ZION PETROCHEMICAL COMPLEX, LOKOJA

"OLEFINS PLANT OF POLYPROPYLE PLASTICS PRODUCTION''

A THESIS SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE, SCHOOL OF ENVIRONMENTAL TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

BY

OLADEBO OLUFUNKE CHRISTIANA AJOKE
MATRIC No. 91/1781

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF TECHNOLOGY (M-Tech) DEGREE IN ARCHITECTURE

DECEMBER 1998

CERTIFICATION

I certify that this project entitled "ZION PETROCHEMICALS LOKOJA: AN OLEFINS PLANT FOR THE PRODUCTION OF POLYPROPYLENE (FEED STOCK FOR PLASTICS INDUSTRY)"meet the requirements and also satisfies regulations governing the award of Master of Technology (M. Tech) in Architecture Degree of Federal University of Technology, Minna and is approved for its contribution to knowledge and literacy presentation.

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SUPERVISOR DATE

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EXTERNAL EXAMINER DATE

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HEAD OF DEPARTMENT DATE

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DEAN OF SCHOOL DATE

DEDICATION

" But store up for yourself treasures in heaven, where moth and rust do not destroy,and where thieves do not break in and steal."

Matthew 6:20.

This project is dedicated first to God the Father, the Son and the Holy Spirit.It has been God inspired.

and

My beloved sister Mrs Amina, Alice Aboh who has stood by me all through it.

and

Dr S.A. and Mrs D. Oladebo both of blessed memory. May their gentle souls continue to rest with the Lord.Amen.

AKNOWLEDGEMENT

This work is a synthetic product of many minds. I am forever grateful to the inspiration and wisdom of the many great men and women who,through their commitment to the passion for releasing their potential have left a legacy to motivate me and my generation.

My beloved father and mother.Chief and Mrs J.A.J. Ajoge ; I love you both,thanks for your love and support.

My lecturers ; Prof.S. Solanke, Arc.Mrs Zubairu, Arc. A. I. Anuobi, Arc. Mrs Adesina, Arc. Olagunju. You have all spent time,resources to advice,show love and to see that I graduate from this noble institution.

Profound gratitude to Sesan Omitayo ; you'll always remain special to me.

F.C.S FUT (His Dwelling Place) I thank God for the opprtunity afforded me to serve as treasurer in this fellowship,thank God for the excos,and other brethren for their prayers and words of encouragement. We can't make it without each other.

600L Arch studio and co.team ladies.A wonderful and inspiring family; we started together and we are ending together.Thanks for your constructive criticisms.

Special friends like Dewumi,Nike Fadeji,Susan Katung,Toyin and Jide,Gloria Ajoge,brother Ayo Fagbemi (who helped to edit and type my B.Tech thesis) Paulyn,Bekky,Kike,Aisha,Segun Ajayi,Yomi,Tunji Abe and others.Thank you for your love and moral support.

Staff of the NNPC Kaduna,who took their time to take me through the plant,explain details,give me books and pamphlets e.g Mallam Matazu and Engr.Aminu a big thanks to you.

Staff of the Warri Refinery,Barrister and Mrs ~~Ande~~ Angle, and PP plant works,thanks for your co-operation.

Staff of the Eleme Petrochemical Complex,Mallam Khamal,Sis Lydia,Mr Afolabi,other lab workers who were so helpful to me during my visit to E.P.C Portharcourt.

To my friends at Lokoja, Mr and Arc Mrs Alhassan,Engr Chris Ushedu and NNPC pump plant workers Lokoja.Thanks for your co-operation and kindness.

Finally,to the source and supplier of all potential,the Omni-Potent One, the father Lord of all creation,and His Son,my elder Brother, Jesus Christ, and my personal Counsellor,the Holy Spirit.Thanks for being the stength of my heart and for the previlege of serving you.

ABSTRACT

The Petrochemical indusrty is a big and complex one.

This thesis focuses on the plant structures and buildings. A literature review in chapter two of Petrochemical industry in Nigeria and a close look at Kaduna Refinery and Petrochemicals, Warri Refinery and Petrochemicals, Eleme Petrochemical Complex, Port-Harcourt.
The proposed location which is Lokoja, the Kogi State capital is studied in respect to site characteristics and selection factors.

Plant layout and operations form the core of chapter six. Here, plant process, production and pipelines are discussed.

Chapter seven gives the design report under which the brief is developed, schedule of accommodation stated, design scope analysed, design concept and functional analysis as well as site planning.

Chapter eight consists of the buildings and structures with respect to construction, and aesthetics materials, services, landscape.

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CHAPTER ONE

1.0. INTRODUCTION

1.1. Preamble

Just a few years back, it was easy to define petrochemicals- they were relatively pure, identifiable substances derived from petroleum and used in the chemical trade. Now, conversion processes are often built in as part of separation processes making original products more complex; oil companies are entering the chemical business; Chemical companies are entering the oil Business; and the whole group is expanding greatly, so most organic chemical substances could be considered petrochemicals The birth and growth of petrochemical has been one of the fabulous stories connected with modern chemical and chemical engineering research. Petroleum companies were uninterested in chemical production, but gave the industry a great boost by selling their off-gas to chemical companies at its fuel value. Cracking furnaces put reactive olefins in these gases, which chemical companies, for example Shell and Standard Oil of New Jersey (now Exxon), became involved in chemical production much earlier than others.

Discovering a suitable economical method to manage the petrochemical industry is not sufficient in these times. The control of quality, environmental effects of the products, sewage disposal, fire fighting procedure, start-up problems, safety, packaging and marketing, building, etc, must all be combined into a "system" utilizing professionals from variety of fields. The system concept extends the scope of a plant beyond just processing, where material and energy are absorbed, products and wastes are removed and energy is either conserved or degraded. The total system must include information processing to sell and service, adapt the whole to the environment, and manipulate the summed information to maximize the desired parameters.
A properly conceived and operated system offers no problems to the society.

Types of plants among others include the thermal plant Olefins, polymerization plant, etc.The desire to handle the design of buildings that is described in functions as above is overwhelming. There is the need to know in the first instance, the procedure and operation of spaces.

This exercise takes a look at the subject Petrochemical- a study of its importance to the Nigerian economy, commerce and industry,Government and Private sector.
The design proposal is an experiment in form of graphical translation of a smaller version of a big petrochemical plant structures.

1.2 MOTIVATION

The economics and uses of petrochemical products have greatly aroused my interest in the design of a petrochemical plant. Currently, well over 80 percent of all organic chemicals are petrochemicals. The classes of use for petrochemical products are enormous ranging; from adhesive, fertilizers, pesticides, paints, plastics, rubber medical products, synthetics and a lot more. The industry will encourage down stream industries to spring up around its location.

With the rich crude oil and Natural gas reserves in Nigeria, this project is strategically located at Lokoja the Kogi state capital because of its centrality and easy accessibility from North to South, East to West.

Government through the NNPC has made concerted efforts to establish three petrochemical plant complexes within the country, located at Kaduna, Warri and Eleme(Portharcourt). These alone are not enough to exploit the Natural gas reserves and satisfy demand. Other individual or Co-operate body efforts need to join the Petrochemical industry. Currently, it is only the Eleme Petrochemical complex that produces raw materials for the plastics industry basically with the discovery of wider ranged uses of plastics, there is a need for more petrochemical plants to spring up in the country to boost the efforts of the existing plants.

1.2. AIMS AND OBJECTIVES

AIMS

This project is aimed at providing architectural structures that would satisfy function, aesthetics and other requirements that would facilitate the smooth running of the petrochemical plant in the production of polyprolyene which is the basic raw materia for plastics production.

OBJECTIVES

To carry out a study on the procedures, processes of operations, space requirements and functional analysis with the view to design a plant-complex that would enhance quality production.

To determine adequate facilities for administration services and operations to satisfy space, function and aesthetics.

To carry out a design that would have fire and safety precautions in view to save life, plant and equipment.

To determine structures and buildings that would meet petrochemical plant standard and other architectural standards.

1.3. RESEARCH SCOPE AND LIMITATIONS.

Within this planned framework, the scope of work is going to cover the following:

(a) A study of the petrochemical industry; its functions, design, plants and units, personnel, feed stock and supporting services.

Other areas of research would include the pipelines transportation of natural gas liquid from source to project location. Petrochemical products and benefactors, manufacturers and end users.

(b) Design proposal of structures in the form of graphic translation of report on a proposed site. This would be divided into operations and services.

This work would also dwell more on providing architectural solutions to raw material inflow, plant operations and services, products outflow and evacuation problems in a petrochemical complex.

(c) Building structures and facilities that would include the following;

i. Operations/production
- The plants and units.
- Control room
- Warehouse and evacuation bay
- Tank farm
- Flare system and waste disposal unit.
- Plant utilities
- Laboratories and workshops
- Stores

ii. Services: Administrative and auxiliary facilities-

- Administrative building
- Clinic
- Fire station and safety units
- Dining Hall
- Parking areas.

LIMITATIONS

Petrochemical industrial design which has a wide scope and complex character would require facilities that would depend largely on the required output of production. Problems encountered during the research were as follows:

-Limited accessibility to existing plants.
-Petrochemical plant design which is complex and purely chemical and civil engineering oriented.

Envisaged problems will include the plant capacity in relation to production and evacuation by plastics manufacturers as there is a fluctuation in feedstock supply and product demand.

1.4. RESEARCH METHODOLOGY

In carrying out a project of such magnitude, various method of of obtaining research information or data would be employed. This would include the following:

i. Literature review: of books, journals, digests, and industrial year books to get information about this aspect of study in order to acquire a sound theoretical base.

ii. Case studies: This entails knowing the extent of work carried out in this area and also involves the study of existing and documented examples. Determining the architectural design problems encountered with the view of solving them in this design. The level of studies available is within the country, all the three selected and carefully analyzed.

iii. Personal observation: My interest in this study has enhanced my personal observation especially in the forms of familiarization with the nature and general characteristic of petrochemical industrial design.

iv. Oral interviews: This involves discussions on the related subject of study with the view of getting information on petrochemical technology from Chemical Engineers, Students, Technicians, Polymer Chemists and Industrial Chemists.

V. Site visitation: Visit to Lokoja town planning authority to broaden the viability of such a project in Lokoja, which entails the study of Lokoja and its environs, historical background and other factors.
Site visit within the industrial layout plan of Lokoja, to get familiar with the site location, size, inventory and other site factors, with the aid of sketches and photographs where necessary.

VI. Data collection: from manufacturers of plastics within the country who will benefit from this industry as well as the construction companies that undertake such projects.

1.5. ARCHITECTURAL SIGNIFICANCE

Architecture is the art and technique of building employed to fulfil the practical and expressive requirements of civilized people. Almost every settled society that possess the technique for building produces architecture. Without it man is confined to primitive struggle with the elements of weather. With it, he has not only a defence against the natural environment but also the benefits of a human environment, a prerequisite for and a symbol of the development of civilized institutions. Types of architecture are thus established by the society according to the needs of its different institutions and not by the architect who is now faced with the job of finding the means of achieving them.

Other design and construction of building and other facilities to enhance the smooth running of the plant have to be provided. Enough space for services and operations have to be provided, these and others are of architectural benefits to the petrochemical industry.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1. THE PETROCHEMICAL INDUSTRY

The petrochemical industry as a large integrated industry arose in the 1940's from roots starting in the 1930's. But since this industry is not one definite thing, it is no contradiction to say that the first petrochemical production took place in 1920 when petrochemical acetone was first produced.

The 1930's were a period of great change in the petroleum industry. Before this, petroleum refining was largely a matter of distilling- that is, separating fractions according to their boiling points. Thermal cracking, introduced in 1913, was relatively simple process resulting in higher yields of the gasoline fraction.

What makes the petrochemical industry complex or rather difficult to grasp is its interrelatedness. There are various raw materials, a large number of intermediate products and countless end-use products, which may reach the final consumer, perhaps directly in almost anything he may lay his hand on.

2.2. THE DEVELOPMENT OF PETROCHEMICAL INDUSTRY IN NIGERIA.

EARLY EFFORTS

Petrochemical are products based on chemicals derived from oil and naturel gas. The range of such products and is enormous and their applications and uses cut across every sphere of life. The need for the production of petrochemical in Nigeria had been recognized since 1968 when an American company, Arthur d. Little was commissioned by Government to study the feasibility for a petrochemical complex in Nigeria.

Though the recommendations of the company did not favor the establishment of a petrochemical complex in Nigeria, however the continued public outcry for Nigeria to harness the tremendous quantities of associated natural gas, being so wastefully flared since the oil production began in Nigeria, led to the inclusion of petrochemical project in the second National Development Plan (1970-1974). In that plan, this project was merely identified as a "Chemical complex" , with a plan allocation of =N=28.2 million. The following was the product slate:

PRODUCT	CAPACITIES
Caustic soda	10,900 ton/yr
Polyvinyl chloride	15,000 ton/yr
Polyethylene	15,000 ton/yr

Table 2.1.1

The plan recognized the importance of chemical industries in the rapid industrial transformation of the nation and stated that the above complex was "designed to broaden the industrial base of the economy and promote a better use of the country mineral resources like natural gas and petroleum''. Nonetheless, during this period, the first significant feasibility study of a petrochemical complex in Nigeria was carried out by Foster Wheeler who concluded that the economic viability of the project depended on finding an outlet for the highest natural gas component, methane, which normally accounts for over 85% of the gas. Methane is not a desirable feedstock for petrochemicals. Higher olefins, ethane, propane and butane, also contained in the natural gas, are the target feedstock.

Foster Wheeler observed that the natural Gas outlets for the methane, which is an excellent combustible hydrocarbon for power production, could be the thermal power stations then be used by NEPA. Other potential outlets included the Ajaokuta Steel Complex, Nitrogenous Fertilizer Complex being planned for Porthacourt and the direct reduction steel.

During the Third National Development Plan (1975-80}, the petrochemical complex continued to be recognized as a key project which will help transform the economy of the country and provide the much needed base for industrialization. The product configuration of the complex had by then been expanded to the following:

PRODUCT	CAPACITIES
Caustic soda	40,000 Mt/yr
Vinyl chloride monomer (VCM)	40,000 Mt/yr
Polyvinyl chloride (PVC)	40,000 Mt/yr
Polyethylene	40,000 Mt/yr
Ethylene	100,000 Mt/yr

Table 2.1.2.

In addition to the above, industrial grade methanol was also to be produced in the complex. The complex slated to start in 1978 and a plan allocation of =N=300 million was made for the project. For a number of reasons, the major achievement during this plan period centered on the development of "detained planning" of the project. In 1976, government appointed Chem System of United Kingdom as a technical adviser on the project. Chem System looked at the project in detail and produced a number of reports including those of Project Implementation, Nigeria market potential, Process Reviews, Recommended Plant Sizing, Selection of Technical Partners and Review of Process Plants etc

In 1978, the project was transferred from Ministry of Industries to NNPC. Following some further studies, a three-phase programme of implementation was devised.

Phase I was to use the by-product of the Kaduna and Warri Refineries to produce Polypropylene. Carbon Black and Linear Alkyl Benzene. Phase II was to be an Olefin based complex and the main heart of the Petrochemicals programme. Phase III was to concentrate on aromatic Petrochemicals, principally synthetic fibre.

The primary success recorded during the 3rd Development Plan was that the Phase 1 project took off in 1979, after the government appointed a managing consultant, BEICIP of France and two engineering contractors, namely Lummus of USA for Carbon Black and Linear Alkyl Benzene and Tecnimont of Italy for the polypropylene plant. Since the work has progressed on the project, implementation of the Phase ii was deferred until the 4th plan period, although its configuration had been defined in the 3rd Plan.

During the Fourth National Development Plan period (1980-85), it was envisaged that both the phase I and phase II projects would be completed while detailed definitive studies would be conducted on the phase III project against implementation during the 5th Plan period. The project cost estimated for phase II was given as =N=900 million and a plan allocation of =N=340 million was provided for. The balance of the project cost was to come from external loans. The 4th Plan allocation for phase III was =N=10 million.

Delays in the implementation of the Petrochemical programme have caused the phase I project to spill into the 5th Plan. The phase I plants were not expected to go into production during the first half of 1988. The phase II project and subsequent phases, now know as the Eleme Petrochemicals Complex project, was to be executed in two stages. Stage I will be primarily executed in the 5th plan while the stage II will be implemented in the 6th plan (19990 - 1995).

NNPC AND PETROCHEMICALS.

Following several feasibility studies which began in 1968, the Petrochemicals scheme was included in the 19970/74 second National Development Plan. Logically, the tack of establishing a petrochemical industry fell on the Nigerian National Petroleum Co-operation (NNPC). The leader of the Nigerian Petroleum Industry.

Consequently, the corporation planned a three phase programme. One of the plants built near the NNPC Refinery in Kaduna, produces 30,000 mt of the Petrochemical feed stock, Linear Alkyl. Benzene (LAB), a year. The Kerosine extracts from the refinery is converted into LAB, heavy Alkylates and Solvents.

The second plant being built near the Warm Refinery uses gas from the Refinery to produce 35,000 mt of POLYPROPYLENE pp a year to satisfy some 60% of National demand because of its desirable qualities, prolypropylene enjoys a wide variety of end use applications.

The third plant also near the Warri Refinery produces annually, 18,000 mt of carbon Black using decanted oil from the Refinery.

The NNPC took subsequent strides in the Petrochemical industry into the phase II, Eleme Petrochemical complex, which uses natural Gas to produce mainly raw materials for plastics production.

2.3. THE PETROCHEMICAL INDUSTRY AND THE NIGERIA ECONOMY.

The intermediate and long term benefit of petrochemicals to the Nation are the following:

i. Diversification of the national resources - base by increasing the value - added to our crude oil and natural gas reserves.

ii. Structural transformation of the national economy by producing basic intermediate raw materials capable of creating and sustaining small and intermediate size manufacturing industries for various end-use applications

iii. Savings in foreign exchange out-law through the import substitution value of locally manufactured petrochemical end-use goods.

iv. Increasing the national acquisition of technology and self reliance in this respect by intensive involvement of indigenous staff in highly sophisticated petrochemical processes and technologies .

v. Creation of tangible opportunities of Nigerians in related technical jobs etc.

2.4. IMPORTANCE OF THE PETROCHEMICAL INDUSTRY.

The points that deserve emphasis concerning the petrochemical industry:

i. It consumes only a small proportion of the total petroleum and natural gas produced, but produces a desirable fraction of the total product of the chemical industry.

ii. It is in a state of repaid growth, so that figures and statistic, even basic facts become out of date almost as soon as they are printed.

iii. It's effects on mankind as a whole can be regarded as highly beneficent, not only on account of the usefulness of its products, but because it replaces coal, the mining which involves such burdensome labour, and also agricultural products, thereby leaving more land available for growing the worlds' foods.

2.5 DESIGN REQUIREMENTS FOR PETROCHEMICAL INDUSTRY.

Open, structural steel work building are normally used for process equipment, closed buildings are only used for process operations that require protection from the weather.

The arrangement of the major items of equipment usually follow the sequence given on the process flow-sheet; with the columns and vessels arranged in rows and the ancillary, equipment, such as heat exchanger and pumps, positioned along outside.

INTERNAL ENGINEERING

The internal engineering facility should be placed in a linear relationship to a fixed facade, and preferably at its extremity. What is extreme at first construction is centralised in future expansion. It is most important to build internal engineering spaces 100 percent larger than initially required. Adequate space for mechanical and electrical installation is a prime and vital requirement in the Petrochemical plant design.-

EXTERNAL ENGINEERING

All the outside utilities and storage facilities required for the plant to operate properly. Packing, truck docks, tank farms, sewage disposal plants, electrical transformer pads. Pumping stations, etc are a few of such requirements.

Since these are by nature permanent and expensive installations, they should not be placed in the way of any possible expansion. As in the case of internal engineering, the external engineering facility should be placed along fixed facade.

CHAPTER THREE

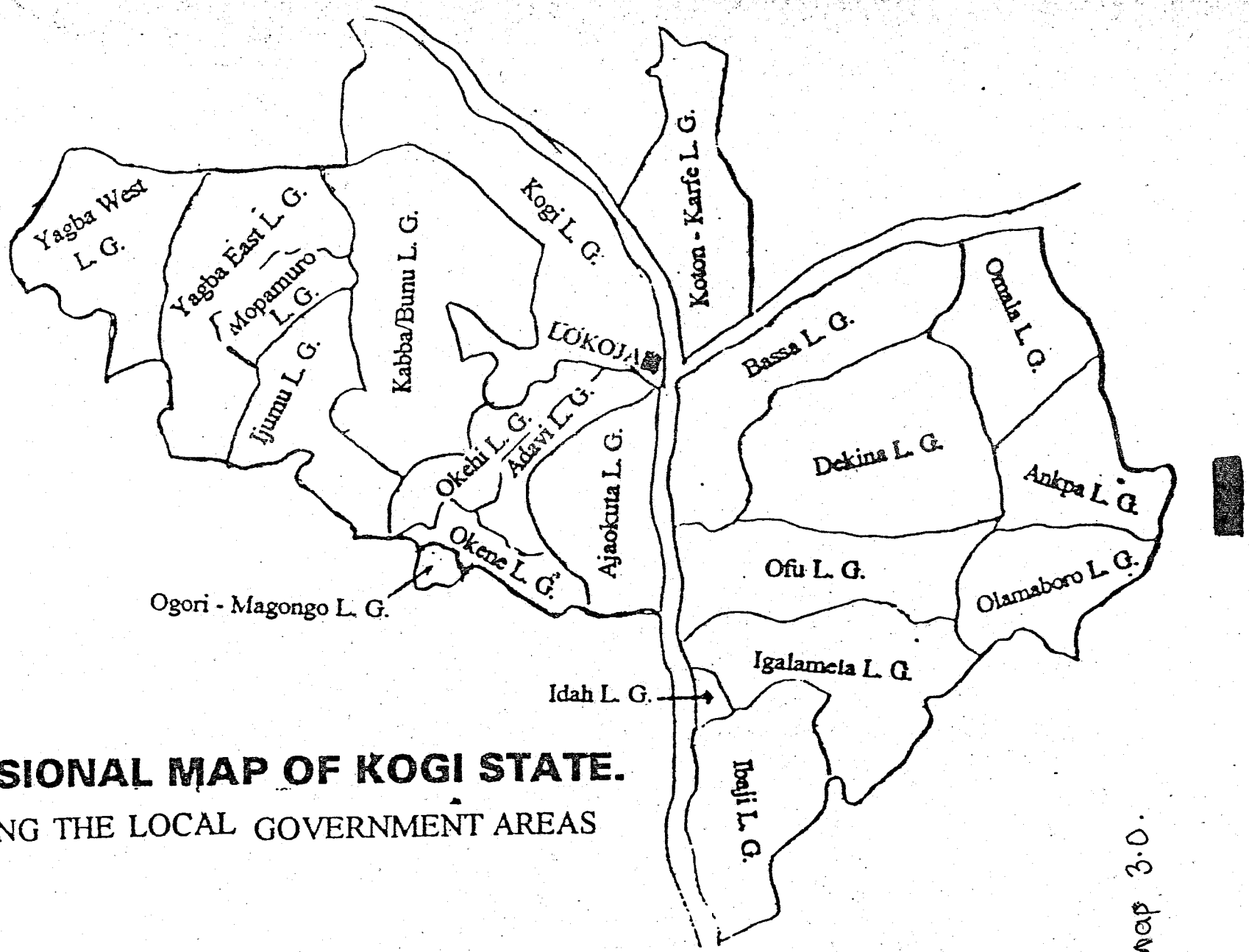
3.0. LOKOJA, KOGI STATE.

3.1. PHYSIOGRAPHY OF LOCATION.

Kogi State is the result of the amalgamation of ten (10) Local Government areas carved out of the former Kwara State with six (6) others carved of the former Benue State. Kogi is located within the Middle Belt of Nigeria. The State is bounded in the north by Niger State, the Federal Capital Territory and Plateau State , in the South by Ondo, Edo State. Enugu and Anambra States and in east by Benue State. The Rivers Niger and Benue run virtually through the total length of Kogi State in the north, hence playing a prominent role in punctuating the terrain.

The state is fairly rugged in the central area, where the Abuja Plateau uses 350.8 M. above sea level and gently undulating in many other places.

Lokoja town is situated on the west bank of the River Niger at the confluence of Rivers Niger and Benue. It is bounded within Latitude 7 47oN and 7 50oN, and longitude 645oE. Lokoja is about 580 km north of the Atlantic Ocean of Nigeria on an elevation of 45-125 M towards the North - West the town is delineated by a high Plateau, the Patti Ridge which reaches an altitude of 435m. The town is bounded by the River Niger on the east and penetrated by a number of streams which join either the Niger or the Benue River. (see map 3.1) .



PROVISIONAL MAP OF KOGI STATE.

SHOWING THE LOCAL GOVERNMENT AREAS

Map 3.0.

3.2. HISTORICAL BACKGROUND AND SOCIO CULTURAL FABRIC.

3.2.1. HISTORICAL BACKGROUND.

Lokoja is located between a range of hills called mount patti and the confluences of Rivers Niger and Benue. It is strategically located, therefore, it serves as a place of refuge for those fleeing for safety. The rivers serve as navigable waterways which has contributed in no small way in directing the history of the town and in the subsequent development.

Details of the activities of the indigenous population in the confluence area is obscure leading to claims and counter claims to the town by these indigenous people of Owaro, Igala, Ebira, Nupe and Yoruba origins. However, the fact of the physical location of the town fueled the interest of European explorers and missionaries in the area in the early 19th century. This European penetration into Lokoja represents a most significant landmark in the history of the town. Beginning by way of exploratory expeditions, the penetration was aimed primarily at exploiting the rich confluences resources as well as finding viable outlets for the growing European industries.

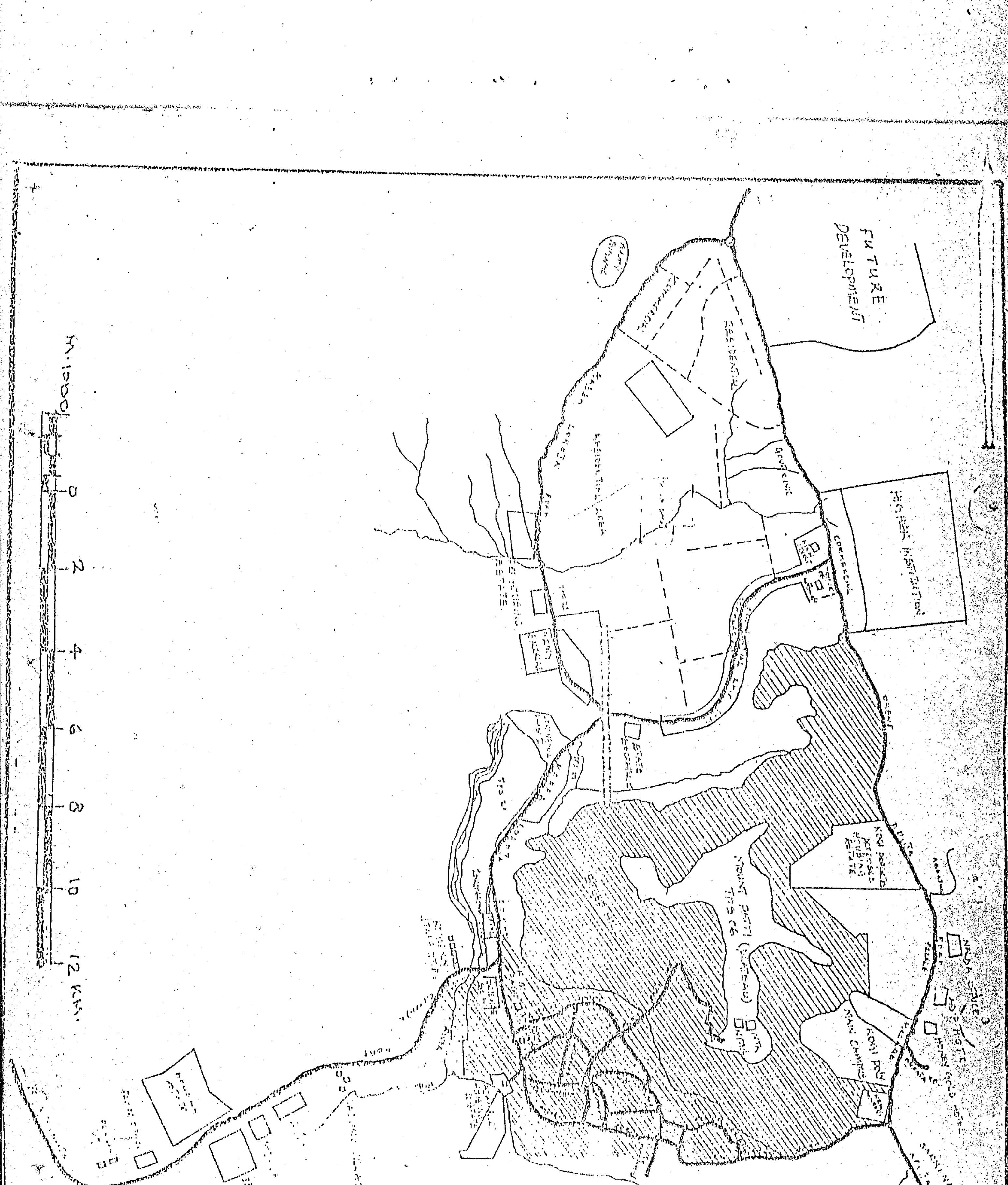
The metamorphosis of Lokoja actually began with the exploratory voyage of Mango Park who in 1775, undertook to explore the River Niger. His work was speeded up by a Briton, William Biaikie, who is still generally associated with the founding of Modern Lokoja.

He was on expedition in the area in 1854 in the Company of Samuel Ajayi Crowther. A treaty was negotiated with the Atta of Igala for the cession of an area within the present day old market for a model farm.

William Baikie further encourage the British people to settle in the town as a base for their commercial activities. He also brought liberated Africans as emigrant settlers and encouraged indigenous populations, most of whom were then on Mount Patti to come down and form a settle was with the visitors.

As a result, Lokoja was catapulted from a transit trading point to a viable commercial centre for European firms in the early 1860's and beyond. The town thus acquired the status of a consulate in 1865 and subsequently, became the headquarters of the Northern protectorate in 1900.

Although Lokoja's fame began to decline in 1904, when it's headquarters status was moved to Zungeru, which was further north, probably due to its centrality the town witnessed the upsurges of diverse ethnic groups who settled to exploit the benefits acquired from European activities. Lokoja is therefore a heterogeneous collection of diverse ethic group.


FUTURE DEVELOPMENT
RESIDENTIAL
RIVER
NIGER
0
2
4
6
8
10
12 KM.

3.2.2 SOCIO CULTURAL FABRIC.

The cultural heterogeneity of Lokoja makes it slightly difficult to give a clear picture of the general lifestyle of the inhabitants. Lokoja does not have any traditional/cultural festival. As a result, much that can be regarded thus is in reality religion.

3.3. PHYSICAL GROWTH OF LOKOJA.

From available sources like previous official maps aerial photographs, historical accounts and field surveys, the pandora stream is the point from which Lokoja Town spreads out. The oldest homes dating back to over 40 years ago (which account for 50% of the houses in this area), are still to be found around there and extending northwards to the old market area where a farm was established by William Baikie when he encouraged both white and indigenous population to settle. From this cradle, development extended further north to Kabawa, Kporoka and the cantonment Area.

Another wave of expansion was eastward and westward but it was halted by the natural barriers of the River Niger and Mount Patti respectively. The town was then forced to grow in the north - south direction. While indigenous development was concentrated in the north, the while foreigners who favoured high grounds away from the "noise" and other vagaries of the native environment, took advantage of the terrain in the Southern part of the town.

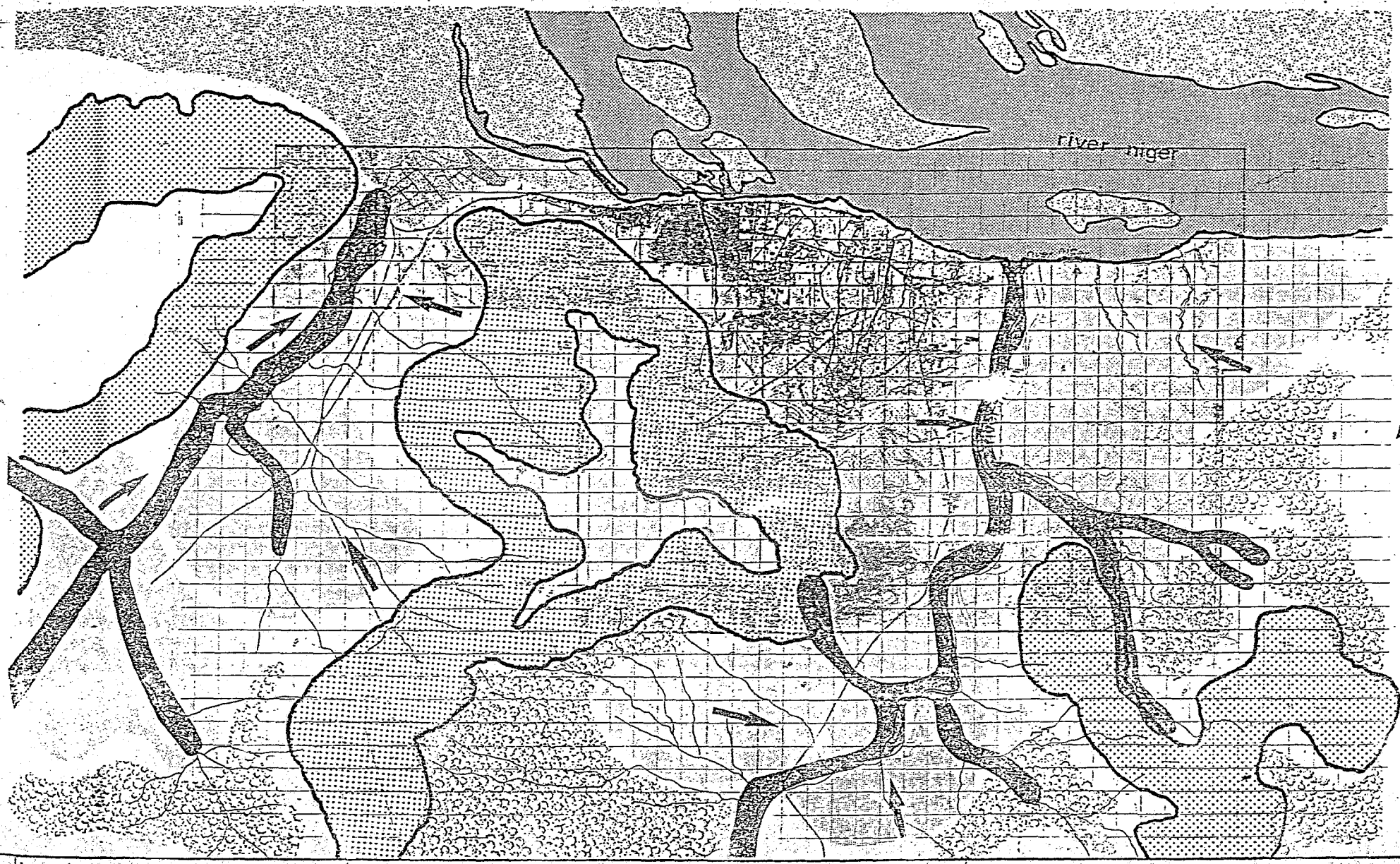
Of importance and relevance to the growth of the town are two separate independent villages of Adankolo in the south and Lonkongoma in the west where respectively the Bassa-Nge and the Yoruba tribes particularly dominate.The picture presented today is a continuum arising from a gradual in-filling of intervening spaces especially with the construction of housing units in Lokongoma and the allocation of plots along Niger Barracks Road.

Of importance and relevance to the growth of the town are two separate independent villages of Adankolo in the South and Lokongoma in the west where respectively the Bassa-Nge and the Yoruba tribes particularly dominate. The picture presented tribes particularly dominate. The picture presented today is a continue arising from a gradual in-filling of intervening spaces especially with the construction of housing units in Lokongoma and the allocation of plots along Niger Barracks Road.

3.4. GEOLOGY AND GEOGRAPHY

The dissected surface of Lokoja is a result of mountain formation activities and the agents of denudation particularly water. The flat topped Mount Patti and the surrounding ridges and valleys, derived from the basement complex rock formation composed of granites, micaschists, gneiss and metal sediments which are themselves igneous and metamorphic.

Weathering of these materials from the plateau give them a thin soil cover that are being washed down by erosion to give the medium aggregates particularly desired by the building construction industries.



location

built-up area

areas of possible expansion

areas steep & unsuitable for development

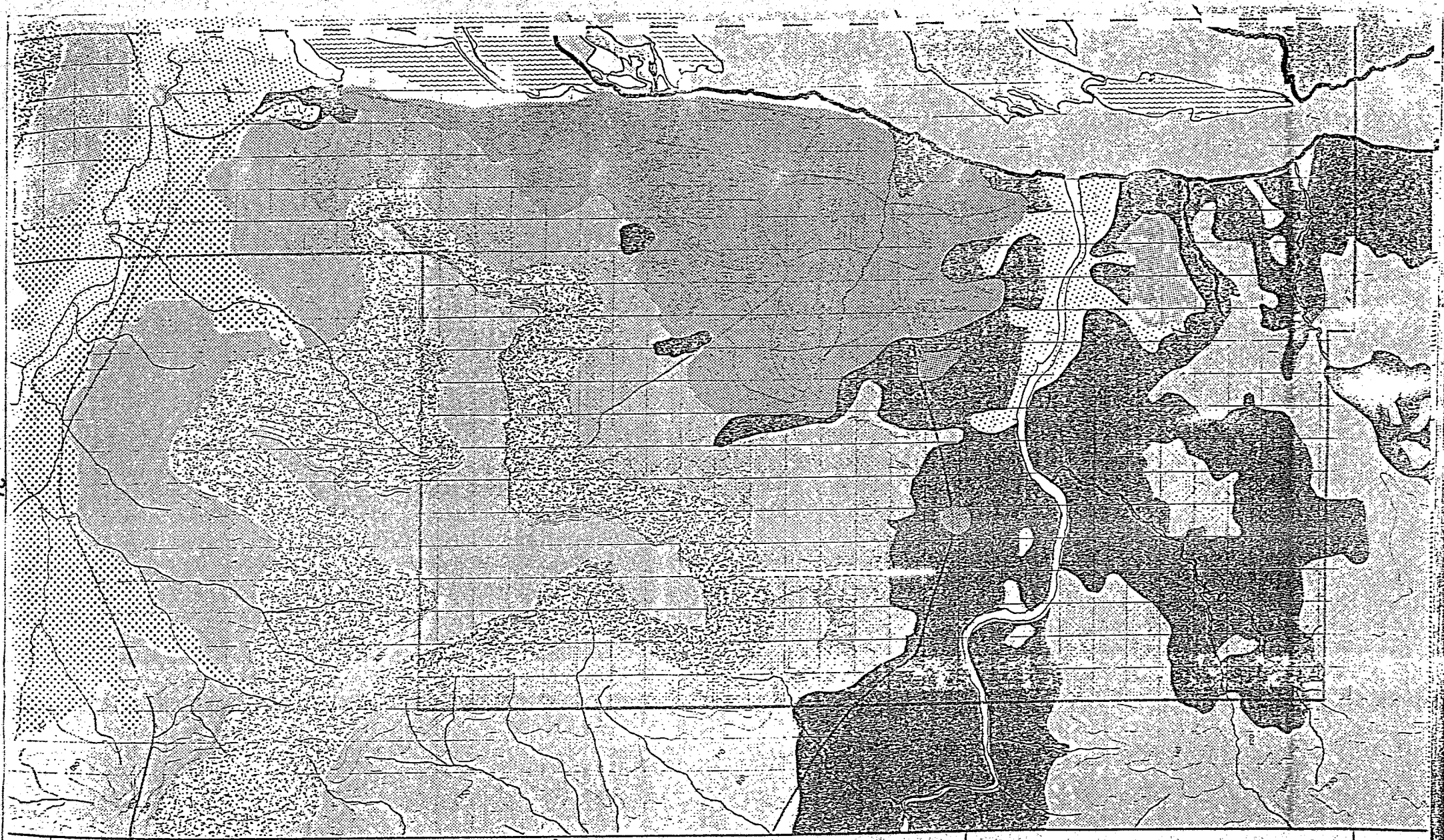
gentle slopes & natural drainage lines

site analysis

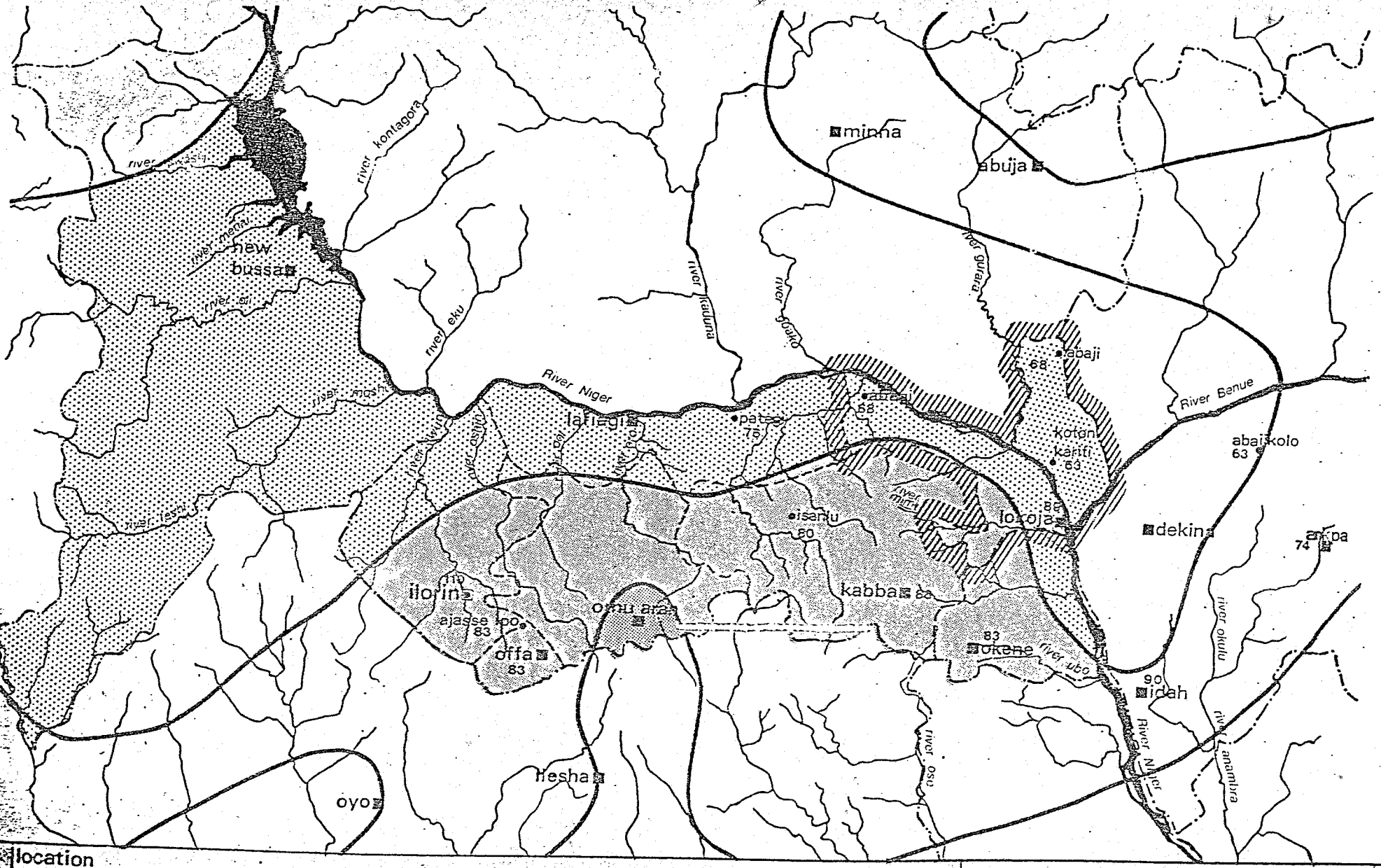
lokoja

scale : 1/50 000

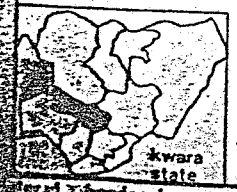
MAP 3.1


location
soils of the flood plain
river carried sediments
thin soil over metamorphic rocks
areas of exposed meta . & igneous rocks
soils of the high plateaus
existing settlements
transported soils
valleys
main roads
rivers
soils and vegetation
lokoja and environs
scale : 1/30 000
0.5
1.0
1.5

MAP 3.1.2 3.3.2



location



state boundary
division boundary
state capital
division headquarters
d.a.a. headquarters
river

750–1000mm
1000–1250mm
1250–1500mm
1500–2000mm
average raindays 86

d.a.a.=development authority area

source: British West African Meteorological Services Nigeria Meteorological notes N°2

mean annual rainfall
kogi division

scale 1/2 000 000

0 50 100 km

north

final: doxiadis consultants, shair and partners. lebanon, nigeria, united kingdom

25

MAP 3.2.1
3.2.1

Although fish farming flourishes along the River Niger, particularly maximum advantage has not been given to the abundant water resources and the adjoining alluvial planes. Pressure on the land in the south east has also forced many indigenes of the state to engage in farming massively in the neighbouring states especially Edo and Ondo states.

Cattle rearing on a free range is common among the nomadic Fulani tribesmen especially around the major river basin and open grassland.

COMMERCE

Lokoja had earlier been noted as an important commercial and service centre. The regional market at the northern edge of the town has a most important impact on the performance of the urban economy aside from the other markets and ribbons of wholesale and retail endeavors along the roads, and the anticipated impact of the prototype shops built in the different part of the town by the state government.

INDUSTRY

Kogi State is an industrially growing state. Industries such as Ajaokuta Iron and Steel, Jakura Marble Industry and Moucha Gas (Plant). Others are brickworks, furniture, bakeries, dressmaking, local flour mills and smitting.

The geology in the vicinity of the town is dominated by the rocks of the basement complex which consist of a varied assemblage of coarse grained polphynitic granites, dissected by pragmatic dykes and reins, biotite horn blended gneiss and schists which have undergone varied grades of metamorphosis. The outcrop of these rocks are common around Lokoja town. The sandstone rock outcrop occurring west of the town covers an area of 155 sq. km.The Niger River is bounded by alluvial plains on both sides.

The plains are very thin and narrow around Lokoja and south of the town where the western bank of the river is generally step with marked cliffs whose relief ranges up to 3 M.
The average width of the alluvial plain is 2.5 M. The Niger channel narrows around Lokoja in conformity with the geology of the area where the valley sides are formed by the crystalline rocks of the basement complex.

3.5. ECONOMY, COMMERCE INDUSTRY AND INFRASTRUCTURE.

The bulk of the population of Kogi state like Nigeria as a whole is rural. Agriculture is the main occupation of the people. The generally rich soil condition and ample rainfall favour ample food and cash crop production. These crops include yam, cassava, guinea corn, rice. onion, beniseed and sugarcane. Among cash crops are cocoa, coffee, cashew and oil palm.

A consulting firm, King Wilkinson of the Hague, Holland in conjunction with NNPC engineers developed the scheme for the Kaduna Refinery from feasibility studies to award of contract and provided data on all the basic aspects of the project like soil characteristic, water quality crude assays, topography and perimeter surveys. The contract was awarded to Chiyoda Chemical Engineering and Construction Company Limited of Yohokoma, Japan in 1977, after an international tender exercise. Basic design and detailed engineering, procurement of plant equipment and materials and construction of refinery was performed by the contractor, CHIYODA.

THE SITING OF KADUNA REFINERY

Nigeria with a current production level of 2.15 million barrels per day occupies the sixth position among crude oil producing countries in the world, and is today, the fifth major exporter of crude petroleum. Crude petroleum therefore plays a vital role in her economy. Local management and utilisation of petroleum products have however been deficient due largely to the fact that up till very recently, most of Nigerian petroleum products requirements were satisfied from outside sources. Before the Warri Refinery went into production in 1078, more than 90% of petroleum products used in this country was imported. Even with Portharcourt and Warri Refineries currently on in operation, much of the petroleum products utilised in the country is still imported. The internal distribution of such imported petroleum products especially fuels is hampered by transportation problems.

CHAPTER FOUR

4.0. CASE STUDIES

OBJECTIVES OF CASE STUDIES.

In the choice of cases to be studied, effort was made to genuinely look at some establishments and scheme in the country and others that exist in other countries. The objectives of carrying out these case studies are as follows:

1. To establish a basis for comparism.
ii. To identify problem areas existing on the case studied and to correct them.
iii. To establish a base for development on the already existing cases studied.
iv. To proper professional suggestions based on the effort and causes of problems identified.
v. To have a basic idea of the intended design by studying the existing one.

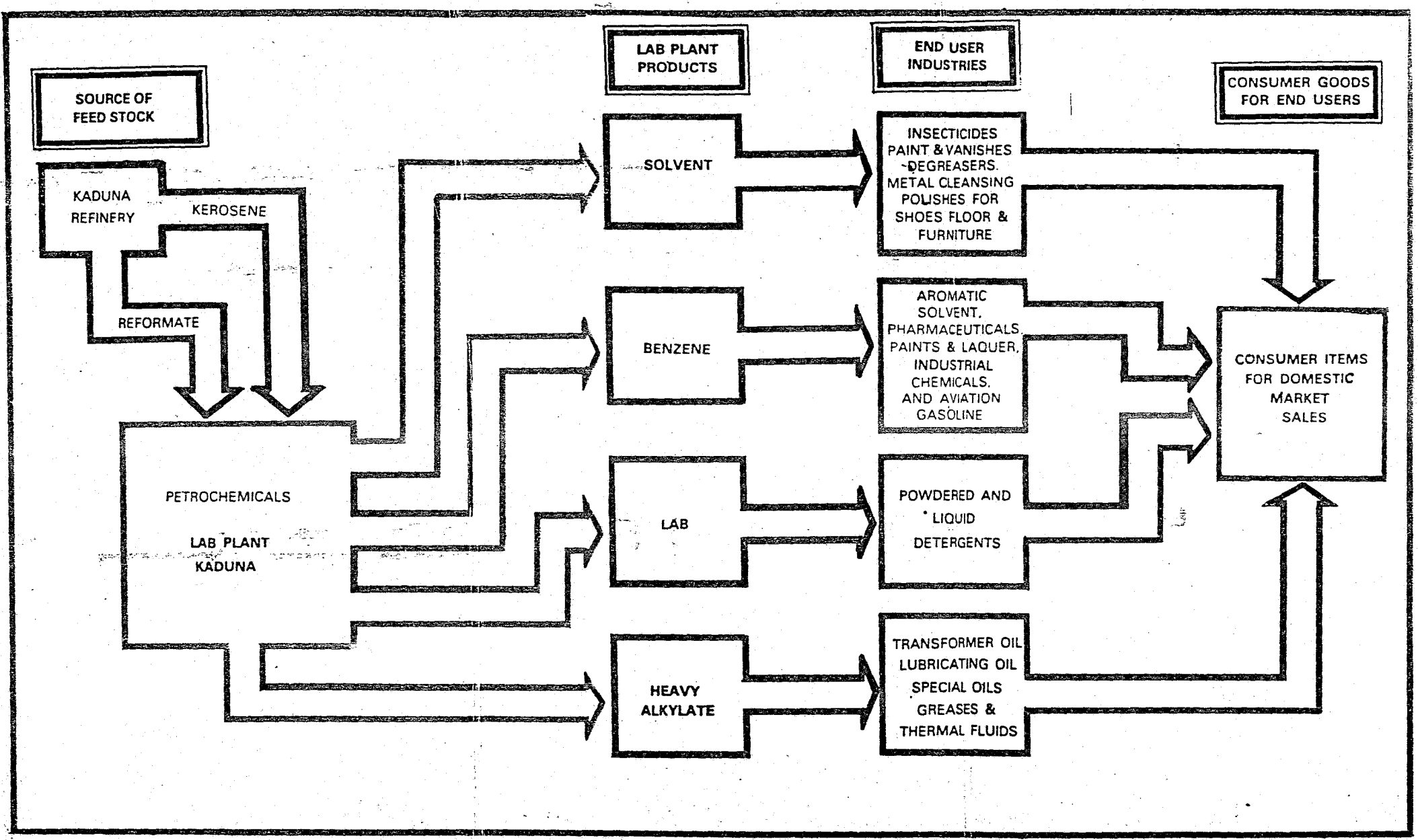
The summary of the findings is employed in the design to achieve a design that is adaptive to the site chosen and meet the requirements set out.

4.1. KADUNA REFINERY AND PETROCHEMICAL COMPANY (NNPC Subsidiary)

4.1.1. INTRODUCTION

The design to construct the third Nigerian refinery in Kaduna was taken as far back as 1974, together with the decision to construct a second refinery in Warri. Work was to however commence on the Kaduna Refinery whenever consumption projections permitted it. Such projections dictated that the construction of the refinery should start as early as 1975 due to biting fuel shortages at the time. A simple hydroskimming-type refinery was envisaged with a crude oil capacity of 42,000 barrels per day (BPSD). In the cause of project development along the lines of the new government decision, serious problems of evacuation of heavy fuel products which could involve the shutdown of the refinery was identified by mid 1975. A significant modification of the original design philosophy of the refinery was the production of a variety of petroleum products. Thus lubricating oils too will be produced at the refinery. Since Nigerian crude oils are not suitable for the manufacture of lubricating oils, paraffin-based oils have to be imported from Venezuela, Kuwait and Saudi Arabia.

Figure 4.1.1


SOURCE OF FEED STOCK
KADUNA REFINERY
KEROSENE
REFORMATE
PETROCHEMICALS
LAB PLANT KADUNA
LAB PLANT PRODUCTS
SOLVENT
BENZENE
LAB
HEAVY ALKYLATE
END USER INDUSTRIES
INSECTICIDES PAINT & VANISHES DEGREASERS. METAL CLEANSING POLISHES FOR SHOES FLOOR & FURNITURE
AROMATIC SOLVENT, PHARMACEUTICALS, PAINTS & LAQUER, INDUSTRIAL CHEMICALS, AND AVIATION GASOLINE
POWDERED AND LIQUID DETERGENTS
TRANSFORMER OIL LUBRICATING OIL SPECIAL OILS GREASES & THERMAL FLUIDS
CONSUMER GOODS FOR END USERS
CONSUMER ITEMS FOR DOMESTIC MARKET SALES

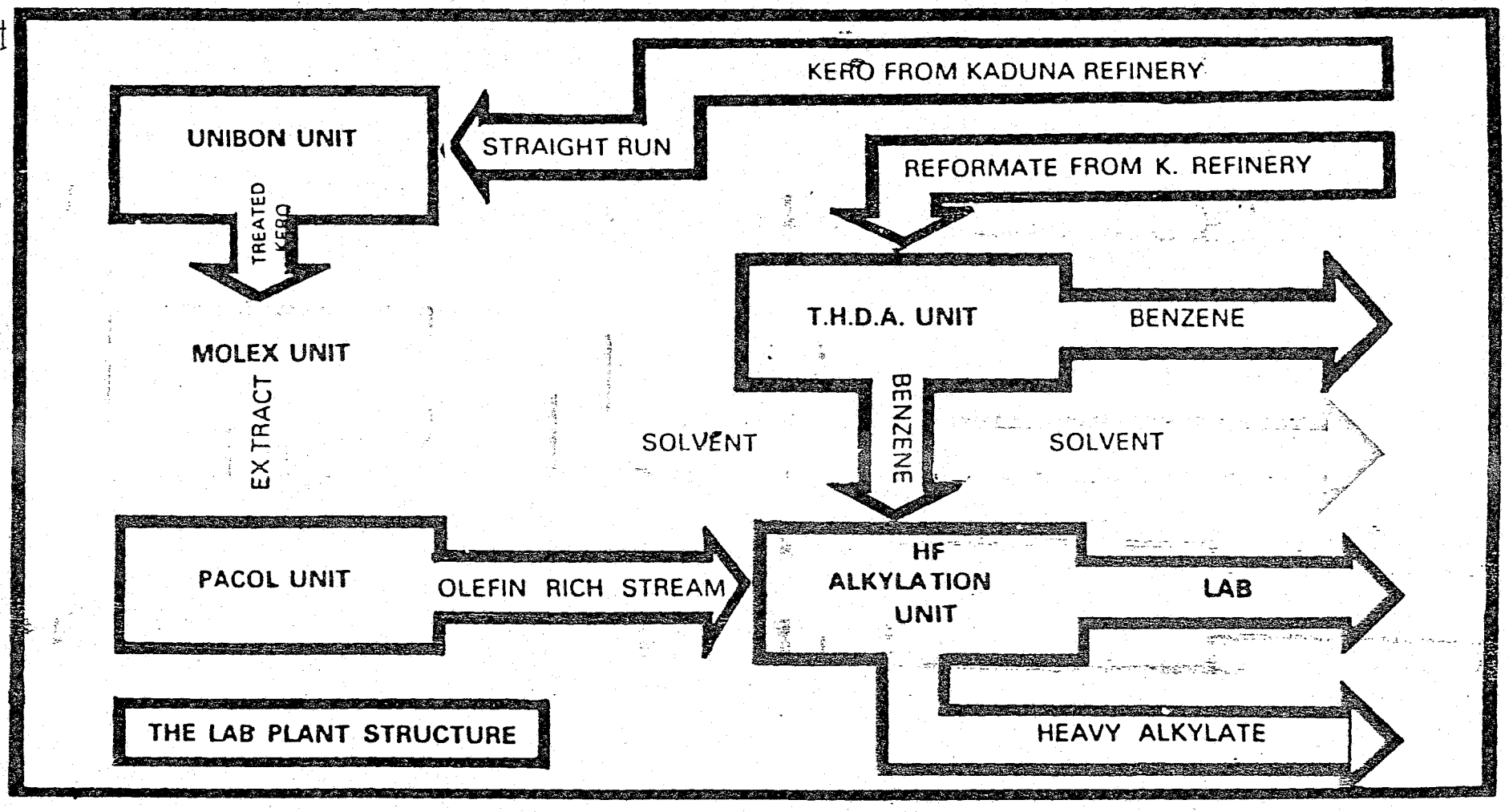

KERO FROM KADUNA REFINERY
UNIBON UNIT
STRAIGHT RUN
REFORMATE FROM K. REFINERY
TREATED KERO
T.H.D.A. UNIT
BENZENE
MOLEX UNIT
EX TRACT
SOLVENT
BENZENE
SOLVENT
PACOL UNIT
OLEFIN RICH STREAM
HF ALKYLATION UNIT
LAB
HEAVY ALKYLATE
THE LAB PLANT STRUCTURE

Figure 4.1.2.

The main market application of both major and by products are:

a. Linear Alkylate Benzene- Powerdered and liquid detergents.

b. Heavy Alkylate- Transformer oil thermal fluids, lubricating oil and greases.

c. De-paraffinated kerosine- Insecticides, paints and vanishes, degreasers, polish and metal cleaners.

KRPC BUSINESS MISSION

Refining crude oil into high value petroleum and petrochemical products, primarily for NNPC by efficent operation at minimum cost. KRPC also exploits other related profitable business opportunities in corporation with other arms of NNPC i the overall co-operate interests. For instance, the Products and Pipelines Marketing Company which is a subsidary of NNPC.

OBJECTIVES.

1. Optimise plant capacity utilisation
2. Minimize total operation costs
3. Exploit new and profitable business opportunities.
4. Commercialise Tin and Drum Plants.
5. Solve pollution problems around the refinery
6. Develop strong professional work force and employment for unskilled and technical person.

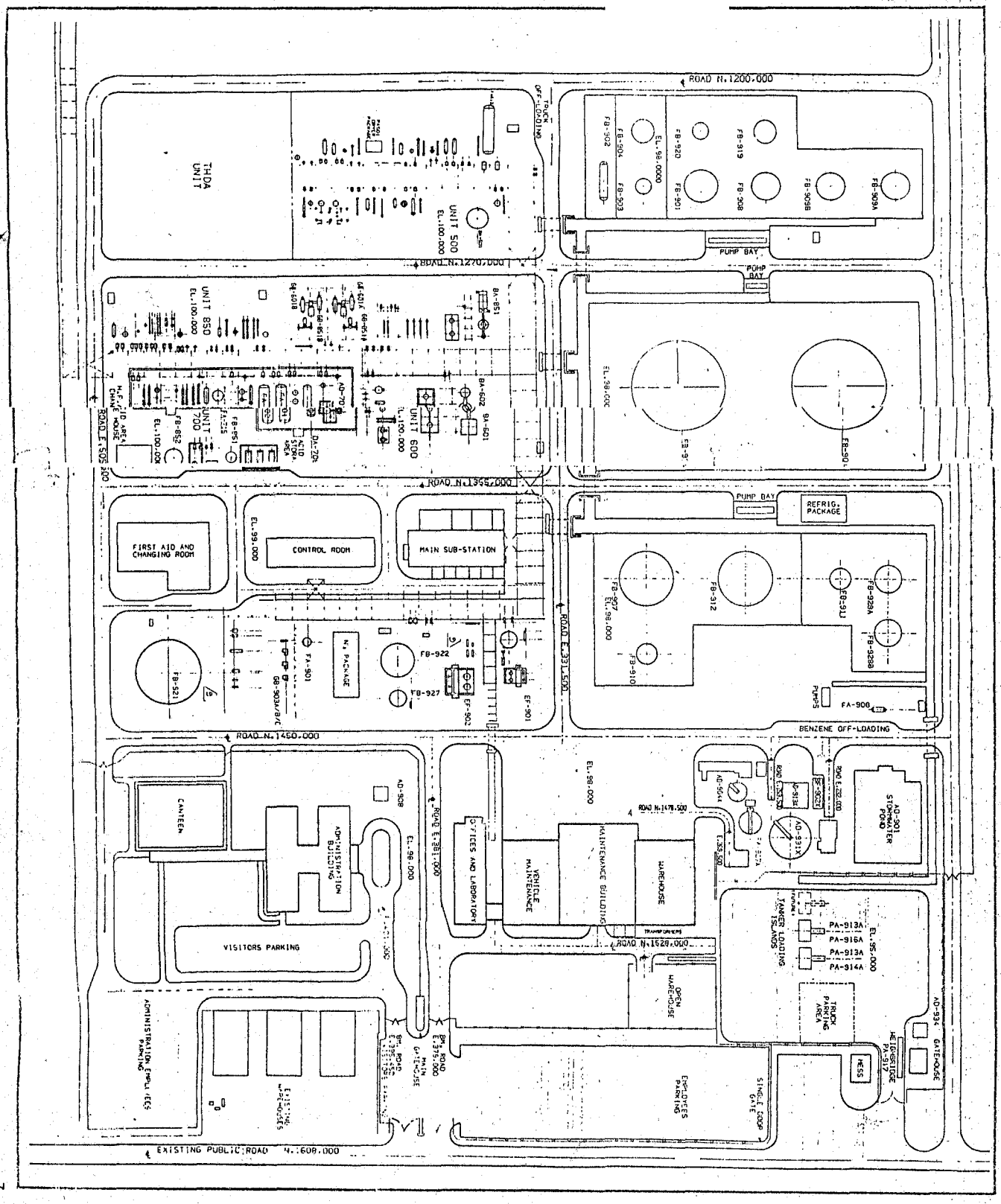
- DINING ROOM: As food is quite important in the effective function of the human system for work output, the dining hall is not left out of the petrochemical complex. The dining hall consist of the kitchen and serving room, conveniences, office, the main eating/dining hall.

- CLINIC: Though first aid kits are distributed within the plant, labortories and other area, the clinic forms a vital part of the complex. The clinic is attached to the administrative building. Though is accessed seperately, it comprise of ; emergence unit, doctor and nurses offices, conviniences, treatment rooms ambulatory, dispensary and observation rooms.

- LOADING STATION: Products of the plant have to be evacuated to customers. The loading station is a sheltered structure having pipes from the plant bearing the products. The loading station comprises of the bagging unit, storage facilities and truck loading unit. Other areas include the water supply and treatment plant, electric power sub-station and waste disposal system.

4.1.3. OBSERVATIONS.

The Kaduna refinery occupies an area of 2.89 square Km. The petrochemical complex occupies one third of the total area.



Kaduna Petrochemical Complex
Kachia, Kaduna.

- Site Layout

figure 4.1.0.

MERITS

- Good traffic system around the plant and complex.
- Good fire and safety precautions in most buildings and plant units.
- Enough dining space for workers.
- Commendable first aid and changing facilities for the plant.
- Structurally balanced warehouse and workshop buildings.

DEMERITS

- Lack of office space to accomodate the programming department.
- Inadequate refuse disposal system around the administrative building.
- Absence of waiting lobby for visitors in the administrative building.
- Non existence of seperate route for tankers both before and after loading in and out of the premises.
- Absence of mess room for shift workers.

4.2. WARRI REFINERY AND PETROCHEMICAL COMPLEX (NNPC)

4.2.1. INTRODUCTION

The Warri perochemical complex is located close to the Warri Refinery Ekpan, Warri, Delta state. The complex consists of two plants which are the polypropylene plant and carbon black plant. The polypropylene plant gets its feed stock from the Warri refinery while the carbon black plant gets its feed stock which is Decanted oil from the Warri refinery.

4.2.2. ARCHITECTURE.

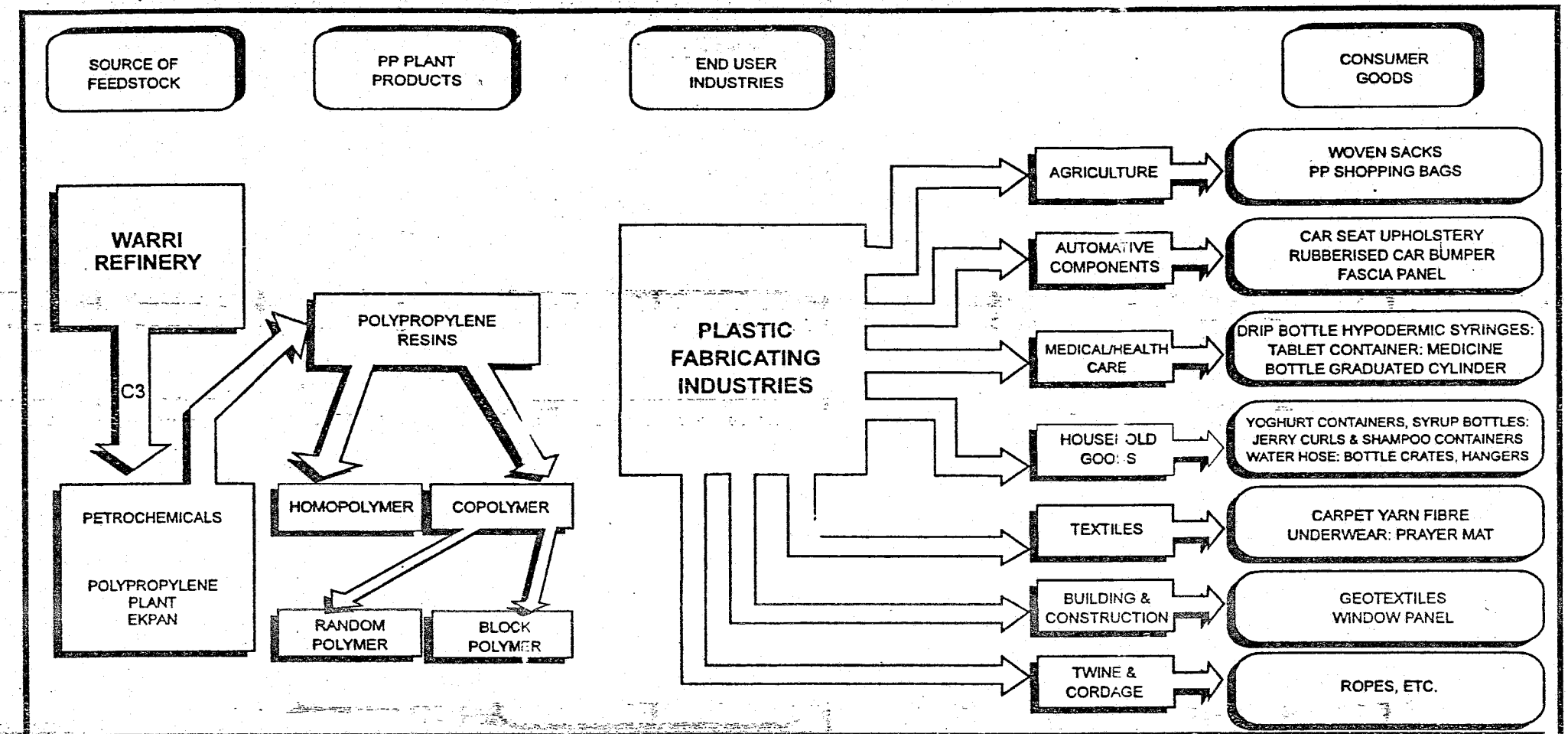
Architectural buildings that form part of this complex include the following:

- THE PLANT CONTROL ROOM: Located within the plant area. This building is heavily cladded and the first impression about the control is the low temperature. The control room has few offices linking to form the control building. The plant could be accessed via steps from the control room to check the upper units.

- THE WAREHOUSE:The next building to the control room and also close to the plant is the warehouse. This is a very big building that recieves the blown pellets from the plant pelletiser. Here the bagging is done and on a conveyor belt quality control and checking/sorting is carried out. The warehouse building measured approximately 30M by 15M. It has offices attached to the main hall. Bagged products are stacked as high as 5M ready for clearing and onward evacuation.

- THE DINNING HALL:Is a location outside the plant area, with a fence seperating them. The Dinning Hall has a kitchen and other Facilities. Other buildings around this area includes the office lock and supermarket.

- LABORATORIES:All the laboratories and adjorning offices were situated in a two story building. The petrochemical plant and Refinery share the same laboratory building, This makes it rather big.

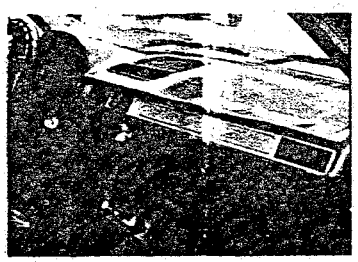


THE POLYPROPLENE PLANT HAS THE CAPACITY TO PRODUCE 35,000 METRIC TONS PER ANNUM OF VARIOUS GRADES OF POLYPROPYLENE RESINS FOR DIFFERENT APPLICATIONS.

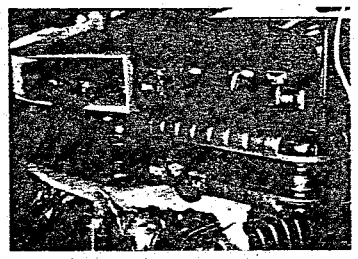
PLASTIC CONTAINERS

WOVEN SACKS

HOUSEHOLD GOODS



CAR CONSOLES



SUIT-CASES

- ADMINISTRATIVE BUILDING:This is a three story building which contained offices for various functions.

- FIRE STATION:As safety is a priority in this plant adequate facilities has been given to the fire station. The station is not far from the main plant.

- CLINIC:A typical industrial clinic with facilities for emergency, ambulance, dispensary, treatment pharmacy, observation rooms and offices.

4.2.3. OBSERVATIONS

My observations are classified into merits and demerits.

MERITS

-Well spaced motor and pedestrian entrance to the complex, complimented by good landscaping.

-Well planned linede arranged building brougt about good layout of the plant.

-The traffic flow at the petrochemical area of the complex is commendable.

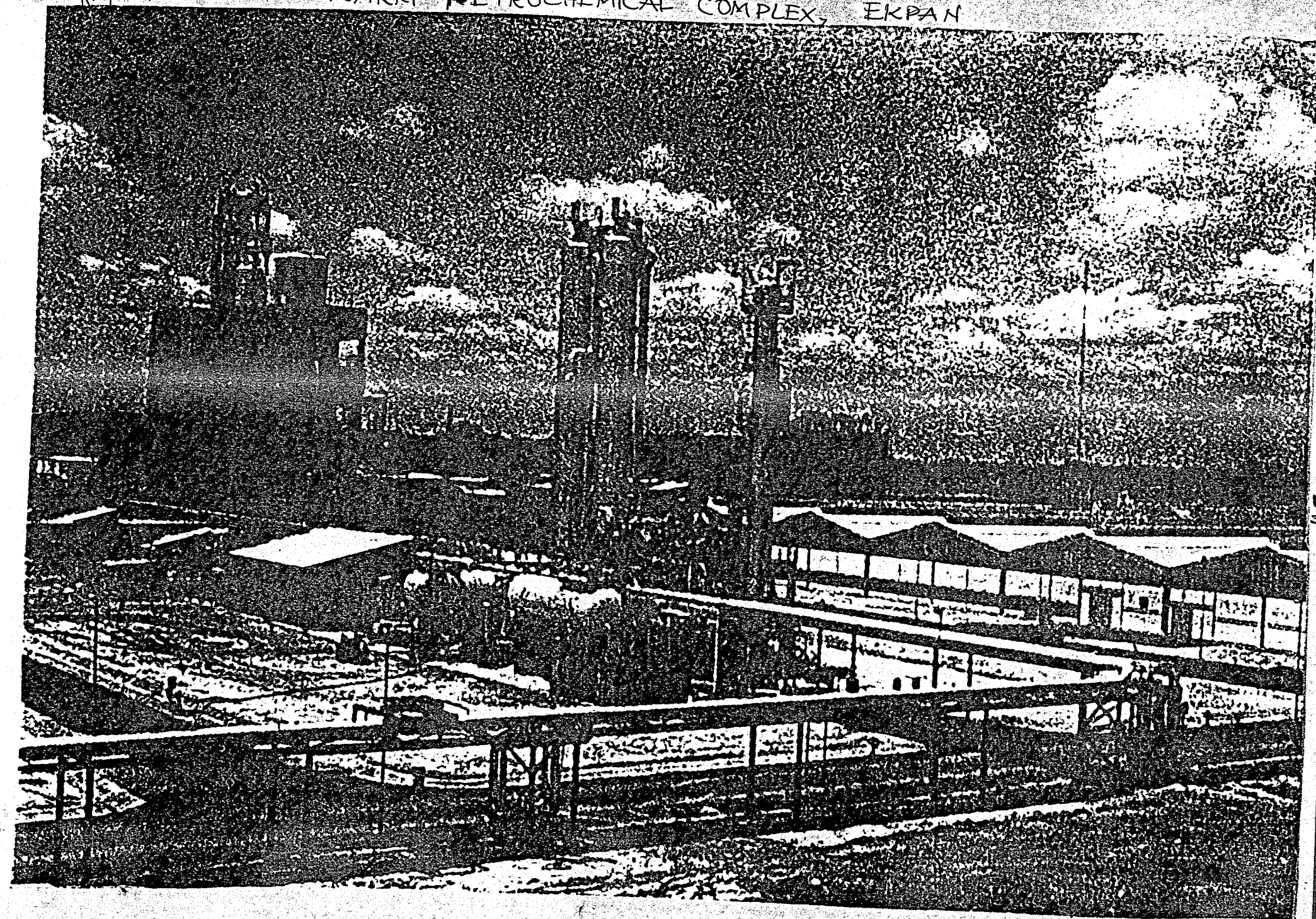
-Adequate office accomodation for staff in the control room.

DEMERITS

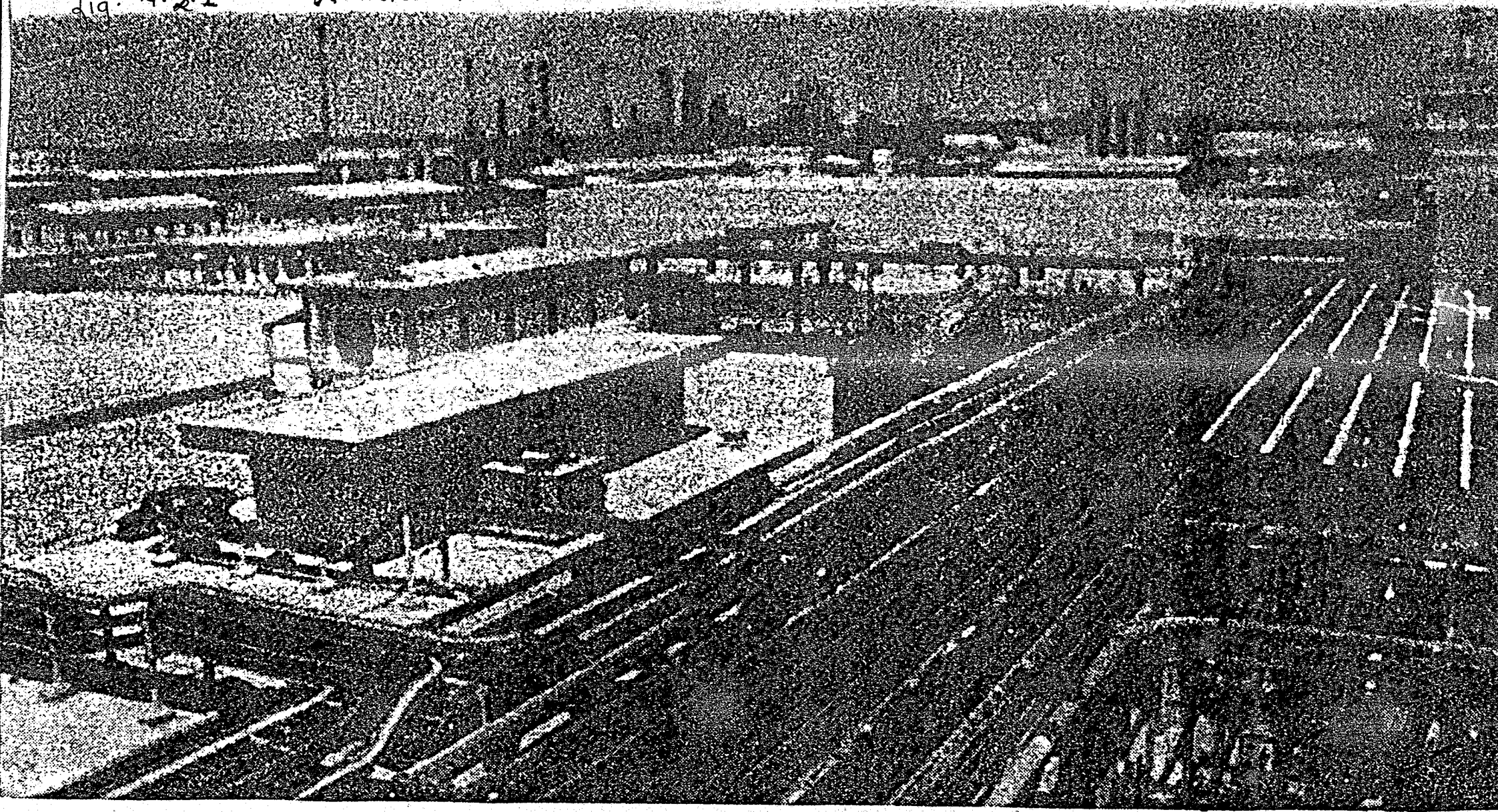
-Some facilities are still being shared by the petrochemical Plant and the refinery, this has led to the over crowding especially at the office building.

-Walkways are not sheltered. As a result, workers moving from office to plant are affected by either rain or sunshine.

fig 4.2.1 KARRI PETROCHEMICAL COMPLEX, EKPAN



dig: 4.2.2 WARRI PETROCHEMICAL COMPLEX, EPKAN



4.3 ELEME PETROCHEMICAL COMPLEX, PORTHACOURT.

4.3.1 INTRODUCTION

The Eleme petrochemical complex located at Eleme near Porthacourt is primarily aimed at satisfying the fast growing National demand for petrochemical products, especially in the building, agricultural, automotive, electrical, textile and packing industries.

The product planned to be produced in the present first stage are:-

-Ethylene
-Propylene
-Butene
-Polyethylene (high density and linear low density grades)
-Polypropylene

The major feed stock to the Eleme petrochemical complex is Natural Gasliquid(NGL) supplied from the NGL plant located at Obiagu/Obiakon.This feedstock is delivered to the complex in liquid phase via a pipeline.

The overall configuration of the Eleme petrochemical complex is shown below.

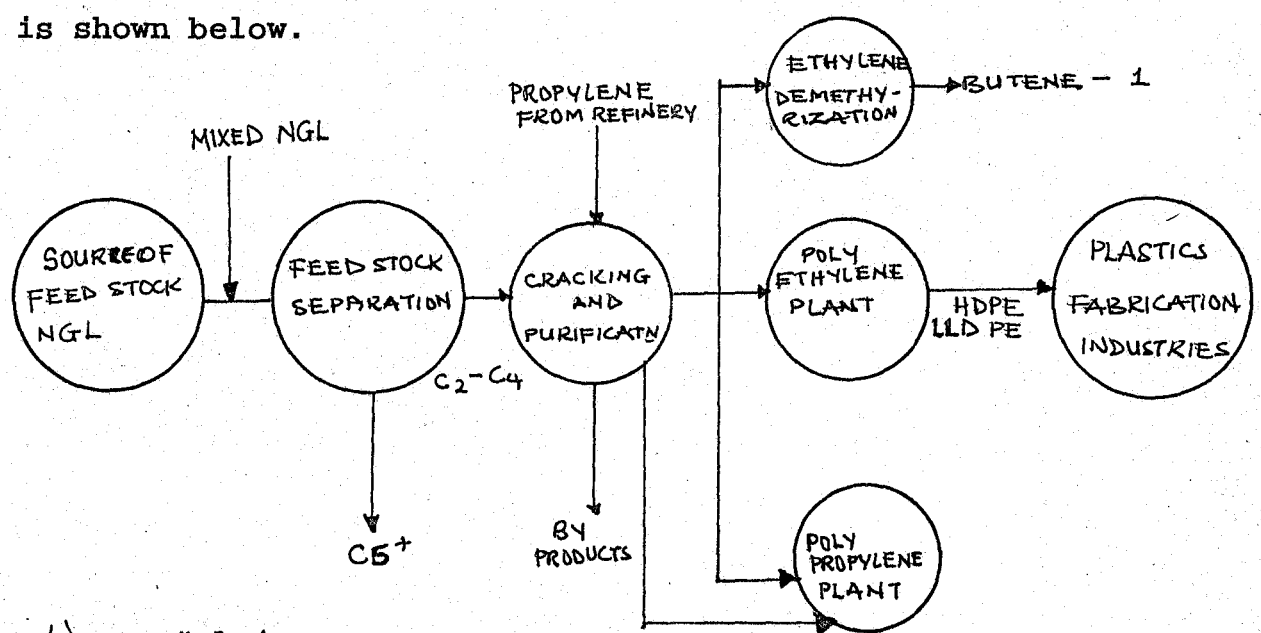


figure 4.3.1

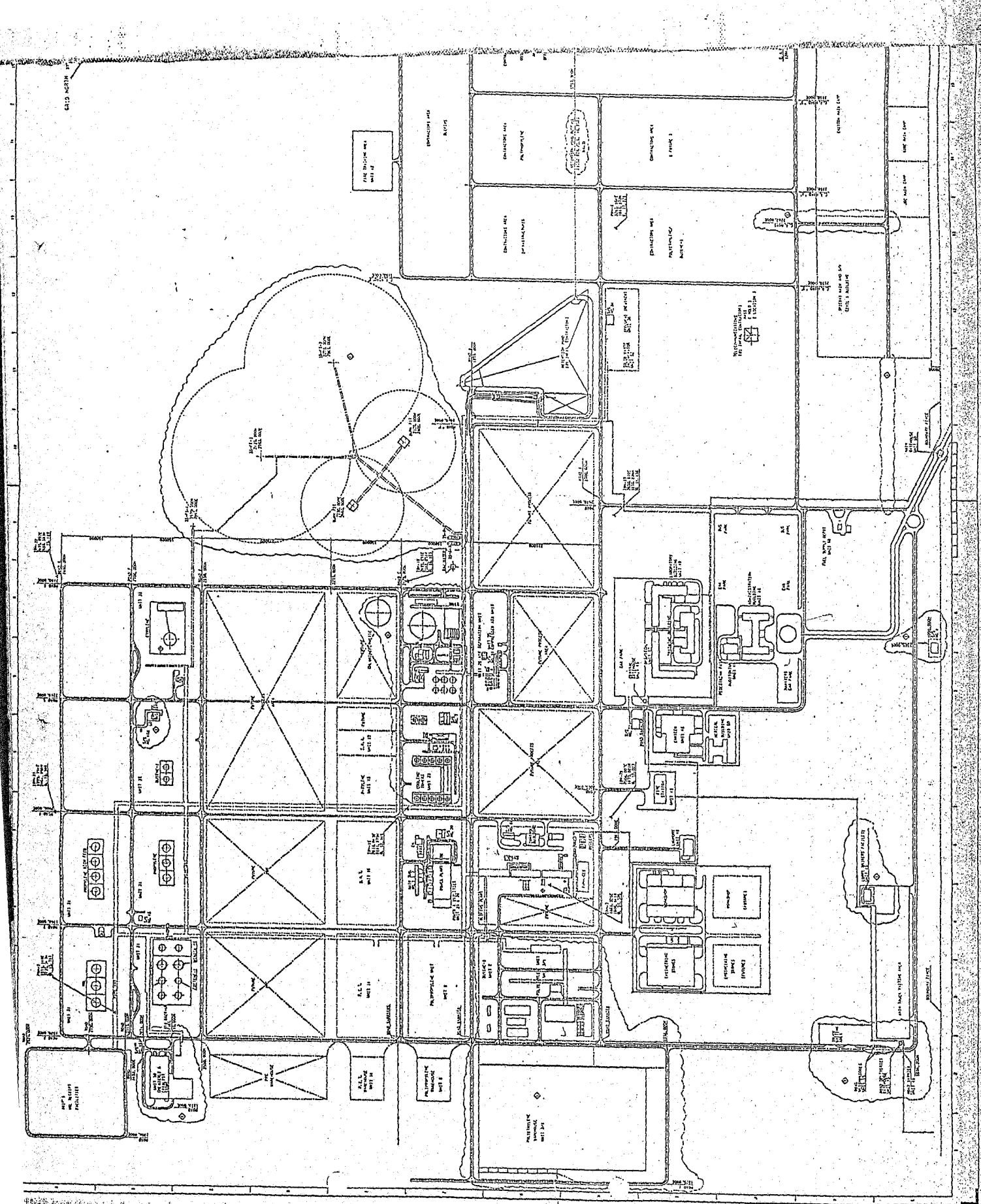


figure 4.3.2

Eleme Petrochemical Complex, Port Harcourt

Site layout

4.3.2 Architectural Buidings in the complex include the following.

- Administrative building:this is a three storey building containing offices and other administrative facilities.
- The laboratory building:this building contains four main laboratories and two smaller ones.The laboratory building with adequate offices for staff.
- Clinic
- Warehouse and stores
- Control building
- Office building
- PDTC(The plastics tecnology Development Centre)
- Fire station
- Workshop.

4.3.3 OBSERVATIONS

The complex has a good landscape and layout with plenty of area for future expansion.Being a new complex,all the buildings are new with adequate offices to contain the present workers.

4.4 CONCLUSION

Presently,there are three petrochemical plants in Nigeria,all under the Nigerian National Petroleum Corporation (NNPC).It can be deduced generally that each plant runs differently and have different turn outs and capacities.This design will be similar to the Eleme Petrochemical Complex, Portharcourt.The Warri petrochemicals also produce poly propylene (PP)but in small quantity.This design will include stuctures for plant operations and services like the ones existing in the three plants.

CHAPTER FIVE

5.0 THE SITE

5.1 SITE CHARACTERISTICS AND LOCATION

The site is located within the layout of the industrial area which is situated at the outskirts of Lokoja off the Abuja - Okene expressway at the junction that leads to Okene.

The site is characterised by existing farmlands,vegetation,a stream and NEPA poles bearing high tension wires.

5.1.1 GEOLOGY

Weathering of materials from the plateau give them a thin soil cover that are being washed down by erosion to give medium aggregate particularly suitable for construction.

5.1.2 SOIL

The site is also characterised by alluvial soil of the flood plain and soils of the high plateaus.The soil is rich for cultivation of crops.

5.1.3 TOPOGRAPHY AND VEGETATION

The site topography is gently sloped especially by the Plateau, towards the Abuja-Lokoja north bypass. Towards the centre of the Industrial layout, the potography is relatively flat to allow easy construction.

VEGETATION

Found on site are; Parkland savanah, scattered shrubs and grasses, and a bit of cultivated crops. The trees that would be beneficial to serve as wind breaks and shade could be left on site, others cleard on construction purposes.

5.2 CLIMATE

The most important elements in the climate of site are rainfall, humidity and temperature. The climate on site is tropical with both the wet and dry seasons.

5.2.1 RAINFALL AND WIND

The wet season starts in May and in October/November, the dry season sets in. The main annual rainfall on site is the same as that of Lokoja which is 1674mm, this was from exceptional long record of 100 years. In other to avoid this erosion which may be caused by rainfall which will eventually affect the building on site. Drainages may be provided round the buildings which could be connected and dicharged to the river.

Lokoja lies within the middle belt of the coutry. It is characterised by the water Laden South-West winds of the equatorial rain belt and the dry dusty harmattarn Winds from the North West. Buildings could be orientated to suit the prevailing winds.

5.2.2 TEMPERATURE AND HUMIDITY

Lokoja has a mean monthly temperature of 70%c. This is greatly due to the river characteristics of the Niger and Benue which flow from North right through the State. As the dry season wets in following the parttern of the water laden South-West wind of the equatorial rain belt origin. The temperature cools down and the dry dusty harmattan winds from the North-West prevails with haze and winds.

HUMIDITY: The River Niger also feeds the atmosphere with vapour such that the relative humidity of the atmosphere can be as high as 80%.

In the wet season, but never falls below 65% during the short harmattan. Although this later condition may not permit presipitation surface evaporation is prevented culminating in the characteritics hotness of the town.

5.2.3 SUNSHINE AND CLOUDS

Peak sunshine periods of eight hours per day are experienced between the months of January to March and October to Deccember; with a lower periods of six hours during August.

The intensity of the sun could be beared on sitee by maintaining shade trees where necessary and the provision for suncsreens for window facing the sunrise and sun set directions.

At the peak priod of sunshine, the clouds are clear giving a cloudless sky. At rainy seasons, the clouds gather to give rainfall.

5.3 SITE SELECTION

The site being located within the mapped out industrial layout of the land use plan for Lokoja. Factors that influence the site selection could be classified into (i) Macro selection factors and (ii) Micro selection factors.

5.3.1. MACRO SELECTION FACTORS

- LOCATION: With respect to the maketing area, the Moukha Gas Plant, Plastics company around the State, Kano plastics, and other industries will benefit from the petrochemical plant.Due to the centrality of Lokoja and the Abuja-Okene express way which links the north and South, the petrochemical plant could be accessible to the marketers and transporters.

- RAW MATERIALS SUPPLY: The basic raw material for this plant is Liquified Natural Gas (LNG). The existing Moucha gas plant makes use of LNG. LNG could be transported to the plant via pipelines under gas pressure from Obrikon to Lokoja.
A direct pipeline is required with only pump station from the source. Due to the nature of the LNG pipeline is much easier than crude oil.With the existing pump / bust station for NNPC at Kabba junction (about 26km from site) raw materials pipeline is viable.

- TRANSPORT FACILITIES: Basic transporation of materials and products to and from the plant is an over-riding consideration in the site selection. Road transportationis being increasingly used, and is suitable for local dsistribution from a central ware house. With the closeness of the River Niger and Benue, water transportation is an asset.

- AVAILABILITY OF LABOUR: Labour will be needed for the construction of the plant and its operation. Skilled construction workers could be brought into site easily from outside the site area and there is adequate pool of unskilled labour available within Lokoja and its environs.

- AVAILABILITY OF UTILITIES: Water, fuel, Power, the site location is suitable for water to be transported or channeled for operation. A Water treatment plant will be needed.Power generation can be done locally on the site for plant operation.Due to the nature of the plant much power will be needed for operation; gas during operation given off- could be use to run the power station e.g Methan gas. Fuel and power could be made available to the plant from the nearby NNPC pump station.

- LAND AVAILABILITY: Available land suitable for plant and other structures is much within the industrial layout.

5.3.2 MICRO SELECTION FACTORS: Environmental impact and effluent disposal. All industrial proccesses produce waste products and full consideration must be given to the difficulties and cost of their disposal.

The disposal of toxic and harmful wastes will be covered by local regulations, the plant will have a waste treatment unit and a flare system and appropriate authorities will be consulted during the intial survey to determine the standards that will be met.

- LOCAL COMMUNITY CONSIDERATIONS: Full consideration is given to the safe location of the plant so that it does not impose a significant additional risk to the community.

- SUFFICIENT AVAILABLE LAND ON SITE FOR FUTURE EXPANSION: The land is ideally flat and well dained with a suitable load-bearing capacities.

- CLIMATE: Adverse climatic conditions at the site will increase cost. Abnormally low temperatures will require the provision of additional inculation and special heating for equipment and pipe run. Fortunately, Lokoja has (2) perfect climatic weather conditions to run the plant efficiently.

- POLITICAL AND STRATEGIC CONSIDERATION: Lokoja shares boundry with the Federal Capital Territory and is strategically located as it serves as a link between the north and south eastern states. With the convergence of the Rivers Niger and Benue at Lokoja, this further gives it a political and strategic boost.

5.4 SITE ANALYSIS

The site is characterised by vegetation (trees and shrubs) and soils. Existing features on site includes a drainage and a bridge as well as the major Abuja-Okene road along the side of the site. The site could be easily accessed from the main road through a proposed road.

CHAPTER SIX

6.0. PLANT PRODUCTION AND LAYOUT

PLANT LAYOUT.

The economic constrution and efficient operation of a process unit will depend on how well the plant and equipment specified on the process- flow- sheet is laid out.

The principal factors to be considered are:-

1. Economic considerations: Construction and operation costs.
2. The process requirements
3. Convenience of operation
4. Convenience of maintenance
5. Safety
6. Future Expansion
7. Modular construction.

COSTS

The costs of construction can be minimised by adopting a layout that gives the shortest run of connecting pipe between equipment, and the least amount of structural steel work. However, this will not necessaily be best arrangement for operation and maintenance.

PROCESS REQUIREMENTS

An example of need to take into account process consideration is the need to elevate the base of columns to provide the necessary net positive suction head to a pump or the operating head for a thermosyphon reboiler.

OPERATION

Equipment that need to have frequent operator attention should be located convenient to the control room. Valves, sample points and instruments should be located at convenient positions and heights. Sufficient working space and headroom must be provided to allow easy access to equipment.

MAINTENANCE

Heat exchangers need to be sited so that the tube bundles can be easily withdrawn for cleaning and tube replacement.Vessels that require frequent replacement of catalyst or parking should be located on the outside of buildings. Equipments that requires dismantling for maintenance, such as compressors and large pumps, should be placed under cover.

SAFETY

Blast walls may be needed to isolate potentially hazardous equipment, and confine the effects of an explosion.
At least two escape routes for operators must be provided form each level in process buildings.

PLANT EXPANSION

Equipment should be located so it can be conviniently tied in with any future expansion of the process. Space should be left on pipe alleys for future expansion/need and service pipes over-sized to alloe for future requirements.

ADVANTAGES OF MODULAR CONSTRUCTION

- Improved quality control
- Reduced construction cost
- Less need for skilled labour on site
- Less need for skilled personnel from overseas

6.1 RAW MATERIAL (FEED STOCK)

The major feedstock to the Zion Petrochemicals Lokoja shall be the Natural Gas Liquid (or Liquified Natural Gas) LNG supplied from the NGL plant located at Obiofu/Obrikon. This feedstock is substantially free from methane and is composed of ethane, propane and butane, with minor quantities of pentane and heavier hydrocarbons. This feedstock could be delivered to site plant in liquid phase, via a pipeline.

6.2 PLANT PROCESSES AND OPERATIONS

The anatomy of petrochemical process.

The basic components of a typical petrochemical process in which each block represents a stage in the overall process for producing a products from the raw materials.

The figure below represents a generalised process; not all the stages will be needed for any particular process, and the complexity of each sstage will depend on the nature of the process.

The major feedstock to the plant NGL is delivered to the Tank farm and with the aid of operation programming, the quantity needed for production is piped to the plant (the Olefin's plant). The plant is made up of the Olefins plant which is the main plant, two smaller polymerisation (polypropylene and polyethylene) plants and the seperation and extrution plant/unit.

At the Olefins plant, the NGL feedstock is fractionated where gasoline is given off next stage/unit is the cracking and quenching where streamis given off. Compresssion takes place next, acid gas is removed and the NGL is dried and cooled. At the cooling stage, H2 is given off as by-product (this could be used as a local source of energy) and the main product is sent to the demethanizer, de-ethanizer and de-patronizer. For the demethanizer, tail gas is given off, while at the demethanizer

the product is sent to the acetylene converter where H2 is added and further to the C2 splitter where polymer-grade ethylene is obtained. At the depronizer the product is sent to the debutonizer where gasoline is given off, C4 to be recycled and to the C3 the C3 Acetilene converter where H2 is added and C3 splitted to obtain polymer-grade propylene and propane.
The products of the olefins plant are polymer-grade ethylene, ethane (torecyle), polymer-grade propylene and propane.
These products are then sent to the ethylene polimerisation and propylene polymerisation plants respectively.

(i) POLYTHYLENE PROCESS DESCRIPTION

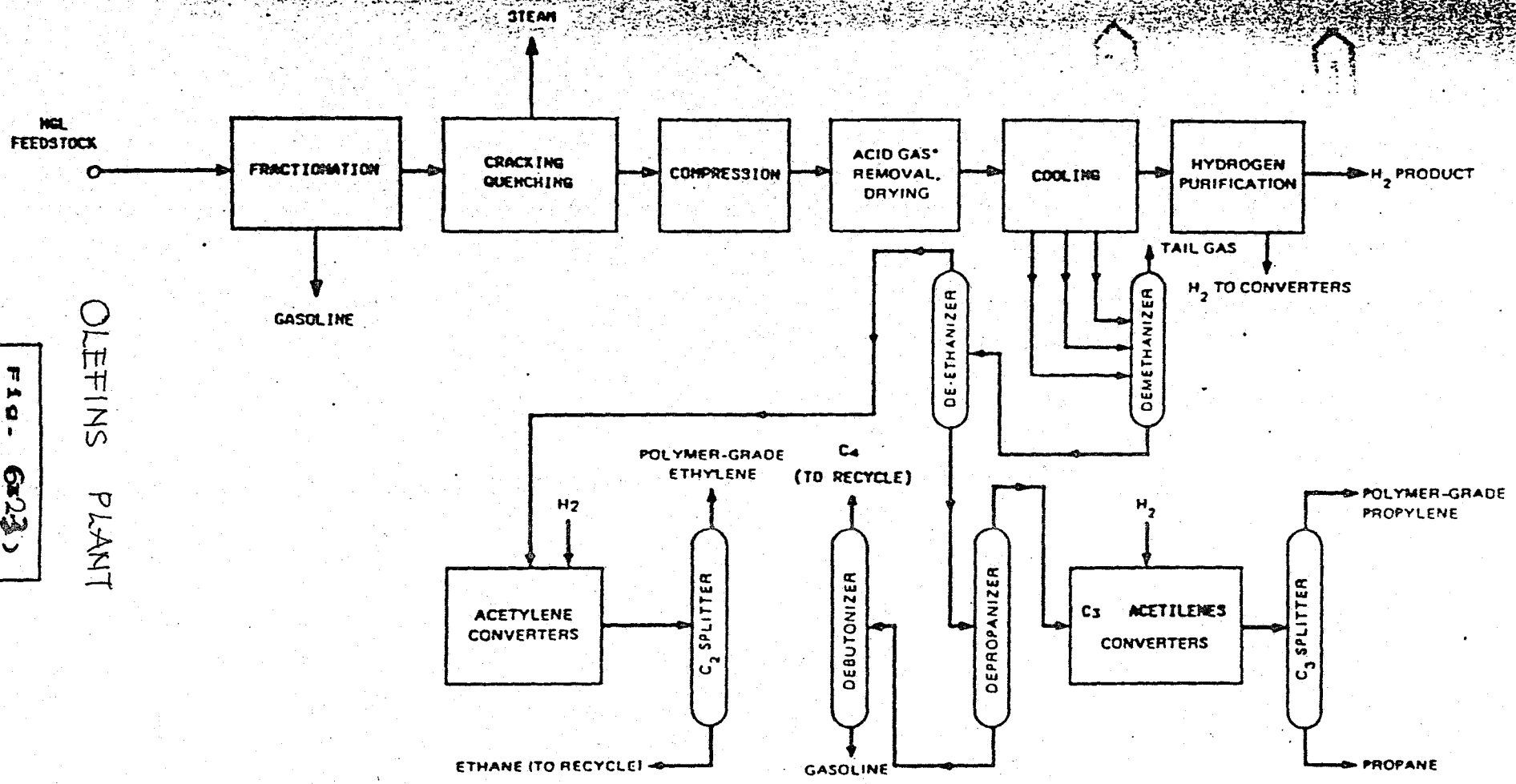
The polythylene plant can be divided into the following sections.

- Catalyst preparation
- Polymerisation
- Polymer seperation
- Extension and finishing
- Suluent and monomer Recovery

A block flow of diagram of defined plant for the production of polymer grade ethylene and polymer grade propylene using NGL (Natural Gas Liquids) as feedstock.

The plant is subdivided into the following main sections.

- Fractionation, where pentane and heavier hydrocarbons are recovered from the NGL, thereby freeing the methane, propane and butane required for the refined production.
- Cracking section, where the mixture of the ethane, propane and butane is converted into ethylene, propylene and by products and then quenched to prevent further reaction.



*ACID GASES REMOVAL AFTER THE THIRD STAGE OF COMPRESSION; DRYING AFTER THE LAST STAGE.

OLEFINS PLANT

Fig. 6223

Dig. 6,2,3
K-7010-11 56

- Compression section, where the gas pressure is increased in view of the subsequent chilling operation; in the same section acid gas and moisture removal is carried out.

- Cooling section, where the compressed gas steam is chilled in a cooling train to obtain a liquid-gas mixture suitable for distillation in fractioning columns.

- Seperation section, where the various components are seperated from the mixture in a series of fractioning columns.

The first one is a demethaniser column, where CH4 and other lighter products are seperated from the main stream.

The botton product from the demethaniser flows to a de-ethanizer to seperate the C2's from C3 and heavier components. The seperation into the various products is then carried out in the down stream column.

The said sections are shown in two process flow diagrames, of catalyst preparation, distillation and polymerisation and Extension and Finishing in figs 6.2.3. and 6.3.1. which shows the solvent and monomer recovery section.

Furthermore, the plant uses stream and Dowthern vapour as heating media; while stream comes from the Olefins plant, the facilities for storing, vapourising and circulating Dowthern are available within the plant battery limits.

(ii) The main feedstock of the polypropylene plant is the polymerisation-grade ethylene monomer produced in the Olefins plant.

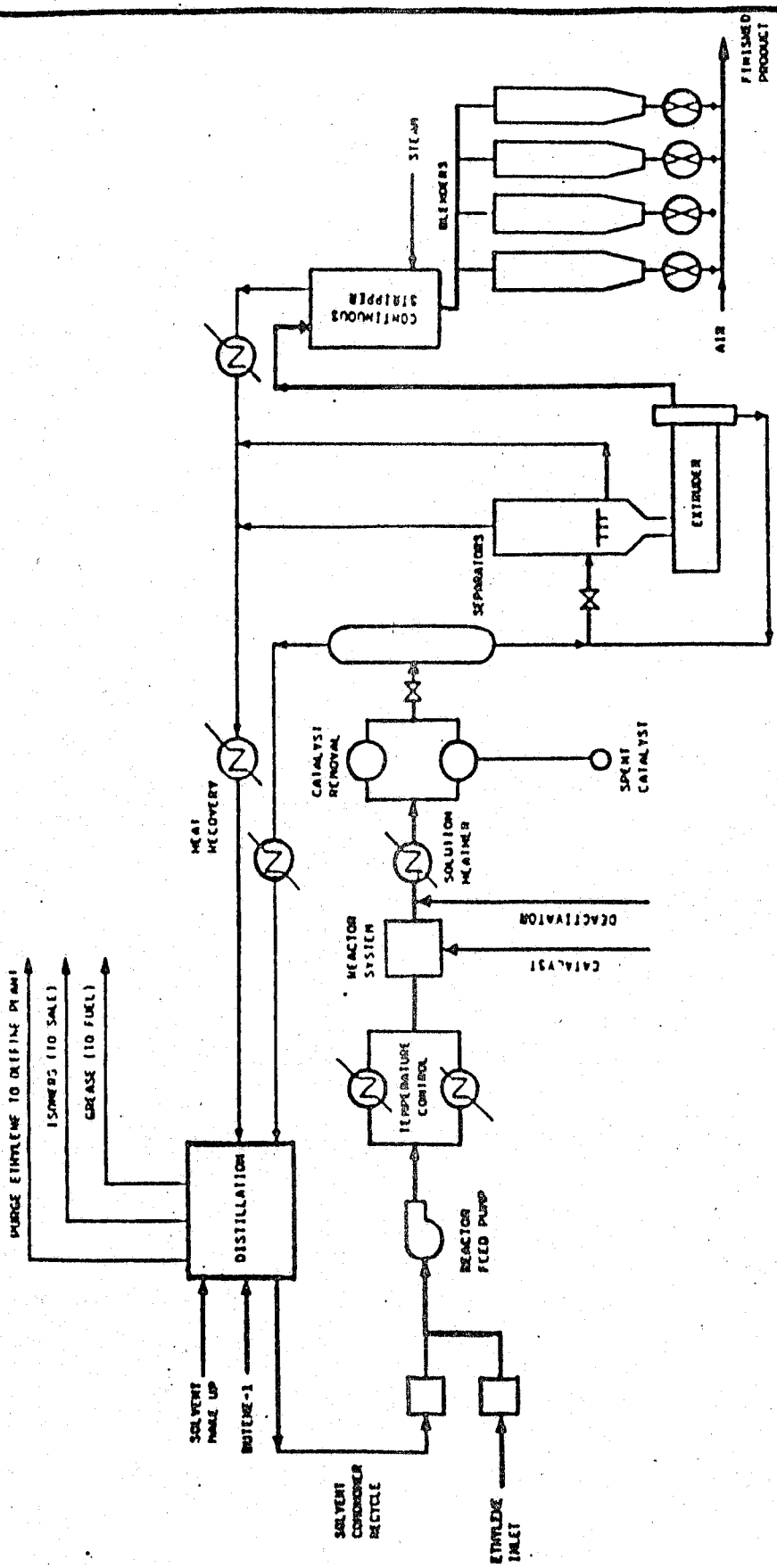
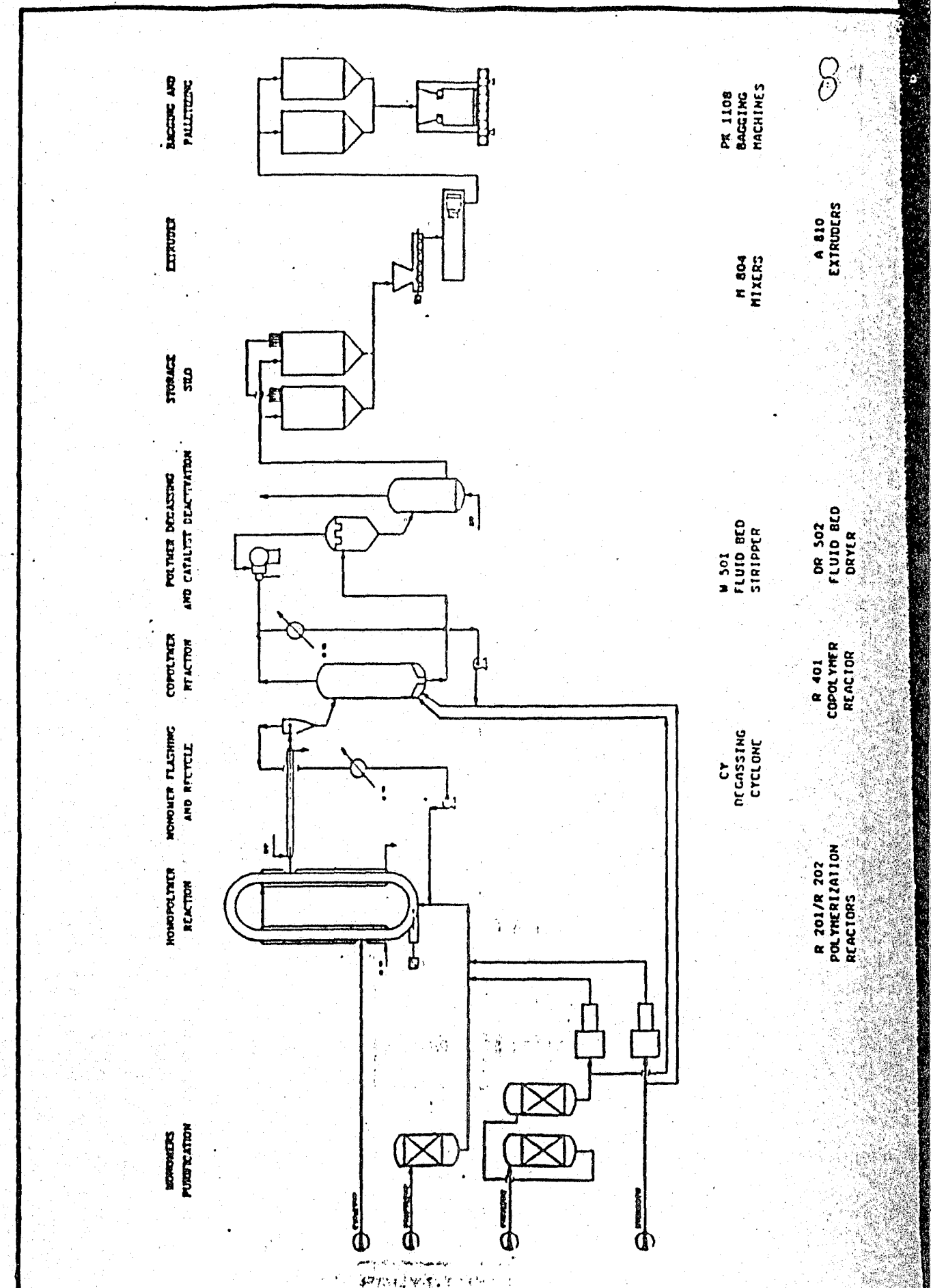


fig. 6.3.1.

EXTRUSION AND FINISHING SECTION



THE POLYPROPYLENE PLANT.

fig. 6·3·2.

An additional important feedstock is butene-1 produced by demerisation of ethylene on the IFP Alfa butol process. Simplified process flow diagram is shown in fig 6.3.2. The polythene is a thermoplastic product which is produced in the plant in the form of solid pellets to make injection moulding resins (e.g production of thin walled disposable containers), Rotational moulding resins (e.g for producing silos, chemical storage tanks etc), blown moulding (e.g for producing bottles), and firm (e.g industrial or supermarkets bags etc).
At the storage and bagging unit, the polymer pellets are routed to bagging machines, where 25kg bags are filled in, pelletized and finally sent to warehouse. (fig 6.3.3.)

6.4 QUALITY CONTROL

Quality control is a prerequisite in any good manufacturing or contracting business. The ASME has formalised the methods to be used in maintaining good welding, fabrication and testing procedures.

The quality control programme has the following features:-

(i) The management support and designation of a manager incharge of all quality control matters, with full authority to implement, maintain,verify and if required change procedures and methods to assume a quality product.

(ii) Organisation chart showing where quality control is to be enforced in design, material selection and inspection; fabrication, testing, final inspection, records documentation and similar interdepartmental responsibilities.

(iii) The usual quality control steps in manufacturing, repairs and alterations.

A- Design and calculations to code requirements. The code requires complete documentation that the design meets code requirements, thus, this is a quality control point.

B- Material Control: This is to ensure that only code permitted material is used and that it is free of defects, is of proper thickness, and is properly prepared for fabrication.

C- Hold Points: after each manufacturing step, hold poits are desired so that inspections can be made on the material to note if any deleterious changes have taken place.

D- A welding procedure and the qualification of the welders.

E- Monitoring and control of the corrections of discovered effects to ensure compliance with the code and good engineering practice.

Quality Control personnel are deeply involved in inspection at holdpoints, including undestructive tests and interpretation of these tests.

F- Periodic checking of gauges, instruments and other divices.

G- Keeping of forms and recorded quality control data for furture references.

6.5 PETROCHEMICAL PRODUCTS AND APPLICATIONS

Generally, products base on chemicals derived from oil and natural gas are called petrochemicals.Petrochemical materials used in the production of industrial, consumer goods like plastics, synthetic fibres, synthetic detergents, synthetic rubbers and solvents. In addition the petrochemical industry is the source of base materials for many other chemical products like dyes, paints, adhesives, agric chemicals, phamaceuticals and other speciality chemicals.

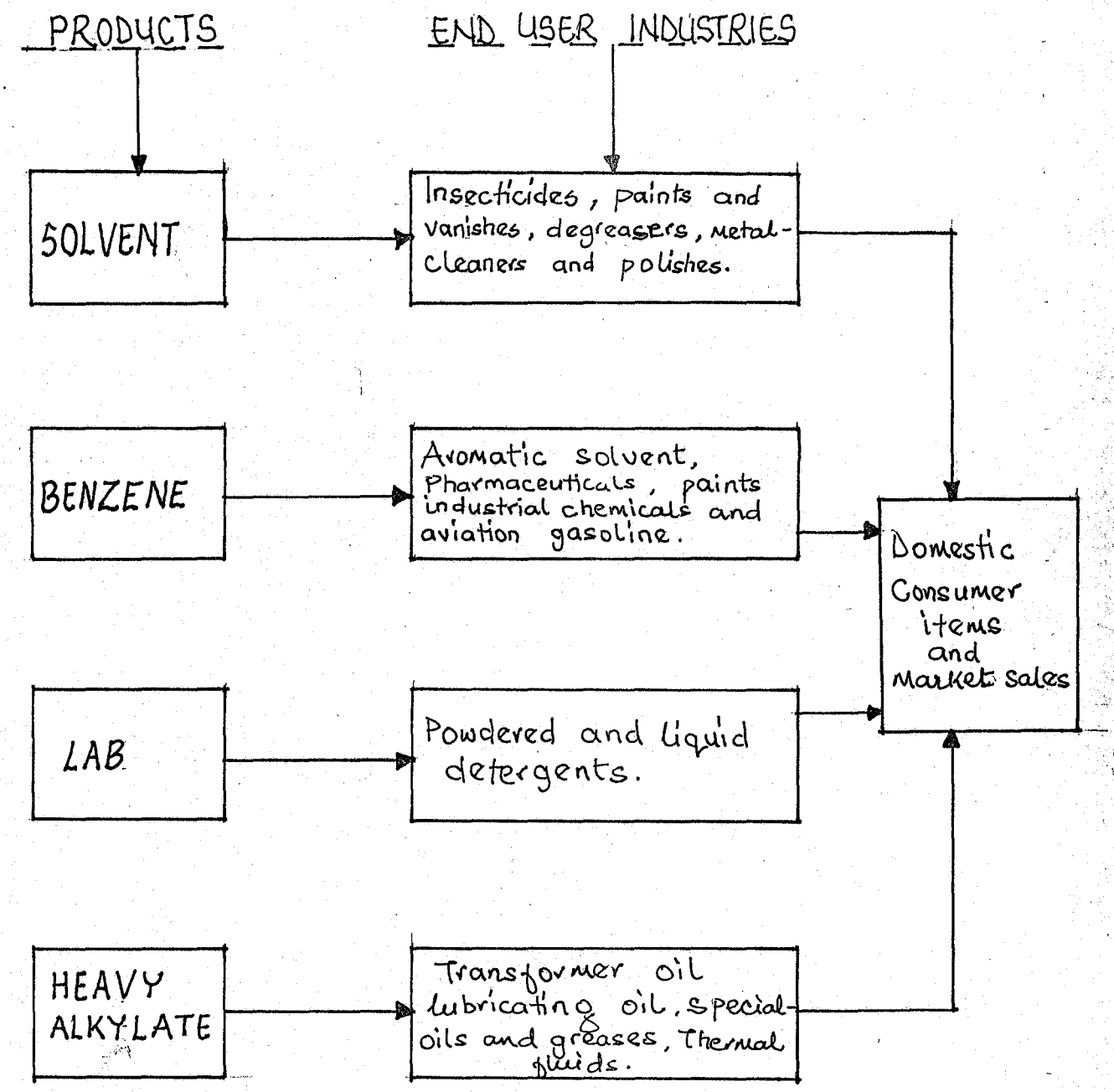
Current products at the existing petrochemical plants in Nigeria include:

PRODUCT	SITE	(mt/yr) CAPACITIES
Carbon black (CB)	Ekpan	18,000
Polypropylene(PP)	Ekpan	35,000
Linear Alkyl Benzene(LAB)	Kaduna	30,000
HF-C4-Alkylation	Ekpan	110,000
Benzene	Kaduna	15,000

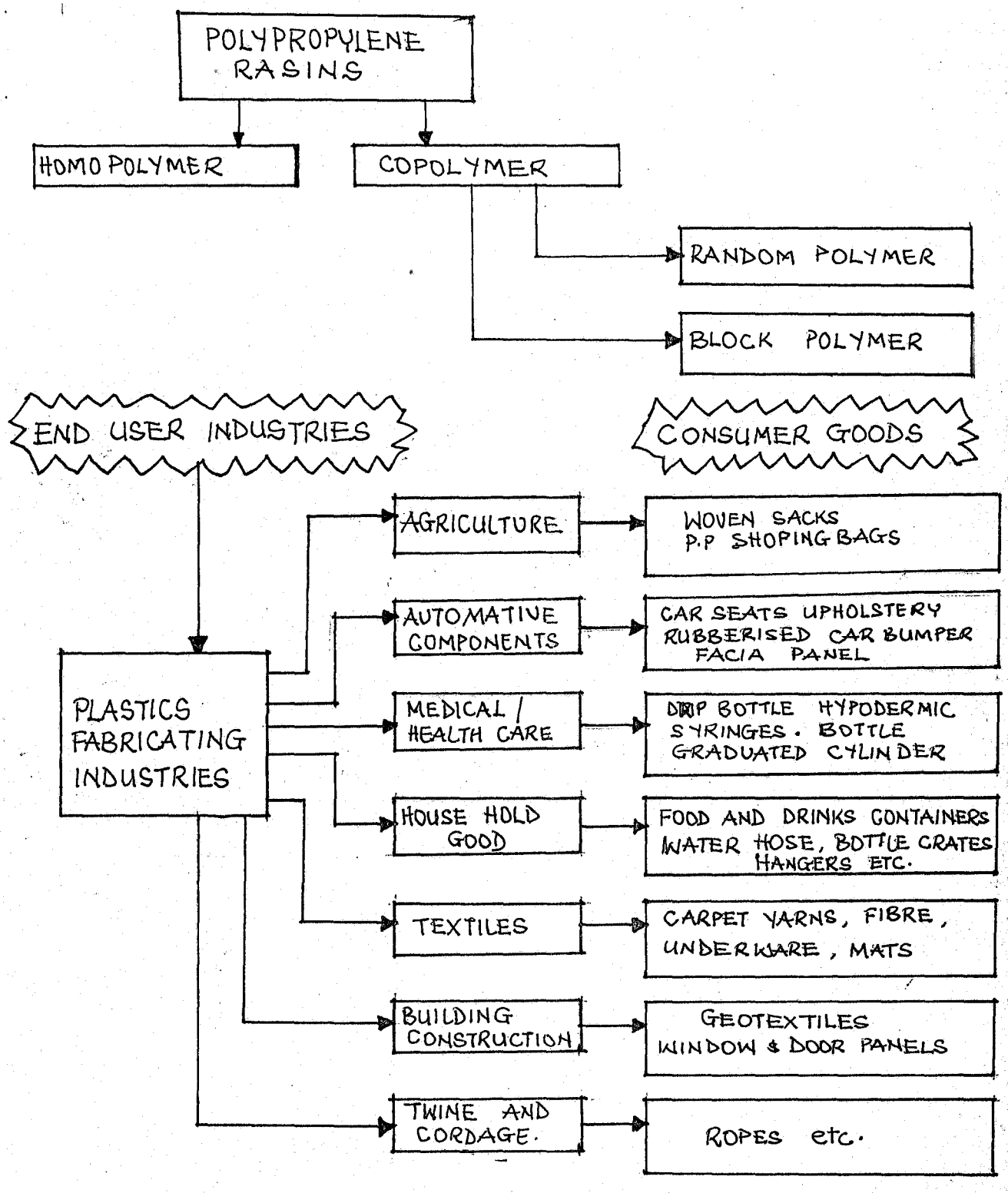
Table 6.5.1

From the Poly propelene plant capacity of 35,000 MT per annum of various grades of poly propylene resins for different applications.

The carbon black plant also at the Warri petrochemical complex has the capacity to produce 18,000MT per annum of hard black N100-N300 series for the rubber,printing and automotive industries.



Feed stock for the Kaduna and Warri plants are derived from the by-products of the Kaduna and Warri refineries.These are kerosine,reformate,offgas and fluid catalytic cracker decanted oil,all of which are obtained locally from the refineries.



Applications of the products relevant in the first stage of the Eleme Petrochemical complex Portharcourt include:

POLYETHYLENE(LINEAR LOW DENSITY -LLDPE) with primary applications in:

(i) Film packaging : processed food packaging,bread wrap,wrapper for garments and textile products,linear films,heavy duty bags for diverse purposes,shopping bags,refuse bags,milk bags etc

(ii) Injection Moulding : Squeezable bottles for cosmetics pharmaceuticals and toiletry products.

(iii) Agricultural and construction film : Green housing for multiple season cropping,outdoor covering ditch and pond liners etc

POLYETHYLENE (HIGH DENSITY - HDPE) with primary application in:

(i) Blow moulding : Jerrycans sor various liquids,industrial drums,house hold chemicals,cosmetics and pharmaceutical bottles,oil and lubricating liquid cans etc.

(ii) Injection moulding : Beverage cases and household wares,toys and simple appliances,stationeries etc

(iii) Film moulding : Merchant bags/sacks,raincoats.

POLYPROPYLENE (P.P) principally for :

(i) Injection moulding : Beer and beverage crates,automotive battery cases,plastics for automotive interiors,house hold appliances,hoses etc.

(ii) Fibre moulding : Bulk filament,tape and fibrilarcious yarns,carpets of all types,wooven sacks for bulk shipment of grains ; seed and granular / powder (e.g flour garri etc).

(iii) Cordage : Twines,ropes,fishing nets, etc.

(iv) Geotextiles : For road stabilisation,erosion control etc.

Other products and applications include :

ETHYLENE OXIDE (EO), ETHYLENE GLYCOL (Monomeg),ETHYLENE GLYCOL (Di-DEG) DEG, ISOPROPANOL (IPA) and POLYESTER CHIPS for the manufacturing of surface - active agents,polyester rasins,fibre and film,antifreezer and coolants, explosives, plasticizers, glues, cosmetics, paints and polishes, polyester bottles and

6.6 PIPELINES

Due to the nature of natural gas liquid,the pipeline is much easier to handle than crude oil. Such gas pipes are turbine propelled from the source.Valves along pipes are made of stainless steel / copper and cast iron. Pipe lines could be laid from the source of the (LNG) to Lokoja where the pipe gets to a river,it is splitted into two with two separating control valves.The pipes are submerged,embedded in the river while the other is left as a spare in case of blokage.After the river has been crossed the pipes are then reconnected to form one main flow till it reaches its destination.

On the arrival of the LNG to the petrochemical plant,it is first piped to the tank farm.from which it is controlled for daily use in the plant.

CHAPTER SEVEN

7.0 THE DESIGN REPORT

Design as defined by Webster Dictionary of English language,is an outline or graphic presentation of a preconceived idea,or plan meant to be built/created/made.Bringing,out an idea from the mind to paper for the purpose of implementing or bringing to reality such idea.

A brief,is what the design entails as desired by the owner.

7.1 BRIEF DEVELOPMENT

In developing this brief there fore,the basic requirements of a petrolchemical plant are considered and the rest deduced from studies on existing plants.

The brief for this project is developed on the premise that this proposal is;

-A private plant to enhance the already existing plants.

-Geographically and strategically located at Lokoja to serve the whole country.

-A smaller plant with limited but specific scope of production.

7.2 SCHEDULE OF ACCOMMODATION

Facilities provided for this plant are deduced from existing plants within Nigeria.The facilities are classified under operations,services and auxillary facilities.

Essentially,space standards arrived at shall be strictly adhered to with adjustments and allowances made where necessary to arrive at the most optimal space allocation

7.2.1 SCHEDULE OF FACILITIES

(a) Operations
- (i) The plants and auxillary units.
- (ii) The control house.
- (iii) Plant utilities.
- (iv) The ware house
- (v) The flare system and waste disposal system.
- (vi) Plant programming unit.

(b) Services
- (i) Administrative offices
- (ii) Conveniencies
- (iii) Public reception

(c) Auxiliary
- (i) Laboratories
- (ii) Clinic
- (iii) Training centre
- (iv) Canteen
- (v) Stores and workshops
- (vi) Bagging unit
- (vii) Fire and safety department

Others are:

(d) Site facilities
- (i) Visitors and staff parking
- (ii) Well landscaped environment
- (iii) Service vehicle parking and circulation.
- (iv) Gate houses.

7.3 DESIGN SCOPE

The scope of this design is limited compared to the existing petrochemical plants,but is also specific in its operations and services.

Basic facilities will be provided to enhance the smooth running of the plant.

Scope of plant is limited to:

-The Ollefins plants and units

-The polimerisation plants and units.

Scope of the plant also depends on the capacity of the plant design.The operations of the plant will be controlled not only from the control room/house but from the programming department.The programming department will design the time / operation of the plant from the tank farm supply of feed stock to expected output at the ware house.

The main consumers of the plant are the plastics fabrication/manufacturing companies.Products (bagged 25kg polypropylene pallets)could be evacuated from ware house by trucks.

Generally,this design proposal will not go beyond what is needed for a petrochemical plant.

7.4 FUNCTIONAL ANALYSIS

These will be considered under the various department that make up the petrochemical plant.Also to be considered is the overall site functional analysis and circulation.The functional relationships of each unit is considered and space requirements is equally given its due consideration.

7.5 DESIGN CONCEPT

The form of industrial and factory buildings are normally guided by elements of functionality because of the use of the buildings.The design should depict a plant, a place of work,

inflow of raw materials,production and products outflow. A place of safety considering the hazzardous nature of petrochemicals.

The plan concept is based on an integration of functionality and circulation.These are arranged to achieve a flow that are inter-related.

The site concept is based on zoninig in plan.Site planning in its narrow sense involves the disposition of space for appopriate uses;the positioning of structures to provide effective relationship (well proportioned masses with attractive outlooks and good orientation);the provision of access to structures in an expenditious,attractive and safe manner;the design of the services,walkways,streets,parking facilities drainage,and utilities;the preservation of the natural advantage of the site and its enhancement by land scaping.

Zoning on site aims at basically achieving a layout that creates a sensible relationship of facilities within the complex and also with the site in general.Due to the hazzardous nature of petrochemicals,the site is zonned in safety proportions,still well spaced to achieve function since each structure on site need the other.

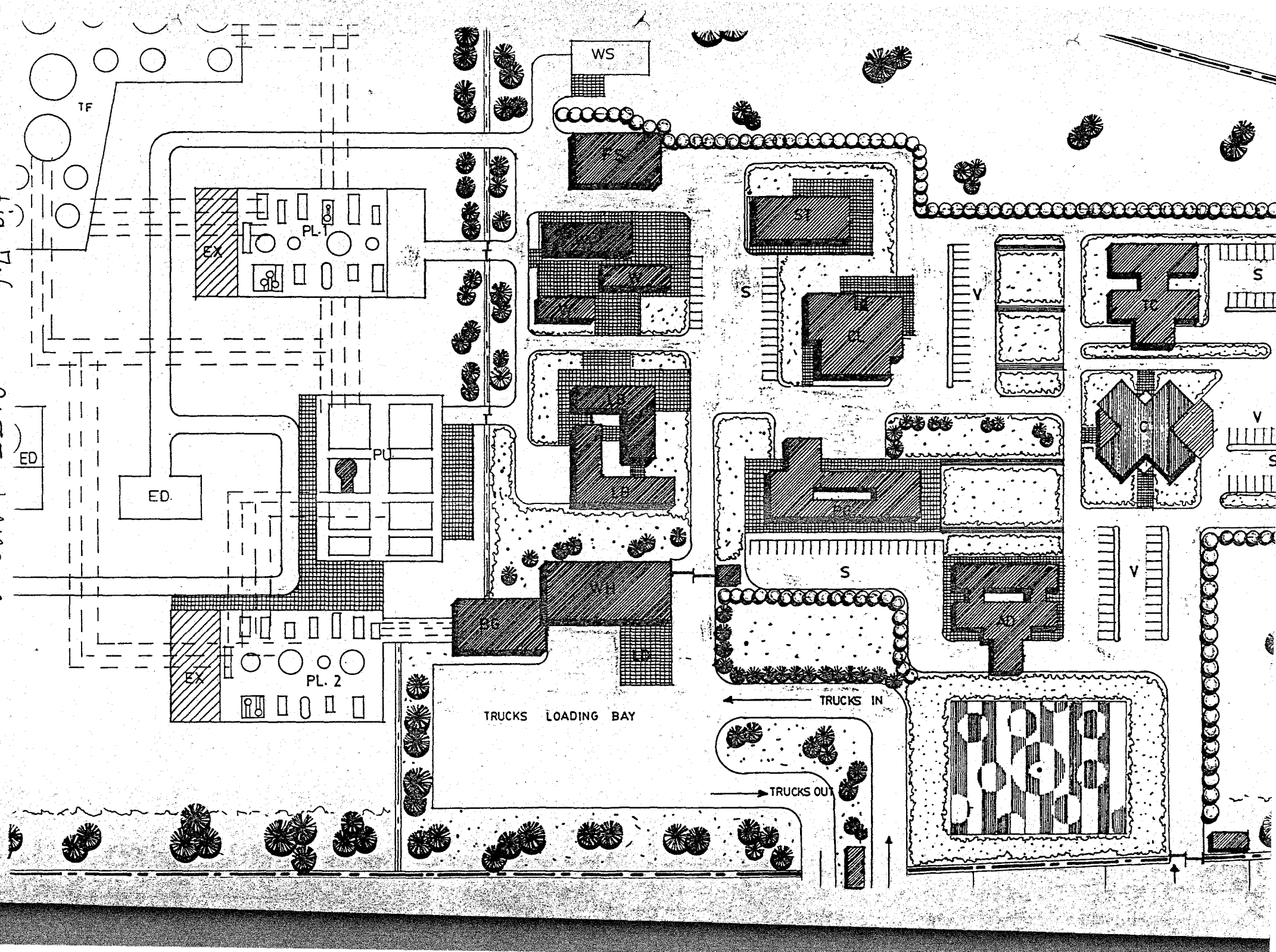


Fig 7.6. SITE LAYOUT

CHAPTER EIGHT

8.0 THE BUILDINGS AND STRUCTURES

Open,structural steelwork,buildings are normally used for process equipment;closed buildings are only used for process operations that require protection from the weather,and other activities and services.For the plant,the arrangement of the major items of equipment will usually follow the sequence given on the process flow sheet;with the columns and vessels arranged in rows and ancillary equipment,such as heat exchangers and pumps,positioned along the outside.

8.1 CONSTRUCTION

- Pieces to be assembled.
- Modular implication
- Connections and joints;method of fastening required (mechanical,welded,adhesives)
- Equipment and tools required
- Place of assembly:on site or at the factory.
- Standardization of parts and prefabrication
- Erection process (work coordination, erection time,workmanship requirements).

The construction assembly:

- control of flow
- heat,thermal conductivity,resistance reflectivity.
- thermal expansion characteristics.
- air infiltration and ventilation

- water vapour,condensation and control

- liquid permeability
  :water roofing/damp roofing

Form and overall requirement.

- construction depth and width

- accommodation of mechanical equipment,distribution and supply systems.

Factors to be considered before design and construction include the following:the site,cost,construction techniques,materials services,function and aethetics etc.

SITE

The site should have ageographical location for its valid existence.One would have to carry out careful studies on the sites' topography,its bearing capacity,orientation,climatic conditions and peripheral conditions.Other inventions on the adjourning site,existing features on site,the size of the site etc.

These factors affect the choice of a buildings structural system,material and construction.The correct siting of a building can also help to control natural light,heat,view,noise and other environmental elements by providing the buildings and occupant with access to desirable elements and absorbing or shielding them from undesirable elements.

SOIL

Practically, all buildings depend on soil for their ultimate support.Their structural intergrity is dependent on the soil type and its strength under loading.A soil strength under loading is dependent on its resistance to shear,a function of its internal friction and cohesion.The measure of a soil strength is its compressibility or bearing capacity in kilogrammes per square metre.

FOUNDATION

The foundation system of a building and its superstructure, is a critical link in the transmission of building loads down to the ground.Bearing directly on the soil,the foundation system should not only distribute vertical loads,so that settlement of the building is either negligible or uniform under all parts of the building;it also has to anchor the superstrucure of the building against uplift and racking forces.

It must be understood that the choice of foundation system and material affects and is affected by the soil which supports the building as well as the potential form of the superstructure.

Foundation design considered in this project include:the site topography,the design building form and structural system.

The plant, the warehouse and utilities have their own `unique'special requirements for foundation.This will be carefully considered because of the nature of equipment that will be hosted on these foundations.This will be accompanied by suitable floors and floor finishes for the safety,functional and aethetic requirements.

WALL SYSTEMS

The control room will have a special interior and exterior treatment knowing the nature and sensitivity of plant control gadgets such fittings and wiring will be done with utmost precision and safety.

DOORS AND WINDOWS

Safety doors and windows would be provided for the control room,laboratories,programming unit and fire station.

Other windows in the other buildings would be basically glass in aluminium frames prefarably sliding windows.The doors will depend basically on the function of the interior space.For instance the laboratories,control interior,programming house, workshops and clinic will have double swing doors to allow involvement of workers and machinery.

Other areas of emphasis include expansion joints were necessary,roofs and ceilings with appropriate finish and treatment.The plant is basically outdoor not roofed.

DRAINS

Floor drains should be wide ,and deep,and have even fall so that water cannot remain in them.They should be covered with metal grating (checker-plate) which should be level and flush with the floor,and can also be removed for cleaning purposes.Roof drains,include gutters to drain water and in some cases piped down to the surrounding sutter for onward flow.

8.2 MATERIALS

Construction materials will include a wide range of the following: concrete,steel iron,aluminium,brick stone, paints, panels, timber etc. Materials basically depend on the following factors:

(i) structural properties

(ii) form and dimensional characteristics

(iii)visual properties:colour,pattern,texture

(iv) durability:resistance to:
- physical abrasion and wear
- the element:sun,wind and water
- corrosion by chemical action of moisture.

(v) finish and maintenance requirements.

(vi)physical properties of:
- weight and density
- thermal expansion
- permeability
- fire resistance
- acoustical valve.

(vii) Method of manufacturing,supply and installations.

FINISHINGS

Elements used to provide the finish skin to exterior and interior surfaces,both vertical and horizontal.

Exterior wall surfaces must be weather resistant ,durable and relatively maintainance free.

Interior walls should be wear resistant,and cleanable;floors should be safe (nonslip) and durable against trffic wear;ceilings should be maintainance free.

Interior walls should be wear resistant, and cleanable; floors should be safe (nonslip) and durable against traffic wear; ceiling should be maintainance free.

The strength of a finished material depends on its stiffness and brittleness and the rigidity of its backing, wheather a planner or a network of thin framing members.

The modular characteristics of a finish materia may indicate the dimension of a wall, floor or ceiling surface. As such due consideration should be given to finish materials in terms of acoustics, thermal and fire resistance, function and aethetics.

For usual appearance, all finish materials should be considered in terms of their colour, texture pattern, scale, modular characteristics and their jointing and edge conditions.

Acoustical tile ceiling may be suspended to provide pleum space for mechanical duckwork, electrical duckwork/conducting, plumbing and ressed light fixtures. The depth of the pleum may vary according to the space requirements of the utilities and the required floor to ceiling height of the interior.

8.3 SERVICES

Mechanical and electrical systems affect human health, safety and comfort, as well as building form and construction.As such, due consideration should be given to the possiblities of accidents, proper working conditions (successful operations) and integration into a total buiding system.

Plant Utilities

The word " utilities " is now generally used for the ancillary services needed in the operation of any production process.These services will normally be supplied from a central site facility ; and it will include the following :

(i) Electricity ;motor drives, lighting and general use.
(ii) Steam ; for process heating.
(iii) Cooling water ; natural and forced - draft cooling towers
(iv) water for general use ; local mains supply ; nearby river

(v) Demineralised water ; from which all minerals have been removed by ion - exchange used where pure water is needed for process use.
(vi) Refrigeration : for processes requires temperatures below those that can be economically obtained with cooling water.
(vii) Compressed and Inert gases ; for general use, pneumatic controllers for chemical process plant control, for blanketting of tanks for purging e.g. Nitrogen.
(viii) Effluent Disposal : Facilities will be required at all sites for disposal of waste materials with a central waste control unit without creating a public nuisance.

Waste Mnanagement.

Waste arises mainly as by products or unused reactants from the process, or as off - specification products produced through mis - operation.There will also be fugitive emmissions from leaking seals, and flanges, and inadvertent spills and discharges through mis - operation.In emergency situations, material may be discharged to the atmosphere through vents normally protected by bursting discs and relief valves.

The designer must consider all possible sources of pollution and where practicable, select processes that will eliminate or reduce (minimise) waste generation.

When waste is produced, processes must be incorporated in the design for its treatment and safe disposal.The following techniques can be considered :

(i) Dilution and dispersion.

(ii) Discharge to foul water server

(iii) Physical treatment : scubbing, settling, absorption and adsorption.

(iv) Chemical treatment : activated sludge and other processes.

(v) Biological treatment : activated sludge and other processes.

(vi) Land fill at controlled sites.

Noise

Noise can be a serious nuisance in the neighbourhood of a process plant.Care needs to be taken when selecting and specify equipment such as compressors, air cooler fans,induced and forced draft fans for furnaces, and other noisy plant.Excessive noise can also be generated when venting through steam and other relief valves, and from flare stacks.

Such equipment should be fitted with silencers.Vendor specifications should be checked to ensure that equipment complies with statutory noise level ; both for the pretection of employees,as well as for noise pollution considerations. Noisy equipment should as far as practicable,be sited well away from buildings. Earth banks and screen of trees can be used to reduce the noise level perceived outside the site.

8.4 AESTHETICS AND GENERAL APPRAISAL.

" Aesthetics deals with ideas and concepts that are fundamental in the cration of a work. It also deals with descriptive attempts to solve visual, mental and sensual issues concerned in a work ". (Anthony C. Anthoniades,1981)

Aesthetics inquiry helps us to understand what kind of feelings are created by our design.The aesthetics of this work is to be looked at from the following points of view :

- The general site layout arrangement.
- The plan arrangement
- The elevations.

The site is planned basically to allow circulation, safety and buildings positioned and orientated to suit sunrise and sunset.Trees, shrubs, grasses and flowers are used to beautify the overall landscape.

The buildings and the landscape are designed to be a single architectural development of the site. Here elements of landscape are conceived as architecture and elements of architecture as landscape.

General Appraisal

In designing this petrochemical plant,an attempt was made to create an environment that is not confusing, the whereabout of workers and users directed by the flow of functions and safety.

8.5 CONCLUSION

The architecture at play here is a work of synthesis in which possible solutions (elements) were put together in a way that constituted a new statement.

The effort is believed to bring quality and efficiency to the Nigerian Petrochemical Industry.

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