AN ASSESSMENT OF INDUSTRIAL SOLID WASTE MANAGEMENT IN ELDORET

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DECLARATION

This thesis is my original work and has not been presented for examinations in any other university.

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DEDICATIONS

I Dedicate this Thesis to My Family

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Otherwise, the opinions and views expressed in this work are entirely mine and I don't apologise.

ABSTRACT

Industrial pollution has become a common phenomenon in the developed countries, and is now a major problem in the developing countries. Industrialisation in Kenya is not an exception but has only increased in the recent past. This has been accompanied by a high degree of industrial pollution.

Industries usually extract raw materials from nature and release by-products like gases, liquids and solid wastes into the environment. We are therefore faced with the problems of determining the appropriate methods of managing these wastes in order to conserve the environment. Proper solid waste management is one of the methods of contributing to this goal.

This study set out to study the way industrial wastes are managed with the aim of providing planning, institutional and organizational solutions to the problems of managing industrial wastes and by extension industrial pollution.

The study took a case study of Eldoret, one of Kenya's fastest growing towns in terms of industries, among other aspects. The study examined the factors leading to rapid industrial development in the town, the types of industries, the types of wastes these industries generate, estimated their amounts, how they are collected, handled, transported and finally disposal.

It was found out that the rapid development of industries without due

consideration to the proper management of wastes in Kenya is directly related to the level of pollution and environmental degradation. It was also found out that poor coordination between the local authorities and industrialists led to unmonitored pollution in the town.

The town of Eldoret has a substantial number of industries, most of them agro-based with a growing number of chemical and engineering industries. The wastes these industries produce are enormous, with various compositions and levels of toxicities given this diverse nature of the industries.

It was also found out that there were no records kept of these wastes, thus making planning difficult. From the fieldwork, an industry in Eldoret produce on average 1.645 tonnes of solid wastes per day, giving a total of about 50.51 tonnes from the whole of the industrial area. Most of the industrialists in Eldoret collect their wastes in their compounds, which also happens to be the disposal site, thus eliminating the need for transport.

They also dispose their wastes by uncontrolled burning, causing alot of air pollution on top of other dangers like fire risks. It was thus considered that proper management of industrial solid wastes called for a more concerted effort by the central government, through the ministries of commerce and industry and environment and natural resources, the local authority and the industrialists themselves. It was further considered that a complete change in policy and laws at the national and local levels were urgently needed in order to be realistic in the protection of the environment.

A number of improvements and changes have been suggested for Eldoret town in the management of industrial solid wastes. Among the methods recommended for the disposal proper of wastes include the use of incinerators, planning for a waste disposal site and the use of covered lorries in transporting the wastes.

And finally, it was recommended that for a lasting solution, comprehensive studies should be instituted at the national level to examine the causes, effects and ways and means of solving the problem of industrial pollution covering the whole country. Specifically, the studies should focus on the types of industries, the nature of their wastes, amounts of wastes generated, methods of collection, transport and disposal and alternative methods of management for better management with the long term aim of preservation of the environment.

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

Industrialisation is now seen by many developing countries as a panacea for all the economic woes besieging them, as a tool for achieving faster economic growth, improving income levels, living standards, employment as well as other innumerable benefits.

But with industrialisation has come environmental degradation. Industry extracts materials from the natural resource base and inserts both products and pollution into the human environment. It has the power to enhance or degrade the environment, "it invariably does both" (The World Commission on Environment and Development, 1987). Even in countries which industrialised earlier, like most developed countries, the environment has been greatly polluted because of volumes and volumes of industrial and domestic wastes produced from an enormous number of industrial establishments and high population figures.

The degradation of the environment through industrial pollution usually affects the three components of the environment, namely; air, water and soil/land-which may be referred to as the third pollution. This is the pollution of the land by industrial solid wastes, which are harmful to the soil and cause unsightly scenery, besides the smell it exudes. Industrial wastes are known to contain heavy metals like lead, mercury, arsenic, cadmium, cyanide among others. These are highly toxic and hazardous to living things including human beings. Developing countries usually do not have very efficient ways of handling industrial wastes,

unlike in developed countries where industrial wastes are classified "special wastes" and handled differently from residential wastes.

For many countries, therefore, the restoration and protection of the environment is now a top priority in their development agendas.

Proper environmental protection, restoration and management will therefore have to involve the management of industrial solid wastes, as one of the methods of environmental preservation.

Kenya, just like any other developing country, has devoted most of her development resources to industrial development, with little regard for the effects the wastes from these industries will have on the environment. Although Kenya is predominantly an agricultural country, with many of the industries being agro-based, this situation has undergone rapid transformation, with a lot of chemical and engineering industries coming up at a very high rate. These industries emit substances which are detrimental to the environment, and efficient management of the industrial wastes needs to be devised as Kenya embarks on its path of industrialisation by the year 2020.

Most of Kenya's industries are concentrated among the major urban centres. Their wastes have therefore been handled together with the residential wastes. This needs to change because of the fact that industrial wastes are more dangerous to the environment and require more specialised methods of management.

The rational management of the environment calls for information on the

magnitude of and trends in pollutants in the various media that constitute the environment: air, water, soils, and so on, and on the causes of observed problems.

In many developed countries, enormous amounts of information on environmental pollution is available. In contrast, in developing countries, there is a lack of basic monitoring facilities. Despite the increase in pollution in such countries, basic information on its scale, sources and on possible control measures still needs to be obtained.
This study therefore tries to contribute to the collection of information on the management of industrial solid wastes in one of Kenya's rapidly industrialising town of Eldoret.

1.2 Statement of the Problem

Eldoret is now one of Kenya's fastest growing towns. It is one of the leading industrial towns in Kenya besides Nairobi, Mombasa, Kisumu, Nakuru and Thika. Its rate of population growth is also very high and was estimated to be 8% per annum in 1989 census. It had a population of 111,882 in 1989 and this population is projected to be 195,869 in 1997 and 265,302 in the year 2000. The amount of wastes this population produce is estimated by the municipal council to be approximately 100 tonnes per day. The facilities to cater for these people causes a lot of strain on the municipal resources.

In terms of industrial development, the total number of registered industries in Eldoret is 94. But the District Industrial Development Officer estimates that there could be as many which are not registered.

And the rate of growth is very high at 9.5% per annum (Kenya, 1997). The amount of solid wastes produced must be enormous, with complex composition, given that there are various types of industries in Eldoret.

With the current growth of the town, these wastes must be analyzed in amounts and composition and an effective management method be found. Otherwise, the industrial development taking place may become self-destroying.

The Municipal Council is faced with a lot of problems in its day to day operations and do not manage the situation perfectly. This includes handling of the wastes from the industrial areas, scattered throughout the town. There is poor monitoring of how industries dispose their solid wastes. This results in illegal disposal methods such as uncontrolled burning, indiscriminate dumping of wastes in open spaces, and even into river Sosiani, which traverses the town and is very highly polluted. Up to now, nobody knows how serious the pollution is.

Many people in urban councils in Kenya who are charged with the responsibility of managing the problem of solid waste do not realise that the problem does not end at removing refuse from residential, commercial and industrial ares. In fact, nearly all disposal techniques in all local authorities in Kenya are dumping. One wonder if existing legislation does not need to be tightened or its policy improved to bring to an end this shameful act (Otieno, 1992).

In most Less Developed Countries like Kenya, wastes are not separated and so industrial waste could mix with household wastes. It is feared

that leachate emerging from dumps containing industrial wastes could contain dissolved chemicals, especially heavy metals which are known to be poisonous to man and animal.

There is therefore an urgently needed information on the management of industrial pollution in this town having a large concentration of industries. For if its not so, or if such an area is neglected, as has evidently been the case, then for a long time to come, careless management of wastes from other industries may seem a normal occurrence.

Industrial wastes in all towns are usually collected and disposed of in the same way as residential wastes or even collected and transported in the same vehicles and disposed together in the same place. There are no records kept of the quantities, composition or even the nature of industrial wastes. Hence it is difficult to approximate the percentages of industrial solid wastes from any town or clearly define their compositions, unless by actual research, which has been very low in Kenya.

In Kenya, there is clear evidence of industrial pollution in all the major towns, exemplified by heaps and heaps of solid wastes, both municipal and industrial; the pollution of rivers passing through the major towns or passing next to an industry; and the thick smog hanging above the industrial areas of these towns perpetually. Some of the rivers are almost blocked, or semi-solid like the Nairobi and Ngong rivers with murky appearances devoid of any living organism.

The same conditions prevails in Eldoret where Sosiani river passing through the town receives all the discharges of the major industries found in the town. In a Workshop held at the Sirikwa Hotel in Eldoret on Trade Effluent in December 1996, the participants observed that the sewage emanating from the industrial activities contained substances or compounds that are harmful to the environment and humans.

Studies carried out in 1985 by OMS Klaranlagen, German Consultants revealed that the discharges from the Eldoret municipal treatment plants contain substances that are harmful to the ecological life of the river. In particular, the discharges were observed to contain dyes and suspended materials and heavy metals believed to be originating from the industries in Eldoret.

A research carried out by Dr. Njoroge, who is the Chairman of the Department of Civil Engineering in the University of Nairobi, and Engineer Wanjau, who is a lecturer in the same department for the Eldoret Municipal Council in 1996, revealed that the discharges from the industries were not only impairing the performance of the treatment plants, but were also not effectively being treated in the treatment plants and were being carried into the Sosiani River. The effluent from the industries were being discharged to the municipal sewers. A number of industries had pre-treatment facilities. However, most of these facilities were not functioning effectively and efficiently.

The analytical results from a grab sample taken by the Eldoret Municipal Council Monitoring Unit indicated non-compliance with the stipulated control levels by most of these industries.

Far back in 1981, the Ministry of Water Development carried out tests on samples from the industries in Eldoret and from the Quarry Sewage Treatment Works. The results showed that the pond treatment performance has been impaired by industrial waste discharges.

Hence there is need to examine the industrial wastes in the town, to establish the amounts, composition; methods of collection, transportation and disposal in order to come up with suggestions and guidelines on better ways of managing these wastes for a healthy environment. This will create the necessary awareness needed for the enhancement of government's policy of sustainable industrial development. Therefore reliable and up to date information is required.

This study therefore intends to focus attention on the management of industrial solid wastes in the town. This will cover the types of industries in the town, the types and amounts of the wastes they produce, how the wastes are collected, transported, and finally disposed. The study will also examine the problems experienced in using these methods and suitable measures for the improvement of the processes. In the final analysis, these methods of management will be assessed in their effectiveness and their effects on the conservation of the environment.

1.3 Justification of the Study

Environmental protection has of late taken centre stage in all development fora throughout the world. This is due to the realisation of the conflicting issues of development and the environment. This issue

was extensively addressed during the Earth Summit in Rio de Jeneiro in Brazil in 1992. Although industrialisation is desirable, it should not lead to environmental degradation. It should be sustainable.

Kenya's development policies have always put forward industrialisation as a means of achieving economic growth. But the conflict between industrial development and environment was recognised or articulated strongly in the National Development Plan of 1994-1996, having as its theme "Resource Mobilisation for Sustainable Development" and the Sessional Paper Number 1 of 1994 on "Recovery and Sustainable Development to the Year 2010", though the current National Development Plan of 1997-2001 having as its theme "Rapid Industrialisation for Sustainable Development" and the Sessional Paper Number 2 of 1996 on "Industrial Transformation to the Year 2020" went a step back by emphasising industrial development with less emphasis on the environment.

All the cited policy documents including the National Environmental Action Plan (NEAP) recognise the need to conserve the environment on our quest for development. The documents therefore, call for information on ways and means of abating environmental pollution. This study therefore, is a contribution to this course.

There are very few researches done on industrial pollution in Kenya. This is due to the fact that such researches are costly and need specialised expertise. This study will therefore contribute to the collection of information on the subject.

As our towns continue to grow, especially industrially, a solid information framework is needed for planning and monitoring. It is therefore hoped that information on the different aspects of growth be found in order to continue on our path of sustainable development as we enter the Twenty First Century.

1.4 Research Objectives

The major objectives of the study were:

1. To identify the major types of industries found in Eldoret and the types of solid wastes they produce;
2. To determine the quantities and composition of industrial solid wastes produced by industries in this town;
3. To investigate and assess the existing industrial solid waste management methods on their performances and effects;
4. To suggest alternative methods and policy measures aimed at improving industrial solid waste management;

1.5 Study Assumptions

The research proceeded with the following hypotheses that:

1. There is no proper industrial solid waste management system in the town;
2. That the policies in place are insufficient;
3. The rate of growth of Eldoret town will continue being high at around 8% per annum with an even higher rate of industrial development in the town; and
4. There is an urgent need for improved and more efficient

industrial solid waste management methods to be established in the town.

1.6 The Scope of the Study

The study basically covers the industrial solid waste management in the town of Eldoret. The institutional arrangements in the management of solid wastes is usually of paramount importance. The contributions of each actor is also crucial. The roles of the Municipal Council and industrialists is examined.

The different types of industries formed the basic unit of study. The wastes produced by these industries are fully analyzed in composition and disposal methods. The industries will be classified and their waste types and composition and their overall management methods examined. The different industries found therein are fully analyzed on the way they generate, collect, transport, treat, recycle and dispose of their solid wastes.

Of paramount importance will be examination of the effects of the wastes on the environment. Also, the performances of the various management methods in operation will be assessed. Otherwise, the critical areas are industrial waste generation, handling and disposal methods.

The study also will examine better ways of improving the management of the solid wastes and minimising environmental degradation. Policy and legal issues associated with environmental protection and the management of solid wastes in particular will also be covered. And

following that will be the examination of alternative policies which will go along way in substituting or complementing those existing policies.

This work is divided into Six chapters.

Chapter One contains the introduction, problem statement, objectives and research methodology.

Chapter Two contains the literature review on the works which have been done on this subject in Kenya and other parts of the world. The Government policies on environment and industrial development are also examined here. This forms a solid foundation for a strong conceptual framework.

Chapter Three has the details on the study area of Eldoret; its location, physical features, extent of industrial development and its future prospects. Of particular interest will be the factors attracting industries to Eldoret, and the type of industries in Eldoret and their distribution within the town. Also included in this chapter is an examination of the provision of services by the Eldoret Municipal Council, the management of solid wastes in the municipality; and in particular the management of industrial solid wastes.

In **Chapter Four** the industrial solid waste management in Eldoret from the research findings is presented. This is done by the use of the data and information collected from the field; which is presented, analyzed and interpreted. The chapter ends with a summary of the findings from the field.

Chapter Five contains the policy implications and recommendations for better management of industrial solid wastes in Eldoret. **Chapter Six** has

the summary and conclusions of the whole thesis.

1.7 Research Methodology

In order to carry out the research successfully, the following methodology was followed.

(i) Collection of Secondary Data.

This was mainly library work and information was collected on issues such as: the environment, industrial development and how it leads to environmental pollution, solid waste management including sources of wastes, methods of collection, transportation and disposal; and also, the institutional and legal arrangements in the management of solid wastes. This information was collected on various parts of the world, on Kenyan towns and also on Eldoret. Other information collected was on industrial solid waste management. This covered areas like the types of wastes produced by different types of industries, how they manage their wastes, the problems encountered, limitations and potentials of the different methods employed, among other aspects. This formed a good background for comparative purposes with the industries in Eldoret, the types of wastes they produce and the management methods employed.

Another area where information was collected from was on the economic aspects of solid waste management, like the creation of employment through the application of recycling as a method of waste disposal among other issues.

(ii) Official Interviews.

This was carried out with different experts, government officials, bodies and organisations dealing with industries or industrial development, environment pollution and protection and solid waste management; and generally on urban management. Appointments were made with the different experts in various positions and a list of discussion items posted to them; so that on the material day of the discussions, the concerned officers were fully prepared and had sufficient information to avail to the researcher. These experts and officials came from among other bodies:

The Ministry of Commerce and Industry which provided information on the registration of industries, including the conditions and requirements for registration; and the development of industries in Kenya. The District Industrial Development Officer provided information on the development on industries specifically in Eldoret.

Ministry of Environment and Natural Resources (MENR) provided information on the environmental in general and environmental pollution situation in Kenya with special emphasis on the environmental policies. The District Environmental Officer provided first hand information on the pollution situation in the district and in the town in particular.

Eldoret Municipal Council which is charged with the responsibility of keeping the town clean provided information on the management of solid wastes in the town. The problems and constraints in the management of solid wastes were discussed.

This was aimed at obtaining a clear understanding of the factors leading to industrial development and the explanations to the solid waste management practices currently being practised. Also, the policies which are in place, their strengths and weaknesses was found from these interviews.

(iii) Primary Data Collection from the Field.

This provided first hand information on the study problem. This was accomplished using a number of instruments.

A **questionnaire** was administered to the sampled industries containing questions which are related to the study problem. Since it was not possible to cover all the industries, a sampling procedure was used as shown below.

Interview schedule was used to collect information from municipal council officials and municipal workers. An appointment was secured and a list of items to be discussed was presented to the concerned personalities. During the interview, subjects of general and particular interest were discussed.

The use of **informal discussions** was mainly done in interviews with industry workers, municipal workers and residents of Eldoret town, mainly those living or working adjacent to the industrial areas.

Visual observation together with **photography** was used to capture the visual impressions of the conditions and different aspects of the study.

The Sampling Framework

There are 94 registered industries in Eldoret with quite a number which are not registered. Inspite of the classification of industries by the Ministry of Commerce and Industry into Agro, Chemical and Engineering and Construction (ENCO), using the International Standard Industry Classification (ISIC), a slightly different classification was used in drawing up a sampling framework. This was simply the splitting up of the Agro group of industries into two groups: Food Processing, and Textile and Wood industries. This is a fusion of the Ministry mode and the method which was used by the Municipal Council of Eldoret in classifying the major types of industries and wastes in the town. This classification was based on the products the industries produce and the expected nature of the wastes produced. This is because of the proliferation of Agro-based industries which was felt would give skewed data.

A 30 percent sample was taken from the 94 industries classified as:

(a) Food Processing: producing or processing maize and wheat products, soft drinks, milk, and other food products;

(b) Chemical: producing chemicals, powders, rubber and plastic products, acids and other chemical products;

(c) Engineering and Construction (ENCO): these were concerned with body building, engineering works, manufacture of metal products and so on; and

(d) Textile and Wood Products Industries: these were concerned with the manufacture of textile products, leather products, and wood and timber products.

The sampling framework used is as shown below:

Table 1.1: Sampling Framework

Type of Industry	Registered Number	Sample Taken
Food Processing	19	6
Chemical	12	4
ENCO	31	10
Textile and Wood	33	11
Total	94	31

The sample for each group was drawn by numbering the industries in each category using two digits starting from 01 up to the number of industries in that category. Then random numbers were generated from a calculator. The correct sample was therefore picked. Where information was not obtained from an industry, the next one on the list was interviewed.

1.8 Study Limitations

In carrying out this study, a number of factors inhibited the smooth flow of the research. In the first instance, literature on industrial pollution in Kenya, and especially on industrial solid waste management is scanty. The only available researches done on the solid wastes have always been on the municipal wastes. However, these greatly helped in the definition of area of coverage in the study.

Secondly, the actual fieldwork was also not smooth sailing. In most cases, the industrialists viewed the researcher with suspicion because they did not fully understand the purpose of the study. This suspicion was so prevalent that some industrialists refused flatly to give some

information. The reasons for these suspicions are many and varied. Some industrialists feared industrial espionage, some feared that their industries could be closed if found engaging in illegal activities thinking that the researcher was a government investigator, while others did not have time to 'waste' on a researcher-obviously not understanding the importance of any researches.

There was also the problem of appointment. In most cases, the industrialists were only interviewed on appointment. But some appointment were not honoured, making the research to take more time than necessary.

In the management of the wastes, all the industrialists did not have any records and the information received therefore depended very much on approximations. Why they don't keep records can be explained by the fact that no authority requires them to do so. And therefore any research on the management of wastes will have to contend with this problem at the moment.

These problems enumerated above have been addressed in the recommendations so that future researches for the management of our environment will be quite a pleasure.

CHAPTER TWO

LITERATURE REVIEW

2.1 Industrial Development and Pollution

There is an evident lack of literature on industrial pollution in Less Developed Countries. Therefore most of the references comes from the work done in the developed countries.

Furthermore, the methods of management of industrial solid wastes in these Less Developed countries are underdeveloped. UNEP (1991) notes that "it is safe to say that virtually all the developing countries have yet to develop a comprehensive assessment of the environmental impact of industries compared to the most industrialised countries". This can be attributed to the fact that most developing countries emphasise industrial development with little regard to industrial pollution.

Henning and Mangun (1989) observed that the Earth's life-support systems are threatened by numerous undesirable by-products of economic and industrial growth. These by-products affect virtually every earth eco-system and resource base. These by-products often characterised as hazardous or toxic substances, may be considered "resources out of place".

Looking at industrial growth and its contribution to the environmental decline and the responses generated, the Brandt Commission (1987) observes that "industry and its products have had an impact on the natural resource base of civilisation through the entire cycle of raw

materials exploration and extraction, transformation into products, energy consumption, waste generation and the use and disposal of by-products by consumers. These impacts may be positive, enhancing the quality of a resource or extending its use; or they may be negative, as a result of process and product pollution and of depletion or degradation of resources". But Edington and Edington (1977) concluded that "of all the effects of industry, pollution is the most pervasive".

Industries operations generate alot of solid and hazardous wastes. Henning and Mangun (1989) note that "in industrialised societies, raw materials are extracted, refined, processed and transformed into finished products. These processes produce large quantities of solid and liquid wastes".

But not all industries pollute at the same rate. Some pollute more than others. Among the industries identified to be most polluting are metal finishing, tanning, textiles, solvents, pulp and paper, and agro-industries. Also, small and medium-sized industries often find themselves unable to afford the changes necessary to meet environmental regulations and product controls because of the limited resources at their disposal. Small scale businesses such as metal working, machine tools, printing, tanning and dying, are frequently among the worst offenders of environmental regulations in any country. And most of these industries are found in Kenyan towns.

Van Tassel (1970) had earlier observed that 'no industry has made more trouble and more violent Public Relations because of river pollution than the pulp and paper industries. A few industries-paper and allied

products,...typicallycomposed of relativelyfew, large plants use most of the nation's industrial water and produce most of the nation's industrialwastes'.

He also went on to say that pollutionproblems manifest themselves not in some abstract nation as a whole, but in specific localities.The negative environmental impacts of industrial activity were initially perceived as localisedproblems of air,water and land pollution.

Furthermore, the Brandt Commission (1987) argues that "it is becoming increasingly clear that the sources and causes of pollutionare far more diffuse, complex and interrelated-and the impacts of pollution more widespread, cumulative and chronic-than hitherto believed. Pollution problems that were once localare now regional or even global in scale".

The Commission took exception of hazardous waste. It noted that industrialcountries generate about 90% of the world's hazardous waste. In 1984, some 325 millionto 375 milliontonnes of hazardous wastes were generated worldwide, around 5 million tonnes of which were in the newly industrialisedand developing areas of the world. Moreover, these wastes are disposed anyhowly because of ignorance.

In reference to solid and hazardous waste problems on a global level, the *International Register of Potentially Toxic Chemicals (1985)* indicates that "Each year, hundreds of millions of tonnes of hazardous industrial wastes are produced, and much of these is discarded with little regard for or knowledge of, its effect on human health and the environment.... The greatest enemy of our safe use and disposal of chemicals is

ignorance".

The amount of wastes crossing national frontiers is also increasing and is likely to do so. Between 1982 and 1983, wastes transported in western Europe for disposal in another country virtually doubled, reaching some 250,000-425,000 tonnes (1-2% of the total hazardous wastes generated). This increase may be attributed partly to the availability of relatively low cost, legal land based disposal facilities in some countries.

International transport of wastes meant for disposal at sea, either by incineration or dumping, account for about 1.8 million tonnes in 1983. Small and poor countries are especially vulnerable to off-shore dumping, as has occurred in the waters of Pacific and the Caribbean, acting as 'pollution havens', as Chapman and Walker (1991) calls.

Some countries have recently proposed what amounts to commodity trade in hazardous (including radioactive) wastes. This is the dumping of wastes (in a developing country) in exchange for cash offers. This is quite tempting for the poor countries. But this action must be condemned by all since it is morally unacceptable. Industrial accidents are also becoming a regular occurrence. For example the Bopal accident which occurred in India in 1984 killed about 25,000 people and injured an estimated quarter of a million.

Combating industrial pollution is now a top priority in development agendas of all the countries. And the management of industrial solid wastes is just one of the methods. This is because the way the wastes from the industrial processes are disposed of have a great deal on the

resultant pollution.

UNEP (1991) while urging for development without destruction observed that "Industrial expansion is an important part of many national development plans". It continued to say that such an expansion, if accompanied by uncontrolled industrial pollution, is a severe threat to both national wellbeing and the global environment. The high cost of remedial action-where this is possible-should make all sectors more conscious of the need to avoid pollution through clean technologies and forward looking policies.

Most solid wastes from manufacturing (sludge, slag, dust and other inorganic and organic materials) are disposed of in landfills, open dumps or impoundments where pollutants can often leach into the surface and ground waters. Even years after disposal, adverse environmental impacts and influences can occur.

As previously pointed out, environmental problems have a cumulative impact that results in considerably higher costs for remedial action undertaken at a later stage of a country's development.

The cost of cleaning the pollution damage is also high. The estimates (available from advanced industrial countries) suggests that total investments, plus operating costs, for cleaning up a polluted environment and maintaining it at some suitable standard might vary upward from 0.5% of GNP. For USA, it was US $645.3 billion in 1977 or about 2.5% of GNP (World Bank, 1977).

This projection indicates that if action on the environment were unduly postponed, the developing countries, as well, could expect to incur higher and ever-escalating expenditures. In developing countries, the problem is of a more fundamental nature. Less than 10% of urban wastes receive some form of treatment and only a small proportion of treatment is in compliance with any acceptable quality standard.

Policy questions arise as to how these processes can be controlled in order to reduce and to control the waste materials from production and consumption of goods. Further questions involve the amount of wastes that can be reused or recycled economically as well as the viable means for disposal of wastes, particularly toxic or hazardous wastes, in order to prevent or reduce damage to human health and environment. Early preventive measures, therefore, avoid or reduce the high cost of restoration measures.

Although conditions in many developing countries now permit more liberal effluent and emission standards than can be tolerated in the more highly industrialised countries, it is nevertheless important to project the cumulative consequences of industrial pollution.

In general, industries and industrial operations should be encouraged that are more efficient in terms of resource use, that generate less pollution and wastes, that are based on the use of renewable rather than non-renewable resources, and that minimises irreversible adverse impacts on human health and environment.

The rapid rate of industrialisation and the resultant industrial pollution

has also set in the Third World. The Brandt Commission (1987) has summarised that "pollution-intensive, resource-based industries are growing fastest in developing countries". It also went on to say that "the expected growth in basic industries foreshadows rapid increases in pollution and resource degradation unless developing countries take great care to control pollution and waste, to increase recycling and re-use, and to minimise hazardous wastes". The developing countries themselves will eventually have to bear the consequences of inappropriate industrialisation and the ultimate responsibility of ensuring sustainability of their development rests with each government.

These countries do not have the resources to industrialise now and repair the damage later; nor will they have the time, given the rapid pace of technological progress. They can profit from the improvements in resource and environmental management being achieved in industrialised countries, and so avoid the need for expensive clean-ups. Such technologies can also help them reduce ultimate costs and stretch scarce resources. And they can learn from the mistakes of developed countries.

Multi-National companies are usually the worst offenders. The Brandt Commission (1987) noted that an industry may get away with unacceptable levels of air and water pollution because the people who bear the brunt of it are poor and unable to complain effectively. This was obviously referring to the poor people in the developing countries.

Kenya, like many of these developing countries is experiencing rapid industrialisation and indeed the problem is noticeable in many of its

industrial towns, of course accompanied by pollution.

Kyalo (1985), in his study on Kenya Meat Commission and East African Portland Cement factories in Athi River town found out that "the problem of resource abuse through industrial activities is a serious one in developing countries". Air pollution, water pollution, acid rain, smog and oil spills are few among the many consequences of resource abuse in these countries. Today, as many countries in the developing world industrialise, the problem on resource abuse is constantly becoming a reality, the difference being only in degree and magnitude.

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

Adolwa (1985), in his study of Pan Paper Mills in Webuye, noted that many developing countries consider industrial development as one way of lessening dependence on the industrialised countries of Western Europe, Japan and North America for finished manufactured goods. As a consequence, most of these countries have adopted an import substitution strategy. That is setting up industries which produces goods which could have been imported, but we have the capacity to produce them.

Coupled with this is the policy is decentralisation or industrial dispersion; that is setting up of industries in other secondary towns other than Nairobi and Mombasa. This is tantamount to 'decentralising' pollution.

Along with the physical and economic impact that the Webuye paper mill has had on the town, there is an accompanying environmental impact. Incidents of pollution of the air, water, corrosion of buildings and withering of plants in the area adjacent to the paper mill have been observed with great concern from the environmentalists and non-environmentalists alike. Whereas the smell emanating from the processes of the paper mill is ubiquitously around the town and can be perceived 30 kilometres away, the corrosion of buildings and wilting of plants has had effects on the people in the area adjacent to the factory who have had to move their residences or business premises to other sites. Crop yields in the direction in which pollution has been most felt has been low as a direct consequence.

Recognising that "pulp and paper mill operations are generally very highly polluting the world over" Adolwa (1985) concluded that although the management has installed some pollution control equipment necessary for this kind of operation, "the conditions are far from satisfactory".

Fadamula's work (1992), on the assessment of industrial solid waste management in Nairobi's industrial area come up with the conclusion that industrial pollution was a more serious problems causing a lot of health problems to the people living near the industrial areas. These are usually the low income people who live next to the industries, where

they provide labour. He noted that there was serious mismanagement of the industrial solid wastes in the study area. He attributes this situation to, among other factors, weak legal provisions and the institutional set up. He says that the collection methods for one are chaotic, with many industries organising their own collection and disposal methods, which included uncontrolled burning of wastes including toxic wastes causing poisonous smoke.

In his study on industrial development in Athi River town, McMireri (1992) found out that the disposal of industrial wastes was raising a lot of concern particularly from Chloride Metal, Athi River Mining and the East African Portland Cement. This situation he attributes to the result of weak pollution control laws and the machinery to enforce them.

UNEP (1991) in its 1990 annual report by the executive director hoped that 1990 and beyond will be the "Year of Decision", ushering in decades of action with 1990 making the beginning of decisive, collective action to address environmental problems. In fact, the damage caused by the industries to the environment may either be irreparable or too costly to correct. Industrialists, being cost minimisers, are reluctant to undertake environmental conservation as it is an expensive undertaking (UNEP, 1989). Therefore the greater responsibility lies with the respective governments.

2.2 Review of Government Policy on Industrial Development and Environmental Protection

2.2.1 Policy on Industrial Development

Since independence, the Kenyan Government has always emphasized the need to industrialise in all her development policies. This is because industry was seen by the government as a sure way of achieving economic development by creation of employment, earning of foreign exchange through exports, manufacture of needed products among other innumerable benefits. Consequently, a number of policies have been pursued in this quest for industrial development.

The National Development Plan of 1964-1970 had taken as its policy the participation of Africans in the Kenyan economy, that is Kenyanization. This involved the assistance of Kenyans to set up businesses, by giving them loans, selling of shares of foreign companies to Kenyans and the employment of Kenyans in the managerial positions in those industries.

Closely related to Kenyanization was the policy of import substitution in industrial development. This involved the setting up of industries which manufacture goods locally instead of importing those goods while we have the resources to manufacture them. This policy was achieved through the use of a number on incentives like tax concessions, tariffs, availing of industrial lands, among other support services.

The government also intended to be involved in industrial development and noted in the 1966-70 development plan that the "Government aims

to increase its own participation in the growth of industry, both in terms of the promotion of new projects and in the financing of them". The participation of the government in industrial ventures was mainly through the Industrial and Commercial Development Corporation (ICDC) by providing loans, equity and protection against imported items.
In the subsequent development plans of 1974--1978, 1979-1983, and 1984-1988, the government aimed at achieving industrial dispersion, that is setting up of industries in different parts of the country, mainly in other towns other than Nairobi and Mombasa. The plan noted that the "Government aims to achieve a wider geographical dispersal of the benefits of industrialisation".

It can therefore be seen that the government has been very instrumental in introducing industrial developers to locate their projects outside Nairobi and Mombasa. For instance, a 20 percent investment credit was given by the government to any industrial undertakings outside these centres. This has been in operation since 1975. The credit is given as a tax rebate on future profits and not before the project gets underway. It is noteworthy that Eldoret chiefly benefited in its industrial development from this policy since it was one of the towns identified for industrial development. A lot of industries were therefore established in Eldoret in the 1970's, including Rivatex and a lot of Kenya Industrial Estates (KIE) industries.

However, government's strategies of industrialisation were changed in the Sessional Paper Number 1 of 1986 on Economic Management for Renewed Growth to make the industries more efficient and export oriented, with a bigger role in industrial development played by the

private sector and less by the government. This saw a lot of private and international entrepreneurs setting up industries in Kenya's major towns.

This sustained determination in industrial development has seen the Kenyan Government devoting the latest development plan solely to industrial development. This is the Eighth National Development Plan covering the period 1997-2001. The theme of the plan is "Rapid Industrialisation for Sustainable Development". This was following closely another sessional paper on industrialisation. This was the Sessional Paper of 1996 on Industrial Transformation to the Year 2010 and also the sessional paper on Jua Kali, which the government hopes to promote as a basis for industrialisation. This shows a determination by the Government to industrialise as soon as possible and as much as possible.

According to these policy documents, Kenya should be fully industrialised by the Year 2020. The government recognised that it is only through industrialisation that it can develop because of the unreliability of the agricultural sector, since agriculture is affected by a number of factors including the vagrancies of weather and fluctuating prices.

All these policies have made Kenya one of the most industrialised countries in East Africa. The growth of industries in Kenya has therefore been very rapid from about 600 industries in 1970 to 1,500 in 1990 and 1,650 in 1997. The manufacturing sector has been growing at an average of 9.1% per annum since independence (Kenya, 1997). This is a commendable development.

Eldoret has benefited from these policies of industrial development to become on of the most industrialised towns in Kenya and the second industrialised town in the Rift valley province after Nakuru, besides being the fastest growing town in Kenya.

However, this high rate of growth implies that if the pollution levels of these industries have not been subjected to adequate supervision, their impacts on the environment must be considerable, especially where different types of industries are concentrated, like in the study area.

It can be observed that despite the encouragement of industrial development, the government has failed to give enough emphasis to environmental protection. So we continue seeing a lot of industries being set up with little regard to the environment. For example, we are yet to see the government devote one of its development plans to environmental protection, though some effort was made in June, 1994 when the government produced the NEAP report.

2.2.2 Industrial Pollution in Kenya

The industrial development in Kenya has hitherto provided a strong impetus to development and constitute an important engine of economic growth for the future. Whereas industrial expansion have brought about extensive positive externalities, certain diseconomies have occasionally set in the process including air, water and noise pollution and solid waste accumulation.

Kenya's industries are mostly agro-based and therefore assumed less

toxic. However, alot of water pollution can be observed in the following areas abutting rivers: River Nzoia has been polluted by the Pan African Paper Mills in Webuye, the Nyando River has been polluted by the Chemelil Sugar Factory, Ngong and Nairobi rivers have been polluted by the industrial establishments in Nairobi, while the Sosiani river has been polluted by industrial enterprises in Eldoret, among others.

Atmospheric pollution has been caused by vapours and gases from industrial process going on throughout the country. The Mombasa Oil Refinery emits about two tonnes of sulphur dioxide daily into the atmosphere.

2.2.3 Policy on Environmental Protection

Whereas Kenya's development policies has favoured industrial development, it has yet to give proportional emphasis to environmental protection. Kenya has yet to devote a whole development plan to environmental issues, just as it has devoted the latest one to industrial development. However, a major effort was made in 1994 with the production of the National Environmental Action Plan (NEAP) by the Ministry of Environment and Natural Resources.

Kenya's environment policies have been almost silent since independence. The first mention of environmental protection was in the Third National development Plan of 1974-78-obviously a response to the United Nations Conference on the Environment and Development held in Stockholm, Sweden, in 1973.

Immediately after the Stockholm Conference, Kenya established the National Environmental Secretariat (NES) in 1974 as a watchdog on environmental matters. Initially, it was under the Office of the President, then later adopted at the Ministry of Environment and Natural Resources created in 1978. The government has recently turned NES into an expanded National Environmental Action Programme (NEAP) to formulate environmental policies in Kenya.

The other policies contained in the subsequent plans have been rather general, taking about environmentally safe technologies instead of industries. The country's environmental policy however has some shortcomings. The National Development Plan of 1994-96 had noted that "Although the NES of the MENR has been carrying out EIAs at district levels, the methodology and the coverage at programme and project levels still leaves a lot to be desired. Moreover, there has not been an agreed system that facilitates regular reporting on the status of the environment in the country"

As noted above, Kenya's environmental policies seems to be a response to international conferences and not borne out of a genuine need to conserve the environment. After the United Nations Conference on Environment and Development in Rio de Jeneiro in Brazil in 1992, which came up with Agenda 21, which tries to find the solutions to the apparent conflict between development and the environment, the government produced the Seventh National Development Plan in 1994 having as its theme "Resource Mobilization For Sustainable Development".

What the policy lacks is what happens to those industries already set up and are the source of the greatest pollution in Kenya. Also, the policies fails to address the issue of prosecuting the industries which are found to be notorious in pollution. Moreover, so far there has not been a favourable taxation system as far as environmentally friendly machinery are concerned. The vital area of environmental information still is inadequate.

What was perhaps one of fundamental importance were the seven steps towards sustainable development proposed. Some of these steps include the assessment of environment and development conditions and the linkages and trends were to be established and made operational. Also, environmental laws were to be streamlined, strengthened and enforced. But this has yet to be realised.

The current development plan which is concerned with industrial development only is a blow to environmental protection. The idea in the plan seems to be that we need to industrialise to grow rich so that we can take care of the environment later. Experience from industrialised countries has shown that they are now paying dearly for the environment which was degraded as these countries pursued their quest for industrialisation and accumulation of wealth.

As the Brandt Commission (1987) observed "the expected growth in basic industries foreshadows rapid increases in pollution and resource degradation unless developing countries take great care to control pollution and waste, to increase recycling and re-use, and to minimise hazardous wastes". The Commission went on to say that "These countries

do not have the resources to industrialise now and repair the damage later; nor will they have the time, given the rapid pace of technological progress".

These countries can therefore profit from the improvements in resource and environmental management being achieved in industrialised countries, and to avoid the need for expensive clean-ups. Such steps can also help them reduce ultimate costs and stretch scarce resources. And they can learn from the mistakes of developed countries. And this is what Kenya should do.

2.2.4 The Legal Framework

Apart from the policy statements of the government, there are also legislations related to solid waste management. Specific acts of parliament which touches on industry, pollution, environment and solid wastes management especially in an urban area are, *inter alia*, the Public Health Act, the Local Government Act and the Factories Act among others.

The local government act chapter 265 of the laws of Kenya gives the local authorities in Kenya the responsibilities of maintaining cleanliness in the areas of their jurisdiction, and this include the collection of solid wastes from, among other areas, residential, industrial and commercial areas. The act also empowers the local authorities to enact by-laws to the same effect. But the application of this act has been somewhat ineffective. Nearly all the local authorities in Kenya do not collect these wastes properly.

The Public Health Act Cap 242 also requires the local authorities to maintain cleanliness of their areas. And the Factories Act deals only with the safety in the factories without mentioning the wider environmental aspects which the industries find themselves in.

All in all, there is lacking an all encompassing environmental law in Kenya. The environmental bill has in parliament for several years now. And currently, issues dealing with environment are scattered in sixty six sections of the Kenyan law. The members of parliament, while contributing to the vote for the Ministry of Environment and Natural Resources in the 1997/98 budget lamented the absence of strong legislation on environment.

2.3 Industrial Solid Waste Management

Introduction

Industrial solid wastes include scrap metal, paper and paper products, abandoned cars, tyres, bottles, cans, plastics, and so on. The rate of generation and characteristics of solid wastes in Kenya is unknown, a limitation that makes planning difficult.

Most solid waste disposal sites are poorly managed and some are located near water bodies, threatening water quality. Stinking refuse heaps from food industries dumped carelessly are not only a health hazard but also add to visual pollution. Disposal of plastic products and polythene bags are of particular concern because they do not breakdown under normal conditions. Polythene bags are often burned, although studies

have shown that the smoke is a hazard to health.

Proper solid waste management includes incentives for those practising environmentally friendly approaches. An appropriate management practice is to minimise the amount of wastes at various stages of production by recycling. Resource recovery is limited by lack of government incentives to recycling industries. One problem is the general lack of information on recycling, for example, the most efficient ways, and their environmental and health impact, among others.

The management of solid wastes in Kenya have been haphazard. Ohnesorgen (1992), points out that people in developing countries do not understand that solid waste management has to be approached systematically. It is normally treated as a non-professional job hence local governments employ non-professionals to man solid waste management departments. He concluded that although it is essential to public health and environmental protection, solid waste management in most cities of developing countries is "highly unsatisfactory".

Solid waste management is the major responsibility of local governments. It is a complex task which requires appropriate organizational capacity and co-operation between numerous stakeholders in the private and public sector.

In Economic Survey (May 1996), the government pointed out that most industrial urban centres and particularly Nairobi, Mombasa, Nakuru and Eldoret, industrial waste management has remained a very serious problem. The situation has to be corrected as the country continues

with the process of attaining NIC status in the year 2020 and if sustainable development is to be achieved.

Sources and Generation of Solid Waste

In order to develop frameworks within which waste management strategies can be planned, it is essential to know not only the amounts of waste generated and their sources, but also the materials in each waste stream, their properties, potential toxicity and hazards to human health and the environment (UNEP, 1992).

This information is very important in determining the methods, the type of equipment and the organizational strategy to be used in solid waste management.

Waste Generation Rates

Industries differ in the rate of solid waste generation and disposal habits according to their sizes, amount and type of raw materials, finished products and production technologies and processes, and a variety of other factors (Sewell, 1975). One industry may generate twice as much waste as another or triple the amount of another.

Because not much studies have been conducted in the industries in Kenya, the waste generation rates of most of them have not been established. According to the study done by Fadamulla in Nairobi's industrial area, an industry produces on average 0.191 tonnes per day which comes to about 80 tonnes per year. When that figure is multiplied

by the number of industries in Kenya, we can see the magnitude of the problem of industrial solid wastes.

The kinds and quantities of solid wastes generated by an industry are largely determined by size of operation and the technology used. For big industries, wastes are also more and those industries using inefficient technologies produce on average more wastes.

Composition of Solid Wastes

Industrial effluent in Kenya are discharged from industries such as food industries, textile and paper industries, petroleum industries, chemical industries and engineering works. Effluent from food industries such as canning, brewing, dairy, meat, sugar, coffee, tea, fruit, vegetable and miscellaneous food processing usually consists of biodegradable organic wastes with no toxic components.

Effluent from textile, leather and paper industries have the following common pollutants: alkalis which causes pH to rise, suspended solids and toxic metals such as chromium. Effluent from petroleum refineries comprise of phenols, oil, grease or suspended solids. Effluent from engineering works include electronics, metal finishing and transport system. The pollutants consists of acids causing pH depression, suspended solids, cyanide, chromium and other metals.

Industries also produce and use a lot of chemicals. Chemical substances play a major role in industry in the production of consumer and producer goods. Demand for more chemicals has led to an increase in

new industries producing and using chemicals. Chemicals released into the environment may pollute the air we breathe, the water we drink and the food we eat with serious consequences.

Industrial chemicals are used in the manufacture of, among other things, rubber, plastics, synthetic fabrics and paints. In Kenya, most chemicals are imported; and they play a very important role in various industrial processes. Industrial chemicals include metals and their compounds, including mercury, lead, cadmium, zinc, copper, chromium, selenium and titanium. Organic chemicals include polychlorinated biphenyls, polychlorinated terphenols, chlorinated chloroflourocarbons and pesticides. Other industrial chemicals are asbestos, arsenic, organic and inorganic solvents, gaseous compounds, nitrogenous compounds and radio-active materials such as those used in hospitals and research laboratories.

Other chemical industries which produce alot of effluent are those producing basic chemicals, fertilizers, pharmaceuticals, preservatives, batteries and dye-stuffs. Its pollutants include phenols, solvents (acetone, benzene and alcohol), acids, alkalis, ammonia, biodegradable wastes, chromium and other metals.

There are also what are called hazardous wastes. Hazardous wastes may be defined as all wastes that have hazardous properties which include being radio-active, toxic, explosive, corrosive, flammable, infectious or other characteristics causing danger to human health or the environment, wether alone or together with other wastes. These wastes include drugs, wastes resulting from manufacture of glues and

adhesives, treatment of metals, waste residues arising from industrial waste disposal operations such as incineration and so on.

Storage of Solid Wastes

The method of storage of solid wastes varies within an industry. The most important method of storage is the use of dustbins of different sizes. In developed countries, receptacles are standardized and labelled for particular industries and separated wastes.

The storage equipment in developed countries are more sophisticated and highly mechanized than in the developing countries. In countries like USA, waste is stored in huge containers (Skips) which are lifted mechanically during collection.

Generally, items used for storage of solid wastes in the industrial areas of Kenya include; plastic containers and bags, dustbins, standard containers, bulkbins and dustless containers, and some industries just heap them without using any containers at all (Fadamulla, 1991).

Collection and Transportation of Solid Waste

Waste collection is the responsibility of the local government. If waste disposal cannot occur on-site, the waste must be transported elsewhere. The frequency and thoroughness of solid waste collection is important since it affects the generation and cost. Hagerty (1976), points out that a great portion of solid waste management expenses arise from waste collection.

In most developed countries, waste collection from industries is contracted to private companies. In Nairobi there are a few number of private companies dealing with solid waste collection and disposal. These companies are normally contracted by individuals, industrialists or estate residents who have organized themselves into neighbourhood groups and they have a mode of paying for the service. An example of these companies is the BINS company. The truck still remains the primary means of collection and transportation especially in developing countries. The type of vehicles used in our towns are usually open trucks. They therefore tend to spill refuse along the route to disposal site.

However, transportation of industrial solid wastes should be minimised since these wastes should not be mixed with residential wastes.However, no municipality in Kenya has so far provided a separate waste disposal site for industrial wastes.

Nevertheless, some industrialists use their own lorries to carry wastes for disposal in the municipal site. This is bad but this trend seems to continue because the local authorities do not seem to have sufficient control over this issue.

Waste Reduction, Resource Recovery and Reuse

Many wastes contain useful materials which can be reclaimed and reused. Waste reduction and resource recovery are distinct waste management approaches for conserving environmental resources, reducing waste collection and disposal costs, and alleviating energy

shortages in cases where waste is used as a source of energy (Geller, 1982). Waste reduction refers to decreasing the generation of waste by reducing the consumption of environmental resources (Geller, 1982). Waste reduction will often require the application of contingencies that offer special rewards for waste reduction strategies.

Resource recovery means the retrieval of materials from wastes for some economically useful function (Sewell, 1975). This include the sorting of paper, cans, bottles, metals and other materials from industrial wastes and subsequent processing.

Recovery can be for an equivalent use such as the processing of newsprint or it can be for a degraded use such as the recovery of compost from domestic waste.

In numerous countries, measures have been instituted to reduce the amount of waste products generated as well as to promote reuse of materials. In the United States, for example a few states have mandatory statewide laws requiring industrialists to separate their wastes into recyclable and no-recyclable and they are collected separately. Some states require industrial waste to be sorted into various categories before collection (Bernstein, 1993). The French government regulate the use of certain materials, elements or energy sources to facilitate the recovery of constituent materials.

Economic instruments can also be used to encourage reduction of waste generated. In some instances, governments have instituted solid waste pricing systems that provide continuous incentives for industries to

reduce waste generation. Other incentives include tax credits to industries that use recycled materials as part of their raw materials, stabilization of markets for recyclables through price supports for the establishment of materials banks, soft loan that encourage private enterprises to implement resource recovery activities and so on. Deposit-refund system is also used in some countries to encourage reuse of containers.

Waste reduction and recycling strategies are not well developed in developing countries. According to Otieno (1992), recycling in developing countries is done on an ad-hoc basis, and those involved do more as scavengers and then sell off their "loot" which is mainly glass, tins and paper.

In Nairobi city the most important resource recovery method employed is recycling of paper into products such as toilet papers, cartons and other packaging materials. And in almost all the industrial towns, there is extensive reuse of scrap metals in the informal *jua kali* sector for the manufacture of various metallic implements. This was boosted by governments policy of encouraging small scale informal enterprises in order to solve the problem of unemployment and as a basis for our industrialisation.

Disposal of Waste

When waste have been collected and transported, there must be either further processing or immediate disposal. Sometimes the wastes are simply dumped and levelled in a landfill. Some wastes needs treatment

before disposal. These include hazardous industrial waste.

Stricter control over waste disposal especially hazardous waste disposal have been instituted in most developed countries and this has led to a rise in wastes exported. A number of instances have occurred where extremely hazardous waste has been sent sometimes under false declaration, to developing countries which have neither the facilities nor the technical expertise to deal with it (UNEP, 1992). However, no such incidence have been observed in our country (Kenya, 1994).

There are a number of methods of waste disposal used all over the world. These include land filling, dumping, incineration, pulverization and pyrolysis.

There are two methods of landfill. Sanitary landfill is the controlled burial of waste under compacted earth. A well drained site distant from any water body is excavated to a depth of about three metres and the wastes compacted in layers of six to eight feet then covered with six inches of compacted earth. When the landfill is completed, it should be covered with at least two feet of compacted earth (Sewell, 1975).

Coverless landfill or open dumping is a method whereby solid wastes are dumped into an open space without any covering. This is the most common method employed in Kenya where wastes are dumped in open spaces.

Provided there is no shortage of land with suitable geological formation, landfill still remains the principal final disposal system for the majority

of wastes, even in the highly industrialized countries. Over 70% of municipal wastes in North America and Western Europe are landfilled with little or no treatment (UNEP, 1992).

Incineration involves the burning of wastes under controlled conditions. Waste volume can be decreased by 80-90% by a conventional low-temperature incinerators and thus transportation costs can be drastically reduced. Only the ashes are taken for disposal (van Tassel, 1970). This seems the practical answer to mounting waste disposal problems in heavily urban and industrialised parts of the world.

A crude way of incineration is employed in Kenya whereby waste is fed to the flames usually because little or no consideration is given to potentially hazardous by-product, black soot is allowed to belch freely from the smoke stacks and fly ash descends upon surrounding land area. This is just uncontrolled burning.

The modern incinerators have been mounted with electrostatic precipitator which are the devices used to trap the particulate matter from the furnace which would otherwise be emitted into surrounding air (van Tassel, 1970).

Waste can also be used to generate energy through steam generators. In industries which produce a lot of combustible wastes for example timber industries which produce a lot of saw dust, this maybe a promising method of waste disposal.

Pulverization is rarely used. It involves smashing up of solid wastes

the high income residential areas and industrial area in Nairobi (Fadamula, 1991). Lack of clear policy on who pays for privatisation is the main obstacle in implementation.

These companies have been found to be efficient because they collect wastes regularly and provide better services, thus giving value for money.

2.5 Effects of Industrial Solid Wastes and their Management Methods on Humans and the Environment

Land Pollution

Solid wastes from industrial activities constitute an obvious threat to human health and the environment. If not properly disposed of, solid waste can result in health hazards such as contamination of ground and surface waters and air pollution. Uncollected waste is a health hazard. It is also a hazard to foraging wildlife and domestic animals. It can cause injury to both animals and human beings.

Beside being unsightly, waste occupy valuable space, block walkways and streets. Where land is used for waste disposal in landfills, the market value of the surrounding property is typically reduced.

Water pollution

The infiltration of rainfall water into landfill, together with the biochemical and chemical breakdown of the wastes, produces a leachate

which is high in suspended solids and of varying organic and inorganic content. All industrial wastes produces leachate. If the leachate enters surface or ground water before sufficient dilution has occurred, serious pollution incidents can occur. In surface waters, leachate high in organic matter and reduced metals will cause severe oxygen depletion and result in fish-kills, (UNEP, 1992).

If leachate enters ground water or shallow aquifers the problems are more serious. Dilution and removal of leachate is slower in ground water than in surface water and it may render the ground water non-potable. The best known example is Love canal in U.S.A where families living near the disposal site suffered health problems and were evacuated and the area was declared a disaster zone (UNEP, 1992).

Air Pollution

The decomposition of solid wastes in landfills can result in the production of carbondioxide and methane. Operation of incinerators can cause nuisance and atmospheric pollution from the emission of particulates, acidic gases, unburnt waste material, heavy metals, and trace quantities of organic compounds. Burning of waste can also cause fire hazard especially in dumpsites and also at industries.

Effects in the Marine Environment

The disposal of industrial wastes and sewage sludge can have diverse harmful effects on the marine environment and direct effects on human health. Ecological effects such as reduction or alteration of the

sedentary fauna populations have been observed in regions where waste is dumped, but it is not clear whether it is due to the physical presence of the waste or its chemical components (UNEP, 1992).

2.6 The Conceptual Framework

According to Tchobanoglous (1977), solid waste management is associated with the control of generation, storage, collection, transfer and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering ¡efficiency¿, conservation, aesthetics and other environmental considerations; and that is also responsive to public attitudes. This, he adds, include all administrative, financial, legal, planning and engineering functions involved in the whole spectrum of solutions to problems of solid wastes thrust upon the community by its inhabitants.

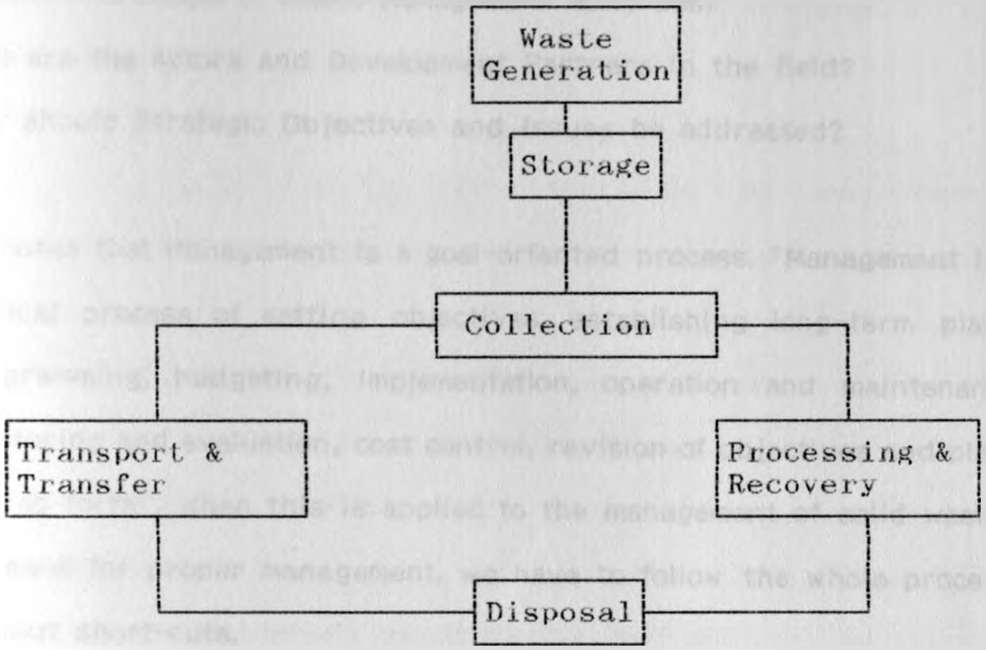
Proper solid waste management therefore involves determining the best method(s) of collecting the wastes produced by a community in a sanitary manner consistent with the desires of the inhabitants.

He suggests that the effectiveness of solid waste management method is measured by the difference between the solid waste generated and those collected. Solid waste management, therefore, concerns the interplay among generation, storage, presentation, collection and disposal; in which workable alternative programmes and plans are developed to solve solid waste problems.

The whole process of solid waste management can be conceptualised as

In Figure 2.1 below:

Figure 2.1: Conceptual Framework



Source: Tchobanoglous, 1977.

But the framework above do not show the actors concerned with the different activities at the different stages, leading to the following questions: Which institutions are concerned with the generation of wastes, storage, collection, transport and transfer, processing and recovery and disposal?

Schubeler (1996) in his **Conceptual Framework For Municipal Solid Waste Management** says that the Conceptual Framework provides definitions of the main concepts of Municipal Solid Waste Management (MSWM) and identifies the goals and principles that normally guide MSWM system development. He discusses key objectives and issues which would be addressed by MSWM strategies and include political, institutional, social, financial, economic and technological aspects.

He also goes on to say that the conceptual framework is structured along three principle dimensions, corresponding to the questions:

What is the Scope of Waste Management activities?

Who are the Actors and Development Partners in the field?

How should Strategic Objectives and Issues be addressed?

He notes that Management is a goal-oriented process. "Management is a cyclical process of setting objectives, establishing long-term plans, programming, budgeting, implementation, operation and maintenance, monitoring and evaluation, cost control, revision of objectives and plans and so forth". When this is applied to the management of solid wastes, it means for proper management, we have to follow the whole process, without short-cuts.

Henning and Mangun (1989) while examining how the concept of solid waste management has come about had noted that "as public appreciation of the extent of the economic and social costs of solid waste has grown, the concept of solid waste management has evolved". The assumption behind the concept is that man can devise a socio-technological system that will wisely control the quantity and characteristics of wastes.

The problems associated with the management of solid wastes in today's society are complex because of the quantity and diverse nature of these wastes (Tchbanoglous, 1977). The problems associated with non-domestically generated wastes are more complex due to the factors such as the uniqueness of the refuse.

In Kenya, there are two broad systems of solid waste management-public and private; with the former being the more conventional and traditional. The solid waste disposal unit is usually established at municipal level. The informal system usually involve the collection and disposal of wastes by individuals ('scavengers').

Habitat (Africa Waste Forum, 1994), noted that in the long-term, effective implementation of sustainable waste management practices should aim at:

(a) methods of reducing the problem of waste at source;
(b) programmes to stimulate recycling and re-use;
(c) addressing appropriate technologies for increasing service coverage; and
(d) ensuring environmentally sound disposal methods.

The composition of the solid waste collected, therefore, should act as a basis on which other management practices are approached. Separating the different wastes into various components at source will give a clear indication on how these wastes can be disposed of, resources recovered, re-used or recycled.

Bernstein (1993) examines the methods which have normally been used in solid waste management in many countries. He says that since the inception of environmental policy in most developed (and developing) countries, the command-and-control approach has been the dominant strategy. However, in recent years, many countries, primarily industrialised ones, have adopted economic instruments to introduce more flexibility, efficiency and cost effectiveness into pollution control

measures.

In theory, economic instruments have the capacity to regulate pollution according to the market mechanisms and thus facilitate deregulation and a reduction in government involvement. These economic instrument include user charges, disposal charges, product charges, subsidies, among a host of other instruments.

Solid waste management therefore need to be developed further. This will involve the need to formulate a theoretical framework. A theoretical framework must have the intention to structure and to integrate information patterns, mostly generated in different sources. It can hereby be experienced that the structure gives a better accessibility and an improvement of the use of the available information and that integration in many cases leads to synergetic effects.

Environmentally sound waste management must go beyond the mere safe disposal or recovery of wastes that are generated and seek to address the root cause of the problem by attempting to change unsustainable patterns of production and consumption. This implies the application of the integrated life-cycle management concept, which presents a unique opportunity to reconcile development and environmental protection.

Accordingly, the framework for requisite action should be founded on a hierarchy of objectives and focused on the four major waste related programme areas, summarised above as minimising wastes, maximising environmentally sound waste reuse and recycling, promoting environmentally sound waste disposal and treatment, and extending

waste service overage.

The four programme areas are interrelated and mutually supportive and must therefore be integrated in order to provide a comprehensive and environmentally responsive framework for managing industrial wastes. The mix and emphasis given to each of the four programme areas will vary according to the local socio-economic and physical conditions, rates of waste generation and waste composition. All sectors of society should participate in all the programme areas.

The study was therefore done based on these broad concepts of solid waste management.

CHAPTER THREE

BACKGROUND TO THE STUDY AREA

3.1 Physical Features

3.1.1 Location

Eldoret is located in the high-agricultural-potential highlands of the Uasin Gishu District in Rift Valley Province. The town is traversed by approximately latitude 0 31' North and longitude 35 16' longitude East. It lies approximately 65 Km north of the equator. Eldoret is approximately 330 Kilometres away from Nairobi by road and almost half-way between Nairobi and Kampala, the capital cities of Kenya and Uganda respectively. It is a focal point for roads from Kapsabet, Turbo, Kitale, Kabarnet, Kipkabus, Moiben and Western as well as Nyanza provinces (Map 3.1).

3.1.2 Relief

Eldoret lies at an average altitude of 2085 metres above sea level. The land rises from the River Sosiani valley both northwards and southwards from about 1800 metres in the extreme north-west and from below 2120m in the extreme south-east towards and beyond the 2200m contour line. The north part of Eldoret is marked by a steep slope (Map 3.2).

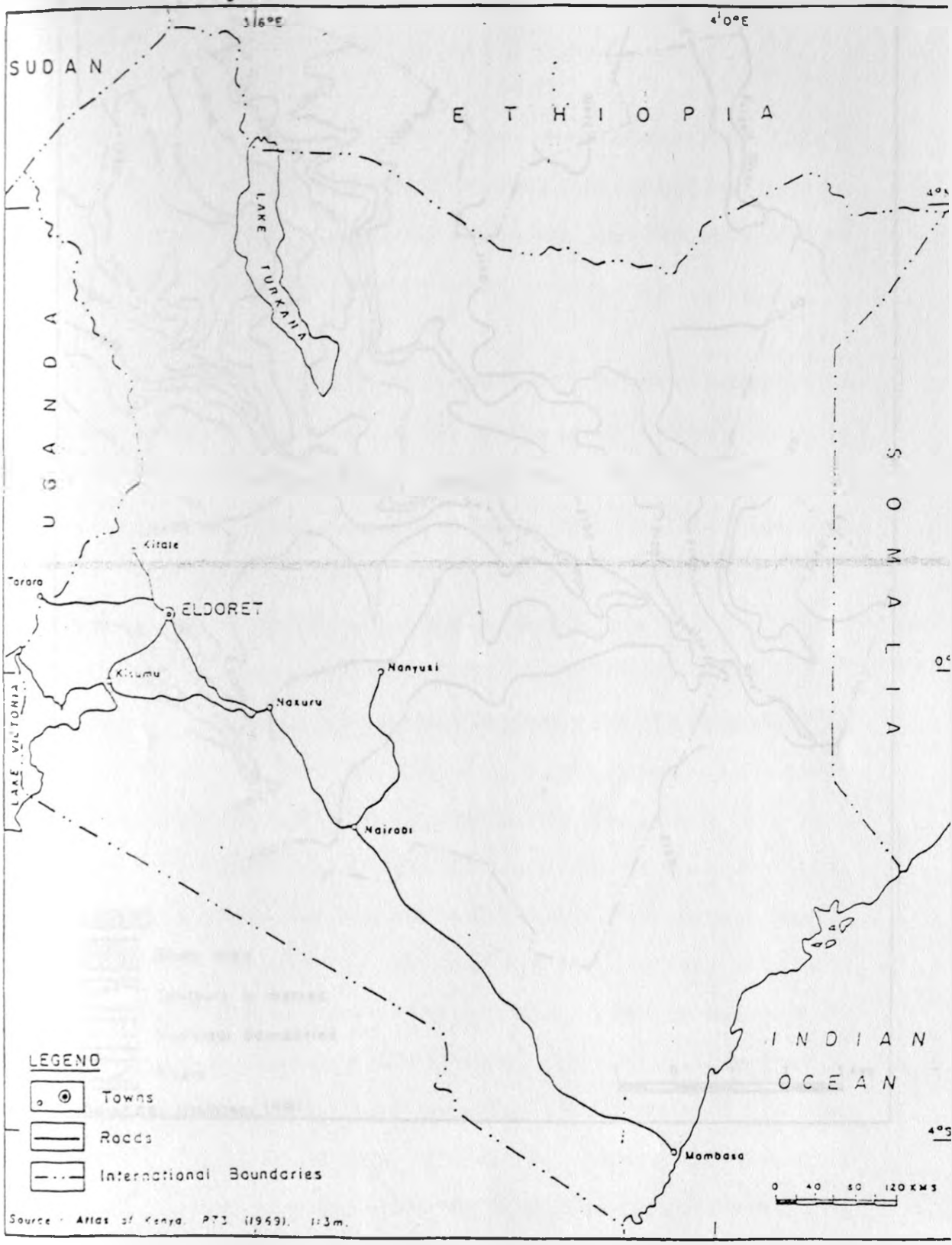
The area comprises of tertiary volcanic Uasin Gishu phonolite lavas. In geological terms, this area is referred to as lower Uasin Gishu

phonolites. Along the escarpment, are slopes of mainly rock outcrops or boulders. These today forms a good source of building materials. Quarrying of stones for building purposes now takes place along the escarpment where these rock outcrops predominate. On the plateau, the landform comprises of extensive level of gently sloping areas with undulations. Depressions are mainly gentle, broad and flat bottomed. The soils are dark brown clay loam laterites. This have a depth of up to 15 cm overlaying strong brown to reddish brown clay. Massive laterites occur at depths of 30-90 cm along where the plateau undulates.

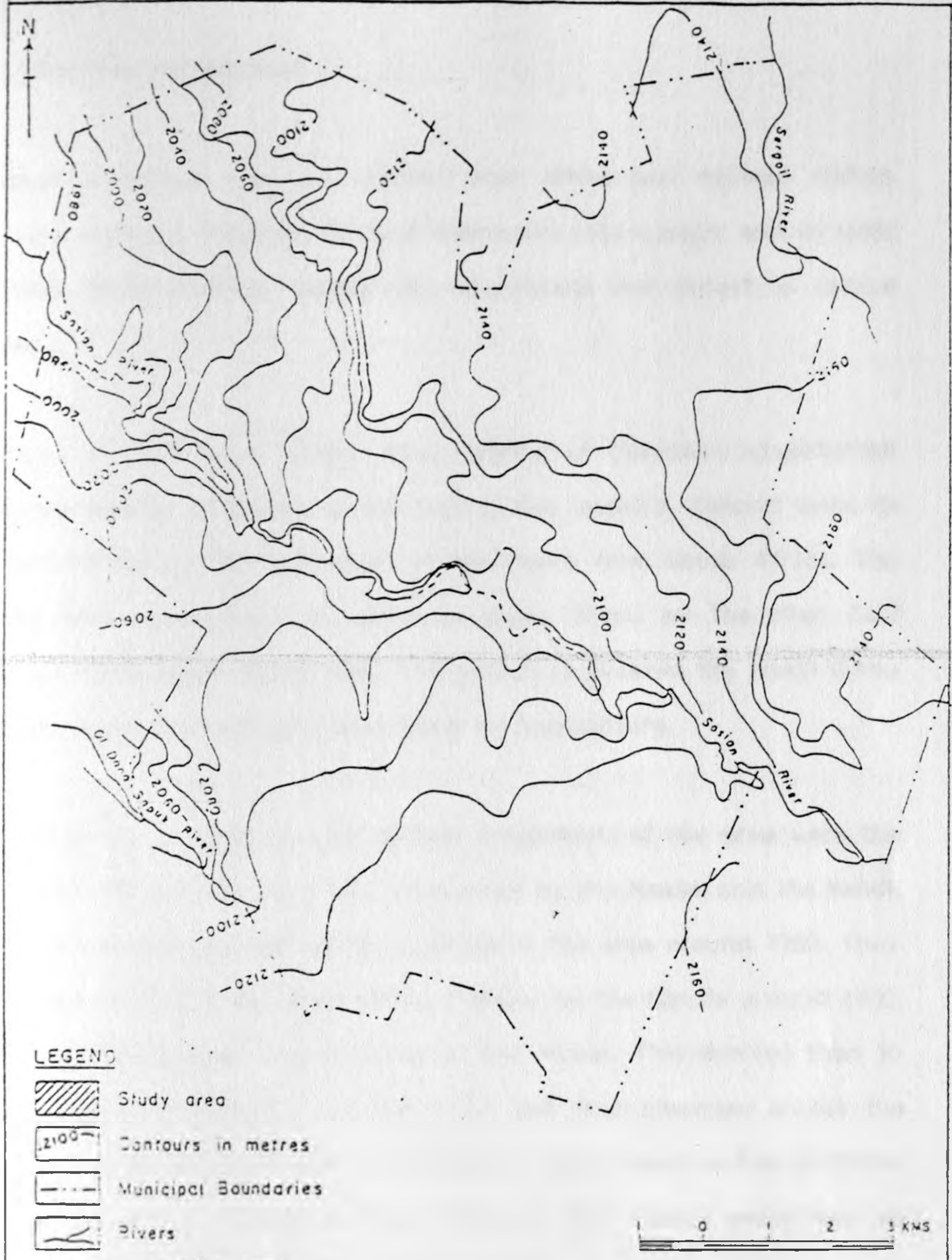
3.1.3 Climate

Eldoret experiences an average daily mean maximum temperature of 24^{0} Celsius. A total annual average rainfall of 1147.9mm was recorded at Eldoret for the period 1975 to 1982. However, between 1980 and 1987, a total annual average rainfall of 729.3mm was recorded. Most of the rainfall in Eldoret is received during the night. The months of June and August normally receive the highest amount, while December and January normally record the lowest.

MAP 3.1: LOCATION OF ELDORET IN KENYA



MAP 3.2 : A TOPOGRAPHICAL MAP OF ELDORET MUNICIPALITY



Source: Habitat, 1991.

3.2 Historical Development

Eldoret developed from an isolated post office and railway station serving mostly a European farming community into a major and dynamic regional administrative, commercial, educational and industrial centre today.

Eldoret, as it is known today, is a creation of European adventurism into the interior of Kenya at the turn of the century. Eldoret owes its modern origin to the settlement of the Boers from South Africa. The Boers were encouraged to settle in Uasin Gishu by the then East African Protectorate authorities. The British considered the Uasin Gishu Plateau as a "*murram pit*" unsuitable for agriculture.

Before the White settlers, the earliest inhabitants of the area were the pastoral Sirikwa who were later conquered by the Maasai and the Nandi. The Sirikwa are believed to have settled in the area around 1750. They were driven out of the Uasin Gishu Plateau by the Nandis around 1850. By 1900, Nandi power was supreme in the region. This enabled them to have access to pastures and salt licks and free passages across the plateau which facilitated barter trade with Arab traders on the northern caravan route to Kavirondo Gulf (Kisumu). The Nandis were then so powerful that when the European expedition later followed the caravan route, they were able to keep it under surveillance and eventually attacked it. Later, however, the British evacuated the Nandis from the Uasin Gishu plateau. The first white settlers in Eldoret area are believed to have arrived in 1900.

By 1910, Eldoret was an isolated post office station for the white farming community. At the same time, the Boer trekkers from South Africa arrived in the Eldoret area. The original site for the post office was an unattractive stony piece of land which was considered not good for farming purposes. In 1912, Eldoret was declared as a British administrative centre for Uasin Gishu and Trans-Nzoia districts.

The name of the town is derived from the Maasai word *Eldore* meaning "stony river". After conquest of the Maasai by the Nandi, the latter added 't' to make it sound like a Nandi name. By 1912, Eldoret was officially gazetted as a township occupying 2770 acres (approximately 11.2 km^2 or 1121 hectares).

Development in the region and the growth of Eldoret town remained slow until 1924, when a section of the Kenya-Uganda Railway passing through Eldoret town was completed. This, together with permanent settlements in Uasin Gishu District, were responsible for the growth of Eldoret as a railway yard with a junction to Kitale. As the seat of district administration and a service centre for the surrounding farming hinterland, Eldoret benefited from the population related to the local government, the railway and the farmers from the adjoining areas. By 1929, the town was elevated to a municipal board and gained municipality status in 1958.

The town boundaries have been extended on a number of occasions. The latest extension was done in 1988, when the town's boundaries were extended from 59 km^2 to enclose a massive 147.9 sq. km (Map 3.3). This extension appears to be well beyond the existing and future

requirements for urban land. The council has in the process engulfed large tracts of agricultural land, some of which have been illegally or legally sub-divided. Most of these sub-urban areas are rapidly developing into slums and/or squatter housing.

3.3 Population

The population of Eldoret has been growing rapidly over the years. The table below gives the population figures for the years 1948-1989.

Year	Population
1948	8,193
1962	19,605
1969	18,196
1979	50,500
1989	111,882

Source: Population Censuses. CBS.

This population is growing at the rate of 8 percent per annum and was estimated to be 193,808 in 1996 and projected to be 265,302 by the year 2000. The high population growth of Eldoret is attributed to the following:

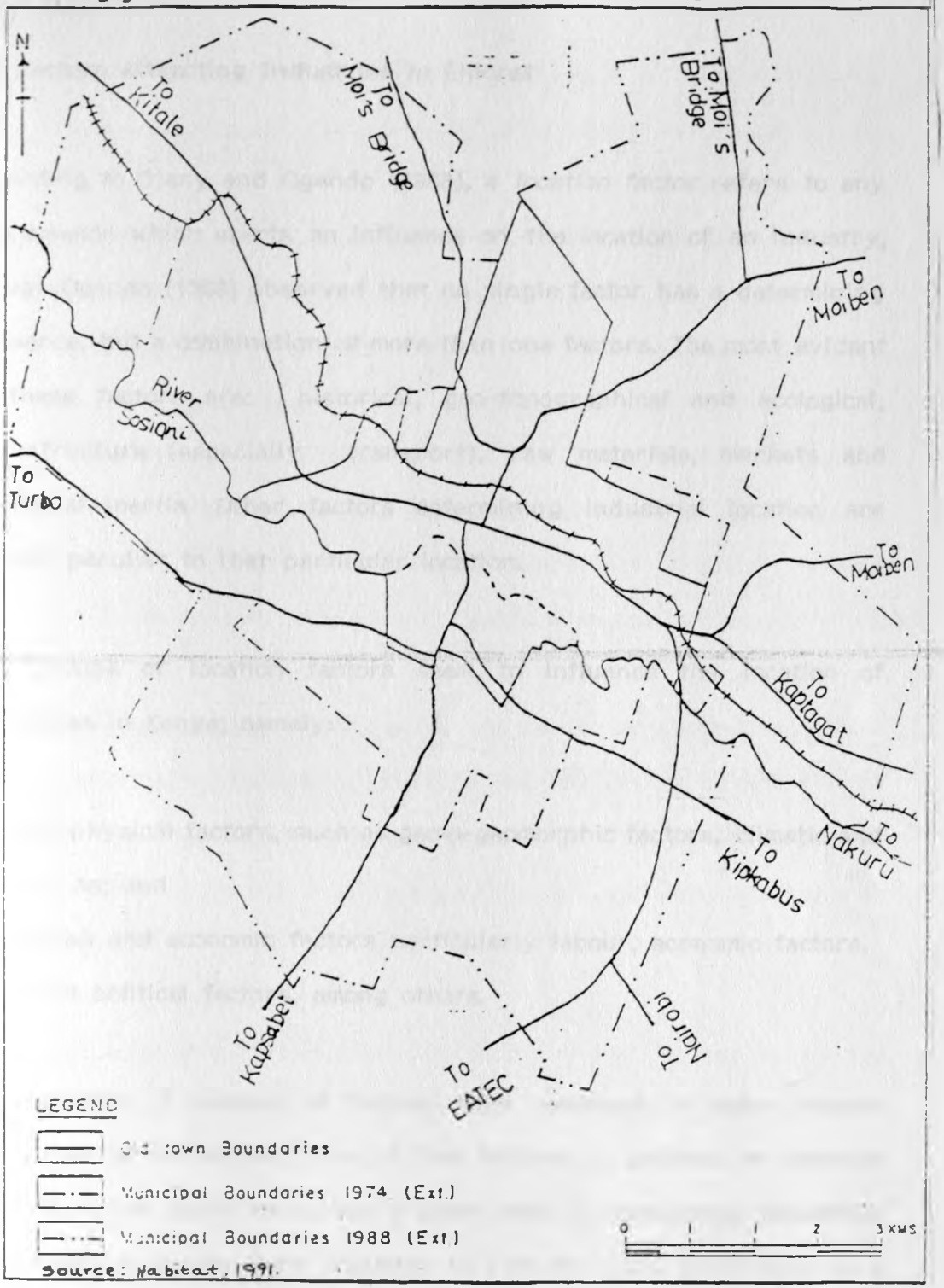
(a) Natural growth;

(b) Net in migration;

(c) Boundary extensions (which basically transform rural population into urban population), and

(d) Rapid increase in industrial growth.

MAP 3.3: ELDORET MUNICIPALITY BOUNDARY EXTENSIONS



Source: Habitat, 1991.

3.4 Factors Attracting Industries to Eldoret

According to Ojany and Ogendo (1988), a *location factor* refers to any phenomenon which exerts an influence on the location of an industry, though Ogendo (1969) observed that no single factor has a determining influence, but a combination of more than one factors. The most evident of these factors are: historical, geo-topographical and ecological, infrastructure (especially transport), raw materials, markets and industrial inertia. Other factors determining industrial location are factors peculiar to that particular location.

Two groups of location factors seem to influence the location of industries in Kenya; namely:

(i) The physical factors, such as geolo-geomorphic factors, climatic and so on; and

(ii) Human and economic factors particularly labour, economic factors, and political factors, among others.

Consequently, a number of factors have combined to make Eldoret attractive to industries. One of the factors is politics or political goodwill. Local politicians play a great role in convincing industrial developers to locate their industry in Eldoret. Local politicians here include both the members of the municipal council and the members of parliament. The present political leadership in Eldoret and adjacent districts have been able to attract many industrial projects and it is hoped that the same trend will continue in the future.

The other factor attracting industries to Eldoret is labour. Eldoret, situated in a very populous region have an abundant supply of labour.

The other factor is the deliberate policy by the central government of Kenya to deconcentrate industries aimed at easing the congestion in Nairobi and Mombasa. From June 1975, a 20% tax allowance is provided by the central government for any industrial undertaking located outside Nairobi and Mombasa. Through the Government's industrial dispersal policy from Nairobi and Mombasa and its policy and support for selected growth and service centres, Eldoret was chosen to develop as a regional industrial centre in the western region of Kenya.

Proximity to sources of raw materials or market is another important locational factor. Adequate supply of a variety of raw materials from the hinterland has led to the development of a lot of industries in Eldoret. A diversified and growing market for industrial products is also a key factor.

Large amounts of water is needed in textile industries for bleaching, washing and dying. Moderate temperatures are essential throughout the process. Eldoret has plenty of water at fairly low prices than Thika and Nakuru. This makes Eldoret highly favoured as far as the location of water consuming industries is concerned. Currently, the construction of the Moiben Dam in River Chebara, with the cost of Ksh. 1.2 billion, funded by the Kenyan Government and the German Republic, with a capacity of 3 million gallons per day, is the town's major water supply. It is estimated to supply adequate water up to the year 2020.

The availability of cheap industrial land is another factor influencing the location of industries in Eldoret. The town has plenty of industrial land, fairly flat to facilitate easy construction of factory premises and necessary services.

The other factor is the relatively well developed transport system. Eldoret is served by a railway line, roads and other communication facilities.

Existence of other supportive services and facilities like financial institutions, banks, real estates, and so on have also led to the rapid growth of industries in the town.

Another important factor which attracts industries to Eldoret is the relatively sound management at the council level. The municipal council of Eldoret is among the best managed municipalities in Kenya, and has been operating without deficits for some years now.

These have all combined to contribute to the steady growth of industries in Eldoret.

Environmental factors seem to be downplayed also are downplayed as far as the location of industries in Eldoret or anywhere else is concerned. Solid waste management do not even feature, though many industrialists know that their industries must produce wastes.

In addition to industries, Eldoret has an enterprising commercial sector. All the major national banks and other financial institutions are

represented in the town. Most commercial activities are carried out in Eldoret. These include wholesale and retail services, hotels and restaurants, among others. This sector is ranked third after manufacturing and service industries.

The construction industry has also been significant in the socio-economic development of Eldoret. In addition, Eldoret has recently acquired the status of an important educational centre. The most important educational institutions include Moi University, Eldoret Polytechnic, and Moi (Science) Teachers' College, now a campus of Moi University.

Other important trends in the development of Eldoret include Moiben Water Supply, construction of the third international airport in Kenya, construction of inland container terminal, among other developments.

3.5 The Provision of Services by the Eldoret Municipal Council

The town has enjoyed a sound management at the council level. The council has over the years operated without deficits. Thus compared with other Kenyan local authorities, Eldoret Municipal Council depicts a sound management standing as portrayed in the Table 3.1 below.

Table 3.1: Eldoret Municipal Council Budget Extract

Year	Revenue	Expenditure	Balance
1990/1991	56,149,432.00	42,446,599.00	13,702,633.00
1991/1992	123,539,297.60	97,984,472.20	25,554,825.40
1992/1993	208,372,454.75	182,161,523.85	26,210,930.90
1993/1994	177,330,178.00	163,566,618.00	13,763,560.00
1994/1995	263,149,135.00	230,303,416.00	32,845,719.00

Source: Eldoret Municipal Council, 1996

From the table, it is evident that the council has had a financially sound account for the last five financial years. All these factors combined have led to the rapid growth of the town.

3.6 Solid Waste Management Systems

The removal and disposal of domestic wastes within the municipality is the responsibility of EMC. However, industries have to manage their own wastes.

But solid waste collection is only done in those areas which are also served by the municipal water supply. About 60% of the town's population is served by solid waste collection services while the remaining 40% is unserved. The greatest challenge for the municipality is the high rate of growth of the town, which is currently fighting for city status.

The municipality however, seems to have left the management of industrial wastes to the industrialists themselves. There is hardly any inspection of the industries on how the manage their wastes.

This should be addressed since the industrialists are first and foremost businessmen and women who are out to make profit. And since wastes are of no value to the owner, there is a temptation to relinquish it at the first opportunity. And the industrialists therefore have been dumping wastes indiscriminately in the vicinity of their premises with impunity.

3.7 Eldoret's Industrial Areas

The Eldoret Municipal Council (EMC, 1986) in a document on why investors should choose Eldoret, gives the following account of the town's industrial area. Land planned for industrial development can be divided into two broad categories:

(i) Railway-served industrial area, and

(ii) Industrial land not served with railway siding.

Railway-served industrial land

(i) **Existing railway-served industrial land:** This is approximately 43.54 hectares (107.586 acres); this has been developed. Another 35.2172 hectares (87 acres) of railway served industrial land has been developed at Sosiani Railway Station which is only 5 Km from Eldoret railway station but within the Eldoret Municipality.

(ii) **Planned Railway Served Industrial Land.**

There is still 7.28 hectares of unused railway served industrial land. A further 20.23 hectares (50 acres) is available in an area which can easily be served. Another 25.395 (62.75) have been planned in an area which is only 2 Km from the railway station.

Industrial Land not Served with Railway Siding

(i) **Existing Industrial Area**

Only 37.3587 hectares (92.31 acres) of this type of industrial land has been developed.

(ii) Planned Industrial Areas

Major industrial land measuring approximately 169.88 hectares (419.78 acres) conveniently located in a site which is partly serviced with the necessary infrastructure conducive to industrial development has been planned.

From the foregoing analysis, it can be seen that Eldoret has appropriately 202.555 hectares (500.51 acres) of industrial land planned for both industry requiring railway siding and those that may not require railway siding.

3.8 The Distribution of Industries in the Town

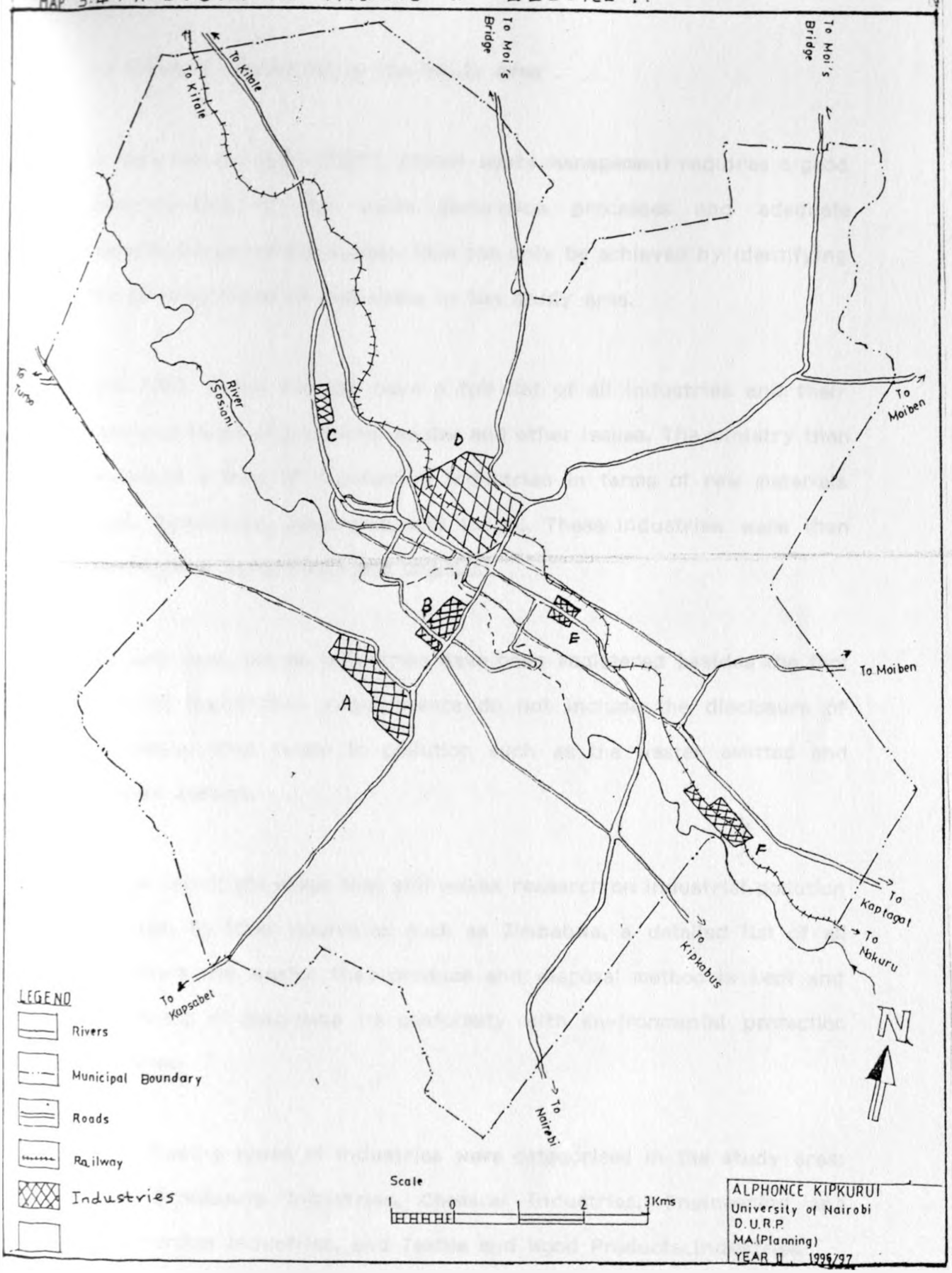
Eldoret do not have a clearly defined industrial area. But we can discern six broad industrial areas (Map 3.4).

Area A consists of industries like the Rivatex, Pyramid packaging and others along the Kipkarren road. Area B along the Kisumu road has mainly ENCO industries like the Farm Machinery Distribution, El Keiyo Tanks, and others.

Area C contains industries like the Raiply, and so on.

Adjacent to it is area D. This is the largest concentration of industries in the town. In the northern side is the KIE sheds and next to it on the eastern side is the Rift Valley Bottlers. In the southern side are industries such as Unga millers, and others. And along the Farmers' street are flour millers and bakers like the King's bakery, among others. Area E, contains Raymond's and opposite in the other side of the road is Ken-Knit. Area F which is further away from the town has the industries of KCC, CPC, EATEC and others.

MAP 3.4 : INDUSTRIAL AREAS IN ELDORET.



3.9 Types of Industries in the Study Area

As observed by UNEP (1989), proper waste management requires a good understanding of the waste generation processes and adequate characterisation of the wastes. This can only be achieved by identifying the existing types of industries in the study area.

Upto 1987, Kenya did not have a full list of all industries and their nature in terms of products, wastes and other issues. The ministry then developed a form of registering industries in terms of raw materials used, technology, ownership and so on. These industries were then classified as Agro, ENCO and Chemical.

But upto now, not all industries have been registered besides the fact that the registration requirements do not include the disclosure of information that relate to pollution such as the wastes emitted and disposal method.

This is one of the areas that still makes research on industrial pollution difficult. In other countries such as Zimbabwe, a detailed list of all industries and wastes they produce and disposal method is kept and monitoring to determine its conformity with environmental protection measures.

The following types of industries were categorised in the study area: Food Processing Industries, Chemical Industries, Engineering and Construction Industries, and Textile and Wood Products Industries.

Food Processing Industries

These are industries concerned with food processing. They are among the oldest industries in the town but form only 19.4% of the industries in the town. Examples of these industries include KCC, Unga, and others.

The wastes from these industries are in two groups. The first is the waste food products and the second is the waste packaging materials.

The waste food products are mainly organic matter in nature and are the least toxic. But if they are left uncollected, they cause very unsightly scenery besides the smell it exudes especially when rotten. They are also a good breeding ground for disease causing organisms like bacteria and disease transmitting vectors like rats, flies and other organisms which feed on the organic matter. They are therefore dangerous if not managed properly.

The food packaging materials include bottles, paper bags, among others. These wastes have various degrees of harm to the environment. They need to be handled like the wastes from the other categories of industries.

Chemical Industries

Chemical Industries make up 12% of the industries in the study area. These industries include acid factories, rubber products, plastic products, industrial chemical elements and compounds and others. The

chemical industries are concerned with the manufacture of chemical products.

This category of industries are feared as far as pollution is concerned. Its wastes have the least potential for reuse and the most injurious in compounds if introduced untreated into the environment.

Engineering and Construction Industries

The main engineering industries are motor vehicle repair industry and service of machinery and repair. There are a number of repair garages and engineering works.

In summary, the type of industries in this category include steel products industries, brass and copper products, machinery assembly, body building, basic metal industries, hand tools and general hardware, structural metal products, et cetera. These type of industries make up 31% of the industries in Eldoret town.

The types of wastes from these industries are mainly non-degradable and hence need very safe methods of disposal. They also have great potentiality for recycling and even Kenya's *jua kali* informal sector derives a lot of materials from these categories of industries. UNEP (1989) notes that at present, many developing countries lack the market structure for economically viable use of wastes from the industry and consequently wastes have to be dumped. Safe dumping sites which need to be properly monitored are not provided for the wastes, whilst new recycling techniques appropriate to local conditions have not yet been

developed. For Kenya, there is still lack of knowledge as to the quantity of wastes and their disposal methods.

In industrialised countries, 40% of steel is manufactured from recycled waste, which also save a considerable amount of energy. In Kenya, such estimates are non-existent although there are some recycling in the industry. It is hence justified to say that due to lack of information, the full potential of wastes in this category of industries still remains untapped, and the current disposal methods are a threat to health and environment.

According to Fadamula (1991), there is a high degree of recycling in this category of industries in Nairobi. About 12.6 tonnes of its wastes are recycled per day.

Textile and Wood Processing Industries

Eldoret has become an important industrial centre for production of textile products and some of the largest industries in Eldoret are in this category. Examples include Rivatex, Raymond's, Ken-Knit, among others.

3.10 Summary

Eldoret is located in a very rich agricultural area and has been experiencing a high rate of growth in all its aspects especially industrially. A number of factors prevail which attracts a lot of industries. These factors include proximity to raw materials, good transportation and communication network, water, power, and other

services. Eldoret also has an enterprising commercial sector.

The municipal council of Eldoret is one of the well-managed municipalities in Kenya, having operated without deficits for a number of years. The collection of wastes, however, is uncoordinated. The municipal council collects wastes in only 60% of the municipality, while the rest are not served. Furthermore, industries manage their own wastes. This has led to illegal disposal methods like dumping in open spaces, uncontrolled burning and so on.

Eldoret's industrial area covers 202.555 hectares (500.51 acres) which is 18.1% of the total land area of the municipality. However, these areas are scattered throughout the town, though three distinct areas can be discerned. These are the central industrial area, the Rivatex area and the KCC area.

The major types of industries in Eldoret are mostly agro-based, with quite a number of engineering and chemical industries. These industries produce different types of wastes which must be handled judiciously.

CHAPTER FOUR

MANAGEMENT OF INDUSTRIAL SOLID WASTES IN ELDORET

4.1 Introduction

Looking at the entire cycle of industrial solid waste management in Eldoret, a number of areas warrant critical attention. This was prompted from the fact that the issues at hand are not given the attention they deserve.

The industrialists in Eldoret appeared completely ignorant of the importance of a well-coordinated and functioning system of solid waste management. So did the municipality.

Starting with the vital issue of the records of the solid wastes produced, none of the industrialists ever thought of making any record of the wastes produced, either in the amounts, nature or the disposal methods. This was attributed to the fact that no authority, local or otherwise, requires them to do so. While they do not recognise that the records could also be useful to them, the industrialists do no have the plans to do so.

So in the management of solid wastes, we can say that there is a general failure from the monitoring point of view. And as such, the study relied very much on the estimates of the amounts of the solid wastes produced from the data collected using questionnaires.

This is a critical area and it needs the full attention of the local

authority, the ministry of commerce and industry and the ministry of environment and natural resources. The industrialists should be compelled to keep records of the amounts of wastes they produce, the types and the disposal methods before being registered. This will make the monitoring of the wastes an easier task.

All the industries in Eldoret produce solid waste. This confirms the fact that all human activities, and by extension, industries produce wastes which have to be eradicated in one way or another.

Solid waste management entails the understanding of the rates of generation of wastes, their quantities, their composition and their effects if disposed carelessly. It also needs an understanding of their nature in terms of those which can be recycled and those that cannot be recycled. In this way, any method of collection and disposal will have to consider the above factors.

This study observed that the understanding of the nature and character of the wastes has been very poor in the industries studied. It has not been known how these wastes affect the environment. The industrialists and the municipal council do not keep records of the wastes produced or their characteristics and therefore the information given here very much depended on estimates and actual measurements at the time.

4.2 Types of Industrial Wastes Generated

Having knowledge of the composition of the industrial solid wastes in

such a town is very important for their management environmentally and economically. For instance, such knowledge will reveal their nature in terms of whether they are predominantly metallic, chemical or organic and their likely effects on the natural environment if poorly discarded. This knowledge will also shed light on the potentials for reuse and recycling that lie in the wastes untapped.

The solid wastes produced by the industries in Eldoret closely correspond to the types of the industries themselves. A brief outline of the types of the solid wastes from the different classes of industries is given in the table below:

Table 4.1: Types of Solid Wastes Generated by the Different Types of Industries

Type of Industry	Types of Solid Wastes Generated
Food	Food Materials: e.g. spoilt flour, etc. Packaging Materials: e.g. papers, bottles, etc.
Chemical	Powders, rubber materials, plastic materials, e.t.c.
ENCO	Scrap metals, pieces of wood, e.t.c.
Textile and Timber	Textile fabrics, dye containers, wood pieces, sawdust, e.t.c.

Source: Field Survey, 1997

Food Processing, Textile and Wood Industrial Solid Wastes

From the table above, it can be observed that the different industries generate a mixture of different types of wastes. The food processing industries generate two types of waste. These are the food wastes from their manufacturing processes and the wastes generated from the materials used in the packaging of the food products. The food wastes

include spoilt flour, spoilt bread, and so on. The packaging materials which are used for packaging of food and end up as wastes in these industries include bottles, for example from Rift Valley Bottlers, paper materials for example from the Unga Group and polythene papers for instance from the bread manufacturing industries. These reflect mainly the raw materials whose primary origins are from agriculture.

The wastes from textile industries are mainly fabrics, and can be used to make pillows, mattresses, and so on. Wastes from wood related industries include saw dust, pieces of wood and so on.

The products of these industries are mainly consumer goods or foods, clothing (textile), wood and paper products, et cetera. And therefore the composition of their wastes closely resemble residential garbage.

Among all the industrial solid wastes, they are the least toxic. If they are disposed on their own specific site, they are biodegradable and can form manure which can be used in agriculture. Paper and wood products can be recycled or reused. However, there was no monitoring to establish these attributes. Nevertheless, these wastes should not be mixed with other wastes.

Engineering and Construction Solid Wastes

These category of industries release wastes that are noxious in nature. This is because these industries deal mostly in metal products. Their wastes have high concentration of metals.

It was observed that there is a high potential for recycling especially of scrap metals especially from body building works, et cetera. The wastes were used by *jua kali* artisans and some which were uncollected posed serious problems because they can cause injuries. This suggest poor disposal.

Chemical Wastes

There were fewer industries dealing with chemicals in the study area. The majority of them, though, dealt with rubber and plastic products, especially those used for packaging, and so on. They have the least potential for reuse and recycling. As far as pollution is concerned, they are the most toxic and the hardest to dispose.

4.3 Amounts of Solid Wastes Generated

The amount of the solid wastes generated in the study area is another area of prime concern in the management of solid wastes, perhaps the most important one. The scale of generation also varied with the majority of industries producing less than one tonne of solid wastes per day. The table below shows the rate of generation. The study observed that till now, there are no specific records on the quantities of solid wastes from the study area. The municipality which is charged with the responsibility of cleaning up the town has only a general estimate of solid wastes generated per day for the whole of Eldoret. The amount of collected by the municipality is about 100 tonnes per day, but it is not easy to state out of these how much comes from the industrial area. The study thus derives that there has been poor management

specifically of industrial solid wastes from quantity monitoring point of view. Given that industries generate more hazardous waste than any other source or land use, the recording and monitoring of their quantities is a very important aspect of their management.

The industrialists do not keep their records of the solid wastes they generate. This was mainly attributed to the fact that no authority requires them to do so. They also seemed not to realise the fact that the records are equally important to them and they can use the same in the management of solid wastes in their industries. Therefore the information collected was based on estimates given by the industrialists and collected using questionnaires.

On average, each industry produces 1.645 tonnes of solid wastes per day. Some industries produce as much as 7 tonnes of solid wastes per day. These are mostly the timber related industries which handle a lot of tonnes of timber in a day. The smallest amount of wastes were 0.04 tonnes per day, as the least. In total, industries in Eldoret produce 51.44 tonnes in a day.

Furthermore, chemical industries produce the least wastes. All the industries in this category produce less than half a tonne of wastes per day. In food processing industries, those producing less than one tonne of solid wastes per day are 80%. ENCO industries also produce less wastes. Those industries in this category which produce less than one tonne of wastes per day are 60 %. Textile and Wood industries produce the highest wastes. Those producing less than one tonne per day are only 25%. Therefore the majority produce more than one tonne of solid

wastes per day.

Table 4.2: Amounts of Solid Wastes Generated per Type of Industry

Type of Industry	Amounts of Solid Wastes (tonnes per day)			
	Minimum	Maximum	Average	Total
Food	0.04	2.5	0.672	8.36
Chem	0.05	0.5	0.2	0.80
ENCO	0.05	3.0	1.30	11.30
Text. & Wood	0.20	3.0	1.688	30.05
All	0.04	3.0	1.645	50.51

Source: Field Survey, 1997

Table 4.3: Solid Wastes Produced by the Type of Industry as Percentage of Total

Type of Industry	Total	Percentage of Total
Food	8.36	16.55
Chem	0.80	1.58
ENCO	11.30	22.38
Text. & Wood	30.05	59.50
Total	50.51	100.00

Source: Field Survey, 1997

It can be observed that the timber and wood industries produce more than half of the wastes in Eldoret.

4.4 Hazardous Nature of Wastes

Industrial wastes have different levels of toxicity. The agro wastes are the least toxic; since they are similar to the residential/household wastes. However, if disposed in an unhygienic manner, it can rot and start exuding bad smells. Also, it can act as a habitat for disease causing organisms. The ENCO and Chemical industrial wastes are very

toxic because it contains heavy metals. UNEP (1989) estimates that 15 to 20% of such wastes are hazardous meaning that in Eldoret, from about 24 tonnes of ENCO and chemical industrial wastes, we have about 5 tonnes of hazardous wastes. In Nairobi for example, it was found out that ENCO wastes contain 15 different harmful elements; while the chemical wastes contained 34 different harmful elements. The harmful elements include lead, cadmium, arsenic, chromium, mercury, among others (Fadamulla, 1991). And there are such wastes in Eldoret.

4.5 Production Technology

The technology of production is also important in the production of solid wastes because it determines the amount of raw materials which end up as solid wastes. The more efficient the technology, the lesser the amount of solid wastes produced, other things constant.

In the study area, the industrialists were asked if the technology they use was labour intensive or capital intensive, or a mixture of both. In all, the following table gives the percentages of industries using particular technologies.

In general, 74.2% of the industries use labour intensive modes of production. Another 19.4% use capital intensive technologies while the remainder (6.5%) use both labour intensive and capital intensive technologies.

Table 4.4: Production Technology

Type of Industry	Labour intensive	Capital Intensive	Both
Food	50	50	--
Chem	75	25	--
ENCO	80	20	--
Text. & Wood	81.8	--	18.2

Source: Field Survey, 1997

In terms of the wastes they produce depending on the type of technology, the following trends were observed:

Table 4.5: Production Technology and the Amount of Wastes Produced

Technology Used	Amount of Solid Wastes Produced			
	Mean	Minimum	Maximum	Sum
Labour Intensive	1.161	0.04	3.0	32.01
Capital Intensive	0.983	0.15	2.5	15.90
Both	0.5	0.25	0.75	13.60

Source: Field Survey, 1997

From the table, it can be deduced that industries using labour intensive technologies produce on average more wastes than the capital intensive industries. Although labour intensive industries are advantageous in that it alleviates the problems of unemployment in developing countries like Kenya, it nevertheless leads to a lot of wastages and inefficiencies.

Recognising that technology plays a very important role as far as the generation of solid waste is concerned, the improvement of the technology of production is a step in the right direction in formulating a proper solid waste management system. This will have the major advantage of minimising the wastes produced.

4.6 Methods of Solid Waste Collection

The collection of the solid wastes produced is another important stage in the whole concept of solid waste management. The way the industrialists in Eldoret collected the wastes they produced varied from one industry to another.

In all, there were two very distinct collection methods in the study area. These were: the use of collection bins and heaping in the compound. In fact, heaping of the wastes in the compound is practised by a great number of industries (66.7%), while only a minority (33.3%) were able to use bins in the collection of the wastes. This shows how the industrialists take lightly the issue of collection of the solid waste and they find it easier to just deposit them in their compounds or just throw them across the fence. They seem not to realise that the impacts of any industrial plant extend beyond its boundary fence. In any case, the dumping of wastes in the compound obviously made it easier for those industrialists to dispose off the wastes in their compounds as will be seen later (Plate 4.1).

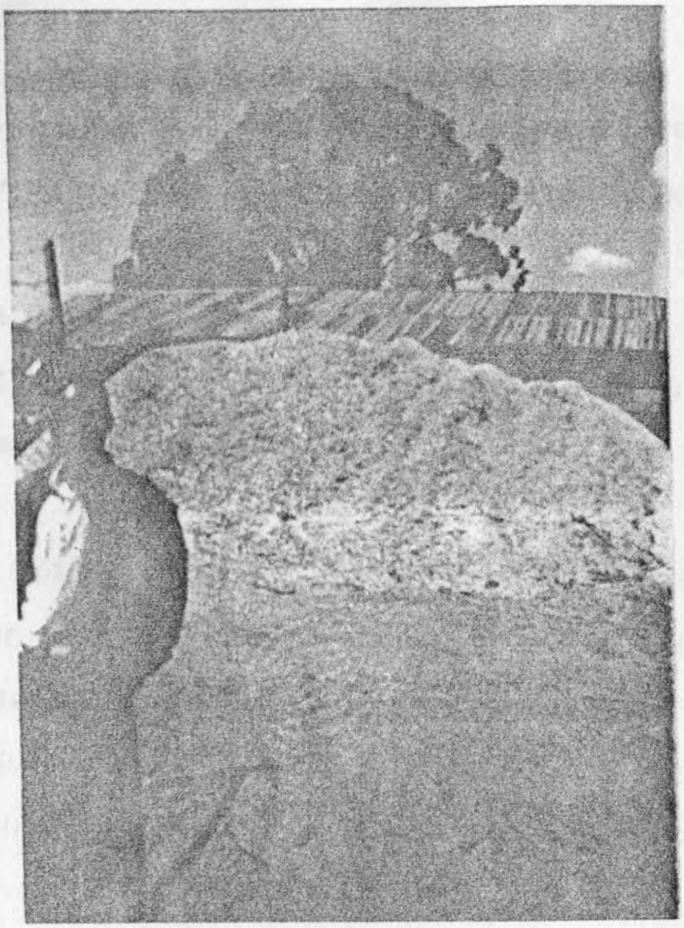


Plate 4.1: A heap of saw-dust piled in front of one of the industries in Eldoret

In these industries also, the safety of the factory workers is not seriously taken into account. They are the ones collecting the wastes and in most cases without any protective attire. This exposes them to a lot of risks especially from hazardous wastes.

Another aspect in the solid waste management which can shed light on the efficiency of the methods used is the length of time the wastes take in their collection points before final disposal. It was found out in Eldoret that the wastes usually take on average five days before they are disposed. This means that during that time, the wastes produce a lot of smells and also those which start to rot expose the workers to a lot of risks. The environment also suffers because the leachate from these wastes find their ways into the soils and even the water as they

await disposal. In the process when it rains, the wastes are washed and spread over an extensive area leading to the spread of pollution.

Given that the majority of the industries (67.7%) dispose their wastes daily and that another 25.8 dispose them within a week, cases were found of industries whose wastes can take as long a time as a month.

The majority (75%) of the food processing industries use bins in collecting their wastes. The rest just heap. This is a worrying trend since the wastes can rot and give out bad smells or act as breeding grounds for disease causing organisms. That explains why the wastes in these industries take less than a week in the collection places before disposal.

Seventy percent of the chemical industries heap their wastes in the compound. Given that the chemical wastes are the most harmful to the environment, this should be discouraged at all costs.

Engineering industries also heap their wastes (72.7%) in their compounds awaiting collection by jua kali artisans or as a way of disposal.

Majority of textile and wood industries also heap their wastes in their yards (60%). This attribute was witnessed by the heaps of saw dust and other wastes from these industries.

4.7 Transportation Methods

Of particular interest in the management of the solid wastes in the

study area was the question of the transport of the solid wastes. After the wastes have been collected, they must be transported to a disposal place.

In Eldoret, it was found out that the majority of the industrialists (86.7%) dispose their wastes in their compounds; thus effectively removing the role of transport. For those who transported the wastes to another place for disposal, the major form of transportation used was the lorry (Plate 4.2). These lorries belonged to the industrialists. It was observed that the majority of those who transport the wastes to another place for disposal were the timber and textile industries. The lorries used were open trucks making them spill wastes along the way.

These wastes which are strewn along the way spread bad smell to the general public, besides causing unsightly scenery along the way. There is also the danger of the spread of diseases in cases where the wastes have disease causing micro organisms. Injuries to people cannot also be ruled out. It is therefore imperative that proper method of transportation is devised.

Plate 4.2: A heap of wastes in one of the industries: Note the vehicle on the left of the photograph taking away recyclable containers for sale

4.8 Disposal methods

When waste have been collected and transported, the following stage is disposal. The disposal of wastes is the consummation of the whole cycle of solid waste management process from the generation stage. And it is no less important than all the other methods. In fact, it should be the most efficient part of the operation because it largely determine the success of failure or any solid waste management method.

The disposal methods used in the study area varied a lot, reflecting the

seriousness with which the industrialists took the issue of environmental degradation. In all the industries, burning of the wastes appeared to be the most popular method of disposal of the wastes practised by 32.3% of the industrialists. Also popular was recycling or reuse of the wastes, which was practised by another 32.3%. Other methods were indiscriminate dumping, selling of the wastes or a mixture of more then on of the above methods. The major methods of disposal found in the area were:

Uncontrolled Burning

Uncontrolled burning of the wastes is the most widespread disposal method practised. It was also found out that the burning of the waste was done inside the compounds of the industries or just outside the perimeter fence (Plates 4.3 and 4.4).

Plate 4.3: The burning of wastes by industrialists as a waste disposal method along the Kisumu road

Plate 4.4: The burning of wastes in one of the industries

In this case, the wastes heaped on the compound or outside the perimeter fence are just set on fire. There is nobody to inspect the way the wastes are burning and the extent of the effect of fire on the wastes or on the surrounding environment. There is also no control over the smoke produced, or the ashes which are produced.

The substances in the waste materials which come from the industries are usually composed of different elements, and the gases which are produced by these elements when burnt vary very much, with varying levels of toxicity. The carbon monoxide gas which is produced when elements containing carbon are burnt cause respiratory problems. Some of the industries dealing with tyre retreading, and using burning as a

Waste disposal method, actually cause a lot of pollution in the industrial area. Burnt tyres exude a bad smell and cause vomiting, among other problems.

This burning of the wastes created a lot of smoke which could be seen hanging over several areas in the industrial areas. Burning also caused a lot of problems in the town because the smell which the burning of the wastes produced was overpowering and in some cases choking. In some areas like the Huruma low income settlement, residents complained of headaches, and respiration problems because of the smoke coming from the direction of the Raiply industry.

Uncontrolled burning therefore is the most inappropriate method of solid waste disposal. The fact that it is practised by 100% of the chemical industries make the situation even alarming.

Incineration

This is the burning of wastes under controlled conditions. Waste volume can be decreased by 80-90% by a conventional low-temperature incinerators and thus transportation costs can be drastically reduced, only the ashes are taken for disposal.

When incineration is used judiciously and plant design and management are of a high standard, these methods of waste disposal can be effective in safeguarding people and the environment from any harm that wastes might cause. Where this is not the case, air and water pollution may occur.

Improper operation of incinerators can cause nuisance and atmospheric pollution from the emission of particulates, acidic gases, unburnt waste material, heavy metals, and trace quantities of organic compounds. Burning of waste can also cause fire hazard especially in dumpsite and also at homes.

In the study area, very few industries (19.3%) employed this method in the disposal of their wastes. These were industries in all the four categories. But this method was found to be insufficient. This is because the incinerators used were very small in a number of cases relative to the amount of wastes generated. In a number of industries which practised this method, the incinerators appeared very small, in fact too small to handle all the wastes produced by the industry (Plate 4.5).

Plate 4.5: The burning of wastes in one of the industries. Notice that the incinerator is in adequate; and the limited separation of reusable waste containers

It appeared that the incinerators were designed along time ago for a smaller industry, because they appeared overfilled and old. And in that case the wastes were burnt next to the incinerator and not inside it- more like the uncontrolled burning method. Proper sizes of incinerators will therefore have to be used in this area.

Recycling and Reuse

It is important here to review the potentials of recycling both as a disposal method and as a form of employment and income generation.

Many wastes contain useful materials which can be reclaimed and reused. Reuse occurs when a product is used over again, usually by another person and sometimes in refurbished form. Recycling of wastes is so far the only environmentally acceptable way of solid waste disposal. Reuse of the wastes was practised by a number of industries. This largely depended on the nature of wastes produced by an industry and of course the type of the industry.

In the first category of industries, that is the food processing industries, recycling of wastes was done at different levels. There were industries which used spoilt cereal products to manufacture livestock feeds. This was largely observed in industries such as the Unga Group of companies, which obtained spoilt flour from the sister companies and converted them into livestock feeds. The market for livestock feeds in Eldoret is very high since the place is an agricultural area. The feeds were therefore in high demand throughout the year.

Some of the broken bottles from the bottling industries like the Rift Valley Bottlers which otherwise would have been treated as wastes were used on top of concrete fences as security measures. This was rampant because of the booming construction industry in Eldoret.

In the second category of industries, that is the chemical industries, the type of recycling done was mainly in the industries making rubber products or reusing of the products. This was mainly the retreading of tyres.

Otherwise the wastes from these industries presented the least potentials for recycling. In the first instance, most of the wastes from these industries are toxic and in powder or other forms.

The engineering and construction industries perhaps provided the most classic example of recycling. The wastes from these industries which composed mainly of metals were found to be extensively reused. Among the industries which produced very large amounts of these wastes are the Eldoret Steel Mills and a number of body building companies.

The major reusers of their wastes were the small scale *Jua Kali* artisans who used them to make a number of products ranging from metal *jikos*, watering cans, metal candles, bowls, metal boxes, frying pans, some implements like knives, slashers, and so on.

This provided a lot of income to a number of people besides creating employment; but above all, conserving the environment. The popularity of this activity of recycling metal products by the *jua kali* artisans can

be attributed to the government policy of developing this informal sector as a basis for Kenya's industrialisation process. This is contained in the government's Sessional Paper Number 2 of 1995 on Small Scale Enterprises and Jua Kali Development in Kenya.

In the fourth category of industries, the major wastes were timber products and textile products. The timber wastes were probably the largest in the area. Tonnes and tonnes of saw dust were found in all the compounds of all these industries.

It became very clear from the study that the industrialists had a lot of difficulties in the disposal of the saw dust. In fact, they did not know what to do with it. But there was a limited use of this saw dust. Since Eldoret lies in a very rich agricultural area, the livestock farmers, especially poultry farmers, collected this saw dust and took them to be used in the poultry and pig houses. But this was insufficient. In fact, this had minimal impact on the situation, which left many industrialists with no option but to burn them, which is illegal.

The possibility of using the saw dust was not being tried in the town. Why the technology has not been adopted was not clear. In Nairobi, the saw dusts from the industrial areas are used to make ceiling boards, cardboards among other boards. This is a potentially useful area.

The other wastes products from the timber industries were an assortment of pieces of wood like the off-cuts, frames and others. These were sold by the respective industries for firewood or to carpenters to make various wood products like chairs, tables, windows, doors, and so

on. Off-cuts were especially used in the construction of temporary shelters either for habitation by low income people or to be used by the same people as kiosks or canteens along the roads or in the residential areas. Fencing using off-cuts was also practised.

The wastes from the textile industries composed mainly of textile fabrics. There was extensive reuse of these wastes. The industries sold them to small scale jua kali operators who used them to make mattresses, pillows, seats, and so on. At one of the industries for example, a bundle of these fabrics weighing about 150 killogrammes was sold at Ksh. 400. This bundle could make about 10 mattresses and when sold, each costing about Ksh. 170.

Between the industries themselves, 16.1% of the industrialists agreed to use solid wastes from another industry. These included the textile industries which use imported fabrics, among others.

This shows that the wastes provided employment and income to other people in the town besides being a good environmental conservation method.

This is one of the areas which seem to attract the attention of the industrialist as a better way of managing solid wastes. When asked if they use solid wastes for any purpose, 58.1% of the industrialists agreed that they use solid wastes in one way or another. There was an even larger percentage of those who think that solid wastes can be of any use (83.9%).

Dumping

The other prevalent method of disposal was dumping. This was just the throwing of wastes into open spaces in the area. This is closely associated with the collection methods. Those industries who heaped wastes in their compounds could be said to be practising dumping on their compounds.

Although the majority of the industrialists did not admit that their actions were dumping, the researcher observed that in a number of industries visited, there were a lot of wastes strewn all over the gates or over the fences of the industries,

Dumping usually is not the best method of waste disposal. The dumps usually act as breeding grounds for disease causing organisms, or the leachate from the dumps can contaminate ground water. The gases from the dumps like methane causes air pollution.

4.9 Place of Disposal

Eldoret has been said to be a town having enough area for industrial expansion. The area covered by the industrial enterprises can give an indication of this fact. The mean number of acres is 24.1 and the minimum area covered being a quarter of an acre while the maximum area covered is about 300 acres. Area covered however varied with the type of industry.

Table 4.6: Area Covered by Industries in Acres

Type of industry	Area Covered in Acres		
	Minimum	Maximum	Average
Food	0.25	40	22.542
Chemical	1	5	2.250
ENCO	0.25	40	5.1
Textile & Wood	0.25	300	50.136
All	0.25	300	24.089

Source: Field Survey, 1997

An outstanding finding was that the majority of the industrialists (86.7%) dispose their wastes in the compounds of their industries. This is because the industries in the study area have relatively large pieces of land. Also, these industrialists use incinerators and some dump the wastes in pits in the compounds. Interestingly, minority of the industrialists (3.3%) use the municipal dumping site (Plate 4.6).

Plate 4.6: The municipal dumping ground in Huruma. This is the place where wastes from residential, commercial and sometimes industrial areas are dumped. Notice the growth of slums in the background and livestock grazing in the foreground-oblivious of the health risks from the dumping site

This is good because the industrial wastes should not be combined with domestic or residential wastes.

However, an informal interview with municipal drivers said that they are sometimes paid illegally by the industrialists to collect their wastes especially when they are collecting municipal or residential wastes in the vicinity of the industries. This is a worrying trend.

Furthermore, the industrialists seem to have the express permission of the municipality to dispose wastes anywhere and in any method they

know. This includes the disposal in the compounds. The fact that the industrialists denied receiving any instructions from the municipality or the government on the way they manage their wastes indicates that the industrialists have some degree of liberty. But given that the industrialists are businessmen, and may not be acting in the best interest of the public, these places of disposal must be suspect.

The place of disposal of wastes becomes a problem when the harmful effects from the place affect the environment and humans. Since the industrialists disposes the wastes in their compounds, with the inevitable burning of the same, then the industrial environment becomes completely polluted.

4.10 Environmental Effects of the Solid Waste Management Methods in the Study Area

Poor industrial solid waste management has had its effect on the environment in the town. These effects included the pollution of land, water and air.

In the first instance, the degraded environment can be observed from the wastes which are thrown everywhere in and outside the compounds of the industries. This presented unsightly scenery thus unaesthetic look.

Burning of the wastes by the industrialists as a disposal method also contributed to a lot of environmental degradation. The smell emanating from the burning of the wastes was nauseating. Besides, the smoke from

the burning of the wastes was choking and irritating to the eyes. In fact, the residents of Huruma slums had complained time and again about the smoke coming from the direction of the Raiply industry, which they said made them have headaches, and respiratory problems.

Water pollution was also very prevalent. As earlier noted, at a seminar on pollution in 1996, it was found out that majority of industries released untreated wastes into the River Sosiani, impairing the proper functioning of the town's treatment works.

Land pollution was observed to be the most prevalent. Heaps and heaps of sawdust, and other wastes from other industries were dumped haphazardly on land.

4.11 Summary

In Eldoret, the major types of industries are agro-based, forming 54.9% of all the industries in the town. This is because the main factors attracting industries in this town are mainly availability of raw materials and market, accepted by 74.2% of the industrialists as the factors which made them locate in the town.

In their management of the wastes, the industrialists do not keep records, therefore the researcher relied on approximations and estimations by the industrialists. However, on average an industry produces 1.6 tonnes per day, giving a total of 50 tonnes of wastes per day from the whole industrial area.

These wastes have various levels of toxicity. The chemical wastes are highly noxious while the wastes from agro-based industries are the least toxic. Most industries use labour intensive technologies of production, which do not minimise wastes, though solving the problem of unemployment which Kenya is facing.

Most of the industries in the study area collect the wastes in their compounds by just heaping. And this is also where most of them dispose their wastes, thus reducing the need for transport to another disposal site. Though this is advantageous in that the industrial wastes will not be mixed with the general municipal wastes because of the different levels of toxicity, the disposal of wastes in the compounds is not sustainable, as the operation levels rises and the number of industries increases.

Also, those who transport the wastes used open trucks which spill wastes along the way. The methods of disposal were found to be mostly uncontrolled burning. This was found to cause a lot of smoke in the whole of industrial area, causing respiratory problems to the residents of the town.

In summary therefore, the industrialists exhibited a lot of ignorance in the effects of the solid wastes in the environment. More so, there appeared a lot of carefree attitude from all those concerned with solid wastes management. In fact, the municipal council seems to have left this activity to the industrialists to do them the way they know. When asked if they received any conditions from the municipal council on how to manage their solid wastes, almost all the industrialists (96.8%) denied

receiving any conditions. This means that the municipal council thinks that the industrialists can manage the wastes on their own.
On its part, the municipal council exhibited a "less concerned" attitude towards the whole issue of monitoring the industrialists in the way they manage the wastes. It was also found out that the municipal council did not allocate any site for the disposal of industrial solid wastes-implying that they do not see any difference between the two types of wastes.

It can also be pointed out that very few industrialists seem to perceive any problems from the solid wastes from their industries. When asked whether the solid wastes presented any problem to their industries, only 25.8% of the industrialists accepted that the wastes presented a problem to the industry. The rest (74.2%) denied. This was also found to be the case when the industrialists were asked if they have problems with the method of solid wastes they were using. Only 22.6% agreed that the current method of management was a problem. The rest (77.4%) did not see anything wrong with the method. This means that these industrialists are unaware of the environmental degradation they are inflicting on the environment. This is because they will be tempted to continue with their current methods without regard to the environment.

In fact, only 19.4% of the industrialists recognised that the solid wastes were harmful to the environment. Although the majority do not think that the solid wastes are harmful to the environment, they do not have a way of determining whether it is harmful or not. They "just think". But if it does not concerns their industries, it becomes polluting. For example, majority of the industrialists think that the solid wastes present problems to the entire industrial area, though they had said

that the wastes do not present problems to their particular industries. What a contradiction!

CHAPTER FIVE

POLICY IMPLICATIONS AND RECOMMENDATIONS

5.1 Introduction

Industries the world over pollute the environment. Whereas the developed countries have the information and the ability to combat this, the developing countries like Kenya do not.

Industries usually extract materials from the earth and insert by-products which are in form of gas, liquid or solid. Therefore reducing pollution includes how to handle these by-products. The focus of this study is on the management of solid wastes from the industries.

Methods of managing industrial wastes have been undergoing tremendous changes since pollution became a problem and the restoration of the environment became a necessity. Initially, industrial solid wastes were disposed of in landfills or open dumps which led to leaching and subsequent pollution of ground waters. Adverse environmental effects could occur even years after disposal.

This was the main method of disposal because there was a lot of ignorance about the hazardousness or toxicity of the wastes. Remedial measures costed a lot, with the cost as high as 2% of the GDP in some countries. Early preventive measures were therefore needed to avoid or reduce the high cost of restoration.

Environmental protection and resource conservation policies and

programmes were established, along with agencies to administer them. Initially, policies focused on regulatory measures. But later, a wide range of economic instruments were considered. Industries also developed new technologies to reduce pollution. From these measures, there was significant improvement on environmental quality.

Third World countries are now experiencing a high rate of industrial development, with little attention paid to the environment. The wastes from these industries are usually disposed of in landfills close to industrial estates that are surrounded by poor or shanty towns. These dangers point to the need for proper land use planning.

Better policies of combating environmental degradation have been found to be those encouraging minimisation of wastes and reusing or recycling of wastes.

In Kenya, a number of studies done on industrial towns like Nairobi, Athi River and Webuye reveal a high degree of pollution. The Government of Kenya has been encouraging industrial development with little regard to environment. This has made Kenya one of the most industrialised countries in East Africa. Eldoret has benefited from these policies to become one of the most industrialised towns in Kenya. The amount of wastes these industries produces is enormous.

Kenya's industries were initially agro-based. But a lot of chemical and engineering industries have been established, giving a new dimension to the level of toxicity of the wastes produced by the industries.

Industrial solid waste management in Kenya has been wrought with many problems. The rate of generation and the characteristics of the wastes is unknown, a limitation that makes planning difficult. Most wastes from industries are collected and disposed with the general municipal wastes, with no regard to their hazardousness.

Better methods of management like recycling is disorganized, limited only to scrap metals by the *jua kali*, supported by the government as a basis for industrialisation.

Another area is legislation, which appears weak, though it merits greater attention.

Effective, efficient and proper management therefore, should aim at the control of generation, collection, transportation and disposal which is in accord with the best principles of public health, economics, engineering and conservation of the environment. It should include all the administrative, financial, planning and engineering functions. An analysis of the scope, the actors and strategic objectives should be addressed.

The foregoing analysis of the study area clearly revealed that there are significant shortcomings in the management of industrial solid wastes in the town. The first institutional factor noted is lack of coordination between the municipality and the industrialists in the management of solid wastes. Thus it was noted that due to this, the industrialists continued managing the solid wastes in ways which are not consistent with good environmental acumen. They are therefore tempted to dispose wastes without regard to the effects these wastes have on the

environment and the general public. Thus the environment has been shown to be greatly affected.

Looking at the whole issue of the management of industrial solid wastes in Eldoret, a number of issues emerged, which have a lot of policy implications in the entire development ventures of the country. Of particular relevance are the policies relating to industrial development and the conservation of the environment, where the management of the industrial solid wastes fall.

Industrial development is desirable for our economy. But it should be a development where environment is well taken care of. This can only be done if for all the industrial development emphasis, an equal emphasis is placed on the environment.

5.2 Issues Emerging from the Field Findings

As has been stated in the summary of chapter four, there exists a lot of ignorance and carefree attitude in the management of the industrial solid wastes in the study area leading to environmental pollution. The environment is being affected by a number of harmful wastes churned out from the industries every day and every year. In order to understand fully how the system works and the loopholes in the entire management framework, an evaluation of the methods found to be practised will now be done in the light of the objectives which the study set out to achieve, in line with the assumptions made.

In the first instance, there are no records of the amounts, nature or

disposal methods of the solid wastes produced. This was attributed mainly to the absence of regulations requiring the industrialists to do the same. This therefore suggests poor management from the monitoring point of view. The first objective of the study was to find out the types of industries and the type of the wastes they produce.

Since there were no records to that effect, then it can be concluded that the management methods used in the area are seriously flawed, and therefore alternative measures will have to be put forward for better management of the same.

It was also part of the research objectives to find out the quantities and composition of the wastes produced by the industrialists in the area. This aspect was also lacking, therefore making the industrialists and the municipal council to be unaware of the magnitude of the problem of the industrial solid wastes.

Both the above factors, that is, the type and the quantities of the wastes produced have a great influence on the management method to use. Since such kind of information was lacking, the conclusion is that this is an area of serious concern.

From the study, it was found out that most of the industries in Eldoret are agro-based, and therefore the bulk of the wastes are organic, and therefore less toxic. But given the high rate of industrial development in the town, especially in the engineering and chemical industries, this situation is bound to change. Industries produce on average 1.645 tonnes of solid wastes per day, giving a total of 50.51 tonnes from all

the industries.

The need for a radical change in the management of the wastes was also found to be evident in the way and place of disposal of the wastes. Whereas most of the industrialists had relatively large pieces of land and therefore disposed their wastes in their compounds, the burning of these wastes gives rise to a lot of smoke, which is both a health and environmental hazard. This method of disposing waste is not sustainable as the number of industries increase and the spaces become small.

The role of the municipal council in the whole process of industrial solid waste management is very important. But in the case of Eldoret, it was found out that the council plays a dormant role in the whole issue. This came out clearly because the industrialists seemed to be operating without any supervision from the council and therefore there is no assessment of the effects of the methods used by the industrialists on the environment. That the council has abdicated its responsibility to nobody in particular suggests that the polluters will continue polluting the environment for sometime to come.

The fact that few industrialists took their wastes to the municipal site is a good sign since industrial wastes should not be mixed with residential wastes because of different levels of toxicity. Although this trend is expected to continue for sometime, the arrangement is not sustainable as the number of industries increase. So the council will have to brace itself for any arrangements to improve the level of collection, transportation and disposal of industrial wastes and also planning for another disposal site, mainly for the industrial wastes.

continue, the level of pollution is sure to rise.

From the foregoing discussion, it would be inferred that it is not only the policies which are flawed, but also the legislative measures and institutional arrangements at the national and the local levels not only regarding the industrial development but also environmental conservation that need drastic changes.

It has been shown that although the level of industrial pollution in Eldoret is rising, it is not the same as those in bigger towns like Nairobi and Mombasa. This is because the main types of wastes in this town come from agro-based industries, thus they are less toxic to the environment.

Therefore any solution to the problem of industrial pollution in Eldoret must take account of this factor. To let it continue like that will be courting disaster. The problem need to be 'nibbed in the bud'.

Under these circumstances, it would appear that it would be necessary for the central government and the local authority to institute comprehensive environmental protection measures to combat this rising level of pollution.

The improvement measures should aim at the monitoring of the industries by the local authority. This will include assisting the industrialists in collecting and disposing the solid wastes since the council has the capacity to do so.

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It is becoming increasingly difficult to separate the industrial development policies from environmental policies since they are all intertwined-each affecting the other. Therefore any examination of either of the policies invariably touches on the other.

Although we may detest the industries for polluting our environment, we still need them for jobs and the different products it produces for our development. What is needed therefore is to formulate a harmonious working relationship between the industries and the environment.

5.4 Industrial Development

While the government of Kenya has been striving very hard to industrialise with a lot of emphasis being given to industrial development, the environmental policies have been seriously inadequate. This can be said to be the cause of the resultant situation in our towns where we have witnessed a lot of industrial development with a lot of environmental degradation. A critical examination of our development policies clearly shows this bias.

Given that scenario, we can conclude that the rate of industrial development will continue being very high and of course the pollution of the environment will obviously be also high.

In Eldoret for example, the factors leading to industrial location were found to be favourable, backed by a lot of political goodwill. In effect, it means that industrial development in the town will continue being high. Thus leading to the production of a lot of solid wastes.

After having looked at factors that were identified as having influenced industrial location in the area, the perception of the study is that if the industrial area was to efficiently manage solid wastes, as a safeguard to environment and resources, then in decisions in planning, this issue should be accorded some strict attention. Failure to pay attention to it would imply lack of foresight about the outcome of high degree of industrialisation in the area when solid wastes emitted could become a difficult problem to manage. This should go further than restricting the location of industries in terms of the category.

In many cases, a good solid waste management programme has been known to increase the contribution of such large industrial development to wage employment.

5.5 Environmental Protection

Kenya's environmental protection policies have been in most cases erratic. They have usually tended to be a response to international conferences and not borne out of a genuine need for environmental protection.

Kenya has recently devoted a whole development plan to industrial development with little regard to the environment. This implies that given all the incentives, the rate of industrial development will be adversely affecting the environment.

The environmental policy in Kenya has been lacking in a lot of areas, especially in curbing industrial pollution. The policies are not specific,

especially on the need to record the amounts of solid wastes produced, the types and the disposal methods. The ministry of commerce and industry, which is charged with the responsibility of registration of industries do not yet have the powers to demand the same information from the industrialists. This is a worrying trend.

5.6 The Role of the Municipal Council

Because so many of the problems and solutions being addressed here have their roots in local activities, the participation and cooperation of local authorities will be a determining factor in fulfilling its objective. Local authorities construct, operate and maintain economic, social and environmental infrastructure, establish local environmental policies and regulations, and assist in implementing national and sub-national environmental policies. As the level of government closest to the people, they play a vital role in educating, mobilizing and responding to the public to promote sustainable development.

According to the Local Government Act, the municipal council is charged with the responsibility of ensuring that the town is clean. As per the Sessional Paper Number 1 of 1986 on Economic Management for Renewed Growth, and also contained in the current National Development Plan covering the period 1997-2001, the role of the municipalities in stimulating economic growth, especially industrial growth is given prominence. In the Eldoret Municipal Council document inviting investors published in 1986, the good attributes of the town are presented, which are ideal for industrial location.

Given these two major functions, the municipalities are the ones therefore on the middle ground between industrial development and keeping the town clean. Whereas there is a lot of industrial pollution in the town, the situation is not as bad as in Nairobi. The municipality seems to have enjoyed a sound management for a number of years.

5.7 Recommendations

After the above analysis, it is necessary for local governments in Kenya to establish a sustainable systems of solid waste management which meets the needs of the entire urban areas. Waste management should be approached from the prospective of the entire cycle of material use, which includes; production, distribution and consumption as well as waste collection and disposal. While immediate priority must be given to effective collection and disposal, waste reduction and recycling should be pursued as equally important long-term objective. The principles of sustainable waste management strategies according to Schubeler (1996) should include:

(a) Minimisation of waste generation,
(b) Maximisation of waste recycling and reuse, and
(c) Ensuring the safe and environmentally sound disposal of waste.

It is also true that solid waste management cannot be achieved through isolated or sectoral approaches. Sustainable waste management depends on the overall effectiveness and efficiency of urban management.

After the analysis of the situation of industrial solid waste management

in Eldoret, a number of steps need to be taken in order to improve the same. These are the recommendations designed to be a guide for better management of the industrial wastes. It was found out that the management of the wastes is a multi-departmental and multi-sectoral undertaking, involving a lot of actors and needs a lot of resources. This is because conserving the environment is not an easy task and obviously needs sacrifices.

5.7.1 Policy Reform

The role of policy in the industrial development and environmental conservation is of great importance. In Kenya, the policies have somewhat emphasised the development of the industrial enterprises without due regard for the environment.

The management of the environment now falls within four bodies. These are the Ministry of Environment and Natural Resources, the Ministry of Commerce and Industry, the Local Authority and the Industries themselves.

The ministry of commerce and industry should be empowered by the government in its registration of industries to be furnished with all the information which concerns the environment on top of the ordinary information like the name of the industry, owners, and the like. These information should include:

(i) the types and origin of raw materials,
(ii) the production technology,

(iii) the types and quantities of the wastes produced,

(iv) the disposal methods.

All these information should be freely available to the ministry of environment and natural resources, the local authorities, the industrialists, the general public and of course the research institutions like the universities.

The ministry of environment and natural resources can now use these information to come up with a policy which directly addresses the environmental issues of industries. Standards can then be set of the minimum requirements in all the industries. Since the local authorities are the ones dealing directly with the industries, they need this information in dealing with the day to day operations of the industrialists.

Bringing these actors together to contribute to the improvement of the environment will need to be given greater attention. It is recommended here that they come together and form a monitoring unit, which will be specifically concerned with the monitoring of industrial pollution of course including the management of industrial solid wastes.

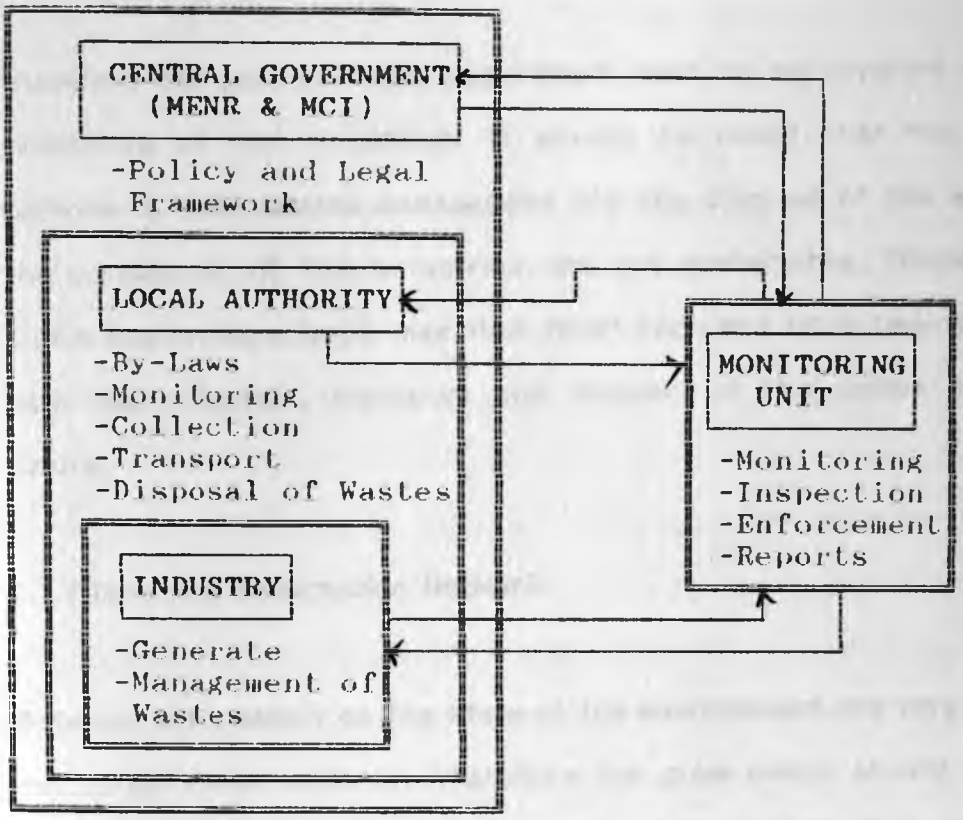
This unit will consist of experts from the central government-the ministries of environment and natural resources and commerce and industry; the local authorities and representatives of industrialists.

The cental government will be concerned with the formulation of policies and laws relating to the environment. The local authorities will be

concerned with formulating by-laws, and in some cases, collecting the wastes which are not collected by the industrialists and disposing them. The industries which produce the wastes are expected to manage the same.

The monitoring unit will therefore be composed of experts who have the technical capacity to undertake the monitoring and inspection of the industries. This body also should have the powers to supervise and enforce any of the regulations formulated by the three entities who came up with them. This body is also required to submit regular periodic reports, say monthly, or annually, on the state of the environment of all the industries in Kenya. This can be conceptualised as in Figure 5.1 below.

Figure 5.1: Policy and Legal Framework for Controlling Industrial Solid Wastes



Source: Author's Perception, 1997.

The Monitoring unit will be expected to report to the central government and any complains made by the industrialist will be determined there.

5.7.2 Institutional Reforms

The collection of solid waste in the Municipality of Eldoret falls within the department of public health. This department concerns itself wholly with the municipal wastes only and it does not cater for the industrial wastes. This is because it has been assumed all along that industrial pollution was not a serious threat in the town. But with the current

high rate of industrial development in the town, the management of industrial wastes can no longer be ignored.

Therefore the public health department need to be involved more in monitoring of the industries. It should be noted that the current methods of solid wastes management like the disposal of the wastes in the compounds of the industries are not sustainable. Therefore the public health department may find itself more and more having to deal with the collection, transport and disposal of the excess wastes in future.

5.7.3 Data and Information Network

Data and information on the state of the environment are very vital for any conservation activity. Therefore the government should establish mechanisms for assessing the value of existing information systems. It should establish a nationwide and regional information collection and dissemination clearing-houses and networks that are easy for government institutions and industry and other non-governmental organizations to access and use. It should undertake data gathering and analysis, establish national goals and monitoring of progress.

The kind of data needed will include amounts and types of wastes, generations rates, effects on the environment, among others.

5.7.4 Minimisation, Reuse and Recycling

Minimising wastes usually has the following objectives:

-To stabilise or reduce the production of wastes destined for final disposal, over an agreed time frame, by formulating goals based on waste weight, volume and composition and to induce separation to facilitate waste recycling and reuse.

-To strengthen procedures for assessing waste quantity and composition changes for the purpose of formulating operational waste minimization policies utilizing economic or other instruments to induce beneficial modifications of production and consumption patterns.

The government should initiate programmes to achieve sustained minimisation of waste generation. It should develop and strengthen national capacities in research and design of environmentally sound technologies as well as adopt measures to reduce waste to a minimum. It should provide incentives to reduce unsustainable patterns of production and consumption.

The government should develop, where necessary, national plans to minimise waste generation as part of the overall national development plans. The policy should aim at maximizing environmentally sound waste reuse and recycling. It should develop and strengthen national capacity to reuse and recycle an increasing proportion of wastes. It should review and reform national waste policies to provide incentives for waste reuse and recycling. The most important part will be to develop and implement national plans for waste management that take advantage of, and give priority to, waste reuse and recycling.

Even when wastes are minimised, some wastes will still remain. Even

after treatment, all discharged wastes have some residual impact on the receiving environment. The capacity to dispose these residues will have to be developed.

Among the strategies for encouraging the reusing and recycling are the control and command principles like the "polluter-pays-principle", where appropriate, by setting waste management charges at rates that reflect the costs of providing the service and ensure that those who generate the wastes pays the full cost of disposal in an environmentally safe way.

The other incentives will be the economic instruments like the reduction of taxes for industries commensurate with the level of pollution and so on, assuming that under economic conditions the management of the wastes will be efficient.

This aspect of the reuse and recycling of the wastes has been extensively covered in the development plan of 1994-1996. The government took the lead by first classifying the wastes into organic and inorganic. The an analysis of the different wastes and their possible reuse or recycling methods presented. For example reusing of the agricultural wastes can be done by briqueting. What needs to be done is to implement these glossy plans.

In the study area, many materials which are potentially reusable are lying idle. Major examples are the saw dusts among others. A technology which utilises these wastes should be introduced in the area.

5.7.5 Privatisation of Service provision

Private sector enterprises vary from micro-enterprises to large business establishments. As potential service suppliers, private enterprises are primarily interested in earning a return on their investment by selling waste collection, transfer, treatment, recycling and/or disposal services. Due to their profit orientation, private enterprises can under appropriate conditions provide solid waste management services more effectively and at lower costs than the public sector. However private sector involvement does not, in itself guarantee effectiveness and low costs. Problems arises when privatisation is poorly conceived and regulated and in particular, when competition between suppliers is lacking.

Privatisation of the management wastes in Eldoret seems promising. In Nairobi, the private companies collecting wastes were found by the industrialists to be profitable and efficient. This is because they collect the wastes regularly and at cheaper costs to the satisfaction of the clients-giving value for money (Fadamulla, 1991).

In Eldoret, there are no private companies collecting solid wastes. The only informal collectors were small scale operatives who picked wastes like the scrap metals and textile products for reuse. This needs to be developed further.

5.7.6 Constant Monitoring

The created professional body discussed above (Section 5.7.1) should

have power to constantly monitor the industries and also prosecute offenders.

Monitoring is a key prerequisite for keeping track of changes in waste quantity and quality and their resultant impact on health and the environment.

5.7.7 Legislation

There should be a comprehensive environment Act, unlike currently where laws touching on the environment are scattered in 66 sections of the laws of Kenya. The environment bill has been in parliament since 1990 and has not been gazetted. It should be gazetted as a matter of urgency.

5.8 Other Alternative Management Methods

Since most of the methods currently practised were found to be inadequate and therefore a number of alternative methods are suggested below.

5.8.1 Planning for a Waste Disposal Site

The municipal council have a lot of land planned for the development of the industries. It would be prudent to set aside some of this land for the disposal of wastes as the number of industries increase and disposal of wastes by industries in their compounds become impossible.

The site may not be easy to come by as Poerbo (1991) noted that city administrators and planners know well that the management of solid wastes is an increasingly difficult problem. As a city grows, so too do the distances between the city areas where the wastes are generated and the dumping sites and this is reflected in increasing costs. This seems to be true for Eldoret's industrial areas which are scattered in a number of places in the town. In addition, he adds, "new dumping sites are harder and more expensive to obtain".

This disposal site is recommended for the wastes from agro-based industries since their wastes are the least toxic and more or less similar to the residential wastes. A good sanitary landfill method of disposal is ideal.

5.8.2 Collection Methods

An improvement in the collection methods is needed so that the wastes are separated at the collection points into those which can be recycled and those which are not recyclable. Also the collection of the wastes should be extended to cover all the areas, unlike the present where the municipal council collect wastes in only 60% of the municipality.

5.8.3 Transportation Methods

It was found out that the role of transport in the transportation of the industrial wastes was minimum because most of the industries disposed their wastes in their compounds. However, those few who transported used open lorries so that the wastes were strewn along the roads. It is

recommended that the methods or means of transport be radically improved. The lorries should be at least covered so that they do not spill the wastes along the road.

5.8.4 Disposal Methods

The particular method which needs a major improvement is the incineration of the wastes by the industrialists. The incinerators which were found to be used were found to be too small to be effective, thus reducing the method of disposal to mere open burning. Standard incinerators should be installed for every industry that disposes the wastes in the compound so that the resultant wastes or ashes are the ones to be thrown away and the smoke generated from burning is minimised.

CHAPTER SIX

SUMMARY AND CONCLUSION

6.1 Summary

The study set out to assess the management of industrial solid wastes in Eldoret. Eldoret is now one of Kenya's fastest growing towns. The rate of industrial growth in Eldoret is also very high. The factors which attract industries in Eldoret were also found to be favourable-thus implying that the town will continue to experience a lot of industrial development in the days to come.

The government has been in the forefront in encouraging industrial development to the extent that it had devoted the eighth national development plan for the period 1997-2001 exclusively to industrial development, with the hope of attaining an NIC status by the year 2020. Most of the policies contained in the plan are modelled from the East Asian 'Tigers'. And Eldoret has benefited from these policies in its industrial development.

But with industrialisation has come a number of environmental pollution problems or degradation. A number of industries which have been set up in Kenya have led to extensive damage to the environment. Notable among these are the Pan Paper Industry in Webuye, East African Portland Cement in Athi River, Chloride Metal in Thika among others. Industries usually pollute the three sub-components of the earth's ecosystem, that is the air, water and the soil or land pollution.

Land pollution involve the accumulation of solid wastes on land from the industrial processes. These wastes have various levels of toxicity on the environment besides causing unsightly scenery. These types of wastes are usually in three types ranging from the wastes from the chemical industries which are highly toxic, wastes from the engineering industries usually composed of metals, to wastes from agro-based industries, whose wastes are mostly organic and resemble the residential wastes in most cases.

The management of these wastes have always been a problem in the developing countries which do not have enough organizational and resource capacity unlike the developed countries. Also, the industries in the developing countries were formerly agro-based, and therefore their wastes posed no serious threat to the environment. However, this situation has changed and now different types of industries are coming up at faster rates in these countries.

The level of pollution in Eldoret is also rising. River Sosiani which passes through the town is highly polluted. The river has been found to contain a lot of harmful chemicals emanating from the industries in the town and impairs the functioning of the treatment works.

Kenya's environmental policies have always been inadequate and the written policies exists only on paper with no effort at implementation. This has made the industries continue polluting the environment with impunity.

In Eldoret, the municipal council manages only the common municipal

wastes while the industrialists manage their wastes. How the municipal council relegated this responsibility to the industrialists despite the provisions of the local Government act which charges the municipalities with the responsibility of cleaning the town is interesting.

The management of solid wastes is usually an interrelationship of so many sectors, institutions and actors. It involves the study of the sources of waste generation, which in this case are the industries, the collection, the transport and the eventual disposal of the wastes.

The study had been approached first by putting forward a number of objectives. The objectives briefly revolved around finding out the types of industries and the types of wastes they produce, the amount and composition of these wastes, the methods of collection, transport and finally disposal.

An outstanding finding was that there are no records of these attributes in Eldoret, a fact which was attributed to the fact that no authority ever requires the industries to disclose the same information, not even to the ministry of commerce and industry which is charged with the responsibility of registering the industries. Therefore the study relied on estimates and approximations given by the industrialists and collected using a number of research instruments like the questionnaire. It was therefore concluded that the management of industrial solid wastes was inadequate from the monitoring point of view.

It was found out that the larger number of industries in Eldoret were

mostly agro-based and therefore generated the largest amount of wastes. On average an industry in Eldoret produces 1.645 tonnes per day which gives a total of about 50 tonnes per day from the whole industrial area. It was also found out that most industries dispose their wastes in their compounds by uncontrolled burning, which though it reduces the need for transport to a disposal site, caused a lot of air pollution.

It was therefore recommended that the industrialists install proper incinerators in their premises to be used in disposal of wastes.

Recycling was also found to be practised in a number of cases with a lot of potentials, creating income and employment to a large number of people. It can be noted that this is a an area where the government is encouraging through its policies of encouraging the development of small scale enterprises and *jua kali*. It is also good because recycling so far is the only environmentally safe method of waste disposal.

Also, a number of policy measures have been recommended for proper industrial solid waste management.

6.2 Conclusion

Proper industrial solid waste management involve the correct handling of the wastes from the generation, collection, transport and disposal. All these stages are interrelated and a deficiency in one stage jeopardizes the whole process.

Furthermore, solid waste management involve the participation of a number of actors starting with the central government, through the ministry of commerce and industry, the ministry of environment and natural resources; the local governments and the private sector (the industrialists). Also, any breakdown in the coordination of all these entities will cause a serious breakdown on the whole management problems.

The emphasis by the government given to industrial development, with little emphasis on the environment portends doom to the environment. Preserving the environment is now a matter of urgent concern. The time to act is now and not later. And with that, we can enjoy the fruits of industrial development long after the year 2020.

In Eldoret,there is a high rate of industrial development. This is also accompanied by the high rate of environmental degradation and the methods found used for handling the solid waste from industries in particular were found wanting, and therefore the suggested recommendations will go along way in environmental conservation.

6.3 Areas for Further Research

A research like this can never be exhaustive. There are quite a number of areas which needs further research in order to come out with a better method of managing industrial solid wastes in the town and in the country in general. One such area is the use of the wastes generated from the industries. One of the wastes, saw dust, was very common.

Given that one of the largest industries in Eldoret are timber industries, the estimated amount of saw dust generated per day is about nine tonnes. With the diminishing forest cover in the country, these materials should not be left to waste as is currently the case. A new method of reusing the saw dust should be developed for industries in Eldoret. This will not only preserve the environment but also save on the use of natural resources.

There are still a lot of areas where research in Kenya still falls short of the expectations. Organisations dealing with industrial research like KIRDI should not only concentrate on industrial development but also on the management of pollution and in particular solid wastes. This will involve researches on waste minimising technologies, reuse of wastes and safe disposal methods.

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Appendix 1: Industry Questionnaire

UNIVERSITY OF NAIROBI

FACULTY OF ARCHITECTURE, DESIGN AND DEVELOPMENT

DEPARTMENT OF URBAN AND REGIONAL PLANNING

ELDORET STUDY

INDUSTRY QUESTIONNAIRE

QUESTIONNAIRE NUMBER: [ ]

Date of Interview.....

Name of Interviewer.....

Name of Respondent (optional).....

NB: This study is purely for academic purposes and the information given will be treated with strict confidence

BACKGROUND INFORMATION

1. Position of the Respondent in the Industry . . . . . .
2. Sex: Male..... Female.....
3. Nationality.....
5. Name of Industry . . . . . .
6. Type of Industry: (a) Food..... (b) Chem....
   (c) ENCO..... (d) Textile & Wood Products . . . .
7. Finished products . . . . . .
8. Ownership . . . . . .
9. Location of Industry (Ward/Street) . . . . . .
10. Size: (i) Number of employees . . . . . .

(ii) Area covered .....

(iii) Production capacity .....

11. When was the industry started? .....

12. Do you export any of your products? Yes..... No.....

13. What are the raw materials used in production? .....

14. From where do you acquire the raw materials? .....

15. What problems do you experience in acquiring raw materials? .....

16. What problems do you experience in production? .....

17. What factors do you think influenced the location of this industry here? .....

18. Do you think the location is appropriate? .....

SOLID WASTE MANAGEMENT SITUATION

19. Does the industry generate solid waste? .....

20. What is the nature/type of the solid waste generated? .....

21. What would you say about the technology used in production? (i) Labour-intensive (ii) Capital-intensive

22. Have you changed the technology since the start of the industry? Yes..... No.....

Give reasons .....

23. Do you think the technology used minimises waste generated? Yes..... No.....

Give reasons .....

24. Approximately, what is the total amounts of solid waste generated per day? .....

25. What facilities do you use for collecting solid wastes? .....

26. Who takes solid wastes to collection points? .....

27. How long does the waste take at collection points before disposal?

28. How do you dispose of your solid wastes? Specify . . . . . .

. . . . . .

29. Where do you dispose of your solid wastes?

Place . . . . . .

Approximate distance . . . . . .

30. Do you think solid waste present any problem to this industry? Yes..... No.....

Specify . . . . . .

31. Do you use your solid waste for any purpose? Yes.. No..

Specify . . . . . .

.32. Do you think your solid waste can be of any use? Yes/No

33. Are there other industries using your solid wastes for any purpose? Yes.... No....

Specify . . . . . .

34. Do you use solid waste from another industry? Yes/No

Specify . . . . . .

35. Do you receive any conditions from the government or the municipal council on how to manage your solid waste? Yes.. No...

Specify . . . . . .

36. How many the stages of production do you have?.....

. . . . . .

37. Among your stages, which one do you think generates more wastes than others? . . . . . .

38. Do you experience any problem with the current solid waste management method(s) Yes..... No.....

Specify . . . . . .

39. Has there been any public reaction about the solid waste produced

by your industry? Yes..... No.....

Specify . . . . . .

40. Do you think the solid wastes produced by your industry is harmful to the environment? Yes..... No.....

41. Do you have a way of determining if the industrial solid wastes produced in your industry are harmful to the environment? Yes.... No....

Specify . . . . . .

42. Is there any other way you think the current disposal method(s) can be improved? Yes..... No.....

Specify . . . . . .

43. Are you allocated your disposal site by the municipal council? Yes.... No....

If yes, specify . . . . . .

44. According to you, do solid wastes present any problems to the entire industrial area? Yes..... No.....

If yes, what kind of problems? . . . . . .

If no, why . . . . . .

45. What would you, as industrialist, suggest to help upkeep the quality of our environment with regard to solid waste disposal? . . . . .

THANK YOU VERY MUCH

Appendix 2: Municipal Council Interview Schedule

UNIVERSITY OF NAIROBI

FACULTY OF ARCHITECTURE, DESIGN AND DEVELOPMENT

DEPARTMENT OF URBAN AND REGIONAL PLANNING

ELDORET STUDY

Name of Interviewer.....

Date of interview . . . . . .

Position of Respondent.....

Name of the Respondent (optional).....

NB: This study is for purely academic purposes and the information given will be treated in strict confidence.

MUNICIPAL COUNCIL INTERVIEW SCHEDULE

1. What would you say is the condition of solid waste management in this town?

   (i) Excellent (ii) Good (iii) Bad (iv) Worst

   Explain . . . . . .

2. Which department manages solid waste in this town? . . . . . .

3. Do you think that department is facing any difficulties in discharging its duties? Yes..... No.....

   If yes, specify . . . . . .

4. How do you think solid waste management could be improved in this town? . . . . . .

5. Approximately, what is the amount of solid waste collected in this town per day? . . . . . .

6. Do you handle any industrial waste? Yes..... No.....

   If yes, from which industries . . . . . .

   If no, why . . . . . .

7. Do you provide industries with different solid waste disposal sites?

   Yes..... No.....

8. Do you think that industrial solid waste is a problem in this town?

   Yes..... No.....

   Specify . . . . . .

9. What are the major types of solid wastes generated by industries?

10. Has there been any public reaction against the solid wastes produced by the industries? Yes.... No....

    Specify . . . . . .

11. What type of industries produce the largest amount of solid waste? . . . . . .

12. In general, how do industries manage their solid wastes (e.g. in handling, transport, recycling, disposal methods)? . . . . . .

    . . . . . .

13. Do you give the industries any instructions, conditions or guidelines on how to handle their solid wastes? Yes... No..

    Specify . . . . . .

    . . . . . .

THANK YOU VERY MUCH