

THE IMPACT OF INDUSTRIAL DEVELOPMENT ON ENVIRONMENTAL  
QUALITY , WITH SPECIAL REFERENCE TO KENYA MEAT  
COMMISSION AND EAST AFRICA PORTLAND CEMENT FACTORY  
IN ATHI RIVER TOWN.

BY

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A THESIS SUBMITTED IN "PART" FULFILMENT FOR THE  
DEGREE OF MASTER OF ARTS, IN PLANNING AND  
ENVIRONMENTAL STUDIES IN THE UNIVERSITY OF NAIROBI.

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

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This thesis has been submitted for examination with my approval as University supervisor.

Signed *P. Ngugi*  
SUPERVISOR

JUNE, 1985

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ABSTRACT

The problem of resource abuse through industrial activities is a serious one in the developed countries. Air pollution, water pollution, acid rain, smogs and oil spills are few among the many consequences of resource abuse found in these countries. Today as many countries in the developing world industrialise, the problem of resource abuse is constantly becoming a reality, the difference being only in degree and magnitude.

Kenya like many of these developing countries is experiencing rapid industrialization and indeed the problem is noticeable in many of its industrial towns.

This study set out to examine the problem of resource abuse by industrial development. A case study of two industries in Athi River town, the Kenya Meat Commission and the East African Portland Cement factory was taken and their operations analysed in depth laying special emphasis on the environmental problems arising from these operations.

The study found that these two industries like many others in the country lack proper and sound environmental protection policies, and thus their operations have continued adversely to affect land, water and air the basic natural resources for human survival.

Through the study it has been revealed that the future of our resources and therefore our environment is indeed threatened.

The study has shown that industrial development without proper environmental policies can bring formidable problems on our environment.

This study in its recommendations calls for an intergration into our national policies the need for environmental protection. Indeed, the country should enact specific regulations and form an enforcement body to safeguard and protect the environment.

"The future of our resources lies on a careful and well coordinated effort by all parties concerned, Governmental, and non Governmental and Private individuals to come up with proper guidelines as part of our national policies on environmental protection. Enactment of a law governing resource use and environmental protection by the Government, establishment of appropriate industrial discharge standards, preparation of impact assesment reports on environment by industries and public participation on environmental protection are some of the necessary measures towards the right direction."

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## CHAPTER 1: INTRODUCTION

This is an introductory chapter which mainly examines the study problem, reviews some literature on related problems, outlines study objectives and hypotheses as well as explains about the research methodology. The study limitations are also outlined, so is the scope of the study.

### Background To The Problem

Rapid industrialization is a major concern for developing countries. It is viewed by the International Community as an Indispensable element and a necessary instrument for achieving sustained self reliant growth of the economies of these developing countries. In the process, these countries will have to use more natural resources and increase the utilization of the environment; and since these are the basis for Industrial activity it is important that they are conserved and properly utilized. It is noted that third world industrialization over the last decade left behind marks of resource misuse, environmental degradation and industrial pollution. Worsening the situation is the fact that during the last decade, some advanced countries increased the location of their pollution generating industries in the developing countries. They reaped the economic benefits while the poor nations suffered the environmental cost.<sup>1</sup>

Kenya, like most developing countries, experienced rapid industrialization during the last decade and like most of them no effective measures were taken to safeguard the environment from industrial pollution.<sup>2</sup> Emissions of airborne fumes from industrial estates are undoubtedly on the increase as the industrial sector develops and diversifies, but again little is being done to monitor and measure this, most air pollution is based on visual observations.<sup>3</sup> There is urgent need to establish pollution standards for all industrial establishments that emit gaseous or particulate discharges. This is clearly stressed in the

National Development Plan for the current period 1984-1988, which also stresses the need for industrial decentralization.<sup>4</sup> But industrial decentralization without proper and adequate pollution abatement and control measures is only likely to spread the effects further.

#### Statement Of The Study Problem

Athi River town has become the home of quite a number of major industrial undertakings. Among the major industries are: Kenya Meat Commission, East African Portland Cement Factory, Athi River Mining Company, Double Diamond Tanneries, Coral Paints, Werrot Company and GarLot Textile Industries not to mention the anticipated, Stellascope Company, Nova Chemicals Company Kiloskar Limited and GarLot wine distillery.

The main problem with respect to industrial undertakings within these industries has been one of misuse and mismanagement of basic natural resources; water, Air and Land a case clearly evident within the first two industries; Kenya Meat Commission and East African Portland Cement factory, the oldest and the 'giants' of all the other factories within the town. This misuse of resources which are basic to all forms of life has led further to several other related problems; air pollution, water pollution, ecological and land destruction as well as soil erosion.

In addition Athi River Town today depends on one major source of water for all its domestic and industrial undertakings, notwithstanding the fact that it is the same source of water that supplies water to many other people far and beyond the town. This major source of water is River Athi, and yet inspite of being such an important source of water, this river is constantly under the threat of pollution from both industrial and domestic effluents. The Cement dust from the East Africa Portland Factory has greatly interfered with the Vegetation and Wildlife

in the nearby Nairobi National Park not to mention the discomfort and nuisance it causes to the Athi River town residents. Parked vehicles, rooftops, window panes, washed clothes as well as buildings all become covered with the dust. Omondi (1983), observed that, "The Athi River Cement Plant located only 50 meters from the border of the park contributes significantly to the poisoning of the Wildlife inside the park"<sup>5</sup>. Today the existence of huge unrehabilitated quarries on land is not only a sign of ecological and aesthetic destruction but as well a sign of destruction and reduction of viable ranching land upon which the raw material base for certain industries such as Kenya Meat Commission and its allied Tanneries and slaughterhouses depend.

The disposal pits and lagoons of the Kenya Meat Commission emit very repulsive and unpleasant odours and smells much to the discomfort of the town residents and visitors alike, and today (1984) with the prolonged drought and high cattle death tolls, the half decomposed decaying and unburied cattle remains are not only an eye sore but a potential health threat to both people and animals alike let alone the repulsive smell they emit.



Literature Review:

Cottrel (1978) observed that, we live at a time when mankind's impact on the natural environment has reached an unprecedented intensity and when there is a great and growing anxiety about the earth's physical and biological capacity to continue to carry such a burden.<sup>6</sup> In 1974, the Onyx Group on Environment in U.S.A. further pointed out that a decade ago, the word environment, if it was used at all by the general public, evoked only a vague awareness that the pollution of air, water and land was reaching objectionable levels.<sup>7</sup>

Today, however the evolution of campaigns for environmental improvement is the most striking. There has been a complete change from ignorance and indifference to widespread social concern and large scale practical action. The campaign for environmental improvement has assumed a more dynamic and vigorous approach; mass media campaigns; workshops, seminars, exhibitions, conferences, written documents and other forms of literature all related to environmental issues have become the order of the day. Today this re-awakening is typical of most Nations where Ministries, departments and other specialised agencies and bodies have been appointed to deal with environmental issues. Many scholars and committees have been on the forefront of these environmental campaigns; For example the Inter-Governmental Committee on pollution in Canada in 1970 pointed out that air, water and soil must be recognised as basic resources which require proper management. This committee further pointed out that the development and use of these basic resources should only proceed after full consideration of the interrelationships between the natural systems and the long term interests of man.<sup>8</sup>

More recently, Lohani (1982) made a more specific challenge on the use of water; He observed, "water is our greatest single natural resource, it constitutes

one of the indispensable basis of existence of a nation and as such it must be so preserved and should not be misused so that no avoidable damage arises to the national economy." <sup>9</sup>

BusinessWeek Magazine of January 1971 Observed that, "Nations must not pursue development programmes without assessing future environmental impacts of this natural resource." <sup>10</sup>

Campaigns on environmental protection started quite early. For example in 1869 the Massachusetts board of Health issued the following proclamation; "We believe all citizens have an inherent right to the enjoyment of pure and uncontaminated air, water and soil, that this right should be regarded as belonging to the whole community, that no one should be allowed to trespass upon by his carelessness or his avarice or even his ignorance." <sup>11</sup> Cottrel (1978) had also observed that pollution as a form of resource abuse has been a townsmans' problem for centuries; in 1273 an edict was issued in London prohibiting the use of coal as being "prejudicial to health." <sup>12</sup>

In spite of all these warnings and early campaigns, environmental degradation as a result of human activity still continues. Industrial development as a form of human activity can interfere with resources in variety of ways. However of all the effects of Industry, pollution is most pervasive. Pollution can interfere with crop production, forestry yields, fisheries, livestock, animals, human health, water resources, it can also damage steel, stone structures as well as works of art (parker 1978); <sup>13</sup> many examples exist in the world about such effects. for (example) In the mid 19<sup>th</sup> Century it was unbearable to breath in the House of Commons unless the window curtains had been soaked in Chloride of lime because of the sickening smell from the highly polluted Thames river (cottrell 1978). <sup>14</sup> Cottrell further points out that in the great London smog of 1952 over 4,000 deaths were

attributed to smoke Sulphurous fumes.

Parker (1978) observed that acid rain is a major threat in Canada, Scandinavian countries and Japan. In Scandinavia, Canada and Northern half of the U.S: many lakes, estuaries and rivers have experienced depletions of fish, and in some cases have become totally devoid of fish.<sup>15</sup> Sweden 1973 placed the economic loss of its recreational and commercial fishing industry at \$50- \$100million.

Edington (1978) observed that in South Wales discharges of Cyanides, phenols and ammonia eliminated fish species such as brown trout (*salmo trutta*), eel (*Anguila*) and bullheads (*cottus gobio*)<sup>16</sup>.

Gilbert (1975) pointed out that Norwegian alluminum smelters have killed a wide zone of coniferous trees;<sup>17</sup> Also Allcroft (1964) emphasised that industrial emission can damage crops or animal stock depending of the distance from the emission source. He observed that Flouride can affect animals stock as was the case in Trent Britain where animals showed severe symptoms of flourosis including skeletal malformations and Lameness.<sup>18</sup>

There are many similar examples; also oil spillage represents yet another significant threat to many forms of life: Croxall (1975) observed that oil spillage represents a significant threat to groups of sea birds such as diving duck, auks and peguins; for example the torreycanyon disaster alone is estimated to have killed 40,000 auks and around the South African coast.<sup>19</sup>

The recent Bophal incidence in India (Dec.1984) which claimed over 2,000 lives, is a case of air pollution associated with Industrial activities.

From these examples it is clear that resource misuse is a great potential danger to all forms of life.

There is thus need for intensification for research, Literature and other forms of campaigns on the environmental issues.

Ferris (1971) noted that, the very fundamental scientific

data necessary for complete understanding of water supply and pollution problems has not yet been fully developed. In tropical Africa regions Literature on the effects of pollution on streams is limited to a few local surveys and observations.<sup>20</sup> In Kenya attention has been paid to some larger lakes in the Rift valley, but little information is available about small lakes, reservoirs and rivers (Lind 1965).<sup>21</sup> River pollution problems have been associated with industrialized societies; GolKerman (1975) observed that many aquatic biologists refer to African rivers and Lakes as being in a natural or pure state. Indeed it has been suggested they be studied as uncontaminated 'controls' for comparison with temperate rivers and lakes,<sup>22</sup> this study contents that this is a fallacy of the worst order. In Kenya a country where industry is beginning to establish itself firmly river pollution is now a reality. Case studies on Rivers Nzoia, Nyando, Kerio and Nairobi confirm this: Nzoia river which drains in Lake Victoria carries effluents discharged from Pan African Paper Mill at Webuye upstream and from Mumias Sugar Factory downstream (KoKwaro et all, 1971);<sup>23</sup> Kerio river is polluted by effluents coming from the flourspar factory (meadows) Nyando river receives molasses effluent from Chemelil and Mohoroni Sugar factory (MOWD 1976). Njuquna (1978) and Oganden (1977) observed that Nairobi river is characterised by anaerobic conditions containing dirty black water with bubbles of methane and hydrogen Sulphide and a blackening of bed and banks, a condition brought about by a combination of domestic sewage, industrialeffluents and urban runoff. This water, both concluded is now a health hazard.<sup>24</sup>

Kenya like most other developing nations has little research done and Literature written on the problem of environmental pollution and in general resource misuse and mismanagement. The attention given to the problem is very little as compared to the much attention given in the more industrialized nations. Today only a sizeable number of scholars and bodies have started devoting

their time in not only creating awareness of the problem but also in spelling out the need for immediate measures to be taken to deal with the problem before it reaches uncontrollable limits. One of the major challenges facing the 1977 Kisumu conference dealing with various aspects of pollution was whether it was not too premature to talk of the problem (Okindi 1977).<sup>25</sup>

Wandiga 1977, expressed the following sentiments:

"There is a dire" concern for the enactment of an environmental Quality Act to outline mechanism for dealing with air, water and land pollution. A major purpose of such legislation would be to protect and enhance the quality of the Nations air, water and land resources so as to promote the public health and welfare and the productive capacity of its population".<sup>26</sup>

GOK/UNEP/UNDP project report on environment and development 1981 made one of the following observations "there is urgent need to establish air pollution standards for all industrial establishments that emit gaseous or particulate discharges. There are no scientifically sound standards for effluent discharges in Kenya. Often, the Royal Commission Standards have been adopted, but their validity in Kenya is highly questionable on the basis of environmental differences between Britain and Kenya."<sup>27</sup>

These three observations reveal three basic aspects into the problem of pollution. These are: timing, standards and an enforcement Bill. They are important as all express the dire concern to deal with the problem of pollution. They however are too general and hence need follow up if they are to be implemented.

GOK/UNEP/UNDP Project report of 1981 further goes on to make the following important observation "Emission of airborne Fumes from industrial estates are undoubtedly on the increase as the industrial sector develops and diversifies. Little however is being done at the moment to monitor this, most air pollution is based on visual

observations. Air pollution measurements have been carried at only two stations in Nairobi. The Mount Kenya Baseline Station project has also done some work in this field.<sup>28</sup>

Today in Kenya the only Literature available dealing with industrial development and river pollution has been carried out by the National Environmental Secretariat (NES). The Ministry of Water Development, Tana and Athi Development Authority and Kenya industrial Research Development institute, among others.

In the area of this study very little research on pollution and industrial development has been carried. The Tana and Athi development authorities have concentrated their research on the lower Catchments and have carried no specific data analysis in relation to any specific industrial undertakings in Athi River town (TRDA 1981).<sup>29</sup>

JARI 1982 made the following observation "The expansion of Athi River town particularly the industrial sector is a threat to the Parks ecological environment. It is therefore necessary to strike a balance between man's activities and natural environment so that the existence of the Park is viable".<sup>30</sup>

Omondi 1984 made similar remarks "The pollution from industrial plants have settled on the leaves of some tree and this has exercised an impact on wildlife feeding habits. The Athi River Cement plant located only 50 meters from the border of the Park also contributes quite significantly to the poisoning of wildlife inside the park."

With the few studies carried there has been none done that integrates fully physical planning and environmental planning aspects, and it is the purpose of this study to integrate these two aspects of the planning process. Most of the studies done so far have tended to concentrate on river catchments without going to specific

industries and examining the pollutants and proposing for each industry the measures of control it must follow. This study, hopes that by examining two specific industries such specific recommendations will be made, both from a physical and an environmental planners point of view.

#### The Need For The Study

The recent shift in Government Policy which puts more emphasis on the districts as the focus for rural development implies that most rural towns and centers are going to assume much greater role interms of functions and services than before. More buildings and industries will emerge and population is going to increase in these centers thus putting more pressure on the use of resources than before; land will be used more intensely for construction of buildings and other services such as roads, waterworks among others.

\* Water will be used more than before for both industrial and domestic purposes and pollution of both air, water and land is likely to increase within these centres as more industries find their way there. There is an urgent need to spread environmental awareness particularly to the rural folks who are likely only to see these industries as a mere blessing without realising that the same industries could mark the beginning of major environmental changes and problems. This study seeks to bring to light such problems.

This study further notes that with the ever increasing congestion of Nairobi, Athi River town has been earmaked as one of its satellite towns and thus the investors alternative; many industries therefore are likely to find their way there. The study notes with dismay the high pollution rates of Nairobi River (Njuquna 1978 and Oganden 1977) which passes between Nairobi town; River Athi similary cuts Athi River Town into almost two parts, a Location which thus puts it directly under the threat of pollution, this study seeks to emphasise

the need to protect this river from pollution as it is the main source of water for all purposes, domestic and industrial.

The study further seeks to highlight some factors influencing industrial growth in Athi River town and its future growth potential, laying special emphasis on the need to create harmony between industrial development and environmental protection.

This study observes also that little regard has been given to environmental problems caused by industrial development by the individual industrialists themselves, it thus emphasises on the need of involvement of industrialists in environmental planning by preparing regular environmental impact assessment reports of their industries outlining the measures taken to safeguard the environment.

This study should therefore be of major interest to the public, municipalities, town authorities, industrialists, industrial and environmental planners as well as to other groups of people concerned with environmental protection at this decade when the whole world is gravely concerned with the worsening state of the environment.

#### Objectives Of The Study:

This study aims at a number of objectives:

1. To examine the industrial undertakings within Kenya Meat Commission and the East African Portland Cement Factories.
2. To establish the major pollutants with respect to the two industries and examine their effects on the three basic resources, water, air and land.
3. To establish the effects of the misuse of the said three resources with respect to further development of Athi River town and its environs.



4. To suggest and formulate policy guidelines and to make recommendations which should be taken with respect to the existing industries and any other that will be established in future

#### Hypothesis:

In order to realise the above objectives the study made a number of hypotheses:

1. That the three basic natural resources, water, air and land are misused and affected adversely as a result of industrial undertakings in Athi River town.
2. That the misuse of these three basic resources will have an impact in the long run towards further development of the town and hence will affect the environmental quality for both residential and working purposes.
3. That there exists several possible alternative solutions into the problem of resource misuse and that the basic one is to intergrate all social, economic and environmental aspects into the whole planning process among others.

#### Research Methodology:

This study relied on two types of data acquisition methods, Primary and secondary

Primary data: This was obtained through a number of methods,

- Personal observation
- Questionnaires (personal Interviews)
- Formal and Informal discussions.

#### Personal Observations:

This was based on an extensive field survey of the study area; specific areas visited included four major industries within town. K.M.C., E.A.P. Cement factory, Refinoil and ~~Metal~~<sup>Exide</sup> Chloride, a note was made however on the location of all other industries and the nature of their operation to get a general view of the

environmental problems associated with them; special observation was made on River Athi the main source of water with a view to ascertaining whether the water appeared polluted in any way; The E.A.P. Cement factory KunKur Quarry-called LuKenya quarry was also visited; other areas visited included the Nairobi Parks Area near the E.A.P Cement factory, the KMC lagoons and disposal area. In general a tour was made throughout the whole town and even Kitengela Market

#### Questionnaires:

These were based on guided questions and were of three different types as they were intended to gather views from three different groups of people: One type of questionnaire was administered to the Officials of Athi River Urban Council, the 'guardians' of Athi River Town the aim was to get their views about industrial development and environmental changes within the town.

The second questionnaires was designed to gauge the feelings and opinions of factory management on their industrial operations and the environmental problems associated with such operations. It was designed to check not only whether they were sensitive to environmental problems caused by their respective industries but also to establish whether they were doing anything to minimise or overcome the problems created.

A third questionnaire was administered to a section of Athi River residents with an aim of establishing whether they were aware of any environmental problems caused by industrial development in "their" town. It was further aimed at getting their suggestions as to what they feel ought to be done to overcome such problems.

#### Formal and Informal Discussion:

These were important in establishing how various agencies, the Government and other concerned individuals have responded to the environmental problems caused by industrial development within Athi River town but as well in othertowns in Kenya. Among those with

whom consultations were held were officials from , National Environmental Secretariat, Ministry of water development Pollution control section, Ministry of Commerce and Industry, Tana and Athi Rivers Development Authority, Kenya Industrial Research development institute, Ministry of Tourism and Wildlife, the planning section in particular, the officials concerned with Pollution Control. of National Parks; and Officials of the Department of Physical Planning in the Ministry of Works Housing and Physical planning.'

#### Secondary Data:

This was mainly obtained through Literature review of books, documents, Journals and seminar papers related to industrial development, resource mismanagement, environmental problems and industrial pollution among other aspects.

Maps, photographs and Aerial pictures were also used where possible to illustrate further the effects of resource misuse as a result of industrial development.

#### Definition Of Concepts/Terms

Some concepts have several meanings and implications and thus can be used differently to mean different things.

Some of the concepts used in this study are defined below depending on their usage in the study.

#### Environment:

The dictionary definition of this word implies, the sum total of all external influences and forces acting upon an object. For mankind the word in general would encompass the air, water, land, vegetation, animal forms and any other matter, force or influence within the plants or outside that could affect a person's life.

Environment for most analytical purposes refers to the biosphere, the zone of the earth's surfaces, waters and atmosphere inhabited by living Organisms. This is the definition adopted and used in this study.

## Environmental Management

Environmental Management is the influencing of human activities as they affect the quality of mankind's physical environment especially the air, water and terrestrial features. As used in this study the word environmental management implies "a conscious systematic effort by one or more persons acting in concert to produce an aesthetically pleasing, economically viable and physically healthy environment.

### Pollution:

There has been a lot of controversy over the definition of this term as many schools of thoughts define it differently or define it with reference to strictly their subject of study.

The Engineers consider pollution to be any waste discharges or even natural environmental changes that are directly detrimental to man.

A second view by the National Academy of Sciences (1966) defined pollution as "an undesirable change in the physical, chemical, or biological characteristics of air, land and water that may or will affect human life or that of other desirable species or industrial processes, living condition, and cultural aspects, or that may or will waste or deteriorate the quality of our resources"

A third broad view sees pollution as a disruption by man of the natural system by gases from a volcano.

This study has adopted a more simplified version of the above three definitions to the term Pollution and here it is taken to imply any activity by man, industrial and domestic that may affect the state or quality of water, air and land; that which may affect or destabilise any form of life, human, vegetation and wildlife alike; any other development or that which may reduce the utility of these resources.

### Limitation Of The Study.

The study was limited in a number of ways;

1. The time allocated for the research was very short. The study had to be carried alongside other course work and the workload proved to be quite enormous. It was thus not possible to examine certain aspects in great details.
2. The financial resources allocated for the study proved to be quite inadequate. This limited the number of trips made to the study area to carry out the research. It was not also possible to visit all the areas intended.
3. Detailed analysis of such a research particularly on the impact of certain activities would have needed certain scientific analysis to get a better appreciation of their effects. Such skills and expertise as well as the necessary equipments were a major handicap to the study.
4. Most of the literature available on environmental issues is about the developed countries; it was thus not possible to get good case studies to use as examples in the study. On the whole however, inspite of these limitations the study was able to achieve its objectives.

#### Scope Of The Study:

The study focuses on the abuse of natural resources, land , air and water by industrial activities. The study thus, specifically examines the operations of two industries in Athi River town; the Kenya Meat Commission (KMC) and the East African Portland Cement Factory (E.A.P.C.F.), with special emphasis on their impact on water, land and air and their implications towards further development of the town and its environs.

The study also covers the mining quarries of East African Portland Cement factory at Kajiado and Lukenya areas, with a view towards establishing the environmental

problems involved. The effects of dust on the Nairobi National Park are also examined.

Chapter one examines the study problem, objectives, assumptions and methodology used.

Chapter two devotes on exploring background information on the study area, location, demography, physical characteristics are among the issues examined. This chapter also examines the growth potential of the town, thus primary and secondary factors which influence industrial growth in the town have been discussed.

Chapter three and four examines the operations of KMC and the E.A.P.C. factories respectively, and their impact on environment. Chapter five evaluates specific environmental impacts discussed in chapters three and four. Chapter six gives a summarised review of the major findings of the study as well as makes recommendations on specific issues raised. The final Chapter (7) gives an overall summary of the study and its conclusion.

#### Summary:

This chapter analysis indicates clearly that the problem of resource abuse is not only rampant but serious one in the developed world. The analysis also shows that the problem has begun to emerge and spread with rapidity in the developing countries, and above all the study has observed that the problem is becoming a serious one in Kenya. The Chapter in general lays a detailed methodological approach that the study is based upon.

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## CHAPTER TWO

This chapter examines the background information about Athi River Town which is the study area in the first section. Here information about Location, historical development, demographic characteristics, physical characteristics such as rainfall, temperature, geology, soils and water resources are examined. In each case an attempt is made to show how each factor will affect the industrial development of Athi River town. The second section of the chapter examines the industrial growth potential of Athi river town by analysing the factors which influence industrial development as outlined by proponents of theories of industrial development and also specifically examining the primary and secondary factors which influence the industrial development of Athi River town. The last section of the chapter examines the Kenya Government policy on Environment and on industrial development; this will give an indication on how industrial development in Athi River town is likely to affect the environment.

### Background To The Study Area.

#### Location Of The Study Area.

Athi River is situated approximately 30 KM. South East of Nairobi a position that has made it benefit from the latter's industrial overspill. It lies along the main A109 Nairobi-Mombasa road. It also lies at the junction of the main A104 road often referred to as the Great North Road which leads to Namanga.

The Kenya railway line from Nairobi to Mombasa passes through Athi River town and has a main stopping point at Athi River Station.

Jomo Kenyatta International Airport lies about 20KM. from Athi River town. (see location map No. 1)

Interms of communication therefore, Athi River is well served; a factor which makes it even more attractive for industrial development.

It also lies next to the extreme South East border of



the Nairobi National Park; the cheetah gate of the Park provides a direct access to the town a position that could make the town benefit from Tourist activities.

### Historical Development Of Athi River Town

Athi River came into existence as a result of the presence of the then Mavoko railway station which is the present day Athi River railway station. Situated conveniently on the Athi Plains after a torturous climb from the coast, the town was a good resting place for the railway builders including colonialists who were eager to push their influence into the interior of the country.

Athi River was also a resting place for the Kamba tribesmen who engaged in poultry trade and had to transport their birds on foot from the surrounding Machakos district to Nairobi in the early 19<sup>th</sup> Century.

Narrators of the Athi River history mention the names of people like Simeon Maele, Nyolo Nthei and Lucas Kiloo as the pioneers of Athi River town. These men are said to have established the first shops in the years 1919, 1924, and 1927 respectively.

Their shops are still thriving upto this day.

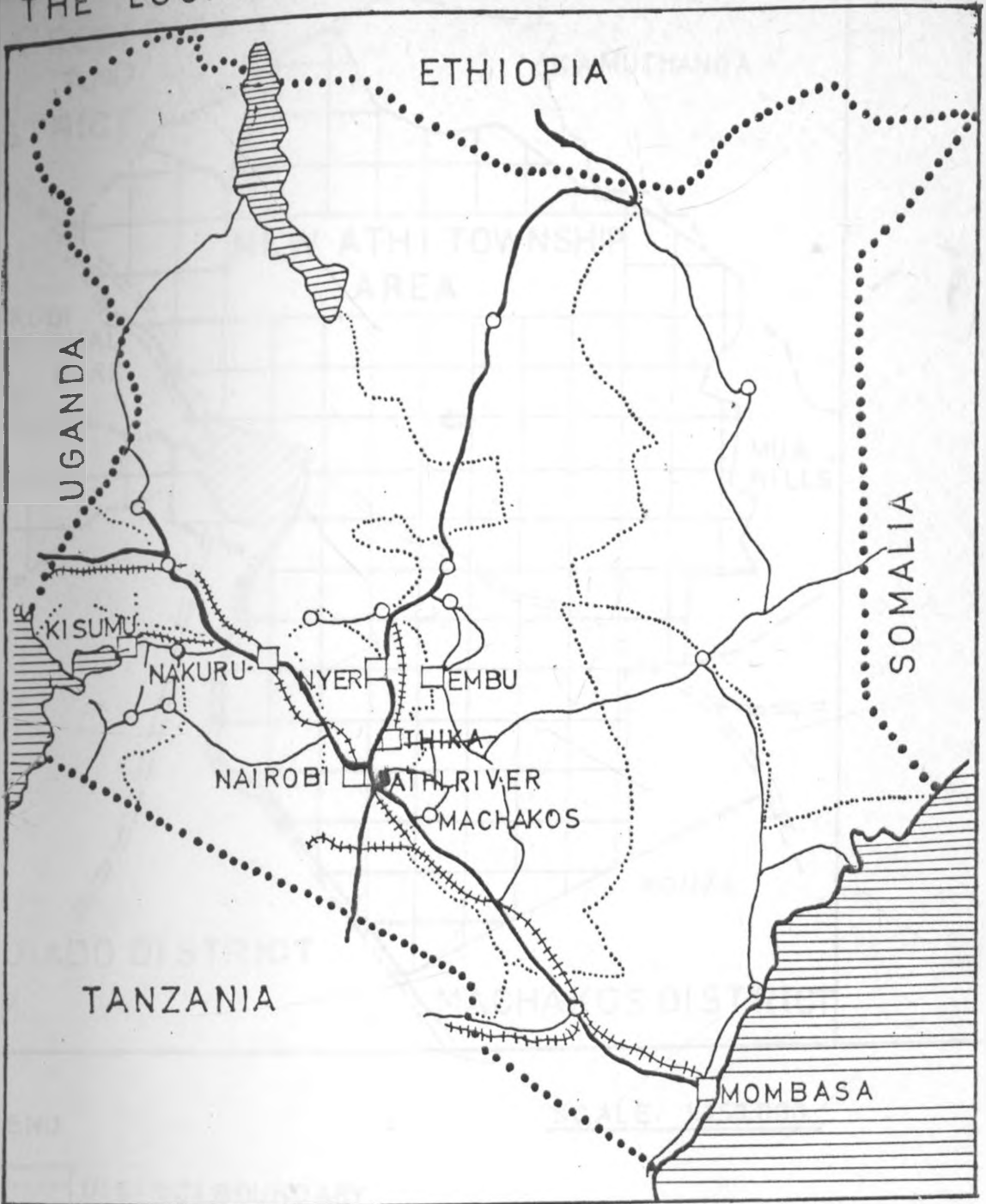
From that time, onwards, Athi River town grew under the auspices of the former Nairobi County Council which was subsequently dissolved in 1923 paving the way for Athi River town to become an autonomous Urban Council.

The first industry was established at Athi River in year 1953 and this was the giant Kenya Meat Commission. It was followed by the East African Portland Cement Factory which was established in the year 1957.

Most of the other industries were established fairly recently in the mid and late 70s; Kenya Thread Industry 1974, Athi Leather works 1976, Garlot Industries 1979, Chloride Metal Limited 1978 and Refineoil Company 1981 among others.

Today, Athi River is the fourth largest Urban Centre in the Eastern Province after Embu, Meru, and Machakos.

# THE LOCATION OF ATHI RIVER IN KENYA



- PRINCIPAL TOWNS
- ATHI RIVER TOWN
- OTHER TOWNS
- INTERNATIONAL TRUNK ROADS
- OTHER MAJOR ROADS
- + + + RAIL ROADS
- ..... NATIONAL BOUNDARY
- - - - - PROVINCIAL BOUNDARY

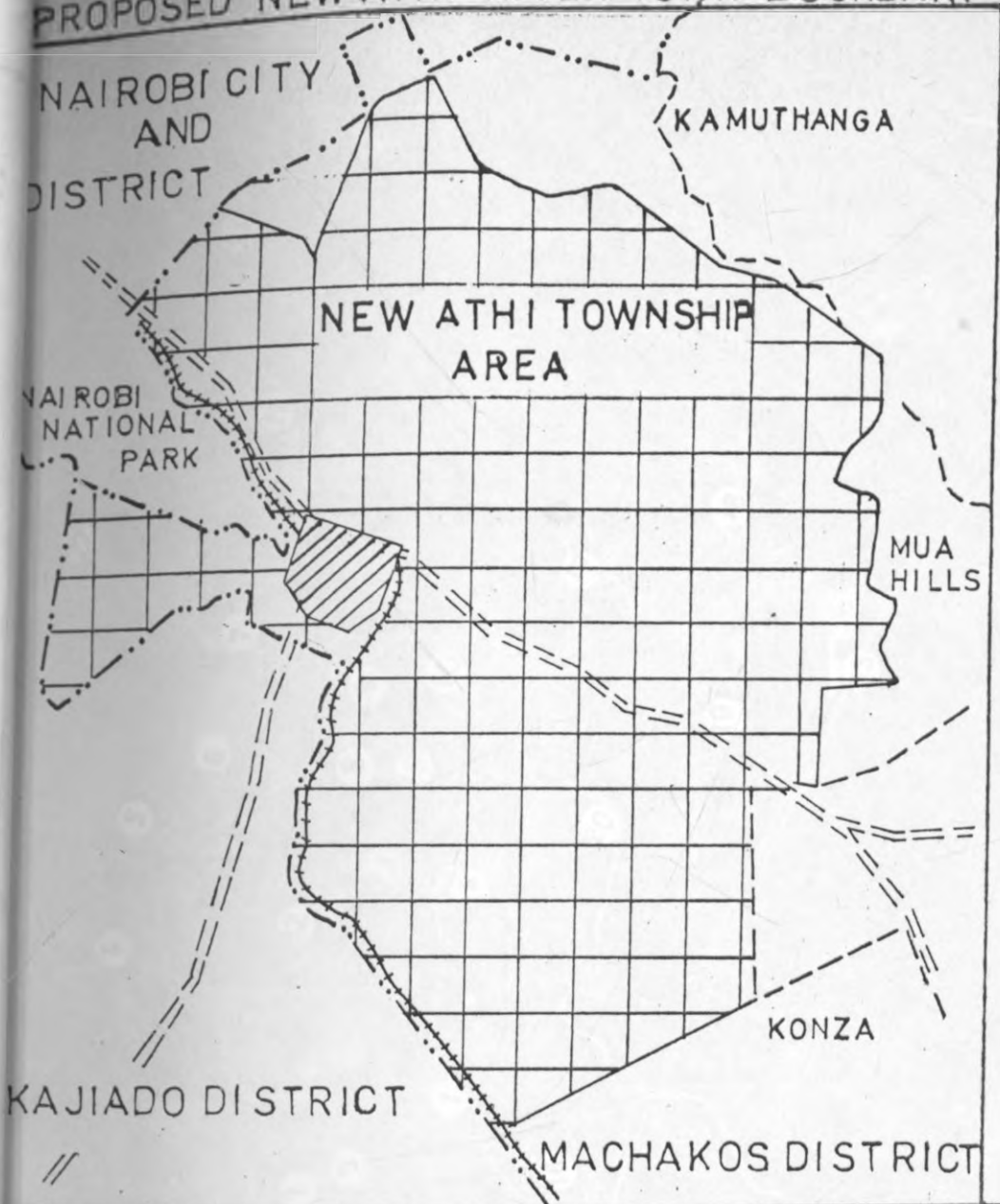
SCALE 1:6,000,000

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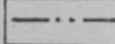
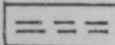
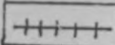




MAP NO 1

# PROPOSED NEW ATHI RIVER TOWN BOUNDARY



## LEGEND

-  DISTRICT BOUNDARY
-  ROAD
-  RAILWAY
-  NEW TOWN LIMITS
-  PREVIOUS TOWN LIMITS

SCALE 1:250,000

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MAP NO 2

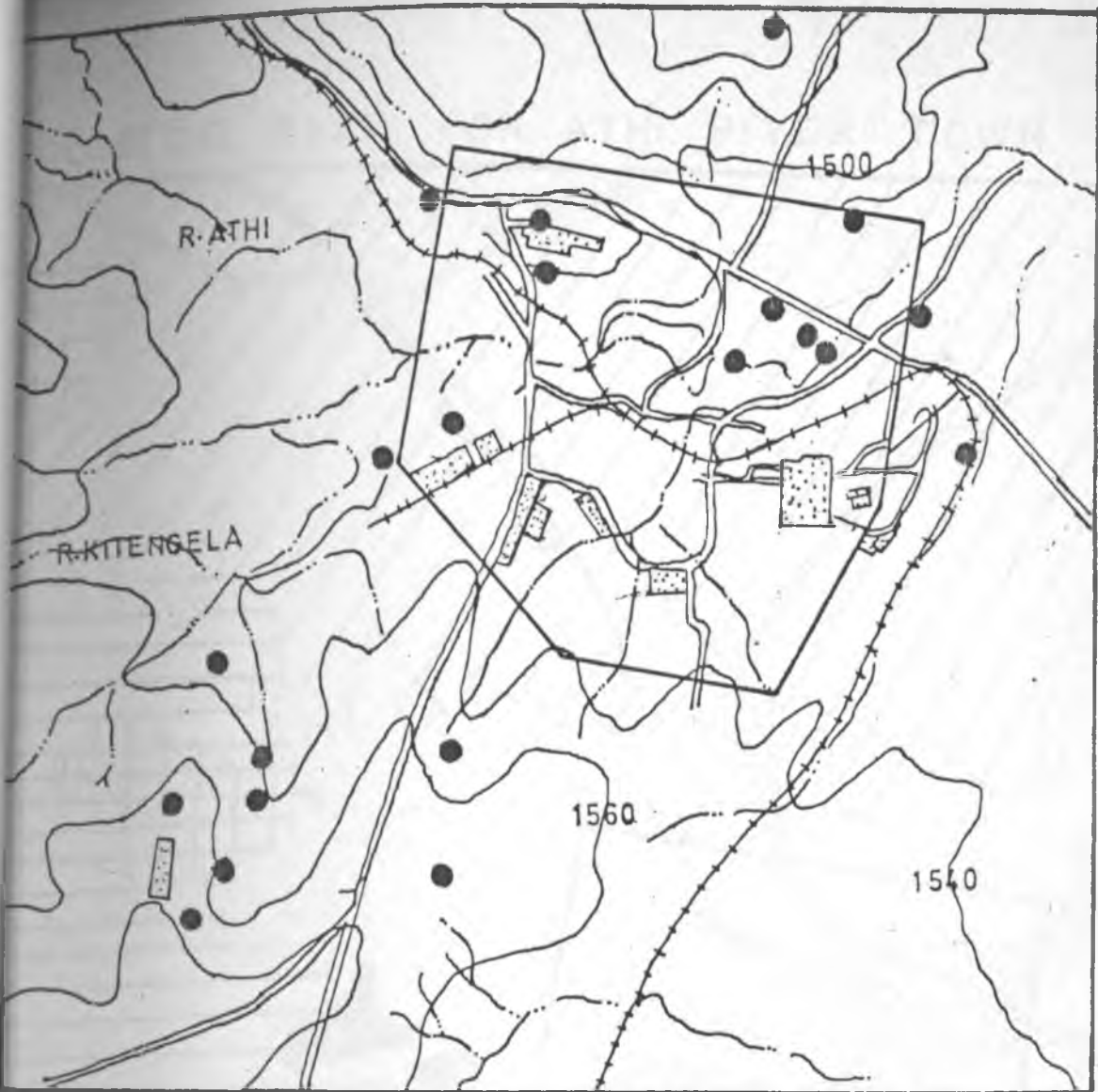


PLATE NO. 1: AERIAL PHOTO OF ATHI RIVER TOWN 1978

Key of Interpretation of the Aerial photo. Plate No. 1


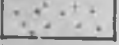
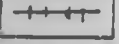
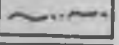

0. Kenya Meat commission (KMC).
1. Water Treatment station .
2. K.M.C staff Houses.
3. Chiefs Office/ Police station .
4. Sophia Estate.
5. Makandar Shopping centre .
6. Council houses.
7. Portland Cement Junior staff houses .
8. Metal Chloride Company.
9. Auto spring Manufacturing Company.
10. Athi Leather works co.
11. E.A. Portland Cement Factory.
12. Werrot co.
13. Railway station .
14. Maboko shopping centre.
15. Kisumu dongo Estate.
16. Veterinary station/meat Training centre .
17. Refine Oil company (under construction).
18. Double diamond Tanneries.
19. Portland Cement Senior staff houses.
20. River Athi (main source of water).
21. Sewage disposal works.
22. Water tank.
23. Mombasa - Nairobi road .
24. Kitengela Goat and sheep project.
25. Nairobi National Park
26. Stony Athi River.
27. Nairobi - Namanga International Trunk road (Great North road)





DISTRIBUTION OF BOREHOLES  
WITHIN AND AROUND ATHI  
RIVER TOWN

SCALE 1:50,000

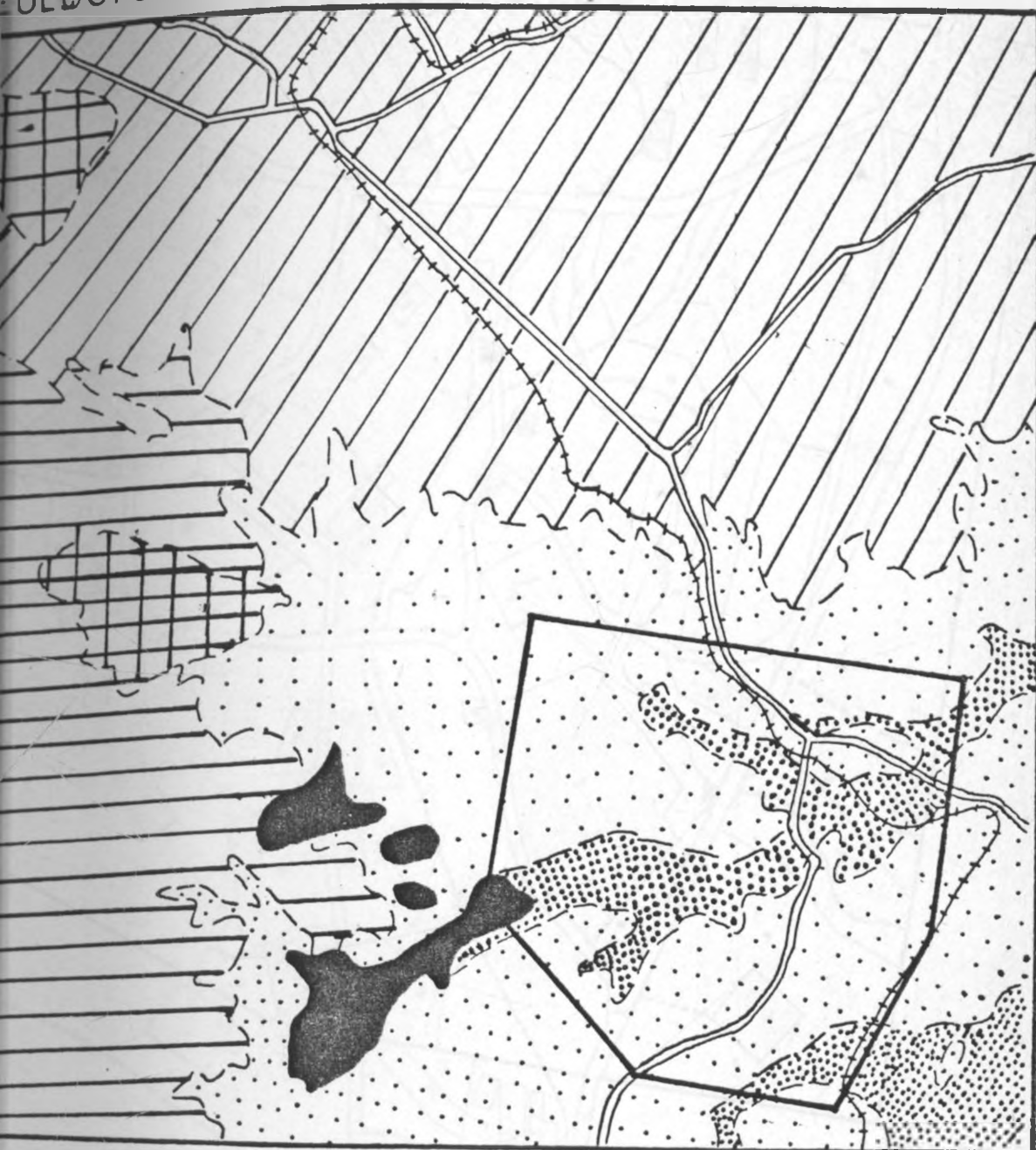
-  BORE HOLES
-  BUILDINGS
-  RAILWAY
-  RIVERS
-  ROAD

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MAP NO.3

# GEOLOGICAL PLAN FOR ATHI RIVER TOWN



SCALE 1:125,000

LEGEND

-  KERICHWA TUFFS
-  MBAGATHI PHONOLITIC TRACHYTES
-  NAIROBI PHONOLITES
-  KAPITI PHONOLITES
-  ATHI TUFFS
-  CRYSTALLINE ROCKS OF MOZAMBIQUE BELT

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MAP NO 4



**LEGEND**

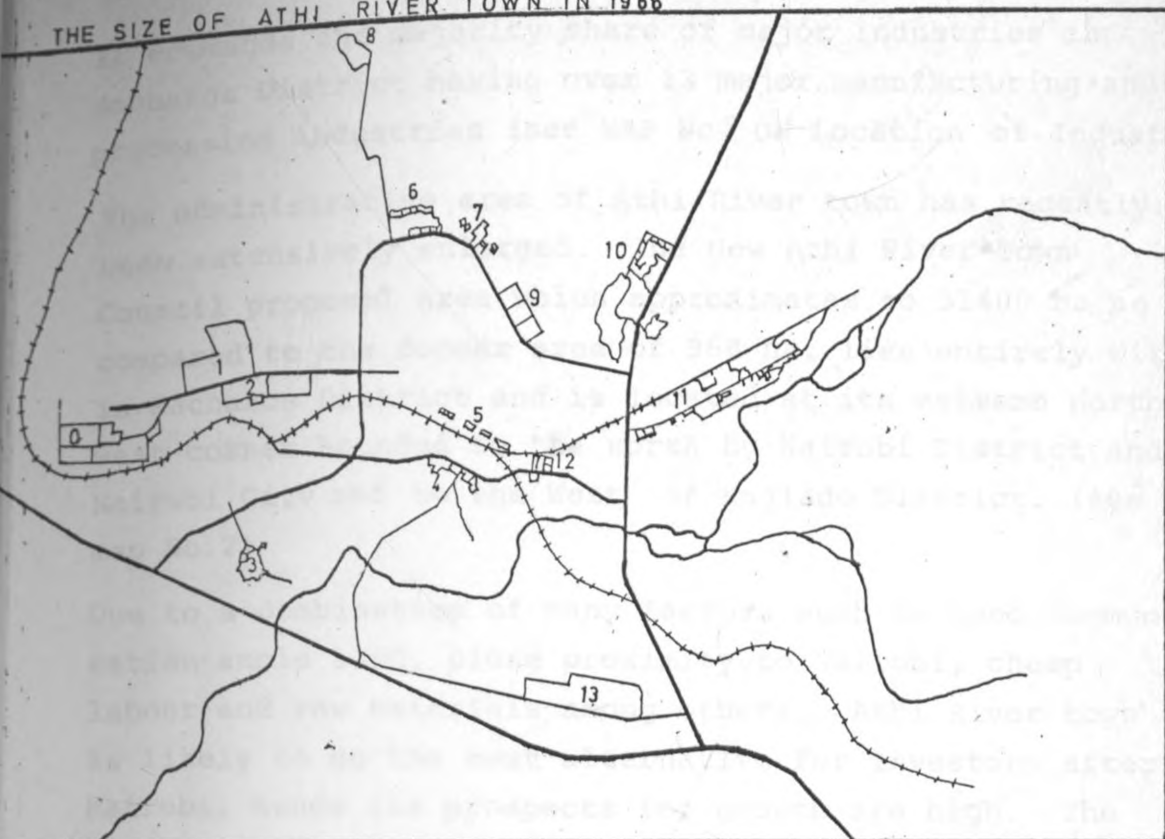
0	RESIDENTIAL	
1	INDUSTRIAL	
2	EDUCATIONAL	
3	RECREATIONAL	
4	PUBLIC PURPOSE	
5	COMMERCIAL	
6	PUBLIC UTILITIES	
7	TRANSPORTATION	
8	DEVERRED	
9	AGRICULTURE	

**ZONES SHOWING LAND USE IN ATHIP**

- 0 RESIDENTIAL**
- 01 PORTLAND HOUSES
- 02 JUNIOR
- 03 SENIOR
- 04 RMC HOUSES
- 1 INDUSTRIAL**
- 11 PORTLAND FACTORY
- 12 RE FINE OIL CO.
- 13 D. D. TANNARIES
- 14 MINING
- 15 A. LEATHER WORKS
- 16 CORAL PAINTS
- 17 AUTO SPRINGMAN.
- 18 NOVA CHEMICALS
- 19 METAL CHLORIDE
- 20 WHITE MEG
- 21 RMC
- 22 DISTILLERY
- 23 BOTTLE WASH. CO
- 24 WASHOUT FITTERS
- 25 ATH MINING CO.
- 26 WERROT CO.
- 2 EDUCATIONAL**
- 21 PRL SCHOOL
- 22 MISSION PRL SCHOOL
- 23 SEC. SCHOOL
- 24 COUNCIL NURSERY SCHOOL
- 3 RECREATIONAL**
- 31 TOWN PARK UNDER
- 32 FOOTBALL FIELD
- 33 PUBLIC OPEN SPACE
- 34 PROPOSED STADIUM
- 4 PUBLIC PURPOSE**
- 41 SOCIAL HALL
- 42 BAPTIST CHURCH
- 43 CEMETRY SITE PROPOSED
- 44 BURNING GHAT
- 45 COUNCIL ADM. CENTRE
- 46 CHIEF'S OFFICE
- 47 POLICE STATION
- 5 COMMERCIAL**
- 51 CBD
- 52 FUTURE BUSINESS
- 53 VET. HIDES AND SKIN TRADING CENTRE
- 6 PUBLIC UTILITIES**
- 61 SEWAGE PUMP
- 62 WATER WORKS
- 63 PUMP HOUSE
- 64 SEWAGE DISPOSAL
- 65 WATER TOWER
- 66 RMC BURIAL SITE
- 67 RMC DISPOSAL LAG.
- 7 TRANSPORTATION**
- 71 ROADS
- 72 RAILWAY STATION
- 8 DEVERRED**
- 9 AGRICULTURAL**



## THE SIZE OF ATHI RIVER TOWN IN 1968



## LEGEND

SCALE 1:25,000

- 0 K.M.C. FACTORY
- 1 K.M.C. STAFF HOUSES
- 2 CHIEFS OFFICE/POLICE STATION
- 3 HIDES/SKIN CENTRE
- 4 MABOKO SHOPPING CENTRE
- 5 MABOKO RAILWAY STATION
- 6 SOPHIA ESTATE
- 7 MAKADARA SHOPPING CENTRE
- 8 WATER TANK
- 9 COUNCIL HOUSES
- 10 E.A.P.C. FACTORY JUNIOR STAFF HOUSES
- 11 E.A.P.CEMENT FACTORY
- 12 KISUMU DOGO ESTATE
- 13 E.A.P.CEMENT FACTORY SENIOR STAFF HOUSES

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MAP NO. 6

It commands the majority share of major industries in Machakos District having over 13 major manufacturing and processing industries (see MAP No.5 ON Location of Industries)

The administrative area of Athi River town has recently been extensively enlarged. The New Athi River Town Council proposed area which approximates to 51400 ha as compared to the former area of 960 ha. lies entirely within Machakos District and is located at its extreme north west corner bounded to the north by Nairobi District and Nairobi City and to the West of Kajiado District. (see map No.2)

Due to a combination of many factors such as good communication ample land, close proximity to Nairobi, cheap labour and raw materials among others, Athi River town is likely to be the next alternative for investors after Nairobi, hence its prospects for growth are high. The already rapid rate of industrial growth noted in the late 70s and early 80s together with the high number of investors who have expressed a willingness to invest there, are clear indications of that potential for industrial growth.

#### Demographic Characteristics.

Past population census reports indicate the following population figures.

<u>Year</u>	<u>Population</u>
1948	582
1969	5,343
1979	10,012
1981	11,500
*1984	17,000

\* Council Estimates

Source: C.B.S

By comparing 1969 and 1979 census statistics of 5,343 and 10,012, there is a growth rate of 6.48% compared with the 4.1% for the overall National trend.

One thing is clear, that this high growth rate is not a result of natural increase by birth but on the contrary, it is directly related to the on going urban-rural migration problem affecting all towns in Kenya.

During the year 1948 there was no industry in Athi River Town; the figure 582 was mainly made up of railway employees who were stationed at Mavoko station and a few shopkeepers as well as other ranching communities.

The establishment of Kenya Meat Commission and East African Portland Cement factory in 1953 and 1957 respectively explains the rapid growth of the population to 5,343 in 1969. Between 1969 and 1979 the population doubled up from 5,343 to 10,012 a fact that is explained by the increase in the number of industries.

The growth of industrial development during this period created more job opportunities and accelerated the rural to urban population movement into Athi River town.

With the increase in industrial growth the economic atmosphere of the town became more favourable and the need for more other services such as schools, churches, dispensary, waterworks, shops, bars and other facilities and all these services needed more people to attend them and as a result they directly influenced the rate of population growth.

#### Population Projections:

1. Using 10,000 as per 1979. It is projected by the year 2010 the population will be approximately 56,000.
2. Ministry of Water Development design manual states a 7% per annum population projection for Urban areas with more than 5,000 persons and with good prospects of industrial development. Using 1980 as the base year

with a population of 10,718, a 7% increase to the year 2,005 will result in a population of 58,171.

The third method used is the industrial Comparison Research into the existing Industries in Athi River town indicates there are 16 employees per hectare, with an employee to residents ratio of approximately 1:5. The Identified industrial land use is 946 ha, which will result in a population of 75,680.

These projections are based on findings by Kennard and LapWorth consulting Engineers for Athi Town water supply report.

These population projections are obtained using the the Linear extrapolation method. The formula used is

$$P_2 = P_1 (1 + r)^n$$

Where:  $P_2$  = Projected Population

$P_1$  = Population at the base year

$r$  = The growth rate

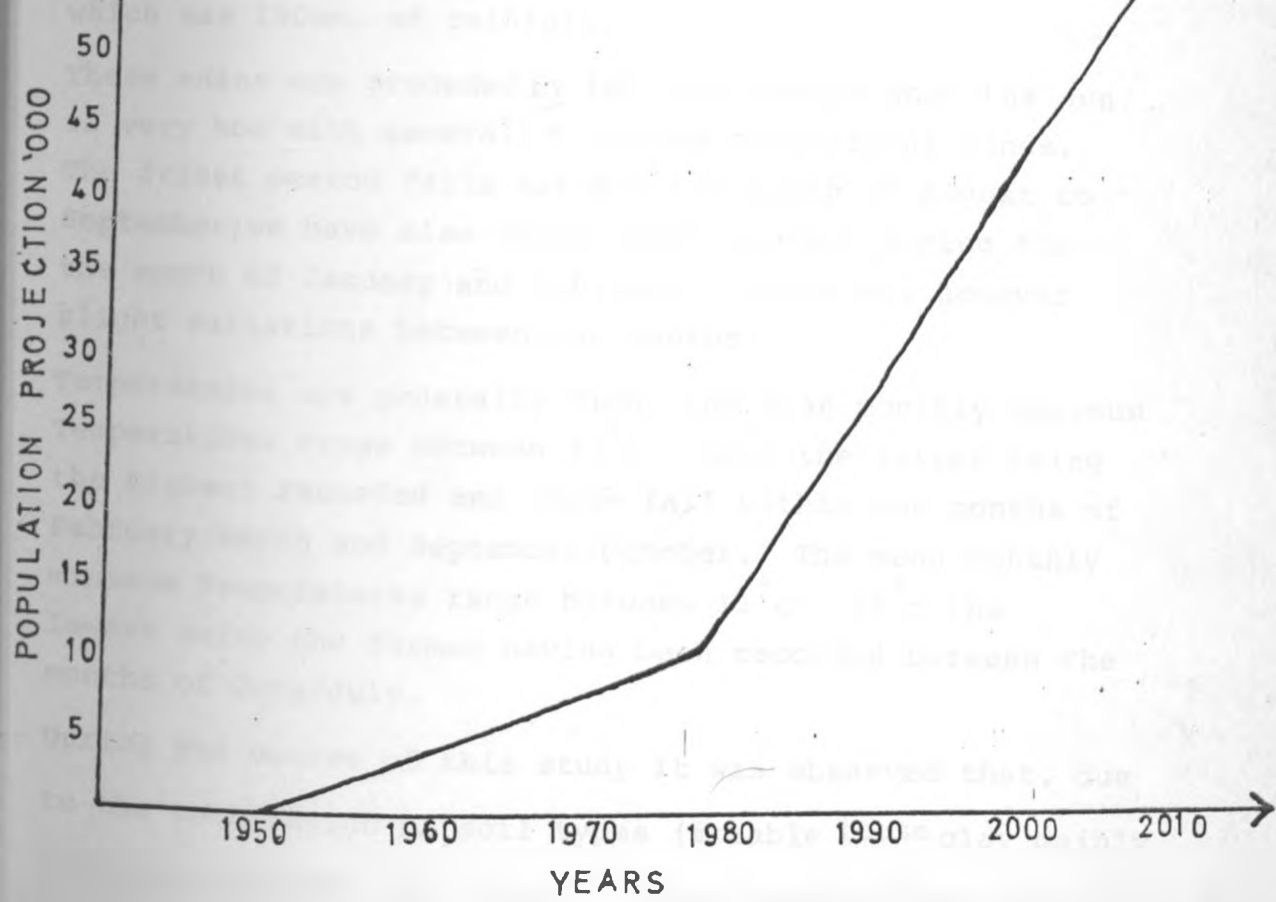
$n$  = The number of year population is being projected.

#### Population Projections.

1948	-	582
1969	-	5,343
1979	-	10,012
1981	-	11,500
1984	-	17,000
2010	-	56,000

(See FIG. No.1 for graphic illustration)

By implication, FIG. NO.1 indicates a gradual population growth from 582 to 5,343 in 1943 in 1948 and 1969 respectively. During this time the Kenya Meat Commission and the East African Portland Cement factories were the major employment agencies.



between 1950 and 1955... The population...  
 population growth...  
 industrial development...  
 economic activities to get...

It is expected with this...  
 that the population will...  
 trend the population growth...  
 where people have better...

### Physical Characteristics

### Malikali and Kandi

Statistics from New Survey  
**FIG NO.1**



Between 1970 and 1980 the number of industries grew up to 10 industries and similarly between the same period population more than doubled from 5,343 in 1969 to 11,500 in 1981, this increase is attributed to growth in industrial development as more people migrate to the town anticipating to get employment.

It is expected with this increase in industrial development the population will increase rapidly. Taking the present trend the population growth rate could increase even 9% as more people flock the town in search of employment.

### Physical Characteristics

#### Rainfall and Temperature

Statistics from the Meteorological department of Kenya indicate that Athi River has two rainfall maximas; long rains between February to May and short spells between the months of October to December. During the short spell the highest recorded was in month of November which is something close to 158mm. Similarly the highest recorded during the long rains was in the month of April which was 150mm. of rainfall.

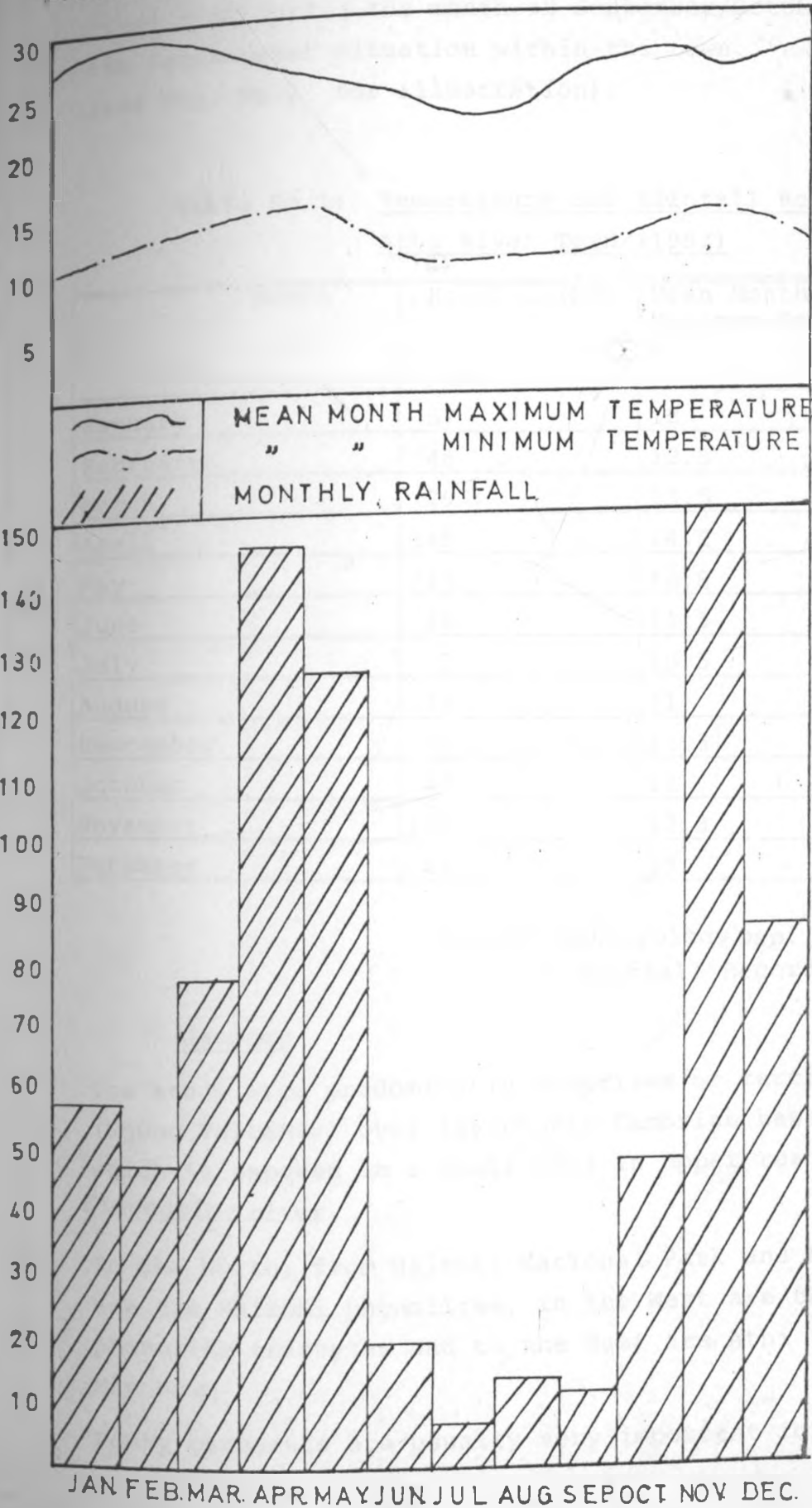
These rains are preceded by two dry spells when the sun is very hot with generally strong occasional winds. The driest period falls between the month of August to September; we have also occasional drought during the the month of January and February. There are however slight variations between the months.

Temperatures are generally high; the mean monthly maximum Temperatures range between  $23^{\circ}\text{C}$  -  $28^{\circ}\text{C}$  the latter being the highest recorded and these fall within the months of February/March and September/October. The mean monthly minimum Temperatures range between  $11^{\circ}\text{C}$  -  $15^{\circ}\text{C}$  The lowest being the former having been recorded between the months of June/July.

During the course of this study it was observed that, due to the combination of soil types (friable loose clay mainly as noted earlier) and these high temperatures, the

ATHI RIVER TOWN; TEMPERATURE IN °C AND RAINFALL IN MILLIMETRES

FIG. NO. 2





evaporation rates, tends to be high, hence the sun tends to suck the moisture back to the atmosphere fairly fast. This could also explain why there is hardly no river flow during the month of September/October; hence the acute water situation within the town. (see fig. No.2 for illustration).

Table No 1: Temperature and Rainfall Records of Athi River Town (1983).

Month	RainFall (MM)	Mean Monthly Minimum Temp °C	Mean Monthly Maximum Temp. °C
January	57	12	27
February	48	12.5	28
March	79	13.5	27
April	145	14.2	26
May	125	13.8	25
June	20	11.5	24
July	7	10.5	22.5
August	14	11	23
September	12	11.3	25.5
October	47	13	27
November	150	13.8	26.5
December	81	13	26.5

Source: Meteorology Dep. of Kenya,  
Rainfall Records.

### Geology

The study area predominately comprises of tertiary rocks (Ngong Volcanic) over-laying Pre Cambrian basement rocks which is exposed in a small area in upper reaches of the Kitengela river.

In the North, from Nairobi National Park and Eastwards are the Nairobi phonolites, in the West are the Mbangathi phonolite trachytes and to the East are Athi Tuffs (see Map No 4)

Rocky basements are usually very important for providing

strong foundations for buildings. In Athi River, however, the rock basement in most of the town is in the deep parts of the soil thus for construction purposes particularly for industrial and residential buildings alot of the top soil has to be removed to reach a strong basement which can support these buildings. This increases the cost of construction involved.

#### Soils:

The area is predominantly characterised by five major soils; Red-Brown soils, Yellow-Brown soils, stony soils and alluvium. Each soil type is discussed below.

#### Dark Soils:

These are classified as dark-grey: brown Calcureous clays with light textured top soil. When dry the clay fractures to form deep cracks. When wet the soil is very stick plastic and has very poor drainage qualities. This type of soil is found predominantly around Mavoko and Makandara. This is one of the areas zoned for industrial development; The soil type here does not however form a strong basement for foundation of industrial blocks. To put up a strong building thus involves alot of scooping of the top soil.

#### Red-Brown Soils:

This soil is mainly loamy clay. It shows up in pockets within the study area but is more predominant to the East of the study area, No active industrial activity has been developed in this soil type. It could however form a good area for the growth of french beans and some irrigated vegetables which could supplement the horticultural industry.

#### Yellow-Brown Soils

This is a shallow Yellow-Brown to red friable clay overlying the laterite horizon or rock and shows up as a thin band between the dark soils North of Athi River Valley opening to large areas along the tributaries of the Athi and Kitengela rivers.

This is the area where East African Portland is Located, it is an area where originally the Cement factory used to obtain its KunKur a basic raw material in cement production. The resource is not exhausted and the quarry can be reactivated incase the other quarries become exhausted.

### Stony Soils

These are shallow stony soils with rock outcrops which underlie the Yellow Brown soils and occur, within the same boundaries as the Yellow Brown Soils above.

### Alluvium

This follows a narrow band along the bed of the Athi and KitenKela rivers but does not extend beyond the tributaries at the Baboon escarpment or the KitenKela swamp and downstream juts out at the confluence with stony Athi River. At this area cash and subsistence crops have been developed:

French beans and vegetables do well here and have contributed to the development of the horticultural industry.

### Existing Water Situation:

Rofe Kennard and Lapworth consulting Engineers commissioned to carry out a water feasibility study for Athi River Town Council summarised the water situation at Athi River with the following words.

" The existing water supply is in a parlous condition despite being augmented as recently as 1976. Sources include the Athi River and boreholes, but the water available is totally inadequate for domestic purposes leave alone for industrial development purposes. The situation is particularly acutest during dry periods when there is hardly no river flow. " 1

These Engineers have gone into great depths of surveying and analysing the water situation in Athi River Town. They in doing so have put alot of efforts in examining the present water situation in the Town, and by looking at the supply, demand and population growth rates have also done projections of the water situation upto the year 2005.

They carried a thorough survey of all water resources both surface and underground as well as assessing their potential interms of actual output and potential capacity in meeting domestic and industrial requirements at different times of the year. They also came up with policy recommendations which if implemented it is hoped will avert the existing and foreseeable water crisis in Athi River Town.

It is the contention of this study that some of these observations, findings and recommendations be highlighted in order to show how water is likely to affect and/or be affected by, industrial development and what impacts are likely to occur.

The present water consumption is supplied from a combination of the Municipal supply, private, licensed Supplies for industrial and smallholders abstracting water from the local rivers, and private licensed abstraction from groundwater.

Table No.2: Existing Water Demand and Estimates:

I. Surface water Licenses	= 5520M <sup>3</sup> per day.
II. Groundwater (borehole) output	= 5500M <sup>3</sup> per day.
III. Municipal Supply	= 966M <sup>3</sup> per day.
Iv. Total available for Industrial and Domestic use	= 6466M <sup>3</sup> per day.

This available water (6466M<sup>3</sup>/pd) is not even enough to meet daily requirements which amount to 7028M<sup>3</sup> per day (1982 estimates). There is thus a noted shortfall. (.562m<sup>3</sup>/pd) Making the situation worse is the fact that even the 6466M<sup>3</sup> p/d. is hard to realise during the dry spells.

Today only two major rivers supply river flow water, these are Athi- Kitengela river and stony Athi river. It has been observed that these rivers are not capable of meeting the total estimated supply during low flows. The situation is even agravated by illegal abstractors who have deprived the municipality its direct water supplies for horticultural irrigation purposes.

At present there are approximately 30 private boreholes

used by industries within Athi River. The total amount of water abstracted from these is estimated at  $4148\text{M}^3/\text{d}$  which represents approximately 80% of the total water available; however, uncontrolled granting of Licenses to abstract ground water has caused some boreholes to dry up causing the general trend of falling levels of groundwater now evident as borehole records indicate. (interviews/discussions held with the town clerk indicate that this illegal abstraction is highly being controlled now)

Rofe Kennard and Lapworth have also proposed the construction of three dams at the upper-reaches of the Athi and Kitengela rivers; Athi Dam, Kitengela dam and Kapiodam, the construction of these dams if implemented, it is hoped will go along way towards solving the existing and foreseeable water crisis in Athi River Town.

Other proposals and recommendations made by the same, include improvement of the existing treatment works to meet this new supply, improvement of existing distribution network and construction of a huge water reservoir near Garlot Industries which is the highest point from which then the flow of water will be by gravitational force

Finally these Engineers have done projections of the water demand situation for both domestic and industrial purposes upto the year 2005. (see Table No.3)

Table No.3: Summary of Water Demand: Total Demand To 2005:

YEAR	1980	1985	2005
POPULATION	10,718	19,764	52,680
TOTAL DEMAND	$5,171\text{M}^3/\text{d}$	$9590\text{M}^3/\text{d}$	$25061\text{M}^3/\text{d}$
TOTAL DEMAND PLUS 5%	$5429\text{M}^3/\text{d}$	$10069\text{M}^3/\text{d}$	$26314\text{M}^3/\text{d}$

Note:1: Total demand refers to demands for the following category of water uses, Residential, Industrial, Education, Green belt, Public Purpose, Commercial, Transport (railway, roads), Agriculture.

- ii. Total Demand Plus 5% - refer to the fact that it was not possible to do certain water demand estimates and projections using the present consumption rates hence an increase was envisaged thus for this reason a 5% increament was thought plausible (Source: Table 3.og 3-17 of Kennard and Lapworth findings 1982/83).

These Engineers have finally concluded that there is need to construct three dams on the upper reaches of Athi - Kitengela rivers in order to overcome this foreseeable "water crisis" in Athi River Town.

This study observes that given the situation of the water analysed above, water is likely to affect the development of Athi River town greatly if no efforts are made to improve the water situation as the report suggests.

Industrial Growth Potential of Athi River Town:

General Theories and Factors Influencing Location of Industries and Their Application to Athi River.

Subtle words expressed by the former Athi River Town Council Chairman 1982/83 Councilor Mulandi are considered appropriate in giving a brief foresight of not only these factors but also of the industrial prospects of the town.

"An industrial revolution is slowly taking place in our homestead. The Athi River Town, which is but a mere 18 miles from our Capital City of Nairobi.

Though gathering in momentum now than ever before, it is a revolution which started at the turn of the century with the building of the famed Kenya - Uganda Railway when our town which is situated on the Athi plains with a welcoming climate was found to be an ideal site for a rest after crossing the hostile Tsavo plains from Mombasa. Today Athi River Town has grown to be a town with well over 10,000 people and a home for more than 13 major companies some with histories dating back to the 1930s. And as Nairobi gets more congested with industries overspilling to adjacent neighbourhoods, Athi River Town

has immediately become the investors alternative with all positive infrastructures being available." <sup>2</sup>

By examining further, theories and views expressed by proponents of industrial Location, Ogendo R.B, among many others, one is able to see how the interplay of various factors are not only significant in determining industrial location of Towns in general but also how these factors relate to the Industrial development in Athi River Town specifically.

<sup>3</sup>  
Ogendo (1969) observed that no single location factor on its own absolutely determines or clearly indicates the right location of a given industry. He further rightfully observed that the location of a given industry in Kenya is the product of a set of suitable factors, though it is often hard to know what the optimum location is.

Though he broadly classified these factors into physical and human factors; he conceded that among the major factors of industrial location include the following;

1. historical, geotopographical and ecological
2. Infra-structural influences with special emphasis on transportation
3. Joint influences of manufacturing and servicing costs, personal considerations and raw materials.
4. Markets and industrial interdependence considered jointly.

Although there are many considerations that Ogendo has looked into with respect to the above factors, he concludedly pointed out that in Kenya the factors of transport costs of finished products does seem decisive in the choice of most industrial plants.

It is worth pointing out that most of the above factors seem to have played a major role in the location of most major towns in Kenya; Nairobi, Mombasa, Nakuru, Kisumu among others seem well fitted in Ogendos analysis of factors of industrial location; Athi River is no exception, good communication (transport by rail, road and air), close proximity to a large consumer market (Nairobi), availability of ample siting (location) space which is

also relatively cheaply available, some raw materials easily available, cheap labour, industrial linkage and industrial interdependence seem all to be playing a major role in influencing the location of most industries in Athi River Town. Most industrialists interviewed during the course of this study were of the opinion that a combination of some of these factors if not all of them greatly influenced their decision to locate their industries in Athi River Town. Others rightfully pointed out that congestion and lack of 'cheap' land in Nairobi have had an influence on their location choice.

Other proponents of the theories of industrial locations; Smith D.M(1971,1977), Christaller W.(1933) Renner G.(1947, 1950), Weber A(1909), Pred (1967,69), Keeble L.(1969) among others single out factors of transportation; raw materials, labour, land/space, water among others as prime factors influencing the location of most industries.<sup>4</sup>

If one takes a brief overview with respect to a number of industries in Athi River Town and sees how these locational factors apply, he would observe that with respect to Kenya Meat Commission, East African Portland Cement factory, the presence of the railway station and excellent road network were significant factors, so was also the factor of close proximity to a large consumer market (Nairobi), both for the cement and meat products among other factors.

For the double diamond Tanneries and Athi Leather works, the availability of raw material (hides and skins from KMC) was an added factor. For the White Meg and Athi River Mining Company the presence of easily quarried raw material was a significant factor so was also for the Portland Cement factory. Garlot, industries Nova chemicals, Metal chloride and others which have expressed interest to locate industries in Athi River Town, the factors of industrial location stated above seem undoubtedly significant as interviews with most senior executives of these firms show.



By examining further Ogendos analysis of industrial location and their classification in Kenya, he defines an industrial town as that;

1. With at least 4,000 inhabitants, 3,000 of whom were adults (1962)
2. With approximately 100 manufacturing operatives employed in mechanized factories each factory employing 5 or more operatives; At least a total of 100 of the operatives must be employed in establishments processing and/or fabricating raw material(s)
3. Located either on the railway network or in an area of either high or medium road density.

Athi River town fits well in this definition as there are over 10,000 people, it is located along two high density roads - Mombasa - Nairobi road and the Great North road and also along a railway line, most factories are highly mechanized in processing and manufacturing and factories like KMC and E.A Cement factory both employ over 100 operatives (employees). According to classification in terms of industrial status Athi River falls within significant towns of the country after Nairobi, Mombasa, Kisumu, Nakuru, Thika, Kitale and Eldoret.

As early as 1964/65 the order was as follows (see Table No.4)

Next page

TABLE No.4: The Industrial Role Of The Main Kenya Towns:

Position	Name Of Town	Industrial Shares%
1	Nairobi	28.9%
2	Mombasa	11.1%
3	Kisumu	3.4%
4	Thika	2.7%
5	Nakuru	2.4%
6	Eldoret	1.8%
7	Kitale	1.1%
8	Athi River	1.0%
9	Machakos	0.6%
10	Nanyuki	0.4%
11	Nyeri	0.3%
12	Naivasha	0.1%

Source: Industrial Role of Main Kenya Towns; Ogendo R.B. (1969)<sup>5</sup>

The above towns today share between them nearly 60% of Kenya's manufacturing and service operatives. However today some of these towns seem to experience faster growth than others (Thika and Athi River are good examples):

Secondary Factors Necessary For Industrial Development The Case Of Athi River Town:

By merely examining industries and their growth is not sufficient interms of understanding the potential for industrial growth of a town, hence the need arises to examine other facilities that go along to provide good atmosphere for industrial investment.

<sup>6</sup>  
Smith D.M (1971) in his theory of industrial location observed that, a part from the already stated factors of industrial location, other facilities are also vital in promoting the industrial growth of any town, among these are, access to social services, medical care, location of hospitals, location of recreational

facilities, police protection, educational facilities among others.

It is the purpose of this study also to examine the situation of some of these facilities with respect to Athi River Town.

#### Education Facilities:

There are two nursery schools, three primary schools and only one secondary school which is managed by the African Inland Church (A.I.C). These facilities are totally inadequate thus some children are transported daily by company buses or individual vehicles to Nairobi, an expensive and strainous undertaking indeed.

#### Medical Facilities

There is one dispensary, three doctors and no hospital. These facilities are very few to cater for the demand from such a huge population. Most of the time the dispensary lacks the necessary drugs and even when there are drugs it is too congested, a spot check during the course of this study as well as a discussion with the clinical Officer confirmed this. The private doctors most of the time are out of reach for the "common mwananchi" because they charge expensively for the services rendered. Most of the people travel to Nairobi or Kajiado hospital for treatment.

#### Housing Facilities:

These are not proportional to the industrial development. Some industries such as the East African Portland Cement factory and the Kenya Meat Commission have supplied most of their staff with houses, otherwise some workers from the various industries are transported daily from Nairobi.

The Council has 408 housing units 240 of which were constructed in 1955/56 by the former Nairobi County Council; These are however too few.

In 1970 the National Housing Corporation constructed 28 houses which were handed over to Athi River council in

facilities, police protection, educational facilities among others.

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In 1970 the National Housing Corporation constructed 28 houses which were handed over to Athi River council in

1978 . The same N.H.C. is planning to develop 148 service plots located at the southern boundary.

Today about 18% of the urban population live in unauthorized settlements containing approximately 190 units.

#### Shopping Facilities:

The town has two trading centers, Mavoko and Makandara and many Kiosks scattered all over the town. The town has more temporary kiosks than permanent shops. Most of the shop owners do not even have title deeds hence most shops are not fully developed. Most people do their shopping in Nairobi. A close comparison with Kitengela which is a shopping center about 2Km. from Athi River showed that most people have put up permanent buildings because they have title deeds to their plots. It is clear that these types of facilities do not offer the kind of service and goods which most people working in the industries need, a reason that could explain why most people do their shopping in Nairobi.

#### Recreational Facilities:

There are no public playing grounds nor any other recreational facility. The few playing grounds found there belong to the primary schools and are poorly managed. Kenya Meat Commission and East African Portland Cement have provided their staff with sufficient sporting facilities, but these are restricted to respective employees of the same companies thus the public has no access to them.

#### Banking Facilities:

For a long time the town has had no banking facilities except to rely on the postal saving bank which is too small to cater for the need. Hence most of the people have to depend on distant banking facilities, Nairobi and Machakos.

About a year ago the Standard bank opened a branch there, which is hoped will attempt to offset the problem.

It is clear that all these facilities discussed are inadequate and inconsistent with the rate of industrial and population growth, there is therefore the need to augment them so that the favourable industrial atmosphere is satisfactory.

Information On Earnings And Employment -Athi River Town

TABLE No.5: Wage Employment By Industry In Athi River Town

Sector	1972	1980
1. Agriculture and Forestry	15	-
2. Mining and quarrying	40	9
3. Manufacturing	1,255	2,554
4. Electricity and Water	3	-
5. Construction	8	71
6. Wholesale, retail trade, Restaurants and Hotels	30	20
7. Transport and Communication	12	26
8. Finance Insurance, real Estate and Business Services	7	-
9. Community, Social Personal Services	132	302
10. Total		

Source: C.B.S/Min of Finance and Planning.7

TABLE No.6: Earnings By Industry In Athi River  
Town K

Sector	1967	1972	1982
1. Agriculture and Forestry	-	3.0	-
2. Mining and Quarrying	1.8	13.1	3.3
3. Manufacturing	469.6	434.8	2,013.4
4. Electricity and water	-	3.4	-
5. Construction	-	2.3	36.4
6. Wholesale and retail-trade, restaurants and Hotes	2.8	6.8	8.3
7. Transport and Communication	4.7	0.7	19.8
8. Finance, Insurance, real Estate and Business Services	-	36.7	-
9. Community, Social, Personal Services	23.9	33.2	137.1
10. Total	502.8	534	2,218.3

Source: C.B.S/Min of Finance and Planning. 8

Summary Of The Primary Factors Influencing Industrial Development In Athi River Town.

From the above analysis this study has identified the following factors as being the most significant in influencing industrial development in Athi River Town.

1. Communication
2. Land availability ✓
3. Proximity to Nairobi
4. Industrial linkage and interdependence
5. Raw materials ✓
6. Water
7. Labour
8. Government Policy

Communication:

Accessibility is very important towards the development and expansion of any town or any place. Athi River in

this respect is well served both by road, rail and to some extent by air as Jomo Kenyatta International airport is about 20Km. from the town. The famed Mombasa - Nairobi railway line passes through the town while two major roads the A104 Nairobi Mombasa road and the A109 Namanga road both pass at the town. This excellence in communication network is a great attraction to would be industrial developers.

#### Land Availability:

The Athi River town Council has already proposed an expansion of its land from 960ha. to 51400ha. Their strong point in doing so was that the council had noted the recent industrial expansion of the town and having assessed the industrial potential it was felt more land should be earmarked for the town.

This study observed that although land for industrial development is not a constraint at the present moment there is need to earmark more land for the purpose of industrial development and future growth of the town as the council has proposed.

#### Proximity to Nairobi:

This nearness to Nairobi has two distinct advantages toward the industrial development of Athi River Town.

1. This nearness accords Athi River town a ready large consumer market for most of its products
2. This nearness has made Athi River to be a satellite town of Nairobi a position which is likely to benefit the town in terms of investment; As Nairobi gets more congested it is becoming more hard to acquire land for industrial development and most investors are likely to resort to Athi River which is a mere 18miles for their industrial development purposes.



## Industrial Linkage and Industrial Interdependence

These factors have become very important in determining the industrial expansion of any industrial town. As one industry develops several other service industries emerge to service the former industry. This is becoming more of a reality with respect to Athi town; A good example is Kenya Meat Commission; its development has induced a lot of activities and development of the livestock industry. K.M.C has further led to the development of other secondary industries such as Double Diamond Tanneries and Athi Leather works which specialise in products from KMC; presently the construction of Nova chemicals which is going to specialise in animal drugs is under construction; its role in servicing the livestock industry and therefore KMC indirectly is important. Banking facilities have also started to emerge to take their talks of allocation of investment and the town in general.

### Raw Materials:

Availability of Raw materials has a primary role to play towards the establishment of certain industries in any town, it is not however true that all industries are located where they are due to availability of raw materials on the spot. Some raw materials can be brought from far. In Athi River however, the role of availability of raw materials in influencing the development of certain industries cannot be underrated. Industries which are benefiting from availability of raw materials in Athi River include:-

The East African Portland cement factory whose source of certain basic raw materials is within Athi River town. Other industries include the Athi Leather works, the Double Diamond Tanneries, and to some extent KMC most or some of their basic requirements in terms of raw materials are met within or around the town. Industries which are likely to emerge or expand as a result of availability of raw materials in Athi River town and its environs include:- the construction industry, the quarries which will benefit from the availability of building stone,

the timber Industry which may benefit from the development of the B.A.T. company forest plantations, the tourism industry if the Nairobi National Park is extended to include the Kitengela Game reserve and the availability of land and water which are basic natural resources is likely to attract more industries.

#### Labour:

Athi River like most other industrial towns in Kenya is experiencing an influx of rural migrants who flock to the town anticipating to get some wage employment. Most industrialists have taken advantage of this labour as observed they employ casual labourers on weekly basis and keep a skeleton staff of few skilled personnel.

#### Government Policy:

The Government Policy on Industrial development for the plan period between 1979-1983<sup>9</sup> and 1984-1988<sup>10</sup> lays great emphasis on industrial decentralization or as the plans call it "geographical industries dispersion to intermediate sized towns and rural centers"/ The plans also talks of investment allowances to would be investors. These factors are likely to see Athi River gain more industries particularly in view of the other factors discussed above which give the town better prospects than possibly other centers which are constrained in these factors.

#### Water Availability:

The availability of water is very important for industrial development. Some industries need to use a lot of water. The location therefore, of industries with high water demand must be affected by the proved availability of water in the right quantity and quality. Earlier analysis on water resources of Athi River town indicate a shortfall in water supply for both industrial and domestic purposes; This shortfall is likely to affect development of Athi River town in futures.

## The Environmental Implication Of Industrial Development

Industrial development is recognised as a basic and a necessary tool, for the development of the economy of any country; but even this being the case there is need to strike a balance between industrial development and environmental protection. Some industrial ventures have left irreversible environmental problems while others are only reversible at a very high cost.

Many examples of environmental abuse exist today in our contemporary world, among these the most pervasive include include, acid rains, smogs, gas leaks, oil spills, unrehabilitated mines and quarries, air and water pollution, particulate and gaseous discharges into the atmosphere and industrial dumping among others (see specific Examples in Literature review: Chapter 1)

Kenya is a developing country where the development of ] industries has been fairly fast over the last few decades. Today the few studies which have been done on industrial development and the state of the environment have given clear indications of the emergence of environmental problems as a direct result of this development of industries (see Example in Literature Review section)

In view of these problems this study considers it necessary to examine the Kenya Government policy on Environmental and Industrial development in the following section.

### Kenya Government Policy On Environment and Industrial Development

This is spelled out in the current Kenya Government development covering the period 1984-88. This dev. plan states "The main concern with environment at this stage of our development is to control human behaviour so as to achieve a balance between the development needs of the nation and the enhancement and protection of the environment.

The plan further points out that due to shortages in resources necessary to rehabilitate areas that have already suffered damage, then emphasis will be put on the strengthening of the institutions necessary for assesment and monitoring of environmental changes that are likely to be harmful in the future.

Also within the same framework of environmental protection Cap. 133 section 24 of the Laws of Kenya on Townships and specifically on the aspect of pollution of water supply; states "Any person who shall

- a) bath in any stream, reservoir, aqueduct or other place containing water belonging to the water Authority or wash, throw or cause to enter there in any animal
- b) Throw any rubbish, dirt, filth or other noisome thing into any such stream, reservoir, aqueduct or other place as a foresaid, or wash or clean there in any clothes or other things;
- c) Cause or permit the water of any sink, sewer, drain, steam engine, boiler or filthy water for the control of which he is responsible to run or be brought into any stream, reservoir, aqueduct or other place as a foresaid or shall do any other act whereby the water of the Water Authority is liable to be polluted; shall be guilty of an offense and shall be liable for any costs or damage that may have been suffered through such offense and shall also be liable to the penalties laid down by the rule.

Section 50 of the same Chapter (133) of the laws of Kenya spells out such penalties and it states that "Any person convicted of any offense against these rules shall be liable to a fine not exceeding one thousand shilling or imprisonment for a period not exceeding six months or to both such fine and imprisonment.

The Ministry of Water Development of the Kenya Government has proposed a water pollution control questionnaire outlining antipollution measures and effluent discharge

standards for factories. In the case of new factories or extensions of existing factories information on the following points is needed prior to the commencement of construction work.

1. A map showing the proposed site of the factory and the surrounding area on an appropriate scale.
2. Technical drawings of the factory layout including water supply and sewage
3. A detailed description of all the different industrial processes to be carried out : indicating the quantities, nature and chemical composition of all raw materials, intermediate substances and by-products and a material balance flow diagram should be provided.
4. Quantities of waste water produced and the expected physico - Chemical characteristics which may be obtained from simulated operations.
5. A flow-scheme indicating the different streams of waste water proposed pretreatment/ treatment process, storage recycling, daily volumes and fluctuations.
6. A description of the proposed methods for handling any solid wastes and/or from the industrial process and effluent treatment system.
7. The proposed safety precautions for the storage of oil and chemicals
8. The number of employees, daily shifts, and number of working days per year. Indicate also whether there will be a staff canteen and indicate the method of domestic waste treatment.

Although the Government Policy seems plausible enough when the above points are taken into consideration in

their totality, yet the problem does seem pervasive. The main problem is that we lack the institutional capacity to handle the problem and even at times the will to deal with the problem. There are just not enough technical experts to deal with the problem, and too, there appears to be a lot of laxity on many factories most of which are foreign owned hence much concerned with maximization of profits with little regard to environmental protection. Many factories do not seem to follow the procedures laid down by the Ministry of water pollution control Questionnaire.

The policy does not seem clear as to who will monitor noncompliance of the regulations set and consequently enforcement of the act. Indeed water pollution is just but an aspect of the whole problem of environmental abuse and mismanagement. We need a detailed comprehensive Environmental impact Assessment report if we are to be justified in saying the Kenya Government policy on Environment is clear.

The policy however as a result of continuous combined efforts from many establishments such as U.N.E.P, Kenya Non-Governmental Organizations, (KENGO) National Environmental Secretariat (NES) and many conferences, seminars and workshops on environment being held in the country seems to become clearer each day: There is yet a lot to be done in this respect. For example, at the moment there are no universally accepted pollution control standards for all the factories in the country; as indicated earlier the country relies on British standards which are highly questionable due to environmental differences between Britain and Kenya. (GOK/UNEP/UNDP; 1981: Project Report on Environment and Development Vol.2 of 3)

The policy further emphasises industrial dispersion into intermediate size towns and rural areas and again there are no sound environmental policies which are laid down which different types of industries ought to follow. The policy appears rather general hence the

need to redefine it, to give specific guidelines which specific industries should follow, to formulate special industrial discharge rates and to spell out punitive measures for non compliance.

#### Summary of the Chapter

The analysis of this chapter has clearly revealed that the industrial growth potential for Athi River town is indeed great. The analysis has clearly shown that within the next two decades Athi River will grow into a major industrial complex with every possibility of linking up with Nairobi to form a major metropolis. The analysis was able to reveal major problems such as shortages in water, housing, recreational facilities among other factors which may affect the rate of this rapid industrial development.

In view of these problems and others identified in the chapter, recommendations will be made in chapter six indicating how to overcome some of these problems and make the climate for investment even more conducive to prospecting industrialists.

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### CHAPTER 3: Kenya Meat Commission(K.M.C.)

This chapter examines the production of meat at the Kenya Meat Commission factory at Athi River town. The chapter is divided into three subsections; the first deals with the whole process of meat production at the factory stage by stage, starting from examining the sources of the raw materials (Livestock) to the final stage of marketing. Some introductory remarks about the nature of the meat industry in the country precede this analysis.

The second section of the chapter gives a special emphasis on the environmental consequences and in particular gives special considerations on the environmental problems that accrue from the various processes associated with meat production in Athi River Town. The final section gives a summary of the two sections above and in particular highlights the main environmental problems.

#### Some General Information On The Nature Of Meat Industry:

The meat industry in Kenya is based on the rearing of cattle, sheep, goats, pigs and poultry mainly. The Ministry of Agriculture and Livestock development within the Kenya Government and in particular the livestock division is charged with full responsibility of ensuring development and proper management of the livestock upon which the meat industry is based.

Three significant things are important for a successful meat industry; sufficient water, sufficient grass and disease free animals. Drought can be more damaging to livestock than disease.

Last year (1984)<sup>1</sup> drought alone claimed the lives of more than 5 million cattle which was half the estimated cattle population in the Country (see table 7,8,9,10)

According to these tables which shows the disposal

of cattle, sheep and goats by various ways by province by the year 1979, drought claimed the lives of more livestock than any other factor. Unless, therefore, steps are taken to combat drought from the 1984s experience the country risks losing most of its livestock and this unprecedented high death rate can cause a considerable fall of beef production in future years in the country.

The major problem in planning for livestock development and improvement is the lack of accurate livestock census. The Ministry concerned has not been able to provide one since the 1960s. The 1984 Kenya Economic Survey journal estimates that in 1984 there were 10 million heads of cattle 5 million sheep and 8 million goats in the country.<sup>2</sup>

Looking back 18 years ago in 1967 Aldington and A. Wilson estimated the cattle population in the country to be 7.331 million heads.<sup>3</sup> It is thus impossible to come up with accurate figures even from the Ministry and this complicates the process of planning for livestock development.

Kenya's current development plan for the period, 1984 -88<sup>4</sup> has outlined several measures to increase and improve beef output.

1. Under the ranch and range development plans, cooperative ranches, grazing blocks and group ranches will be rehabilitated, better management and support services will be provided.
2. Existing livestock programmes in arid and semi arid areas like Baringo, Machakos, Embu, Meru, Isiolo, Turkana, Kitui, West Pokot, Elgeyo Marakwet and Ndeia-Karai will continue while new programmes for Laikipia, Taita, Taveta, Kwale and Kilifi will be set up.
3. More credit will be given to farmers and also better provision of fodder and veterinary services will be intensified

4. Improved extension service network and research into livestock programmes will be intensified.

Unless these measures are taken the future of our livestock and therefore our meat industry looks bleak.

TABLE No.7: Distribution of Livestock Numbers And Mean Per Holding By Animal Type By Province (1979)

Number (100)	Coast	Eastern	Central	R.Valley	Nyanza	Western	National Total
Cattle	4.3	78.9	24.8	723.7	85.3	73.7	990.7
Sheep	5.2	50.8	35.8	298.4	16.7	4.5	411.5
Goat	19.1	251.1	49.3	382.4	18.1	13.3	694.1

Source: C.B.S/Min. of Economic planning and Dev. Nov. 1981 (The intergated rural surveys 1976-79 Basic report.

As can be seen from the Table, Eastern Province and Rift Valley province were predominantly goat oriented than the rest of the provinces and the same appears the case also for cattle and sheep.

TABLE No.8: Distribution of cattle Disposals(1000head) By Type Of Disposal By Province 1979.

	Coast	Eastern	Central	R.Valley	Nyanza	Western	National Total
Live sales	0.6	3.9	0.9	54.5	6.2	4.3	70.2
Slaughtered	0.3	0.6	0.4	7.1	2.9	16.9	28.2
Given As							
Wages	0.0	0.5	0.0	1.2	0.9	4.0	6.6
Given As							
Gifts	0.0	1.0	0.0	4.5	1.5	1.8	8.7
Deaths							

This Table shows the disposal of cattle from intermediate Farms in 1979 and also shows that during that year half of the cattle disposals were due to deaths (mainly due to drought).

TABLE No.9: Distribution of Goat Disposals (1000head), By Type of Disposal  
By Province 1979

Live Sales	Coast	Eastern	Central	R.Valley	Nyanza	Western	National Total
Live Sales	1.2	27.2	0.0	18.6	1.0	0.5	48.5
Slaughtered	0.6	8.7	0.9	23.5	2.1	21.6	57.3
Given as Wages	0.0	0.4	0.0	0.0	0.0	0.0	0.4
Given as Gifts	0.1	2.9	0.0	0.9	0.3	0.0	4.2
Deaths	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thefts	0.0	0.6	0.0	0.2	0.2	0.1	1.1
Total	1.9	39.8	0.9	43.2	3.6	22.2	111.5

The above Table shows disposals of Goats by Province Unlike cattle and Sheep deaths did not significantly affect the Goat population in 1979.

TABLE No.10: Distribution of Sheep Disposals (1000head) , By Type of  
Disposal By Province 1979

	Coast	Eastern	Central	R.Valley	Nyanza	Western	National Total
Live Sales	0.3	3.9	1.2	23.0	2.0	0.4	30.7



	Coast	Eastern	Central	R.Valley	Nyanza	Western	National Total
Given as Gifts	0.0	0.2	0.0	1.3	0.2	0.1	1.7
Deaths	1.9	5.9	2.7	41.1	2.0	7.8	61.5
Thefts	0.0	0.1	0.0	0.9	0.1	0.0	1.0
Total	2.2	11.2	5.4	90.2	5.8	9.4	224.0

This Table shows disposals of sheep; like cattle half of the disposals were due to deaths (mainly drought) in 1976-79.

Source: CBS:/Min. of Economic Planning and Dev. Nov. 1981 (The Intergrated rural Surveys 1976-79. Basic Report

An Overview of the Historical Development of  
Kenya Meat Commission KMC

The Kenya Government policy on beef industry is largely vested on KMC the chief agent.

The historical development of KMC dates back to the early 1940s when the then Kenya Meat Marketing Board was established.

This marketing board which was to be the predecessor of KMC initially operated a slab house at Kamukuji in Nairobi. One early pioneers of the present KMC was Mr. Leibigs who during this early period slaughtered cattle for British soldiers fighting the second world war. It was not until the year 1950 that KMC moved to its present site at Athi River town. Actual slaughtering did not however start until 1953. Later in the year 1958 another important section of the factory, the canning plant was opened.

At present KMC has the capacity to slaughter on average 750 heads of cattle and 1,000 sheep and goats per day.<sup>5</sup> These figures are however subject to a lot of variations much of it being governed by the climatic changes.

During the course of this study it was observed that during dry seasons KMC is usually forced to stretch its slaughtering capacity of 1,000 cattle per day. During the course of the research the country was experiencing one of the worst spells of drought (June-October, 1984) KMC was thus forced to exceed its slaughtering capacity to over 1,200 heads of cattle per day.

Theoretically KMC encompasses five branches; Mombasa Eldoret, Nakuru, Kajiado, and Athi River. The study is concerned with the Athi River branch which is the oldest and the largest in operation. Today however, of these five only three branches are in operation; these are Mombasa, Kajiado and Athi River.

The Nakuru branch could not meet the hygiene standard

required to achieve what is called the International Standard Certificate for export, a certificate necessary for the operation of any export meat oriented factory, it was thus closed down. Due to lack of sufficient local demand, the Eldoret branch had to close down since it was operating at a loss. Of the three operating branches only Athi River branch cater for the foreign market on top of catering for the local needs. Both Mombasa and Kajiado (Halal) branches cater for the local consumption the latter having being only opened recently (1984) after a long period of closure due to financial and other management problems.

#### Sources of Livestock

KMC gets most of its livestock from many parts of the country. The Rift Valley Province, Eastern Province and North Eastern Province provide most of the cattle. The leading districts are Kajiado, Machakos, Nakuru and Uasin Gishu. Most of the small stock (sheep and goats) come from the Eastern and North Eastern Provinces.

#### Method Governing Buying of the Livestock

This is considered a very important aspect for KMC operations because of three reasons;

1. The Method ensures that livestock delivered to KMC factory is free from disease contamination which can be harmful to consumers.
2. The Method ensures that during the process of transportation and depending on the mode of transportation no disease infected animal is transported and thus risking the possibility of passing the disease to other livestock it comes in contact.
3. The method ensures that farmers only transport the required number of cattle to KMC hence ensuring smooth operation at the factory.

To ensure that the buying process is well coordinated KMC has field officers, (called Booking Officers) in every livestock buying area. These officers are responsible for booking cattle from farmers to KMC. They do so by issuing special orders to livestock farmers instructing them the dates of delivery of their livestock to KMC.

The officers also ensure that the livestock are inspected and vaccinated against any possible disease infection. The farmer upon getting a booking order must also obtain a letter of clearance called "the movement permit", from the area veterinary officer showing his livestock are disease free and can thus be transported to KMC without fear of infection

At KMC a further health check is given on the livestock before slaughtering is done and even after slaughtering is done a further inspection is done on the beef to examine any possible internal infection.

#### Methods of Transportation of the Livestock

The method of transportation of the livestock depends largely on, 1. Preference or choice of the Individual farmer

2. Distance Involved

3. Health state and number of livestock involved.

Three methods of transportation are used by various farmers. These include rail, using railwagons; road using lorries and finally "hoofing method" which simply means the farmer walks his cattle to KMC.

This last method depending on the distance involved can subject the livestock to a lot of strain, exhaustion and even starvation. This may affect their weight and thus deny the farmer a competitive price for his livestock. This last method also entails a major environmental problem of soil erosion. During the course of their travel the cattle trample on the soil loosening it up thus leaving it for the rains to wash it away.

### The KMC Livestock Holding Grounds

In order to guarantee their daily requirements KMC has three holding grounds for 'reserve' cattle awaiting slaughter in case of shortage. These holding grounds are Bikoni ranch, Mackinon road ranch and Kitengela ranch.

While the livestock holding capacity was not officially determined it was clear during this research that these holding grounds are usually overstocked. Worse still these holding grounds act as 'open grounds' for cattle farmers who encroach into them with their cattle particularly during the dry season; or when they are at KMC awaiting to deliver their cattle to the factory for slaughter.

It was observed that these holding grounds have been overgrazed and highly impoverished as a result of the many cattle trodding on them. During the rainy season the problem of soil erosion becomes rampant. What makes the problem worse is that even during rain season since there seems to be no rigid control over the ground, grass never gets time to fully recover as there are constant herds of cattle feeding on it. There is no "resting" period. The problem of soil erosion has thus tended to persist over the years.

On the whole upto this stage the main environmental problems that one can identify are problems of soil erosion.

### Processing and Marketing

For the purpose of production KMC has three sections; the production section itself, the cannery section and the By products section, all however are concerned with processing of meat and other meat products.

The production process involves receiving the cattle from the farmers by veterinary officers who inter alia check whether the cattle have proper documentations, pertaining to movement and health. After documentation and health check the animals are put in open pens at the KMC "Boma". A procedure called 'mobbing' follows which involves individual farmers identifying their stock and

making arrangements to deliver them for slaughter. The animals are thus led to a knocking box where they are knocked unconscious using the captive bolt pistol. The animals are then put on a conveyor belt which slides to a muslim slaughterer who slits the animals throat. The process of skinning the animals follows after which veterinary officers give their final health check..The animals are then graded according to quality of beef and age and the farmers price determined. The beef is ready either for canning, or is in preparation for export to overseas markets

At the cannery section the most ideal meat for the purpose is lean meat which has little or no fat lining. At this section the first process is called boning the meat, where all bones are removed, after which the meat is cut to small pieces ready for mincing.

Mincing is followed by cooking after which the meat is separated from the soup and dried. It is finally ground and packed into small tins or containers. The tins are certified and sealed ready for the market.

The soup is further dried using hot steam to a thick fluid and put to tins ready for export. It contains about 80% protein, thus it fetches a lot of money. A tin of 16 Kilograms cost between 20,000-30,000 shillings in overseas markets.

The bones, the horns, skins, hides, hoofs, ears, tails, blood all find their way to the by products section.

By products are traditionally known as the "fifth quarter" of the animal because after processing the meat the remainder of the carcass is put to a very wide range of uses.

At KMC the bones, horns and hooves are crushed and processed to make various animal feeds.

The bone marrow is processed to make various tallow which are exported to form major constituents of the manufacture of expensive soaps and perfumes.

The hides and skins are processed and exported through Barcelona in Spain the sole agent for European markets. The tails and ear hairs after sifting to different colours find their way to America, Europe and other parts of the world where they are used as wisks and as soft brushes for various uses such as for cleaning Laboratory equipments.

And finally the blood is processed to make various rich animal feeds.

On the whole, ater processing of all its products, KMC caters for three different markets;

1. The local market where it faces strong competition from small slaughter houses.
2. The European markets the main consumer being United Kingdom.
3. The middle East countries, Indian Ocean countries and Hong Kong. There is great potential for meat exports in the middle East countries. Statistics indicate that between 1970 and 1978 beef imports by these countries including live animals increased from 50,000 tonnes to 300,000 tonnes. Iran and the Gulf states the biggest market imported beef worth 7 million dollars in the year 1978 alone.

In summary the study observed a well organized and elaborate method of meat processing at the KMC factory at Athi River Town. On the whole at the factory the study observed no major environmental problems. It was however at the next stage, that of disposal of the various condemned animal body wastes and remains that serious environmental problems were observed with respect to the operations of this factory. It is the purpose of this study to examine these problems in details in the following section

## The Environmental problems Associated with Meat Production

This section as earlier indicated examines the environmental problems caused by the process of meat production at Athi River town. So far the problems of soil erosion have been discussed, this section will thus specifically concentrate on examining the environmental problems caused by bad disposal methods at KMC.

Some introductory remarks by Logie Gordon (1952) on smell related industries precede this discussion.

Logie (1952) observed that smell can cause a nuisance to other industries as well as to the general public. He further pointed out that industries with the slaughtering of animals, abattoirs, tanneries, bone and skin, glues and gelatine are all liable to produce quite repulsive smells, and they should only be allowed in special industrial zones as far as possible removed from housing. Logie further explained that under the Town and Country Planning Act 1947, a number of industries were listed as "special industries" which were regarded as being sufficiently noxious to warrant special precautions in their siting, among these is the Meat industry which is given class IX (Group D); for such industries it is imperative that planning permission be obtained first before their actual location.

Logie also explained that industry as an integral part of a town pattern should be so planned such that it does not interfere with the proper functioning of other forms of development, industrial nuisance often makes a healthy life impossible for people living near the factory; smell is categorized among such nuisance.

It is the purpose of this study to examine whether such problems as observed by Logie do arise at KMC at Athi River town.

### The Problems of Disposal At KMC

As one moves around Athi River town particularly during



evening hours, he experiences a highly objectionable and highly repulsive smell. This bad smell is intense particularly as one moves towards the Kenya Meat Commission factory which is situated at the extreme south west direction of Athi River town and also along Nairobi Mombasa road and railway line both of which directly serve this factory. This smell is experienced by people not only living within Athi River town alone but in the neighbouring areas such as Kijengela market which is about 5Km. away from the KMC factory.

During the production of meat at such a large scale as is the case at KMC certain animal organs have to be disposed off, such organs include, condemned beef, intestinal and stomach waste, infected hides and skin, unwanted blood fatty substances as well as any other organs deemed not fit for human consumption. These substances can be themselves a major source of repulsive smell if not properly disposed.

This section seeks to examine the problems of disposal at KMC, it specifically examines the areas of disposal and the methods of disposal as well as highlights views about people interviewed in connection with the problem, and finally the section seeks to examine the likely effects of this problem on Athi River residents and workers as well as other development functions and activities within the town.

#### The KMC Disposal Lagoons

These disposal lagoons are two in a series. The first lagoon contains a thick viscous slurry of settled animal waste while the second one contains mainly dark water which drains from the first lagoon.

These lagoons have been neglected for a long time and tall grass and other weeds have engulfed the lagoons on all sides. They have become a major mosquito breeding ground and as well a source of awful smell.

The state of these lagoons is indeed a health hazard.

All around the lagoons small scale vegetable farmer have established themselves and have greatly interfered with the lagoons to irrigate their small plots; as a result of this, slurry finds its way further down towards River Athi the main source of domestic and industrial water for Athi River town and its neighbourhood.

This slurry has formed a marshy area across Nairobi Mombasa road and this area emits a very repulsive smell which is a great discomfort to motorists and pedestrians

During the course of this study two other major observations were made in connection with these disposal lagoons; it was observed that there is no treatment method applied to these lagoons . It is expected that aerobic and anerobi processes will break down the substances. But apparently since the residue is not dredged out, these lagoons are filling up and thus continue to emit a very bad smell.

It was also observed that there is no form of protection or concern given on these lagoons. They are not fenced neither is there anybody to cut the tall grass around them. They are also not sprayed regularly to eliminate the mosquitoes which pose great danger to human health.

From the aesthetic point of view these lagoons are indeed an eyesore to any person passing by. They are indeed a complete contrast of the smooth meat production process one observes at the factory itself. There is therefore every need for proper measures to be taken with respect to treatment and maintenance of these lagoons is concerned if the welfare of the town residents, workers and visitors is to be safeguarded.

#### The KMC Disposal Pit

Ideally, KMC is supposed to have a pit or series of pits which serve as a burial ground for all condemned and rejected meat and other meat remains such as infected intestines, liver, hides and skins bones and other animal remains

The present burial site is located about  $\frac{1}{4}$ Km. away from the KMC residential quarters, KMC market, Athi River AIC church and secondary school, Sophia Estate, Makadara Estate and the muslim quarters. Other activities close to this site include the chiefs camp, the police station, the Athi River slaughterhouse, the council Nursery school and the proposed site and service housing scheme. (see Aerial photo Plate No. 1)

Although this area is supposed to have a proper pit or pits during the course of this study it was observed that the present burial ground has nothing close to what one would call a pit. Since the pits initially dug have been filled up KMC today digs trenches and small furrows for burial purposes. About an area of 2 acres is covered with such furrows which are dug and covered on regular basis.

A number of observations were made concerning the present burial site; that this area is today a dumping ground rather than a burial ground, alot of unburied carcasses can be seen littered all over the place. Many vultures and dogs can be seen devouring the decaying unburied animal remains.

It was also observed that the present burial methods are completely unsatisfactory. There is no pit dug for the purpose and the trenches and furrows dug are very shallow hence dogs and vultures find no difficult in unburying these remains. It was also found out that the state of this area is made worse by some illegal businessmen who have established themselves firmly at the area where, with prior arrangement with some KMC men they come and unbury the hides, skins and bones for sale in Nairobi and thus leave the decaying animal remains in the open. This burial area has thus become the major environmental hazard and a potential health risk as thousands of flies breed here and these could easily spread diseases to the town residents and workers.



PLATE NO. 4 ABOVE: A ghastly scene of decaying and decomposed  
PLATE NO. 5 BELOW: cattle. The problem of disposal



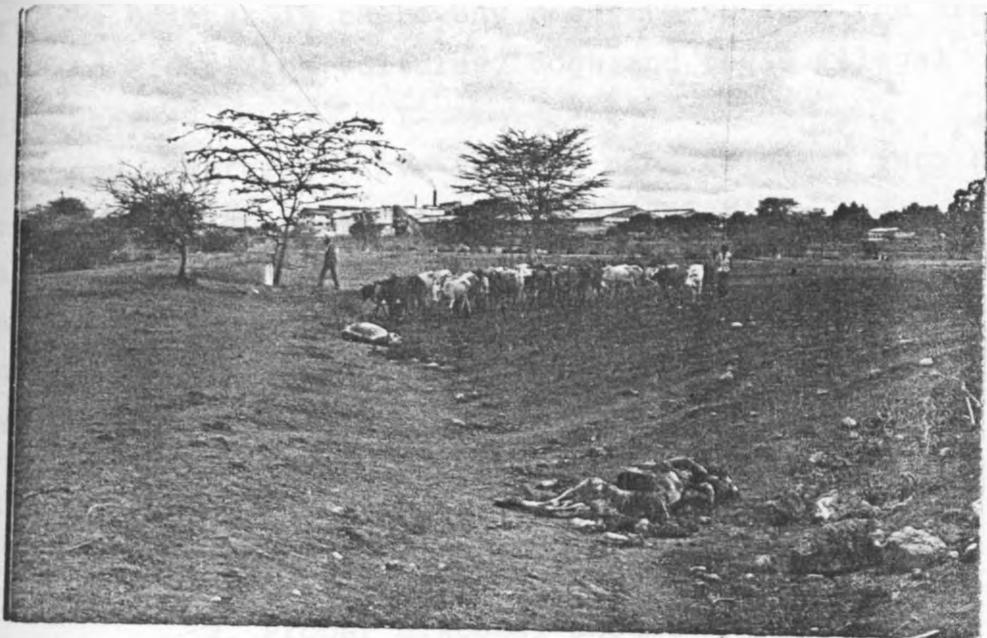
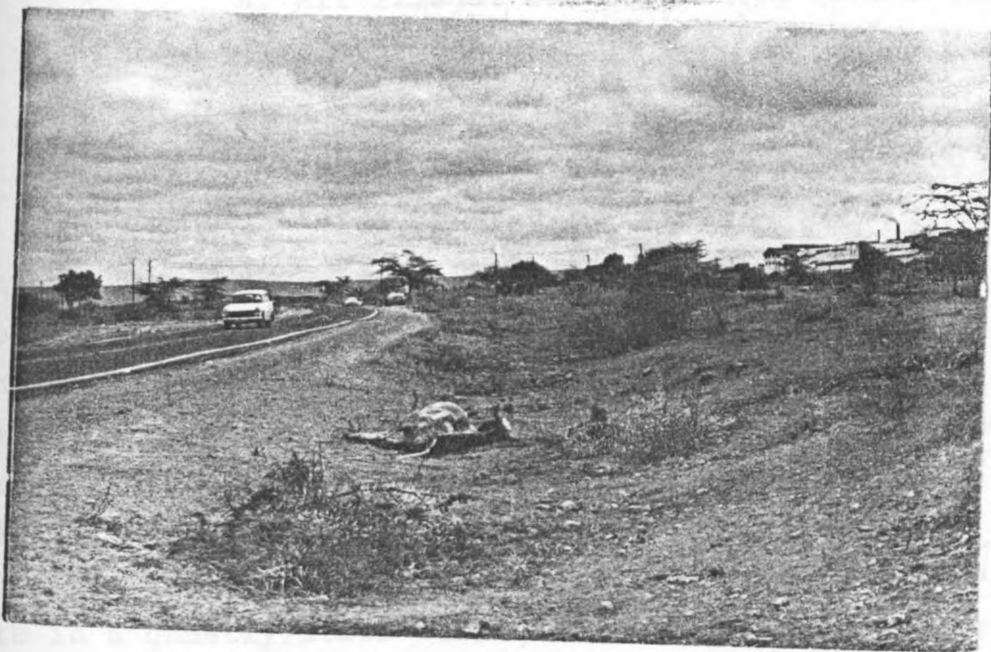


PLATE NO. 6. ABOVE: The grim face of death, a psychological torture  
 PLATE NO. 7. BELOW: to famers, motorists and live cattle



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It was finally found that there is no maintenance done at the site. There is no fence to protect the area from intruders neither is there any security to keep the area clean and clear from vultures, dogs and these illegal businessmen.

In summary, therefore five factors need to be taken into account when examining the practical solutions and possibilities of making this burial site a proper and ideal burial area which does not interfere with the smooth running of the rest of the activities in the town.

These factors are and

1. Ideal location of the burial pits further away from residential and industrial area,
2. Proper disposal should be done, a proper pit to be dug
3. Proper fencing of the area, and a guard posted to protect the area.
4. All illegal businessmen be banned from the area and
5. Some personnel be appointed to ensure all animal remains are properly buried and flies sprayed.

This study also found out that apart from these two sources of smell, the lagoons and the burial ground there was yet another third source of bad smell. This smell is caused by dead animals (cattle) lying unburied around the town. These animals are skinned by the illegal hides and skins businessmen and left for the vultures and dogs to do the finish. These animal remains are in a ghastly state having been half-devoured and emit very repulsive smell (plates No. 3-8 show women drawing water next to the animal remains)

From these observations it is clear that the disposal methods used by KMC are quite unsatisfactory and thus as a result contribute greatly to the bad smell one experiences in the town, Unless appropriate measures are

taken this bad smell will continue in the town much to the detriment and comfort of the town residents, workers and visitors alike.

In view of these observations a number of interviews and discussions were held with some of the KMC management officials, council officials, the public health technician, the clinical officer of the town and some local residents to get their opinions on this problem. This study hopes by examining and highlighting some of the opinions expressed during the course of these discussions will help in revealing more insights concerning the problem and thus provide a solid framework for policy recommendations and proposals later in the study.

Views by KMC Management (Factory Manager and Food Technologist):

The two were of the opinion that smell is part and pertinent of the whole process of beef production. They however, expressed their view that KMC was doing its best to ensure that its health standards of beef production were high.

On disposal both agreed that with the increasing number of cattle slaughtered daily (about 1,000 cattle and 1,000 goats and sheep), and with much pressure from farmers for service and repayment problems certain areas have gone without much attention. Both conceded that the disposal lagoons had be greatly interfered with by farmers. Apparently these officials felt the work of spraying the lagoons should be left to the town council public health section.

Concerning the location of the burial pits both agreed that this area was sought recently as an alternative when the old site got filled up; there has been no time to dig a deep proper pit. This would be done in due course.

From the discussion with these officials it was clear that disposal is not given enough attention as the other processes of meat production at KMC. It was clear that



the company was not thinking of looking for an alternative burial site neither was it thinking of better disposal methods both at the lagoons and at the burial site. The company had no immediate plans to fence these areas leave alone 'incurring' costs in employing a security man.

On the whole however whether KMC does perceive the problem or not, it is clear to the study that the disposal methods of KMC pose major environmental problems to the town residents and workers alike both in terms of their comfort and therefore the working atmosphere and as well in terms of their health due to the mosquitoes and flies rampant in these areas. The study does thus content that there is every need to institute proper disposal methods; such as treatment of lagoons, dredging out of the slurry and proper pits to be dug and proper burial of the animal remains to be done among others.

Views by the town Clerk and the Public Health Technician:

It was felt necessary to get the opinions of the council officials as these are the guardians of the town, hence the town clerk and the public Health Technician were interviewed.

The town clerk expressed his view that the good welfare of the town residents was the single most important duty that the council was committed to. He however pointed out that due to financial and personnel constraints it has not been possible to achieve all that the council has set to do.

On health standards of the Town it was his conviction that the Public Health section was doing its best to maintain high health standards despite shortages of personnel, equipment and drugs. He further pointed out that the council views the disposal problem at KMC with great concern. He emphasised the fact that the repulsive smell from the factory was not only a source of great discomfort to the town residents and visitors to the Town but was also a source of great embarrassment and humiliation to the



council.

As a result of persistent complains from the residents the council had mobilized the public Health section to help burry and dispose any carcasse found lying around the town. He further cited a case whence the council had to go and spray the KMC lagoons to eliminate the mosquitoes, he pointed out that due to lack of drugs such as DDT the exercise could not be carried on a regular basis.

The Public Health Technician expressed optism that the health department would rid off the Town all the dead carcases, he however lamented that KMC was too reluctant to assist in burrying dead cattle found dead outside the factory premises. He termed the situation as temporary which would end as soon as the rains start. He shared the opinion with the Town clerk that the disposal pits were too near the residential areas and pointed out that the KMC should consult the council to recommend another site preferably further away from the residential areas.

He further explained that in 1983 the Health department took samples from the KMC lagoons for pathologenic analysis, the results were negative. He however pointed out that the disposal lagoons had become breeding ground for flies and mosquitoes and thus a potential health risk to the lives of the people. He stressed that his office had the mandate to take legal action where a certain activity by an industry, firm or individual threatened the lives of the public (No measures have been taken with respect to KMC).

Other officials interviewed were the clinical officer of Athi River who atributed the high rise of malaria, diarrhoea cases during the five drought stricken months to the increased number of flies and mosquitoes which he felt were increasing due to bad health standards of the Town; he cited the case of dead carcases and bad drainage as a possible course.

TABLE No.11: The Table below Shows the Number of Malaria and Diarrhoea patients from January to August.

Month	Malaria Cases	Diarrhoea Cases:
January	189	41
February	380	60
March	301	22
April	369	98
May	724	133
June	397	74
July	445	84
August	377	80

Source: Athi River Clinical Officer:

The month of May has the highest incidence for both cases. The clinical officer pointed out that this was the month when the Government issued a directive to KMC to buy as many cattle from farmers as possible the number of cattle deaths increased. He observed that this could have caused the high disease incidence .

The veterinary officer for the area expressed his concern that the dead carcasses unburied lying around the town were a potential health problem. He further pointed that his office had received information about illegal dealings of uninspected hides and skins upon which the police were informed and one culprit apprehended. He blamed these businessmen for uncovering the animal remains and also skinning of dead cattle and leaving them to decay in the open thus causing a bad smell and becoming breeding ground for flies.

Since public health revolves around the people it was also felt necessary to get opinions from the local residents of the town.

#### Opinions Of the Local Town Residents

60 resident town dwellers were interviewed from different parts of the town. About 100% of them pointed out that

the bad smell from KMC Factory was a great nuisance and a source of great discomfort to them. Most residents indicated that this smell was the cause of lack of appetite for food for most of them. They expressed their fears that some of the dead and uninspected meat could be finding its way to the town butchereries.

These residents attributed the smell to the bad disposal methods by KMC and the location of the burial ground too near the residential estates. They pointed out that KMC should relocate this burial ground to another area further away from residential areas.

They attributed the high incidence of Malaria and diarrhoea outbreak to these bad disposal methods which resulted to increased flies and mosquitoes.

#### Summary of the Chapter

This chapter has examined in length the process of meat production at KMC plant in Athi River Town. In this analysis special attention has been given on the environmental problems arising from the operations of this factory.

A number of major findings were made in this chapter;

- ✓ 1. The disposal process of KMC is unsatisfactory, thus constitute a major environmental problem, of air pollution,
- ✓ 2. The major pollutants are the decaying unburied and half buried animal wastes and animal remains?
- ✓ 3. There is no treatment method applied on KMC disposal lagoons.
- ✓ 4. Mosquitoes and flies have been on the increase thus pose a health danger to the town residents due to bad disposal methods by KMC.
- ✓ 5. Working and living conditions are made very uncomfortable due to the bad smell from KMC
- ✓ 6. KMC has no environmental protection policy.
7. Soil erosion has been accelerated due to over-

stocking at KMC grounds and thus constitutes another environmental problem

✓ These findings among others will be taken into account }  
when making recommendations later in this study.

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#### CHAPTER 4: The East African Portland Cement-Factory:

This chapter examines cement production process at the East African Portland Cement factory at Athi River Town. The analysis pays special attention to the environmental problems involved in this process both at the factory premises and at the quarries where various mineral resources necessary for cement production are mined. The first sections of the chapter give stage by stage of the cement production process, however this analysis is preceded by some general information about the evolution of the product cement. The later sections of this chapter concentrate on analysing the environmental problems. Views about various people interviewed in connection with these problems are also highlighted. Finally the chapter gives a summary of the major findings.

##### The Evolution of Cement, A General Perspective:

"Cement is a basic ingredient for modern construction, the lifeblood of development today" these are the introduction words of the East African Portland Cement Publication of 1980.<sup>1</sup>

Portland cement is the modern equivalent of a classic cementing material which has been used for a long time. Cement has been defined as a adhesive and cohesive material capable of bonding mineral fragments into a compact whole.<sup>2</sup>

The use of cementing material is very old, the ancient Egyptians, Indians, the Greeks and the Romans developed the art of using cementing materials by mixing impure gypsum or lime with crushed clay tiles or bricks and then with sand and crushed stone to form rudimentary concretes.

The Romans during these early days ground together lime and finely ground burnt clay tiles or volcanic ash to produce what is known as pozzolanic cement, which takes its name from the village of Pozzuoli near Vesuvius, where the ash was found. Some of the Roman

structures in which this material was used, including the Coliseum in Rome have survived to this day.

It was only in the 18<sup>th</sup> Century that Cement, as we know it today, began to be developed in a scientific manner. In 1756, John Smeaton became the first man to understand the chemical properties of clay. Producing the best mortar of the time by mixing pozzolana with limestone he rebuilt the Eddystone lighthouse of the Cornish Coast.

The development of other hydraulic cements followed, culminating in the patent for Portland cement taken out in 1824 by Joseph Aspidi a Leeds builder. In 1845, Isaac Johnson made the prototype of modern cement by burning a mixture of clay and chalk to form Clinker.<sup>3</sup>

The name Portland cement was given due to the resemblance of the colour and quality of set cement to Portland stone, a Limestone quarried in the Isle of Portland, Dorset, England. The name to this day is used to describe cement obtained by mixing calcareous and argillaceous or other silica, alumina and iron oxide bearing materials, burning them at a clinkering temperature and grinding the resulting clinker.

In his application for a patent in 1824, Joseph Aspidin saw a variety of uses for his cement or artificial stone for stuccoing buildings, waterworks, cisterns or any other purpose. At the time, not even the wildest visionary could have imagined the myriand uses which builders and engineers have found for the modern descendant of cement.

Today, the establishment of cement works is a first step in the establishment of a modern industrialized economy. In 1913, the total cement production in the world was 40 million tonnes.<sup>4</sup> The production by 1980 was over 800 million tonnes which shows the ever-growing importance of cement.<sup>5</sup>

Until the end of the First World war, over 85 percent of the world's cement production was concentrated in Western Europe and North America, over 50% in the United

states alone.<sup>6</sup>

Today more than 60 countries all over the world produce cement. Since the end of the Second World War, Cement production in developing countries has risen fifteen fold and they account for more than 20 per cent of the total world cement production.<sup>7</sup>

#### The Evolution Of Cement In East Africa:

In East Africa, Portland cement was first used in Zanzibar to construct the roof arches of the Cathedral church of Zanzibar in 1877.

The real need for cement was acutely felt in the construction of the Uganda Railway at the end of the last century. Cement was used in harbour foundations and in bridge and culvert building along the line. The railway was completed in 1902, however the need for cement did not end there, indeed, it became even more of a necessity with the opening up of Kenyas vast hinterland.

Administration, residential and commercial buildings had to be built and cement was the most effective material for the purpose.

In 1933 the East African Portland Cement Company was registered, it was however not a full fledged manufacturing plant, it was only a grinding mill which was set up in Nairobis industrial area to process cement clinker imported from England, this was a major milestone in cement production within East Africa because before 1934 all cement requirement were met through importation from Britain and India, then British-India colony.

In 1950, Dr. Felix Mandl of cementia Holding of Zurich visited Kenya with representatives of Almaganated limestone Company(UK.); and found development conditions favourable for the manufacture of good cement from the extensive coral deposits on Kenya's coastline, This led to the opening up of Bamburi Portland cement company in 1954. At the time Kenya's cement requirements were about 100,00 tones and Bamburi could meet that.<sup>8</sup> However the demand for cement soon surpassed the production capacity



of 120,000 tonnes per year.<sup>9</sup>

The Production of Cement in Athi River Town  
(The E.A.P. Cement Factory)

Brief Introduction

The Athi River Cement plant as the name suggests is located within Athi River Town along the Great North Road. It is situated about 50 meters to the boundary of the Nairobi National Park and is close to the Kitengela and Athi rivers both important sources of water for Athi River Town.

The factory together with its mining operations employs about 600 employees. During its initiation the factory had a capacity of 120,000 tonnes in 1958 when production started. In 1974 with the installation of a second Kiln the capacity rose to 250,000 tonnes a year and today the capacity is over 300,000 tonnes per year.<sup>10</sup>

Sources Of The Raw Materials:

The Athi River Cement plant gets its raw materials from a number of sources. Limestone and KunKur which are the basic cement raw materials come from Kabini Hill Quarry and Lukenya quarry respectively, Gypsum an important additive to the two basic raw materials comes from Bisil Quarry in Kajiado district about 30Km. away. And finally another additive called tuff comes from the Lukenya Quarry but at a site about 4Km from Athi River cement factory.

Transportation Of The Raw Materials:

There are two methods used for transporting the raw materials from the various sites; The first method is by road using Lorries, this is used for transporting KunKur from Lukenya Quarry and Gypsum from Emboloi in Kajiado district. The second method is by using the Nairobi-Mombasa railway line as used in transporting limestone from Kabini Quarry in Sultan Hammud.

Of the two methods the first method entails an environ-

tal problem; as the Lorries are usually overload they discharge alot of dust on the way which obscures vision for other motorists; ( Plate No.19 Show a typical example of such an overloaded lorry)

#### The Cement Making Process:

The basic constituents of Portland Cement are lime, silica, iron oxide and alumina . Lime comes from chalk or Limestone and Silica from clay or shale or KunKur. These two are chemically combined to manufacture Clinker which is then ground with volcanic tuff and gysum to form Portland Cement.

#### Preparation of Raw Materials:

The first stage is the winning and handling of raw materials. The raw materials at Athi River as indicated earlier are crystalline limestone and KunKur.

The limestone is blasted in the quarry, picked up by diesel-driven shovels and transported by dump trucks to a vibratory feeder. Larger rock pieces are reduced to convenient size by a larger primary jaw crusher before being transported to the storage bins via conveyor belts. Thereafter the rock is fed from the bins into specially designed railway wagons for transportation to the works at Athi River, where conveyor belts then carry it through a double hammer mill which reduces it to fine limestone and on to a stockpile.

Kunkur as indicated earlier is dug by front-ended loader and bulldozer at the Athi River quarry and transported by dump truck to the screening plant. The screened KunKur is conveyed to the loading bin from which it is loaded into tipping lorries for transport to the factory. KunKur too passes through the double hammer mill and on to the stockpile. Volcanic tuff and Gypsum both additives to the raw materials are likewise transported from site to the works

#### Cement Manufacturing:

This basically involves four stages namely slurry, clinker, cement and quality control. These are described in the following section.

### Slurry:

from the stockpiles, limestone and Kunkur are waded by cranes into separate hoppers each fitted with avairable speed device which feeds closely controlled quantities of the rawmill where raw materials are reduced to fine powder and warer is added. The resultant fine creamy liquid called slurry (an aqueous suspension ) is pumped from the raw mill into blending tanks.

It is then stored in large concrete basins, through which air is constantly pumped to keep it agitated, thoroughly mixed for pumping into the Kiln. Because all water in the slurry must be driven off in the 'Kiln, consuming heat in the proces, water content in the slurry is kept to the minimum needed to maintain its fluidity during pumping, blending and storage. Reduction of water content gives greater manufacturing efficiency.

### Clinker;

From the large basins, the fluid slurrv is pumped to two long rotary Kilns where it is 'burnt'. Slurry is fed into the higher end of the greater steel cylinder, continously rotating and travels slowly to the lower end where jet of furnace oil is injected

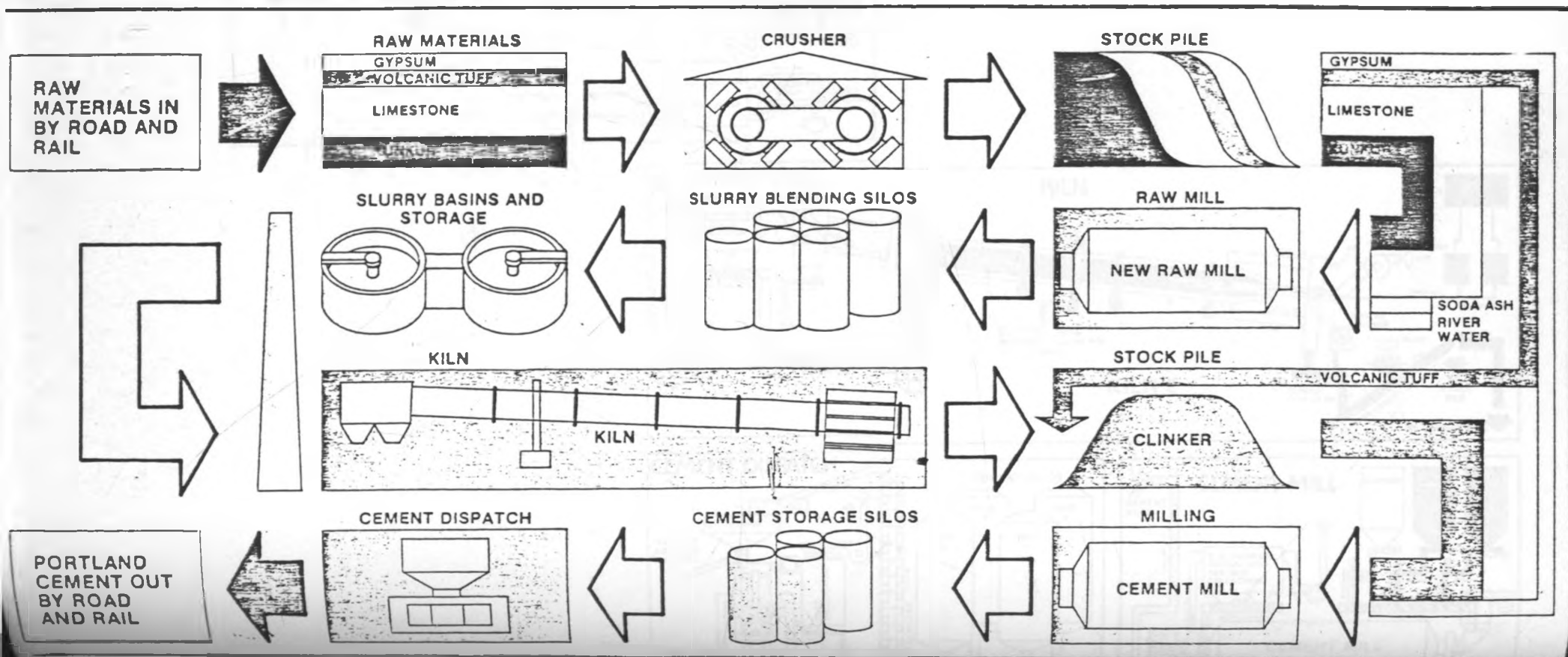
The upper zone of the Kilns is fitted with chains which transmit the heat to the slurry. It dries as it moves down the rotating Kiln, its water content being driven out in the form of steam. After it is thoroughly dried the material passes temperature ranging from  $800^{\circ}\text{C}$  to  $1,400^{\circ}$  as a result of which the oxides of calcium, silica, aluminum and iron combine to form cement clinker.

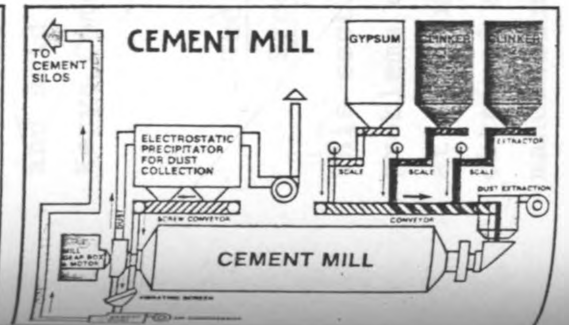
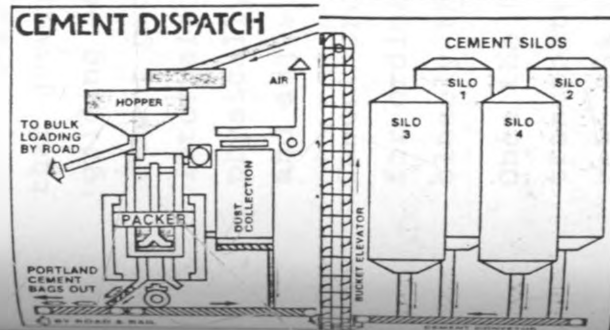
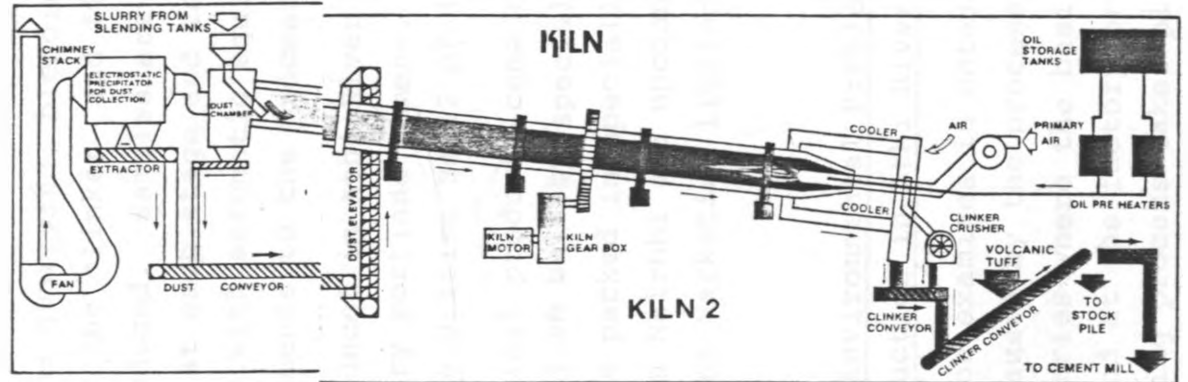
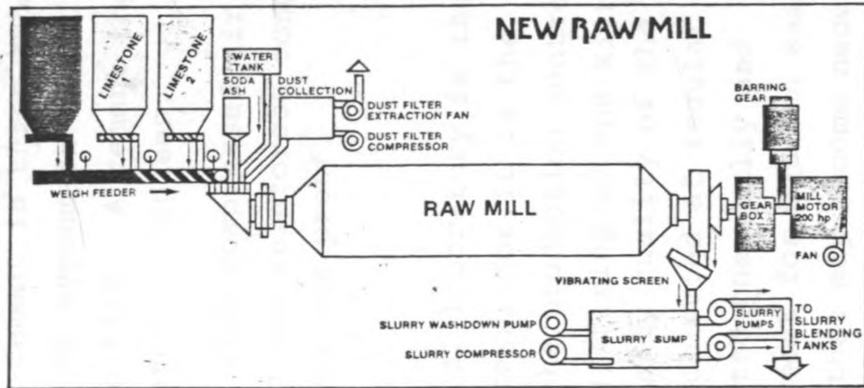
This is cooled by means of cooler installed by drab-chain conveyors to the clinker store.

### Cement;

while the production of clinker is round the clock process the production of finished cement follow seasonal fluctuation in market demand, since storage life of finshed cement is short. On the other hand clinker

# LOW DIAGRAM OF PORTLAND CEMENT MANUFACTURE AT ATHI RIVER—WET PROCESS





can be conveniently stored in large quantities to meet peak demands.

Clinker is ground into finished cement in three tube mills. At this stage small quantities of gypsum are added to control the end products setting time. A cement that sets too quickly is useless for commercial purposes.

The finely ground cement, mixed with compressed air is pumped through the pipeline into the reinforced concrete cement storage silos which are weather proof.

#### Quality Control:

At Athi River, the quality control laboratory is the key to the entire manufacturing process; for it is the laboratory analysis feedback to the production controllers that governs quarrying, blending, firing of the Kiln, grinding of the clinker and finally quality of the cement produced. Samples are collected at regular intervals at each stage and tested chemically and physically with automatic equipment for between sampling and adjustments to the process that may become necessary. Cement produced in Athi River conforms to the standard for ordinary portland cement. The Kenya standard follows closely the British Bs 12 of 1958.

Once the final product, cement, is produced 15% of it is transported in bulk by specially built tankers while the rest 85% is packed in specially manufactured paper bags and sold in Nairobi and upcountry centers. Kencem, the Kenya Cement Marketing limited is the selling organization.

#### The Environmental Problems Caused by Cement Production in Athi River town and its Neighbourhoods

This section examines in details the environmental problems caused by the process of cement production both at the quarries where the basic raw materials are obtained and at the factory premises where actual cement manufacturing process takes place. The analysis is

however preceded by some general observations made by some proponents of industrial development and environmental protection.

Helen and O.Church (1980) made the following observations with respect to industrial development:

"Industry makes a significant contributions to development; but while this development process bring about social - economic advancement, it need not be ecologically destructive"<sup>11</sup>

Lee Guernsey in his findings on the problems of Indian's abandoned coal minelands observed that, surface mining results in loss of capacity to support revegetation, reducing the future economic value of the surface. He further pointed out that the principal adverse environmental effects of surface mining can be on surface productivity surface and ground water quantity and aesthetics.<sup>12</sup>

<sup>13</sup>  
Logie Gordon (1952) made the following remarks in relation to the location of certain industries in towns.

1. A number of industries produce dust in the course of their operations, such as lime burning, asphalt, cement works----- . In such cases every attempt should be made to confine these industries to positions where their operations are unlikely to be prejudicial to adjoining industries and other development.

Under the 1947 Act on Town and Country planning is a list of "special industries" which were regarded as being sufficiently noxious to warrant special precautions in their siting; cement industry is one of such industries and is given class VI (GroupA).

2. Logie further pointed out that cement and quarry industries have a characteristic tendency to cause dust from various grinding operations and this should be borne in mind when such factories are sited in built up areas, and they should be

placed far enough away from housing and other development when dust would be a nuisance.

3. Logie finally observed that one of the main problems of cement manufacture, is that when a new site is suggested in a country there is often local opposition and even appeals, the objections raised are the bad effect of cement on growing crops, the spoiling of landscape, the digging of large quarries with consequent loss of farming land.

These summarise the environmental effects of cement production as, loss of farming land, spoiling of aesthetics, bad effects on plants, dust nuisance to other activities and developments.

These observations will be taken into account when examining the environmental problems caused by cement production in Athi River town and its environs.

During the course of this study two quarries, LuKenya quarry and Emboloi quarry were visited and extensively surveyed. Gypsum mining at the Emboloi quarry at Kajiado district had attracted the attention of a local journalist John Mugo of the Kenya Times Newspaper, formal discussions were also held with him and he was able to give a comprehensive view of the environmental problems at this quarry; later Mugo was able to accompany the researcher to this site; his views and observations are also included in this discussion.

Omondi (1984)<sup>14</sup>, Jari (1982)<sup>15</sup> had expressed their views about the dangers of the cement dust on wildlife and vegetation in the Nairobi National Park, their views are also incorporated in the study. Similarly discussions were also held with Chabeda a pollution expert in the National Parks and he too contributed to this analysis.

Fears had been expressed during the course of this study about the high mortality rates of goats and sheep at the nearby Kitengela small stock Unit; these deaths were being attributed to prolonged cement dust accumulation on the vegetation which these goats and sheep fed on.



Discussions were thus held with the officer incharge of unit; his views are also included in this analysis. It was felt necessary to examine all these views as they form the basis of recommendations formulation later in the study in view of the fact that it was not possible to carry actual sample analysis of these effects.

On the whole the activities of cement production both at the quarries and at the factory affect the environment in a number of ways. These effects will be examined in the following sections.

### Effects of Mining and Quarrying on the General Environment

The mining of cement raw materials like most other forms of mining operations involves removal of great amounts of soil and stripping off, of vegetation; in general it interferes with the natural environment, distabilising the existing situation and often setting in motion many changes some of which are detrimental and disastrous and at times irreversible.

At Athi River several observations were made with respect to the cement production process, mining and quarrying.

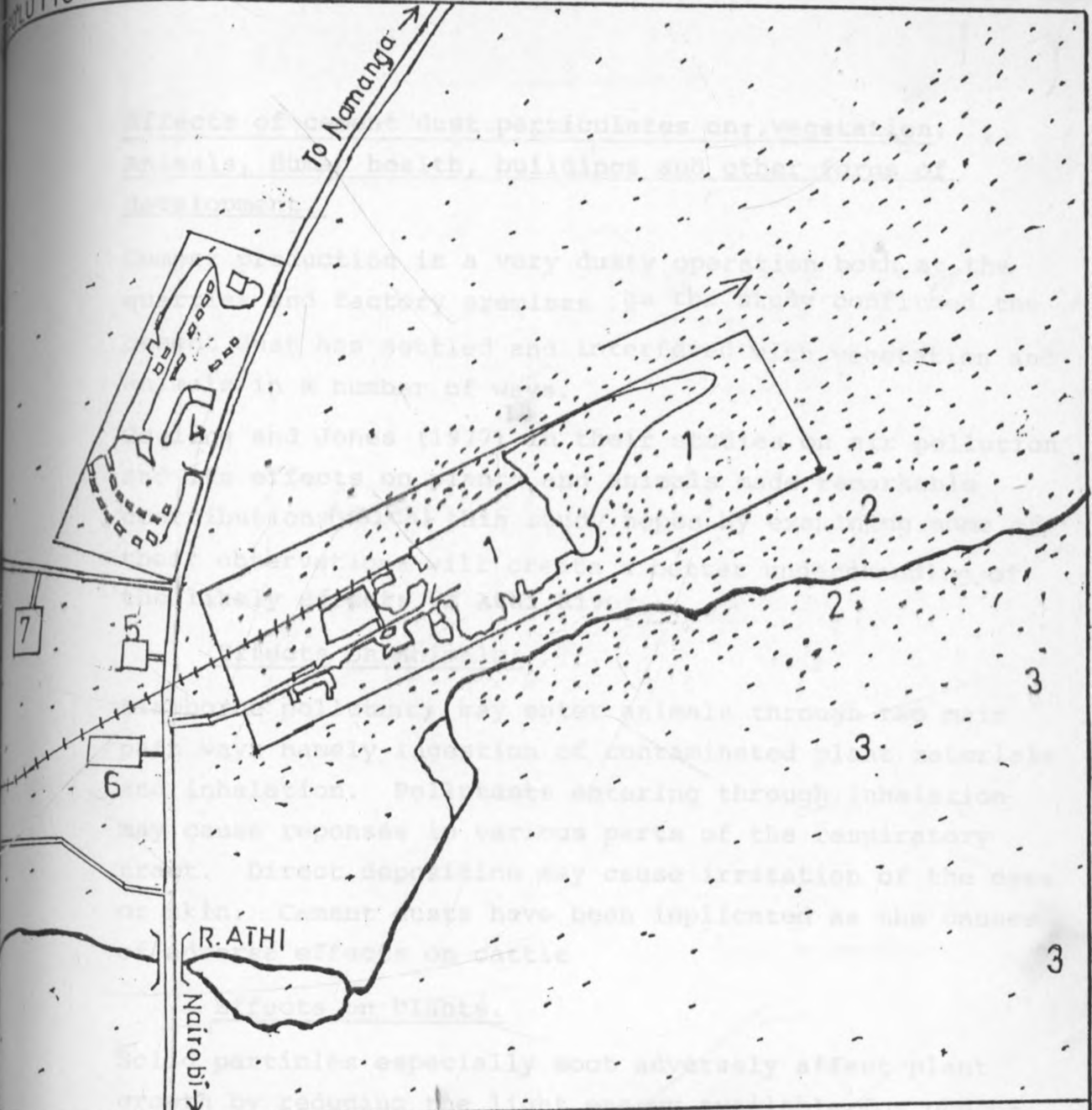
1. It was found that in all quarries the mining of various raw materials involves great interference with the landscape. The flat terrain has been completely changed and instead what exists are heaps of man made 'ridges' of barren soil where no vegetation grows. In all cases vegetation; trees and grass alike have been striped off
2. It was further observed that since the raw materials lie underground, in all cases the top soil which is rich in nutrients necessary to support plant growth has been removed to reach the resources. As a result therefore there is no vegetation and the area remain bear and barren. The aesthetics of the once flat terrain characterised by tall grass have completely been changed.

3. It was found that the extreme form of this environmental degradation and destruction was taking place at Embolioi in Kajiado district where the mining of gypsum takes place. With respect to mining, at this area Mugo, Kenya Times Newspaper journalist observed

"Mining here at Enkirgiri (Embolioi) is survival for the fittest as individual prospectors all equipped with the simplest tools to the most sophisticated machinery struggle to get as much as possible and yet with the most uncontrolled indiscriminate use of land; what was once Masai prime ranching grassland is now dotted by rock man made hills which only thorny scrub has managed to take root in patches. Here it is a question of financial gain not destruction of environment. The Masai is the land owner, the labourer and the loser, for as soon as the resources is depleted in one area the prospector simply moves and leases another area and the process of environmental destruction continues uncontrolled" (see photographs No.10-17 20, 21)

4. On the question of rehabilitation it was found no efforts have been made at Kajiado and Sultan Hamud. In the year 1984, however the East African Portland Cement Factory launched what it called "tree planting spree at Portland." Possibly from the influence of their counterparts the Bamburi Cement factory at Mombasa which has become a classic example in rehabilitation programmes of its quarries some of which have been made fish ponds, marine parks and active revegetation exercise carried using the famous tree species *Casaurina Estifolia*.<sup>17</sup> At Athi River however even after these initial efforts what one notes with dismay at Lukenya quarry are few drying trees which apparently nobody is concerned with. One wonders what happened to "the tree planting spree at Portland Athi River." Even if this spree was to be a reality young trees need care and protection until they mature, this concerted effort is lacking at Athi River Portland quarries.

POLLUTION BY EAST AFRICAN PORTLAND CEMENT FACTORY ATHI RIVER



SCALE 1:12000

- POLUTED AREA BY CEMENT DUST
- E.A.P. CEMENT FACTORY
- KITENGELA GOATS/SHEEP PROJECT
- NAIROBI NATIONAL PARK
- HOUSES FOR JUNIOR STAFF OF E.A.P.C.F.
- AUTO SPRING CO.
- ATHI LEATHER WORKS
- METAL CHLORIDE CO.
- WIND DIRECTION

P.K KYALO  
 DEPARTMENT OF PLANNING  
 UNIVERSITY OF NAIROBI  
 M.A THESIS 1984/85

 MAP NO.9

Effects of cement dust particulates on; vegetation, Animals, Human health, buildings and other forms of development.

Cement production is a very dusty operation both at the quarries and factory premises, as the study confirmed the cement dust has settled and interfered with vegetation and animals in a number of ways.

Cowling and Jones (1977)<sup>18</sup> in their studies on air pollution and its effects on plants and animals made remarkable contributions (which) this study hopes by examining some of their observations will create a better understanding of the likely effects in Athi River.

Effects on Animals;

Air borne pollutants may enter animals through two main path ways namely ingestion of contaminated plant materials and inhalation. Pollutants entering through inhalation may cause reponses in various parts of the respiratory tract. Direct deposition may cause irritation of the eyes or skin. Cement dusts have been implicated as the causes of adverse effects on cattle

Effects on Plants.

Solid particles especially soot adversely affect plant growth by reducing the light energy available for photosynthesis through the blackening of leaves and of glass-house panes which can make horticulturalists move to cleaner areas. Soot and fine dust may also interfere with gaseous exchange in plants by blocking the pores of the stomata.

Cowling and Jones further pointed out that cement dust can cause direct injury to plants. This has been attributed to the dust falling on wet leaves forming alkaline droplets which saponify the protective cuticle and penetrate and injure the underlying palisade cells.

Deposits of various solids on soft fruits and vegetables, such as lettuce, cauliflower, may be sufficiently obvious

an objectionable to reduce their market value or to require the grower to incur extra costs in preparing them for the market

#### Effects on Human Life

This can be direct or indirect. When man drinks contaminated water, eats contaminated food or inhales polluted air or the harmful industrial material enters his body through the skin are direct effects. The effects can also be indirect as when dust settles on man's buildings, rooftops, windowpanes, clothes and vehicles making him incur extra expenses to repaint or wash. Parker (1978)<sup>19</sup> observed that the smaller grit and dust particles penetrate houses and other buildings through open windows, crevices and ventilators and are deposited on floors, walls, ceilings, furniture, curtains and other materials. These deposits increase the labour and costs and decorations. They frequently contain sharp, gritty matter which causes scratches and other damage. If the grit and dust impinge on freshly painted surfaces they stick to and damage the paintwork and reduce the period before repainting is necessary.

It is appropriate at this stage to examine the effects of cement dust particulates with respect to Athi River town.

#### Effects on Vegetation and Wildlife:

Jari (1982) and Omondi (1984) both observed that the dust particulates from the East African Portland Cement factory has greatly interfered with the wildlife and vegetation. Both have pointed out that a lot of cement dust has accumulated on the leaves of the vegetation and in some places the vegetation has lost its green colour and exhibit signs of withering.

Omondi observed "the Athi River cement plant located only 50 meters from the boarder of the Park contributes quite significantly to the poisoning of the wildlife and vegetation inside the Park."<sup>20</sup>

Information from the Wildlife Planning Unit of the National Park has indicated a shift in wildlife movement from the area near the dust fallout, also high mortality rates were registered.

Discussions with officials from the Kitengela goat and sheep unit which is next to the cement plant also revealed the unit has been experiencing high mortality rates after constant attacks of pneumonia. These deaths though results from the laboratory analysis have not been made available have been associated with continuous accumulation of the dust on the vegetation which the animals fed on. The Athi River Divisional Veterinary officer also shared same opinion on the cause of these deaths.

Personal observations showed that this dust covers quite an extensive area, it covers most of the Athi River town, the Kitengela area, the National Park, the ranching areas around, and goes as far as Athi River prison.

A number of horticultural farmers along River Athi were interviewed and they expressed their concern on the amount of dust that is usually found on their vegetables. They pointed out that their vegetables have developed coarse leaves and need alot of time to wash and cook. Usually the leaves of the vegetables have developed yellow patches and generally look retarded. The researcher however lacked the technical skills required to carry analysis and establish whether these patches were associated with cement dust in anyway; the area Agricultural officers should however do so.



PLATE NO. 16: ABOVE.  
PLATE NO. 17: BELOW.

Water marshes formed by mining of cement raw materials. Now a threat to Wildlife, livestock and human life. Also potential breeding ground for mosquitoes.







PLATE NO. 20: What was once prime flat ranching land is now dotted with man made hills and water marshes, (insert women wash with the water.



PLATE NO. 21: The masai is the labourer, the land owner and the loser. This land was once his pride, tall grass and flat terrain.





PLATE NO. 22: Part of the advanced technology used at the quarries. Similar efforts are needed in rehabilitation programmes.

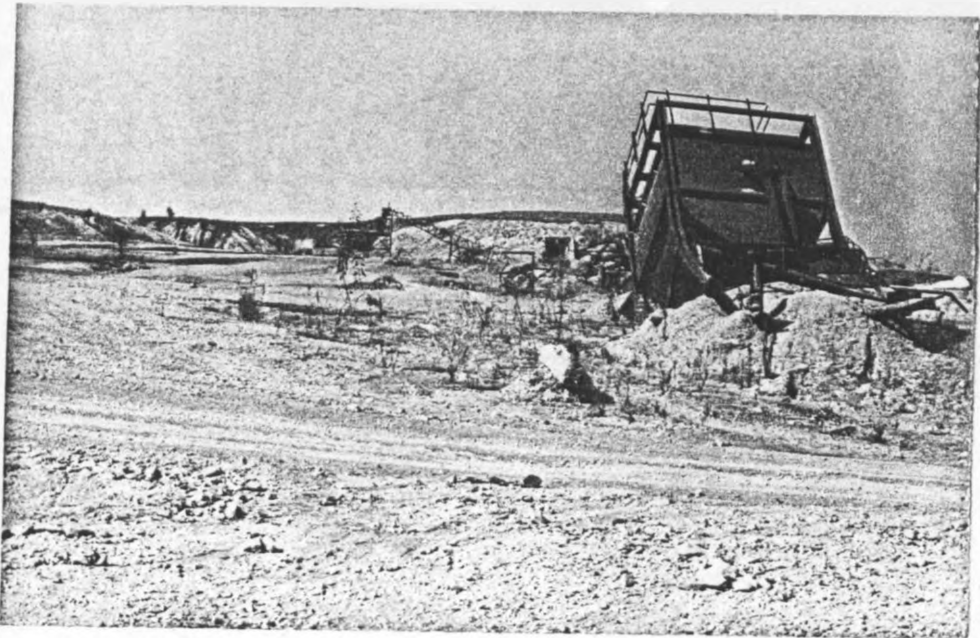


PLATE NO. 23: No efforts have been made to rehabilitate this disused quarry. Notice no efforts have even been made to remove the broken down machinery.



PLATE NO. 24: Parked vehicles are a target of the cement dust. Notice the dust accumulations on the windcreens. These vehicles are parked 2Km. from the factory.

No. of Respondents Interviewed	Effectation:-	Number Affected	%	Remarks Made By The Respondents:
60	Clothes 40		67%	Washed clothes become stained, coarse and dirty, colour is distorted.
60	Buildings 50		83%	Houses become dirt, are constantly covered with dust, window panes, walls and rooftops are all covered, time is spent on cleaning and repainting this incurring extra costs on maintainace.
60	Vegetables 10		17%	Vegetables leaves are hard and dirty they need thorough washing and seem to take long in cooking
60	Vehicles 20		34%	These are covered with dust and have to be undusted and regularly cleaned. If you park for a long time you have to use a detergent to remove the dust from the windscreens
60	Water 40		67%	Water colour changes to milk white . when clothes are washed in this water they appear stained.
60	Human bodies 60		100%	Skin become itch, the hair is also covered with dust, constant coughing arises, eyes become sore and itchy.

Source: Research Data. TABLE NO. 12: A Summary of effects of cement dust on various aspects of human life.

On the whole the Table NO.12 gives a summary of the effects of cement dust on various aspects of human life. In cases where the percentage of the people affected seems low on specific aspects such as in cases of vegetables and vehicles; For vegetables of the 60 interviewed only 15 of them are engaged in this activity and are able to notice major changes

On the case of vehicles the most comprehensive view was witnessed at Kitengela livestock marketing ofivision where they have parked vehicles for over 3 months. The cement dust has accumulated and got stuck on the wind-screens: so much one cannot see through the windscreens neither can this dust be removed with mere water . Officers at the station indicated they have to use detergents to remove the dust on the windscreens, the bodies of the vehicles (see plate No:24 )

People interviewed expressed their concern with the manner in which the portland management seems reluctant in trying to minimise or control the dust problem. These people further pointed out that they were greatly concerned with the way more of the dust oriented factories were being located within residential areas; other such factories apart from East African Portland cement factory are the white Meg, and the Athi River Mining Company (see their location in Map No 5 )

It is clear from the table that cement dust from E.A.P. cement factory has interfered with peoples lives in many ways and continues to do so much to the detriment of their health, comfort and living and working conditions.

E.A.Portland cement factory employees interviewed indicated that this dust interferes with their working conditions very much as it covers the bodies, equipment such as desks, tables, chairs, typewriters and anything around, hence they have to spend time constantly undusting these things; a process that is repeated now and then thus consuming valuable working hours.

Interview with Chief Lab. Chemist:

The chief chemist was of the opinion that the factory management had done its best to install dust filter bags and the modern electrostatic prespitators, hence he sees the problem as one of negligence rather than equipment or technology.

On allegations by town residents that the factory constantly released alot of dust during the night when people are asleep; he dispelled such allegations and emphasised that the factory was highly committed to good working conditions and maintaing a healthy good environment

Observations of the factory premises by the researcher revealed the following:

That there is alot of dust accumulated all over the factory premises covering, vehicles, buildings and trees, it was further observed that most of the dust infact escape through the chimney as earlier thought but does so during the process of crushing and mixing up of the raw materials. Little has been done to arrest or control this dust, most of the efforts are concentrated in ensuring that dust does not escape through the chimney. It was further observed that some of the electrostatic dust precipitators are not properly maintained hence are clogged thus reducing their efficiency in reducing dust that escapes through the chimney chimney.

Summary Of the Chapter

This chapter has attempted to give an outline of all the the processes involved in cement production. The chapter has examined production not only within the factory premises but also the mining of various types of raw materials and various quarring sites. In doing so, the analysis has laid special emphasis on the environmental problems which occur as a result of all the combined activities of cement. Analysis has shown without doubt that operations of this factory have created major environmental problems which if left unchecked are likely to affect the lives of people, the animals and the quality and quantity of resources such as water, air and land this in the long run is likely to affect the development of Athi River town and its neighbourhoods.

Among the major findings of this chapter are;

1. That, air has been considerably polluted by discharge of cement dust particulates into the atmosphere.
2. These dust particulates have continued to affect different aspects of human life in many ways; This dust has continued to poison vegetation and wildlife in the Nairobi National Park; it has affected farming particularly of vegetables it has become a major nuisance to the comfort of the town residents, covering the houses, clothes, bodies and water among others.
3. This dust escapes from the factory through two areas; through the chimney and at the crushing mill. It has also been established that the electrostatic dust precipitation have clogged down with alot of dust accumulations thus their efficiency level has droped considerably.
4. It was also found that the mining and quarrying for cement production entails alot of environmental destruction. The land has been stripped of vegetation and left bear and barren. Over 2,000 acres of land today lies bear barren. There has been no meaningful rehabilitation efforts made to protect the environment. Both livestock and wildlife apart from losing their grazing ground, some have lost their lives in the water marshes created unable to retrieve themselves from the mud.
5. The study has found that East African Portland Cement Factory has no sound environmental protection policy.
6. The study was also able to witness a cultural transformation among the Masai tribe. Most of them have changed from nomadism to mineral prospecting, in the mining of gypsum. Women who customarily look after the home are now active members of mineral prospecting. This activity

however is destroying the environment greatly. These findings among others will be taken into account when making recommendation later in this study.

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CHAPTER 5: An Evaluation Of The Various Impacts Of  
Industrial Development On The Environment

This chapter seeks to identify and examine specific impacts that have been analysed in chapter three and four respectively. The first section of the chapter gives general information on various aspects of impact analysis, this is followed by the second section which examines the types and nature of impacts brought about by the operations of the two factories KMC and E.A.P.C.

The Two Phase Model Of Evaluation:

For the purposes of facilitating evaluation of the various environmental impacts from the two industries in Athi River town the two phase model of evaluation sketched below was used.

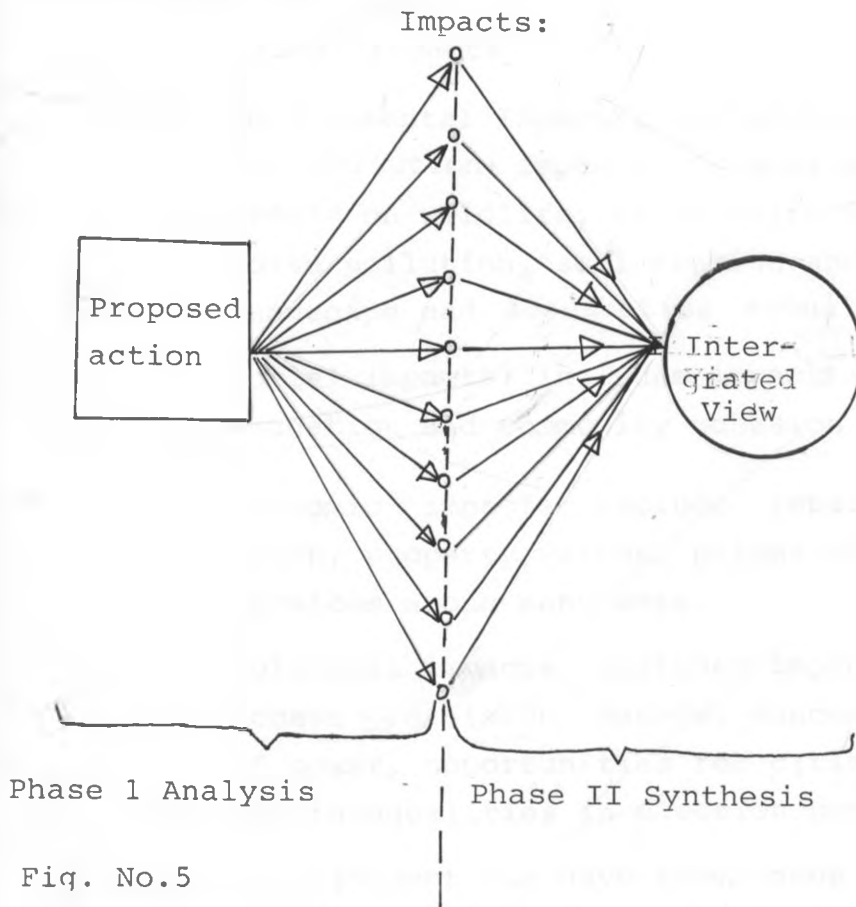


Fig. No.5

Source: Donald.McAllister (1980)Page 9.

This model has two phases; Analysis and synthesis. At the Analysis phase, the model attempts to define and estimate the various impacts of the actions of

Industrial development. This is seen necessary as it gives a detailed understanding of the many consequences of such industrial actions.

This analysis phase will form the bulk of this chapter (chapter five). The second phase of the model, synthesis which tries to bring the impacts together in an intergrated view so that proposals and recommedations of the actions to be taken can be made from the findings; will be dealt with in Chapter six.

### Some General Aspects About Impacts

Impacts can be quite diverse but in general they are classified into four groups

1. Environmental Impacts
2. Social Impacts
3. Economic impacts
4. Political impacts

1. Environmental Impacts; includes, impacts on air (air pollution) Impacts on water (water pollution), impacts on wildlife, noise pollution, soil erosion noise pollution, soil erosion and destruction of landscape and aesthetics among others
2. Social impacts; includes impacts on health, education and community cohesion among others.
3. Economic impacts; include impacts on income, taxes, property values, prices of good and services among many more.
4. Political impacts; includes impacts on, public access to decision makers, concentration of of power, opportunities for citizen participation and in-equalities in election process

Industrial development can have tremendous effects on the occurence of the first three types of impacts. However for one to develop an intergrated view of all the impacts of industrial development on the environment there is need to have a clear appreciation of all types of impacts.

There are many problems in studying impacts because some are tangible while others are not; some can be quantified while others cannot.

But in all, to estimate impacts often requires skills of technical experts in many different fields familiar with the systems in which the impacts occur and which they are transmitted; for example; Chemists geologists and ecologists, sociologists and anthropologists are needed for estimating social impacts; For economic impacts economists are needed and for finally we need political scientists and public administrators to estimate political impacts.

The kinds of knowledge therefore necessary for estimating impacts are diverse and at times quite technical. It is however the contention of this study that in a developing country like Kenya, where the main environmental problem is lack of awareness of the emerging environmental problems, one does not need all the technical expertise to carry out an environmental consciousness reawakening study, as most of the phenomena under study can be seen and felt without going into detailed technical analysis. The study was therefore able to identify major environmental problems associated with industrial development in Athi River town as has been shown all along the study particularly with respect to Kenya Meat Commission and East African Portland Cement Factory. The impacts of the two industries are discussed below.

The Environmental Impacts of K.M.C. And E.A.P.  
Cement Factories

Impacts on Land

Certain industrial activities can have devastating effects on land, a good example are quarrying activities of the East African Portland Cement factory.

The first direct impact of such activities has been on the landscape which has been greatly interfered with and altered as a result of mining for the raw materials necessary for the manufacture of cement. Today, what was once flat land is now characterised by bear man made 'hills' and water bogs and marshes which are a threat to animals and human life, this covers an area of over 2,000 acres.

The second direct impact observed was on land productivity. Most of the quarrying area were initially fertile lands but today with all the top soil which is rich in mineral nutrients necessary for vegetation growth removed nothing grows on such land. What is worsening the situation is the fact that the activities of quarrying are being intensified without any efforts to rehabilitate the land.

The third impact is related to aesthetics. Apart from quarrying which has interfered with outlook of the terrain, alot of heaps of soil can be seen al around the town and near the quarrying areas. The scenic beauty of the town has been changed. The land is no longer attractive for psychological and recreational purposes.

The fourth impact on land is one of soil erosion, which is a result of combined activities of both Kenya Meat commission and the East African Portland Cement factories.

Quarrying has exposed the land and left it bear while overstocking of livestock has led to overgrazing.

and trodding of the land. As a result of these combined activities the land has been degraded and made very vulnerable and is easily susceptible to erosion when it rains

#### Impacts On Air

The most obvious impact on air is pollution. This impact greatly reduces the quality of air within an area. In Athi River town the impact of air pollution as a result of the activities of the two industries is most evident.

Portland cement factory pollutes the air through discharge of cement dust particulates into atmosphere. The study observed that people working and living near the quarries and the factory are subjected to constant coughing as result of inhaling cement dust laden air. This dust makes living and working conditions unbearable. It covers clothes, vehicles, office equipment, buildings, and people.

On the other hand the activities of Kenya Meat Commission, particularly the disposal pits and lagoons emit very objectionable and highly repulsive smell. This bad smell makes the air very foul for breathing purposes. This again makes working and living conditions very uncomfortable. As earlier indicated there is little maintenance carried on these disposal areas and today they are a potential health risk to the town. There are many flies and mosquitoes both in the lagoons and the disposal pits, these are potential disease carriers. The smell undoubtedly attracts the flies which could be responsible for spreading diarrhoea, eye diseases and dysentery among other diseases.

#### Impacts on Water:

The impact on water is pollution. Water pollution affects the quality and utility of the water. When the quality of water is affected by pollution through industrial or domestic effluent discharge such that its utility in its many purposes is minimised or impaired then the impact of pollution is felt.

When water is polluted, there is a direct impact felt by various animal species. Some become asphyxiated due to loss of dissolved oxygen (B.O.D), others are poisoned and die if the industrial effluents contain toxic chemicals; while due to rise of temperatures of water particularly depending on the industrial machines certain other animals and plant species are retarded while others die.

Water is used for many domestic activities such as drinking, cooking, washing, building, irrigating, for domestic animals and many other purposes. When water is polluted, depending on the amount of pollution and also rate of pollution as well as the substances involved in polluting the water such as poisonous chemical substances, its quality is affected and consequently its utility for most of these purposes is reduced.

In the study area effluents from industries have started to interfere with the water quality of River Athi greatly; this is the main source of water for both industrial and domestic purposes. During dry periods when there is very little river flow, evidence of river pollution is prevalent. This study was able to observe that water has developed a dark oily film with bubbles of leather. It was found that town residents who use this water directly from the river before treatment were finding it difficult to use this water for most of their domestic purposes, for example clothes washed in this water were stained causing distortions to their original colour.

This study did not find significant evidence to suggest that Kenya Meat Commission and East African Portland Cement Factory were the major factories responsible for water pollution. There was however evidence to suggest water pollution from other factories such as the Double Diamond tanneries, Athi leather works and the sewage industry.

#### Impacts on Vegetation and Food Crops

As earlier indicated, there are significant impacts on vegetation as a result of the activities of the two

industries, most of these exhibit signs of poor health, while others are infact stunted.

Quarrying activities have stripped off all grass and trees from the mining areas. Large quantities of dust from the quarries and the factory have covered trees and grass and vegetables alike, the leaves have large amounts of dust accumulation. The vegetables have to be thoroughly washed and cooked for a long time.

This dust acumulation blocks the stomata and the process of ... photosynthesis is thus impaired, these plants cannot manufacture their food effectively some have changed their colour to yellow patches while other exhibit signs of poor growth, they have become stunted.

Cowling and Jones (1978) observed "...in addition to providing a pathway of entry for gaseous pollutant the leaf is important as a surface for deposition of particulate matter; the leaf is the first part of the plant which first and most obviously displays visible symptoms of injury".<sup>2</sup>

Over-grazing in K.M.C. holding grounds is yet another severe and direct impact on the natural vegetation. Tall grass species such as Thermenda, Tetrahendra are quite susceptible to overgrazing. In areas where they occur particularly in the Kitengela holding ground; the area during drought is overgrazed leaving bear land surface which is easily susceptible to soil erosion during rainy season.

#### Impacts on WildLife and Livestock:

Omondi (1983) observed, "the Athi river Cement plant located only 50 meters from the border of the Park also contributes quite significantly to the poisoning of the wildlife inside the park. The pollutants from the industrial plant have settled on the leaves of some trees and this has exercised an impact on wildlife feeding habits"<sup>3</sup>. This was also confirmed by discussions held with the experts from the Wildlife Panning Unit in the Ministry of Tourism and WildLife.



Officials of the nearby Kitengela goat and sheep project indicated they had to shift their stock far away from the cement factory as they were experiencing high mortality rates. There is however need for research to be done by experts to establish whether there is any relationship between the dust accumulation on vegetation and the mortality rates of the small stock and wildlife.

#### Impacts on People:

Man is the most obvious victim of all impacts caused by industrial development on the environment. His life is totally depended on the environment and any impact on it is likely to have direct implications on his life.

Water, air, land, (soil) parks, are all basic resources that man needs for his survival, when any activity by industries interferes with these either by way of pollution or any other degradation then man's dependence on them is impaired/minimised

The impacts of Industrial development on these resources have been discussed above, specific effects on human beings in Athi River town have also been discussed, It is however fitting to emphasise that the Industrial activities of the two industries have quite a number of impacts as the study has shown all along; such impacts range from Economic, social, health to environmental, it is however not possible to quantify or to do a costing of these impacts in monetary terms.

On the whole the activities of the two industries were found to have a number of adverse effects on the residents of the town, air is polluted by both industries; through cement dust and bad smell from unburied decomposing car-cases. Most buildings are usually covered with dust so are vehicles and clothes, this it was found has forced the residents to spend more money and time on washing and repainting. Their vegetables have been affected and cannot compete well in the market for better prices. Finally it was found that the life of man, his comfort, his health and his working conditions have been affected

adversely by the activities of these industries

#### Summary of the Chapter

It is no easy task identifying impacts and evaluating them against one another to know which is the most pervasive nor was this the intention of this study but rather to establish the types of impacts, their effects to the basic environmental resources and their implications to man and other forms of life.

Impacts must be evaluated with an aim of achieving an intergrated view, because most have complementary relationships and it is hard to isolate them. For example when environmental impacts are identified we begin to ask questions about the monetary values of such impacts (Economic impacts) and we also begin to question their implications to human life (social impacts).

This study has been able to identify the major industrial impacts on the environment. It has been able to establish the implications of such impacts to resources and to human forms of life.

It has however not been possible to quantify such impacts in monetary terms nor has it been possible to analyse these impacts in technical procedures such as taking samples and measuring them to establish the extend and magnitude of the impacts. It is hoped however further study will be carried to establish that where possible.

The following figures, No. 4 and No. 5 give a summarised picture of the effects of these various impacts discussed above.

Fig No.4: Summary Chart Of The Environmental Effects And Impacts of K.M.C :

A

Factory: Kenya Meat Commission (KMC)	Effect Of poor Disposal of Animal carcasses, condemned beef and other body remains and wastes:	Likely Impacts:
✓	1. Repulsive smell within and around town(Air Pollution)	1. Social impacts; on general comfort of the people and values. 2. Economic Impacts; property values and working conditions. 3. Environmental impacts, quality of air adversely affected.
✓	2. Health hazard to workers and inhabitants	1. Social and Economic impacts: as a result of diseases people become weak and inactive useful workhours are spend in hospitals instead; this leads to poor Economic performance and loss of income.
✓	3. Multiplication and spread of many flies	1. Social Impact, human health endangered. The spread of flies increases the incidence of eye diseases, dysentery and

<p>K.M.C. cont</p>	<p>1. Increase in number of dogs and Vultures seen devouring decaying animal remains.</p> <p>✓ 5. At the lagoons are marshes of untreated waste which not only emit bad smell but the area is a breeding place for mosquitoes.</p>	<p>1. Social Impact, aesthetics and social values are affected.</p> <p>2. Social Impacts: on human health, incidence of malaria increase, human comfort and social values.</p>
	<p>B</p>	
<p>Kenya Meat Commission (KMC)</p>	<p>Effects of Overstocking At K.M.C. Holding Grounds.</p>	<p>Likely Impact</p>
	<p>1. Over Grazing and destruction of other vegetation.</p>	<p>Environmental Impact: destruction of vegetation leading to soil erosion, revegetation is slow and often</p>
	<p>2. Trodding and tramping</p>	<p>Environmental impact, these, effects loosen up the soil and make it easily susceptible to soil erosion, this in return affects productivity.</p>

Fig.No5: Summary Chart Of The Environmental Effects And Impacts:

A

Factory	Effects Of Dust Particulates	Likely Impacts:
East African Portland Cement	1. General Dustiness in the Area	1. Social impacts on Aesthetics
	2. Retarded Growth on Vegetation and destruction of crops and vegetable market value.	1. Economic impact, on destruction 2. Economic Impact, on loss of income from affected crops 3. Social Impact, on loss of food.
	3. Nuisance to inhabitants	1. Social Impacts, on aesthetics and social values
	4. Reduced Visibility	1. Social impacts, Accidents and loss of life. 2. Economic impacts, Disablement loss of workhours, and income.
	✓ 5. Health hazard to workers and inhabitants.	1. Social and Economic impacts: people become weak and inactive, work hours are spend in hospitals leading to loss of income and less economic perfomance.
	✓ 6. Deterioration of exposed material	1. Economic impact; constant and

Cont.fig No 5

		thus incurring more money in these activities
	7. Retardation of vegetation and grass within and outside Nairobi National Park.	<ol style="list-style-type: none"><li>1. Change of wildlife and livestock feeding habits</li><li>2. mortality rates and Health hazards on wildlife and livestock. (Economic impact).</li><li>3. Environmental impact, destruction of vegetation.</li></ol>
	B	
East African Cement Factory	Effects Of Quarrying	Likely Impact.
	<ol style="list-style-type: none"><li>1. Destruction of Vegetation</li></ol>	<ol style="list-style-type: none"><li>1. Loss of ranching land (Economic impact)</li><li>2. Interference with Ecological balance by removal of trees and grass (Environmental impacts)</li><li>3. Loss of productivity (Economic impact)</li></ol>



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CHAPTER 6: Summary Of The Findings And Recommendations:

This chapter seeks to do an over-all evaluation of the major findings of the study. Basically the chapter is organised into two sections; the first section deals with major findings and recommendations on general issues within the study area. The second section examines specific findings and recommendations on Kenya Meat Commission and on the East African Portland Cement factory. This second section also gives broad guidelines on environmental protection and on industrial development which the study has proposed.

This study set out to examine the impact of industrial development on the environment. The study was going specifically to examine how industrial development and industrial activities have affected three basic natural resources land, water and air. The town of Athi River which lies about 30Km to the South East of Nairobi was chosen for the purposes of this study. This town had been noted for its rapid industrial growth over the last decade and therefore offered good scope for the purposes of this study. The Industrial growth potential of Athi River town was analysed at length in terms of the main factors that have influenced the growth of industries in this town .

It was revealed that no one single factor can account for the industrial development of this town. The study was thus able to identify a number of key factors which can explain the industrial growth of this town. Among these was excellent communication; it was found that the town is well served and linked to other parts of the country by a good network of roads, the Nairobi-Mombasa and Nairobi-Namanga International roads being good examples. The town was also found to be well served from Mombasa, Nairobi to Kisumu and joining other major towns such as Thika, Nakuru, Eldoret and Kitale. It was also found that the presence of Jomo Kenyatta International Airport close by has been a major added

advantage to Athi River particularly in transportation of french beans and other products to overseas markets. Another factor identified was proximity of Athi river to a large consumer market. it was found that the location of Nairobi close to Athi River has been able to benefit the latter tremendously interms of providing a ready consumer market for its products. Alot of meat products and cement finds its way to Nairobi so do other industrial products. Many investors therefore see Athi River as an alternative investment town after Nairobi; and this is likely to influence Athi Rivers development.

It was also found that there is enough ample land for industrial development in Athi River town and with the proposed boundary expansion of the town from 960 ha to 51,400 ha land is not likely to pose any limitation to industrial development . It was also found that since this land is flat most industrial developers are not going to incur alot of expenses in making it flat for industrial construction purposes It was however found that the soil characteristics of this town being predominantly friable loose clay , does not offer a firm foundation for buildings hence industrial developers will have to dig deep to reach firm foundation for their buildings.

It was revealed in this study that Athi River town is facing an acute water shortage for both domestic and industrial purposes. It was found that, the present supply from boreholes and surface ground sources, the main one being river Athi were not enough to meet the demand. It was found that the present supply from these sources is only  $5466\text{M}^3$  per day, against an estimated demand of  $7028\text{m}^2$ . per day, this indicates a short fall of  $562\text{m}^2$  per day. Certain factories, it was found, such as K.M.C, East African Portland Cement factory have had to rely on private boreholes to augment their daily requirements. In view of this existing water situation it was found that further industrial development in the town may be faced with difficulties in obtaining water for their Industrial operations.

In the above regard this study therefore recommends that

the proposed plan to construct three dams on the upper reaches of river Athi to supply water for this town be implemented immediately without failure. Through a feasibility water report commissioned by the Athi River town council in conjunction with the Ministry of water development and carried out by Rofe Kennard and Lapworth as consulting Engineers, It was revealed that with the construction of these three dams, the water needs of Athi River town both for industrial and domestic purposes would be met. At present no action seems being taken interms of implementing this, the study has noted this and it is in this regard that it proposes prompt implementation of the dams, construction.

The study also found out that the Government Policy was likely to influence the industrial growth of Athi River town greatly. The study found that the country has an active industrial policy, Promotion of industrial development is being emphasised both at the National and at the local levels. At the National Level while the policy emphasises on encouragement of more industrial investments at the major urban centers, the policy is also emphasising the need for industrial decentralization or as it is being referred to industrial dispersion to intermitted towns; Athi River town is likely to benefit from this policy interms of industrial development. The recent Government policy towards the districts as the focus of rural development is likely to benefit many town interms of adminstration and investments and Athi River town should also get its share.

At the local level the policy emphasises establishment of industrial rural clusters as a means of promoting industrial development in these rural centers. The industrial policy as a whole is thus very sound.

On the other hand the study found out that the country's environmental policy is not as well defined as the industrial one. The policy states broadly that in view of the escalating number of industrial ventures in the country all efforts should be made to safeguard and protect the environment. The policy states that

industries will be expected to prepare environmental impact assessment reports, the policy does not say what will happen for non compliance neither does it lay legal framework which should be used in enforcing the law, nor does it even indicate who will be the enforcement body. The study observed that there appears to be no consistency between the industrial policy and the environmental policy. It would appear that industries are being developed at the expense of the environment. The study has noted the rampant misuse of basic resources by industrialists; water is being constantly polluted by industrial discharges and effluents, 'our' air is now also being polluted by discharge of various toxic substances into the atmosphere the land has become the target of all forms of destruction, soil erosion is on the increase, the number of unrehabilitated mines and quarries is on the increase and in general the landscape is being subjected to all forms of abuse with no subsequent efforts of management. At Athi River town the study found that there was rampant misuse of these resources as later findings will show.

✓ This study recommends therefore that in the process of industrial development adverse effects on the environment should be avoided and this should be done through a sound planning policy. A sound planning policy means the balanced utilisation of land, air and water and of human resources for all purposes. It is true that economic activity and in particular industrial development constitutes the very basis of urban development, but it is also essential to ensure a health environment so that industrialisation may proceed under favourable conditions and that the population may derive from it all the advantages hoped for.

There are many advantages to be gained at this stage of industrial planning by incorporating all necessary measures that will safeguard the environment, into

relevant legislation for environmental control, including regulations to deal with urban zoning, location of industries, protection of natural resources and powers of enforcement where necessary.

The study further found out that the country still relies on British standards for measuring industrial discharge rates. The study revealed that these standards are for all purposes and intent inadequate and unsatisfactory. It is clear that there are major environmental differences between Britain and Kenya hence to adopt British standards wholesome into Kenya is indeed highly questionable. This study therefore, recommends that discharge rates which are relevant and applicable in the country be established. The Kenya Bureau of Standards, the Ministry of Water Development pollution control section and the Kenya industrial research development should be charged with the responsibilities of forming these discharge standards; as these bodies are already undertaking various aspects of industrial development, the monitoring of pollution being a major one.

It was also revealed that the country has no specific legislation which governs the use of the said resources (land, air, water) neither is there any enforcement body for environmental protection. Today industries can pollute and have been indeed doing so without being prosecuted as the country lacks the legal basis to do so. Today there exists many unrehabilitated mines and quarries at Athi River but there is no law to force the miners to rehabilitate them. In view of this the study recommends that the parliament should table a Bill with an aim of enacting a legislation that will protect the environment from industrial abuse and other form of abuses. At the same time the study recommends that an enforcement body be established to deal with the problem of resource abuse and environmental protection. This body should be so empowered so as to enforce certain environmental protection measures before the establish.

ment of any industry. It should also be able to prosecute against any industrial activity that contravenes the Environmental protection act enacted.

There are other social facilities which make the climate for industrial development conducive and favourable for investors. Such factors include schools, recreational facilities, shops, hospitals and churches among others. This study was able to examine the availability of such facilities in Athi River; out of this analysis the study found out that there are two nursery schools, three primary schools and one secondary school managed on 'harambee' basis by African Inland Church. The study found that these educational facilities were quite inadequate and some children have to be transported on daily basis to schools in Nairobi.

In this respect the study recommends that the council examines the possibility of establishing a further two nursery schools to cater for the demand. This recommendation is being made from the view that the present council nursery school is well built and well managed a factor that has contributed to its overpopularity, thus creating congestion for admission places, quite a number of parents have had their children turned away. This study revealed that with respect to primary school education the problem was not much of lack of vacancies in the existing primary schools but, rather, that some parents feel the standard of the schools available do not meet their preferences and expectations and would rather take their children to schools in Nairobi. It is therefore recommended that possibilities of establishing another primary school which preferably will be medium high cost and will also offer better educational facilities be examined with an aim of establishing one which would cater for the demands of this part of society. Indeed as the town grows and as population increases there will be need to establish more schools.

This study found with great concern that at the moment

there are only three private doctors and one dispensary in the town. These medical facilities were found to be totally inadequate to meet the towns demands. It was found that many people travel to the already congested Kenyatta National Hospital in Nairobi. Many end up not getting treatment and thus go back again incurring more expenses on transportation and wasting valuable working hours. It was also found, that the lone dispensary in the town is constantly faced with shortage of drugs a problem that has forced many people to resort to the private doctors. But for the majority of the town poor who cannot afford to pay for these private doctor services, for them there is no hope. It must also be understood that the present dispensary does not serve Athi River town alone but does offer its services to people from Kinanie market and Kitengela market. On the whole it is recommended therefore that the Government should elevate the status of the present dispensary to a full fledged hospital which should also offer dispensary services to outpatients and maternity services to the women who today even in times of labour pains have to be taken to Nairobi which is 30Km. away.

This study also revealed that the present sewer pipes were designed to cater for a population of 5,000 people. Today the population is estimated to be 17,000 people; these sewer pipes are subjected to a lot of pressure; and they have frequent <sup>burst</sup> busts now and then as information from the health officer revealed. In times of these <sup>burst</sup> busts it was found, raw and untreated sewage finds its way to Athi River the main source of water for domestic and industrial purposes of the town; this pollutes the water and indeed could cause health problems.

The study also found that much of the air pollution, within town also comes from the sewage treatment plant which is located just within the town. This study recommends the bigger pipes for sewerage disposal be laid instead of the existing ones. The study also recommends that the sewage treatment plant be moved further away from the town (see Map No.8 for proposed site)

It was also found that the town is facing a serious housing shortage to the effect that some workers commute daily from Nairobi. It is recommended that the proposed site and service scheme in the town be implemented immediately. It is also recommended that the council should allocate more plots to private developers to build more houses. This should not create problems because the council has enough land for this purpose. It is further recommended that industrialists should participate in building houses for their employees as the East African Portland Cement factory. The council should allocate plots to industries which are willing to participate in this housing exercise.

#### Findings And Recommendations On KMC And EAPC

##### Brief Overview:

This study specifically set out to evaluate the environmental problems resulting from industrial development; a case study of Athi River town as an industrial town was taken for this purpose. The study also found right from the beginning due to constraints in time it was not going to be possible to carry out a comprehensive evaluation of all the industries in Athi River Town. Two major industries, the Kenya Meat Commission and the East African Portland Cement Factory were chosen for the purposes of this study. The study on these industries was to lay special emphasis in particular on examining the impact of the operations of these industries on three basic resources, water, air and land as this was one of the objectives of the study, this has been done in the study. It was also further within the objectives of this study to examine stage by stage the process of production within these two industries with a view towards establishing the environmental problems resulting from each operation, this has also been done in this study. It was further within the intention and the objectives of this study to examine the Implications of the misuse of these basic resources, on the lives of the residents and workers of Athi River town and also on any other form of activity



or function of the town and finally to examine how these are likely to affect future industrial growth of the town.

The study has endeavoured all along in the analysis of each chapter to work in accordance to the laid down objectives. It is the contention of this study that these objectives have been fulfilled as set out. The study has finally come up with major findings from the analysis of each chapter and listed them in summary at the end of each. The analysis from the first two chapters which formed the background to the study area has been discussed. It is therefore the intention of this study to review the findings of chapter 3 and chapter 4 on KMC and E.A.P.C.factories, which form the basic thrust of this study with a view towards providing practical solutions to the problems indentified in the form of recommendations as this was infact the final objective of the study.

Specific Findings And Recommendations on Kenya Meat Commission (KMC):

Chapter 3 of the study has explicitly examined the process of industrial production at KMC stage by stage. From the analysis it was found that production (process) at KMC is a well organized process that entails hardly no major environmental problems. It was found that KMC has endeavoured as much as it could to ensure that meat production meets the international health standard required . It was also found out that at the premises all facilities are properly inspected to avoid any form of contamination. On the whole, the study was greatly impressed with the whole methodological process of meat production; the efficiency and the stringent health measures involved are indeed remarkable.

On the other hand a critical examination was made on the methods of disposal, and here, the picture was totally different. The study found that the disposal process at KMC is quite unsatisfactory and entails major environmental problems which threaten even human

life. It was found that KMC relies on two methods of disposal of the various animal remains and other unwanted wastes. Each of these methods was analysed in depth: with respect to the first, which is disposal of various substances such as blood, fat, waste water which has been used in the factory and general animal body wastes find their way into lagoons built for the purpose. In otherwards all the liquid substances finds their way here. It was found that these lagoons are two in a series, the first one contains the substances discharged directly from the factory. It was further found that the lagoon contains slurry residue which has settled at the bottom of the lagoon. It was found that the more refined liquid finds its way into the second lagoon where it seeps to the ground after sometimes.

The study found out that the state of these lagoons constitute a major environmental health hazard, it was observed that thousands of mosquitoes have made these lagoons their breeding ground.

The study was able to reveal that these lagoons emit highly repulsive smell. It was further found that there is no specific task force to deal with the maintenance of these lagoons. They are not fenced and tall grass grows all around them. It was further found that several vegetable farmers have established themselves around the lagoons and interfere with the lagoons to considerable extent getting water to irrigate their small plots.

The study observed that a marshy area has formed all along the area and drains all the way into River Athi the major source of water for the town. It was also found that this marshy area which extends beyond the main Nairobi-Mombasa road has become a major source of bad smell which is indeed a major source of discomfort to motorists and is of great embarrassment to the town. The study revealed that statistics from the clinical officer records indicate high incidences of malaria, this according to him could be attributed to the increase of mosquitoes in the town in areas such as these lagoons. The study also found that the bad smell from these lagoons

makes living and working conditions very uncomfortable in the town. It was indeed found that the smell does interfere with the appetite for food for quite a number of people in the town. It was found that for recreational and leisure purposes the repulsive smell does indeed render the town unsuitable. This study further revealed that there are no treatment methods carried on these lagoons, indeed KMC does not even spray them to eliminate the mosquitoes, the lagoons are not dredged hence contain accumulation of a lot of residue which can be used for a number of purposes as recommended later.

On the whole this first method was found to be unsatisfactory and wholly inefficient and one which causes a lot of air pollution and constitutes a major health hazard much to the detriment and comfort of the residents and workers of Athi River town.

In view of the above problems therefore the study recommends quite a number of programmes and courses of action which should help in minimising and eliminating these problems.

In broad terms and in the short run it is recommended that;

- ✓ 1. KMC should endeavour in every way to eliminate the hazard of mosquitoes, and
- ✓ 2. That KMC should also make all the efforts to minimise air pollution.

For recommendation number 1, it is proposed the following strategies could be used.

- ✓ 1. Spraying of the lagoons with insecticide to eliminate the mosquitoes. Further, that this exercise should be repeated on weekly basis.
- ✓ 2. The possibility of using oil on top of these lagoons should be considered. Oil is considered an appropriate 'weapon' because it does not have to be poured on daily basis and does effectively control the spread of mosquitoes.

For recommendation number 2, it is proposed that the following strategies be adopted:-

The second method of disposal at KMC was also analysed in details. This method of disposal is concerned with burial of all the non-liquid animal wastes, these wastes include condemned beef, intestines, condemned hides and skins, bones and any other wastes. The method currently used by KMC is burial in a big open pit at times a series of pits.

This burial site at the moment is about  $\frac{1}{2}$ Km. away from from the factory. It was however found to be located between many residential estates among them Makandara Sophia and KMC Estates.

This study found that this burial ground has been turned from a burial ground to a dumping ground. Instead of most of the remains being buried they are dumped on the surface. It was indeed found that there is no "pit" as the KMC management had indicated during the initial interviews. This is an open ground where furrows and trenches are dug on weekly basis to bury the animal wastes.

This study revealed that this 'burial site' is the major source of the highly objectionable smell one experiences in Athi River town. Indeed the state of this site apart from being aesthetically unappealing constitutes a major environmental health risk for the town. There are many decaying animal remains which emit a very bad stench.

It was found that since the furrows and trenches dug are very shallow dogs and vultures unbury these rotting remains; the study found many of these dogs and vultures devouring these remains which emit a highly repulsive smell. This smell is very uncomfortable and highly embarrassing to the town. It was further found that some illegal bone, hide and skin dealers operate from this site and on occasions unbury these remains to get bones without the slightest effort to cover the remains again. This increases the smell.

Because of its bad state, this site has become a breeding place for thousands of flies. As one walks across the site one is likely to think there is a swarm of bees around

According to the clinical officer these flies are the main cause of the high incidences of eye diseases, and disease cases reported at the dispensary.

This study also found that KMC does not maintain this area in any way, the area is not fenced nor is there anybody to ensure all the remains are properly disposed. It was clear to this study that the people concerned with disposal of these remains do not seem to care about how deep they are buried or whether they bring any environmental problems or not.

On the whole therefore the study found this method of disposal quite unsatisfactory and highly inefficient. In view of these problems three recommendations are made; on the short term

1. KMC must endeavour in all ways to eliminate the bad smell.
2. KMC must find a way of eliminating all flies because they pose a health hazard.
3. KMC should maintain burial site properly. In order to facilitate the realisation of these recommendations the study proposes the following strategies to be used.

On recommendation 1, these strategies should be used. 1. The present burial site should be relocated immediately to another site further away from residential estates. This, it is hoped will help minimise the smell from directly interfering with the people (see Map. No 8 for proposed site ) This site is felt ideal because it is far away from the people and there is enough land for the purpose.

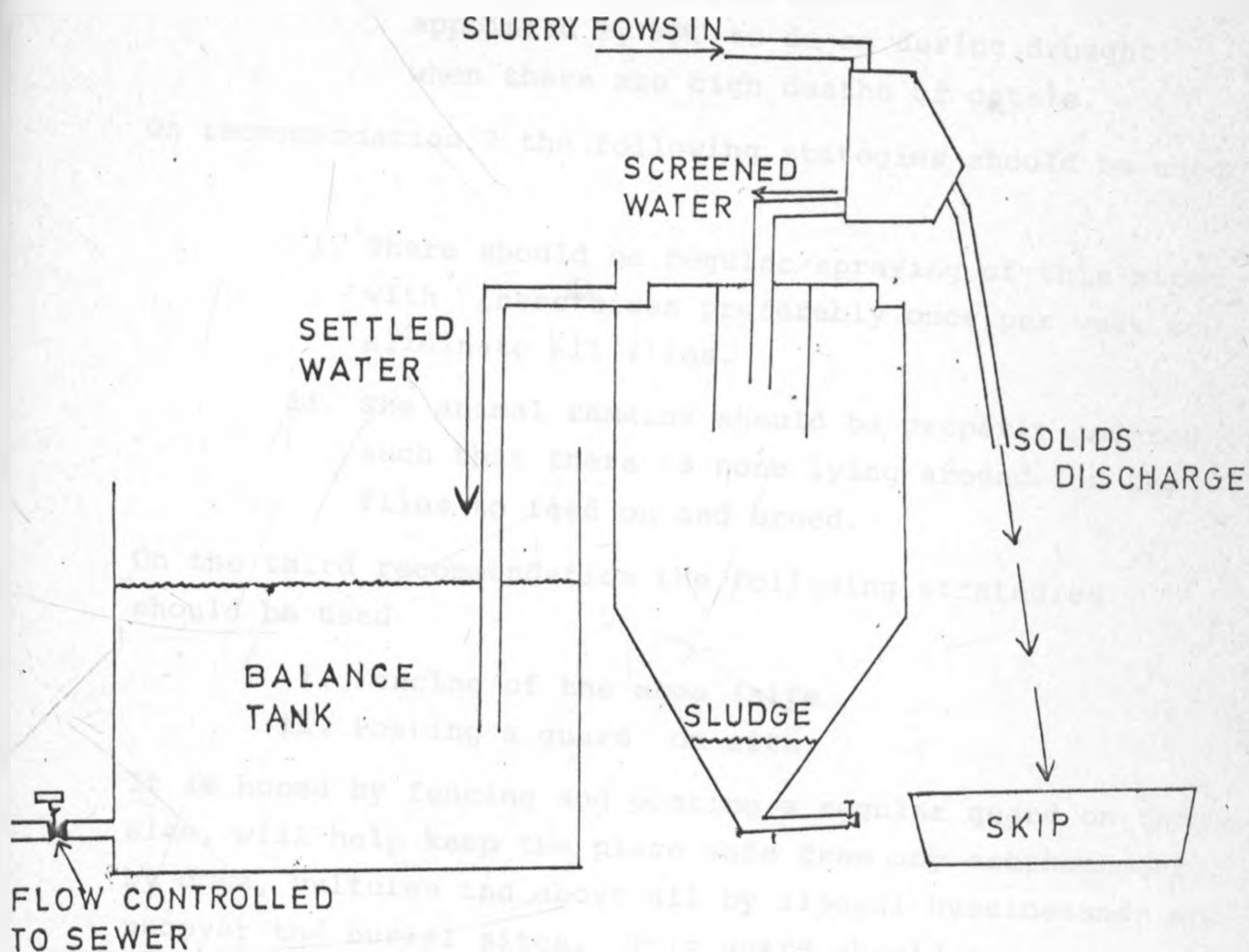
- ii. A proper pit should be dug, in fact this study recommends that two pits be dug in a series such that when one fills up there is already another one. These pits should be deep enough to ensure no dogs or vulture can unbury the remains. These pits should be properly covered at every stage of disposal

1. There should be a regular treatment method in these lagoons to avoid the long accumulation of the slurry residue which tends to emit a highly repulsive smell, There should be a constant dredging of this slurry from the lagoons. The study recommends that the following design should be adopted as it ensures ease separation of the slurry from the liquid substance  
(see design model Fig. No.5)
2. That this slurry which emits smell should be constantly flushed with water to minimise the smell once the design model 5 has been adopted
3. The use of oil to form a layer on top of this slurry should be considered as it is considered that this will also minimise the amount of smell, at this level.
4. Some personnel should be specially employed by KMC to deal with maintenance of the lagoons, he should be able to examine when the dredging out of slurry should be done and also when oil should be added.

#### Long Term Recommendations:

In the long term period the following recommendation are made;

1. That KMC should consider fencing of these lagoons to bar any form of encroachment from unauthorised persons who interfere with the lagoons
- ✓ 2. Possibilities of relocating the lagoons to a distant area should be examined and using the model design given pretreatment should be done first.
- ✓ 3. Possibilities should be explored for (i) making bricklets for supply of energy fuel from the slurry or (ii) This slurry should be converted and sold as manure to farmers, and/or (iii) The slurry could be used to make biogas, which should supplement some of the energy needs of the factory.



**FIG NO5 PRIMARY SCREENING AND SETTLEMENT SYSTEM**

"This is an ideal system for treatment of liquid waste discharged from large meat plants. The substances usually include fatty and bloody substances and other forms of animal wastes from the stomach and the intestines, These flow in a slurry (liquid) form to a primary screening and settlement system through a pipe which leads to a separator from where the solid wastes are directly discharged into a skip from which this solid waste can be discarded away.

Meanwhile the screened water flows into a settlement point from where the residue settles in another chamber from where it is discarded. The clear water proceeds to a Balance tank from where it can be discharged away usually to the sewer line Note; it is usual to incorporate some form of aeration in the balancing tank to prevent settlement and prevent the BOD level rising. The study recommends this system to KMC instead of the open lagoons currently used".

- iii. All carcasses around the town should be buried in this pit through a task force appointed by KMC to do so during drought when there are high deaths of cattle.

On recommendation 2 the following strategies should be used

- i. There should be regular spraying of this site with insecticides preferably once per week to eliminate all flies.
- ii. The animal remains should be properly covered such that there is none lying around for the flies to feed on and breed.

On the third recommendation the following strategies should be used

- i. Fencing of the area (site)
- ii. Posting a guard on site

It is hoped by fencing and posting a regular guard on the site, will help keep the place safe from any encroachment by dogs, vultures and above all by illegal businessmen who uncover the burial sites. This guard should act as the maintenance "engineer" ensuring all remains are properly buried and none is left lying unburied.

Long Term Recommendations:

- 1. KMC should consider the method of burning of carcasses instead of burying. This is considered appropriate some cattle die and are buried without diagnosis of the diseases. These carcasses can act as disease transmitters for deadly diseases such as anthrax. KMC should acquire an incinerator for this purpose.

Priority should be given to

- 1. eliminate of flies
- 2. elimination of smell and
- 3. proper maintenance of the burial site.

It was also found out that due to overgrazing at KMC holding grounds, a problem of soil erosion does persist.



It was also found that these grounds are not fenced, which make them open to encroachment from other cattle farmers ; overgrazing is thus a problem aggravated by these illegal cattle farmers .

In the short run it is recommended that KMC should fence these grounds to avoid any further encroachment by these illegal farmers.

In the long run it is recommended that

1. KMC should establish buying centers in all Districts where they can buy cattle from. These cattle should be transported in trucks and where possible in railway wagons. This will eliminate "hoofing" of cattle to KMC which causes erosion on the way and puts the cattle at risk of contacting diseases in the areas they pass. This also ensures the cattle farmers are saved valuable time of transporting their cattle to KMC and also reaching the cattle exhausted which can make the farmer fetch non-competitive price for his livestock.
2. To minimise the congestion at KMC it is recommended that KMC reopens it's branches at Nakuru and Eldoret. This will minimise the number of cattle being transported all the way to Athi River and this will minimise congestion at the factory and ease erosion problems created when transporting these cattle using the 'hoof' method.

Specific Findings and Recommendations on East  
African Portland Cement Factory (E.A.P.C.F).

Chapter 4 was concerned with specifically examining the process of industrial production of cement at the East African Portland Cement Factory at Athi River town and the environmental problems that arise out of the process. It was also within the scope of this study to examine other related cement production processes. Here specifically the study was to examine the sources of various types of raw materials for this factory, this was also in conformity with the first objective of this study which was to examine the whole process of production within each of the two industries KMC and E.A.P.C. Factory

Out of this stage by stage analysis as the Chapter has done, quite a number of major findings were revealed. It is within the purpose of this section to review some of these major findings in order to form a solid basis for making recommendations which should be seen as practical solutions to the problems identified, this is also in line with the fourth objective of the study which states, "to suggest and formulate policy guidelines and make recommendations which should be adopted with respect to the existing industries and any other that will be established in future".

This study in no doubt found that the production of cement at the East African Portland Cement factory at Athi is indeed a successful operation. It is an operation that ties closely with the government policy on employment which emphasises the need for the creation of many industries which should provide meaningful employment to the citizens of this nation, in all the factory employs slightly over 600 people. It is also an operation that earns the country the highly needed foreign exchange for investment into programmes of national development through the export of cement into foreign markets.

It was however found that the production of cement at Athi River factory entails major environmental problems

which indeed threaten the very survival of human life, vegetation, wildlife, livestock and also the quality of our resources, water, air and land

The study was able to identify five major problems.

1. Air pollution
2. Destruction of landscape
3. Destruction and poisoning of vegetation
4. Poisoning of livestock and wildlife and
5. Interference with human health, his comfort and his other forms of activities and developments.

The study revealed that the combined activities of mining of various mineral resources necessary for cement production and the cement production itself at the factory premises entails discharge of considerable amount of dust into the atmosphere, as a result this affects the quality of air which is an important natural resource.

At the quarries it was found that the activity of mining involves digging deep down using large caterpillars (tractors), It also involves scooping up the soil occasionally using explosives to blast resistant rock boulders, all these activities involve the discharge of alot of dust into the atmosphere, indeed it is difficult to work in this place without some protection of the head as alot of dust blows up and it becomes difficult to breath and see through. Some of the fine dust particles remain suspended in the air for a long time while some larger particles have fallen down and accumulated on the vegetation which exhibits poor health and is infact stunted in growth

The study found that lorries which carry Kunkur from Lukenya quarry are quite often overloaded and discharge alot of dust as they speed away to the factory along the ever busy Nairobi - Mombasa and Nairobi - Namanga International trunk roads. This dust is a constant nuisance to motorists as it obscures vision creating the possibility of occurence of accidents when overtaking and often the pebbles crack vehicle windscreens while, some

other motorists are afraid of overtaking these lorries. It was also revealed that the activities of mining at the quarries involve a lot of destruction of vegetation and landscape within the areas involved. Before mining the land is completely stripped off its vegetation and the mining activity itself involves a lot of scooping of soil and complete alteration of the landscape. The flat terrain is changed to many small man made "mountains" and ridges and big open mines where often marshes of water develop; this interferes with the scenic beauty of the land. At one area alone (Kajiado, Emboloi ranch), the activity of mining has completely destroyed over 2,000 acres of originally fertile ranching land, not to mention that the activity is still being intensified thus claiming more land and vegetation; grass and trees alike.

It was indeed found that livestock and wildlife have lost their prime grazing fields not to mention the loss of life often involved for these animals as they get stuck in the water bogs and marshes created in these quarries.

At the factory premises it was found that the actual process of cement production entails the discharge of a lot of dust into the atmosphere. The study revealed two main areas where the dust escapes; at the crushing mill and through the chimney. It was found that this dust has greatly poisoned the vegetation and wildlife within the Nairobi National Park and vegetation and livestock around the factory. The Kitengela Goat and sheep unit has been a direct target of this dust. Indeed the officers in charge attributed the high mortality rates of smallstock on accumulation of this dust on the vegetation which in turn these sheep and goats feed.

The vegetation around this area exhibit poor health and appear stunted.

It was also found that this dust is a great nuisance to man and his other activities not to mention its effects on his health. It was found this dust covers buildings,

vehicles, crops, cloth and human bodies among other things. Building and vehicles have constantly to be cleaned, repainted, while clothes and human bodies have to be washed quite regularly for the people near the factory and on the windward, side where there is a direct fall out of this dust. And finally the study found people around the factory premises experience constant coughs, eye itching and chest pains.

On the whole, the study found that the operations of this factory continue to have tremendous effects on resources not to mention its many effects on human life and other activities as analysed above

In view of these problems the study proposes a number of recommendations which seek to provide practical solutions to some if not all of the problems.

1. Environmental destruction must be stopped at all costs and mining should be done in a controlled manner.
2. All effects must be made by the factory to minimise dust to acceptable limits.
3. Lorries and trucks carrying Kunkur from Lukenya quarry should be re-routed to the old Mombasa road.

To facilitate the realization of these recommendations the following strategies and programmes should be employed.

#### Recommendations 1:

On this recommendation the study proposes two programmes to be employed by the East African Portland Cement factory at the quarries.

- i. Landscaping
- ii. Revegetation

In landscaping two strategies should be employed one, using tractors to flatten the bear man made "Moutains" and two, filling up the open mines and quarries with soil. These strategies will ensure rehabilitation of land to its original terraine. Further on the study proposes that rehabilitated land should be filled up with soil which is rich in nutrients to support plant growth.

On revegetation programme the following strategies should be employed;

- 1, Planting specially selected tree species which can adopt in this environment. The study recommends the casaurina tree species to be used, however soil and climatic characteristics should be first carried to determine the right casaurina species which can best grow in the areas.
- II. Specially grass species should be planted also, the study recommend the indigenous grass in the area Ther menda be used.

Young trees need to be protected and cared for, therefore the study recommends the East African Portland Cement factory engages a qualified forester to maintain these trees as the case in Bamburi cement factory Mombasa.

In order to control mining and ensure a healthy environment Portland cement factory should effectively control all mining rights of its mineral resources. In this respect the mining right at Kajiado gypsum mines currently controlled by private developers should be taken over by the company as these individuals have continued to mine without any due regard to the state of the environment.

#### Recommendation 2;

It was found that alot of dust discharged by the factory has had very adverse effects on human life, vegetation , wildlife, livestock and other forms of development as earlier indicated. The study does appreciate that cement production is a dusty operation, but this study recommends out of its findings the following courses of action to check the dust discharge to be taken

1. The factory to engage a team of experts to measure and determine the discharge rate which currently the study felt surpasses permissible limits. The recommended discharge rate, according to the Threshold limit value (T.L.V.) which is a standard of measurement requires cement plants not to exceed dust discharge of 1,750 parts per cubic centimeter (1,750PPCC.)

- II. The laboratory section of this factory should include qualified personnel who can deal with constant measurement and monitoring of dust discharges rates, the study recommends the factory should hire, or train such personnel.
- III. The study noted that the company has installed a highly reputed dust control device, the electrostatic dust precipitators, whose design efficiency is 99%. This study was however concerned with the poor maintenance of this equipment; the equipment has clogged with dust and now operates at a very low efficiency level. This study recommends that the proposed personnel above, should be charged with specific duties of maintaining this equipment and ensuring it operates with the designed efficiency at all times.
- IV. At the crushing mill where more dust escapes from the study recommends that the factory should seal this area to ensure that dust does not spread and possibilities of using filter bags to trap most of the dust should be considered.

### Recommendation 3

On this recommendation the study proposes two strategies or alternatives to be used.

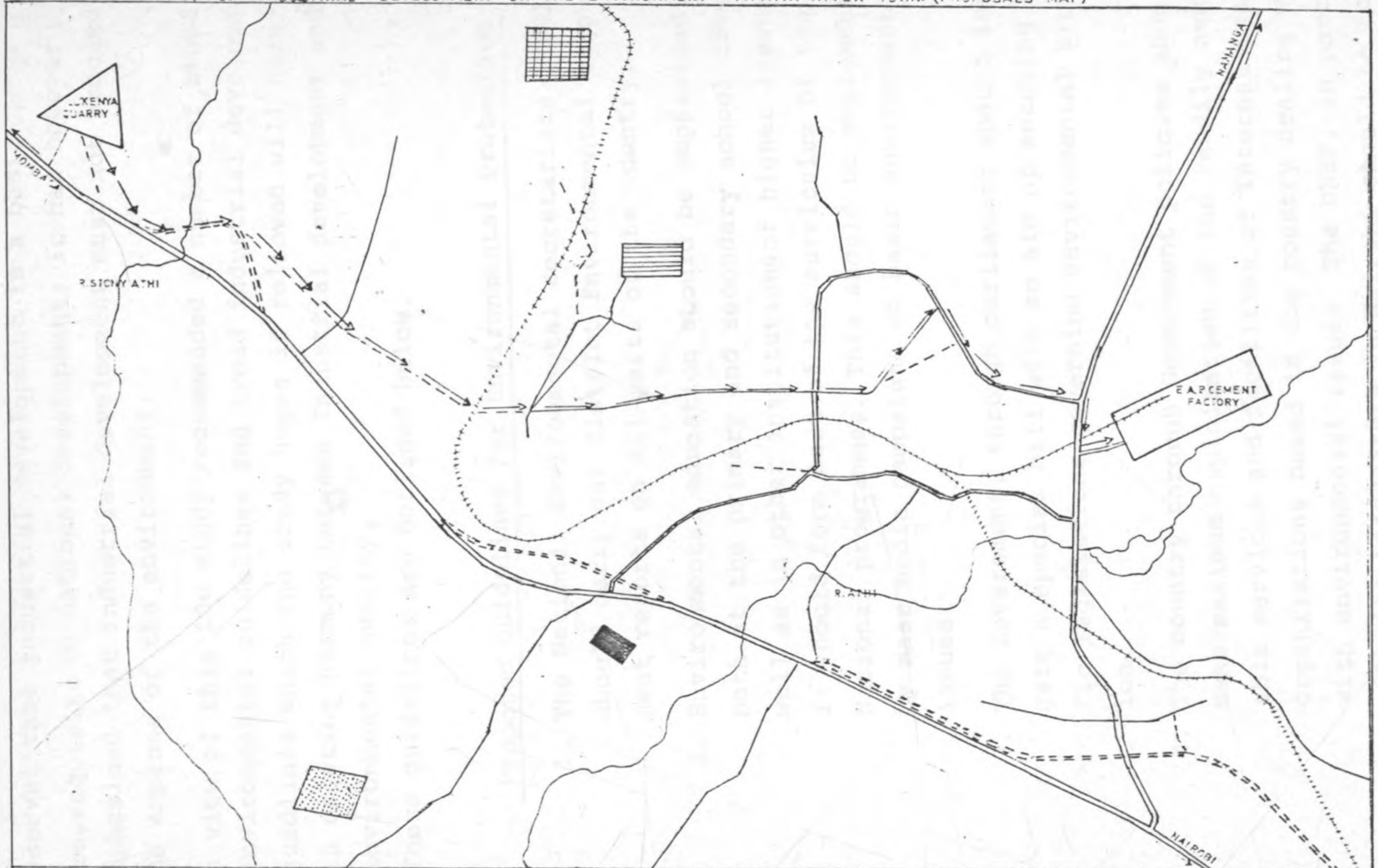
1. The lorries should be re-routed to use the old Mombasa road with a major diversion at KMC and on to Portland factory. This will ensure the lorries avoid using the two busy International trunk roads, Nairobi - Mombasa and Nairobi - Namanga (the Great North road). (see proposed route on Map No. 8)
2. Possibilities of using the railway should be explored in the long run. At the moment the factory uses the railway line transport limestone from Kabini in Sultan Hamud and passes

near this quarry; a railway diversion from the quarry to this railway should be constructed and used for transporting Kunkur from LuKenya quarry .

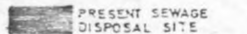
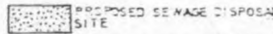
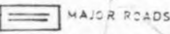

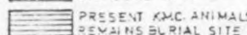
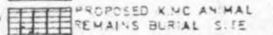

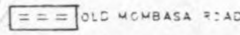


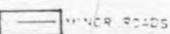
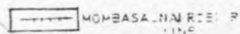
3. These lorries should not be overloaded. it is also recommended they should use canvas to eliminate dust blowing out as they speed to the factory



THE IMPACT OF INDUSTRIAL DEVELOPMENT ON THE ENVIRONMENT IN ATHI RIVER TOWN: (PROPOSALS MAP)



LEGEND

- |   |   |  |  |
|---|---|--|--|
|  PRESENT SEWAGE DISPOSAL SITE            |  PROPOSED SEWAGE DISPOSAL SITE                         |  MAJOR ROADS     |  MOTORABLE TRACKS             |
|  PRESENT K/MC ANIMAL REMAINS BURIAL SITE |  PROPOSED K/MC ANIMAL REMAINS BURIAL SITE              |  SECONDARY ROADS |  OLD MOMBASA ROADS            |
|  (Empty)                                 |  PROPOSED ROAD TO BE USED BY LORRIES TO CEMENT FACTORY |  MINOR ROADS     |  MOMBASA-NAIROBI RAILWAY LINE |

SCALE 1:25,000

P.K. KYALO  
DEPARTMENT OF PLANNING  
UNIVERSITY OF NAIROBI  
M.A. THESIS 1984/85

MAP NO. 10



The scope of this study entails two basic concepts, industrial development versus environmental quality. The study has observed that industrial development is a basic pre-requisite to national development; it has however emphasised that industrial development must not proceed at the expense of the environment.

In view of this the study recommended a number of broad environmental guidelines and broad industrial development guidelines which the study hopes if followed will help in creating harmony between Industrial development and environmental quality.

These guidelines are outlined below.

#### Proposed Guidelines for Environmental Protection

1. The National Environmental secretariate (NES) should carry out district Environmental assessment reports on all parts of the country.
2. Environmental education should be emphasised both at the primary and secondary school levels as well as in other institutions of higher learning. It should form part of the curriculum of the National programmes. This should be supplemented by mass media campaigns on basic environmental issues.
3. The Government, through parliament should instigate a special bill with an aim of enacting specific legislations governing environmental protection
4. The country through Government policies should make maximum exploitation of the readily available services and facilities of International organizations based in the country dealing with environmental issues. The UNEP, in particular with its headquarters in Nairobi should be fully utilised.

5. Seminars and workshops on environmental protection should be established at the grassroot level throughout the country possibly at the location level to deal with the problems facing the environment in that area. In this regard chiefs and Assistant chiefs should be given basic courses on the principles of environmental protection.
6. The new policy shift which focuses on Districts as the center for rural development should be utilised in ensuring that environmental reports from locational reports are coordinated here to form the basis for District environmental reports, upon which national policies on environmental are based.
7. A special commission should be appointed to act as the coordinator of all the work on environmental protection being currently undertaken by various ministries, International Organizations, non Governmental Organization, Private Institutions and Individuals. Out of these reports the commission should come up with an annual environmental manual indicating the state of our environment, the measures being taken and the Government stand on this issue. Such manuals should be accessible to all citizens.
8. The training of personnel to deal with environmental protection should be intensified at all levels.
9. The Government should consider a method of giving incentives to people dealing with environmental protection as a way of inducing more active participation; such incentives could include promotion of chiefs and their assistants, giving them locational trophies on outstanding locations among others.

Proposed Guidelines For Industrial Development:

1. Planning guidelines and zoning regulations must be used towards the location of any industry in the country, the department of physical planning should ensure that these regulations are adhered to by any prospecting developer in the country.
2. All industries that emit toxic substances should be located away from residential areas such that they do not interfere with living conditions of the people.
3. Pollution standards should be established for all types of industries. These standards should specify all types of industrial activities.
4. The Ministry of water development pollution control section and the Kenya Industrial research development should establish offices in all industrial towns to do constant monitoring of pollution and other forms of resource abuse and that these two be empowered to enforce pollution discharge standards.
5. An enforcement bill be passed in parliament empowering the two bodies above to take necessary action for non-compliance by any factory of the set standards.
6. That all existing industries and any other prospecting industrialists be required to prepare environmental impact assesment reports. That these impact reports include among others the following
  - I. a description of the proposed action, a statement of its purposes, a description of the environment affected.
  - II. The probable impact of the proposed action on the environment, including both positive and negative effects and secondary or

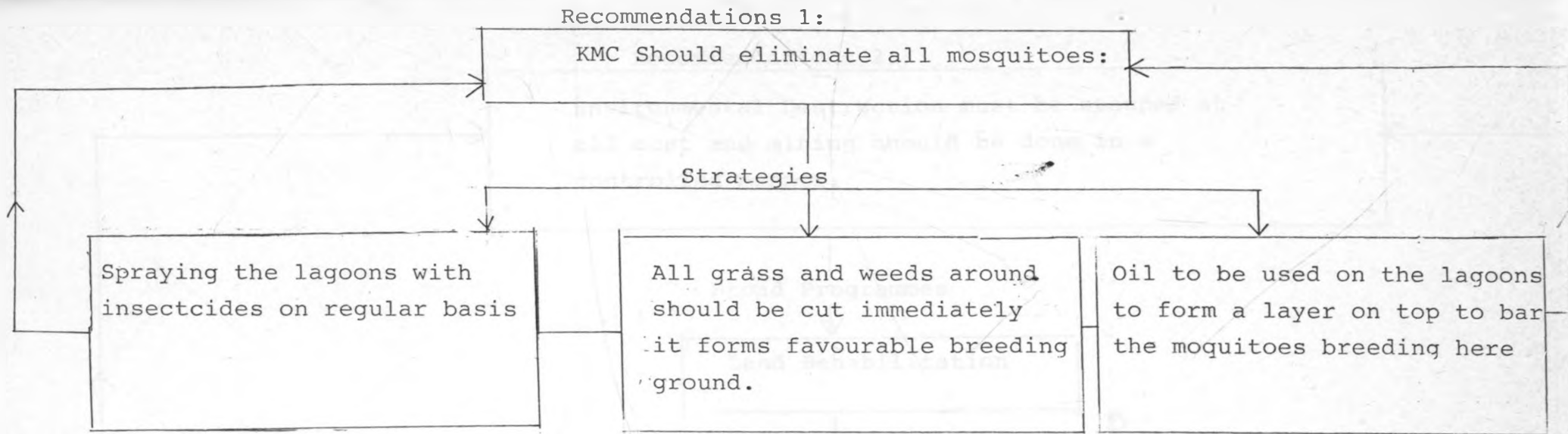
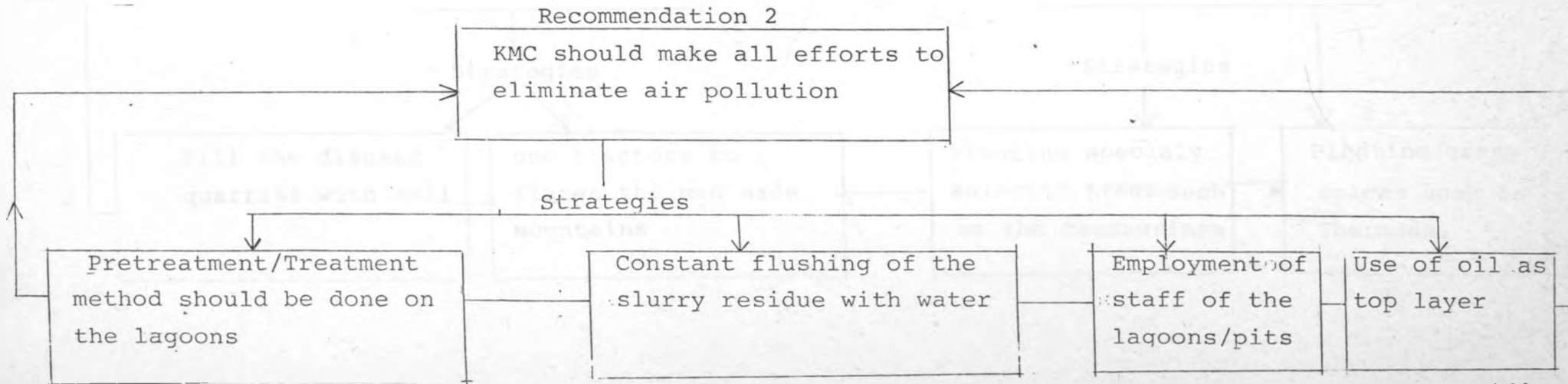
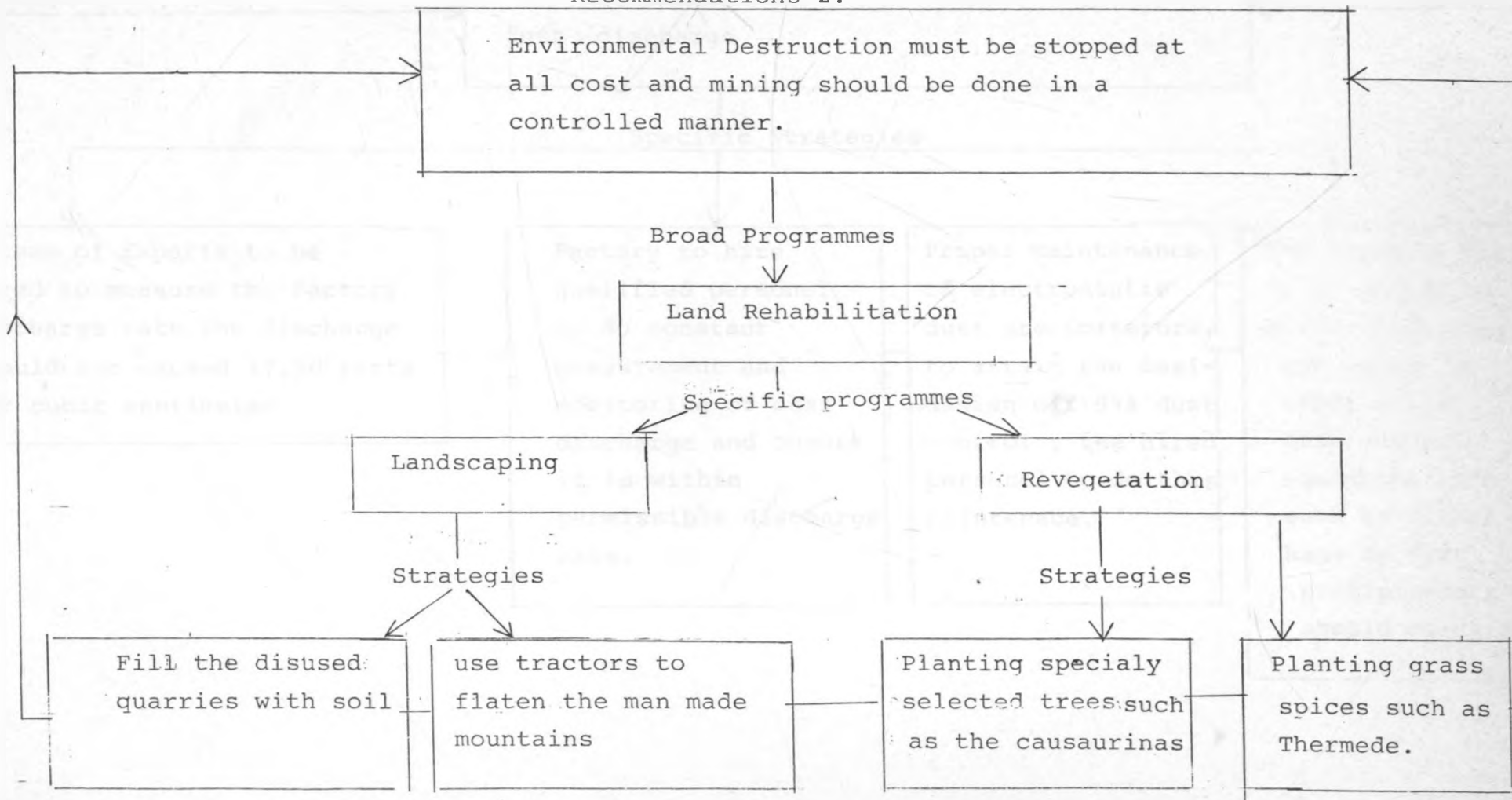


Fig. No.7



Recommendations 2:



Recommendations 2.

All efforts must be made to eliminate/minimise dust discharge

Specific Strategies

A team of Experts to be hired to measure the factory discharge rate. The discharge should not exceed 17,50 parts per cubic centimeter

Factory to hire qualified personnel to do constant measurement and monitoring of dust discharge and ensure it is within permissible discharge rate.

Proper maintenance of electrostatic dust precipitators, to attain the design off 99% dust control, the hired personnel to do this maintenance.

The crushing mill to be sealed to ensure dust does not escape to other areas dust control equipment such as filter bags or dust precipitators should be used

Recommendations 3.

Lorries/Trucks carrying Kunkur from Lukenya quarry should be re-routed to old Mombasa Road

Strategies

Repair the destroyed areas of the road and create access via KMC factory

The lorries should not be overloaded and a canvas should put to control dust blowing out

The Lorries should drive at slow speed / create road bumps within the town to slow them



direct as well as primary or direct consequences

- III. The relationship of the proposed action to land use plans policies and controls for the effected area.
- IV. Alternatives to the proposed action.
- v. Any proposed environmental effects which cannot be avoided and are therefore predictable.
- vI The relationship between local, short term uses of man's environment and the maintainace and enhancement of long term productivity.
- vIi. Any irreversible and iriritrievable commitments of resources that would be involved in the proposed action, should it be implemented.
- vIII. An indication of what other interests and considerations are thought to offset the adverse environmental effects of the proposed action. In other words discharge rates and their methods of control should be indicated and diagramatically represented where possible. (\*These impact points are based on analysis by F.A.O. through the courtesy of H.L. Teller a senior programme specialist in UNESCO.

#### Summary Of the Chapter

The study hopes these general guidelines will form a reasonable basis for the formulation of national policy on industrial development and environmental protection. The study also hopes that if action is taken with respect to the recommendations and possible courses of action proposed in this Chapter then major changes will be witnessed and the study will have realised its main objective "to provide practical solutions which if adopted will minimise the problem of resource abuse".

CHAPTER 7:Conclusion

This study set out to examine the problem of resource abuse by industrial activities. The study sought specifically to examine how air, water and land our basic natural resources are affected by industrial operations. A case study of two industries in Athi River town, the Kenya Meat Commission and the East African Portland Cement Factory, was taken. The operations of these two industries were examined in great depths, with special emphasis being given towards establishing the environmental problems that arise from such operations.

The study has revealed that there exists fundamental environmental problems as a result of the operations of these industries. The study has been able to identify and evaluate these environmental problem. Various impacts have been analysed with respect to how they affect or influence various forms of life.

It was also found that although the industrial growth potential of Athi is great, this is likely to be affected as a result of continued resource misuse. The study was able to clearly reveal that these two industries have no sound environmental protection policies, a problem facing many industries in the country. The study has indeed shown that our National policies on industrial development do not reflect enough seriousness on environmental protection. Industries have thus continued to grow while at the same time creating major environmental problems which the country will find very difficult to solve. It was particularly noted in the study that the country continues to rely on industrial discharge standards specially designed to suit the British environment; The study has observed that there are major differences between Kenya and Britain hence the need to establish discharge standards suited to our local environment.

The study also found out that the country has no legal framework in the form of a law that deals specifically with environmental protection, the study has emphasised the urgent need for the enactment of such a law by the Parliament.

On these issues and others analysed in the study particularly with respect to protection of our resources, study has given certain recommendations, which if adopted will form part of the practical solutions to the problem of resource abuse.

On a concluding note, the study has been able to reveal that our land, air and water resources do have limits and our demands upon them are growing at increasing rates. We must therefore build into our decisions the understanding that unwise actions affecting these resources are difficult and costly if not impossible to correct. All our decisions therefore on industrial development and other forms of activities must be build on pro understanding of the need to protect the quality of our environment. Our national policies at least must reflect that understanding.

This study finally calls for the need to intergrate all our national policies with the need to protect our resources and therefore our environment lest we find ourselves faced with a similar environmental situation as the one facing the developed and highly industrialised nations "We must act now before it is too late".

The scope of this study is by no means exhaustive, the study therefore calls for,

1. Further research to be carried on all the other industries in Athi River town inorder to establish all the environmental problems facing the town, this will help in future planning for industrial development of the town.
2. Similar studies should be carried on other industrial towns in the country; and

3. The researcher does recognise the major limitations facing the study particularly in skills and equipments to measure certain aspects of the study as deemed necessary. Such inputs should be incorporated in future similar research.

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Appendix A

Questionnaire For - Athi River Urban Council

Date of Interview.....

Official Interview.....

- 1. (a) How many industries are in Athi River town.....
- 2. (b) Name them and specify their activities briefly

<u>Name of Industry</u>	<u>Type of Activities</u>
(i).....	.....
(ii).....	.....
(iii).....	.....
(iv).....	.....
(v).....	.....

2. What is the role of your council in relation to industrial promotion and development (explain briefly)

(i).....

(i) What amount of money for Example has your Council earmarked for industrial development?

.....  
.....

(iii).What more industries do you anticipate?

.....  
.....

3. Industrial development requires alot of land and water

(a) Where for example do you get your water?

.....  
.....  
.....

(b) Is this water adequate both for the town residents and for the industries (if no (c) What measures are you aiming to take to solve the problem?

.....  
.....  
.....  
.....

4. Pollution has become a major problem in most towns due to Industrial activities. Would you say this problem is present in Athi River Town. (comment briefly)

.....  
.....

5. (i) Which Industries would you say are the major sources of this pollution?

(a) (water) river pollution?

(b) Air pollution?

(c) Dumping ? (or any other type - specify

.....  
.....  
.....

(iii) Would you say this pollution is affecting seriously the quality of

(a) Land

(b) Water

(c) Air

(d) Environment

(iv) If this is the case what measure has your council taken so far to slove the problem?

.....  
.....

6. Quite a number of Industries are located next to the National Park. Would you say their activities have had a bad effect on the park - for example on the vegetation

Vegetation

WildLife

Number of tourists

(If yes specify briefly the effect in each case)

.....  
.....  
.....

7. A part from pollution what other problems does your council face with respect to industrial development?

.....  
.....  
.....

8. And finally, with anticipated rapid rate of Idustrial development what programmes has your council made to preserve the environmental quality? (Explain briefly if any)

.....  
.....  
.....

Appendix B

Questionnaire For - K.M.C. And Portland Cement  
Factories In Athi River Town

Date Interviewed.....

Part A:

1. Name Of Industry - (tick whichever appropriate)

- (a) K.M.C.
- (b) Portland

2. Officer Interviewed:-Rank/Position  
(specify).

3. What are the major products of your firm:-

- (a).....
- (b).....
- (c).....
- (d).....

4. Where do you get your raw materials (locally/abroad?)  
(state what type of raw material)

.....  
.....

5. How do you transport these to your factory? (tick which-  
ever appropriate)

- (a) rail:
- (b) Air
- (c) Road
- (d) other way / specify

6. Are there problems encountered when transporting this?  
(if yes; explain briefly the nature of the problems)

.....  
.....  
.....

7. What precautions do you take when transporting this raw  
material (if any state them)

.....  
.....

8. Where do you store this raw material?

are there any present measures taken in doing so  
(if yes state how)

.....  
.....

9. Describe briefly how your industry works?

.....  
.....  
.....

10. What are your final products:-

- (a) ..... (d) .....
- (b) ..... (e) .....
- (c) ..... (f) .....

11. Are there any waste products from your industrial activities? (if yes name them)

- (a) ..... (d) .....
- (b) ..... (e) .....
- (c) ..... (f) .....

12. How do you dispose off these waste products?

.....  
.....  
.....

13. Is this method satisfactory? (if no)

What changes do you intend to institute.

.....  
.....  
.....

14. Have your disposal methods encountered any Public criticism? (if yes) What has been done your r

.....  
.....

15. Do you have any programmes of rehabilitation (if yes specify them)

.....  
.....

1. I have these progra