KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

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TITLE:

PLASTIC RECYCLING PLANT, TEMA.

BY

LANCELOT WRIGHT-HANSON
B.Sc. ARCHITECTURE

MAY, 2009.

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,
KUMASI - GHANA.

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A DESIGN THESIS REPORT SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

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MAY, 2009.

DECLARATION

I, hereby declare, that except for portions where references and acknowledgement have been duly cited, this thesis report is an outcome of my own research under the supervision of Arc. B.O.G. Odame , and that it has not, in part or in whole, been presented for the award of any degree anywhere.

..... 18th Sept. 2009.

LANCELOT WRIGHT-HANSON Date

(Student)

I declare, that this dissertation herein submitted was written under my supervision and I confirm that the student has my permission to present it for assessment.

Certified by:

..... 18th Sept. 2009

MR B.O.G. Odame Date

(Supervisor)

Certified by:

....

PROF. G.W.K. INTSIFUL Date

(Head Of Department)

DEDICATION

This dissertation is dedicated to GOD ALMIGHTY, my family especially Mr and Mrs Wright-Hanson , Ms Paulina Mley Kusah, and Mr Roger Martey, for their inspiration, motivation, unwavering support and unlimited encouragement.

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SAMPLASTIC PRODUCT LTD, TEMA

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- Mr Emmanuel Abuah – Controller of Operations
- All the production room staff

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- Mr. Ampofo – Resident Engineer

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CHAPTER ONE

INTRODUCTION

1.0 OVERVIEW

Ghana in recent times has been referred to as the gateway to Africa. This vision has brought more attention to bear on the nation and the spotlight on its well known cities like Kumasi, Sekondi-Takoradi and Accra being the most relevant in that it is the nation's capital.

As many cities in the world boast of their ratings which tend to attract tourist to these cities, the same cannot be easily said of Accra. This is due to the enormous sanitation problems the city faces. The current environmental sanitation status of Ghana leaves much to be desired. The Joint Monitoring Platform of the WHO and UNICEF West Africa 2006 report, ranked Ghana 48th out of 52 and 14th out of 15 countries in Africa and West Africa respectively. The sanitation and waste management practices in the Accra metropolitan area is of urgent health concerns to the residents of the region. The heap of filth that has engulf the central business districts and some unauthorised dumping sites can be said to have contributed to the outbreaks of cholera in and around Accra with the most recent occurring between December 2008-January 2009.

-source the statesman newspaper 29-09-08,ghanadot.com march 10,2009.

As the city grows, the strain on waste management services will aggravate the problem. Waste is described as a material to which no economic value can be attributed and therefore must be disposed. On the other hand recycling is collection, processing, and reuse of materials that would otherwise be thrown away.

Materials ranging from precious metals to broken glass, from old newspapers to plastic spoons, can be recycled. The recycling process reclaims the original material and uses it in new products.-Microsoft ® Encarta ® 2009.

The country is witnessing an emerging trend in the use of plastics in the packaging industry which gives cause for concern. Food-in any form, drinks and sachet/bottled water make use of these plastic which end up on our streets. The waste generated by the population does not only cause diseases but exacerbates flooding within the metropolitan area by clogging of U-drains.

Arguably, this system of packaging is cheaper and more convenient for shoppers. In effect these products after its use can found in every refuse dump site-landfills.

"It is estimated that an average city dweller may produce a ton of refuse in a year, a volume that rapidly overflows local dumps. Cities running out of space for landfill often turn to incinerating their waste or transporting it to other areas, although up to 90 percent of the material might have been recycled."-Microsoft ® Encarta ® 2009.

The Waste Management Department of the AMA recorded the city of Accra by 1999 was generating 500-750 tons of waste daily. Currently, 1800-2000 tons of waste is generated daily in Accra of which 1500 tons is collected by waste collection contractors. Of the 1500 tons collected, 65% comprises of organic waste and 35% inorganic waste. 3.5% of the inorganic waste is plastic. It is however projected by 2010 the city will generate 4500 tons. With the gradual exhaustion of formal dumping sites at Mallam, Djanman and Oblogo, and the ever increasing waste generation in the Accra metropolis, the AMA together with stakeholders is advocating the development and use of engineered landfill and the establishing of various recycling plants with the aim of increasing the life of landfills in the region.

1.1 PROBLEM STATEMENT

With almost every purchase made from the markets and shops in business district comes plastic packaging. This makes shopping easy and convenient for shoppers to handle.It cuts across economic and social standing i.e. from supermarkets to petty trading along most streets in Accra. The indiscriminate disposals of these plastic bags, iced water sachet and bottles after use if not checked and controlled will negatively affect the environment on which we depend for survival. The non biodegradable nature of plastics necessitate special care hence the need for its collection and separation from general waste for recycling.

1.2 JUSTIFICATION

The generation of waste within cities in the country poses a huge sanitation problem for authorities to manage. To a large extent, the country's landfill sites and dumps have been exhausted giving cause for research into other methods of waste management.

Among the solutions aimed at targeting waste treatment and management are power generation, compost for agriculture use and recycling.

The choice of recycling is preferred for the treatment of plastic waste since it significantly contributes to both economic and environmental development of the country. Recycling seeks to reuse waste generated in the production of other durable, yet cheaper plastic for consumer and helps in safe guarding our environment.

The government has over a few years encouraged private participation in this regard with incentives for interested companies.

1.3 OBJECTIVES

- To reduce environmental pollution hereby making our cities more attractive and friendly for human habitation.
- To provide a facility aimed at reusing plastic waste generated in the CBD for economic benefit.
- Providing a conducive environment for the recycling of plastics.
- Creating opportunity for employment.

1.4 SCOPE OF THESIS

This thesis seeks to propose the establishment of a plastic recycling plant within the metropolitan area to help reduce the gradual environmental pollution that confronts the Greater Accra region. Plastic waste at this plant will be processed into plastic pellets and other film products according to client specification. It is therefore recommended that this plant can be replicated in all the regions of the country, and if possible, in the various district on a smaller scale to help reduce the waste that end up in our limited landfills around the country. The facilities to be provided to aid the effective operation of the plant are

1. Parking-costumer/staff
2. Administration
3. Production facility
4. Storage areas/warehouse
5. Maintenance unit
6. Welfare facility-canteen, changing rooms, clinic.

1.5 TARGET GROUP

This proposed project is aimed at helping the waste management department to process plastic waste which will generate raw materials for the plastic production industries.

1.6 CLIENT

- Accra metropolitan assembly
- Private investor

1.7 LOCATION

Export processing zone, Tema Industrial area, Tema - Greater Accra Region, Ghana.

1.8 CLIENT'S BRIEF

1. Security post
2. Parking
3. Administration
4. Production facility
5. Storage areas/warehouse
6. Maintenance unit
7. Ancillary facilities

1.9 PROJECT FINANCING

The project will be financed with the

- Assembly Common Funds-Accra/Tema Metropolitan Assembly
- Private Investor Funds

REFERENCES

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CHAPTER TWO

2.0 LITERATURE REVIEW

A recycling plant or facility is a building for the processing of materials referred to as waste. Waste can therefore be the unwanted or unusable items, remains, or by-products or household garbage. Its generation indirectly provide another raw material source for other manufacturing processes. Waste is waste only when no other material can be obtained from it or reused for other purposes after its initial reason of manufacture.

Plastic recycling in Ghana is done by the mechanical processes which involve the collection of resins, washing, drying, crushing and pelletization.

Blowplast recycling limited is the largest plastic recycler in the country and uses the complete system for its plastic production. It runs at a 16 metric ton [16000kg] capacity a day. Municipal solid waste currently is not separated at source hence available raw material tends to contain a lot of dirt. Coupled with this are low equipment capacities ranging between 200-320 kg per hour. Production output is low leading to the bulk storage of the raw materials in the open, at the mercy of the ever changing weather. This system of storage if possible should be avoided in other not to reduce the quality of resins for production.

With the incorporation of faster washing lines and large storage silos more plastic waste will be taken off our streets and landfills. In order to have more and clean raw material apart from that which is sold by collectors, dumps and landfills sites must be equipped with industrial sorters to help segregate the waste at the this stage for the recycling plants in the country.

In Madrid, Spain, the Valdemingómez Recycling Plant for urban waste is part of a larger plan to improve both the social and environmental aspects of the Southeast Region. Designed by Madrid's own Abalos & Herreros, the Plant is only part of a group of projects to create a system for waste treatment and recycling, while also transforming the area to achieve the regional plan's goals.

The project unifies the typically separate components - including selection, processing and treatment facilities, offices, workshops and storage space - under a single,sloping, green roof.

In the architect's words, the roof echoes "the gravitational character of the process as it does the original hillside upon which it sits".

Aside from the roof, the other major exterior feature is the polycarbonate panels - appropriately recycled. The translucent panels admit light during the day and reverse the process at night, as the Plant admits a soft, yellow glow to the surroundings.

Fig.1 The single sloping roof

Fig.2 The glowing poly carbon panels

Fig.3 A view of the factory

A unique aspect of the Recycling Plant is the incorporation of a museum and a route for visitors to watch the recycling process. In addition to the actual working conditions of the Plant, it also tries to educate the public by putting itself on display. In a way, then, the polycarbonate panels allude to the exhibition of the working processes. With the structure and interior finishes showing environmental sensitivity, the overall project - both building and program - goes beyond other "green" buildings.

Intended to act as a recycling plant for 25 years, the building will either become a service building or dismantled with the parts recycled or re-used. Hopefully at that time the building will successfully change uses, because even though it is essentially an industrial container, it has been designed and built with such care that it would enhance its region, even if it exists as something else.

2.1 PLASTIC INDUSTY IN THE UNITED KINGDOM

The world's annual consumption of plastic materials has increased from around 5 million tonnes in the 1950s to nearly 100 million tonnes today. This means we produce and use 20 times more plastics than we did over 50 years ago.

In the UK, a total of approximately 4.7 million tonnes of plastic products were used in various economic sectors in 2001.

Plastic consumption is growing at about 4% every year in Western Europe.

2.2 USES OF PLASTIC

Packaging represents the largest single sector of plastics use in the UK. The sector accounts for 35% of UK plastics consumption and plastic is the material of choice in nearly half of all packaged goods.

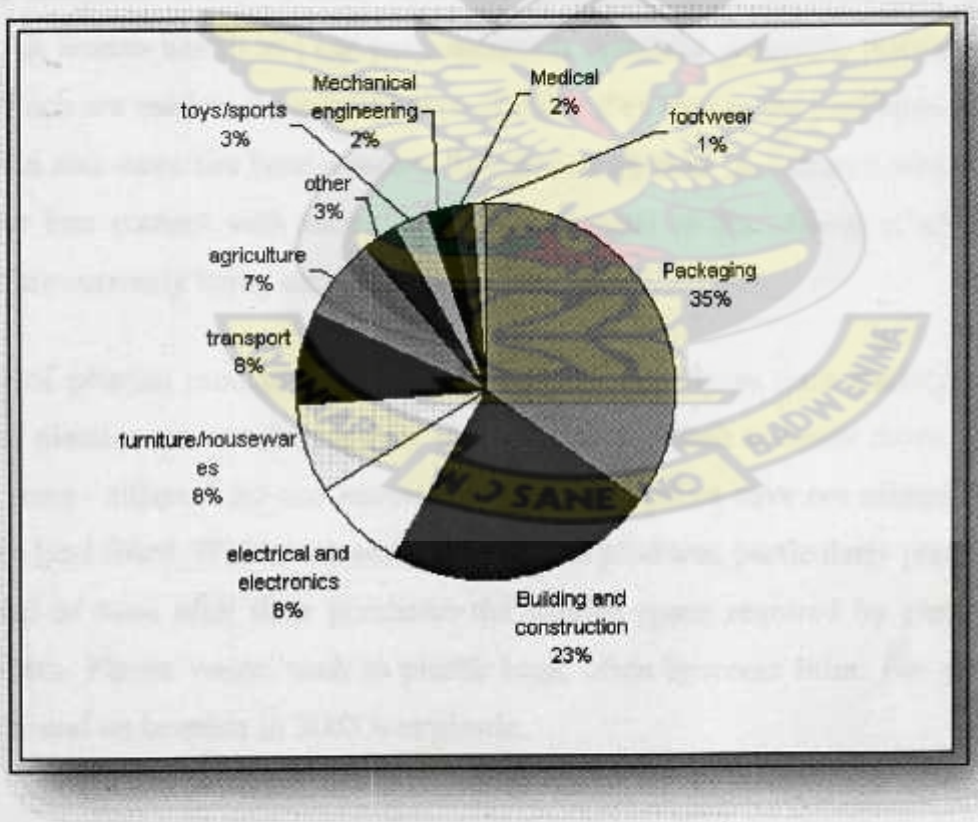


Fig.4 Plastic consumption in the UK

2.3 PLASTICS WASTE IN THE UNITED KINGDOM

The amount of plastic waste generated annually in the UK is estimated to be nearly 3 million tonnes. An estimated 56% of all plastics waste is used in packaging, three-quarters of which is from households. Plastics make up around 7% of the average household dustbin. It is estimated that only 7% of total plastic waste resins are currently being recycled.

The production and use of plastics has a range of environmental impacts. Firstly, plastics production requires significant quantities of resources, primarily fossil fuels, both as a raw material and to deliver energy for the manufacturing process. It is estimated that 4% of the world's annual oil production is used as a feedstock for plastics production and an additional 3-4% during manufacture. In addition, plastics manufacture requires other resources such as land and water and produces waste and emissions. The overall environmental impact varies according to the type of plastic and the production method employed.

Plastics production also involves the use of potentially harmful chemicals, which are added as stabilisers or colorants. Many of these have not undergone environmental risk assessment and their impact on human health and the environment is currently uncertain. An example of this is phthalates, which are used in the manufacture of PVC. PVC has in the past been used in toys for young children and there has been concern that phthalates may be released when these toys are sucked (come into contact with saliva). Risk assessments of the effects of phthalates on the environment are currently being carried out.

The disposal of plastics products also contributes significantly to their environmental impact. Because most plastics are non-degradable, they take a long time to break down, possibly up to hundreds of years - although no-one knows for certain as plastics have not existed long enough - when they are land filled. With more and more plastics products, particularly plastics packaging, being disposed of soon after their purchase, the landfill space required by plastics waste is a growing concern. Plastic waste, such as plastic bags, often becomes litter. For example, nearly 57% of litter found on beaches in 2003 was plastic.

2.4 PLASTIC WASTE SYSTEMS IN THE UNITED KINGDOM

Plastics are used in a wide range of applications and some plastics items, such as food packaging, become waste only a short time after purchase. Other plastic items lend themselves to be reused many times over.

2.5 TYPES/SYTEMS OF PLASTIC RECYCLING IN THE U.K

- Reusing plastic waste
- Plastic process scrap recycling
- Post-use plastic recycling
- Mechanical recycling
- Chemical or feedstock recycling

2.5.1 REUSING PLASTIC WASTE

Reusing plastic is preferable to recycling as it uses less energy and fewer resources. Long life, multi-trip plastics packaging has become more widespread in recent years, replacing less durable and single-trip alternatives, so reducing waste. For example, the major supermarkets have increased their use of returnable plastic crates for transport and display purposes four-fold from 8.5 million in 1992 to an estimated 35.8 million in 2002. They usually last up to 20 years and can be recycled at the end of their useful life.

According to a 2001 Environment Agency report, 80% of post-consumer plastic waste is sent to landfill, 8% is incinerated and only 7% is recycled. In addition to reducing the amount of plastics waste requiring disposal, recycling plastic can have several other advantages:

- Conservation of non-renewable fossil fuels - Plastic production uses 8% of the world's oil production, 4% as feedstock and 4% during manufacture.
- Reduced consumption of energy.
- Reduced amounts of solid waste going to landfill.

- Reduced emissions of carbon-dioxide (CO_2), nitrogen-oxide (NO) and sulphur-dioxide (SO_2).

2.5.2 PLASTIC PROCESS SCRAP RECYCLING

Currently most plastic recycling in the UK is of 'process scrap' from industry, i.e. polymers left over from the production of plastics. This is relatively simple and economical to recycle, as there is a regular and reliable source and the material is relatively uncontaminated. Process scrap represents some 250,000 tonnes of the plastic waste resins in the UK and approximately 95% of this is recycled. This is usually described as reprocessing rather than recycling.

2.5.3 POST-USE PLASTIC RECYCLING

Post-use plastic can be described as plastic material arising from products that have undergone a first full service life prior to being recovered. Households are the biggest source of plastic waste, but recycling household plastics presents a number of challenges. One of these relates to collection. With over 20 million UK households, kerbside recycling systems are required to regularly collect relatively small quantities of mixed plastics from a large number of sources. Currently, just over half of local authorities offer some form of plastic bottle collection service, and only an estimated 15% of UK households are served by kerbside collections that include plastic bottles. The densest network of plastic bottle collection schemes is found in the South and East of England and the Midlands. East Anglia, Wales, Scotland and Northern Ireland have the least coverage. There are approximately 4,000 plastic bottle collection banks in the UK.

RECOUP (Recycling Of Used Plastics Limited) undertakes an annual survey of plastic bottle recycling activity in the UK. Results of the most recent survey indicate that an estimated 24,000 tonnes of plastic bottles were collected in 2003. However, this still only amounts to approximately 5.5% of all plastic bottles sold.

2.5.4 MECHANICAL RECYCLING

Mechanical recycling of plastics refers to processes which involve the melting, shredding or granulation of waste plastics. Plastics must be sorted prior to mechanical recycling. At the moment in the UK most sorting for mechanical recycling is done by trained staff who manually sorts the plastics into polymer type and/or colour. Technology is being introduced to sort plastics

automatically, using various techniques such as X-ray fluorescence, infrared and near infrared spectroscopy, electrostatics and flotation. Following sorting, the plastic is either melted down directly and moulded into a new shape, or melted down after being shredded into flakes and then processed into granules.

2.5.5 CHEMICAL OR FEEDSTOCK RECYCLING

Feedstock recycling describes a range of plastic recovery techniques to make plastics, which break down polymers into their constituent monomers, which in turn can be used again in refineries, or petrochemical and chemical production. A range of feedstock recycling technologies is currently being explored. These include: pyrolysis, hydrogenation, gasification and thermal cracking. Feedstock recycling has a greater flexibility over composition and is more tolerant to impurities than mechanical recycling, although it is capital intensive and requires very large quantities of used plastic for reprocessing to be economically viable (e.g. 50,000 tonnes per year).

2.6 PLASTICS RECYCLING IN THE UK

In 1998, a pilot feedstock recycling plant went operational at BP's Grange mouth site in Scotland, with a capacity to process 400 tonnes of mixed plastic waste per annum. A feasibility study into its viability concluded that a 25,000 tonnes per annum plant could be supported from the area's municipal waste sources alone.

In 1991, LINPAC Plastics Recycling opened a unique plant with the ability to recycle post-consumer polystyrene products. The plant, based in Allerton Bywater, West Yorkshire, has a capacity of over 14,000 tonnes per year, which is set to increase to 25,000 tonnes per year by 2005. The plant is able to process fast food boxes, meat trays, egg cartons, yoghurt pots, vending cups, and a range of other polystyrene products. In addition, the plant processes a range of polyethylene and polypropylene goods, such as bottles, crates, sheets, caps, pipes and fibres.

2.7 DEGRADABLE AND BIO-PLASTICS

2.7.1 DEGRADABLE PLASTICS

A number of UK retailers have recently introduced degradable carrier bags. These bags are made from plastic which degrades under certain conditions or after a predetermined length of time. There are two types of degradable plastic: bio-degradable plastics, which contain a small percentage of non oil-based material, such as corn starch; and photo degradable plastics, which will break down when exposed to sunlight.

Degradable plastics are already being used successfully in Austria and Sweden, where McDonalds has been using bio-degradable cutlery for three years. This enables all catering waste to be composted without segregation. Carriers for packs of beer cans are now being manufactured in a plastic which photo-degrades in six weeks. There is also potential to use such plastics in non-packaging applications such as computer or car components.

There are a number of concerns over the use of degradable plastics. First, these plastics will only degrade if disposed of in appropriate conditions. For example, a photodegradable plastic product will not degrade if it is buried in a landfill site where there is no light. Second, they may cause an increase in emissions of the greenhouse gas methane, as methane is released when materials biodegrade an aerobically. Third, the mixture of degradable and non-degradable plastics may complicate plastics sorting systems. Last but not least, the use of these materials may lead to an increase in plastics waste and litter if people believe that discarded plastics will simply disappear.

2.7.2 BIO-PLASTICS

A number of manufacturers have been exploring alternatives to plastics made from non-renewable fossil-fuels. Such alternative 'bio-plastics' include polymers made from plants sugars and plastics grown inside genetically modified plants or micro-organisms.

Health and safety concerns have arisen over potentially hazardous chemical additives to plastics and consumer pressure has contributed to manufacturers switching to plant-based plastics in such cases. For example, the world's largest toy manufacturer Mattel announced in 1999 that PVC would be replaced with plant-based plastics in new products from 2001 onwards. A range of other companies, including LEGO, IKEA, Nike and The Bodyshop have made similar pledges.

2.8 USES OF RECYCLED PLASTIC

There is a wide range of products made from recycled plastic. This includes polyethylene bin liners and carrier bags; PVC sewer pipes, flooring and window frames; building insulation board; video and compact disc cassette cases; fencing and garden furniture; water butts, garden sheds and composters; seed trays; anoraks and fleeces; fibre filling for sleeping bags and duvets; and a variety of office accessories.

Despite the wide range of recycled plastics applications, the actual tonnage of waste plastic which is returned to the material cycle is relatively small. Currently, recycled plastics are rarely used in food packaging - the biggest single market for plastics - because of concerns about food safety. A method of addressing this problem is by enclosing the recycled plastic between layers of virgin plastic to ensure the packaging conforms to hygiene standards. These multi-layered containers are now being used in some drinks bottles, but recycling cannot eliminate the colours from plastics so they cannot be used in transparent or light coloured applications.

Another constraint on the use of recycled plastics is that, to be economically viable, plastic processors require large quantities of recycled plastics, manufactured to tightly controlled specification at a competitive price in comparison to that of virgin polymer. This is a challenging task, particularly in view of the diversity of sources of waste plastics, the wide range of polymers used and the high potential for contamination of plastics waste.

In order to encourage market development for recycled material applications, the UK Government has set up the Waste and Resources Action Programme (WRAP) whose task is to promote sustainable waste management by creating stable and efficient markets for recycled materials and products.

2.9 A BRIEF HISTORY OF WASTE MANAGEMENT IN ACCRA

Accra is Ghana's capital city as well as its largest city, and is situated on the Atlantic coast about 25km west of the Greenwich Meridian. It has been Ghana's capital since 1877, and contains fine public buildings reflecting its transition from a 19th century suburb of Victoriaburg to the modern metropolis it is today. Accra stretches along the Atlantic Coast and north into the interior. Accra's current built-up dimensions are approximately 25 km east to west by about 12 km north to south (Grant and Yankson, 2002). It was originally built around the port. Its architecture ranges from large and elegant 19th Century colonial buildings to skyscrapers and apartment blocks made of concrete, glass and steel in the 1970s.

General Waste Management in Ghana is the responsibility of the Ministry of Local Government and Rural Development, which supervises the decentralized Metropolitan, Municipal and District Assemblies (MMDAs). However, regulatory authority is vested in the Environmental Protection Agency (EPA) under the auspices of the Ministry of Environment and Science. The Metropolitan, Municipal and District Assemblies are responsible for the collection and final disposal of solid waste through their Waste Management Departments (WMDs) and their Environmental Health and Sanitation Departments.

The policy framework guiding the management of hazardous, solid and radioactive waste includes the Local Government Act (1994), Act 462, the Environmental Protection Agency Act (1994), Act 490, the Pesticides Control and Management Act (1996), Act 528, the Environmental Assessment Regulations 1999, (LI 1652) the Environmental Sanitation Policy of Ghana (1999), the Guidelines for the Development and Management of Landfills in Ghana, and the Guidelines for Bio-medical Waste (2000). All these Acts and Regulations emanate from the National Environmental Action Plan.

The only guidelines, which indirectly discourage unsustainable practices and promote sustainable consumption and production, are those on the Environmental Impact Assessment. Standards relating to pollutants into the atmosphere (air, water and land) have also been prepared to ensure that production/consumption activities are sustainable.

Environmental Impact Assessment is a requirement under legislation (Act 490) and guidelines have been prepared through the Environmental Protection Agency with private sector collaboration. These guidelines and standards are mandatory for the execution of all *major projects in the country.* - *SanitationGhana-2004.*

2.10 WASTE MANAGEMENT TRENDS IN GREATER ACCRA

2.10.1 WASTE COMPOSITON AND GENERATION

According to the Waste Management Department of the Accra Metropolitan Assembly, about 1800 tonnes of municipal solid wastes is generated per day in the metropolis and the average waste generated per capita per day is estimated at 0.5 tons per person. Holding change in production and consumption patterns constant, future projections are subject to population growth, taking into account the present population of 3million and growth rate of 3.5 per cent. The generated waste in the metropolitan area comes from these sources such as:-

- Residencies
- Companies/Cooperate Organisations
- Shops
- Industries
- Hospitals

The markets and lorry stations/stops contribute about 60 percent of all waste in the region. Hospital waste is classified as hazardous and toxic, hence its collection and disposal is strictly monitored by the waste managing authorities. The hospitals in the region currently have a private waste management company tasked to collect and dispose hospital waste by incineration.

Waste from all the mentioned sources are usually categorised into two (2) distinct groups.

- Organic Waste- 65% - household waste e.g. food.
- Inorganic Waste- 35% - plastics, glass etc.

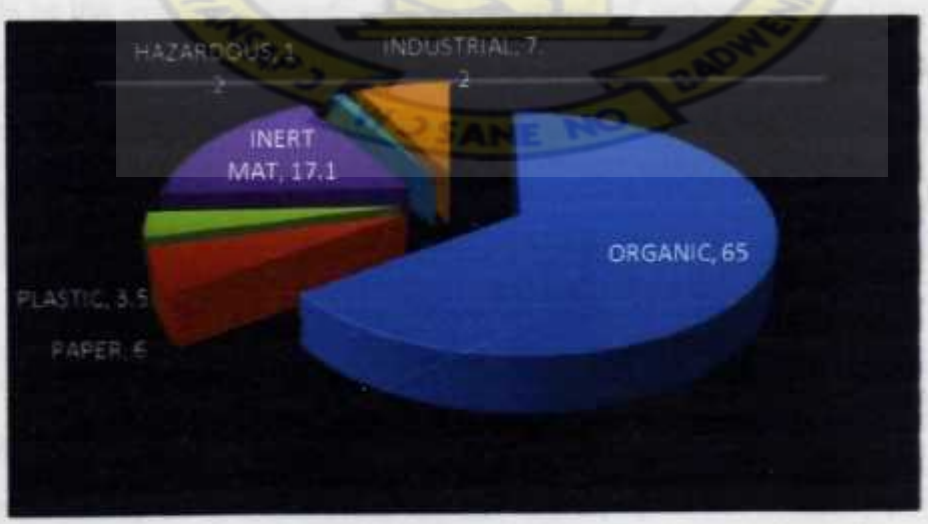


Fig.5 The waste type and composition in the Accra metropolitan area

Waste type	Organic i.e. Food and plant	Paper	Textile	Plastic	Glass	Metal	Inert	Others
Percentage	65%	6%	1.7%	3.5	3%	2.5%	17.1%	1.2%

A notable new source of waste is E-waste. E-waste is the generic name for electronic or computer wastes. These are discarded electronics devices that come into the waste stream from several sources. Other gadgets include televisions, personal computers (PCs), telephones, air conditioners, cell phones, electronic toys, refrigerators, washing machines, dryers, kitchen equipment or even aeroplanes. People patronise these used equipment mostly because they are cheaper as compared to new ones hence the influx on the market.

The consequences of its indiscriminate disposal reverberate in potential environmental as well as health hazards that put the globe at risk since it is one of the largest known sources of heavy metals, toxic materials and organic pollutants in city waste.

2.10.2 E- WASTE: A GROWING CONCERN IN GHANA

E-waste is the generic name for electronic or computer wastes. These are discarded electronics devices that come into the waste stream from several sources. They include gadgets like televisions, personal computers (PCs), telephones, air conditioners, cell phones, and electronic toys. The problems posed by e-waste are becoming more challenging, because the increase in the quantity of e-waste in the system is largely due to the speed of technological advancement and innovation coupled by a high obsolete rate. And because of the very critical role of technology in social and economic development, the issue of e-waste has become a complicated one. Among industrial waste campaigners the world over, electronics equipment is one of the largest known sources of heavy metals, toxic materials and organic pollutants in city waste and Ghana is no exception.

2.10.3 SOLID WASTE COLLECTION

The Waste Management Department (WMD) of the Accra Metropolitan Assembly is responsible for garbage collection and disposal, and general sanitation within Accra. Starting in 1997, solid waste collection and haulage was privatized and contracted out to fifteen (15) different companies.

The three million inhabitants' of the city of Accra currently generate averagely 1800-2000 tons of municipal solid waste daily of which 75% is collected by eighteen (18) refuse contractors. There has notably been an increase of 1300-1500 tons of waste generated in the city as of 1999 likewise the waste collection companies. By 2010, the Greater Accra population is expected to reach 4 million persons, generating 4,500 tons of solid waste per day (Ministry of Local Government, 1992). If capacity for waste management is not drastically increased, potentially 72% of the population will not be served by the existing waste management services.

Table 1. Volume and Daily tonnage of waste collected in Accra

	750	450 - 600
	960	600 -800
	1650	1200 – 1500
	1700	1300 - 1500
	1720	1300 – 1500
	1800	1300 – 1500

Source: AMA Waste Management Department (August 2004)

The collection of solid waste in Accra by approved companies is done by the following concepts;

1. House to house – this system serves middle to high income residential areas in the metropolis. A compacting refuse truck usually moves from house to house on specific days -once a week to empty bins left on the frontage of homes for a fee.

2. Communal centre container –this system usually employs skips and roll-on & off trucks at markets and lorry stations. Designated dumping grounds are also provided with such containers where fees are charged per bin emptied. This sight is common within low income residential areas and slums, e.g. Nima and Chorkor

Location Sub-metro areas	Collection by Central collection	Collection by House-to-house	Estimated tonnage
Ayawaso	157	120	277
Kpeshie	116	96	212
Ablekuma	224	132	356
Okaikoi	103	60	163
Ashiedu keteke	132	12	144
Osu klottey	84	138	222
Total	816	558	1374

Table 2 Estimated daily waste collection in Accra-source: waste management department, 2003

Despite the strategies put in place for the collection of waste in Accra, all is not well for maximum waste collection according to the Waste Management Department of the Accra Metropolitan Assembly.

Until recent, municipal solid waste generated was not separated. This has lead to the early exhaustion of available landfills and official dump sites. People must be encouraged to separate waste according to their contents in homes since its introduction at source will go a long way in improving the sanitation in the city. For the separation of waste in the city-public areas, the Accra Metropolitan Authority introduced coded litter bins at some 'trotro' stops and embarked on programs to educate the public. This program has not yielded the necessary result since it takes much effort to change behavioural patterns of people.

2.10.4 SOLID WASTE TREATMENT

The region has relied on dump sites and landfills for the disposal of waste. Having exhausted the dumping grounds at Djaman and Mallam, the attention shifted to the Oblogo dump site. This site was receiving an average daily waste load of about 1200 metric tons. The new dump site at Saba became operational in January 2009.

Plans are far advanced at a proposed engineered landfill at Kwabenya, 18 km north of the Accra. The area to be used for land filling is about 75 ha while the buffer zone including the compound was originally 119 ha giving a total land acquired to be 194 ha. With time, most of these sites will be exhausting their capacities forcing the metropolitan authorities to acquire new sites. In

order to extend the life span, waste destined for this site will have to be separated and recyclable components processed.

10% to 15% of solid waste collected in Accra is composted at the Teshie-Nungua Compost Plant, located east of the city centre and was established in 1980 by the Ministry of Local Government and the Accra Metropolitan Assembly. This facility composted more than 60 tons of domestic waste each day in 2000. The daily volume of composted trash increased to between 125 and 188 tons per day.

There are some existing concerns about operational consistency and reliability at this composting facility. The plant is currently not operational due to financial constrains and obsolete equipments hence the increase in material dumped into landfills.

Since the formal systems of solid waste disposal cannot cope with the ever increasing volume of solid waste being generated in Accra, the public itself employs various means of waste disposal. Waste is thus disposed off indiscriminately especially in watercourses and drainage channels and also through burning. Some residents interviewed admitted disposing their solid waste into drainages or burning. In the 2000 Population and Housing Census, 625,746 members of the public in Accra interviewed on their means of solid waste disposal gave results in table

Table 3 OTHER MEANS OF WASTE DISPOSAL BY THE PUBLIC

Disposal means	Population	Percentage
Waste collected by agents	122,034	19.5 %
Burned by household	76,359	12.2 %
Public dump	321,824	51.4 %
Dumped elsewhere	72,016	11.6 %
Buried by household	28,948	4.6 %
Other	4,565	0.7 %
Total	625,746	100%

Source: Statistical Service (2002)

2.11 HISTORY OF RECYCLING IN GHANA

Clean and environmentally sound technologies are promoted through activities, which ensure that industries meet national environmental standards and at the same time promote the more efficient use of resources. Under the auspices of the Ministry of Environment and Science, a Waste Management Stock Exchange is to be established as a means of identifying and making waste available to other consumers who need such waste materials for their production activities. Through this arrangement, another company for its own production activities could, for instance, identify wastes generated by that company for use. This should help in reducing the quantities and types of waste generated in the country.

The country's steel and paper industries, and to some extent the plastic industry, are engaged in programmes of recycling wastes. A number of small-scale aluminium fabrication companies have been assisted to improve on their production systems. Though these programmes were initially meant to address the environmental problems associated with their operations, the improved production systems also led to improved efficiency in the use of materials and reduction in waste from the industries. All programmes for the management of waste relate only to waste generated within the country. The country does not permit the importation of waste for processing or disposal.

The issue of waste management has become a subject for research in many stakeholder institutions. The management of plastic waste is receiving attention. Some technologies have been developed to assist recycling of waste. A number of small-scale plastic waste recycling plants have been set up in the Greater Accra Region. There are plans to set up similar ones in other metropolitan, municipal and urban areas of the country.

The management of other solid and hazardous waste is also being researched at the Ghana Atomic Energy Commission and the Center for Scientific and Industrial Research (CSIR). Exogenous technologies are also being studied for their appropriate adoption and transfer for local use. The following are the recycling arrangements and the amounts the industries are able to recycle

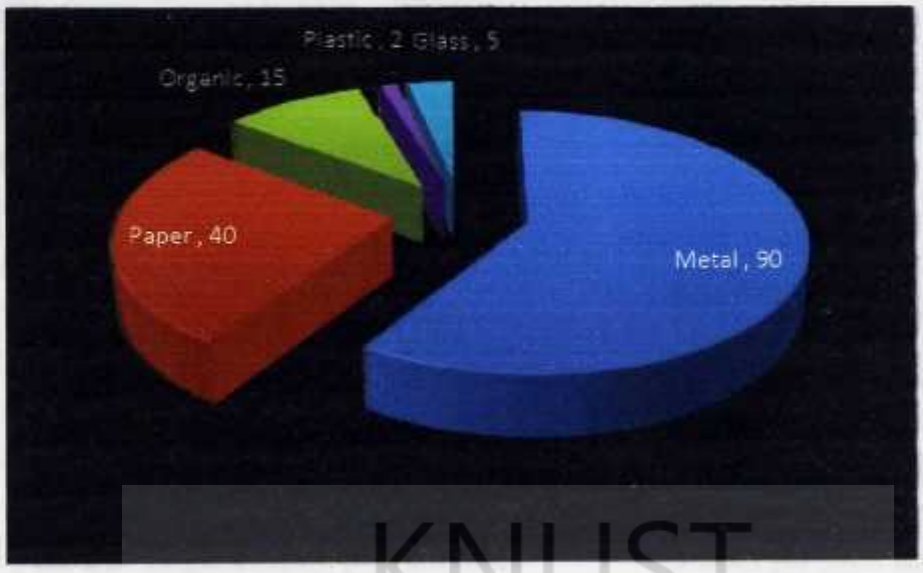


Fig. 6 Waste recycling in Ghana -Source: WMD (August 2004)

2.12 TYPES OF PLASTICS

There are about 50 different groups of plastics, with hundreds of different varieties. The types and their most common uses are listed as follows:

CODES	NAME & PROPERTIES	PRODUCTS
	**PET -Polyethylene Terephthalate** **Clarity,toughness,barrier to gas & moisture,heat resistance**	***Fizzy drink bottle and oven ready meal trays***
	**HDPE- High-density polyethylene** **Stiffness,strength,toughness,resistance to chemicals,permeability to gas,ease of processing,ease of forming.**	***Bottles for milk and washing-up liquids***
	**PVC -Polyvinyl chloride** **Versatility,clarity,ease of blending,strength,toughness,resistance To grease,oil & chemical**	***Food trays, cling film, bottles for squash, mineral water and shampoo.***
	**LDPE- Low density polyethylene** **Easy processing,strength,toughness, flexibility,water barrier**	***Carrier bags and bin liners.***
	**PP- Polypropylene** **Strength,toughness, resistance to Heat,chemicals,grease,oil,moisture barrier, versatile.**	***Margarine tubs, microwaveable meal trays.***
	**PS- Polystyrene** **Insulation,clarity,versatile, easy to form**	***Yoghurt pots, foam meat or fish trays, hamburger boxes and egg cartons, vending cups, plastic cutlery, protective packaging for electronic goods and toys.***
	**OTHER-resins** **Plastics that do not fall into any of the above categories.**	***An example is melamine, which is often used in plastic plates and cups.chicle in gym,fabrics egnylon,teflon***

Table 4 plastic classification

2.13 CATEGORIES OF PLASTICS

All plastics, whether made by addition or condensation polymerization, can be divided into two groups: thermoplastics and thermosetting plastics. These terms refer to the different ways these types of plastics respond to heat.

- Thermoplastics can be repeatedly softened by heating and hardened by cooling.
- Thermosetting plastics, on the other hand, harden permanently after being heated once.

The reason for the difference in response to heat between thermoplastics and thermosetting plastics lies in the chemical structures of the plastics.

Thermoplastic molecules, which are linear or slightly branched, do not chemically bond with each other when heated. Instead, thermoplastic chains are held together by weak attractions between the molecules that cause the long molecular chains to clump together like piles of entangled spaghetti. Thermoplastics can be heated and cooled, and consequently softened and hardened, repeatedly, like candle wax. For this reason, thermoplastics can be remoulded and reused almost indefinitely.

Thermosetting plastics consist of chain molecules that chemically bond, or cross-link, with each other when heated. When thermosetting plastics cross-link, the molecules create a permanent, three-dimensional network that can be considered one giant molecule. Once cured, thermosetting plastics cannot be remelted, in the same way that cured concrete cannot be reset. Consequently, thermosetting plastics are often used to make heat-resistant products, because these plastics can be heated to temperatures of 260° C (500° F) without melting.

The different molecular structures of thermoplastics and thermosetting plastics allow manufacturers to customize the properties of commercial plastics for specific applications. Because thermoplastic materials consist of individual molecules, properties of thermoplastics are largely influenced by molecular weight. For instance, increasing the molecular weight of a thermoplastic material increases its tensile strength, impact strength, and fatigue strength (ability of a material to withstand constant stress). Conversely, because thermosetting plastics consist of a single molecular network, molecular weight does not significantly influence the properties of these plastics. Instead, many properties of thermosetting plastics are determined by adding different types and amounts of fillers and reinforcements, such as glass fibres. Source: Microsoft ® Encarta ® 2009.

2.14 BENEFITS OF PLASTICS

The considerable growth in plastic use is due to the beneficial properties of plastics. These include:

- Extreme versatility and ability to be tailored to meet very specific technical needs.
- Lighter weight than competing materials, reducing fuel consumption during transportation.
- Extreme durability.
- Resistance to chemicals, water and impact.
- Good safety and hygiene properties for food packaging.
- Excellent thermal and electrical insulation properties.
- Relatively inexpensive to produce.

2.15 EFFECTS OF PLASTIC MANUFACTURING ON THE ENVIRONMENT

The disposal of plastics products also contributes significantly to their environmental impact. Because most plastics are non-degradable, they take a long time to break down, possibly up to hundreds of years - although no-one knows for certain as plastics have not existed for long enough - when they are land filled. With more and more plastics products, particularly plastics packaging, being disposed of soon after their purchase, the landfill space required by plastics waste is a growing concern.

Plastic waste, such as plastic bags, often becomes litter. For example, nearly 57% of litter found on beaches in 2003 was plastic.

Source: www.wasteonline.com

2.16 IMPORTANCE OF PLASTIC RECYCLING

The production and use of plastics has a range of environmental impacts. Firstly, plastics production requires significant quantities of resources, primarily fossil fuels, both as a raw material and to deliver energy for the manufacturing process. It is estimated that 4% of the world's annual oil production is used as a feedstock for plastics production and an additional 3-4% during manufacture.

A report on the production of carrier bags made from recycled rather than virgin polythene concluded that the use of recycled plastic resulted in the following environmental benefits:

- Reduction of energy consumption by two-thirds.
- Production of only a third of the sulphur dioxide and half of the nitrous oxide.
- Reduction of water usage by nearly 90%.
- Reduction of carbon dioxide generation by two-and-a half times.
- A study concludes that 1-8 tonnes of oil is saved for every tonne of recycled polythene produced

In Ghana, plastic litter is generally disposed of in gutters which clog them obstructing the free flow of waste water and rain water hence causing flooding in our cities. Choked drains and gutters have created stagnant waters that act as breeding grounds for mosquitoes, which transmit, among other diseases, malaria. Stray livestock feed on the indiscriminately dumped plastic waste causing suffocation leading to death. The waste, which contains a high amount of plastic bags are blown about by the wind. This windblown litter makes the area unsafe and creates unsightly conditions in the environment. The litter and plastics make parts of the city very untidy and unhygienic.

2.17 PLASTIC WASTE IN ACCRA

The plastic component of waste generated in the country has been increasing steadily over the years. By 1998, the daily average of plastic waste generated ranged between 16-21 tons. This increased to 45-52 tons by 2003. Due to population increases, it was projected that by 2008 the plastic component in waste generated in the metropolitan area will increase to 70 tons. Currently in Accra, 70 tons of plastic waste is generated each day by the capital's three million inhabitants. Officials estimate that plastic water sachets account for about 85% of that refuse. Over the years plastics have replaced leaves, glass and metal as a cheaper and more efficient means of packaging.

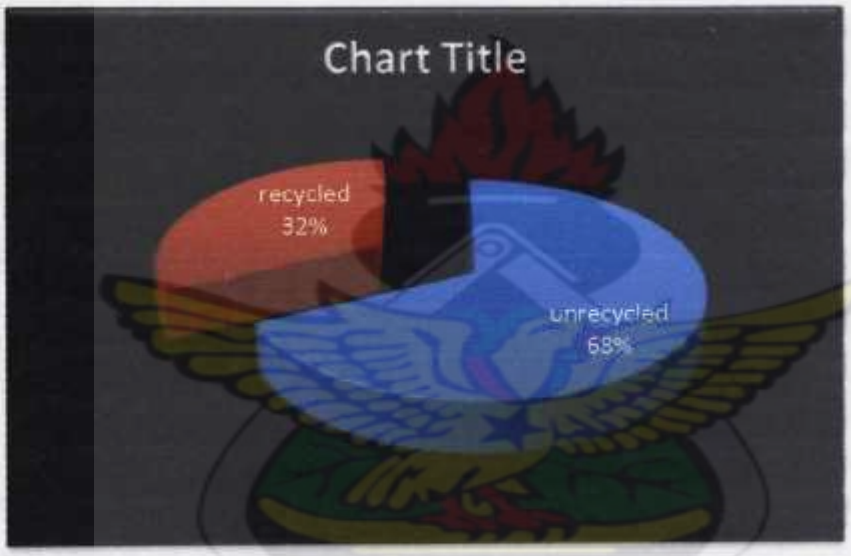


Fig.7 Percentage Of Plastic Waste Recycled

2.17.1 METHODS OF COLLECTION

In order to have a secured source of raw material for the plant the methods stated below would be employed:

- Encourage the separation of plastic waste at homes to improve the efficiency in the house to house collection.
- The available designated points of collection must be increased to cover the entire metropolitan area reducing travel time to dump site.
- Creating plastic banks in and around supermarkets, markets, lorry stations, shops etc noted for generating over 60% of municipal solid waste.
- Purchasing waste plastic from scavengers and plastic waste collectors.

2.17.2 SEPARATON OF WASTE

All waste items including packaging, food wastes, paper, etc. will be collected together via waste bins located at households, places of business, public areas, etc. The collected material will be sent first to a depot where manual or automated sorting takes place to extract recyclable materials. The remaining waste is either sent to landfills or incinerated.

Smart tips about sorting waste are listed below and the metropolitan authorities must encourage and ensure these are adhered to, with defaulters made to pay hefty fines or face punishment stated by the by-laws of the assembly.

- Arrange the sorting well in your home, so you can dispose of garbage and recyclables easily in the waste room. The easiest way is to have two buckets, one for household waste and one for recyclable material. Then you can sort the recyclable waste in the waste room.
- Rinse or wash sticky packaging.
- Separate all multi-material packaging, except for metal tubes with plastic corks (for instance mustard or mayonnaise). They can be disposed of as a whole in the bin for metal recyclables.
- Fold or flatten small and large cardboard boxes. Open cans in both ends and flatten them because this will save a lot of space.
- Do not mix clear and coloured glass. The container for clear glass is for uncoloured glass only. Glass with the slightest tint of brown, green or light blue must be disposed of in the container for coloured glass.
- Please tie and dispose of your trash bags properly.

To feed the machines with clean raw material, there will be the need to re-sort the plastic waste on site to remove contaminants that may be present.

CHAPTER THREE

3.0 METHODOLOGY

The following are measures considered and adopted so as to come out with the best proposal for the plastic recycling plant for the metropolitan areas in the Greater Accra Region.

- ***Visual survey***: - regular visits to the site was very important to help appreciate on firsthand the existing nature, conditions, constrains and potentials of the site.

- ***Interviews: -*** a series of interviews were held with stakeholders in the waste management industry. These include the Waste Management Department of Accra Metropolitan Assembly, the waste collection company and some recycling companies. It was aimed at gathering current trends in the industry and helping in the future proposal in improving the industry.

- ***Case studies:***-the case studies conducted at Samplastic product Limited and Progressive Plastic Limited helped in developing an appropriate brief and to know firsthand how the whole setup functions especially the machinery.

- ***The internet: -*** The World Wide Web provides a vast database of information relevant to the study, i.e.-Information on pertaining situations around the world and projections into the future for the industry. Types and various systems of operation of machines and equipments.

- ***Photography:-*** Pictures of the site were taken, analyzed and documented. In addition, pictures were retrieved from books, journals, internet to serve as a visual documentation for case, special and technical studies.

3.1 LIMITATION OF STUDY

It was difficult acquiring official data from the major plastic recycling companies on the processing systems being used, consumption levels of both water and electricity while others denied total visit to their production areas.

3.2 CASE AND TECHNICAL STUDIES

3.2.1 CASE STUDY 1 [PROGRESSIVE PLASTIC LTD]

Progressive plastic is a company located in Accra, off the old Fadama road near the Agbogbloshie market. It is within the south industrial area of the capital city. The factory was previously producing metal head pans and recycling plastic waste.

Fig. 8 A view of the Administration Block & night manager's apartment.

The production of the metal head pans seized, making room for the increase capacity in plastic waste recycling. The plant uses the incomplete system of plastic waste recycling. By this system the processing is geared at producing pellets being raw materials for the numerous plastic producers in the country. It recycles plastic waste of about 1-2 tons in a day.

The site covers an area of 100' x 70' and has 2 entrances clearly distinct from each other. The first is on the north which is for customers and staff to access parking. The second can be found south of the factory building. This provides access to the service yard for the discharge of raw material to feed the factory.

Fig .9 A Worker Dragging Bagged Raw Material To The Washer

Fig. 10 Service Yard Used As Storage For Raw Material

The building houses the different departments under one structure i.e. administration, raw material store, finished goods store, and generator and production floor. The post and beam structural system is used for this factory. The peripheral positioning of the columns frees the production floor for easy movement of both workers and raw materials. Timber trusses spans the entire factory with aluminium sheet covering-evenly spaced perspex to aid lighting on the production floor.

Fig.11 A View Of The Production Floor

Fig.12 Finished Goods store on Production Floor

The walls are built of sandcrete blocks held at regular intervals by reinforced columns. Painting combines both light and dull colours. Areas from the floor to about 2 meters, which can easily to be smeared with oil and grease are painted with dull gloss paints which are washable in nature. From the 2 meter boundary, lighter paint is used to help defuse light within the space.

There are few windows making ventilation a problem. The high level opening ie design blocks admit light but contributes little to ventilate the building. With temperature of equipments reaching over 300 °C, there is a need to cool these machines and providing a conducive environment for workers.

Electrical cable run horizontally along walls but not placed in trunks exposing workers to shock and may even be the cause of fires on the premises.

The floors are of reinforced concrete with portions having uncovered drains. These where around the water baths that is used for cooling the strings of recycled plastic.

No provision has been made to fight fires when they occur-fire hydrant, extinguishers, sprinklers or smoke detectors.

3.2.2 CASE STUDY 2 [SAMPLASTIC PRODUCTS LTD]

This is a plastic manufacturing factory located in Tema off the Aflao- Tema highway. This can be found within the light industrial area about 1 km from the Kpone police barrier.

Samplastic produces polyethylene sheets, industrial bags, rolls for sachet bags, plastic aprons, carrier bags, garbage bags, seedling bags and HDPE pipes.

Fig. 13
A View Of The Administration Block And Costumer Parking

The main facility –administration, production hall, storage, recycling, printing and maintenance departments are under one shed.
On entry, the positioning of the structure is skew to the left leaving room for future expansion on the right. This area now provides temporal storage for waste to be recycled.

Fig.14 A View Of The Production Block And Virgin Material Store.

Fig.15 Undeveloped Land Used As Raw Material Storage

The administration is joined to the production hall; this system ensures direct supervision of the production process aiming at increasing quality and reducing waste.

The structural system is the post and beam with sandcrete blocks as in-filling and reinforced columns. The steel trusses used for the roofing structure frees the production hall for easy movement of workers and raw materials and positioning of equipment.

Fig 16 A Film Extruder

Fig.17 Perspex Over Production Floor To Admit Natural Light

This system was also used to accommodate the high machines used in the film production of plastics – [12-18 metres].

Ancillary facilities are mainly aligned to the left of the main block with the exception of the out-of use changing room. The others include the water storage, air compressor unit, transformer, generator set and fuel storage.

Fig 18. A View Of The Water tank

Fig 19. The Air Compressing Unit

The structure makes use of high level windows and extractor funs to ventilate the building. In the printing area, low level windows are used to aid in drying of printed works and ventilate the space.

Fig. 20 natural lighting using high level window

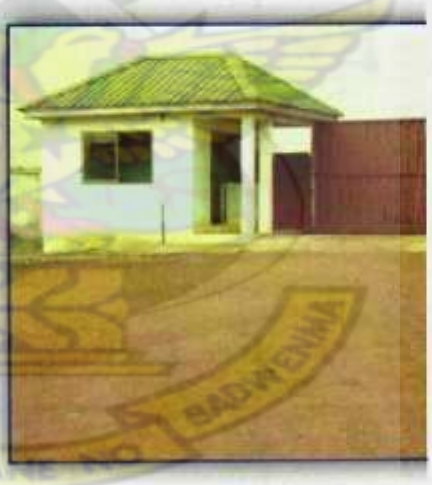
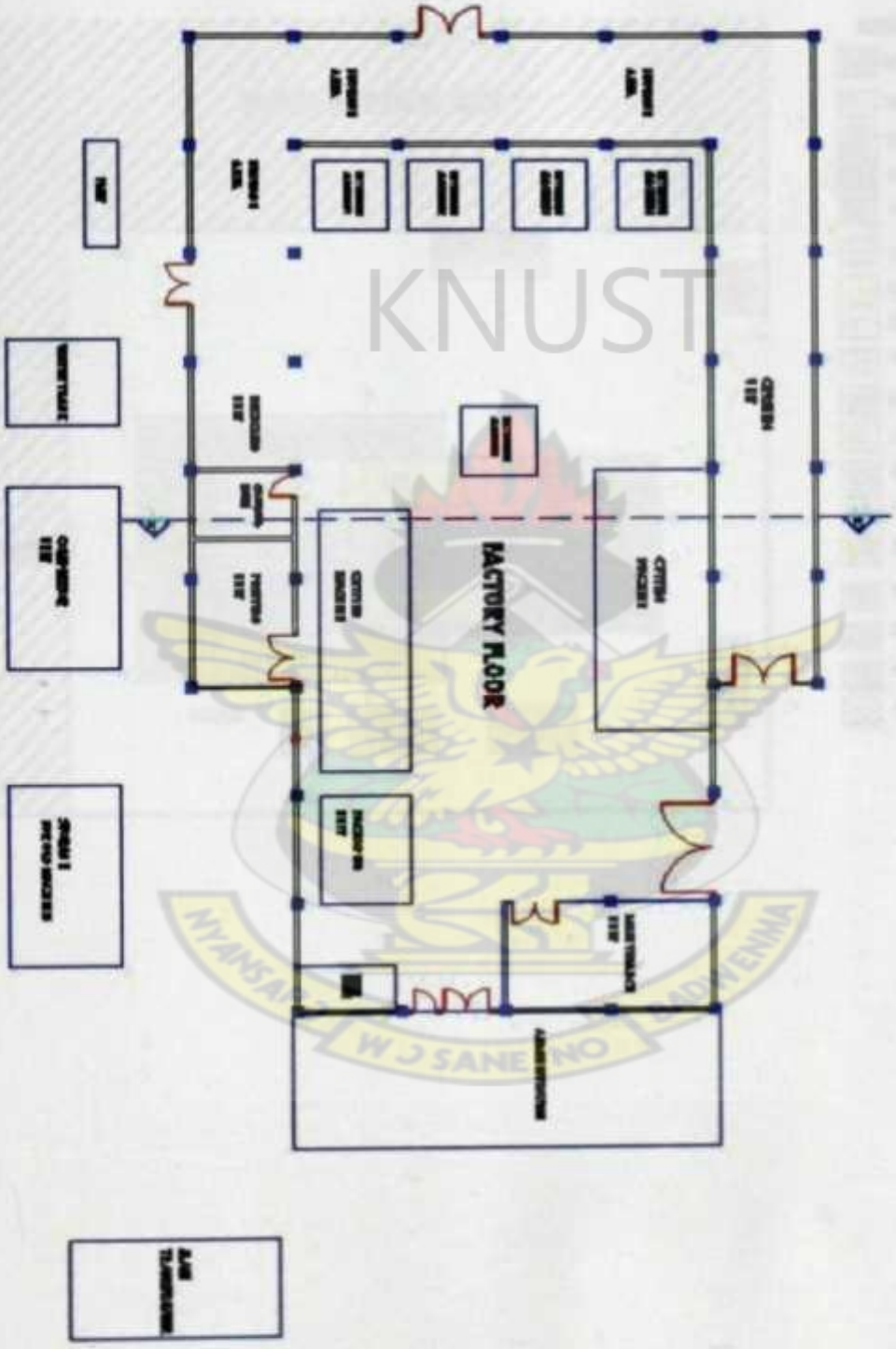


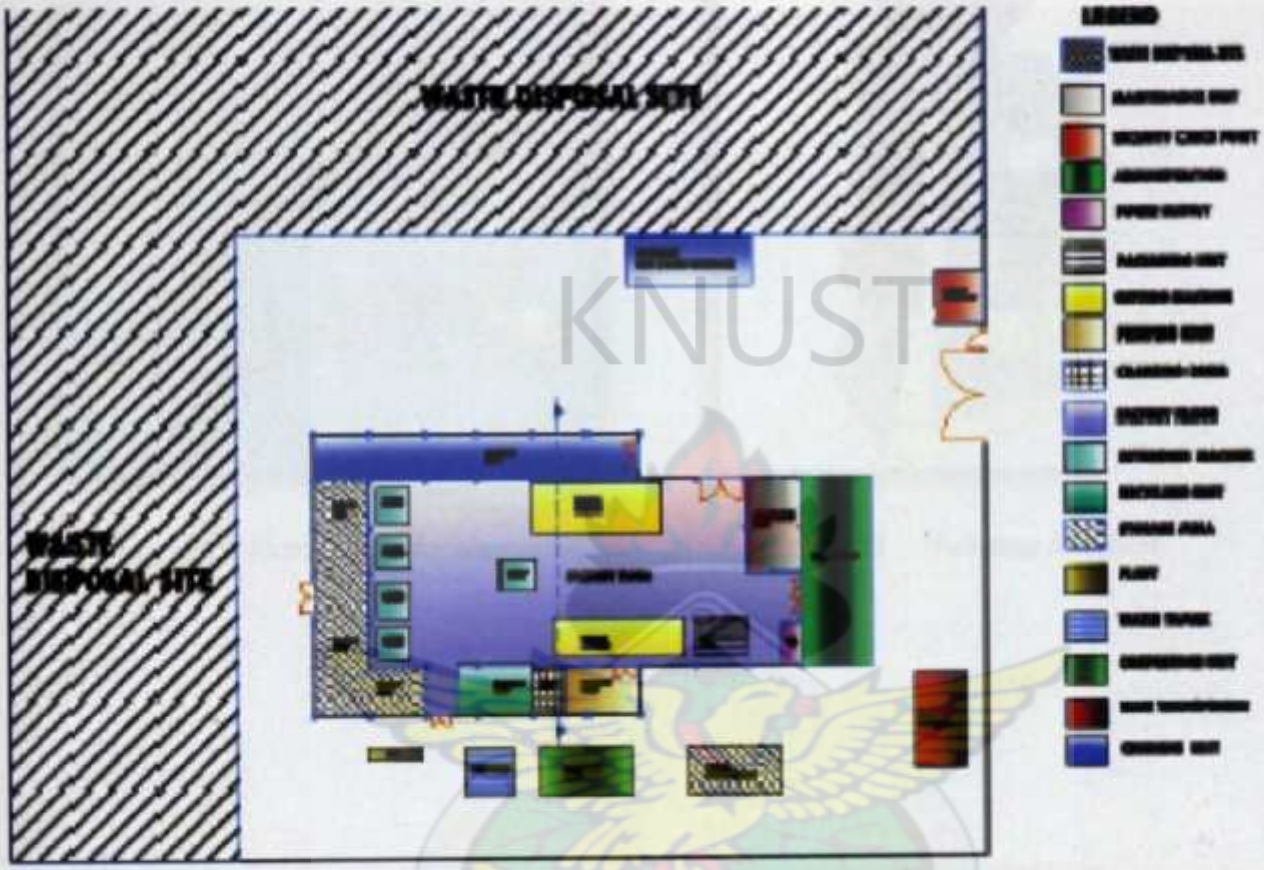
Fig.21 A security post to check entry and exit of goods and persons

Perspex evenly positioned in the aluminium roofing sheet distributes natural light onto the production floor to augment the artificial lighting. Security is high on the premise which has only one entry. This also creates vehicular conflict at the check point.

PLAN OF PRODUCTION FLOOR -*Source: Samplastic Products Ltd)*



GENERAL LAYOUT OF SAM PLASTIC LIMITED



3.2.3 SPECIAL/TECHNICAL STUDIES

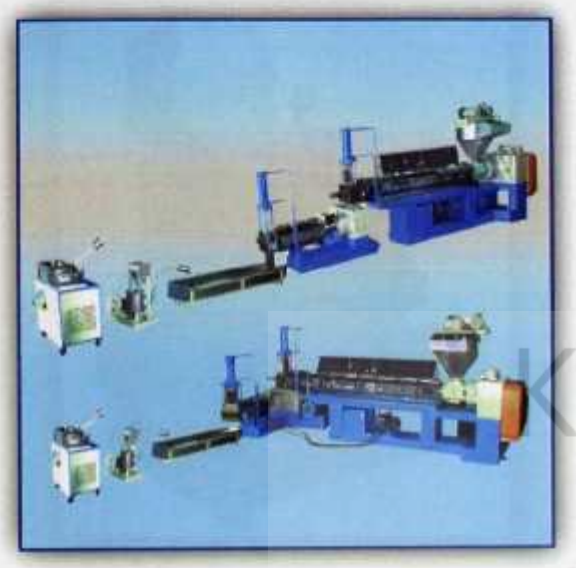


Fig. 22 Extruding Machine

Fig. 23 Washing Machine

Fig. 24 Temporal Silos

Fig 25. Inclined Feed Conveyor

Fig. 26 Agglomerator

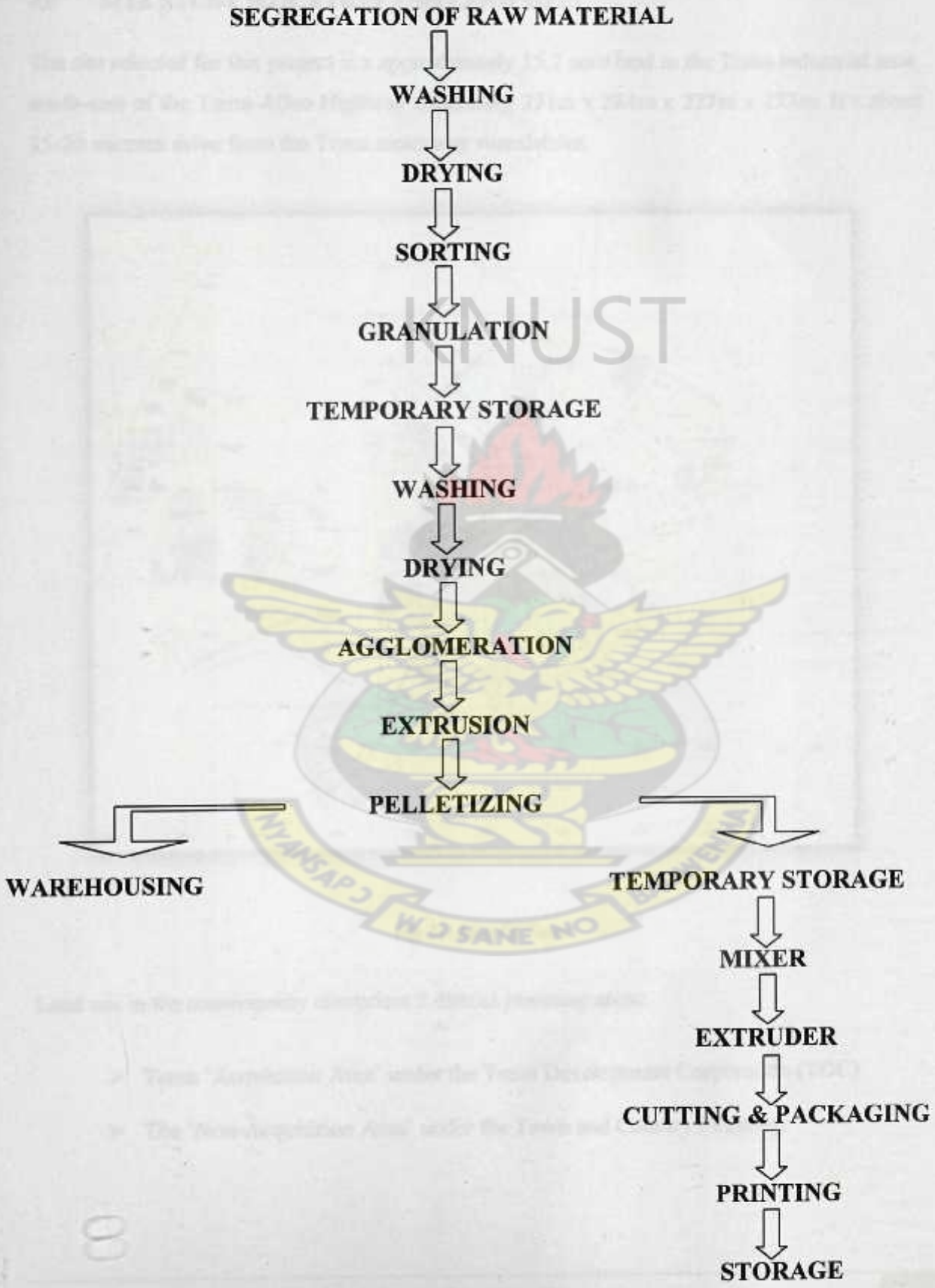
Fig. 27 Granulator

Fig. 28 Film Cutting & Packaging Machine

Fig. 29 Film Extruder

Fig. 30 Packaging Machine

3.3 THE RECYCLING PROCESS



CHAPTER FOUR

4.0 SITE STUDY [LOCATION AND LAND SIZE]

The site selected for this project is a approximately 15.7 acre land in the Tema industrial area, south-east of the Tema-Aflao Highway measuring 231m x 284m x 227m x 273m. It's about 15-20 minutes drive from the Tema motorway roundabout.

Fig 31: Map Of Tema

Land use in the municipality comprises 2 district planning areas:

- Tema 'Acquisition Area' under the Tema Development Corporation (TDC)
- The 'Non-Acquisition Area' under the Town and Country Planning

4.1 MACRO-ENVIRONMENT OF TEMA

Tema is a coastal city, situated about 25km East of Accra; it has a land area of 368.3 square kilometres and an estimated population of 0.6 million people. Tema is located on Longitude 0^0 (Greenwich Meridian) and Latitude 5^0 32' North. From the 1960s through1980s, Tema has been transformed rapidly from a small fishing village into an industrial nerve centre of Ghana's economy. With a deep seaport, Tema handles about 70% of all shipment to Ghana and some land locked countries in the West African Sub-Region.

Tema accommodates over 200 small, Medium and large industries include an aluminium smelter, an oil refinery, and food processing plants.

The Tema Municipal Assembly, which is one of the five municipal authorities of the Greater Accra Region, can be divided into urban, and a small rural population occupying a rather larger geographical area. The provision of social amenities have followed the urban (suburban)Rural dichotomy. While the urban area enjoys organized solid waste collection services, uninterrupted electricity, pipe borne water supply, a central sewerage system and a fairly good net work of roads and drains, the sub urban and their rural neighbours are not that "fortunate."

Fig.32 The Proposed Site

4.2 SITE INVENTORY AND PERIPHERAL STUDY

Fig. 33 A View Of The Savannah Lands Covered With Grass And Few Shrubs

Fig. 34 Good Roads, Paved Walk-Ways Street Lights And 'U' Drain

Fig. 35 A Clothing Factory South Of The Proposed Site

Fig. 36 A View Of Factories In The Industrial Area Of Tema

Fig. 37 The cordoned transformers And overhead power lines

Fig. 38 A view of the overhead water storage tanks north of the site

4.2.1 TOPOGRAPHY

The site is relatively flat, able to drain off rainwater and does not become waterlogged.

Fig. 39 Section Through Site

4.2.2 VEGETATION

The site is located in a coastal savannah and sparsely vegetated with shrubs.

4.2.3 GEOLOGY

The subsoil shows a composition of Precambrian rocks of the Dahomeyan formation: metamorphic rocks mainly consisting of granite, gneiss and schist probably derived from sedimentary layers. These rocky formations are weathered or decomposed at the surface with a thickness (of weather component) not exceeding 12 metres in the area.

4.2.4 INFRASTRUCTURE AND SERVICES

ROADS

- The road network around the site is that of high class. It is a level and tarred road that runs north of the site. On the north-east of the site is the Tema-Aflao highway.
- All existing roads have street lights and paved walk ways allowing easy pedestrian movement.

DRAINAGE

- Due to the current development of the local road network around the site and its environs 'U'-drains have been provided to collect run-off rain water from the site.
- Portions are covered with either metal grills or cast concrete for both vehicular and pedestrian access.

ELECTRICITY

- Tapped from the main power lines close to the site. 3 phased 415 volts tapped into site.

4.3 WEATHER AND CLIMATE

4.3.1 CLIMATE

- Tema lies in the coastal savannah zone of Ghana and enjoys a dry equatorial climate.

4.3.2 RAINFALL

- Main annual rainfall ranges between 730mm to 790mm. The rainy season (major season) is between the months of April and July, and the minor season is between the months of September and November.

4.3.3 RELATIVE HUMIDITY

- Humidity levels range from 60% minimum to a maximum of 80% or more in the wet season to less than 30% in the dry season.

4.3.4 TEMPERATURE

- The periods spanning October through to April are the warmest of the year with daily temperatures ranging from 30°C – 32°C maximum and 22°C – 27°C minimum. Cooler temperatures characterise the periods of May to September with daily maximum temperatures of 27°C – 29°C and daily minimum temperatures of 22°C – 24°C.

4.3.5 WIND SPEED

- Winds of low velocity blow over the area from the South during the day and evening and from the West in the night and early morning.

CHAPTER FIVE

5.0 PLANNING AND DESIGN

5.1 BRIEF DEVELOPEMENT

For the purposes of this thesis the client's brief has been developed and expanded following the case studies and precedent studies from local and foreign facilities.

ADMINISTRATION

- Entrance
- Reception
- Kitchenette
- Waiting area
- General office
- Showroom
- Office (General Manager)
- Meeting Room
- Office (Secretary)
- Office (Marketing Manager)
- Kitchenette
- Office (Personnel Manager)
- Sanitary
- General Office (Research)
- Store

CANTEEN

- Eating Area
- Kitchen
- Kitchen yard
- Dry Store
- Cold Store
- Sanitary
- Servery
- Changing Room
- Office (Matron)

WELFARE (Changing /Clinic)

- Changing Room (male)
- Changing Room (female)
- Treatment Room
- Recovery
- lounge
- Laundry
- Janitor
- consulting room

MAINTENANCE UNIT

- Workshop
- Store (parts and tools)
- Office (plumber)
- Office (Engineer)
- Changing room/sanitary

PRODUCTION BLOCKS

- Production floor
- Warehouse
- Raw Material Storage
- Packaging
- Office (Quality Control Manager)
- Office (Production Manager)
- Loading Platform
- Offloading platform

ANCILLARY FACILITIES

- Powerhouse
- Security post (main entrance)
- Security post (service entrance)
- Water Treatment plant

5.2 ACCOMODATION SCHEDULE

SPACES	SIZE	AREA
General Office	4.50x8.60(m^2)	38.70 m^2
Showroom	6.00x5.30(m^2)	32.0 m^2
Sanitary		21.20m^2
Corridor	8.60x1.70(m^2)	70.85 m^2
Store	3.08x1.75(m^2)	13.98 m^2
Staff Training/ Board Room	6.30x4.00(m^2)	25.20 m^2
Void	4.05x6.15(m^2)	24.90 m^2
Staff Common Room	4.12x5.0(m^2)	27.91 m^2
Kitchenette	3.15x1.75(m^2)	5.38 m^2
General Manager	5.15x4.0(m^2)	20.60 m^2
Secretary	4.0x4.0(m^2)	16.0 m^2
Office	4.0x4.0(m^2)	16.0 m^2
Office	4.0x4.0(m^2)	16.0 m^2
TOTAL		328.72 m^2

PRODUCTION HALL

SPACES	SIZE	AREA
Off –Loading Bay	20.40X3.78(m^2)	76.22 m^2
Raw Material	67.44X15.40(m^2)	1028.49 m^2
Corridor		326.96 m2
Packaging Area	57.00X17.01(m^2)	893.49 m^2
Ware house	25.80X14.70(m^2)	379.26 m^2
Loading Bay	26.02X5.03(m^2)	160.41 m^2
Sanitary		16.56 m^2
laboratory	8.38X3.31(m^2)	27.71 m^2
Carton Storage	5.05X3.42(m^2)	17.06 m^2
Raw Materials Store	25.83X9.73(m^2)	235.43 m^2
TOTAL		**3161.59 m^2**

MAINTENANCE UNIT

SPACES	SIZE	AREA
Head of maintenance	4x3.425(m^2)	13.7 m^2
Electrical Engineer	4x3.425(m^2)	13.7 m^2
Driver's Toilets		13.7 m^2
Tools Room	4x4.275(m^2)	17.1 m^2
Parts Store	4x4(m^2)	16.0 m^2
Plumber	4x4(m^2)	
Driver's Waiting Area	10.50x7.44(m^2)	78.12 m^2
Maintenance	11.0x8.70(m^2)	95.65m^2
Corridor		5.54 m^2
TOTAL		253.51 m^2

WELFARE AREAS

CLINIC/CHANGING ROOMS

SPACES	SIZE	AREA
Recovery Area	4.15x3.70 m^2	15.355m^2
Treatment Area	4.00x3.00 m^2	12 .00m^2
Sanitary		6 .00m^2
Male Changing Room	7.85x7.30 m^2	57.30m^2
Female Changing Room	7.15x6.45 m^2	46.12m^2
Laundry	4.41x3.00 m^2	13.23m^2
Lounge	7.00x6.00 m^2	36.95m^2
Nurses Station	3.80x3.80 m^2	14.44 m^2
Waiting Area	4.15x3.00 m^2	12.45 m^2
Consulting Room	4.00x3.00 m^2	12 .00m^2
Lobby	4.00x4.70 m^2	18.8 m^2

TOTAL		244.65 m^2

CANTEEN

SPACES	SIZE	AREA
Kitchen	8.10x6.73 m^2	54.5m^2
Kitchen Yard	3.55x3.50 m^2	12.43 m^2
Male Changing Room	3.34x2.65 m^2	8.85m^2
Female Changing Room	3.24x2.65 m^2	8.59m^2
Outdoor Eating Area	18.87x5.44m^2	102.65m^2
Indoor Eating Area	11.11x9.00 m^2	100.06m^2
Matron's Office	5.22x3.50 m^2	14.26m^2
Servery	5.21x1.2 m^2	6.26m^2
Wet Store	2.85x2.54 m^2	7.24m^2
Dry Store	2.85x2.54 m^2	7.24m^2
Corridor		35.441m^2
TOTAL		357.52 m^2

ANCILLARY FACILITIES

SPACES	SIZE	AREA
Security Post		33.32m^2
Water Treatment	12.68X15.33(m^2)	194.38(m^2)
Customer Car Park		837.85m^2
Staff Parking		304.02m^2
Truck Parking		671.37 m^2
Power House	12.40X14.84(m^2)	183.53m^2
TOTAL		**2224.47 m^2**

5.3 DESIGN PHILOSOPHY

Plastic waste generation seems to be engulfing the nation's cities and towns. Although local authorities are putting in measures to encourage its recycling within the metropolis the efficiency and speed for the processing tends to be lacking behind.

This design seeks to improve the **efficiency** and **speed** in the entire processing of the plastic resin.

5.4 DESIGN CONCEPT

To achieve the design philosophy, certain concepts would critically be incorporated in the design.

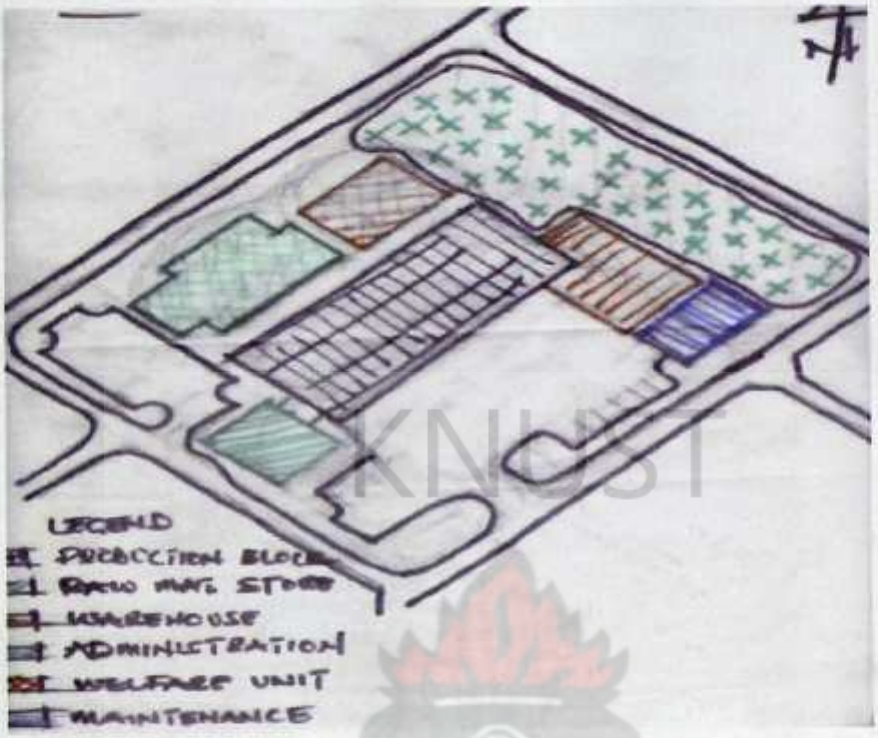
Firstly, the design would make provision for uninterrupted adequate space for the movement of both workers and raw materials during the processing to reduce and if possible eliminate wastage.

A workers output level is dependant largely on the environment within which s/he works. For this reason this design will incorporate a congenial environment for workers aimed at improving the general welfare on the factory premises.

Lastly, this plastic recycling plant will employ the latest equipment and machinery in order to increase efficiency.

5.5 CONCEPTUAL SITE PLANNING

OPTION 1



OPTION 2

Fig 40 Conceptual Site Planning

MERIT

- Separate entry and exit for staff, raw material and finished goods.
- Land for future expansion

DEMERIT

- Production units are separate breaking flow process

OPTION 3

2.

1.Car park
Administration
3. Canteen
4. Granulation unit
5. Pelletizing unit
6. Changing rooms
7. Film production unit
8.Maintenance unit

Fig. 41 Conceptual Site Planning

MERIT

- Separate entry and exit for staff, raw material and finished goods.
- Land for future expansion.
- Production units are linked by covered walkways
- Production blocks are orientated north -south to reduce solar ingress and aid natural ventilation

Fig 42 Conceptual 3D Impression

5.6 THE DESIGN

A successful and efficient factory is one that runs on the principles of uninterrupted flow of raw material and the easy with which the finished product is dispatched to the customer.

5.6.1 THE BLOCK PLAN

The layout above gives an overview of the positions of the various components of the facility and its interrelation for it to work as a whole. The general grouping of all the individual component on this site can be categorised into

1. public areas i.e. the administration and canteen
2. Private areas i.e. the production areas and all ancillary facilities.

5.6.2 ACCESS AND CIRCULATION

The site has two distinct entry points. The first which can be found on the south-east will be used by all workers and visitors to this facility. The first point of call is the car parks which are clearly demarcated for staff and visitors. The lay-by on the major access route is link by a walkway to the changing room for use by workers. The first turn on the left upon entry by this route takes workers who are carted by the company bus to the changing room area on the north of the site.

The second entry which can be found south of the site which is dedicated for the intake of raw material as well as the prompt dispatch of finished goods. This was done to prevent any vehicular conflict on the site thereby saving time and reducing cost.

The provision of walkways (some covered), staircases and ramp aid pedestrian circulation between buildings on the factory premises.

5.6.3 ADMINISTRATION

This is the second most important structure on this production site. The provision of the administration is essential in the bid to achieving the efficiency and speed in the processing of waste resins into pellets and film products. It is a two[2] storey building that has offices for the administration staff, sanitary areas, reception and waiting area, store, showroom, common room and a conference room. This unit is located west of the production hall. The immediate surroundings have a lot of soft landscaping to help cool the spaces in the building.

5.6.4 THE WELFARE AREAS

These areas comprise the workers changing rooms, the mini clinic and the canteen. All these spaces were provided to cater for the physical, social and health needs of the worker. The deliberate separation of the blocks was to break from the monotony of work on the production floors and also help to reduce the spread of fires when they do occur. There are walkways linking these two buildings. The changing rooms and canteen share a common service yard which serves as a drop off and pick up zone for workers and also serves the kitchen of the canteen.

5.6.5 THE PRODUCTION HALLS/WAREHOUSE

The processing of resin in this factory is done in three stages. The first stage comprises the granulation i.e. washing, drying, sorting and crushing. Stage two deals with further washing and drying before agglomeration, extrusion and pelletizing. This area has a mezzanine floor for supervision during production. At the third stage, the semi finished product, pellets are used in the film blowing. The spatial requirement of the film extruder translate into the height of this particular block.

5.6.6 STRUCTURE

Buildings on the site employ the simple post and beam system to form the main structural frame with sandcrete block infilling. The walls are non-load bearing and the roof system makes use of a well network of trusses which are well braced to keep them in position. There

are portions which are reinforced concrete roof and are drained by the use of p.v.c pipes along the columns into a reservoir.

5.6.7 CAPACITY

This plastic recycling plant is proposed to be processing on the average a 1000kg per hour having a work force of about 100 persons.

5.7 SERVICES

5.7.1 ELECTRICITY

Electricity is provided to the factory at 11000 Volts and this will be on 50Hz. A step down transformer will then step the voltage down to 415 Volts/50Hz on a four phase supply system to the production areas and 240Volts/50Hz for lighting and other light equipment.

There is the need to have a good electrical network since the plant is required to operate on a 24-hour basis. Depending on the machinery used, various electrical points at varying voltages will have to be established. This is to ensure easy identification of faults for repairs and maintenance works to be carried out.

Power distribution within the factory shall be concealed by either insulated cables drawn into pipe trunking from armoured underground cables. An automatic change over switch in the generator house to switch to the alternative power source should there be power failure.

5.7.2 TELEPHONE AND INTERNET NETWORK

An efficient modern auto-direct exchange system shall be linked to the existing network to facilitate both national and international communication.

5.7.3 LIGHTING

Natural light will be the major source of light for the production areas as well as the administration and as such large window openings are provided in the external envelope of the structure. All other units are to depend on natural light. This will be supplemented by a small percentage of artificial lighting.

5.7.4 VENTILATION

Natural ventilation was also considered in the size of window opening and the level at which it should be placed to aid good air flow through the structure to help workers feel comfortable while working. The window positioning allow for cross ventilation.

5.7.5 FIRE

Doors with the required fire rating will be provided for high-risk areas. Fire hydrants will be provided at vantage points not more than 30m apart around the various blocks. Fire extinguishers, water sprinklers, fire alarms, smoke detectors will all be provided at vantage points in the various blocks. The road network and accesses should be such that fire tenders can access every side of the factory.

5.7.6 WATER SUPPLY

The main water supply for the facility will be tapped from the Ghana Water Company Limited (GWCL) pipeline along the main access road. The overhead water storage north of the site will provide alternate water source for the plant. The water will be distributed to the various points of need. Again rainwater will be harvested and transported to the water treatment plant to be treated and pumped back to the overhead tanks located at certain points on the site. This water will be used for main for the washing of dirty resins, flushing, watering plants among other uses. In the rainwater collection, pvc pipes (75mm – 100mm diameter) will be connected to the roof gutters(parapet) to bring down water to the receptacles at the ground level to be further transported to the treatment plant for processing.

5.7.7 DRAINAGE

Surface covered drains will be provided where appropriate. The covered drains are important to prevent flooding in the event of heavy downpour.

5.7.8 LANDSCAPING

The purpose of the landscaping is to minimize the effect and restore the natural vegetation destroyed or taken up by the design. Decorative trees such as royal palm shall be lined along the major access routes to give a pleasing appearance to workers and visitors alike.

Grass with low maintenance requirements together with shady trees and shrubs shall be used extensively. Again, trees shall be carefully selected and positioned to serve as wind breaks, sound absorbers, etc as well as for general beautification of the factory.

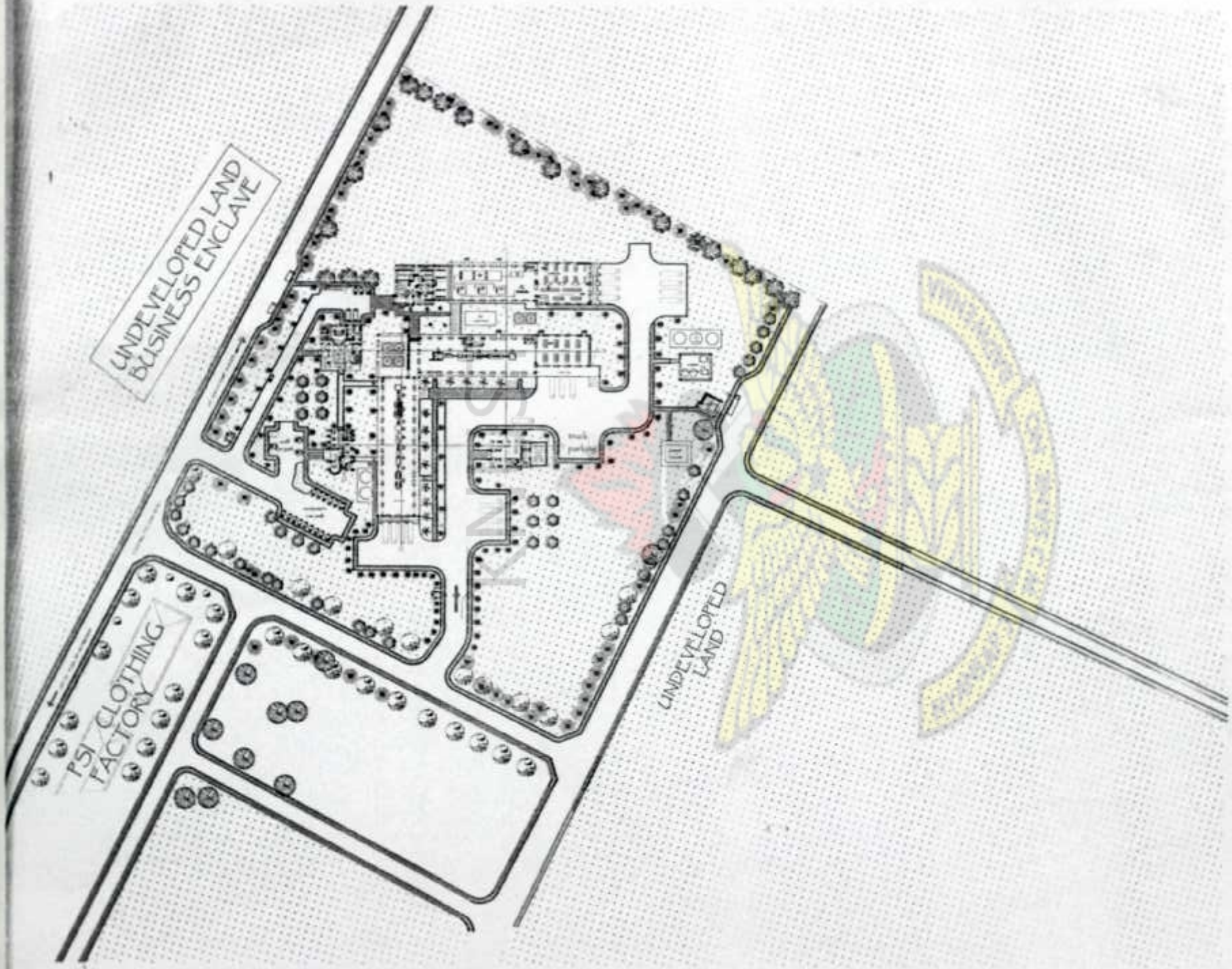
5.7.9 SEWAGE DISPOSAL

Soil waste is conveyed through waste pipes from the sanitary areas to the waste treatment south of the free zone enclave.

5.8 CONCLUSION

With regards to the ever increasing amounts of plastic waste generated by the inhabitants and visitors to Accra, the capital, it is relevant that stringent measures are adopted for the successful management of the city's plastic waste.

This design thesis seeks to improve the current processing capacities for both personnel and equipment/machinery in order to adequately reduce the harmful effects of indiscriminately discarded plastic resins in our environment. The proposal of such a facility and furthermore its provision would significantly improve the environment and sanitation concerns in the city. This would accelerate the achievement of the goal of making Ghana the gateway to the sub-region and Africa as a whole.



1. SORTING MACHINE
2. SCREW CONVEYOR
3. WASHER
4. DRYER
5. SILO
6. GRANULATOR
7. PNEMATHIC PUMP
8. AGGLOMERATOR
9. EXTRUDER/PACKAGING MACHINES
10. PELLETIZER
11. MIXER
12. FILM EXTRUDER
13. CUTTING MACHINE
13. CUTTING MACHINE
14. CUTTING MACHINE

WEST ELEVATION

EAST ELEVATION

NORTH ELEVATION

SOUTH ELEVATION

SECTION J - J

SECTION K - K

SECTION N - N

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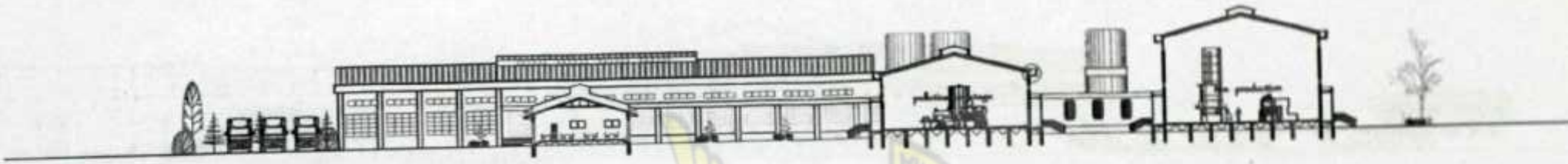
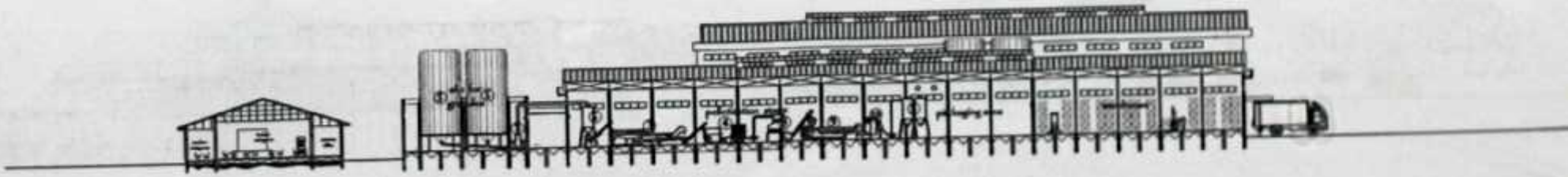


SECTION M - M

SECTION O - O



TION L - L

Figure 43 3D IMPRESSIONS OF THE PROPOSED PLANT

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LIST OF FIGURES

List of Tables