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TOPIC:

AN ENVIRONMENTAL AUDIT OF SUAME MAGAZINE

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE MASTER OF SCIENCE DEGREE IN ENVIRONMENTAL RESOURCES MANAGEMENT

BY

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DECLARATION

I do declare that, except for references to other people's work which have been duly cited, this work submitted as a thesis to the Department of Mineral Processing and Extractive Metallurgy/Mineral Science ad Engineering, Institute of Mining and Mineral Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, for the degree of Master of Science in Environmental Resources Management is the result of my own investigation and has not been presented for any other degree

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DEDICATION

To my wife Bernice Naa Amerley Dankwa Wiredu and our daughter Crystal Mensah-Wiredu.

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ABSTRACT

The environment of Suame Magazine has been audited. Notable among the characteristics of Suame Magazine is the high level of ingenuity exhibited by the over 4000 artisans who work there.

The audit took the form of a general survey of environmental practices prevalent at Suame Magazine. The audit sought to determine the extent to which Ghana's environmental laws and standards were being adhered to at Suame Magazine. It also sought to determine the suitability and efficacy of health and safety measures adopted by the authorities at Suame Magazine. Lastly, attention was focused on environmental management practices with the aim of determining how well the authorities were preserving the integrity of their environment.

Methods adopted for the study included site visits, documentation of observations and conducting interviews with the artisans. Samples were also taken from the Suame Magazine stream for chemical analysis. The aim was to examine the pollution load of the stream and identify the sources of pollution.

The audit revealed that less than 5% of the artisans at Suame Magazine had been educated beyond middle school form four. Environmental concerns did not play a major part in the problems of the artisans and residents of Suame Magazine. It was realized that obsolete vehicles, obsolete machinery, and human solid waste were major sources of pollution at Suame Magazine. Siting of rubbish dumps along the banks of the Suame stream was seen as very unhealthy. Corrosion was observed as a common feature at Suame Magazine. The product of corrosion and other chemicals such as oil and acids were constantly washed by rain into the stream. Noise, dust, vehicle exhaust emissions,

metal vapour and poor architectural and spatial design were identified as other sources of environmental problems at Suame Magazine.

The artisans were found to have very little knowledge of environmental legislation. They seemed to believe it was the duty of the Kumasi Metropolitan Assembly and the Ghana National Association of Garages to keep the larger environment clean. Theirs was to keep their immediate surroundings tidy. Suame Magazine was found to be a dirty place. Health and safety standards simply did not exist at Suame Magazine. However, no major symptoms or diseases were identified as peculiar to Suame Magazine. Management practices were found woefully inadequate. The attitude of management was almost entirely indifference.

The pollution load of the Suame stream was too high and unacceptable. The major pollutant in the stream was human solid waste and oil. The stream was therefore a major source of pollution of the Owabi reservoir.

Better architectural and spatial planning were seen as a means of addressing some of the environmental problems at Suame Magazine. Education of the artisans and management is also crucial.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Non-living environmental resources have been exploited by man over the entire span of history. This has been to the betterment of human existence on earth. However, the exploitation of these resources has sometimes impacted negatively on the environment. In the last fifty years a lot of concern has been expressed about the environment. The general feeling of the major players in environmental issues is that conscious effort should be made to mitigate the level of resource exploitation and destruction [Beale, 1956].

The crux of the matter as put forth by environmentalists suggests that environmental resources should be exploited in such a way as to ensure that succeeding generations of all life-forms on earth can benefit by such resources. This will ensure the sustenance and enhancement of their existence and allow for sustainable development [Acquah, 1997]. The argument has been that man's selfish attitude has caused him to disregard the dependence of other life forms on the earth's resources. This unfortunate attitude has impacted negatively on the quality of man's life. It has seriously impaired the effectiveness of certain natural processes that cleaned up the wastes that man?s activities generated. It has thus been realized that man?s survival is indeed linked up with the survival of other life forms. It has therefore become important that man ensures that other life forms are given every needed support for their survival. It has also been suggested that human activity should as much as possible, have minimal detrimental impact on natural processes and phenomena [Holling, 1973].

A number of methods have been suggested and used in various places to curb environmental degradation. One of the methods is recycling [Defeuilley & Godard, 1997]. This is what basically happens at Suame magazine and it has the effect of greatly minimizing the volume of wastes and pollutants that would otherwise have been freely discharged into the biosphere. Suame Magazine is a light industrial area in Kumasi where various forms of metal processing and trade in metal items as well as auto parts take place.

Recycling in simple terms is giving a new life to an item that has literally come to the end of its current life span. It is achieved by changing the current form of the item into another or by using the current item as a raw material for the manufacture of a new item.

Recycling as a process, employs a number of methods for dealing with various waste materials. The most common of such methods, as applies to Suame Magazine, is re-melting and casting for metal items. Paper is usually pounded into pulp and used to produce more paper products. [UN Newsletter]. Textiles and glass have also been converted to other forms.

1.2 Statement of Problem

It must be said that even with current advancement in technology, not all products are recyclable. Again, recycling itself as a process has its own associated wastes [Defeuilley & Godard, 1997]. This is also the case with Suame Magazine. The rather tall list of items manufactured at Suame Magazine includes:

i. Coal pots,

ii. Bolts,

iii. Nuts,

iv. Gears,

v. Corn mill plates,

vi. Crank shafts,

vii. Satellite Dishes,

viii. Hoes,

ix. Chisels,

x. Acetylene reactor vessels,

xi. Guns,

xii. Pumps,

xiii. Gates, and

xiv. Steel railings.

This list is by no means exhaustive. A wide range of items are fabricated at Suame Magazine. All of the manufacturing processes employed in the production of the foregoing items lead in one way or the other, to waste generation. The problem of waste generation and disposal is evident in so many forms. The range includes biodegradable and non-biodegradable, metallic, polymeric, and composite materials.

1.3 Objective

This audit therefore, aims at identifying all wastes and pollutants associated with all metal working processes at Suame Magazine. Additionally, all modes of

environmental degradation associated with human activity at Suame Magazine will be assessed in the light of sound environmental practices.

After identifying all the wastes and pollutants associated with the manufacture of items, this study will consider the management, mitigation and where possible, attenuation of the environmental problems of Suame Magazine.

To summarize, this audit will be concerned with:

i. Identifying all major and even minor contributors to environmental pollution at Suame Magazine.

ii. Documenting all current environmental management practices that have been evolved as a result of the general depletion in metal resources, availability of relatively cheap technology and the generally enhanced environmental awareness in developing countries.

iii Examining alternatives for cleaner production.

iv. Establishing the inter-relationships between spatial development of Suame Magazine, human behaviour and environmental pollution.

1.4 Scope of Work

To achieve the set objectives, the following parameters will be critically studied in relation to the physical environment, the biological environment and the social environment.

i. Noise

ii. Solid Waste

iii. Liquid Waste

iv. Gaseous Waste

v. Spatial development

vi. Social perceptions and education

This will permit an assessment of the impact of all the foregoing parameters on any water bodies which run through Suame Magazine and drain into the Owabi Dam, a major source of potable water to inhabitants of the Ashanti Region.

1.5 Essence of Study

At the end of the study, it is expected that a deeper appreciation of the value of the Suame Magazine environment will be obtained. The information so obtained will offer a firm basis for policies regarding the environment of light industrial areas to be made.

CHAPTER 2

LITERATURE REVIEW

The World Bank defines an environmental audit as a methodical examination of environmental information about an organization, a facility or a site to verify to what extent they conform to specified audit criteria [UN Newsletter]. In recent years, environmental auditing has come to be seen as a tool for generating environmental information on industries and other types of enterprises. It is also used for assessing such organizations for the potential environmental risks they may place the larger society to.

The audit also seeks to identify the degree of compliance of such facilities with environmental standards and legislation. Again, environmental auditing is used for monitoring the impact of the operations of various businesses and facilities on the environment. It reveals the efficiency of administrative and managerial procedures in dealing with environmental problems.

2.1 Environmental Problems in Perspective

In the chequered history of the earth, man is said to be the last life-form to appear on earth.[Marsh, 1984]. Man appeared on earth about 100,000 years ago. It was not until about 10,000 years ago that modern man emerged with the development of village, agriculture and the domestication of animal and plant species [Attenborough, 1980].

Primitive man with his meagre wants and wastes existed largely in ecological balance with his surroundings [Laws, 1980]. Early agricultural man made a greater impact on his habitation, especially on soil resources. The abundant food resources that

was produced from his activities was a great booster to population growth. Population growth went along with an aggravation of environmental degradation [Ehrlick, 1971].

Modern industrialized man has reached a high level of affluence, especially in cities and towns where the residues of daily living are seen as concentrations of litter, garbage or rubbish. The general societal attitude has been to produce, consume and dump [Kneese et al., 1970].

The underlying attitude at all stages of man's development has been survival. Man for a long time has been an endangered-specie on earth [Meadows et al., 1972]. He has thus set himself the task of ensuring his continued existence in as much comfort as possible. Man's dilemma has always been whether to opt for short-term gains or accept the more difficult constraints of far-sighted actions [Matthews, 1976].

In an evolutionary trend, the developed countries are at the start of an era of recycling [UN Year News]. Their concerns are mainly to combat dirty air, polluted water, noise, congestion, outmoded housing and local energy shortages, and to reduce dumping/landfilling among others. These problems, products of man's technological development, are now threatening the very foundations of human existence, the main reason why he sought to advance in the search for new technology. [Acquah, 1997].

Developing countries on the other hand are primarily agriculture or natural resources based with small industrial sectors. [Beale, 1956]. Exploding populations, overcrowding, low-grade housing, exploitative agriculture, pastoral pursuits, forestry, hunting, fishing or mining of natural resources have increasingly caused damage to the environment.

Developing solutions therefore accelerate the use of natural resources to get as quickly as possible to the living standards of most developed countries. The dilemma is how to achieve this without getting into the environmental crises of most developed countries.

On this basis, environmental concerns emerged as a public issue during the 1960s [Strong, 1980]. It was conceived almost exclusively as a concern of the industrialized countries. The argument was that the process of urbanization, industrialization and development had produced obviously desirable benefits for these societies. However, the same benefits were also producing unexpected costs in the pollution of air and water, destruction of natural resources and deterioration in the quality of urban life.

With the same argument has come the realization that developing countries; in their search for enhanced standards of living are more or less treading the same ground that industrialized countries have trodden to their present environmental predicament. The major global environmental problems; to wit;

- Acid rain;
- The Greenhouse effect (Global Warming);
- The destruction of the rain forest; and
- Damage to the Ozone layer
- Depletion of Natural Resources

in addition to various localized environmental problems, have been seen to be a direct consequence of:

a) The products, by-products, emissions and wastes of industrial processes; and

b) Peoples attitudes, habits and cultures.

The industrial problem (i) is seen to prevail in developed countries whereas the social problem (ii) is more a characteristic of developing countries. The dilemma of most developing countries is how to solve the inherent social problem and the effects of technology borrowed to accelerate their industrialization. The industrial problem referred to in the foregoing encompasses the generation of products that are potential pollutants of air and water, and by their non-biodegradable nature, destroy vast stretches of flora and fauna and some water bodies.

The social problem has to do with peoples attitudes to disposal of the pollutants generated by industrialization. Pollutants are in the main, by-products, wastes and eventually, the very products of industrial processes when they become obsolete and inefficient with time. They may occur as solids, liquids or gases and become pollutants when by their nature, they disturb the equilibrium in natural processes and pose a threat to the survival of life-forms in general.

It would be agreed that the mere generation of so-called pollutants does not necessarily pollute the environment. This argument looks very tangible except that the fact remains that the products, by-products and wastes would have to be disposed off somehow at one-time or another.

The problem of pollution therefore is observed to have two sources:

1) The generation of substances - solids, liquids or gases - which have the inherent potential of disturbing the equilibrium in natural processes or disturbing the inherent balance in nature; and

2) Disposal of such substances as described in (i) above.

The international community in its attempt to solve environmental problems from a global perspective has held a number of meetings at various levels. At these meetings, substantial progress has been made at streamlining a number of industrial activities and setting common goals of environmental management. The aim is to ensure that environmental problems are not simply transferred from one part of the earth to another. The agreements reached so far have been summarized under the following headings. [UN Newsletter].

a) Convention on biological diversity.

b) Convention on international trade in endangered species of wild fauna and flora.

c) Convention on the conservation of migratory species of wild animals.

d) Convention on wetlands of international importance especially as waterfowl habitat.

e) Framework convention on climate change

f) Vienna convention for the protection of the ozone layer. Montreal protocol on substances that deplete the ozone layer.

g) Basel convention on the control of trans-boundary movements of hazardous wastes and their disposal.

h) United Nations convention on the law of the sea.

h) International convention for the prevention of pollution from ships.

i) Convention on the prevention of marine pollutants by dumping of wastes and other matter.

k) Convention on long range trans-boundary pollution.

l) Convention concerning the protection of the world?s cultural and natural heritage.

m) Regional seas convention.

The diversity and extent of these conventions have made the international community consider alternatives for cleaner production. Cleaner production simply means adopting industrial processes that generate relatively few harmful substances either as products, by-products, emissions or wastes. Alongside cleaner production, recycling has been identified as a major tool for cleaning up the huge environmental mess that has been created by past unbridled generation and disposal of solid, liquid and gaseous pollutants.

2.2 History of Environmental Auditing

In the 1970s, some European and North American companies started to systematically evaluate their own compliance with environmental legislation. The practice in many ways resembled financial auditing and so it became known as environmental auditing.

By the mid 1980s, the International Chamber of Commerce had made environmental auditing an internal management tool to facilitate management control of operating practices and to ensure compliance with company policies. The International Standards Organization is presently developing a range of standards in the area of environmental management including standards for environmental auditing.

In the last few years, Governments, through the Environmental Protection Agencies (EPAs), multilateral banks and lending agencies have promoted environmental audits as a management tool. Audits then are used to assess past and current

environmental performance of companies and utilities that they directly or indirectly finance.

2.2.1 Types of Environmental Audits

Audits have been classified as internal and external depending on who requests them. They are internal if they are requested by management to assess the adequacy of controls on operations to ensure regulatory compliance.

Examples of external audits are those required by customers to check environmental quality or a lender to assess the environmental risks of an investment. An external audit done by an independent entity is sometimes called a third party audit.

Alternatively, audits have been distinguished by their scope and objectives, and by how the audit results are to be used. Examples are compliance audits and liability audits.

2.2.2 The Nature of the Environmental Audit

The environmental audit involves three stages - the pre-audit, site visit and post-audit. The pre-audit stage involves setting-up Terms of Reference to describe the project, its scope, the objectives and criteria of the audit and to provide relevant background information. Procedures for the audit, how investigation should be performed and to what extent; and the amount of verification required is usually spelt out at this stage.

The audit stage is when site investigation takes place. It may involve drilling and sampling, interviewing workers, operators and management, and conducting laboratory work to verify some findings or observations.

During the post-audit stage, all the information gathered in the previous stages is assembled and documented. Reports are usually submitted to the requesting agency in this period.

Auditing would usually:

a) Verify compliance with host country's laws and regulations and international standards for all important environmental standards.

b) Examine significant risks including chemical use, risk of soil and groundwater contamination and fire and explosion risks.

c) Examine health and safety issues for both employees and local community.

d) Assess adequacy of internal controls, management procedures and practices for dealing with the environmental, safety and health issues at hand.

The following checklist is employed to achieve the above.

(a) Legislation

- Review relevant existing and pending environmental, legislation, standards and permits.
- Evaluate knowledge, awareness of, and responsibility for applicable legislation.
- Examine compliance record with company management and with relevant government authority.
- Examine monitoring programs, procedures and controls in place. Assess the reliability of data by evaluating monitoring design, sampling strategy, calibration routines and quality control procedures.
- Examine procedures for corrective action ? including shutdown ? if monitoring parameters are out of control limits.

- Examine if such incidents are actually reported, investigated and followed up.
- Check if monitoring data is used for reporting to management or government agencies. Verify monitoring results or compliance by taking and analyzing representative samples.

(b) Risks

- Examine areas for storage of dangerous substances, fuels and gases. Check warning systems, fire-fighting equipment, labeling of containers, spill protection, and compatibility of materials stored together.
- Assess procedures and controls in areas where dangerous processes occur.
- Check safety data sheets for spills and leakage, which should be available centrally and at all points of use.
- Evaluate adequacy of emergency procedures and contingency plans.
- Evaluate risk of natural hazards like floods earthquakes, storms, landslides etc.
- Perform a tour of areas where practices of waste management, storage and use of dangerous substances may have caused contamination.
- Take samples for verifying the state of ground or ground water.

(c) Health & Safety

- Examine procedures and rules for employee protection and assess the level of compliance with company policies in the areas of noise, personal protective gear, hot work and other potentially harmful activities.
- Evaluate accident/incident reporting, analysis and follow-up.

- Check if medical examinations for employees working in areas where they may be exposed to dangerous substances are available. Check if particular symptoms or diseases are monitored.
- Examine the existence of asbestos in buildings, and equipment, and procedures for dealing with asbestos.
- Evaluate the adequacy of training and emergency drills for employees.
- Examine record of complaints from the local community and the adequacy of procedures for warning and emergency responses.

(d) Management

- Assess management awareness and commitment to environmental issues.
- Evaluate adequacy and clarity of policies, objectives, targets and plans in the context of legislative requirements.
- Evaluate how well environmental goals are communicated, understood and implemented in the organization.
- Examine responsibilities for environmental laws and regulations and the communication process with enforcement agencies. Evaluate the roles and responsibilities for environmental management functions.
- Assess document control procedures and the quality and use of records, procedures, registers and instructions.
- Examine feedback mechanisms in the form of corrective action systems, audit procedures and management reviews.

2.3 OTHER ENVIRONMENTAL ASSESSMENT METHODS

In addition to environmental audits, other environmental assessment methods are employed from time to time. These methods help environmentalists to determine how new developmental projects such as road construction, bridge building or the setting up a new industry is likely to impact on the environment. They also permit the evaluation of the environmental performance of existing facilities. There are three main methods namely, environmental impact assessments, environmental management plans and product life-cycle analysis.

2.3.1 Environmental impact assessment (EIA)

It is used to determine the impact of new developmental projects on the environment. It describes in quantitative terms, the relative impacts of certain aspects of the project on the major players in environmental concerns.

It works by listing vertically, all the aspects of the project that will have some effect on the environment thereafter, the major players in environmental concerns are listed in a horizontal manner. The importance of each environmental concern is quantified on a pre-selected scale (x). The effect of each factor on the environmental concerns is quantified also on a pre-selected scale (y). The x- and y- figures are multiplied across the row and the sum taken down the column. The sum is a direct reflection of the impact of the proposed project on the environment.

2.3.2 Environmental management plan (EMP)

It is used by the management of existing facilities, to outline how they propose to deal with the environmental problems that are created by their operations. In particular, it shows the environmental problems that are created by the operation of a given facility. It also reveals management awareness of these problems. Finally, it helps management to assess the efficacy of the environmental management practices they have employed to deal with these problems.

2.3.3 Product life-cycle analysis (PLA)

This method is employed to reveal opportunities for cleaner production in a given production cycle. It works by selecting a particular item and tracing its history from the raw material stage to the finished product and ultimate disposal. At every stage the types and volume of waste produced is determined. Avenues are then sought to eliminate those production methods that generate a lot of waste. Cleaner methods of production are then employed to curb waste generation.

2.4 RECYCLING, A TOOL FOR POLLUTION CONTROL

Recycling is the practice of giving new life to an item which has come to the end of its current life span. This practice is achieved by taking the item apart into individual components and reprocessing the components into other forms or even similar forms.

2.4.1 Metallic Items

The success of recycling depends on whether the basic natural resource is renewable or not. Metallic items for instance belong to the class of non-renewable or stock resources. These resources by their non-renewable nature have made it imperative that technology be found to make maximum use of what is available. Those flows or renewable resources can with good management practices, be regenerated easily and naturally. This has made recycling such resources unnecessary.

The advantage with metals is that they respond to a wide range of metallurgical treatment. After coming to the end of its usefulness in its current form, a metallic item can be changed into another useful form by metallurgical processes such as casting, forging, welding, and fabrication [Wiredu, 1996].

2.4.2 Non-metallic Items

Non-metallic items may be put into two major groups depending on how easily they can be treated like metals. The first group, consisting of glass and some other ceramic items, react reversibly to temperature changes and can thus be recycled.

The second group, made up of mostly ceramic items, wooden and most polymeric items, cannot exist in all three states of matter under ambient thermodynamic conditions. They react irreversibly to temperature changes especially temperature increases. This class of non-metals can therefore not be recycled and therefore present the most serious challenge to environmental management.

In this group of non-recyclable materials, ceramics, by virtue of the fact that they are derived from the soil – ceramics are metal oxides. [Kingery, Brown & Uhimann,

1975] – with minor reversible alterations in their chemical nature, tend to be very compatible with the soil. When disposed off into the natural environment therefore, they wither with time and become part of the soil. However, they undermine the value of the soil for agriculture due to the unbearably high concentrations of some metals and other elements in them.

Wooden materials are acted on by natural biological and chemical agents when disposed of into the natural environment. They are thus said to be biodegradable. Their disposal therefore does not pose a major environmental problem. On the contrary, some of them could improve the soil fertility, enhancing agricultural production in the course of their decay. In respect of the foregoing therefore, wooden items though not recyclable, are not a problem as far as environmental pollution is concerned.

The more serious problem is in cutting down the wood to make these wooden items.

The practice:

- Removes the forest cover.
- Desecrates natural terrestrial and arboreal habitats of flora and fauna.
- Enhances water loss from natural water bodies by evaporation.
- Affects the carbon cycle and aggravates global warming by bearing excess CO_2 in the biosphere.
- Causes loss of natural water bodies by the spread of deserts; and finally,
- Depletes the rain forest and forest cover.

Polymeric materials are hardly amenable to recycling. Their uncontrolled production therefore goes hand in hand with disposal problems. In developing countries, polymeric materials are usually a major source of pollution due to inadequate disposal techniques. Littering with polyethylene sacks and disposal of polymeric material into water bodies have become a major environmental problem in Ghana. It is only recently that some companies have started developing biodegradable polymers and researching into methods for recycling others.

2.4.3 Energy Consideration

Recycling, though a very viable solution to environmental pollution by metallic materials and others - pulp and paper and glass for instance - has an inherent shortcoming - it leads to further expenditure of energy [Owen, 1986]. Population growth with its accompanying dwindling energy resources has made productive and efficient use of energy a major consideration in any industrial setting. It is estimated that 20% to 30% of all industrial energy use goes into recycling. The dilemma is, should more energy be used to clean up the environment? It is noted that the exploitation of energy resources itself has major impacts on the environment.

2.4.4 Waste generation due to recycling

In addition to its energy requirements, recycling itself has its own associated wastes. The fact however remains that wastes generated from recycling are very small compared to the volume of wastes that would otherwise be available for disposal. This is a plus for recycling but with environmental legislation getting tougher and tougher,

idealism seems to be getting the better of environmental managers. It can be expected that the minutest generation of waste and its disposal will very soon catch the eye of pollutant-sensitive environmentalists: as it has indeed done in the more developed countries.

Some of the common solid wastes generated by industries are:

a) Slag and dross from melting operations

b) Sawdust and wood shavings from timber and wood processing

c) Metal pieces from melting, fabrication, forging, and metal shredding and shaving.

j) Unserviceable machines and auto parts

k) Unserviceable electronic gadgetry such as computers, video decks (VCRs), television sets and money counters.

f) Used ceramic material

g) Used paper boards

h) Polymeric material (foam and rubber products) for packaging.

i) Broken glass, and

j) Dust and mud (sludge)

k) Residues from refineries & petroleum processing.

2.5 LIQUID POLLUTANTS

The group comprises aqueous or other liquid media in which particles are either suspended or dissolved. The particles are in the main, heavy metals in elemental or complex forms, oils and inorganic chemicals which adversely affect the existence of life-forms in aquatic environments [Laws, 1980].

Most liquid pollutants are effluents from industrial processes and are discharged ultimately into natural water bodies by direct or indirect routes.

Other sources of liquid pollutants are:

- Domestic or communal effluents;
- Urban storm water run-offs;
- Spoil heaps;
- Agricultural wastes [Asiam, 1997].

Industrial effluents are the source of heavy metal, oils and other inorganic chemicals as already noted above. These constituents arise from waste products of certain industrial operations, eg. Electro-plating, metal finishing, metal extraction, mining, photographic processing and other similar industries.

Water has a wide variety of uses in industrial operations and so it picks up a lot of polluting substances at various stages in the industrial process. Some of these pollutants such as Iron (Fe), Tin (Sn) and inorganic matter dissolve in the water. Others such as Mercury (Hg) and dust are suspended within the water while still others such as oil and organic matter are just carried along by the current of water.

Such waste water is discharged into gutters and drains and are carried into existing natural surface water bodies. Others are discharged over land areas where they seep through the underlying bedrock into the water table and ultimately into surface water bodies [Koziorowski, & Kucharski, 1972].

Domestic or communal effluents are wastes from domestic human activity. A full discussion is given under the section on human activity and spatial development.

Urban-storm-water-run-off is in itself not a source of industrial pollutants. It merely serves as a medium within which finely divided pollutants such as dust, metal vapor and oil droplets deposited on exposed surfaces are washed down and transported into surface and sub-surface water-bodies.

In mining areas where sulphide ores are prevalent, Acid Mine Drainage poses a serious threat to ground and surface water. The acid forms when sulphurous ores are exposed to air and rain water. Acid so formed may seep through the bedrock if the latter is porous and settle into ground water. On the other hand, it may be transferred into surface water. In both cases, it poses a serious health risk to all life forms that obtain potable water from that source.

Spoil heaps refer to waste dumps through which water may seep and dissolve or carry along in its current, a wide variety of waste material present in the waste dump. The spoil heap may be of industrial or domestic origin and may contain heavy metal and other compounds as already discussed.

Agricultural waste water is a source of chemicals, soluble or insoluble which have been obtained from pesticides, herbicides, fungicides, fertilizers and other chemicals used to enhance agricultural production. These chemicals are usually transported by urban storm-water run-offs into existing natural water bodies.

2.6 GASEOUS POLLUTANTS

These are the volatile emissions from various industrial, agricultural and domestic processes. They are released directly into the atmosphere and are inhaled directly by humans and other living organisms.

Common among the list of gaseous pollutants are:

- Ammonia
- Hydrogen cyanide
- Hydrogen sulphide
- Metal vapour eg. Mercury
- Smoke
- Chloro-fluoro-carbons (CFCs)
- Carbon dioxide
- Oxides of nitrogen
- Oxides of sulphur
- Vehicle exhaust emissions

Some of these pollutants are toxic even in very minute quantities and make working with them very hazardous. An example of this class of gaseous pollutants is hydrogen cyanide. [Hasler, 1970]. Others like metal vapour and ammonia are slow killers and high concentrations are required over long periods of accumulation within living cells before any appreciable level of damage can be observed. The danger with some of these pollutants, especially metal vapour (Mercury, Lead and other low-melting metals) is that living cells do not easily excrete them. When they are inhaled therefore, they remain in the system and accumulate over a period. Eventually, their concentrations assume toxic levels and become hazardous to life forms.

Another group of gaseous pollutants does not present toxicity problems to life forms per se. They rather create an imbalance in the atmosphere or in the biosphere. This imbalance ultimately affects a host of living things. Carbon dioxide for instance creates a

heating effect, a phenomenon known as the greenhouse effect and is a major contributor to global warming.

Chloro-fluoro-carbons (CFCs) react with the ozone layer. They have caused it to thin out in certain areas. Harmful radiation such as Ultra Violet rays and Infrared rays from the sun penetrate the thin sections of the ozone layer and adversely affect life-forms on earth. These rays have been found to cause cancer and gene mutations in human beings. Cleaner production and re-processing are some of the methods that have been employed to attenuate gas pollution of the atmosphere.

Cleaner production seeks to use inputs that will not generate some of these gaseous pollutants whose presence in the atmosphere is largely undesirable. One major success of cleaner production is the replacement of CFCs with liquefied Nitrogen in refrigeration [Gosney, 1982].

Re-processing uses the effluent gas from one stream as a raw material in another stream to create a new product, gaseous or otherwise. Hydrogen sulphide gas for example has been used in the manufacture of sulphuric acid. Arsenic dioxide gas has also been used to manufacture insecticides instead of being discharged freely into the atmosphere [Metcalf & McKelvey, 1991].

The following tables give the EPAs standards for various industrial emissions.

Table 1a. GHANA EPA CENTRAL EFFLUENT QUALITY GUIDELINES FOR DISCHARGES INTO NATURAL WATER BODIES	
PARAMETER	MAXIMUM PERMISSIBLE LEVEL
PH	6.9
Temperature	<3°C above ambient
Colour (TCU)	200
Oil & Grease (mg/l)	10
BOD (mg/l)	50
COD (mg/l)	250
Total dissolved solids (mg/l) TDS	50
Total Suspended solids (mg/l) TSS	50
Turbidity (NTU)	75
Conductivity (µS/cm)	750
Total Coliforms (MPN/100ml)	400
E-Coli (MPN/100ml)	0
Ammonia as N (mg/l)	1.5
Nitrate N (mg/l)	0.1
Fluoride (mg/l)	1.5
Phenol (mg/l)	0.5
Sulphide (mg/l)	1.0
Total phosphate (mg/l)	2
Total Cyanide (mg/l)	1.0
Free Cyanide (mg/l)	0.1
Cyanide as weak acid dissociable	0.5
Total pesticides (mg/l)	0.5
Total Arsenic (mg/l)	1.5
Soluble Arsenic (mg/l)	0.1
Cadmium (mg/l)	0.1
Chromium +6 (mg/l)	0.1
Total Chromium (mg/l)	0.5
Copper (mg/l)	1.0
Lead (mg/l)	0.1
Nickel (mg/l)	0.5
Selenium (mg/l)	1.0
Zinc (mg/l)	2.0
Mercury (mg/l)	1.0
Silver (mg/l)	0.1
Tin (mg/l)	2.0

Table 1b: GHANA EPA SECTOR EFFLUENT QUALITY GUIDELINES FOR DISCHARGES INTO NATURAL WATER BODIES (MAXIMUM PERMISSIBLE LEVEL)

PARAMETER	SECTOR						
	CEMENT CERAMICS & TILES	THERMAL POWER PLANT	GLASS	HOSPITALS & CLINICS	OIL & GAS	MINING & MINERALS	METAL
PH	6.9	6.9	6.9	6.9	6.9	6.9	6.9
BOD_5 (mg/l)	50	50	50	50	50	50	50
Oil & Grease	10	10	10	10	10	10	10
TDS (mg/l)					50	50	50
TSS (mg/l)	50	50	50	50	50	50	50
Cadmium (mg/l)	0.1				0.1	0.1	0.1
Total Phosphorus (mg/l)	20	20	20	20	20		
Temperature Increase	<3 °C above ambient	<3 °C above ambient	<3 °C above ambient	<3 °C above ambient	<3 °C above ambient	<3 °C above ambient	<3 °C above ambient
Colour (TCU)	200	200	200	200	200	200	200
COD (mg/l)	250	250	250	250	250	250	250
Chromium (+6) (mg/l)	0.1		0.1	0.1	0.1	0.1	0.1
Sulphide (mg/l)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Phenol (mg/l)				1.0	0.5	0.5	0.5
Total coliforms (MPN/100ml)			400	400	400	400	400
E.Coli (MPN/100ml)			0	0	0	0	0
Turbidity (N.T.U)	75	75	75	75	75	75	75
Lead (µg/l)	0.5		0.5		0.1	0.1	0.1
Nitrate (mg/l)	0.1	0.1	0.1	0.1	2	2	2
Total phosphorus (mg/l)	2	2	2	2	75	75	75
Conductivity (µS/cm)	750			750	750	750	750
Mercury (µg/l)				10	10	10	10
Zinc (mg/l)					2	2	2
Tin (mg/l)							2
Total chromium (mg/l)					0.5	0.5	
Total Iron (mg/l)					2	2	2
Free Cyanide (mg/l)						0.1	
Cyanide as weak acid dissociable (mg/l)						0.5	

Table 1c: GHANA EPA SECTOR EFFLUENT QUALITY GUIDELINES FOR DISCHARGES INTO NATURAL WATER BODIES (MAXIMUM PERMISSIBLE LEVEL)							
PARAMETER	SECTOR						
	TEXTILES	FOOD & BEVERAGES	PAINTS & CHEMICALS	PHARMACUETICALS	PAPER & PULP	HOTELS & RESORTS	WOOD
PH	6.9	6.9	6.9	6.9	6.9	6.9	6.9
BOD_5 (mg/l)	50	50	50	50	50	50	50
Oil & Grease	10	10	10	10	10	10	10
TDS (mg/l)	50	50	50	50	50	50	50
TSS (mg/l)	50	50	50	50	50	50	50
Cadmium (mg/l)	0.1				0.1	0.1	0.1
Total Phosphorus (mg/l)	2	2	2	2	2	2	2
Temperature Increase	<3 °C above ambient	<3 °C above ambient	<3 °C above ambient	<3 °C above ambient	<3 °C above ambient	<3 °C above ambient	<3 °C above ambient
Colour (TCU)	200	200	200	200	200	200	200
COD (mg/l)	250	250	250	250	250	250	250
Chromium (+6) (mg/l)	0.1				0.1	0.1	0.1
Sulphide (mg/l)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Phenol (mg/l)				1.0	0.5	0.5	0.5
Total coliforms (MPN/100ml)	400	400			400	400	400
E.Coli (MPN/100ml)	0	0			0	0	0
Turbidity (N.T.U)	75	75	75	75	75	75	75
Lead (µg/l)			100				
Nitrate (mg/l)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total phosphorus (mg/l)	2	2	2	2	2	2	2
Conductivity (µS/cm)	750	750	750				
Mercury (µg/l)				10			
Ammonium as N (mg/L)		1.5				1.5	1.5
Total pesticides (mg/l)		0.5			2	0.5	0.5
Total Arsenic (mg/l)							1.0
Soluble Arsenic (mg/l)							0.1

Tables 1-(a,b,c) The limits set by the EPA Ghana, for discharge of liquid effluent into natural water bodies.

Allowable limits for Oil & grease, E-coli, COD and BOD are very low. This clearly indicates that the legal framework in Ghana demands very high environmental standards.

2.7 NOISE

Sound or noise is what we hear (continually). Without sound, life would be impossible. Noise is perceived when the sound causing it forces air molecules to vibrate. This vibrates in sympathy with the air surrounding it. The intensity of the eardrums vibration correlates positively with the loudness of the perceived sound. Loud noise, as well as continuous sound therefore causes a huge strain on the eardrums.

In respect of the foregoing, the maximum allowable sound in any industrial setting is 70dB continuously. This level of safety however does not guarantee the safety of an individual's eardrums in any industrial setting [Sobotie, 1997]. According to Sobotie, every individual has his own tolerable noise level that may be far in excess of or lower than the 70dB. It is therefore an individual?s responsibility to determine which noise level becomes a nuisance to him. It is not advisable for an individual to work in areas that in the individual?s estimation are noisy [Faber, 1989].

2.8 DOMESTIC HUMAN ACTIVITY

A lot of waste is generated by human activity and such wastes need to be handled with a lot of care. Environmental management in itself is not managing the environment. Rather, it is managing the activities of human beings within the environment [Beale, 1956].

In this section, the inherent wastes associated with human existence will be addressed. Attention will be focussed mainly on:

a) Human solid waste

b) Human liquid waste

c) Waste from human cleansing activities

d) Human food residues

e) Sundry wastes

Human solid wastes or faecal matter is a natural waste product of human nutrition. [Goldrich, 1996]. Its proper disposal should therefore be of paramount importance to any developmental initiative. Various methods have been employed to facilitate the disposal of faeces. The aim has been to avoid contamination of soil and water bodies as well flora and fauna with faeces. Developers have been all too aware of of the danger of diseases being transferred from one person to another by way of contamination with faeces. [Laws, 1980]. The basic treatment method has been to collect faeces from the immediate environs of concentrated human activity - i.e. houses, factories, offices, stations, markets etc - using water closets, and transporting them to centralized treatment plants where they are digested aerobically or an-aerobically. Another method is simply to collect all faeces as before and dispose of them directly into rivers, streams or the sea. This second method though not environmentally sound is still practiced in the developing countries whose frail economies can hardly support any improved disposal method.

Faced with dwindling water resources and the non-availability of funds, cheaper and easier means of disposing of faeces have been sought by developing countries. This

has led to the development of the Kumasi Ventilated Improved Pit (KVIP) and the Ventilated Improved Pit (VIP). They have similar modes of operation and basically store faeces deep within the soil where it decomposes naturally. Septic tanks and KVIPs, which are used as storage facilities, however become nuisances with time. Septic tanks become breeding sites for mosquitoes and cockroaches. KVIPs on the other hand present serious odour problems to areas located within a hundred metres radius of it. To avoid contamination with natural water bodies, it is recommended that the pit be located at least one hundred meters away from a water body and its base should be well above the water table. [Awuah, 1997].

Human liquid waste goes hand in hand with human solid waste in terms of its generation, effects and disposal. It is noted urea in urine decomposes upon exposure to the atmosphere and produces among other things, ammonia, which is in itself a pollutant. Cleansing activities generally involve the use of soap and/or detergents and water. The wastewater is treated and recycled in developed countries. In developing countries it is discharged through gutters into streams and rivers. The phosphates and nitrates in soaps and detergents cause eutrophication and eventually lead to the loss of water bodies as plant growth is highly enhanced.

Human food residues fall into two main categories; those that are biodegradable and those that are not. The biodegradable food residues are usually disposed of in compost dumps and landfills. Here they decompose by bacterial action and can be used as manure in agriculture. The non- biodegradable ones present a major problem. In advanced countries, technology is available for recycling some of these wastes as has been outlined in earlier sections. These technologies are however too costly for

CHAPTER 3

SURVEY OF THE SUAME MAGAZINE ENVIRONMENT

3.1 General Topography

Suame magazine occupies the area lying between the Suame roundabout - Offinso road, the Tafo-Suame Link road and the Tafo Cemetery. The land slopes at a general angle of 15° to 20° into a valley that accommodates a stream. The land generally rises again at an inclination of about 15° to 20° into the Tafo Public Cemetery area. Another slope descends from the area of the cemetery into a valley and then there is a general rise into the Tafo township. Refer fig 1.

3.2 VEGETATION

The main area housing the various workshops has only a few trees spaced widely apart. However, the vegetation of the Tafo cemetery, the Suame township towards Abrepo, and from the Tafo Suame link road towards Maakro and Breman reveals that the entire stretch of land has the Guinea Savanna vegetation with tall elephant grass covering the entire land surface, interspersed with tall shrubs and trees spaced 20-50 metres apart. The area around the river banks have a lot of water yam growing in them. This is in addition to the elephant grass that flourishes abundantly in the area. (Refer fig.2). The vegetation in the Magazine area has been cut down to make room for the various workshops and offices. Only a few trees have been left growing to provide shade in a few places for some workshops.

Good environmental management depends more on human attitudes than anything else. It is important that people are helped to develop the right attitudes for sound environmental management practices

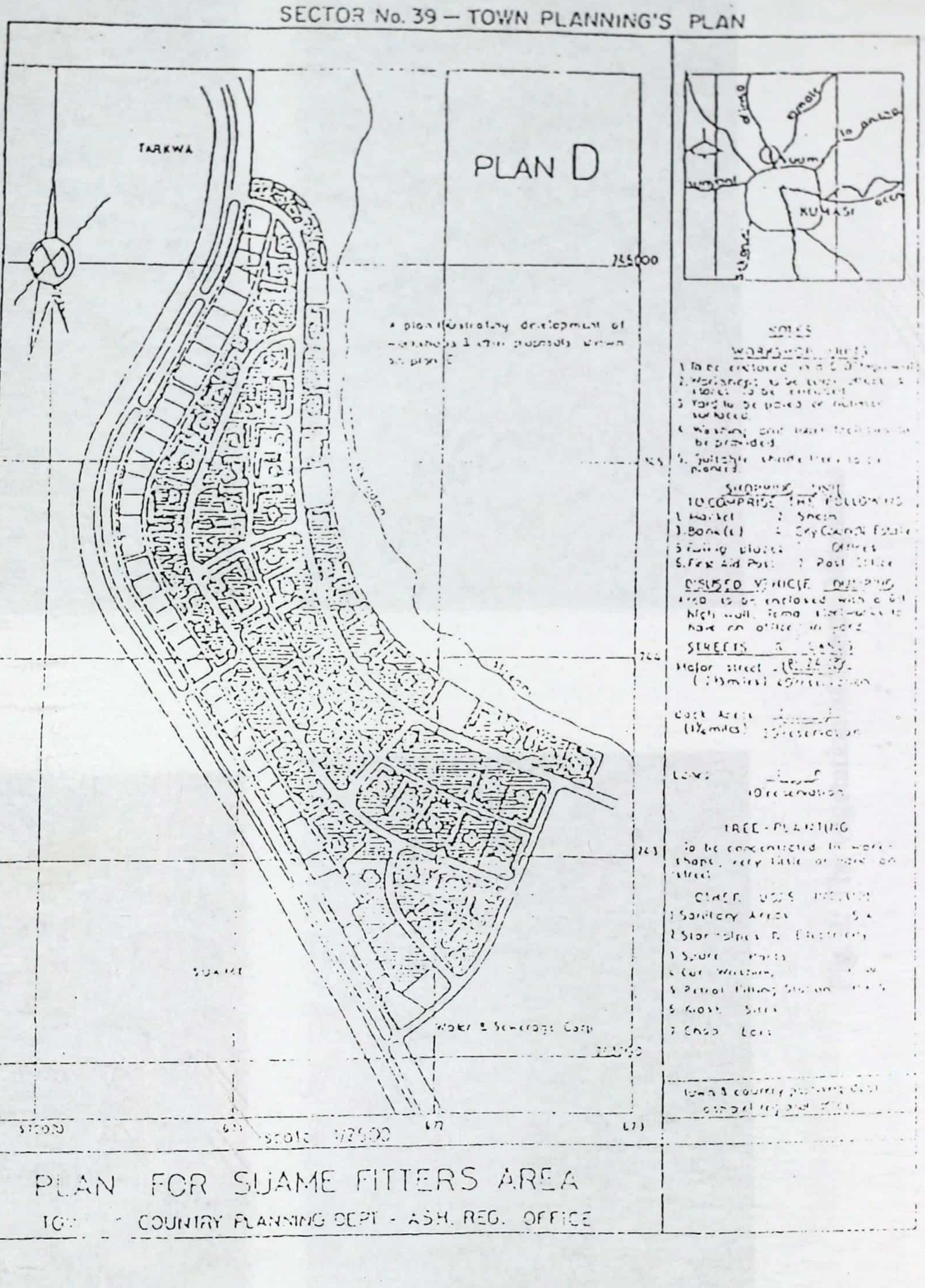


Fig.1. A map of the Suame Magazine area.

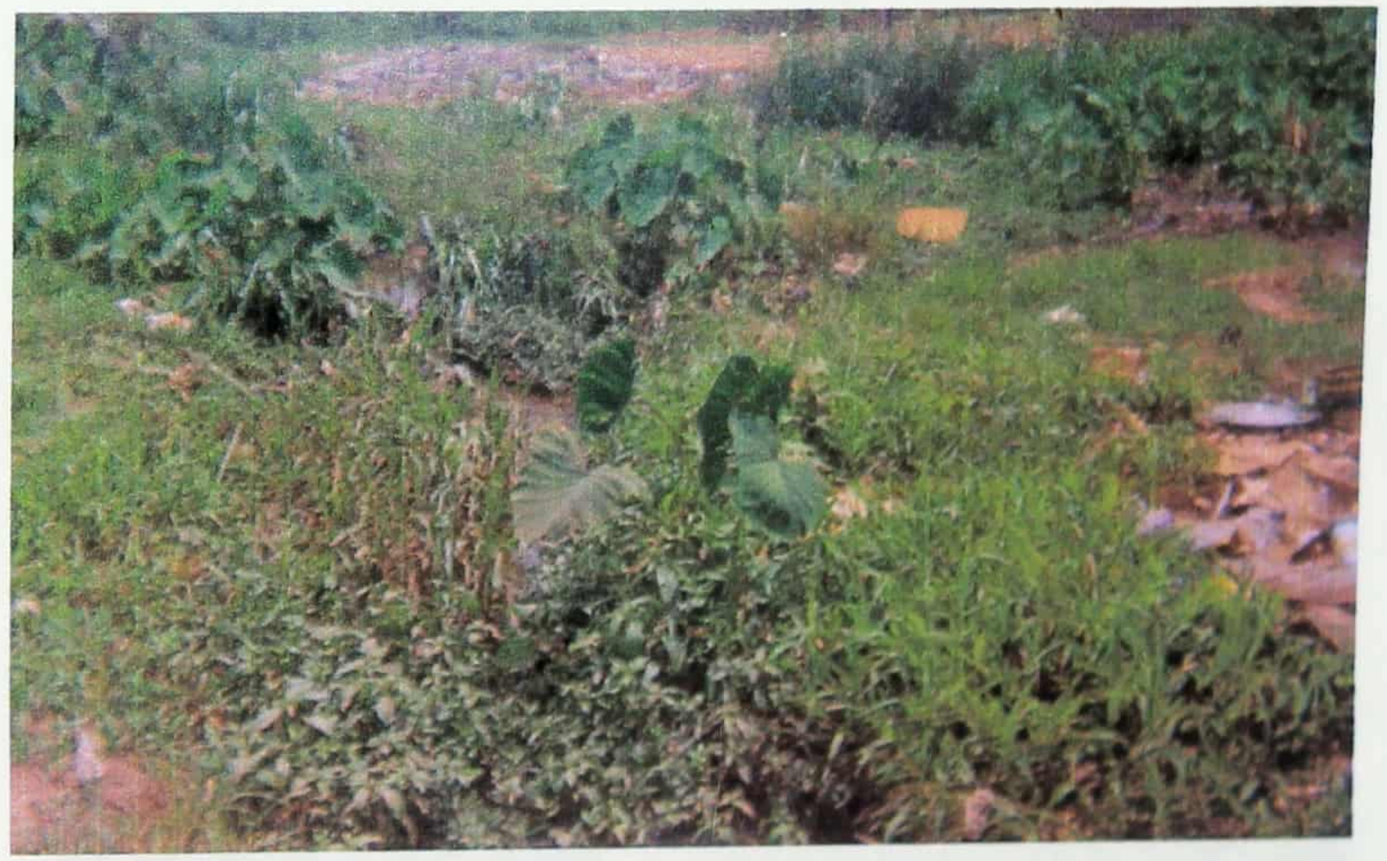


Fig. 2: The vegetation of Suame Magazine

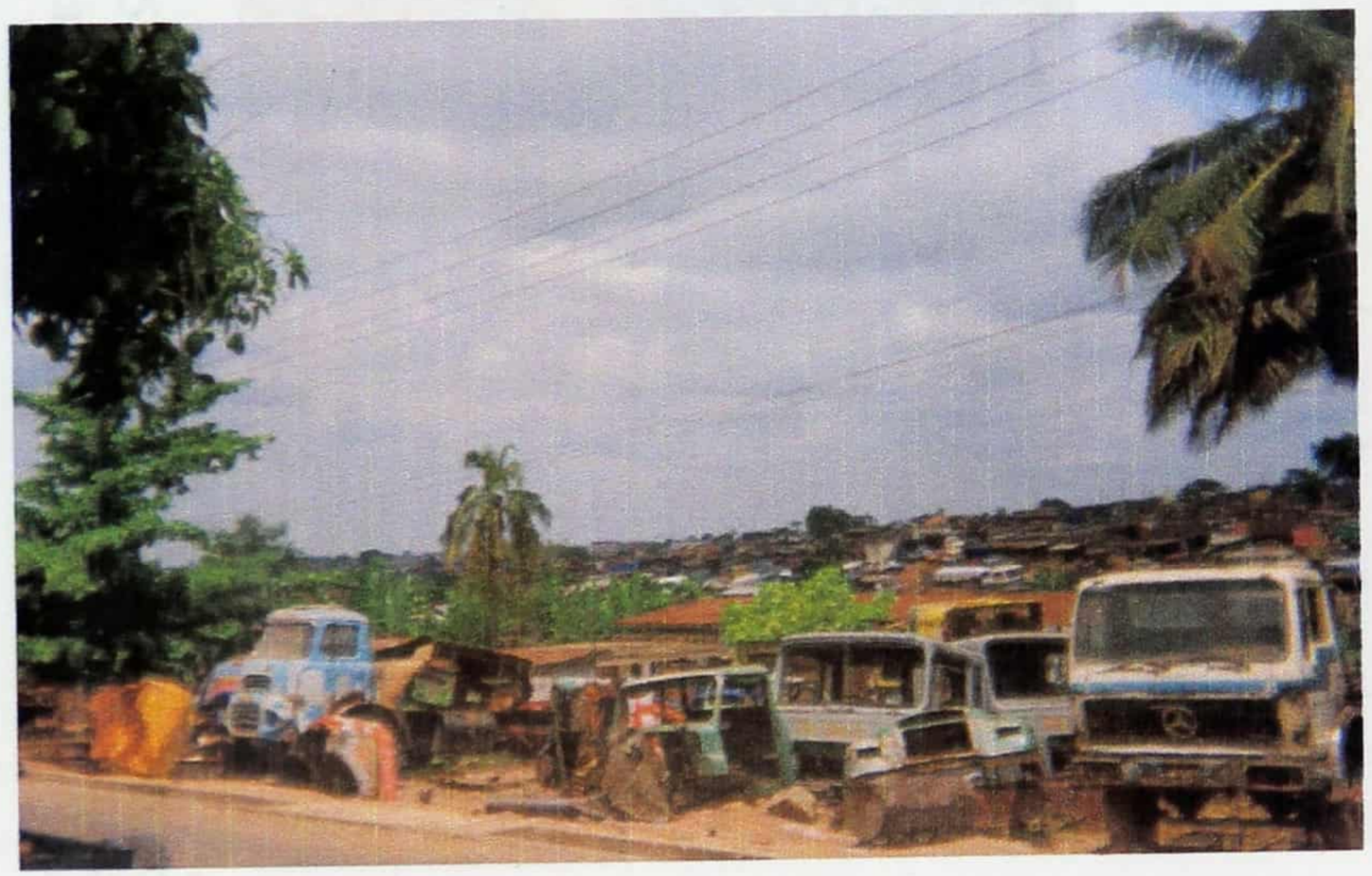


Fig 3. Some unserviceable vehicles and machinery that have been paraded for sale at Suame Magazine.

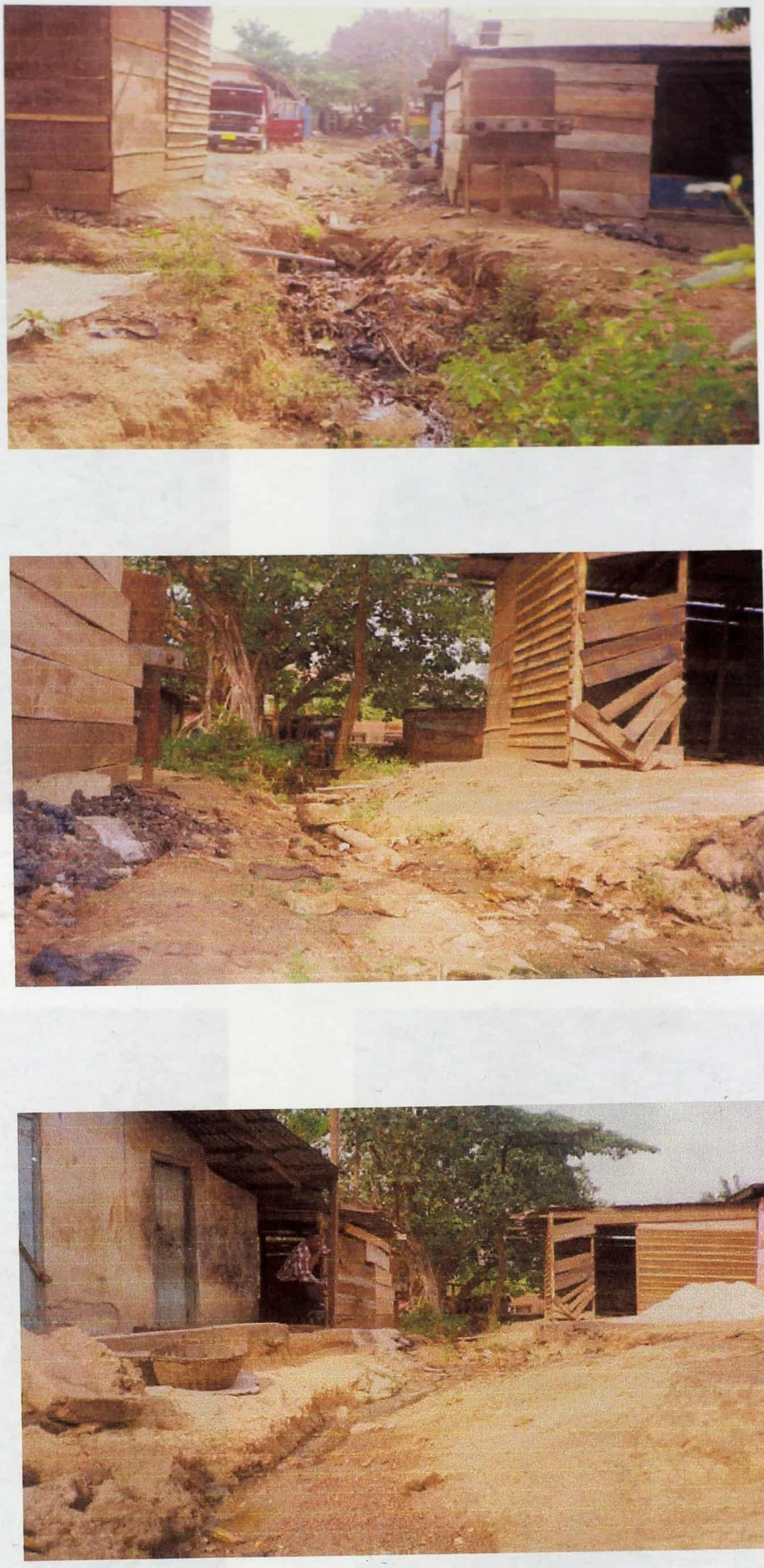
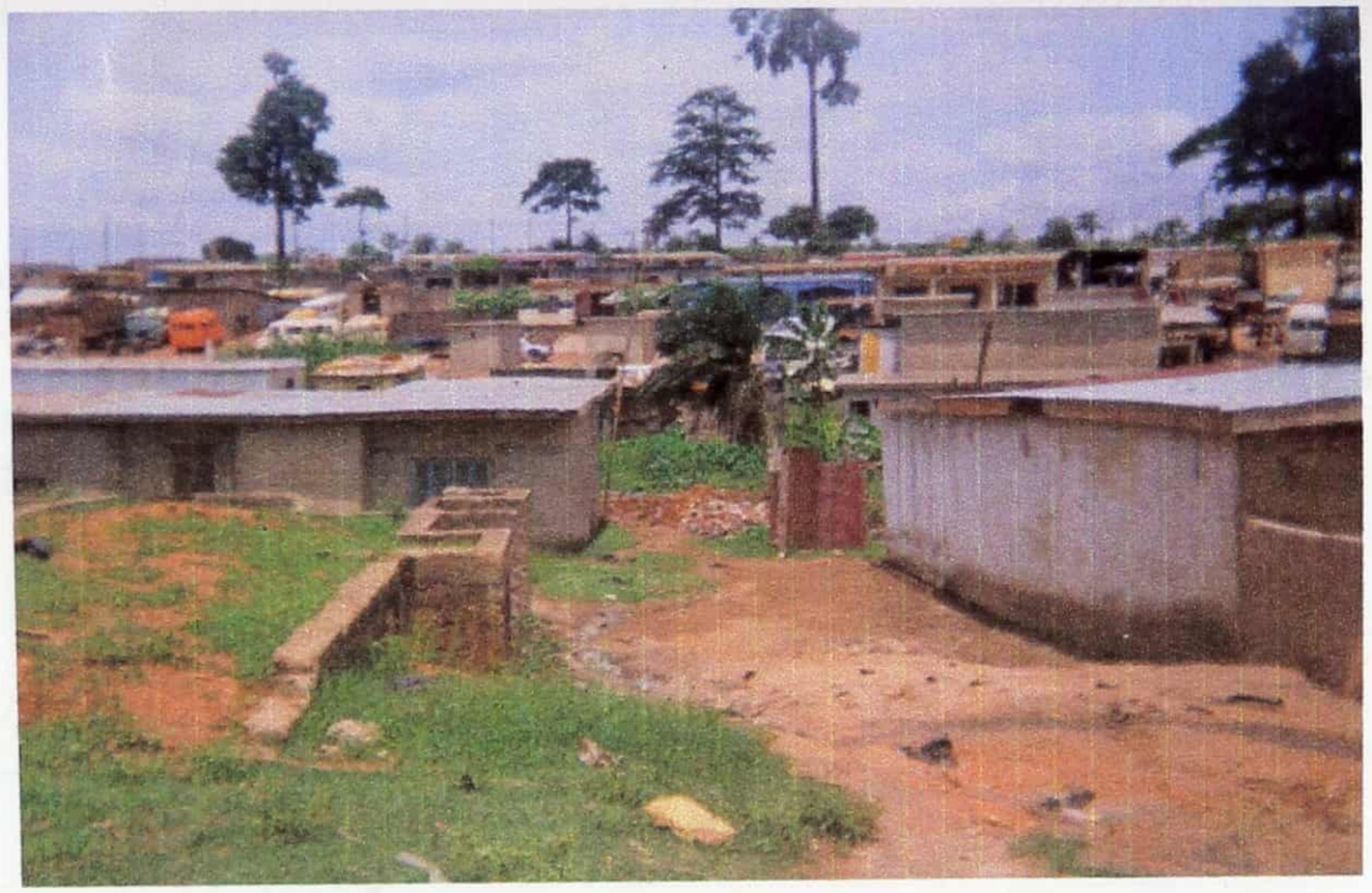


Fig 4: An open drain in Zone 5 of Suame Magazine. The drain accommodates a pipe through which raw sewage is discharged into the Nkradan Stream.

Fig. 5: The Nkradan Stream (Suame Magayine Stream)



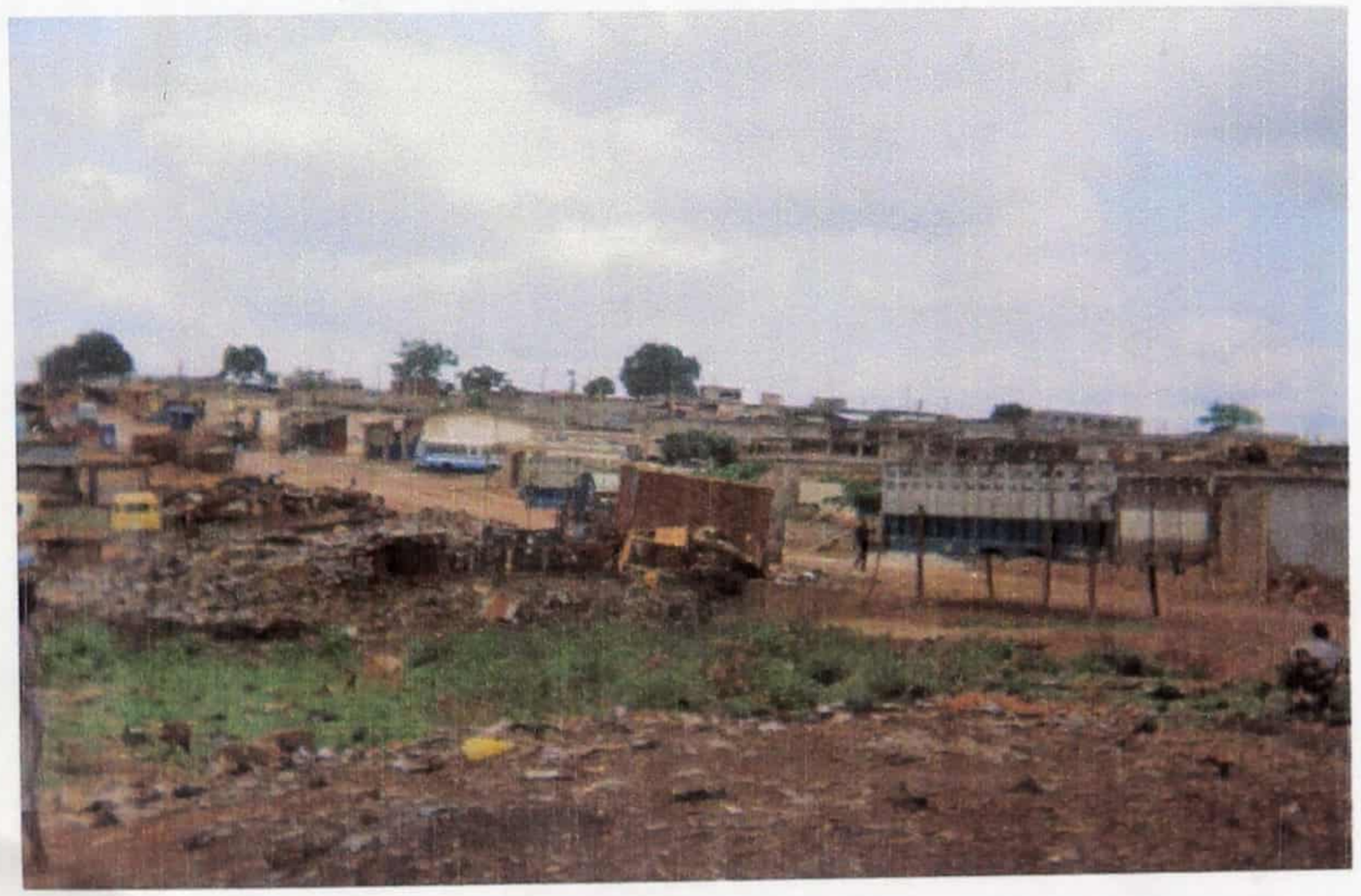


Fig. 6: Some structures used as shops and offices at Suame Magazine

3.3 METAL WORK AT SUAME MAGAZINE

Suame Magazine is the home of over 1000 workshops employing over 4000 artisans. 18% of the workforce is engaged in metalwork, 52% in vehicle repair and about 30% in trading. The 20 acres of land that houses Suame magazine is divided into administrative zones by the Ghana National Association of Garages (GNAG). The zoning however has nothing to do with job specialization. Each zone is a microcosm of Suame Magazine. It portrays all the ingenuity of the artisans. Each one also brings out in very vivid terms, the environmental problems of Suame Magazine.

Suame magazine has acquired international recognition by the level of ingenuity displayed by the artisans. A lot of ingenious technology is employed in the production of various metal items. The vibrant timber and woodworking industry, and the transportation industry in the Ashanti Region have enjoyed tremendous support from Suame Magazine. Indeed they owe their continued existence to the Suame Magazine.

Less than 5% of the artisans at Suame Magazine had formal education beyond middle school form four. This unfortunate situation has largely accounted for the low level of development of Suame Magazine. It is also the reason why environmental concerns do not provoke any enthusiastic response from the artisans. They simply do not understand what the "fuss" is all about.

3.4 SOLID WASTE

The generation and disposal of solid waste at Suame Magazine can be examined under the following headings:

- Metallic Items embedded in the soil.

- Discarded machinery.
- Unusable imported spares.
- Wastes generated from machining.

Suame magazine is popular for the high level of ingenuity exhibited by the artisans. Every metallic item is seen not as waste but a resource that can be employed to make another product. In general therefore, metal items of whatever kind are not discarded but stored somehow until it is needed. There is however a problem of improper storage. This results in metal items being left about anyhow. These items are left at the mercy of the weather and ultimately end up partially or entirely buried in the soil.

The phenomenon is most common in scrap shops. The corrosion product of such items such as ferrous alloys, mix freely with the soil when corrosion occurs. Ultimately, the corrosion product is transported by storm water run-offs into the stream.

A lot of obsolete machinery can be found in various workshops at Suame Magazine. Some of these are lathe machines, vehicles, drilling machines and the like. Owners of such workshops find it very difficult to scrap these machinery because:

i. They believe such machinery can be repaired.

ii. There are no dumping sites for obsolete machinery.

In the end, space which could accommodate a new machine or which could be employed to streamline industrial operations is used to accommodate non-productive machinery. Discarded vehicles and auto accessories have almost the same effect as obsolete machinery on the environment. Refer Fig. 2.

Most vehicles in Ghana are second-hand. The ages of most vehicles range between 10 years and 30 years. Such vehicles develop problems very often and in a lot

of cases, replacements cannot be found for faulty parts. These vehicles are thus left at the service shops where they gather dust and rust. Corrosion leads to the aggravation of the vehicles' condition such that when a replacement is finally found for the part which originally required replacement, the vehicle still remain unserviceable because its problems would have increased in number.

Eventually, the vehicles completely lose their road-worthiness. They are just left at the service workshop to rust. Three main problems are presented by this phenomenon. Space that could have been used productively, is occupied by unserviceable vehicles. Congestion is a direct result of this unproductive occupancy of valuable space, which could easily have been avoided. Lastly, the corrosion product of these automobiles which is mainly rust Fe(OH)3 is carried away by rain water. It eventually pollutes the soil and the stream at Suame Magazine. The congestion discussed earlier in (i) obstructs further spatial development of Suame Magazine [Bartomy & Chernov, 1993].

Discarded auto parts is another major contributor to the problem of unproductive occupancy of space and congestion at Suame Magazine. Indigenous Technology at the Magazine has virtually no use for non-metallic items such as battery cases, leather covers and asbestos stuffing of auto seats, broken windscreens and other glass, polymeric and non-metallic items. The only use to which some of these items can be put is as replacement for parts which re not readily available. Otherwise, they are just left about anyhow to occupy any space available and to add to the general congestion in the area.

Various parts of machinery, especially auto parts, are imported into the country and sold as spare parts to vehicle users. Some of these spare parts are second hand engines, front wheel and back wheel axles and shafts, radiators and a host of other

already used parts. A lot of these parts are totally unusable or just on the brink of uselessness. These parts end up on the Ghanaian market and a sizeable proportion of them at Suame magazine where they are paraded for sale. Such parts are difficult to sell because they are virtually useless. Even when they are bought, they are eventually returned to Suame magazine for repairs where in every three cases out of ten, they have to be scrapped. They are thus left to occupy productive space and rust. The bottom line is that Suame Magazine becomes dumping ground for wastes generated elsewhere or in another country.

Machining with the lathe machine, the milling machine or the shaping machine produces a lot of waste in the form of steel, cast iron, aluminium, bronze and brass chips. All of these chips, with the exception of cast irons, are however remelted by foundries and steel plants and cast into billets and other machine parts. Cast iron chips are thrown away (into rubbish dumps).

3.5 Liquid Waste

This waste is generated in two main ways:

a) Waste oil from automobiles and heavy duty trucks and machinery, commonly known as "dirty oil"

b) Human waste in the form of urine that is discharged into every available corner.

Dirty oil is discharged from the engines of vehicles and machinery. Vehicle-service workshops have characteristic blackened smooth and shiny topsoil that is a result of dirty oil having spilled into the soil. Dirty oil is however used by tractors and some

heavy-duty trucks as engine oil to lubricate the piston. It is also used by some foundries as fuel in the oil-fired crucible furnace. These practices have turned dirty oil from a waste liquid into a very important fuel resource. This fact notwithstanding, areas in Suame Magazine where dirty oil is discharged or sold are characterized by very conspicuous spillage which give the environmentalist a cause for concern.

Pieces of land that are affected by oil spills cannot be used for agriculture. [Bouveng, Davisson & Solyoon, 1995]. All vegetation previously existing on the piece of land die off leaving the bare oil-soaked blackened soil which presents a bad spectacle to the eye. During rainfall, the run-off transports some of this oil into existing natural waterways and streams.

Urine is a by-product of human cell metabolism. Few toilet facilities - five in number - exist at Suame Magazine and are spaced far between. People are therefore reluctant to walk from their workshops to the toilets to urinate. In this regard, every obscure corner serves as a convenient place for urinating. Storm water run-offs is expected to transport urea and other salts into the stream

Faeces or human solid waste goes hand in hand with urine. The artisans find it more convenient defaecating along the banks of the stream instead of using the toilets. Reasons for this phenomenon are :

a) The toilets are too few (five of them).

b) Poor maintenance leaves the toilets with a very bad and strong odour from the faeces .

c) The toilets by design are too hot inside. Ventilation is very poor.

It must be said that a number of people reside permanently in Suame Magazine. Some of them have their own water closets in their homes. A number of shops too have installed water closets for the use of their workers. Such toilets are closer, cleaner and better ventilated than the public ones and so are well patronised by workers within such facilities and nearby.

The foregoing reasons notwithstanding, some people still find it more convenient using the toilets. Their main reason is proximity to the toilets. A very disturbing environmental problem was encountered in the form of disposal of faeces. The septic tanks of the public toilets in Suame Magazine fill very quickly. This is due to high patronage. However, when the tanks fill up, an emptying truck is not brought in to carry away the waste material to a proper disposal site. The septic tanks are emptied through a network of pipes and open drains into the Suame Magazine stream. Each day, 60 to 100 gallons of raw sewerage are discharged from one toilet in zone 5 alone. Apart from the bad odour that emanates during the discharge, the raw sewerage flows directly into the Owabi reservoir. (Refer Fig. 4)

3.6 Gaseous Waste

Gaseous waste comes from three major sources:

a) Vehicle exhaust emissions.

b) Smoke.

c) Dust.

Vehicle exhaust emissions form a major pollutant at Suame magazine. The major contributors to this problem are vehicular traffic and the running of engines after they

have been repaired by fitters/mechanics. Smoke contains carbon monoxide (CO) gas. This gas inhibits respiration and causes death over long periods of inhalation.

Smoke comes mainly from the few foundries at Suame magazine. The foundries melt cast iron, bronze, brass and aluminium using fuels like coal, dirty oil, and palm kernel shells. These fuels burn giving off various fumes that are discharged directly into the atmosphere. Fumes from welding activities i.e., arc welding and gas welding, mix freely with the atmosphere. Smoke from melting activities is a source of metal vapour. Although heavy metals occur in the materials that are commonly melted to only a small extent, the fact that inhalation of such metal vapour occurs over a long time poses a serious threat to health.

Given that it is only recently that a few of the major roads in Suame Magazine have been tarred, the problem of dust in the air is not difficult to appreciate. Most shop floors are bare earth. The contaminants in the soil rise with the dust and are freely inhaled by human beings.

3.7 Noise

As the main area that accommodates the greatest number of artisans, one encounters a gradual almost imperceptible but steady increase in noise levels. Along the main road, there is a confused blend of the honking of vehicle horns and the muffled noise from the interior of Suame Magazine. The immediate environs of the Suame roundabout - Offinso road accommodates shops which that deal in the trading of all kinds of spare parts. These shops muffle most of the noise from the Magazine. The confused blend of noise from metal clanking against metal, lathe machine tools screeching against

cast metal, ore welding metal splutter, vehicle horns and a host of other minor sources can be very irritating indeed.

3.8 Spatial Development

This section will concern itself mainly with:

a) Spatial planning.

b) Architectural design.

c) Drainage.

d) Rubbish dumps.

Suame Magazine although intended to be a light industrial area, also serves as a residential area for some of the artisans. Total land area is about 20 acres. Land utilization is very high, averaging 100 to 150 workshops per acre. The road network in the area is very good and provides easy access to various clusters of workshops with second and third class roads.

Shops are fairly well arranged but in a few cases, the clusters leave very little space between workshops, leading to congestion. The amount of space left to each shop for its operations is quite small, and has been reduced further by discarded vehicles. Very often cars have to be parked partially in the roads before they can be serviced. This leads to partial closure of some of the roads.

The general architectural workmanship on workshops at Suame Magazine is poor. Most workshops are made of wood, have a floor area of between 2m x 2m and 6m x 6m, and served by a main door 1-2m x2m and at most three windows each of average

dimensions 50cm x 50cm (Refer fig 6). The workshops are generally dark and stuffy. Mice are very common there.

Drainage is largely under-developed. Erosion has created gullies, which are sometimes filled with stinking stagnant water. These are convenient breeding sites for mosquitoes. Rubbish dumps have not really been planned for. Each workshop dumps its wastes in open drains or as far away from its operating area as is convenient (Refer figs. 4 & 5).

CHAPTER 4

AUDIT RESULTS, DISCUSSION AND CONCLUSION

On the basis of the findings of the survey and the audit checklist presented in the literature review, the audit of Suame Magazine reveals the following:

4.1 Verification Of Compliance With Host Country Laws And Regulations

The environmental Protection Agency (EPA) has outlined a National Environmental Policy which aims at ensuring a sound management of resources and the environment to avoid any exploitation of resources in a manner that might cause irreparable damage to the environment. The management of Suame Magazine, i.e. The Ghana National Association of Garages (GNAG), Ashanti Regional Branch, is at least aware that the EPA has some guidelines on the environment and pollution. However, the artisans are not aware of these. They accept that it is proper to maintain environmental cleanliness but are not aware of any environmental laws and standards as outlined above. The artisans believe it is the responsibility of the Kumasi Metropolitan Assembly (KMA) to collect and dispose of rubbish and to maintain environmental cleanliness.

The GNAG has no enforced guidelines for environmental management and no records of compliance or otherwise. Monitoring programs, procedures and controls are simply non-existent. The database is hence non-existent as well as procedures for corrective action. The only reports that are made from time to time involve accumulation of rubbish in a place not designated as a rubbish dump or discharge of waste into another person's area of operation.

4.2 Examination of Significant Risks

Dangerous substances like radioactive material, chemicals that can cause damage to the skin and fabric within 3-6 hours upon contact are not used at Suame Magazine on a large scale. Some auto-electricians keep open battery cases containing PbS04 and H2S04. These are not properly stored and operators generally have to be careful when they go within the work area.

Warning systems and fire-fighting equipment are non-existent in most shops. Containers are generally unlabelled but are kept well covered to prevent spills. Materials stored together are generally compatible and do not pose any major health problems. Where dangerous processes occur, for example, in oxy-acetylene gas welding and sand casting, care is taken to ensure that the gases exist at the correct pressures and that gauges are functioning correctly. Welding is done far away from the gas containers and from any high temperature sources, every care is taken to protect against leakage. Moulding sands are checked to ensure that moisture levels are adequate. No instruments are used per se but through experience, the moisture content is set within the 5-7% limits to prevent any molten metal splashes and explosions. Safety data sheets are not employed and virtually no records of disasters are kept even at the central level.

Suame Magazine does not lie in an earthquake zone and has never been flooded in the past seventy years. Indeed the topography limits any chances of flooding to the flood plain which is largely overgrown with water yam and tall elephant grass. Once in a while, storms rip off the iron and aluminium roofs of structures. These are quickly replaced usually within a day. Now most shops are roofed with felt.

The high density of shops per unit area and the fact that some of these shops are living premises for some of the artisans and their families has introduced some discipline into rubbish disposal. The KMA has provided containers at vantage points into which rubbish collected from various shops are dumped.

The corrosion product from the corrosion of vehicles, machinery and scrap metal which is mainly rust Fe(OH)3 is left to mix freely with the ground and ultimately with ground water. Dirty oil spills are quite common near foundries and vehicle service shops as well as sales points.

Welding of fuel tankers has sometimes led to explosion in which loss of life has occurred. The following table presents data on the spillage, ground and ground water contamination.

SUBSTANCE	PARAMETER	LEVEL
Dirty Oil	Average area of coverage	80%
	Average depth of contamination	20mm
Stream	BOD5	4 - 46mg/l
	Total dissolved solids (TDS)	46 - 160mg/l
	Total suspended solids (TSS)	5-100mg/l
	Faecal matter (E-coli)	4-43MPN/100ml
	pH	5.94-7.26
	Oil and Grease	40-200mg/l

4.3 Examination of Health and Safety Issues

Procedures and rules for employee protection are clearly set out in the Factories and Shops Act of Ghana, 1970. Individual workshop owners generally do not supply protective gear to workers. Accidents are generally not recorded. Most workers have to personally bear the costs of medication and hospitalization when they are involved in accidents. Most shop owners do not pay Social Security for their workers.

Regular medical check-ups are rarely undertaken by employees and even employers. Particular disease symptoms are not monitored. The foregoing notwithstanding, there is no particular disease that can be said to be common among the artisans at Suame Magazine.

Asbestos is generally not used at Suame Magazine. It rarely exists in buildings. Employees are not trained in safety procedures and hazard management. The local community accepts the noise, smoke and dust as part of their lives. Nobody drinks from the stream though. Hazards or risks to the local community come in the form of smoke, carbon monoxide from vehicle exhaust, metal vapour from foundry melting activities and noise.

4.4 ASSESSMENT OF ADEQUACY OF INTERNAL CONTROLS, MANAGEMENT PROCEDURES, AND PRACTICES.

Management is aware of environmental issues but commitment to preserving environmental integrity is practically absent. This is made evident by the fact that no policies are set to serve as guidelines for environmental management. In this regard,

objectives, targets and plans for sound environmental management practices are non-existent.

The major goal of management is to ensure that as much as possible, rubbish is dumped into containers provided by KMA or onto the nearest rubbish dump for further disposal. Even with this, littering with polyethylene products; paper and leaves is very common at Suame Magazine.

Having so audited the Suame Magazine environment, attention was now focussed on the effect of the oil contamination on the river Owabi, which drains into the Owabi Dam. Samples were obtained from the stream at its confluence as it enters the river Owabi. Other samples were obtained from the River Owabi itself and analyzed for their oil contents.

Results obtained were as follows:-

Oil entering River Owabi from the Suame

Magazine stream	-	40-50mg/l
Oil in River Owabi (Upstream of confluence)	-	5-15mg/l
Oil in river Owabi (Downstream of confluence)	-	40-100mg/l

The results indicate clearly that oil that has been found in the Owabi Reservoir was transported from Suame magazine via the stream. These results generated further interest in the pollution load of the river Owabi around the confluence.

The following results were obtained:-

PARAMETER	LEVEL
pH	6.23 - 7.58
TDS(mg/l)	30 - 80

TSS(mg/l)	5 - 50
BOD_5(mg/l)	3 - 25
COD(mg/l)	0 -120
E-coli(MPN/100ml)	1-15

The danger to human beings and other life forms that are dependent on the river Owabi for its potable water is immediately evident (Refer Appendix). The amount of oil in the river, 40-200mg/l is far in excess of the allowable limit of 10mg/l. The same holds for the level of faecal matter, (e-coli). Whereas the EPA requires that the level be zero (0 mg/l), the minimum level obtainable in the stream is 100mg/l. This is where the real problem lies. Very stringent treatment methods are required to purify water from the dam before it is consumed.

TDS and TSS levels are not too high. They are not far in excess of the allowable limits. That however does not give any room for complacency. The fact is that the limit has been exceeded. Efforts should thus be put into bringing down the levels to acceptable limits. BOD and COD levels lie within limit and are thus acceptable.

4.5 Managing the Suame Magazine Stream

This section details management practices that could reduce and totally cease the pollution of the Suame magazine stream. To reduce the discharge of waste products into the stream, it is recommended that shop floors should be paved with concrete. The pavements should be enclosed by raised borders to contain any waste products.

This method will give problems in the rainy season but will work very well in the dry season. The most effective management tool will be to make conscious efforts to

avoid oil spillage. This means that potential oil spillage should be identified before hand and measures taken to collect all such oil into drums or other containers and sold to foundries for their firing activities.

The rubbish dumps along the banks of the stream should be immediately removed and relocated. The use of removable rubbish dumps is highly recommended instead of permanent sites being earmarked as rubbish collection points. This calls for a number of measures. Law enforcement officers and Zonal Chairmen should be charged with ensuring that rubbish dumps are not located along the banks of the stream. Tolls charged on the patrons of the toilets should be increased. This will ensure that the toilets can be effectively managed. The practice of discharging raw sewerage into the stream should be immediately eliminated.

A lot of education will be required to get inhabitants of the Suame Magazine area to clearly understand the consequences of dumping rubbish and defaecating along the banks of the stream. This will hopefully create an awareness of the risks to which the inhabitants of the Ashanti Region which includes inhabitants of Suame magazine themselves, have been put. Efforts should then be made to render it easier for residents of Suame Magazine to dispose of faeces and rubbish elsewhere other than the banks of the stream. To this end, the idea of community toilets should be discouraged and efforts made at helping people to build private toilets in their own homes. One could say these are expensive management techniques but that is what is required to avert a major epidemic from the consumption of polluted water. The use of protective gear such as; ear muffs for noise, nose protectors for dust and fumes, and eye goggles for smoke, dust and fumes, should be made imperative.

It is important that containers be provided for the collection of particular wastes. In the U.K., for instance, containers are provided at vantage points for the collection of:-

- Brown glass
- Clear glass
- Green glass
- Clothing and fabric
- Leather
- Other waste products.

The last group of wastes - other waste products - are later sorted out into paper, metal, polymeric, wood and ceramic which are reprocessed into different forms or recycled. It is true that lack of funds may render reprocessing of some waste forms difficult in Ghana. However, sorting out wastes in this way will make it possible to dispose them off properly. It should be noted that no country will solve another country's pollution problems for her. Ghanaians should find ways of keeping the environment clean otherwise, other people will help to further pollute the Ghanaian environment.

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APPENDIX

SUAME MAGAZINE STREAM							
SAMPLE	pH	TDS (mg/l)	TSS (mg/l)	BOD_5 (mg/l)	COD (mg/l)	OIL (mg/l)	E-COLI (MPN/100ml)
1	5.94	46	5	4	NIL	200	9
2	7.04	115	10	11	80	60	4
3	7.16	160	100	46	880	120	43
4	7.26	155	90	18	40	40	23

STREAM AT CONFLUENCE							
SAMPLE	pH	TDS (mg/l)	TSS (mg/l)	BOD_5 (mg/l)	COD (mg/l)	OIL (mg/l)	E-COLI (MPN/100ml)
1	6.51	42	5	5	NIL	62	4
2	7.34	30	2	3	10	55	10
3	7.58	73	30	19	90	80	9
4	6.23	48	22	11	70	40	14
5	6.92	60	28	8	80	70	8

RIVER OWABI, UPSTREAM OF CONFLUENCE							
SAMPLE	pH	TDS (mg/l)	TSS (mg/l)	BOD_5 (mg/l)	COD (mg/l)	OIL (mg/l)	E-COLI (MPN/100ml)
1	7.31	68	30	3	70	7	8
2	6.49	49	20	5	60	15	3
3	7.02	51	29	7	100	5	10
4	7.11	58	15	10	30	8	6
5	6.85	70	8	9	40	12	1

RIVER OWABI, DOWNSTREAM OF CONFLUENCE							
SAMPLE	pH	TDS (mg/l)	TSS (mg/l)	BOD_5 (mg/l)	COD (mg/l)	OIL (mg/l)	E-COLI (MPN/100ml)
1	6.91	80	31	25	100	48	3
2	6.81	34	6	11	20	92	2
3	7.12	63	50	15	120	61	13
4	7.38	52	18	21	60	100	7
5	6.30	70	25	4	20	77	15