pumice or volcanic ash), predominantly composed of fine volcanic glass, that is used as a pozzolan (Mehta, 1981).

5.1.1 Geochemistry and mineralogy

The major pozzolanically active component of volcanic pumices and ashes is a highly porous glass. The mineralogical composition of unaltered pyroclastic rocks is mainly determined by the presence of phenocrysts and the chemical composition of the parent magma. The major component is volcanic glass typically present in quantities over 50% weight. Pozzolana containing significantly less volcanic glass, such as a trachyandesite from Volvic with only 25% of the weight are less reactive.

5.1.2 Uses

Pozzolana is abundant in certain locations and is extensively used as an addition to Portland cement. Compared to industrial by-product pozzolans they are characterized by larger ranges in composition and a larger variability in physical properties. The application of pozzolana in Portland cement is mainly controlled by the local availability of suitable deposits and the competition with the accessible industrial by-product supplementary cementitious materials.

5.1.3 Pozzolanic reaction

The pozzolanic reaction is the chemical reaction that occurs in Portland cement containing pozzolans. At the basis of the pozzolanic reaction stands a simple acid-base reaction between calcium hydroxide, also known as Portlandite, or ($Ca(OH)_2$), and silicic acid (H4SiO4, or Si(OH)4). Simply, this reaction can be schematically represented as follows:

$$Ca(OH)2 + H4SiO4 \rightarrow Ca2+ + H2SiO42- + 2\ H2O \rightarrow CaH2SiO4 \cdot 2\ H2O$$

Or summarized in abbreviated notation of cement chemists:

$$CH + SH \rightarrow C\text{-}S\text{-}H$$

The product of general formula ($CaH2SiO4 \cdot 2\ H2O$) formed is a calcium silicate hydrate, also abbreviated as C-S-H in cement chemist notation, the hyphenation denotes the variable stoichiometry.

5.2 Gypsum

Gypsum is an evaporite mineral most commonly found in layered sedimentary deposits in association with halite, anhydrite, sulfur, calcite and dolomite (Anthony et al, 2003). Gypsum (CaSO4.2H2O) is very similar to Anhydrite (CaSO4). The chemical difference is that gypsum contains two waters and anhydrite is without water. Gypsum is the most common sulfate mineral.

Table 6: Physical properties of gypsum

Physical Properties of Gypsum	
Chemical Classification	sulfate
Color	clear, colorless, white, gray, yellow, red, brown
Streak	white
Luster	vitreous, silky, sugary
Diaphaneity	transparent to translucent
Cleavage	perfect
Mohs Hardness	2
Specific Gravity	2.3
Diagnostic Properties	cleavage, specific gravity, low hardness

Chemical Composition	hydrous calcium sulfate, CaSO4.2H2O
Crystal System	monoclinic
Uses	Use to manufacture dry wall, plaster, joint compound. An agricultural soil treatment.
Chemical Classification	sulfate

5.2.1 Uses of Gypsum

Gypsum uses include: manufacture of wallboard, cement, plaster of Paris, soil conditioning, a hardening retarder in Portland cement. Varieties of gypsum known as "satin spar" and "alabaster" are used for a variety of ornamental purposes, however their low hardness limits their durability.

5.3 Clinker

Clinker is dark grey nodular materials made by heating ground limestone and clay at a temperature of about 1400 C-1500 C. Clinker nodules range in size from 1mm to 25mm or more and are composed mainly of calcium silicates, typically 70%-80%. The nodules are ground up to a fine powder to produce cement, with a small amount of gypsum added to control the setting properties.

6. PROJECT DESCRIPTION AND DESIGN

6.1 Components of the proposed expansion

The components of the proposed expansion of MCL Athi River Unit will consist cement grinding mill, raw material storage i.e. godowns and clinker stock pile, two cement storage silos, a cement packaging plant and bulk cement loading.

6.2 Raw material acquisition

Raw materials to be used will be clinker, gypsum and pozzolana. Clinker will be sourced from MCL Vipingo plant, gypsum will be imported while pozzolana will be sourced from existing local suppliers.

6.3 Description of the cement grinding

In the cement mill cement production will be carried out by grinding of clinker, gypsum and pozzolana and packaging of the resulting cement. The process will involve three main activities namely:-

- ✓ Conveying of raw material from one point to another using various equipment.
- ✓ Grinding of material by equipment like ball mill, and, roll press.
- ✓ Separation of product from ground material and recycling of the coarse material back to grinding equipment.

The cement mill operation will be divided into the following steps:

i) Conveying the product to silo from separator.

ii) Conveying and separation of product with desired quality and recirculation of the unqualified product for further grinding.

iii) Grinding of the feed and recirculation material in ball mill.

iv) Mill lubrication and circulation system.

v) Controlled conveying of fresh feed to mill from hoppers.

vi) Raw material filling to hoppers from storage area.

6.3.1 Cement grinding system

The equipment for the grinding system will be divided into the following groups according to function and positioning.

a) Silo transport group

b) Mill out let group

c) Mill lubrication group

d) Bag filter group

e) Mill group

f) Hopper and feeding group

6.3.1.1 Silo transport group

The equipment from silo top bag filter to the separator cyclone discharge air slide blowers will sequentially be included in this group, in reverses of the material flow. The sequence will be as follows; silo top bag filter fan- sequential timer for bag filter purging- BE discharge air slide blower BE main drive motor- BE- air slide blower- twin blowers for the long conveying air slide and the blowers for the parallel air slides below the cyclones. There will be two large silos for storing different types of cement and for bagged and bulk packaging. There will be two BE installed in the silo feeding system and will be facilitated to feed any of the silos. A pneumatic operated diverter will guide material flow to the elevators.

6.3.1.2 Mill out let group

The mill outlet group will include equipment for the recirculation, separation and separator feeding according to the material flow. There sequence will be separator bag filter, bag filter fan sequential timer for bag filter purging, blower for the air slide carrying separator reject to the mill through the solid flow meter, separator lubrication pump, separator drive, separator fun drive, separator air slide nib trap blower, separator feed air slide blower, mill out let BE and mill discharge air slide blower.

6.3.1.3 Mill lubrication group

The mill lubrication group will consist of mill inlet and outlet slide shoe, high pressure or pre -jacking pumps, mill inlet and outlet slide shoe bearing lubrication pumps (low pressure), axial guide pump, mill gear boxes 1&2 gear box lubricating pumps and the mill girth gear grease spray system. Mill gear boxes will have two independent lubricating pumps; which run as per the selection from central control room. The pumps system will be provided with pressure and flow switches, to monitor the conditions, reporting in central control room. Various bearing and oil temperature as per the requirement for machinery safety are monitored and reporting to central control room.

6.3.1.4 The bag filter group

The bag filter group will consist of the separator de-dusting bag filter RAL, bag filter fan, and sequential timer for bag filter purging. The bag filters will be fixed in different locations. The capacity of the bag filters will ranges from 5,000m^3 to 55,000m^3 while the filter area will range from 60m^2 to 730m^2. The number of bags per location will range from 42 to 510.

6.3.1.5 Mill Group

Each cement mill will have two main drives of 1900KW and two motor cooling fans on each motor

6.3.1.6 Mill feed group

Each cement mill will have mill feed belt conveyor, reversible belt conveyor feeding to mill belt conveyor below weigh feeders, de-dusting bag filter RAL, bag filter fan, sequential timer for bag filter purging and weigh feeders for Clinker, gypsum and pozzolana.

6.3.1.7 Hopper feeding group

This group will constitute three hoppers for clinker, gypsum and pozzolana filling and extraction from the storage area for each mill. There will be a motorized diverter at the main feeding belt for each mill which will serve to divert clinker to clinker hopper when it is open to the direct chute to clinker hopper and closed to the gypsum/pozzolana hopper feeding reversible belt conveyor, gypsum feeding condition when the diverter closes to direct chute/ open to belt conveyor side running forward to gypsum hopper and pozzolana hopper when

filled as the diverter closes to direct chute/open to belt conveyor running reverse to pozzolana hopper. The sequence of this group will be hopper top diverter to the position as per selection, hopper top de-dusting bag filter RAL, bag filter fan sequential timer for bag filter purging, belt conveyor running as per selection, belt conveyor below the clinker storage area or belt conveyor below the gypsum/ pozzolana storage area. The plant will be operated and controlled through programmed logic control system from the Central Control Room. The various process control parameters will be monitored and adjusted as per the conditions.

6.3.2 Products

Two types of cement will be produced from the cement mill namely Portland Pozzolana Cement (PPC) and Ordinary Portland Cement (OPC).

6.3.3 Packaging

Packaging of cement will be of two types bagged packaging in50kg bags which will be done by Rotor Packer and bulk packaging for cement tanker from an overhead chute .

7. PROJECT ALTERNATIVES

Analysis of the alternatives proposed project focused on the following:-

- ✓ The "Yes' and "No" project alternative
- ✓ Project site alternatives
- ✓ Technology alternatives
- ✓ Alternative sources of raw materials

7.1 The "Yes" and "No" Project alternatives

The "Yes" project alternatives means the proposed cement plant expansion project at the Mombasa Cement Limited-Athi River plant be implemented as currently proposed without any alterations. On the other hand the "No" project alternative means that the proposed cement plant expansion project as currently proposed be rejected in its entirety with no alterations. The pros and cons of this alternative include the following;

- ✓ The EIA Study seeks to expand the cement plant.
- ✓ Noting that Mombasa Cement Limited contributes to the revenue of the country and creates jobs to the local community for their benefit, the yes project alternative is consistent with this objective.
- ✓ The construction industry relies on cement as one of the main construction material, cement from this expansion of Mombasa Cement Limited-Athi River serve both the Kenyan market and beyond boarders.
- ✓ The no alternative if implemented will deprive the local community of more job opportunities hence denying them an economic opportunity to improve their livelihoods.
- ✓ The no project alternative will mean that cement in the country will remain in short supply and that the deficit will have to be sourced from elsewhere.

7.2 Alternative Location

There are a number of key factors determining the location of a cement factory. These include but not limited to:

- ✓ Availability of raw material, key of which is coral limestone
- ✓ The availability of key infrastructure in the particular location

- ✓ Availability of market or linkages to market of the product
- ✓ Availability of land space to site the project
- ✓ Consideration on proximity to location of other cement plants.

These factors are briefly discussed below:-

7.2.1 Availability of Raw Materials

Pozzollana is an important raw material used in the production of Portland cement. For a cement plant to be economically viable, it is important that pozollana sources be close to the processing plant. This is because owing to large contribution in the raw material content, bulk transportation cost will form a major factor in determining cost of cement. To minimize unit cost of the finished product, the location of the plant should be convenient enough relative to the source of pozoollana. In the proposed project, pozollana is just a short distance from the proposed project site which is most convenient.

7.2.2 Infrastructure

Close proximity to developed infrastructure such as good road network, railway line, and adequate sources of electricity and availability of water for industrial use (cooling) is also a key factor determining choice of site for a cement plant. The proposed project site is located close to the Mombasa road, linkage to a railway line is available at the nearby Syokimau railway station, a 33KV electrical line is on site and water is also available on site from existing boreholes.

7.2.3 Water supply

The Cement plant uses water as a coolant and for dust suppression. The plant therefore must be located where a dependable supply of water is available. Water is available on site from existing boreholes.

7.2.4 Power supply

Electrical supply requirement is a basic requirement for the production of cement. For the proposed project, a 33KV electrical line is on site.

7.2.5 Transportation consideration

Availability of a good transport network in one of the requirement for consideration when locating a cement industry. As a general rule, it is most economical to have the plant located where there is a well-established transport network this need is met for the proposed expansion.

7.2.6 Markets

The project site in the fast growing Machakos County and is linked to the ever-growing Nairobi City County-the capital city. A large fraction of the cement produced in the country is consumed in Nairobi. Nairobi is also the connecting point to other major towns and neighbouring countries by both road and railway. Therefore, the proposed cement plant will be well linked to markets for its products.

7.2.7 Availability of land

A cement plant requires a large area of land in order to effectively accommodate its different operations. This need is met for the proposed expansion.

7.2.8 Location of other cement plants

Mombasa Cement Limited-Athi River proposes to expand an existing cement production factory. Bamburi Cement Company, one of the leading producers of cement in Kenya is located in just next to the Mombasa Cement plant. There are about six other cement plants within Athi River and at Kitengela in the neighbouring Kajiado County. Therefore, cement production is not new in the locality of the proposed project area.

7.3 Technology alternatives

Alternative technologies in the proposed project can be discussed in terms of:

- ✓ The main process route for the manufacture of cement
- ✓ The choice of cement grinding mill
- ✓ The type of cement silo

7.3.1 The process route

Mombasa Cement Limited employs the dry process of cement production where the raw materials are ground to raw meal in the form of a flowable powder. The dry raw meal which is first sent into the raw mill silo for blending is then extracted from blending silo and fed to the pre-heater with pre-calciner for pre-heating before it is fed into the rotary kiln for clinkerization. After the clinker emerges from the kiln it is cooled before adding gypsum and pozzolana in readiness to grind them to produce cement. The blended mixture is then fed into a cement mill and is crushed into the fine powder cement. The cement is stored in cement silo from where it discharged for packaging.

Other alternative process routes for manufacture of cement: - semi-dry, wet and semi-wet processes.

- ✓ In the semi-dry process, dry raw meal is pelletized with water and fed into a grate pre-heater in front of the kiln or into a long kiln equipped with crosses.
- ✓ In the wet process, the raw materials (often with high moisture content) are ground in water to form a pumpable slurry. The slurry is either fed directly into the kiln or first to a slurry dryer.
- ✓ In the semi-wet process, the slurry is first dewatered in filter presses. The filter cake is either extruded into pellets and fed to a grate pre-heater or fed directly to a filter cake dryer for raw meal production.

These alternative processes are more energy consuming, and thus more expensive comparative to the dry process route.

7.3.1.1 Similarities of all the four process routes

All the cement production processes have the following sub-processes in common:

- ✓ Winning of raw materials
- ✓ Raw materials storage and preparation
- ✓ Fuels storage and preparation
- ✓ Clinker burning
- ✓ Cement grinding and storage
- ✓ Packing and dispatch

7.3.1.2 Why the Dry Process Route is preferred

Mombasa Cement Limited opted for the dry process route for making cement in the proposed project for three reasons. These are:

- ✓ The production will be based on dry processes due to the availability of dry raw materials. Plants using wet or semi wet processes normally only have access to moist raw materials
- ✓ Semi-dry, semi-wet and wet processes are more energy consuming, compared to dry processes
- ✓ Plants using semi dry processes are likely to change to dry technologies whenever expansion or major improvement is required

7.3.2 Choice of cement grinding mill

A cement mill is the equipment used to grind the hard, nodular clinker from the cement kiln into the fine grey powder that is cement.

There are basically four types of cement mills in use today:

7.3.2.1 Ball Mill

This is the most predominant. It is essentially a large rotating drum containing grinding media-normally steel balls. As the drum rotates, the motion of the balls crushes the clinker. The drum rotates approximately once every couple of seconds. The drum is generally divided into two or three chambers, with different size grinding media. As the clinker particles are ground down, smaller media are more efficient at reducing the particle size still further. Grinding systems are either "open circuit" or "closed circuit." In an open circuit system, the feed rate of incoming clinker is adjusted to achieve the desired fineness of the product. In a closed circuit system, coarse particles are separated from the finer product and returned for further grinding. Gypsum is inter-ground with the clinker in order to control the setting properties of the cement. This type of Mill often operates with roller press for pre-grinding or in combined grinding;

Ball milling has the following advantages over other systems:

- The cost of installation and grinding medium is low;
- It is suitable for both batch and continuous operation,

- Similarly it is suitable for open as well as closed circuit grinding; and
- It is applicable for materials of all degrees of hardness.

The demerits of this type of Mill include;

- Clinker grinding uses a lot of energy
- The higher amount of energy used makes the cement become hot-this can result in the gypsum becoming dehydrated, with potentially undesirable results.

Mombasa Cement Limited Athi River will employ the use of the ball mill in cement grinding.

7.3.2.2 Vertical Roller Mill (VRM)

In terms of grinding of raw materials, fuels and cement, grinding ball mills are now considered to be outdated technology, especially when considering their electricity consumption. While the specific energy consumption of standard ball mills has been improved with the development of high efficiency separators, a major technological step was achieved with the development of the Vertical Roller Mill (VRM). The VRM is now considered by many companies as standard and tested technology for milling in cement plants. VRMs present a compact and efficient grinding method. Roller mills employ a mix of compression and shearing, using 2-4 grinding rollers carried on hinged arms riding on a horizontal grinding table. The feed material is ground on the rotating table by rollers that are pressed down using spring or hydraulic pressure. The material is forced off the table by centrifugal force, where it is then swept up into an airstream to an internal classifier immediately above. Material that is too coarse is returned to the table for additional grinding while material that is fine enough is collected as product. Hot gas is used for drying during the grinding process when required. The compact design of a VRM allows it to dry, grind, and classify, all within one piece of equipment and all in a relatively compact space. VRM technology allows power consumption savings, consistent product quality and process simplification. This type of mill has gained popularity in last decade due to lower energy consumption & higher capacity.

The benefits of the vertical roller mill are;

- They are smaller footprints
- Can be erected on site which avoids logistical issues.

- Low wear rate
- More grinding capacity (approx. 20–25% more) than ball mill
- Lower power consumption (KWh/Ton) than ball mill

Its limitations are that;

- It is complex system
- Maintenance requirement are higher
- Higher overall cost

7.3.2.3 Horizontal Mill (HM)

The horizontal mill consists of a tube shell, supported by slide shoes, that rotates at a hypercritical speed. Inside the shell, a hydraulic roller exerts a pressure on the grinding bed, often causing material to become attached to the inner face of the shell by hypercritical shell speed. Scrapers are employed to remove this material, which then falls onto a diverting system, which pushes the material against the shell face for regrinding and adjusts the motion of this material inside the mill. The material is ground several times before leaving the mill and being classified by a dynamic separator. The horizontal mills have relatively low power consumption however maintenance costs are high.

7.3.2.4 Roller Press (RP)

This is a more recent choice especially after the advent of the V-separator & improved roller life, offers the lowest energy consumption but even few plants in service; These consist of a pair of rollers set 8-30 mm apart and counter-rotating with surface speed around 0.9 - 1.8 m/s. The bearings of the rollers are designed to deliver a pressure of 50 MPa or more. The bed of material drawn between the rollers emerges as a slab-like agglomeration of highly fractured particles. Like the VRM and the HRM, roller press systems are also based on the particle bed compression principle of energy saving. High pressure roller press systems for finish grinding employ a static V-separator to first separate the fine fraction from the feed. The course fraction is fed in to the roller press itself and the fine fraction is fed into a dynamic separator to separate out the final product. The coarse fraction is fed back to the roller press. The two rollers of the roller press pressurise the coarse material to break up the particles. One advantage of this milling system is that the return of the coarse material from the static

separator is performed by a bucket elevator instead of less energy efficient pneumatic conveying (as is done internally in a VRM). The energy efficiency of this process is comparatively high. Systems have been designed, including a de-agglomerator and separator, that will deliver material of cement fineness. However, particle size distribution is again a problem, and roll presses are now increasingly popular as a "pre-grind" process, with the cement finished in a single chamber ball mill. This gives good cement performance, and reduces energy consumption by 20-40% compared with a standard ball mill system.

7.3.3 The type of cement silo

A silo is a structure for storing bulk materials. Silos are more commonly used for bulk storage of grain, coal, cement, carbon black, woodchips, food products and sawdust. For the storage of cement, usually various silos are required. However new silo designs allow the storage of more than one type of cement in the same silo. Nowadays for cement storage the silo configurations listed below are used.

There are four types of cement storages in use:

7.3.3.1 Single Cell Silo with Discharge Hopper (SCSDH)

This is a cement storage silo with a single compartment and whose cement dispenser mechanism is a discharge hopper. In this type of silo, the homogeneity of stored powdered bulk materials is not well achieved.

7.3.3.2 Single Cell Silo with Central Cone (SCSCC)

Intensive development during the last few decades in the field of silo technology has produced pneumatic emptying and blending systems which provide reliable storage and good homogenization of the powdered bulk materials.

7.3.3.3 Multi-Cell Silo (MCS)

Changes in the production of binders and fillers, for example by grinding the mixing components separately or utilizing waste materials, fly ash, etc., have had an effect on silo technology, the preparation of the bulk materials and ultimately the dispatch technology. The concentration of storage, blending and dispatch for a greatly increased number of bulk materials, inter-ground additives and mixed products has eventually led to the concept of a multi-compartment, high capacity silo system with integral positive mixer and dispatch

station. The multi-compartment silo comprises individual storage units that can be very flexibly designed. This silo is therefore also ideal for convenient storage of widely differing binding agents using a common out-loading system.

7.3.3.4 Dome Silo with Central Cone (DSCC)

With the progressively increasing size of the production units in the cement industry there has been a corresponding increase in size of the silo units for storing the cement. Silos with large diameters and with very high individual storage capacities must be capable of efficient and trouble-free emptying. The dome-shaped central cone silo is today's answer to this task. Several discharge gates placed at the circumference of the silo opened one after the other make the cement flow downwards near the outer shell. This system allows recovery of more than 99% of the stored material

7.4 Raw material source alternatives

The main raw material of Mombasa Cement Limited is the, coral limestone is quarried at the Vipingo Plant and used to make clinker which is then transported and used to make cement at the Athi River plant. Other raw materials for cement production are pozzolana and gypsum which are added in little quantities compared to limestone. Gypsum required is imported from Oman through the port of Mombasa while pozzolana is sourced from Athi River and Kajiado areas. Alternative Sources of limestone include from Eastern parts of Kenya including Kitui area, the Rift valley area and West Porkot areas. These alternative sources would prove costly because Mombasa Cement does not own land in those areas.

8. OCCUPATIONAL SAFETY AND HEALTH

8.1 Introduction

Occupational Safety and Health (OSH) is of paramount importance in all working environment. It is always important for mechanisms to be put in place to predict potential risks, incidents and hazards in the said working environment. This is because the occupational environment directly affects employees involved in operations, the neighbourhood, visitors, contractors, sub-contractors and the general public. Therefore during the operation of all activities of the proposed project, a number of safety measures have to be put in place to ensure the safety of employees, neighbour s and the general public. Employees and visitors may be exposed to a variety of personal health and safety risks. The type and level of exposure is generally related to factors controlled by the proponent. Such factors include design, equipment, tools, work procedures, and employee training. Occupational health and safety risks that must be considered by the proponent arise from normal functions and operations and during unusual circumstances such as accidents and incidents.

Mombasa Cement Limited-Athi River, together with the hired contractors are responsible for Occupational Safety and Health requirements at the proposed expansion of the cement grinding unit and all associated facilities. The company has to put in place required OHS measures that include the following:-

- ✓ Implementation of appropriate national and internal recognised OSH standards, codes and guidelines.
- ✓ Inclusion of meaningful participation of employees in implementation and maintenance of procedures and processes.
- ✓ Implementation of a programme to change employee involved in operation culture and altitudes regarding health and safety.
- ✓ Planning, implementing and monitoring programs and systems required to ensure OSH at the workplace.
- ✓ Maintain equipment, tools and machinery and organise work so as to eliminate or control hazardous ambient work factors.
- ✓ Provision of adequate personal protective equipment to all employees at no cost to employees.

- ✓ Recording and reporting of occupational injuries and illness to the Directorate of Occupational Safety and Health.

Mombasa Cement Limited-Athi River will have to develop and documented an elaborate Occupational Health and Safety Policy. The policy will seek to ensure that the workplace is safe and that workers are protected against accidents and injuries. Some of the features to be captured in the policy may include work safety procedures, machinery safety, chemical safety, use of personal protective equipment, reporting of injuries, accidents, alcohol and drug use at the workplace, housekeeping practices safety committee and safety training and safe work practices.

8.2 Employee safety

In addressing requirements and needs to ensure employee safety, the following will need to be addressed: -

- ✓ Provision of adequate personal protective equipment.
- ✓ Servicing of plant and equipment as per manufacturer's specification and schedule.
- ✓ Hiring of experienced and competent plant and equipment operators.
- ✓ Continued training of employees on emerging technologies relevant to the operations of the company.
- ✓ Provision of appropriate welfare facilities to the workers.
- ✓ Putting measures in place to minimise noise, dust and other emission to the stipulated legal limits.
- ✓ Pre- medical examinations for new employees before hiring them and annual medical examination thereafter to tract employee health.

8.3 Machine Use and Electrical Safety

Machinery and equipment for the proposed expansion will include, hoppers, conveyors, bucket elevators, pumps, such as lubricating pumps, pre-jacking pumps, axial guide pump, electric motors, cement grinding equipment such as, ball mill, lifting equipment such as forklift truck, bucket excavators, air receivers, electrical equipment such as welding machines, cutting machines, electrical generators

In regard to electrical safety, the following should be observed

- ✓ All lifting equipment and pressure vessels to always undergo statutory examination and certification by a registered OSH Inspector before use.
- ✓ Installation and fitting of proper electrical system to enable supply of electrical energy to utility point.
- ✓ All electrical installations and fittings to be done according to electrical safety rules.
- ✓ All electrical wires to be appropriately and safely insulated
- ✓ Sockets and other electrical outlets must be securely fitted
- ✓ Appliances to be properly earthed

8.4 Chemical safety

Mombasa Cement Limited-Athi River will operate a laboratory where the quality of the various raw materials to be used will be tested and the quality of the products will be monitored. In doing this some chemical reactions may be necessitated that will require the use of acids and bases. To address the requirement of chemical safety for the users of the laboratory chemicals the following will be necessary.

- ✓ Hire trained and experienced chemists to man the laboratory.
- ✓ Provide appropriate laboratory equipment necessary for the required chemical reactions
- ✓ Provided appropriate laboratory reagents in required concentrations.
- ✓ Provide appropriate laboratory first aid equipment including eye wash station
- ✓ Ensure every reagent used has the appropriate Material Safety Data Sheets (MSDS) available.

8.5 Fire Safety

With regard to fire safety at the workplace, the following among others will have to be taken into consideration; emergency exits, housekeeping, fire fighting appliances, fire detection system, fire audit, emergency evacuation procedures, ventilation and overcrowding.

- ✓ Appropriate fire exits to be provided in all sections and be appropriately labelled.
- ✓ Sound housekeeping practices to be embraced and upheld at all times.
- ✓ Appropriate fire warning system to be installed.

- ✓ Appropriate serviceable fire fighting appliances to be installed.
- ✓ A fire marshal team to be trained and appropriately equipped.
- ✓ Ventilation at the workplace to be sufficient.
- ✓ No overcrowding at any workstation.
- ✓ Safe passages to be provided for.
- ✓ Appropriate signage should be put in place

9. STAKEHOLDERS CONSULTATION

Consultation with various stakeholders and public participation was done during this Environmental Impact Assessment Study Report data collection and report compilation. This is in line with the requirements of Legal Notice No. 101, Kenya Gazette Supplement No. 56 of June 13th 2003, the Environmental (Impact assessment and Audit) Regulations, 2003. Consultations and public participation was encompassing, interactive and intensive, so as to ensure that as many stakeholders as possible and the public were reached. Special attention was paid to general public especially those drawn from the proposed project site and the immediate neighbourhood. Views, comments, concerns and opinions of stakeholders concerning the project were sought. The Environmental Impact Assessment team solicited possible and practical ways to address the issues and concerns raised with the stakeholders. The consultation was vital as it served to:-

- ✓ Inform the local community especially those drawn from the proposed project site of the proposed development within their locality.
- ✓ Explain to the local community the nature of the proposed project, its objectives and scope.
- ✓ Give local community especially those drawn from the proposed project site an opportunity to present their views, concerns and issues regarding the proposed.
- ✓ Obtain suggestions from the local community and other stakeholders on possible ways potential negative impacts can be effectively mitigated, potential negative impacts can be enhanced and how the local community can be part of the proposed project.

The consultation was two-fold, namely;

- Questionnaire survey
- Public Barazas

9.1 Questionnaire Survey

A detailed questionnaire survey was carried out that targeted to reach out to primary stakeholders at the grass root. This included administrative leaders, learning institutions, companies and the business community, the hospitality and service industry, community

based groups, religious institutions, medical institutions, and general community members (appendix 7).

The following were the respondents to the questionnaires;

Administrative Leaders

- ✓ Cosmas Musyoki Nzanga: Asst. Chief, Mavoko Sub-Location
- ✓ Machakos Investment Promotion Board

Learning Institutions

- ✓ St. Augustine Mulolongo Secondary School
- ✓ Kiuini Preparatory School
- ✓ Oak Tree School
- ✓ Mlolongo Primary School
- ✓ St. Bakhita School –Sabaki
- ✓ Anthena School

Companies & Business Groups

- ✓ Multiple Hauliers (E.A) Ltd
- ✓ London Distillers Kenya Ltd
- ✓ Halyard Ventures Ltd
- ✓ Ramrod Tanks Limited
- ✓ Tuff Bitumen-Mercy Makori
- ✓ Adsite Limited-Justine Migere
- ✓ Exon Plastic (K) Ltd
- ✓ Dynamart Motors Ltd
- ✓ Jubilee Jumbo Hardware Ltd
- ✓ Foam Mattress Ltd-Mr. Dakshesh Patel
- ✓ Davis & Shirtlif Ltd
- ✓ Moldplast Kenya Limited
- ✓ Star-Pet Limited

- ✓ Vishkarma Body Works Ltd
- ✓ Kisumu Concrete Products Ltd
- ✓ Bell Energy Savings-George Ndirangu
- ✓ Animix Limited
- ✓ Vintz Industries Limited
- ✓ Kenlube Limited
- ✓ Graphics & Allied Ltd
- ✓ Day World Systems Ltd
- ✓ Lean System Consultants Ltd
- ✓ Quality Assurance Systems Ltd

Hospitality & Service Industry

- ✓ Millennium Park Annex (MPA Hotels Ltd)
- ✓ Bustani Guest House-Athi River Senior Staff
- ✓ Interchange Bar & Restaurant
- ✓ Green Garden Hotel
- ✓ Imani Hair & Beauty Salon-Franciscar Clarah

Community Organized Groups

- ✓ Doors of Hope –Jacqueline Shibalira (Program Manager)

Religious Institutions

- ✓ Fountain of Grace Church
- ✓ Redeemed Gospel Church
- ✓ Rev. Titus Mwendwa

Medical Institutions

- ✓ Athi River Shalom Community Hospital

Residents/Community Members

- ✓ 102 South Park Estate

- ✓ Shamit Singh Varma
- ✓ Eunice Anyore
- ✓ Bodas Masiza Dere
- ✓ Charles M. Mutiso
- ✓ Mr. & Mrs. Raphael Lerionka Kapai
- ✓ Charles Wachira
- ✓ Susan Mwelu Makuta
- ✓ George
- ✓ Samson K. Mwilu
- ✓ Nthiwa Patricia
- ✓ Cyrus David
- ✓ Langat Kipkorir Cornelius
- ✓ Joel Oyaro Kebwaro
- ✓ Franciscah Nzui
- ✓ Patrick Ngei Matei

9.1.1 Stakeholders' Views, Issues and Concerns as captured from the questionnaire responses

- ✓ Dust release into the environment from the plant will increase as a result of the proposed expansion and thus accelerating air pollution.
- ✓ Environmental pollution will increase from this expansion project.
- ✓ Many trucks plying to and from the factory may contribute more to air pollution.
- ✓ Noise pollution from trucks and the plant may increase.
- ✓ The proposed expansion will lead to a labour influx into the areas and hence increased population in the area.
- ✓ The project will create more employment opportunities for the growing population in the area.
- ✓ The proposed project is bound to boost cement production, a good step towards meeting the cement demand in the country.
- ✓ Traffic jams are bound to increase as there will be more vehicles to make deliveries to and from the plant premises.
- ✓ The project will enhance the industrial sector.

- ✓ The expansion program will boost both the local and national economy of the country.
- ✓ The project will lead to more infrastructural developments.

9.1.2 Proposed measures to be put in place to address the issues and concerns as captured from questionnaire responses

- ✓ Appropriate technology should be put in place to minimize dust emissions.
- ✓ Ensure that the safety of workers during and after the construction of the proposed project is guaranteed.
- ✓ A program for night deliveries into and from the proposed project site should be developed to ease the traffic.
- ✓ Efforts should be made to employ the use of clean energy in the production processes.
- ✓ Waste resulting from the proposed project should be properly managed.
- ✓ The proponent should embrace deliberate tree planting efforts to minimize carbon emissions and to green the area.
- ✓ Establish a proper turning point for the trucks accessing the factory.

9.2 Public Baraza

The second level of public consultation involved carrying out three public meetings within the neighbourhood of the proposed project site.

9.2.1 First public Baraza

The first stakeholder consultative meeting (baraza) was held at the chief's office grounds-Mavoko Location, Machakos County on 3rd October 2017 (appendix 8).

9.2.1.1 Issues raised during the baraza

The following were the main views, issues and concerns that emanated from this meeting:

- ✓ That Mombasa Cement Limited-Athir River should keep up the practise of sprinkling water regularly to arrest fugitive dust on the access road.
- ✓ Mombasa Cement Limited was urged to embrace corporate social responsibility projects for the community. Among the projects suggested by the community members were bursaries for needy and bright students, provision of water and rehabilitation of the Chief's Office Mavoko Location.

- ✓ The community urged the National Environment Management Authority to ensure potential negative impacts likely to result from the proposed expansion are effectively addressed.
- ✓ Suggestions were made to have the access road serving Mombasa Cement properly reconstructed as it is too dusty and full of potholes.
- ✓ Dust pollution was noted to be the biggest concern and problem to Athi River residents. Residents said that as a result of the dust local people suffer eye problems and chest ailments. The residents urged the Authority to ensure the dust problems in the area are effectively addressed.
- ✓ Mombasa Cement Limited was urged to give priority to local youths for employment opportunities. The residents suggested that atleate 70% of the company employee should be from the local community.
- ✓ Requests were made for Mombasa Cement Limited to consider sponsoring orphans and physically challenged children from the local community.
- ✓ The residents took issue with some projects in the neighbourhood and wondered how they were approved and licenced sighting a petrol station constructed under residential flats and wondered if there was to be a fire outbreak what will happen and a factory for burning tires at Cosovo area that emits harmful chocking smoke to the residents.
- ✓ The residents wanted to know how dust and noise from the plant will be mitigated.
- ✓ The residents noted that Mombasa Cement Limited was doing poorly in terms of corporate social responsibility as compared to other investors in the area.
- ✓ Mombasa Cement Limited was urged to support the local Kwamangeli Primary School that lacks sufficient classrooms.
- ✓ Residents urged the company to address the views raised by stakeholders.
- ✓ Residents noted that local companies were contributing to the pollution of the Athi River water course and urged Mombasa Cement Limited to ensure their activities do not pollute the said water course.
- ✓ The community members noted that Namanga Road lacks an appropriate turnoff to exit into the access road serving Mombasa Cement Limited and as a result there are many accidents at that spot.

- ✓ It was noted that the adjacent city carton area lacks a public primary school; Mombasa Cement Limited was therefore urged to assist the local community to help in constructing one.
- ✓ Residents noted that the consultative forum for the EIA process was good and important as local people have the opportunity to air their views and concerns and present their suggestions to the developer. They said that some projects in the area and elsewhere that have issues could be that such an elaborate consultative process was not followed and perhaps local people in those areas were not consulted before their approval for implementation.
- ✓ The Lead Expert was urged to ensure that he proposes appropriate mitigation measures for the issues and concerns raised to effectively mitigate them. Further they said Mombasa Cement including its appointed contractors should ensure that they follow all the proposed mitigation measures by the Lead Expert to ensure that adverse negative impacts do not result during implementation and operation of the project. Residents noted that Mombasa Cement has the potential to further expand in the future and hence the need to strictly follow all mitigation measures to be suggested in the EIA report to be prepared.
- ✓ The Chief noted that Mavoko Location was growing and expanding rapidly. He suggested that employees in local companies in the location such as Mombasa Cement Limited should be at least 50-60% local people. He noted that local youths once employed will reduces cases of crime and insecurity in the area. He decried that there has been many accidents when exiting Namanga Road to enter the access road serving Mombasa Cement due to no provision of safe exit. He suggested the need for urgent action to be taken to address this serious road safety concern in the area to save lives.
- ✓ The Assistant County Commissioner-Athi River Sub-County emphasized that Mombasa Cement Limited should employee local youths, have appropriate corporate social responsibility projects for the community, an assist in construction of water boreholes in Mavoko for Mavoko people to access water.

9.2.1.2 **Responses to some of the issues**

The following were the responses to some of the issues raised at the baraza

- ✓ On the issues of mitigation measures the Lead Expert said that appropriate mitigation measures for each of the potential negative impacts predicted will be provided and a plan

to implement the measures be spelled out in an environmental management plan to be developed in the EIA study report to be prepared.

- ✓ On the mitigation of potential negative impacts of dust, the Lead Expert said that the bag filter technology will be the main technology that will be used to remove cement dust from the production line. He said that Bag filters technology employs Pulse-Jet Dust system to collect cement dust from the entire cement production system including auxiliary equipment, transfer and conveying points. He said that the dust collection technology that will be proposed has a dust-tight casing with three sections, namely; a clean-air plenum at the top, a filtration housing containing a number of cylindrical or envelope type filter bags in the middle, and a dust storage hopper at the bottom. The filter elements are supported by a tube sheet that separates the filtration housing from the plenum.
- ✓ On mitigation of noise the Lead Expert noted that this will be by assessing the risks, protecting employees, maintaining and equipment use, training and sensitising of workers, health surveillance and work review.
- ✓ On Employment of people from other areas not Athi River, Dr. Rushein Delwash, the Human Resource Manager Mombasa Cement Limited, said that Athi River is a cosmopolitan area it is difficult to know who does not come from the area. He promised in future to go consult the Chief Office when recruiting people from the local community.'
- ✓ On Corporate social responsibility, Dr. Rushein Delwash, the Human Resource Manager Mombasa Cement Limited, noted that Mombasa Cement has in the past supported local police stations and hospitals but said this is not enough. He promised he will consult with his directors to scale up community support projects in the area.

Plate 3: Proceedings during the first public baraza

9.2.2 Second baraza

The second stakeholder consultative meeting (baraza) was held at the Alpha Rama Village Grounds-Mavoko Location, Machakos County on 6th October, 2017 (appendix 9)

9.2.2.1 Issues raised during the baraza

The following were the main views, issues and concerns that emanated from this meeting:

- ✓ Residents noted that the proposed project was welcome but raised concern that people working at the plant are sourced from elsewhere as opposed to the Alpha Rama area-the catchment area of the Athi River Plant. They therefore urged the management of the plant to also consider hiring people from the Aplha Rama community for the community to benefit from the proposed project.
- ✓ The local community decried that contractors do not source labour from the local community but instead only use people from their families. Due to this local people have not benefitted from employment opportunities in the company.
- ✓ Residents urged the management of Mombasa Cement Limited-Athi River to regularly sprinkle water along the access road to reduce fugitive dust. They also said that the company should give priority to the local youth for employment opportunities.
- ✓ Residents said that Alpha Rama residents should be given priority for employment opportunities despite their low education, to reduce on cases of insecurity in the area.
- ✓ Residents noted that dust pollution was already a concern; they therefore wanted to know how the extra dust as a result of the expansion will be managed.

- ✓ They wanted to know how the members of the community would benefit from the proposed project.
- ✓ In terms of Corporate Social Responsibility, they requested the company to pipe water to the community connect electricity and build a public toilet for the Alpha Rama community.
- ✓ They also proposed that at least70% of employment opportunities at the company should go to the locals.
- ✓ Residents said that youths from the locality should be given priority for employment opportunities. They decried that some people purporting to be managers from the company allegedly sort for bribes from unsuspecting local youths with a promise to have them employed at the company.
- ✓ They requested the company to consider putting up a school within the Alpha Rama area or at lease equip existing public primary school within the sub-location.
- ✓ They requested Mombasa Cement to consider supporting the only public primary school within Mavoko location. They requested for at least hundred bags of cement and iron sheets to build additional classrooms in the school.
- ✓ Residents said that none of the Alpha Rama residents is employed at Mombasa Cement; they therefore wanted to know how locals will benefit from the proposed expansion.
- ✓ Residents noted that the heavy trucks are causing dilapidation of local roads and that the company should help in road maintenance for local roads.
- ✓ Residents said that there is no road signage at the entrance to the plant that would help prevent potential accidents.
- ✓ Residents proposed that the same procedure used to call the public baraza should be used when recruiting people for employment in Mombasa Cement. This thsy noted will ensure that local people benefit from available employment opportunities.
- ✓ Residents said that they have benefitted from Mombasa Cement Limited as a company and therefore welcomes th proposed expansion.
- ✓ They suggested that Mombasa Cement Limited should use their waste rocks in road maintenance.
- ✓ They also requested that Mombasa Cement Limited should hire the local community groups in their tree planting activities.

- ✓ Residents noted that water is a problem in the neighbourhood and that Mombasa Cement should consider providing water to the community.

9.2.2.2 Responses to some of the issues

The following were the responses to some of the issues raised during the baraza

- ✓ On employment opportunities, Dr. Rushein Delwash Human Resource Manager Mombasa Cement Limited said that the company would try its level best to employ people from the community through the Chief's office.
- ✓ On corporate social responsibility, Dr. Rushein Delwash Human Resource Manager Mombasa Cement Limited said that he will communicate the request to the Directors for considerations. He went on to say that he believes the company was willing to undertake the requested projects, however he said that prior to that appropriate systems will have to be put in place first.
- ✓ On the issue of some people purporting to be managers of the company and soliciting for bribes to employ people in the company, Dr. Rushein Delwash Human Resource Manager Mombasa Cement Limited said that those people are not employees of Mombasa Cement and that nobody should give any bribe to be employed in the company.
- ✓ On the issues of Dust pollution management the Lead Expert said that in the study report he and his team will propose appropriate mitigation measures to address dust pollution from the proposed project. He went on to say that some of the measures will include use of appropriate bag filters which will be installed in the system to extract dust, regular maintenance of the bag filters and prompt replacement of worn out ones to ensure optimal efficiency and that regular sprinkling of water will be undertaken to arrest fugitive dust.
- ✓ On the issues of road safety the Lead Expert said that his team will recommend in the report that the proponent to liaise with the Kenya National Highways Authority and the Machakos County Government to address the issue of the said road.
- ✓ The Mombasa Cement Limited-Athi River Environmental Officer said that local community groups like the Mavoko Kanahari Self-Help Group should be encouraged in its tree planting activities initiatives, this he noted will contribute in improving greening of Mavoko.
- ✓ The Mombasa Cement Limited-Athi River Environmental Officer urged the people to be more creative instead of being over-reliant on the government and the company.

- ✓ The Mombasa Cement Limited-Athi River Environmental Officer urged local youth to embrace formation of self-help groups and seek help as a group instead as seeking assistance as individuals.
- ✓ Residents said that social corporate responsibility projects proposed by the community at Alpha Rama should be implemented. They also said that local groups should be supported to grow.
- ✓ The Assistant Chief Mavoko Sub-Location Mr.Cosmas M. Nzanga said urged Mombasa Cement Limited to consider the requested corporate social responsibility projects, prioritising the toilet project at the Alpha Rama village.

Plate 4: Proceedings during the second baraza

9.2.3 Third baraza

The third stakeholder consultative meeting (baraza) was held at the City Cotton Village & Kwawere Village, Kanaan Sub-Location, Mavoko Location, Machakos County on 10th October, 2017 (appendix 10).

9.2.3.1 Issues raised during the baraza

The following were the main views, issues and concerns that emanated from this meeting:

- ✓ The residents noted Mombasa Cement Limited-Athi River was beneficial to the area.
- ✓ The residents registered their appreciation for being consulted on the proposed project.
- ✓ Residents raised concerns that residents from the informal settlements within the Plant's catchment area are not being employed at the company.
- ✓ The residents wanted to know whether Mombasa Cement Limited-Athi River has the capacity to control dust pollution.

- ✓ The residents wanted to know whether Mombasa Cement Limited-Athi River has the capacity to control noise and vibrations.
- ✓ The people said that the proposed expansion could be a potential health concern to the area.
- ✓ They raised issues to do with road safety as there is no proper exit from the Namanga Road into the access road to the plant.
- ✓ They urged Mombasa Cement Limited to employ the locals from the informal settlements within its catchment area.
- ✓ The residents decried that road safety is not guaranteed for school going children as there is no proper exit from the Namanga road into the access road to the plant and they requested that efforts should be made to erect a flyover.
- ✓ They sought clarification on whether the proposed expansion will be undertaken within the boundaries of the current MCL Athi River land or new land will be bought elsewhere.
- ✓ They sought clarification on how Mombasa Cement Limited intends to deal with stacks emissions.
- ✓ The residents supported the proposed expansion and observed that the existing two cement grinding units at the plant are cleaner and thus the proposed one should be just like the existing two or better.
- ✓ They urged Mombasa Cement Limited to consult with the government and establish a proper turn-off into their plant.
- ✓ They urged Mombasa Cement Limited-Athi River to device even better dust and stack emissions management systems as has been agreed consistently in the consultative meetings
- ✓ They urged the company to embrace corporate social responsibility and assist the community.
- ✓ Some residents said a recent fire incident razed down their houses and therefore requested for assistance form the company to rebuild the burnt houses.

9.2.3.2 **Responses to some of the issues**

The following were the responses to some of the issues raised in the baraza.

- ✓ On employment opportunities, Dr.Rushein Delwash the Human Resource Manager Mombasa Cement Limited-Athi River noted that the issue has come up in all the barazas

and said that the company has limited employment opportunities but would try its level best to employ at least one person from each village through the Chief's office.

- ✓ On corporate social responsibility, Dr.Rushein Delwash the Human Resource Manager Mombasa Cement Limited-Athi River said the company has put measures in place to help in the levelling of the Athi River Stadium. On improvement of villages within Athi River, he said that a research would first be conducted to identify relevant areas of intervention and that it is a process that could take up to two years.
- ✓ On the issues of Dust pollution management the Lead Expert said that in the study report he and his team will propose appropriate mitigation measures to address dust pollution from the proposed project. He went on to say that some of the measures will include use of appropriate bag filters which will be installed in the system to extract dust, regular maintenance of the bag filters and prompt replacement of worn out ones to ensure optimal efficiency and that regular sprinkling of water will be undertaken to arrest fugitive dust. He also said that regular dust monitoring would be undertaken as per the provisions of the Environmental Management and Coordination (Air Quality) Regulations 2014 and that proper protective equipment would be provided and their use enforced.
- ✓ On noise management the Lead Expert said that regular equipment maintenance would be undertaken, noise attenuators fixed and appropriate engineering controls established on the equipment. He said that regular noise monitoring and noise survey would be undertaken and the right protective equipment provided to workers and their use enforced.
- ✓ On the issues of road safety the Lead Expert said that the drivers of trucks delivering raw materials to the cement plant and collecting cement from the plant should be encouraged to observe highway code and that his team will recommend in the report that the proponent to liaise with the Kenya National Highways Authority and the Machakos County Government to address the issue of the said road turn off challenges brought out in the three barazas.
- ✓ On the land where the proposed expansion would take place, the Lead Expert said that the proposed expansion would take place within the current land owned by Mombasa Cement, where the current plant is.
- ✓ On stack emissions, the Lead Expert said that proper maintenance of equipment would be undertaken regularly and that monitoring of stack emissions would be undertaken as per

the provisions of the Environmental Management and Coordination (Air Quality) Regulations 2014.

- ✓ The Assistant Chief Mavoko Sub-Location Mr.Cosmas M. Nzangat retaliated that all the environmental issues should be addressed appropriately in the environmental impact assessment study report as per the appropriate legal provisions. He urged Mombasa Cement Limited to consider the requested corporate social responsibility projects, as a good neighbour. He noted that 11 people from the two villages lost their houses through a fire incident and hence needed help. He noted the multiplier effect of the companies in the area that has led to improved purchasing power and emphasized that as a location, county and country, such investments are necessary for development to be attained. He urged local investors to embrace environmental concerns.

Plate 5: Proceedings during the third baraza

10. ENVIRONMENT MANAGEMENT AND MONITORING PLAN

The Environmental (Impact Assessment and Audit) Regulations, 2003 define Environmental Management Plan (EMP) to mean "all details of project activities, impacts, mitigation measures, time schedule, costs, responsibilities and commitments proposed to minimise environmental impacts of activities, including monitoring and environmental audits during implementation and decommissioning phases of a project". The proposed project activities are elaborated in the project description section, this EMP covers the following

This environmental management and monitoring plan consist of the following:-

a) Potential positive impacts as a result of project implementation.
b) Potential negative environmental impacts as a result of project implementation
c) Proposed mitigation measures of potential negative impacts
d) Environmental management action plans
e) Environmental monitoring and audit
f) Training and capacity building needs
g) Institutional arrangement for safeguards implementation and reporting
h) Conceptual decommissioning plan

10.1 Potential positive impacts

10.1.1 Introduction

According to the Economic Survey of the Kenya Bureau of statistics of 2014, cement production registered an accelerated growth of 7.8 per cent in 2013 compared to a growth of 4.8 per cent in 2012. This translated into 5,059.1 thousand tonnes in 2013. Cement consumption and stocks also increased from 3,991.2 thousand tonnes in 2012 to 4,266.5 thousand tonnes in 2013 as a result of increased construction activities. For a second consecutive year, imports of cement declined to stand at 34.4 thousand tonnes in 2013. Total exports of cement to Uganda and Tanzania, which had decreased in 2012, reversed to record 594.0 thousand tonnes in 2013. Table 1 summarizes this information.

Table 7: Cement Production and Utilization, 2009-2013

'000 Tonnes

YEAR	PRODUCTION	IMPORTS	CONSUMPTION AND STOCKS	EXPORT TO	
				Uganda and Tanzania	All other counties
2009	3,320.3	35.2	2,671.3	608.2	76.0
2010	3,709.8	27.1	3,085.2	548.3	103.4
2011	4,478.4	53.0	3,870.9	583.1	125.3
2012	4,693.7	35.3	3,991.2	561.7	176.7
2013	5,059.1	34.4	4,266.5	594.0	233.9

Source: Economic Survey of the Kenya Bureau of statistics of 2014

Cement production and consumption have both been on the rise in recent years, although the latter continues to outpace the former, with the Kenya National Bureau of Statistics (KNBS) reporting in its "2017 Economic Survey" that total cement production increased by 5.6 per cent in 2016, compared to a growth of 8.0 per cent recorded in 2015. The quantities of cement produced went up from 6,352.9 thousand tonnes in 2015 to 6,707.2 thousand tonnes in 2016. Consumption has equally been increasing, with the KNBS reporting that Cement consumption and stock increased from 5,708.8 thousand tonnes in 2015 to 6,302.0 thousand tonnes in 2016, driven by robust growth in the construction industry. In February 2015 Standard Investment Bank forecast that Kenya will remain the dominant country for cement activity in the EAC through to 2017, accounting for 42% of total consumption and 51% of total production.

The table below shows cement production and utilisation for the period 2012 to 2016. Cement production increased by 5.6 per cent in 2016, compared to a growth of 8.0 per cent

recorded in 2015. The quantities of cement produced went up from 6,352.9 thousand tonnes in 2015 to 6,707.2 thousand tonnes in 2016. Cement consumption and stock increased from 5,708.8 thousand tonnes in 2015 to 6,302.0 thousand tonnes in 2016. Total cement exports dropped by 38.3 per cent to 420.4 thousand tonnes in 2016, which was the lowest export in the last four years. Cement export to Uganda and Tanzania declined to 325.0 thousand tonnes in 2016 from 487.4 thousand tonnes in 2015. Imports of cement dropped from 37.6 thousand tonnes in 2015 to 15.1 thousand tonnes in 2016.

Table 8 Cement Production and Utilisation, 2012-2016

'000 Tonnes

Year	Production	Imports	Consumption and stocks	Exports to	
				Uganda and Tanzania	All other countries
2012	4,693.7	35.3	3990.7	561.7	176.7
2013	5,059.1	34.4	4265.6	594.0	233.9
2014	5,882.5	36.4	5196.0	547.7	175.2
2015	6,352.9	37.6	5708.8	487.4	194.2
2016*	6,707.2	15.1	6302.0	325.0	95.4

Source: Kenya National Bureau of Statistics-Economic Survey 2017

Implementation of the proposed expansion of the Mombasa Cement Athi River Unit may results in positive impacts. Potential positive impacts likely to result from the proposed expansion may include:-

- ✓ Increased mining of minerals used in cement production
- ✓ Increase in cement production in Kenya
- ✓ Reduction in cement imports
- ✓ Increase in Cement exports
- ✓ Employment opportunities
- ✓ Support of local businesses
- ✓ Increased revenue to government

10.1.2 Increased mining of minerals used in cement production

The proposed expansion of Mombasa Cement Athi River Unit will likely result in increased mining and exploitation of the three raw materials namely clinker, pozzolana and gypsum that will be used to manufacture cement at MCL Athi River Unit. Whereas there is no manufacture of clinker at MCL Athi River Unit, the clinker to be used in the proposed expansion of the cement mill will be sourced from MCL Athi River Unit. It is important to note that clinker is produced from burning of limestone together with other clays. Other minerals whose exploitation is likely to increase as a result of the expansion may gypsum and pozzolana.

10.1.3 Increase in cement production in Kenya

The proposed expansion of Mombasa Cement Athi River Unit seeks to increase the production capacity by 4, 300 tons per day. This if achieved will effectively contribute to significant increase in cement production in Kenya.

10.1.4 Reduction in cement imports

The proposed expansion of Mombasa Cement Athi River Unit will mean there will be more cement produced in Kenya than before. This will mean previous cement deficit will be farther narrowed. There will thus be less need for cement importation. Reduced cement importation will translate to reduced spending of foreign currencies; this will mean there will be more foreign currency reserves due to reduced cement importation.

10.1.5 Increase in Cement exports

The proposed expansion of Mombasa Cement Athi River Unit will result in production of more cement in the Kenya. This will mean that there will be more cement available for export than was previously. Increased export of cement will translate to increased foreign exchange earnings for the county.

10.1.6 Employment opportunities

The proposed expansion of Mombasa Cement Athi River Unit will provide opportunities for employment for more people to work in the expanded factory. It is envisaged that the workforce may increase by 20% to cater for the expansion needs.

10.1.6 Support of local businesses

Services of local businesses such as transporters will be required to cater for the expanded factory. This will contribute to growth and development of such businesses. Other businesses may start or be farther developed to cater for the needs of the expanded factory such businesses likely to grow my include housing to cater for the increased workforce, hospitals, schools, shops among others.

10.1.7 Increased revenue to government

The proposed expansion of Mombasa Cement Athi River Unit will translate to increased tonnage of cement that will be produced. Tis will translate to increased tonnage of sells of cement translating to increased profits to the company. Increased profits will translate to increased taxes hence increased revenue to government. The expansion will translate to increased use of raw materials this will result to increased cess to the Machakos County Government among other taxes.

10.2 Potential Negative Impacts

Potential negative impacts that may result from the proposed expansion of the Mombasa Cement Limited Athi River Unit may include: -

- ✓ Dust emission
- ✓ Noise disturbance
- ✓ Occupational injuries and accidents
- ✓ Waste generation

10.2.1 Dust emissions

10.2.1.1 Background

Dust can be defined as an aerosol and disperse system that consists of small solid particles suspended in a gaseous medium. Separate particles and particle aggregates—from ultra-microscopic particles to those visible with the naked eye—have various shapes and compositions. In most cases, dust is formed as a result of the dispersion of solid bodies. It consists of particles that range in size from 10^{-7} to 10^{-4} m and that carry an electrical charge or are electrically neutral. Dust concentration, or dust content, is expressed by the number of

particles or their total weight per unit volume of gas (air). Dust is unstable; its particles adhere during Brownian motion or during sedimentation. Dust from cement or more appropriately cement particulate matter, at a cement plant is typically caused by physical attrition, combustion particle burnout, or nucleation. Physical attrition occurs as particles abrade against each other. Particles generated by physical attrition range from less than 10 micrometers in size to more than 1,000 micrometers. Combustion particle burnout refers to the residues remaining from the pyroprocess. These particles are typically in the 1 to 100 micrometer range. Nucleation particles are generated when materials that are in a vapor form condense. These particles are truly very small, usually between 0.1 and 1.0 micrometers.

10.2.1.2 Potential sources of dust

The proposed expansion will generate cement dust from the following sections of the MCL Athi River Unit.

i) **Raw material handling**: dust will be produced during tipping of raw materials from tippers that are ferrying in the raw materials and at the tunnel venting where the raw materials drop into the belt conveyor system.

ii) **Feed hopper and conveyor**: dust will be produced when raw materials are being feed into the hopper and conveyor.

iii) **Separator:** dust will be produced during material separation.

iv) **Mill**: dust will be produced when the raw materials are dropped into the ball mill for grinding.

v) **Mill air slide**: dust will be produced when fine ground powdery material move by means of air slide from mill area to the storage silo.

vi) **Silo top cement discharge:** dust will be produced when the powdery cement is discharged into the silo at the top of the silo.

vii) **Silo bottom cement extraction**: dust will be produced when cement is extracted from the bottom of the silo.

viii) **Cement packaging and loading:** dust will be produced during automated packaging of cement and loading into the trucks.

ix) **Unpaved areas**: - Fugitive dust will be produced from the unpaved sections of the plant including internal roads.

10.2.1.3 General health effects of cement dust

Health effects of cement dust may include occupational lung disease, skin irritation, conjunctivitis, stomach ache, headache, fatigue and carcinoma of lung, stomach and colon. A brief explain on these health effects is as follows.

- ✓ The aerodynamic diameter of cement particles range from 0.05 to 5.0 micrometer in diameter. These particles are respirable in size hence Portland cement is important as a potential cause of occupational lung disease.
- ✓ This particle size distribution would make the tracheobronchial respiratory zone, the primary target of cement deposition.
- ✓ The main route of entry of cement dust particles in the body is the respiratory tract and / or the gastrointestinal tract by inhalation or swallowing respectively.
- ✓ Both routes, especially the respiratory tract are exposed to numerous potentially harmful substances in the cement mill environment. The physical properties that are of importance include particle size and density, shape and penetrability, surface area, electrostatic charge, and hygroscopicity. Among the more important chemical properties influencing the respiratory tract's response is the acidity or alkalinity of the inhaled agent. The deposition of inhaled material is primarily dependent on particle size and is best described in forms of an aerodynamic diameter. All particles with an aerodynamic diameter in excess of 10mm are deposited on the mucous membrane in the nose and pharynx and particles between 3 and 10mm in diameter can be deposited throughout the tracheobronchial tree. Particles between 0.1 and 3mm in diameter are mostly deposited within the alveoli and particles smaller then 0.1mm remain in the air stream and are exhaled. The pathogenesis is most probably due to its irritating, sensitizing and pneumoconiotic properties.

- ✓ High concentration and / or prolonged inhalation of cement dust in cement industry workers can provoke clinical symptoms and inflammatory response that may result in functional and structural abnormalities.
- ✓ Clinical features of cement mill workers exposed to cement dust in cement mill could include chronic cough and phlegm production, impairment of lung function, chest tightness, obstructive and restrictive lung disease, skin irritation, conjunctivitis, stomach ache, headache, fatigue and carcinoma of lung, stomach and colon.

10.2.1.4 Potential negative impacts of cement dust

Potential negative impacts of exposure to cement dust would include

- ✓ Lung infection resulting from inhaling of cement dust
- ✓ Skin irritation
- ✓ Itching of the skin
- ✓ Irritation of the eyes
- ✓ Chronic cough
- ✓ Reduced visibility
- ✓ Choking of plants

10.2.2 Increased Noise disturbance

10.2.2.1 Introduction

Noise can be defined as any undesirable sound that is intrinsically objectionable or that may cause adverse effects on human health or the environment {EMC (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009}. Noise can be either intermitted or intrusive. Intermitted noise is noise whose level suddenly drops to several times the level of background noise, on the other hand; intrusive noise is external or noise from another part of the building which penetrates the structural defences of a room or building. Noise can also be defined unwanted or undesirable sound derived from sources such as industrial set up and

operations, road traffic or construction works that interferes with normal activities such as conversation, sleep or recreation.

10.2.2.2 Noise generation/sources

Industrial machinery and processes are composed of various noise sources such as rotors, stators, gears, fans, vibrating panels, turbulent fluid flow, impact processes, electrical machines, and internal combustion engines among others. The basic mechanism of noise generation can be due to mechanical noise, fluid noise and/or electromagnetic noise. Sound fields in the workplace are usually complex, due to the participation of many sources which may include propagation through air (air-borne noise), propagation through solids (structure-borne noise), diffraction at the machinery boundaries, reflection from the floor, wall, ceiling and machinery surface, absorption on the surfaces among others. The mechanisms of noise generation depend on the particularly noisy operations and equipment including crushing, riveting, blasting (quarries and mines), shake-out (foundries), punch presses, drop forges, drilling, lathes, pneumatic equipment, tumbling barrels, plasma jets, cutting torches, sandblasting, electric furnaces, boiler making, machine tools for forming, dividing and metal cutting, such as punching, pressing and shearing, lathes, milling machines and grinders, pumps and compressors, drive units, hand-guided machines, self-propelled working machines, in-plant conveying systems and transport vehicles.

10.2.2.3 Health Effects of noise

Noise health effects are the health consequences of elevated sound levels. Elevated workplace or other noise can cause the following health effects, hearing impairment, hypertension, ischemic heart disease, annoyance, bowel movements and sleep disturbance. Noise exposure has also been known to induce tinnitus, hypertension, vasoconstriction and other cardiovascular impacts. Elevated noise levels can create stress, increase workplace accident rates, and stimulate aggression.

10.2.2.4 Potential negative impacts of noise

- ✓ Continuous exposure of workers at the work place to high noise levels for a long time may result in noise induced hearing loss.

- ✓ Extremely laud noise at the work place can result in immediate lasting damage to the worker's hearing mechanism.
- ✓ Exposure of workers to laud noise will result in reduction of productivity and efficiency of the workers at the workplace, this will ultimately translate to overall reduction of productivity in the workplace and hence reduced output.
- ✓ Exposure of a worker to laud noise can upset the sense of balance and cause blood vessels to constrict, this will result in a rise in blood pressure hence reduction in the volume of blood flow.
- ✓ High noise levels at the work place can result in fatigue, headache, nervousness, irritability and high pretension; this will increase the likelihood of accidents at the workplace.
- ✓ Exposure of a worker to high noise levels will result in stressing the worker and thus result in reduced concentration.

10.2.3 Occupational injuries and or accidents

Occupational health and safety impacts occurring during the construction and operational phase of cement manufacturing plant include, dust, heat, noise and vibrations, physical hazards, radiation, chemical hazards and other industrial hygiene issues .

10.2.3.1 Dust

Exposure to fine particulates is associated with work in most of the dust-generating stages of cement manufacturing, but most notably from raw material handling, and clinker / cement grinding. Exposure to active (crystalline) silica dust (SiO_2), when present in the raw materials, is a relevant potential hazard in the cement manufacturing.

10.2.3.2 Heat

The principal exposures to heat in cement manufacturing occur during operation and maintenance of kilns or other hot equipment, and through exothermic reactions. However for cement grinding mills potential heat exposure is minimal.

10.2.3.3 Noise and Vibrations

Exhaust fans and grinding mills are the main sources of noise and vibrations in cement manufacturing plants. Thus the proposed expansion being a cement grinding mill utilizing a ball mill will result in noise and vibration.

10.2.3.4 Physical hazards

Injuries during cement manufacturing operations are typically related to slips, trips, and falls; contact with falling / moving objects; and lifting / over-exertion. Other injuries may occur due to contact with, or capture in, moving machinery (e.g. dump trucks, front loaders, forklifts). Activities related to maintenance of equipment, including mills, mill separators, fans, coolers, and belt conveyors, represent a significant source of exposure to physical hazards.

10.2.3.5 Radiation

An X-ray station is sometimes used to monitor the, raw material mix on the belt conveyor feeding the mill. Operators of this equipment should be protected through the implementation of ionizing radiation protection measures.

10.2.3.6 Chemical Hazards and other Industrial Hygiene Issues

Chromium may contribute to allergic contact dermatitis among workers handling cement. Prevention and control of this potential hazard includes a reduction in the proportion of soluble chromium in cement mixes and the use of proper personal protective equipment (PPE) to prevent dermal contact.

10.2.4 Waste related pollution

10.2.4.1 Solid waste

Sources of solid waste in cement manufacturing can be of three categories namely process waste, domestic waste and office waste. Process waste includes clinker and cement production waste, mainly composed of spoil rocks, which are removed from the raw materials during the raw meal preparation. Limited waste is generated from plant maintenance (e.g. used oil and scrap metal). Domestic wastes include waste from canteen and

other eating place within the plant Office waste includes wastepaper, electronic waste and sweepings.

10.2.4.2 Potential negative impacts of solid waste

- Air pollution especially from cement dust
- Skin irritation when in contact
- Water pollution
- Production loss
- Irritation of eyes
- Chocking of plants
- Odor from decomposing food leftovers from the canteen
- Blockage of drainage system by scrap and other non-decomposing solid wastes.
- Some electronic office waste such as used toner cartridges and absolute office electronic equipment contain hazardous substances.

10.2.4.3 Liquid waste

Liquid waste generated from cement manufacturing process includes water use for equipment cooling, sanitary wastewater, storm water and waste oil. Wastewater is generated mainly from utility operations for cooling purposes in different phases of the process (e.g. bearings). Wastewater is also generated from sanitary facilities from the plant, from cleaning of floors and other surfaces and from tools and equipment cleaning such as motor vehicles. Water used for cooling systems may have suspended solids among other contaminants. Techniques for treating such water after being used in the cooling process may include flow and load equalization with pH adjustment; sedimentation for suspended solids reduction using settling basins or clarifiers; multimedia filtration for reduction in non settleable suspended solids. Waste oil is generated from servicing of machines and equipment.

10.2.4.5 Potential negative impacts of wastewater generation

- ✓ Water shortage due to increased demand and use.
- ✓ Water contamination due to dissolved solids and other contaminants
- ✓ Contamination of ground water if untreated contaminated wastewater is discharged into the environment

- ✓ Odor from untreated contaminated wastewater
- ✓ Degradation of the quality of water of the receiving water body if contaminated wastewater is discharged into aquatic environment prior to treatment.
- ✓ Contamination of soils if contaminated wastewater is discharged into the ground prior to treatment

10.3 Proposed Mitigation Measures

10.3.1 Proposed mitigation measure of exposure to cement dust

10.3.1.1 Dust removal

Exposure to cement dust can be mitigated by removing the cement dust being generated. Some of the dust removal technologies to remove dust from the production line that can be used include water sprinkling and bag filters. Water sprinkling to remove dust can be done in unpaved open areas. The bag filter technology will be the main technology that will be used to remove cement dust from the production line. It is proposed that the bag filters may be fixed in twelve different locations of the production and packaging line; the capacity of the bag filters will range from 5,000m^3 to 55,000m^3while the number of bags per location will range from 42 at the silo to 510 at the mill. Bag filters technology employs Pulse-Jet Dust system to collect cement dust from the entire cement production system including auxiliary equipment, transfer and conveying points the technology also vents out clean air. The system has a dust-tight casing with three sections namely a clean-air plenum at the top, a filtration housing containing a number of cylindrical or envelope type filter bags in the middle, and a dust storage hopper at the bottom. The filter elements are supported by a tube sheet that separates the filtration housing from the plenum. The de-dusting system operation is as follows:

⇒ Dust-laden air enters the collector through a diffuser, which absorbs the impact of the high velocity dust particles, distributes the air, and reduces its velocity. The slow air speed causes the heavier particles to drop into the hopper. The air stream then flows through the filter units, depositing the fine dust on the outside of the cloths. The cleaned air continues upward into the plenum and exhausts into the atmosphere.

⇒ The filter elements are cleaned by a momentary, high-pressure back-pulse of compressed air from the clean side of the filter element. Blowpipes, arranged over each row of filter elements, deliver the pulses. The bursts of air are optimized by venturis located at the top of the filter elements to effectively dislodge dust along the length of the elements.

⇒ A pulse control timer times the cleaning cycles. A different pressure (between the clean and dirty sides) gauges helps to determine cleaning frequency.

⇒ Bag filters are installed on various operational points to fulfil the requirements and the collected material recycled to appropriate points in the circuit as per location and material characteristics.

Proper design, operation, and maintenance of the bag filters are needed to achieve high cement dust removal efficiency.

- ✓ One of the main design requirements is to provide sufficient filter media in the fabric filter system. The quantity of filtration media is expressed in terms of the air-to-cloth ratio (gross) defined below: A/C=Gas flow rate, m^3/min (actual)/Total filtration media area, m^2n As the air-to-cloth ratio increases, the localized gas velocities through the dust cake and fabric increase. At high air-to-cloth values, some small particles can gradually migrate through the dust layer and fabric. This is possible because dust particles within the cake are retained relatively weakly. After passing through the dust cake and fabric, these particles are re-entrained in the clean gas stream leaving the bag. To minimize emission problems related to excessively high air-to-cloth ratios, the design levels are limited. As an example, typical air-to-cloth ratios for plenum pulse fabric filters usually range from 0.6 to 2.4 (m^3/min per m^2).

- ✓ A second important design requirement is to provide sufficient filtration media cleaning capability. Routine cleaning of the filtration media is needed to ensure that a portion of the dust is removed from the filtration media surfaces to prevent excessively high gas flow resistance. In most types of fabric filters, agglomerated clumps or flakes of particulate matter are removed from the filter media surface. By allowing the material to agglomerate on the particle surface, the gravity settling of material from the vertical filter media to the hoppers below is facilitated. As indicated

earlier, gravity settling of the collected material is an essential second step in the filtration process. Optimal cleaning of fabric filters also requires cleaning on the frequency and intensity most appropriate for the specific characteristics of the dust cake. Plant personnel operating and maintaining the fabric filters have an important role in ensuring proper cleaning. Bags that are allowed to collect dust have critical impacts on the entire system. Fugitive emissions increase, pressure drop across the bag house increases due to higher system resistance, the flow rate along with the fan current decreases for the same reason, the fan static pressure increases, and the hood static pressure decreases along with the decrease in flow rate.

- ✓ The third general design area of importance in all fabric filtration systems is the solids collection and handling systems. Cement plant sources generate relatively large quantities of material that must be collected and transported. Continuous removal of the solids from the fabric filter system is needed to ensure proper operation.

10.3.1.2 Cement dust management

Keeping in view the hazards of cement dust it is advisable therefore, the cement industry management, their workers and health officials should work together to adopt technical preventive measures, such as well-ventilated work areas and workers should wear appropriate personal protective equipment. It is also suggested that cement mill workers must undergo pre-employment and periodic medical surveillance tests. These measures would help to identify susceptible workers in due time and improve the technical preventive measures that will decrease the risk of occupational hazards in the cement industrial workers. Potential negatively impacts likely to a result from exposure to cement dust can be mitigated in the following ways among others:-

- ➢ Proper maintenance of the de-dusting systems i.e. water sprinkling, bag filters and electrostatic precipitators to ensure efficiency in dust collection.
- ➢ Workers to undergo pre-employment and periodic medical surveillance tests by a designated medical practitioner.
- ➢ Workers working in dusty area should wear appropriate Personal Protective Equipment all the time.

- Management to ensure strict enforcement on the use of personal protective equipment by all workers.
- Management to ensure that the workplace is always well ventilated.
- Workers to be trained on the importance of making proper use of personal protective equipment provided.

10.3.2 Proposed mitigation measures of increased noise

Management of the noise risks can be done in six steps namely:-

- ✓ Assessing the risks
- ✓ Protecting employees
- ✓ Maintaining and equipment use
- ✓ Training and sensitising of workers
- ✓ Health surveillance
- ✓ Work reviews

Assessing of noise risks involves identification of noise hazards at the work place and developing the appropriate action plans. Employee protection involves elimination or controlling noise risks to acceptable legal limits by use good practice, appropriate engineering controls and employee protection. Equipment use and maintenance involves appropriate use of all noise control equipment and appropriate use of hearing protection. Training and sensitization of workers involves employee accessing information and training on noise risks, control measures and hearing protection. Health surveillance involves hearing checks for exposed workers and using result to improve on protection of the workers. Work reviews involve constant review of work practice, changes in noise exposure and new ways to reduce risks. The figure below is a schematic flow chart that summarises how to manage noise risks.

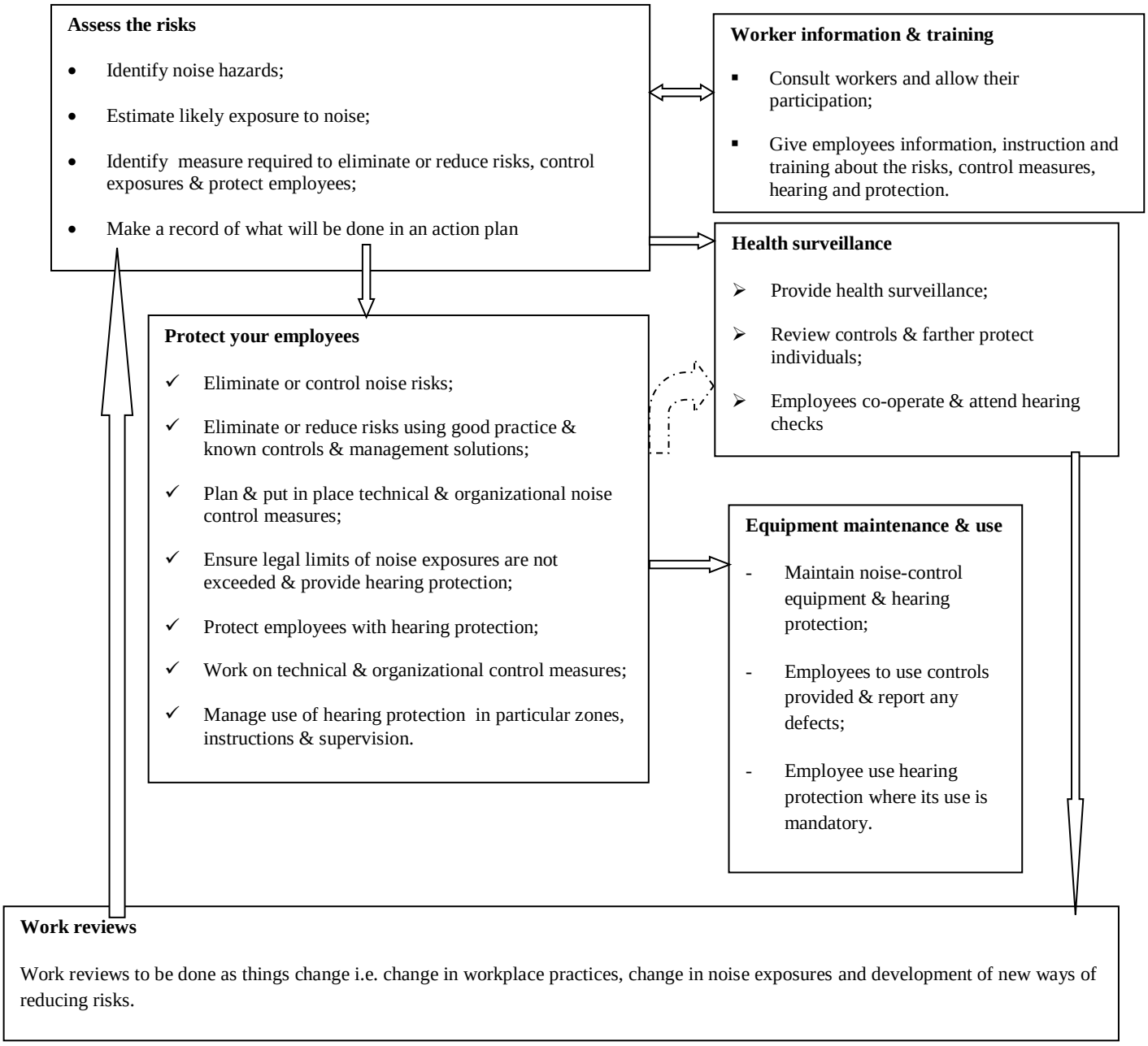

Figure 3: schematic flow chart for managing noise risks

10.3.3 Proposed mitigation measures of occupational injuries and accidents

Methods to prevent and control exposure to dust include the following:-

⇒ Control of dust through implementation of good housekeeping and maintenance.

⇒ Use of air–conditioned, closed cabins.

⇒ Use of dust extraction and recycling systems to remove dust from work areas, especially in grinding mills.

⇒ Use of air ventilation (suction) in cement-bagging areas.

⇒ Use of PPE, as appropriate (e.g. masks and respirators) to address residual exposures following adoption of the above-referenced process and engineering controls.

⇒ Use of mobile vacuum cleaning systems to prevent dust buildup on paved areas.

Recommended prevention and control techniques against exposure to heat include the following:

- ✓ Shielding surfaces where workers' proximity and close contact with hot equipment is expected.
- ✓ Using personal protective equipment (PPE), as needed (e.g. insulated gloves and shoes).
- ✓ Minimizing the work time required in high temperature environments by implementing shorter shifts at these locations.
- ✓ Making available and using, as needed, air- or oxygen supplied respirators.
- ✓ Implementing specific personal protection safety procedures in the process to avoid potential exposure to exothermic reactions.

Control of noise emissions may include the following:

- ➢ Use of silencers for fans.
- ➢ Room enclosures for mill operators.
- ➢ Noise barriers and attenuators.
- ➢ Personal hearing protection.

The potential accidental contact with chemicals such as CaO / CaOH on skin / eyes / mucous membranes is a specific hazard in cement production that needs to be assessed, prevented, and mitigated through emergency procedures and equipment. The presence of moisture may result in burns. Facilities for immediate washing of the affected body surface should be available, including eyewash station. The handling areas should be covered and enclosed, if possible, to avoid generation of a dust hazard.

10.3.4 Proposed measures to mitigate against solid waste generation

Measures that can be put in place to mitigate solid waste generation may include appropriate management practices and deliberate prevention of waste generation.

10.3.4.1 Management practices

Some of the management practices that can be put in pace to mitigate waste generation include:-

- ⇒ Establishing waste management priorities at the outset of activities based on an understanding of potential Environmental, Health, and Safety (EHS) risks and impacts and considering waste generation and its consequences.
- ⇒ Establishing a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes.
- ⇒ Avoiding or minimizing the generation waste materials, as far as practicable.
- ⇒ Where waste generation cannot be avoided but has been minimized, recovering and reusing waste.
- ⇒ Where waste cannot be recovered or reused, treating, destroying, and disposing of it in an environmentally sound manner.
- ⇒ Collection of data and information about the process and waste streams in existing facilities, including characterization of waste streams by type, quantities, and potential use/disposition.
- ⇒ Establishment of priorities based on a risk analysis that takes into account the potential EHS risks during the waste cycle and the availability of infrastructure to manage the waste in an environmentally sound manner.
- ⇒ Definition of opportunities for source reduction, as well as reuse and recycling.
- ⇒ Definition of procedures and operational controls for onsite storage.
- ⇒ Definition of options / procedures / operational controls for treatment and final disposal.

10.3.4.2 Waste generation prevention

The cement production processes should be designed and operated to prevent, or minimize, the quantities of wastes generated and hazards associated with the wastes generated in accordance with the following strategy:

- ✓ Applying manufacturing process that convert materials efficiently, providing higher product output yields, including modification of design of the production process, operating conditions, and process controls.
- ✓ Instituting good housekeeping and operating practices, including inventory control to reduce the amount of waste resulting from materials that are out-of-date, off specification, contaminated, damaged, or excess to plant needs.

10.3.5 Proposed measures to mitigate wastewater generation

10.3.5.1 Utilities operations wastewater management

Utility operations such as cooling tower and demineralization systems may result in high rates of water consumption, as well as the potential release of high temperature water containing high dissolved solids, residues of biocides, residues of other cooling system and anti-fouling agents. Recommended water management strategies for utility operations include:

- ⇒ Adoption of water conservation opportunities for facility cooling systems.
- ⇒ Use of heat recovery methods (also energy efficiency improvements) or other cooling methods to reduce the temperature of heated water prior to discharge to ensure the discharge water temperature does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity among other considerations.
- ⇒ Minimizing use of antifouling and corrosion inhibiting chemicals by ensuring appropriate depth of water intake and use of screens. Least hazardous alternatives should be used with regards to toxicity, biodegradability, bioavailability, and bioaccumulation potential. Dose applied should accord with local regulatory requirements and manufacturer recommendations.

⇒ Testing for residual biocides and other pollutants of concern should be conducted to determine the need for dose adjustments or treatment of cooling water prior to discharge.

10.3.5.2 Sanitary Wastewater management

Sanitary wastewater includes effluents from domestic sewage, food service, and laundry facilities serving site employees. Miscellaneous wastewater from laboratories, water softening plant. Recommended sanitary wastewater management strategies include:

⇒ Segregation of wastewater streams to ensure compatibility with selected treatment option (e.g. septic system which can only accept domestic sewage).

⇒ Segregation and pretreatment of oil and grease containing effluents (e.g. use of a grease trap) prior to discharge into the environment.

⇒ Treatment to meet national standards for sanitary wastewater discharges.

⇒ Sewage from the industrial facility is to be discharged to either a septic system, or where land is used as part of the treatment system, treatment to meet Environmental Management and Coordination (Water Quality) Regulations, 2006, standards for sanitary wastewater discharges.

⇒ Sludge from sanitary wastewater treatment systems should be disposed in compliance with Environmental Management and Coordination (Water Quality) Regulations, 2006.

10.3.5.3 Storm water management

Storm water includes any surface runoff and flows resulting from precipitation, drainage or other sources. Typically storm water runoff contains suspended sediments, metals, petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs), coliform, etc. Rapid runoff, even of uncontaminated storm water, also degrades the quality of the receiving water by eroding stream beds and banks. In order to reduce the need for storm water treatment, the following principles should be applied.

✓ Storm water should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge.

✓ Surface runoff from process areas or potential sources of contamination should be prevented.

- ✓ Where this approach is not practical, runoff from process and storage areas should be segregated from potentially less contaminated runoff;
- ✓ Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g. by using vegetated swales and retention ponds).
- ✓ Where storm water treatment is deemed necessary to protect the quality of receiving water bodies, priority should be given to managing and treating the first flush of storm water runoff where the majority of potential contaminants tend to be present.
- ✓ When water quality criteria allow, storm water should be managed as a resource, either for groundwater recharge or for meeting water needs at the facility.
- ✓ Oil water separators and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas.
- ✓ Sludge from storm water catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with the Environmental Management and Coordination (Water Quality) Regulations, 2006.

10.4 Action Plans

The following environmental management action plans are proposed in line with the predicted potential negative impacts of the proposed project.

- ✓ Cement dust management action plan
- ✓ Noise management action plan
- ✓ Solid waste management action plan
- ✓ Liquid waste management action plan
- ✓ Occupational safety and health management action plan

Table 9: Cement dust management action plan

Issue/concern	Potential negative environmental impacts	Proposed mitigation measures	Environmental Monitoring	Responsible actors	Time frame	Cost estimate (KSH)
Cement dust pollution	-Occupational illness (lung infection, itching skin, eye irritation, coughing, to workers and other people exposed to the cement dust; - Reduced visibility; Chocking of plants	-Ensure de-dusting system is always efficient; -workers to use appropriate PPE; -Strict enforcement on PPE use; -Ventilation at workplace to be sufficient;	-Dust surveys Results of periodic dust surveys within the production line, packaging line and the neighbourhood of the facility to determine dust levels from time to time; - Medical severance Results of medical tests of workers likely to be exposed	Plant Head MCL Athi River -MCL workers - County Occupational Safety and Health Officer -County Environmental Officer; -Neighbours; and -The general public	-Dust surveys should be carried preferable every six month; -Medical severance should be carried out every twelve months	200,000

Issue/concern	Potential negative environmental impacts	Proposed mitigation measures	Environmental Monitoring	Responsible actors	Time frame	Cost estimate (KSH)
			to cement dust			

Table 10: Noise management action plan

Issue/Concern	Potential Negative Impacts	Proposed Mitigation Measures	Responsible Actors	Monitoring Indicators	Timeframe	Approximate Cost (KSH)
High noise level at the workplace	-Noise induced hearing loss -Poor concentration at the workplace	➢ Developing and implementing an effective noise control and hearing conservation programme; ➢ Carrying out periodic noise measurements; ➢ Fitting noise machines with noise	-Plant Head MCL Athi River MCL staff	Reduction of noise levels at the workplace to the stipulated legal limits	The proposed mitigation measures to be implemented from the beginning of the	150,000

Issue/Concern	Potential Negative Impacts	Proposed Mitigation Measures	Responsible Actors	Monitoring Indicators	Timeframe	Approximate Cost (KSH)
	-Reduced productivity	reduction devices; ➢ Providing suitable hearing protection to all workers exposed to noise levels above 85dB(A); ➢ Posting notices and signs in noisy areas; ➢ Carrying out audiometric test by a designated medical practitioner to all workers exposed to noise levels above 85dB(A); ➢ Educating all workers on importance of marking correct use of PPE provided to protect them			implementation of the proposed project, be sustained throughout the project cycle ensuring continuous improvement	

Issue/Concern	Potential Negative Impacts	Proposed Mitigation Measures	Responsible Actors	Monitoring Indicators	Timeframe	Approximate Cost (KSH)
		against high noise levels.				

Table 11: Solid waste management action plan

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
Process solid waste management and disposal	- Air pollution especially from cement dust; - Skin irritation when in contact; - Water pollution, - Production loss, - Irritation of eyes;	- Recycle and reuse where applicable; - Segregate for appropriate disposal; - Process improvement	Quantity of process waste generated	Plant Head MCL Athi River	From the onset of the production process and then throughout the operational life of the plant	100,000 per year

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
	- Chocking of plants	to minimize waste generations. - Material substitution to minimize waste generation. - Technological improvement to minimize waste generation				
Domestic waste managem	- Odor from decomposing food leftovers;	- Sorting of waste at source;	- Regular checking of handling	MCL top management, other workers,	From the onset of the production	50,000 per year

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
ent and disposal	- Blockage of drainage system	- Waste disposal as provided for in the Environmental Management and Coordination (Waste Management) Regulations, 2006. - Provide appropriate waste	areas; - Waste disposal records.	the general public,.	process and then throughout the operational life of the plant	

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
		handling receptacles.				
Office waste management and disposal	Some electronic office waste such as used tonner cartridges and absolute office electronic equipment container hazardous substances	- Absolute electronic equipment and other electronic waste to be returned to manufacturers for safe disposal	Records of disposal	MCL top management, other workers, the general public, h	From starting of operation of the plant and then be sustained throughout the operational life of the plant	50,000 per year

Table 12: Liquid waste management action plan

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimates (KSH)
Utilities operations wastewater	- Water shortage due to high use - Water contamination due to high dissolved solids and other contaminants	- Adaption of water conservation opportunities - Minimizing use of antifouling and corrosion inhibiting chemicals; - Testing for residual biocides and other	Sampling and testing for conformity with Water quality standards before discharge	Plant Head MCL Athi River	The proposed mitigation measures to be implemented from the beginning of the implementation of the proposed project, be sustained throughout the project cycle ensuring continuous	100,000 per year

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimates (KSH)
		pollutants of concern. - pH adjustment; - Sedimentation for suspended solids reduction using settling basins or clarifiers; - Multimedia filtration for reduction in non settleable suspended			improvement	

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimates (KSH)
		solids.				
Sanitary Wastewater	- Contamination of ground water; - Odor	- Segregation of wastewater streams; - Treatment to meet national standards for sanitary wastewater discharge	Sampling and testing for conformity with Water quality standards before discharge	MCL top management, MCL, employees, NEMA, Public Health	The proposed mitigation measures to be implemented from the beginning of the implementation of the proposed project, be sustained throughout the project cycle ensuring continuous improvement	200,000 per year

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimates (KSH)
Storm water	- Degradation of the quality of water of the receiving water body. - Contamination of soils; - Erosion	- Storm water should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge; ✓ Runoff from areas without	Sampling and testing for conformity with Water quality standards before discharge	MCL top management, MCL, employees, NEMA, WRMA, Public Health	The proposed mitigation measures to be implemented from the beginning of the implementation of the proposed project, be sustained throughout the project cycle ensuring continuous improvement	2,000,000 per year

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimates (KSH)
		potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g. by using vegetated				

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimates (KSH)
		swales and retention ponds); - Oil water separators and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and				

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimates (KSH)
		containment areas.				

Table 13: Occupational safety and health management action plan

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
Dust	- Lung infection, - Itching skin, - Eye irritation, - Coughing, to workers	- good housekeeping and maintenance; - Use of air–conditioned, closed cabins;	- Dust survey every six months; - Visual observations; - Medical examination of	MCL top management Workers General public	Proposed mitigation measures to employed before start of plant operations and be sustained	300,000 per year

	and other people exposed to the cement dust.	- dust extraction and recycling systems - air ventilation (suction)	workers exposed to dust		and improved on throughout the functional life of the plant	
Heat	- Physical burns of workers exposed to heat; - Burning and damage to process equipment.	- Shielding surfaces; - using personal protective equipment; - Minimizing the work time required in high temperature	- Periodic Heat measurement	MCL top management Workers	Proposed mitigation measures to employed before start of plant operations and be sustained and improved on throughout the functional	200,000 per year

		environments by implementing shorter shifts; - Use of air- or oxygen supplied respirators.			life of the plant	
Noise and vibrations	- Noise induced hearing loss; - Poor concentration at workplace; - Reduced productivity.	- Use of silencers for fans; - Room enclosures for mill operators; - Noise barriers; - Personal hearing	- Noise survey at the workplace every twelve months; - Audiometric test for workers exposed to high noise levels	MCL top management Workers	Proposed mitigation measures to employed before start of plant operations and be sustained and improved on throughout	100,000 per year

		protection			the functional life of the plant	
Physical hazards,	- Slip; - Trips; - Falls; - Contact will falling/moving parts	- Good housekeeping; - Ensure surfaces are not slippery; - Clearly mark all uneven surfaces; - Guarding of machine moving parts; - Provide and mark safe passages and	- Physical checking/inspections of all workplaces at short intervals	MCL top management Workers	Proposed mitigation measures to employed before start of plant operations and be sustained and improved on throughout the functional life of the plant	50,000 per year

		exits; - Spills to be promptly cleaned.				
Radiation	- Exposure to radiations	- Implementation of ionizing radiation protection measures	- Periodic radiation survey of affected areas	MCL top management DOSH NEMA Workers	Proposed mitigation measures to employed before start of plant operations and be sustained and improved on throughout the functional life of the plant	50,000 per year
Chemical hazards and	- Physical	- PPE use;	- Sport checks at workplaces on	MCL top	Proposed mitigation	50,000

other industrial hygiene issues	burns; - Sickness/ - disease/ill health	- Appropriate handling as per material safety data sheets; - Training and sensitizations. - Medical examination of exposed workers	appropriate handling	management DOSH NEMA Workers	measures to employed before start of plant operations and be sustained and improved on throughout the functional life of the plant	

10.5 Environmental Monitoring and Auditing

10.5.1 Introduction

In order to ensure good environmental management over the life of the MCL Athi River Cement grinding plant, management should undertake the monitoring and auditing of the quality of key environmental parameters and the environmental management plan as a whole. Monitoring should involve measuring, observing, recording, evaluation and recording of physical, social and economic variables associated with the development impacts such as:

1. Air quality
2. Noise and excessive vibration monitoring
3. Occupational health and safety
4. Soil contamination
5. Water quality
6. Waste management

10.5.2 Ambient Air Quality Monitoring

Identified potential emissions from cement manufacturing are airborne pollutants, primarily as exhaust gases and fugitive dust. To promote a clean a healthy environment for both the workers and surrounding communities the following parameters are recommended for monitoring of air quality as per the provisions of the Environmental Management and Coordination (Air Quality) Regulations, 2014. Table 7 below is an excerpt from the third schedule to these regulations on the emission limits for cement plants. The fourth schedule to these regulations gives guidelines on air pollution monitoring parameters from stationary sources. Table 8 below is an excerpt from the said guidelines, the shaded areas represents parameters to be monitored. Monitoring is on a quarterly basis.

Table 14: An excerpt from the third schedule to these regulations on the emission limits for cement plants

Air Pollutant/Industry	**Opacity**	Particulate (Dust) PM_{10} (mg/Nm^3)	Sulphur oxide (SO_X) (mg/Nm^3)	Nitrogen oxides (NO_X) (mg/Nm^3)	Carbon monoxide (mg/Nm^3)	Carbon dioxide (mg/Nm^3)	Hydrocarbons (mg/Nm^3)	Hydrogen sulphide (mg/Nm^3)	Hydrogen chloride (mg/Nm^3)	Hydrogen fluoride (mg/Nm^3)	Dioxins/Furans
Cement plants		50	400	1500		500	300				0.5ng/N m 3

Source: Environmental Management and Coordination (Air Quality) Regulations, 2014

Table 15: An excerpt from table on the forth schedule of the regulations on parameters to be monitored

Air Pollutant/Industry	**Opacity**	Particulate (Dust) PM_{10} (mg/Nm^3)	Sulphur oxide (SO_X) (mg/Nm^3)	Nitrogen oxides (NO_X) (mg/Nm^3)	Carbon monoxide (mg/Nm^3)	Carbon dioxide (mg/Nm^3)	Hydrocarbons (mg/Nm^3)	Hydrogen sulphide (mg/Nm^3)	Hydrogen chloride (mg/Nm^3)	Hydrogen fluoride (mg/Nm^3)	Dioxins/Furans

Cement plants											

Source: Environmental Management and Coordination (Air Quality) Regulations, 2014

10.5.3 Noise and excessive vibrations monitoring

The noise levels should be monitored periodically as per the provisions of the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009, ensure they are in line with the provisions as highlighted in the table 9 below.

Table 16: Maximum permissible noise levels for as per Noise Regulations sites (When Measurement taken within the facility).

Facility		Maximum Noise Level Permitted (Leq) in dB(A)	
		Day	Night
i.	Health facilities, educational institutions, homes for disabled etc.	60	35
ii.	Residential	60	35
iii.	Areas other than those prescribed in (i) and (ii)	75	65

Timeframe: Day; 6:01am-6:00pm & Night; 6:01pm-6:00am

Source: Second schedule of the Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009.

10.5.4 Occupational Health and Safety monitoring

Occupational health and safety of employees is of paramount importance in safeguarding their overall health and ensuring the increased productivity. Towards this end monitoring of health and safety of employees will be undertaken as part of the project core activities. This will involve an annual comprehensive medical examination of workers by a Designated Medical Practitioner and analysis and reporting of results in the annual Environmental Audits. Noise level survey at the work

environment to be undertaken and corrective actions to be undertaken as need arise on a continuous basis.

MCL Athi River will:

(1) Incorporating safety into the working culture of the organization though continuous reinforcement of safe working practices, use of safety awards, and senior executive attention.

(2) Initiate a systematic program for tracking, reporting, and analysing all safety related incidents at the inception of the project.

3) Undertake an on-going analysis of incidents, responses and progress to provide information and focus on continuous improvement in the working environment.

10.5.5 Water Quality monitoring

Water quality management will involve monitoring of key pollutants that serve as indicators of acceptability of water for other uses. Monitoring of water quality for human consumption will done as provided for in the Environmental Management and Coordination (Water Quality) Regulations, 2006, this will include: measurements of fecal coliform; toxic organics such as benzene, trichloroethane, tetrachloroethene, chlorophenols; polynuclear aromatics such as benzo (a) pyrene, carbon tetrachloride, polychlorinated biphenyls (PCBs), dioxins, and furans; oil and grease; pH; toxic metals, including arsenic, cadmium, chromium, copper, lead, and mercury; and cyanides, as well as color, taste, odor, turbidity, and hardness. Water samples will be drawn from existing well within MCL premises for laboratory analysis.

Table 17: Summary of parameters to be monitored

Parameter	Results	
	Observed value	Guide value(maximum allowable)
pH		6.5-8.5
Suspended solids		30 (mg/L)
Nitrates-NO_3		10 (mg/L)
Ammonia-NH_3		0.5 (mg/L)
Nitrite-NO_2		3 (mg/L)
Total dissolved solids		1200 (mg/L)
E-coli		Nil /100ml
Floride		1.5 (mg/L)
Phenols		Nil (mg/L)
Arsenic		0.01 (mg/L)
Cadmium		0.01 (mg/L)
Lead		0.05 (mg/L)
Selenium		0.01 (mg/L)
Copper		0.05 (mg/L)
Zinc		1.5 (mg/L)
Alkyl benzlsulphonates		0.5 (mg/L)

Permanganate value		1.0 (mg/L)

Source: The Environmental Management and Coordination (Water Quality) Regulations.2006 Legal notice Number 120

10.5.6 Waste management and Disposal monitoring

Solid wastes, particularly remnants of raw materials used in cement grinding i.e. clinker, pozzolana and gypsum; and generated dust must be handled carefully especially if not recycled back into the system. This waste must be weighed and accurate records of disposal kept. Liquid waste particularly used oil will be inventoried and accurate records of disposal be properly maintained. Handling, management and disposal of solid waste will be in accordance with the provisions of the Environmental Management and Coordination (Waste Management) Regulations, 2006 while handling, management and disposal of liquid waste will be in accordance with the provisions of the Environmental Management and Coordination (Water Quality) Regulations, 2006.

10.6 Training and capacity building

The following training and capacity building is proposed:-

- Sensitization of the Contractor, and Proponent Representative on the importance of the EMP, its contents, how it is applied and who is responsible for the implementation of each part of the EMP.
- Training and capacity building for staff on the importance and proper use of PPEs.
- Training and capacity building for staff on acceptable waste management practices.
- Training and capacity building on occupational safety and health safety committee and occupational safety and health requirements and individual safety obligations.
- Training and capacity building of site first aid for the staff.
- Training and capacity building on site fire safety for the staff.

10.7 Institutional arrangements for safeguard implementation and reporting

10.7.1 Institutional arrangement

The responsibility of implementation of the safeguards is vested on the project proponent while the National Environment Management Authority (NEMA) ensures compliance through enforcement. NEMA will coordinate with relevant lead agencies to ensure compliance and enforcement of the EMP. There will be periodic site visits by relevant lead agencies coordinated by NEMA to assess compliance. Inspection reports of the outcome of the site visits will be prepared by NEMA and the lead agencies and served to the proponent for implementation. The proponent will be required to prepare periodic monitoring reports and annual environmental audit reports and submit these reports to NEMA. Further the proponent will be required to promptly respond to NEMA improvement orders by compiling a report on the issues raised in the orders and implementing the orders as will be required by NEMA and other relevant Lead Agencies. The contractor implementing the project will be required to prepare periodic progress reports and submit the progress reports to the proponent on the contractor's contractual obligations on safeguards implementation responsibilities specified in the EMP. The contractor will be supervised on the ground directly by the representative of the proponent.

10.7.2 Reporting obligations

The following reports will be prepared:

- ✓ Monthly progress reports by the contractor on the implementation status of every obligation of the contractor on safeguards implementation specified in the EMP. These monthly reports will be submitted by the contractor to the Proponent.
- ✓ Periodic monitoring reports to be prepared by the proponent and submitted to NEMA. Specifically; quarterly effluent monitoring reports, waste management reports, air quality monitoring reports and noise and excessive vibration monitoring reports.
- ✓ Initial Environmental Audit report to be prepared by the proponent and submitted to NEMA in the first year of operation of the project to confirm the efficacy and adequacy of the EMP.

- ✓ Self-environmental audit report to be prepared annually by the proponent and submitted to NEMA to report on the progress of implementation of the EMP. The first self-environmental audit reports will be prepared one year after submission of the initial environmental audit report.
- ✓ Reports responding to NEMA improvement orders to be prepared by the proponent and submitted to NEMA as and when such improvement orders are issued.
- ✓ Progress reports on the implementation of NEMA improvement orders to be prepared by the proponent and submitted to NEMA.

10.8 Decommissioning Plan

10.8.1 Introduction

Decommissioning is the last phase of the life of the project. This will involve terminating the operations of the MCL Athi River. However, situations and circumstances may arise that may force terminating a project before its actual lifespan expires. In such a case decommissioning of the project will come much earlier than expected. Termination of project operations can be due to varied reasons which may include the following:

- ✓ Expire of project life;
- ✓ If project operations are no longer profitable to undertake;
- ✓ Stoppage order from government;
- ✓ Change of company investment interest in the sector or/and in the area;
- ✓ Natural calamities and other unforeseen circumstances; and
- ✓ Lack of crucial process inputs (raw materials, power, water)

10.8.1.1 Expire of project life

All developments project have got an economic life within which it will be profitable to operate. Within project life, it is projected that there will be sufficient and economically exploitable raw materials necessary for the project; there should be sufficient economic labour and a market for the product. The cost of production during the project life should be economically affordable. Once the projected economic life of a project comes to an end, operating the project may not be viable unless new machinery and equipment are put in place. It will involve putting a new phase to the project. Otherwise the project comes to an end.

10.8.1.2 Non-profitability

When setting-up an economic venture like a cement grinding plant, the ultimate goal is to make profit. Unit cost of production should not be higher than unit cost of the product at the shelf. In a case where the cost of production becomes higher then no profit can be realised from the investment, then such a project can be terminated.

10.8.1.3 Stoppage Order

All projects operating in a given country are guided by laws and regulations of that country. If a project contravenes the legal requirements and the government finds it a threat to the environment, its citizens and the security of the country, then such a project may be issued with a stoppage order. This may include denial of operating licences among others. In such a case the project has to be terminated.

10.8.1.4 Change of company investment interests

A company may also change its investment interest in a particular sector of the economy, in a particular locality, country or region. Change In investment interest may be necessitated by change in political climate, security situation, and state of infrastructure, market availability and access, legal requirements among others. Such changes may result in termination of the project before it lifespan expires.

10.8.1.5 Natural calamities

Occurrence of natural calamities in an area can result to an abrupt end of a project much before its economic life expires. Such calamities may include severe earthquakes, volcanic eruptions and floods. Such calamities results in much loss in terms of property and investment and human life.

10.8.1.6 Lack of process inputs

A project may be forced to come to an end due to acute shortage of major inputs and other utilities. This can be occasioned by poor planning, lack of sufficient reserves, significant change in prices, increased demand relative to supply, change in government policies and insecurity. In either of these, the cost of raw materials and other inputs may either be too costly or totally unavailable thus necessitating closure of the project.

10.8.2 Components of Decommissioning Plan

This decommissioning plan presents a conceptual programme for dismantling of the cement grinding plant, disposal of machinery, buildings, support infrastructure and land; and handling of employees and the local community.

10.8.2.1 Dismantling and Disposal of Cement grinding line

At the completion of the proposed expansion, MCL Athi River will be having an additional one cement grinding line in addition to existing and operational two cement grinding lines. Other components of the cement grinding lines include clinker stock piles, raw material storage sheds and cement silos. Other auxiliary facilities include electricity sub-station, electrical generators, reverse osmosis water treatment plant, workshops, office block, staff canteen an assortment of plant and equipment and office equipment. At the end of lifespan of the cement plant different components of the plant will be of different economic value. The value of each component will vary depending on the following among others:-

- ✓ If replacement were done during the operational period;
- ✓ What proportion of useful economic life of the component was utilised during the entire time of operation; and
- ✓ Efficiency of servicing during the entire life of operation.

Plant dismantling should be planned with the above factors in mind. When preparing to dismantle the plant the following should be taken into considerations:-

- ✓ Safety of workers involved in the dismantling, this is because dismantling will involve working at height and in some cases in enclosed environment;
- ✓ Protection from inhalation of dust, it is expected that dust will be produced when dismantling, mechanisms should be put in place to ensure that the dust is contained and that it does not become a nuances to the surrounding;
- ✓ Handling and disposal of debris and resulting scrub that may arise from the dismantling should be well planned and executed;
- ✓ Rehabilitation of the site after dismantling should be thought out and well executed well in time. Site rehabilitation should include.
    - Clearing all debris and scrap;
    - Ground levelling;
    - Planting of trees and grasses; and
    - Making arrangements to ensure the trees and grasses are well attended to especially in the early stage to ensure they do not wither. Tendering should include regular watering especially when rains are poor, wedding and protection from animal destruction.

- Appropriate arrangement for disposal of rehabilitated site should be made.

Disposal of cement production plant components can either be by:-

- Selling usable parts of the plant if the company will not be having further interests in clinker or cement production elsewhere;
- Relocating usable parts of the plant to another site where the company could be having similar interests. Evaluation should be done on the cost of relocation visa avis selling them and obtaining new ones to ascertain which option is more cost effective;
- Selling the entire plant to an interested party for refurbishment;
- Refurbishing the entire plant and continuing with cement production activities

10.8.2.2 Disposal of Machines and Equipment

There will be different types of machinery to be disposed at the end of the lifespan of the cement plant. The machines will be in different usable conditions.

- ✓ There will be those which will be out of use;
- ✓ There will be those which will be serviceable; and
- ✓ There will be those acquired recently.

Depending on size, type and uses, condition at time of disposal and company policy on machine and equipment disposal; MCL Athi River can adopt different ways on how to dispose the machines and equipment.

10.8.2.3 Disposal according to condition

- o If the company will still be having similar interests elsewhere, then machines and equipment still with an economic life can be retained for use;

- Machines which will be out of order can have spare parts removed and sold together with any resulting scrap; and
- Also, some machines can be donated to local authorities. Such machines should be in good working condition and should be able to be of use to the Authority. Such can include tractors and dump trucks.

10.8.2.4 Disposal according to size

- ✓ Small company vehicles still in sound condition can either be donated to long serving employees as a sign of appreciation, be donated to local learning institutions;
- ✓ Some company vehicles still in good working condition can also be donated to local community organised group as a sign of appreciation for a good working relationship that prevailed during the company's operations in the community;
- ✓ Unserviceable company vehicles can have parts removed and sold and scrap generated can also be sold to scrap dealers or recyclers;
- ✓ Specialised equipment can be retained for future use if in good working condition, or be sold out to similar concerns;
- ✓ Unserviceable heavy machinery and equipment can have parts dismantled and used to repair other machines which can then be sold.

10.8.2.5 Disposal according to type and use

- Capital equipment in sound working condition can either be retained for future use, or sold out to similar concerns;

- Capital equipment and heavy machinery out of use can be disposed as scrap after removal of usable parts;
- Specialized equipment still in sound working conditions can be reused elsewhere or sold out altogether,

10.8.2.6 Disposal of Buildings and Other Structures

Building and structures on site will include:-

- Electricity sub-station
- Bulk water storage tanks
- Office blocks
- Stores
- Shades
- Structures housing cement mills
- Silos
- Workshops.

Decision on how to dispose these structures will depend on Kenya Power for decommissioning of the electricity sub-station, decommissioning of other structures will depend on MCL Athi River policy, needs, requests and proposals from local community, local authority and government in general.

10.8.2.7 Disposal of Land

The land in which the cement plant is located is leasehold.

Disposal of leasehold land will depend when the lease expires. Once the lease expires,

- ✓ MCL Athi River will have the option of renewing the lease for a new term.
- ✓ In the event MCL is not interested in renewing the lease or the government declines to renew the lease then, MCL will be required to return the land back to the government.

10.8 3 Disposal of Supportive Infrastructure

The company will be having a number of supportive infrastructure which will include; boreholes, diesel pumps, electricity lines, telephone lines, water tanks. Disposal of these supportive infrastructures should be in a manner that benefit to the local community is realised with minimum environmental impacts.

10.8.4 Termination of Project/Closure

Closure of the cement production plants is the last stage of decommissioning. Complete closure of the project will have an impact on former employees, local community, local economy, business community and the general society at large. All the likely parties to be affected should be prepared well in advance psychologically, socially and financially.

10.8.5 Handling of employees

Former employees will be the most affected by closure of the project. Proper mechanisms should be put in place well in advance to inform them of impending closure and to prepare them in adapting to a new way of life.

10.8.6 Local community

Closure of the project will have an impact on the local community. This includes reduced purchasing power of local people as employees will be laid off; closure and/or relocation of businesses and services that were drawing clientele from the project; termination of certain services to the community.

11. CONCLUSION AND RECOMMENDATIONS

11.1 Conclusion

Based on field observations, document reviewed, data collected and analysed the following are the main conclusions drawn from EIA study.

- ✓ The proposed expansion is to be undertaken on plot No. I.R 63766/4, which is owned by Mombasa Cement Limited.
- ✓ The proponent has two operational cement mills and various support infrastructure on plot No. I.R 63766/4.
- ✓ The proponent has two environmental impact assessment licences for the existing cement mills and support infrastructures.
- ✓ The objective of the proposed expansion is to increase the cement production capacity by 4,300 tons per day.
- ✓ The scope of the proposed expansion will cover construction of cement grinding mill, raw material storage, two cement storage silos, a cement packaging plant and bulk cement loading.
- ✓ The raw materials to be used in the production process will be clinker, pozzolana and gypsum.
- ✓ Two types of cement will be produced from the cement mill namely Portland Pozzolana Cement (PPC) and Ordinary Portland Cement (OPC).
- ✓ Cement production and consumption locally has been increasing steadily in the past years as per records from Kenya National Bureau of Statistics. This perhaps underpins the need for the proposed expansion.
- ✓ Envisaged benefits from the proposed expansion may include increase in usage of local minerals in cement production, increase in cement production, reduced cement importation, and increase in cement exports.
- ✓ Potential negative impacts may include dust emission, noise disturbance, occupational injuries and accidents and waste generation.
- ✓ There are appropriate and feasible mitigation measures that can be put in place to effectively reduce the potential negative effects of the proposed project while maximizing positive effects.

- ✓ Stakeholder consultations brought out various issues, suggestions and concerns while acknowledging the potential of the proposed project in job creation for local youths.
- ✓ Enforcement of all relevant legal provisions will be vital in ensuring implementation of safeguards and compliance to various environmental standards.
- ✓ Environmental monitoring at different stages of the project cycle will be vital especially monitoring of air quality in order to ensure environmental and social sustainability.

11.2 Recommendations

The following recommendations are made to ensure environmental and social sustainability of the proposed project.

- ✓ The proposed Bag filters technology to be used in dust collection that employs Pulse-Jet Dust system to be installed and maintained as per the manufacturer's specifications.
- ✓ Air quality monitoring to be undertaken as specified in the Environmental Management and Coordination (Air Quality) Regulations, 2014.
- ✓ The proponent to pay attention to suggestions raised by stakeholders during stakeholder consultations. Deliberate efforts to be made to address recommendations from the stakeholders consulted.
- ✓ Priority to be given to youths and women from the project area when recruiting people to work in the project.
- ✓ The developed EMP for the project to be implemented fully to ensure environmental and social sustainability of the project.

12. REFERENCE LIST

Almagi, D., Sondo, V.A. and Ertel, J. (2007).Constrains to environmental impact assessment practice: a case study of Cameroon. *Journal of Environmental Assessment Policy and Management* 9 (3), 357-380.

CEC 1985. On the assessment of effects of certain public and private projects on the environment. Official Journal L175, 5 July.

CEMBUREA; 1999-"BEST AVAILABLE TECHNIQUES" FOR THE CEMENT INDUSTRY"

ECA 2005. Review of the Application of Environmental Impact Assessment in selected African Countries. Addis Ababa: ECA. www.uneca.org/eca_programmes/sdd/documents/eia_book_final_sm.pdf.

Elliot, M and Thomas, I. 2009. Environmental Impact Assessment in Australia, 5th edn. Annandale: The Federation Press.

Glasson J., Therivel R. and Chadwick A., (2012) Introduction to Environmental Impact Assessment Fourth Edition, Milton Park, Abingdon, Oxon.

Government of Kenya Env ironmental Management and Co-ordination (Water Quality) Regulations, 2006, *Government Printer Nairobi*, 2006.

Government of Kenya Environmental Management and Co-ordination ((Noise and Excessive Vibration Pollution) (Control) Regulations 2009. *Government Printer Nairobi*, 2009.

Government of Kenya, Environmental Management and Co-ordination Act No. 8 of 1999. *Government Printer* Nairobi.

Government of Kenya, The Employment Act 2007; *Government Printer,* Nairobi 2007

Government of Kenya, The Labour Institutions Act 2007 *Government Printer,* Nairobi 2007

Government of Kenya, the Occupational Safety Act 2007 *Government Printer,* Nairobi 2007.

Government of Kenya, the Public Health Act. *Government Printer,* Nairobi.

Government of Kenya, the Water Act, 2002, *Government Printer,* Nairobi, 2002.

Government of Kenya, The Work Injuries Benefits Act 2007. *Government Printer,* Nairobi 2007

Government of Kenya; Environmental (Impact Assessment and Audit) Regulation. *Government Printer* Nairobi 2003.

Government of Kenya; the Physical planning Act. *Government Printer,* Nairobi.

http://ficem.org/boletines/boletines2014/BOLETIN_DE_RESULTADOS_CT_2014_/PRESENTACIONES_CT_2014/5_procesos%20prod%20cemento/8_TIM%20NOWACK_CHRISTIAN%20PFEIFFER/Improvements%20in%20Cement%20grinding.pdf; Tim Nowack; Improvements in New & Existing Cement Grinding Mills.

http://www.eskom.co.za/sites/idm/Documents/128251_Cement_Brochure.pdf

https://www.iocl.com/products/LPGSpecifications.pdf

IAIA. (2009).*What is Impact Assessment*? Fargo, ND:IAIA.

Jay, S., Jones, C., Slinn, P., Wood, C., 2007. Environmental impact assessment: retrospect and prospect. *Environmental Impact Assessment Review*. 27, 287-300.

Kenya National Bureau of Statistics-Economic Survey 2017

Kilifi District Strategic Management Plan 2008-2012

Moorman, J.L and Ge, Z.2007. Promoting and strengthening public participation in China's Environmental Impact Assessment process: comparing China's EIA law and US. NEPA. Vermount Journal of Environmental LAW 8, 281-335.

Morara, M., Okello, N., Kuhanwa, Z., Douven., W., Beevers, L. and Leentvaar, J. (2011). The importance of context in delivering effective EIA: case studies from East Africa, *Environmental Impact Assessment Review* 31 (3), 286-96.

Munn, R.E. 1979. Environmental Impact Assessment: Principles and Procedures, 2nd edn, New York: Wiley

Nicholas B. Winter, 2012; Understanding Cement.

O'Riordan T. and Sewell W.R.D (1981).*Project Appraisal and Policy Review*. Chichester: John Wiley and Sons.

UNECE 1991, Policies and systems of environmental impact assessment. Geneva: United Nations.

Wood, C. 2003. Environmental Impact Assessment: a comparative review, 2nd edn, Prentice Hall.

13. APPENDICES

Appendix 1 Land documents

Appendix 2 copy of the certificate of incorporation and copy of PIN

Appendix 3 Proposed layout plan

Appendix 4 Environmental impact assessment licenses for existing cement mills

Appendix 5 Approval of ToR

Appendix 6 Registration certificate and practicing licence for the Experts

Appendix 7 Questionnaire survey responses

Appendix 8 Minutes of the proceedings of the first baraza

Appendix 9 Minutes of the proceedings of the second baraza

Appendix 10 Minutes of the proceedings of the third baraza