DESIGN PROPOSAL

FOR

LOW COST HOUSING ESTATE YENAGOA, BAYELSA STATE WITH EMPHASIS ON EFFECT OF WATER ON BUILDINGS

M.TECH. THESIS (ARCHITECTURE)

BY

BERENA THERESA
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DECLARATION

I, Berena Theresa (Miss) of the Postgraduate school, Department of Architecture, School of Environmental Technology, of the Federal University of Technology Minna, hereby declare that the research project entitled '**LOW COST HOUSING ESTATE YENAGOA, BAYELSA STATE, WITH EMPHASIS ON EFFECT OF WATER ON BUILDINGS**' is a product of my research work under the supervision of Arc J.U Aniya, my supervisor. All information utilized and their sources have been duly acknowledged by the way of reference.

BERENA THERESA (MTECH/1046/2003/2004)

CERTIFICATION

This is to certify that this research project entitled **'LOW COST HOUSING ESTATE YENAGOA, BAYELSA STATE WITH EMPHASIS ON EFFECT OF WATER ON BUILDINGS'** is an original work undertaken by Berena Theresa (Miss) (MTECH/SET/1046/2003/2004) under the supervision of Arc J.U Aniya, and has been prepared in accordance with the regulations governing the preparation of the award of Masters of Technology degree in the Department of Architecture, Federal University of Technology, Minna.

BERENA THERESA
Candidate

Berens 7-02-05
Date / Sign

Arc J. U. ANIYA
Project supervisor

07/02/05
Date / Sign

DR. S. N. ZUBAIRU
Head of Department

12/4/05
Date / Sign

External Examiner

Date / Sign

Dean, Postgraduate school

Date/ Sign.

DEDICATION

You can have more than one brother, sister, uncle, aunt, cousin, niece, nephew, or relation, but you can never have more than one set of parents. This research project is dedicated to my dear parents, Mr. and Mrs. B.J Berena, who believe that the greatest gift a child can receive is a sound education.

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I would first and foremost like to thank God Almighty who in my weakness gave me strength and grace to do all things and continues to shower me with blessings. I wish to acknowledge with great appreciation, the assistance of the persons who where of great help and aided me in one way or the other in making my project a reality.

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ABSTRACT

Housing development and delivery in Nigeria has been through many stages and has produced various results over the years. However the effects have not been felt as housing demands increase steadily every year. With rapid urban growth due mostly to rural urban migration as well as rising birth rate and decreasing death rates, the need for housing cannot be overemphasized. The truth about housing is that its availability and quality contributes to human health and also a measure of environmental quality.

Water, with all its uses and benefits, has however become a problem in residential areas, causing damage to the structures and property within. Efforts have to be made to resolve this problem. This thesis aim to identify the effect of water on buildings, to identify sources and means of moisture penetration in buildings and prefer preventive measures. Thereby providing qualitative housing that is comfortable, affordable and durable.

The research methodology utilized in this research included the historical method and descriptive survey.

The importance of proper planning as well as implementation cannot be overemphasized as proper planning considerations should be given to housing schemes in Nigeria especially in the wet-zone of Nigeria.

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CHAPTER ONE

1.0 INTRODUCTION

Shelters have always been one of the basic necessities of life-from caves in the Stone Age to the masterpieces in present day to satisfy great need for comfortable shelter.

The central position that housing occupies makes the demand for it a universal demand, universal because it is a basic requirement for all. The truth about housing is that its availability and quality provide some leavers to other sectors of the economy. Not only does it contribute to human health it is environment related and so it provides a measure of environmental quality it is said that access to safe and healthy shelter is essential to a persons physical, psychological, social and economic well being and should be a fundamental part of national and international action.

The increase in demand for housing through current rapid urban growth could be translated into favourable investment climate for shelter. While it is tempting to regard these vales of urbanization as a problem, they could also be viewed as an opportunity to increase employment and the efficiency of housing supply mechanisms to the benefit of both the working people and the economy as a whole.

Bayelsa state is one of the states created in 1996. Since its creation, there has been a high demand for office and residential accommodation within the capitals city. Unlike other states in the Federation where structure can be constructed on the existing terrain,

Bayelsa state is characterized by swampy terrain. Thick mangrove forests, seasonal flooding and an intricate network of rivers and creeks, which pose a development nightmare.

With the development challenges in the state, it has become necessary for the government to provide qualitative and affordable housing for its population.

1.1 AIMS OF STUDY

i To provide affordable shelter for average and low-income earners.

ii To create a close knit environment, which encouraged interaction between residents

iii To create awareness of the need for good health and sanitary conditions within residential areas.

iv To provide housing facilities that satisfies comfort conditions

v To bring attention to the need to promote proper housing settlements and development schemes.

1.2 RESEARCH METHODOLOGY

The research methodology adopted was based on descriptive survey. This involved the observation and collection of data from existing infrastructure

A detailed study of existing housing schemes in the country was carried out. Also research existing journals, textbooks and publications on the Internet.

1.3 SCOPE OF WORK

This thesis shall focus on the areas concerned with housing units and other related facilities:

i. **2 bedroom-housing units**

ii. **3 bedroom-housing units**

iii. **4 bedroom-housing units**

iv. **Lettable shops**

These are to be provided for small-scale commercial activities within the estate.

v. **Health care facility**

Thesis will be provided for health care services within the estate

vi. **Recreational Facilities**

Recreational facilities such as play grounds and public courts will be provided. This will serve as a place of interaction between youths, children and adults within the estate.

vii. **Security post.**

1.4 LIMITATION OF STUDY

In the course of data collection some problems were encountered. These include:

i Inaccessibility of the site layouts and building drawings for housing estates visited

ii Original design of building within some estates had been altered

1.5 IMPORTANCE OF STUDY

With the present trend of urban growth and development, it has become important for various governments to provide shelter for their citizens. The high rate of inflation which influences the cost of materials and eventually the total cost of construction poses a problem to housing delivery for low income earners who cannot afford the high cost of houses presently.

It is hoped that this study will draw attention to the following:

i The need to adopt cost effective construction methods

ii To encourage the use of local building materials

iii To improve the quality of housing provided for low income earners

iv To shift attention of housing delivery from just civil servants to the general

public.

1.6 DEFINITION OF TERMS

Bryophyte (*plural* **bryophytes**) *n*

Nonflowering simple plant: a nonflowering plant, often growing in damp places, that has separate gamete-bearing and spore-bearing forms. Mosses are bryophytes

Cretaceous *adj* **chalky:** resembling or consisting of chalk (*technical*

Delta (*Plural* **deltas**) *n* **geography triangular land area at river mouth:** a triangular deposit of sand and soil at the mouth of a river or inlet

Epiphyte (*plural* **epiphytes**) *n* **Plant that grows on another:** a plant that grows on top of or is supported by another plant but does not depend on it for nutrition.

Mosses, tropical orchids, and many ferns are epiphytes

Exacerbate (*3rd person present singular* **exacerbates**, *present participle* **exacerbating**, *past* **exacerbated**, *past participle* **exacerbated**) *vt* **make worse:** to make an already bad or problematic situation worse

□ Her *silence merely exacerbated the problem*

Caulk *or* **calk** *vt* (*3rd person present singular* **caulks**, *present participle* **caulking**, *past* **caulked**, *past participle* **caulked**) (*3rd person present singular* **calks**, *present participle* **calking**, *past* **calked**, *past participle* **calked**) **make boat watertight:** to make a boat or the seams between its planks watertight by filling the seams with waterproof material, for example pitch

stop something up: to stop up the cracks or gaps in something, for example a pipe or a window frame, with a waterproof material

Something used to fill gaps: material used to make a boat watertight by filling in its seams, or to stop up the cracks or gaps in something. *Also called* caulking

Plug [plug] *n* (*plural* **plugs**) **filler for a hole:** something used to fill and tightly close up a hole

Damp course (*plural* **damp courses**) *n* **Waterproof layer in brick wall:** a layer of waterproof material near the ground in a brick wall that prevents damp from rising. *Also called* damp-proof course

Hygroscopic *or* **hygroscopical** *adj* **Absorbing moisture:** capable of easily absorbing moisture, for example from the air

Stucco *n* **Wall plaster:** plaster used for surfacing interior or exterior walls, often used in association with classical mouldings

Masonry *n* **mason's trade:** the trade of a mason, **stonework:** the stone or brick parts of a building or other structure

Capillary action *n* **Attraction of liquid surface to solid:** a phenomenon in which a liquid's surface rises, falls, or becomes distorted in shape where it is in contact with a solid.

It is caused by the difference between the relative attraction of the molecules of the liquid for each other and for those of the solid.

Suction *n* **force created by pressure difference:** physical force created by a difference in pressure such as that caused by sucking a liquid through a straw

Condensation *n* **conversion of gas to liquid:** the process by which a vapour loses heat and changes into a liquid

Film of water droplets: tiny drops of water that form on a cold surface such as a window when warmer air comes into contact with it

Plasticity *n* **ability to be moulded:** the condition of being soft and capable of being moulded

Spandrel (*plural* **spandrels**) *or* **spandril** (*plural* **spandrils**) *n (i)* **space between one arch and another:** the triangular space between the right or left exterior curve of an arch and the framework of another arch

(ii) Space between two arches and cornice: the area between two arches and a horizontal cornice above them

Damp-proof *adj* **resistant to moisture:** impervious or resistant to damp or moisture

vt (*3rd person present singular* **damp-proofs**, *present participle* **damp-proofing**, *past* **damp-proofed**, *past participle* **damp-proofed**)

Make resistant to moisture: to make something such as a building damp-proof

Flashing *n* **metal making roof joints waterproof:** pieces of sheet metal attached around the joints and angles of a roof to protect against leakage

Rising damp *n* **damaging moisture absorbed by walls:** moisture that is absorbed from the ground into walls, resulting in structural damage

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 DEVELOPMENT OF HOUSING POLICIES AND PROGRAMMES IN NIGERIA.

The period of development of housing policies in Nigeria can be divided into two periods. These periods are; the period of passive commitment and the period of active commitment.

2.1.1 PERIOD OF PASSIVE COMMITMENT

This covered the pre-independence housing policies and the post independence policies till 1975. The first housing programme in Nigeria was said to be through the establishment of the Lagos Executive Development Board (L.E.D.B) in 1928. It was established in response to out-break of two epidemics in Lagos. The first was the out-break of influenza in about 1919 while the second was the outbreak of bubonic plague in 1924. These two epidermises were traced to overcrowding and poor housing conditions.

In 1954, the Board attempted to solve the problems of housing and undertook some housing development progammes and site and services schemes at Apapa, Ikoyi, Ilupeju and Surulere. The LEDB experiment encouraged the regional governments to establish housing corporations. The first was established in 1958. That of the Eastern Nigeria and

participating in the provision of housing for all income groups. It identified the importance of housing and its impact on the health, welfare and productivity of individuals. The aim of the Third National development Plan was to achieve a significant increase in the supply of housing and bring relief to the low income groups who are the worst affected by shortage.

2.2 THE NATIONAL HOUSING POLICY OF NIGERIA, 1991

2.2.1 GOAL

The ultimate goal of the National Housing Policy is ensure that all Nigerians own or have access to decent housing accommodation at affordable cost by the year 2000 A.D

2.2.2 OBJECTIVES

i Encourage and promote active participation in housing delivery by all tiers of government.

ii Strengthen institutions within the system to render their operations more responsive to demand.

iii Emphasize housing investments, which satisfy basic needs.

iv Encourage greater participation by the private sector in housing development.

2.2.3 STRATEGIES OF IMPLEMENTATION

i Establishment of appropriate institutional framework to facilitate effective planning in housing development.

ii Restructuring of existing public institutions involved in housing delivery at the Federal and State government levels with a view to making them more effective and responsive to the needs of Nigerians.

iii Revival of existing laws and regulations such as land use Decree, Planning laws etc. in order to facilitate housing delivery.

iv Mobilization of private sector participation in the provision of housing.

v Improvement of Finances and empowerment of local Governments to enable them contribute more effectively in housing delivery.

vi Production and update of Regional Development plans and urban and Rural Master Plans.

vii Up date of low quality houses in urban areas as a step towards improving the quality of the environment.

viii Provision of sites and services to facilitate home ownership and orderly urban and rural development.

ix Improvement of the quality of rural housing, rural infrastructure and environment.

x Restructuring of the Federal Mortgage Bank of Nigeria to serve as an Apex housing Finance institution.

xi Mobilization of savings through the establishment of a National Housing Fund.

xii Ensuring continual flow of funds from various sources into Apex Institution for on lending to other mortgage institutions.

xiii Encouragement of Research into and promotion of locally produced building materials as a means of reducing cost of housing.

xiv Adoption of functional designs standards to reduce cost and enhance socio-cultural acceptability, safety and security.

xv Increasing the quantity and improving the quality of man power needed in the housing sector.

xvi Utilization of housing location as an instrument for a balanced population distribution in order to minimize associated problems of transportation and services.

xvii Ensuring the preparation of a National Housing Plan to Spell out the details and strategies for achieving the objectives of the housing policy.

2.2.4 INSTITUTIONAL FRAMEWORK FOR HOUSING DELIVERY

Institutional framework forms the basis of the entire housing delivery system and as such greatly influences the success of housing delivery. Institutional roles begin at the initial stages of the policy development and continue through the implementation and review stages.

Given the socio-economic and political significance of housing and housing facilities all the three tiers of government in the country must be involved and assigned specific roles in housing delivery.

2.2.5 FUNCTIONS OF THE FEDERAL GOVERNMENT

i The Federal Government shall initiate, define and coordinate the policy options an instrument for achieving the objectives in the housing sector while the actual implementation shall be undertaken by appropriate agencies at the Federal State and local Government Levels.

ii The Federal Government shall formulate policies, to coordinate construct and monitor housing programmes.

2.2.6 FUNCTIONS OF THE STATE GOVERNMENT

Each state shall formulate its housing policy and programmes in line with the overall National Housing Policy. The state Governments shall perform the following functions:

i Establishment of appropriate agencies to execute public housing programmes.

ii Establishment of State committee of National Housing Facilitation council as provided for in the Employees Housing Scheme, Decree 54 of 1979.

ese projects, though commendable, seem to focus on senior and vel civil servants leaving out the low income earner who is not y a civil servant.

OBLEMS OF HOUSING DELIVERY IN BAYELSA STATE

pid urbanization and population growth as a result of rural-migration

nature of terrain

cost of developing infrastructure

3.6 RECOMMENDATION

The first step to providing affordable housing is for the government o make available for development serviced land, that is, provision of good access roads, proper drainage, electricity, and water among other facilities.

The government should also use the services of the professionals employed by the ministries to execute projects. This will reduce the need for employing contractors who are out to maximize profit. These professionals such as architects, engineers, land surveyors, quantity surveyors should be engaged to carry out design of housing projects and also supervision of construction works. They can also research into building materials and ways of reducing construction cost.

There should be collaboration between government and host unities of these housing schemes. Such communities could provide

CHAPTER THREE

3.0 RESEARCH AREA

EFFECT OF WATER ON BUILDINGS

3.1 INTRODUCTION

Water, common name applied to the liquid state of the hydrogen-oxygen compound H2O. The ancient philosophers regarded water as a basic element typifying all liquid substances. Scientists did not discard that view until the latter half of the 18th century.

A water molecule consists of an oxygen atom and two hydrogen atoms, which are attached at an angle of 105°. Each hydrogen atom possesses a pair of electrons that are not involved in bonding to the oxygen atom.

3.2 PROPERTIES

Pure water is an odourless, tasteless liquid. It has a bluish tint, which may be detected only in layers of considerable depth. Under standard atmospheric pressure (760 mm of mercury, or 760 torr) the freezing point of water is 0° C (32° F) and its boiling point is 100° C (212° F). Water attains its maximum density at a temperature of 4° C (39° F) and expands upon freezing.

Water is the only substance that occurs at ordinary temperatures in all three states of matter, that is, as a solid, a liquid, and a gas. As a solid, or ice, it is found as glaciers and ice caps, on water surfaces in winter, as snow, hail, and frost, and as clouds formed of ice crystals. It

occurs in the liquid state as rain clouds formed of water droplets, and on vegetation as dew; in addition, it covers three-quarters of the surface of the Earth in the form of swamps, lakes, rivers, and oceans. As gas, or water vapour, it occurs as fog, steam, and clouds.

3.3 THE HYDROLOGICAL CYCLE

Whenever it rains, the water is part of the way along its circular journey from the ocean to the land and back to the ocean. This intricate cycle, which encompasses the whole globe, is the most important environmental system on Earth. Without it, all of our continents would become dry, lifeless deserts.

The hydrological cycle is what is known as a closed system because there are no external inputs or outputs of water to or from the system. The same water has been continually circulating since the beginnings of life on Earth.

The Sun's heat drives the hydrological cycle. As wind blows across the surface of the ocean, this heat causes water to evaporate from the sea and become absorbed into the air as water vapour—the amount absorbed depends on the temperature of the water. If the ocean is dominated by a cold current very little evaporation will take place. This is why the continental regions next to these cold currents are dominated by deserts. Conversely, if the ocean is dominated by a warm current the air becomes highly saturated with water.

The water vapour in the atmosphere forms clouds. These clouds are blown across the land, and forced upwards by hills or mountains, or by two air streams meeting and pushing them upwards. Cooler temperatures higher up cause the water vapour to condense and fall to the Earth as rain, snow, sleet, hail, or frost. This is called precipitation. Some of the falling water is intercepted directly by trees and plants. Much of it infiltrates into the soil and is drawn up through the roots of plants. This water helps the plants to grow, and any excess is drawn out of the leaves and back into the atmosphere by a process known as evapotranspiration.

Rainwater that is not used by plants runs through or over the surface of the soil until it reaches a river. Water that runs over the surface is called surface runoff. Through flow is water that moves through the soil, and water that infiltrates further to the water table is called groundwater flow. Eventually the water in the river flows back into the sea and the cycle begins again.

3.4 MOISTURE PENETRATION IN BUILDINGS

Buildings at one point in time or the other are exposed to various sources of moisture. These include rain, groundwater, and water from default plumbing. This finds its way into buildings through cracks, weak joints and it is aided by gravity, wind pressure, air pressure and capillary action.

3.5 RAIN PENETRATION OF WALLS OF UNIT MASONRY

In many parts of Nigeria heavy wind-driven rains occur periodically and it is not uncommon in such storms for the rain to strike the wall of a building and pass through to the interior. This has happened in many buildings of unit masonry with walls of brick, stone, or block and the result has been not only inconvenience to the occupant, but a condition that often is difficult and expensive to correct, and which may lead to premature decay of the materials.

3.5.1 FACTORS INFLUENCING MOISTURE PENETRATION IN WALLS.

The problem of rain penetration of unit masonry walls, like many other problems in building, has a long history. In many countries the wide-spread use of renderings such as stucco on unit masonry walls indicates that rain penetration is a problem. Several factors have a bearing on the problem:

i the degree of exposure of a building is important; low buildings or those in sheltered locations obviously are less likely to be affected

ii the properties of the masonry materials used, that is, absorptivity of masonry material

iii the care with which the masonry was designed and constructed also has an important influence on the resistance to moisture penetration.

3.5.2 MEANS OF ENTRY OF RAIN

During a rain storm the air pressure at the outside surface of the rain-wetted wall is usually higher than that at the inside surface. The rain falling on a wall is forced through the wall by this pressure difference, provided that there are pathways within the units and mortar, or between them, which the water can follow, and provided that the storm lasts long enough for the water to reach the inside of the wall. In low buildings (two stories or under) much protection from rain is derived from a wide overhanging roof; this is therefore a valuable feature. In higher buildings the amount of protection afforded by such a roof is less, and it probably should be expected that regardless of the type of roof some part of the wall of a high building will be wetted in a storm.

"Structural" cracks in masonry walls, caused by differential movements of parts of the building, are a means of entry of rain into the

wall. Another means, which is frequently more important, is penetration through masonry which is free of structural cracks, but which contains unbonded areas between unit and mortar.

In most instances of rain penetration of brick walls leakage takes place between the brick and the mortar; only under unusual circumstances does rain pass through the brick or through the mortar. The same situation usually applies to stone masonry. Even when water is available and an opening exists, leakage will not occur unless a force or combination of forces is available to move the water through the opening. The forces contributing to rain penetration are kinetic energy of the rain drop, capillary suction, gravity and air pressure differences.

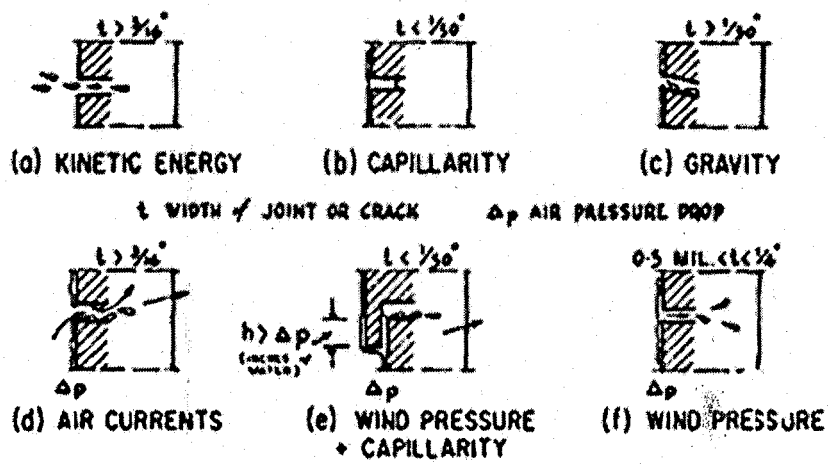

Figure 3.1 Forces producing rain penetration.

In some other cases, however, units are used which are sufficiently permeable to moisture that when exposed in a wall to heavy rain, leakage takes place through the units. With such highly permeable units, therefore, it is customary to apply stucco or other rendering to ensure resistance to rain penetration.

3.5.3 LACK OF BOND IN BRICK MASONRY

Unbonded areas between brick and mortar, which usually are the cause of leakage in brick walls, may result from faulty construction techniques in which insufficient mortar is used to form the joint, or from an unsuitable combination of brick and mortar. In the latter case a "tight" bond between the brick and mortar is not obtained when they are brought together in the construction of the brickwork. The bond that develops between brick and mortar depends on their properties, in particular the rate of water absorption (or "suction") of the brick and the water retention property of the mortar. When placed on a high-suction brick, mortar quickly loses its moisture to the brick and becomes stiff and non-plastic. This change in the mortar may take place before the next brick can be set in the mortar bed, in which case the mortar is not sufficiently plastic or "adhesive" to bond well with the brick. Some mortars resist loss of moisture better than others. Such mortars may remain plastic long enough so that good bond is developed when the next brick is placed in the mortar.

The interaction of brick and mortar when they are brought together in the construction of the brickwork therefore determines the completeness of the bond between them. If the bond is incomplete, rain penetration through the unbonded areas is a possibility.

Damp conditions on the surface of walls, particularly in conjunction with condensation, allow the growth of moulds both on the

surface and within porous or fibrous materials, such as wallpapers or carpets fitted against the base of the wall. Not only is this aesthetically unacceptable and damaging to finishes, but it can be a significant health hazard to occupants. Where evaporation takes place, the deposition of soluble salts on the surface or within the pores of materials can cause aesthetic and structural damage.

3.6 REMEDIATION

3.6.1 IMPROVEMENT OF BOND

Since the bond between brick and mortar is so important to the "tightness" of the wall, everything possible should be done in the construction of brickwork to obtain an intimate contact between brick and mortar, with no unbonded areas at the interface. If, for example, bricks with a high suction value are to be used (by the standard test, more than 25 grams of water absorbed when the brick's bedding surface is dipped in water for one minute), the bricks should be wetted before they are laid. This reduces the suction and so produces a better condition for bonding with mortar. Similarly, with high-suction bricks, it is best to use a mortar of high water-retention value, i.e., of high capacity to resist loss of moisture to an absorbent brick. To achieve as good a bond as possible, any mortar should be used as wet as possible; mortar of stiff consistency when laid produces a poor bond with the brick.

The bricklayer's method of constructing brickwork also affects the bond; better bond between brick and mortar is obtained when a short, rather than a long, mortar bed is laid out in advance of the work. In this way, by the time the last brick has been placed, the mortar is still plastic and has good bonding properties, whereas a long mortar bed would have lost its plasticity and the last bricks set in it would be poorly bonded. The bricklayer should not move or shift bricks after they have been set in the mortar since the movement will break the bond between brick and mortar and produce a crack at the interface. Full mortar joints are necessary; incompletely filled joints allow easy penetration of rain.

The resistance of brick masonry walls to rain penetration is improved if the mortar joints of the newly built masonry are tooled to form a concave surface. Other types of mortar joint tooling, or joints which are raked-out or flush-cut, do not provide as much resistance to entry of moisture as that given by concave tooling.

3.6.2 INFLUENCE OF BUILDING DESIGN

Failure in the design of a building to provide for the accommodation of differential movements between its parts may lead to cracking of the masonry. Rain may then enter where the masonry has "opened up" as a result of the stresses placed on it. The cracking of masonry walls in which concrete floor and roof slabs are embedded, for example, has been attributed in many instances to "working" of the

concrete (caused by its initial shrinkage or later movements due to changes in temperature and moisture content), which stresses the adjoining masonry to failure by cracking.

Expansion or contraction of walls may also be a cause of cracking. In the latter case, a familiar example is that of cracking from "drying shrinkage" of the units. Certain types of masonry units shrink an appreciable amount on drying, and if this shrinkage is restrained, severe stresses which lead to cracking may be set up in the wall. The provision of "control" joints may therefore be necessary to accommodate the movements safely.

The combination of unit masonry and the structural frame of a building sets up a difficult situation with regard to the prevention of rain penetration. The thickness of the masonry at columns and spandrel beams is usually reduced and thus is more vulnerable to moisture penetration than the remainder of the wall. In addition, differential movements between frame and masonry are a possible source of cracks in the masonry. A flashing in the wall at spandrel beams, for example, has sometimes provided a "cleavage plane" for the relief of stresses in the masonry resulting in cracking of the wall.

Parapet walls are frequently a source of entry of rain when they have not been isolated from the wall below by proper flashings. If such "damp-proofing" is omitted, rain may permeate the parapet wall and then pass downward into the masonry below. On this account, carefully

installed flashings at the base of the parapet are necessary. In addition, due to the severe weathering conditions to which the parapet wall is exposed, its top and back surfaces should be protected by suitable coverings.

Common sources of leakage can be avoided by providing drains of adequate capacity and by eliminating surfaces adjacent to masonry, which run water onto the masonry. Carefully applied and complete caulking around windows and doors is also necessary for protection against rain penetration. In short, careful design of the building and the installation of proper flashings and caulking are required to ensure satisfactory performance when wind-driven rain strikes.

3.6.3 TREATMENT OF DAMP WALLS

Direct penetration of rain through masonry is only one cause of dampness on the inner surface of a wall. Other causes of dampness are: condensation of water vapour on a cool surface, defective drains or pipes within or near a wall, defective flashings, lack of caulking around wall openings, and the rise of ground moisture into the wall from "wicking" action. The possibility of other causes should therefore be investigated before attempting to correct an existing problem of dampness.

Most of the rain, which penetrates unit masonry, passes through unbonded areas between unit and mortar. These usually cannot be seen and the wall appears perfectly sound. Some penetration may also occur

through the units if they are sufficiently permeable, but the amount is usually small in comparison with the leakage through the interface. To overcome leakage between unit and mortar it is necessary to "plug up" the openings. This may be done by brushing a paste of Portland cement and fine sand into the mortar joints; some of the paste is carried into the openings and closes them. Another method is repointing which requires that the mortar be removed to a depth of about ½ inch from the joints and replaced with fresh mortar tightly packed in the opening so that it bonds well with the units and the original mortar.

Walls of permeable units require treatment additional to that of the mortar joints. The treatment required depends on the permeability of the unit and on the severity of exposure. For units that are highly permeable and in severe exposure condition stucco may be the only treatment that will overcome rain penetration. In other cases, painting the wall or applying a colourless "waterproofer", such as a silicone material, may prevent penetration. These treatments will have to be renewed periodically.

It should be emphasized that an essential part of the treatment for damp walls is the filling of structural cracks, renewal of caulking around windows, and the repair and correction of faulty drains and flashings.

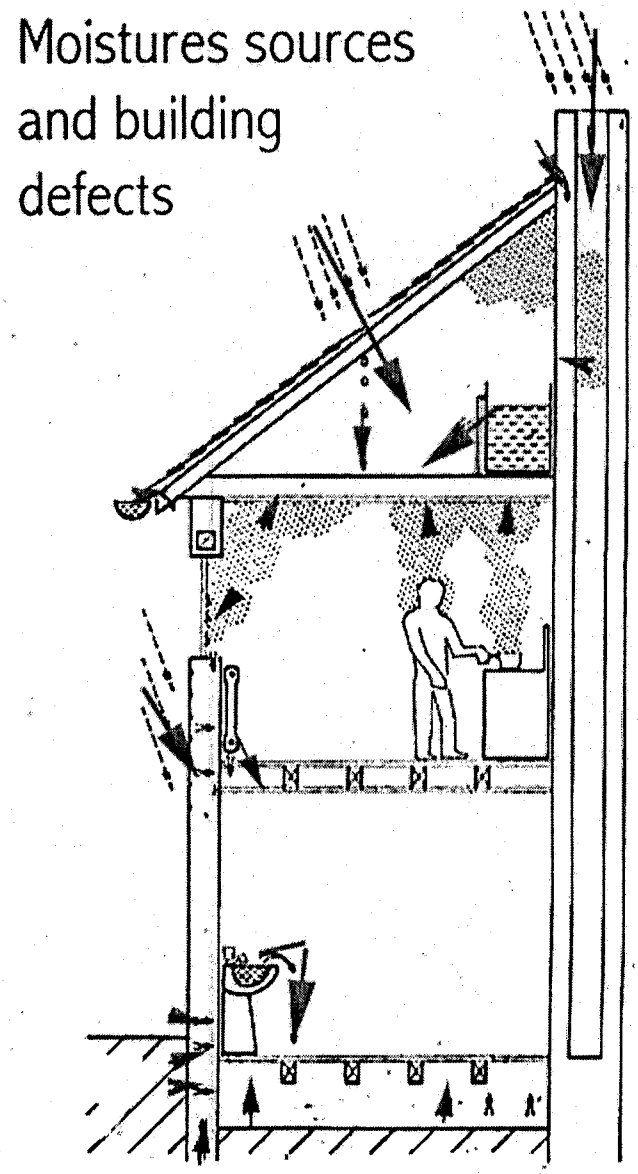

Fig 3.2 moisture sources and building defects

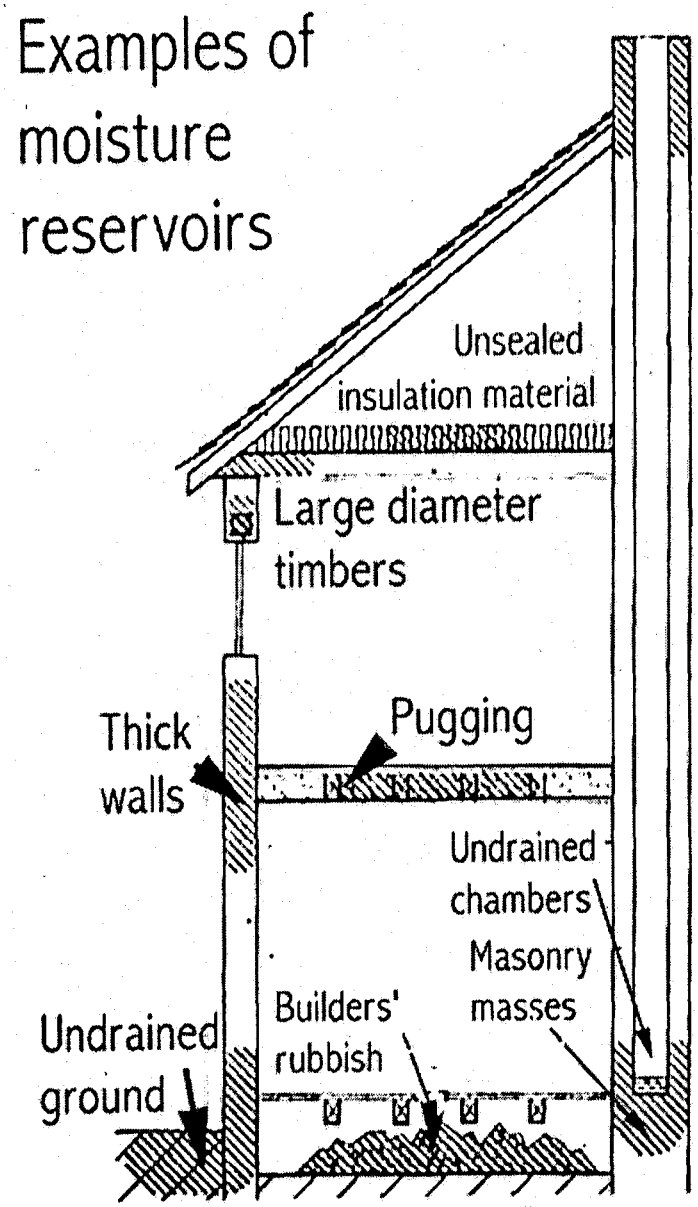

Fig 3.3 moisture reservoirs in buildings

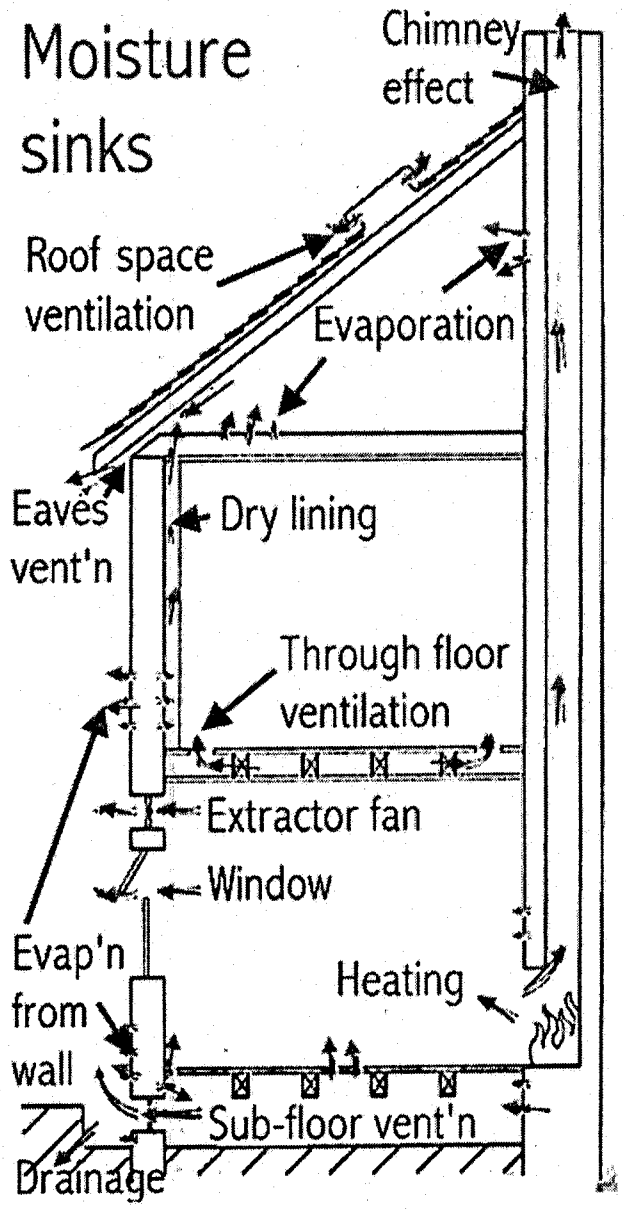

Fig 3.4 Reducing humidity in buildings

3.7 RAIN PENETRATION IN ROOFS

There are basically two types of roof systems namely; low slope roofs and pitched roofs. Both are prone to moisture penetration but in different ways.

3.7.1 LOW SLOPE ROOFS

The elimination of accumulated moisture from the roof's surface is vital to the success of the system. Accumulated moisture must be gone from the roof surface within 48 hours of a rainfall. Standing water that remains beyond this time period poses serious threats to the roof system.

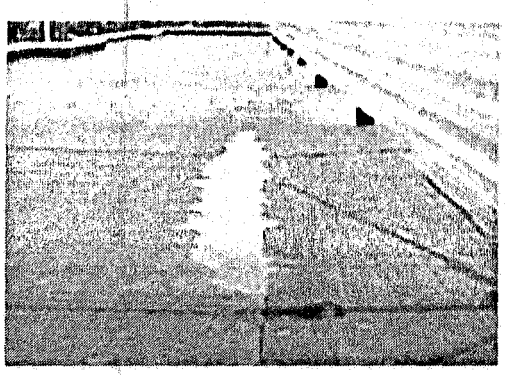

Plate 3.1 Standing water on low slope roof

The most serious (and least likely) consequence is structural damage. Standing water can be deceptively heavy and the added weight of the water causes the roof to exceed the design load, possibly leading to collapse. Structural damage to this extent often occurs after a heavy rainfall on a roof that does not have adequate slope or proper drainage.

A more common consequence of standing water is membrane degradation. Standing water can rot the membrane because it leaches oil from bitumen in asphalt-based roof systems. Once the membrane has been reduced to a vulnerable stage, the possibility of moisture penetrating into the system increases. Moisture intrusion is especially prevalent at all membrane imperfections. Fish mouths, splits, bare

felts, open seams and unsealed felt laps are all areas where water can penetrate into the system. If water is ponded over any of these imperfections moisture will find a way into the system.

3.7.2 PITCHED ROOFS

Moisture penetration is not uncommon in these types of roofs although they are rear and far between. This is basically due to driving rain, which makes its way through joints that are not properly sealed by means of air and wind pressure. Also in roofing systems made of asbestos, cracks may occur due to expansion. These serve as areas of entry. Wear and tear also weakens roof materials and makes them prone to moisture penetration.

3.7.3 ROOF DRAINS

The roof drain area is vulnerable to moisture penetration because of the constant water buildup. The drainage area is the second most common area for roof leaks. Due to this fact, corrective actions should be taken to guard against moisture penetration A common cause of drainage failure is the accumulation of debris that enters the drain and causes a system backup. This can be prevented in a number of ways. The first way is to secure a strainer over the drain to act as a protective covering. The strainer should be fitted to match the drain and strong enough to withstand weathering elements. Annual

maintenance inspections should be conducted to make sure drains are free-flowing and not clogged with debris.

3.8 MOISTURE PENETRATION IN FOUNDATIONS

The most common source of moisture in the base of the walls of buildings is from defective ground and surface drainage. This is present to some degree in almost every building in the country, due to a combination of such factors as rising ground levels, the failure of ground drainage systems, and the increased use of concrete or tar macadam finishes around buildings without proper consideration of drainage slopes. The accumulation of 'moisture reservoirs in the foundations may also arise as the result of chronic plumbing leaks or floods from catastrophic plumbing or drainage defects

Plate 3.2 Rotting of timber skirting caused by rising damp

Damp conditions at the foot of walls may be greatly increased by condensation. This occurs when warm moisture-laden air cools to due

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Plate 3.2 Rotting of timber skirting caused by rising damp

Damp conditions at the foot of walls may be greatly increased by condensation. This occurs when warm moisture-laden air cools to due

point (the temperature at which moisture condenses) against a cold surface. Such cold surfaces commonly occur when the insulation value of the external wall is reduced by water penetration, as described above.

Damp masonry at the base of walls may lead to a number of problems:

The moisture content of the structure may rise to a level at which decay organisms may grow, or the materials themselves may be adversely affected. For example, timber skirting boards along the base of walls may become infected and decayed by dry rot, wet rot, weevils or woodworm. In very damp conditions, the inorganic materials themselves may lose their structural strength. This occurs most spectacularly with walls made of cob (earth) soaked with water.

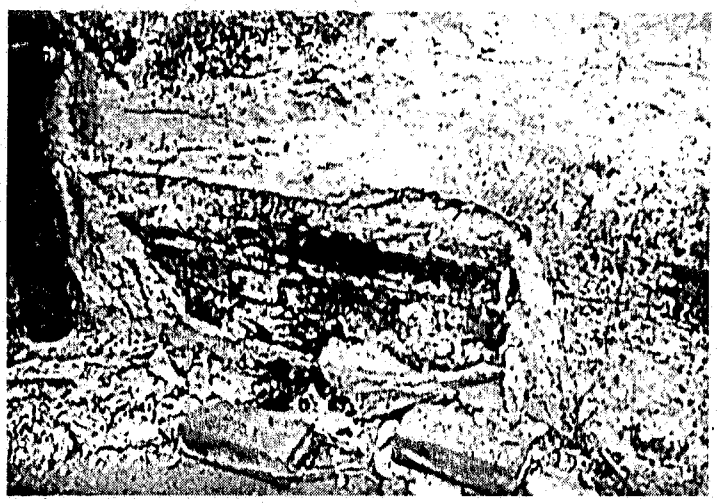


Plate 3.3 Wall damaged by rising damp

3.8.1 REMEDIATION.

The most cost-effective way of preventing damp problems in buildings, including those resulting in damp masonry at the foot of walls, is to minimise moisture sources and provide adequate passive moisture

sinks to dissipate any penetrative moisture so as to make the system fail-safe. This should start with the provision of adequate ground drainage around the building to minimise water penetration to the foundations, and the re-detailing of surface drainage so as to ensure surface water is drained clear of the foot of the walls.

Provide an increased depth allowance around the edges. That is, the depth of the concrete around the edges, depending upon the size of the floor and the topography, should be at least 3 or 4 times the thickness of the main surface. This provides a sort of floating footing at the edges, which also serves to contain the gravel grade under the slab and assist in deflecting moisture away from the gravel bed.

Surface grading sloping away from the house will encourage water to drain away from the structure.

3.9 MOLD IN THE ENVIRONMENT

Molds are a subset of the fungi family and are common, abundant, and an essential part of the world's ecological system. Fungi are found nearly everywhere and are necessary for recycling organic material, which is required to sustain plant and animal life.

Mold spores are airborne and travel into and out of buildings as air is exchanged and with the movement of people and their belongings. Mold grows on wet surfaces and, if left untreated, may eventually release spores into the air. Airborne mold spore concentrations can become unhealthful when large areas are wet for prolonged periods. Resolving

excessive moisture conditions can prevent and minimize mold growth in the indoor environment.

3.9.1 MOLD GROWTH

In order to reproduce, molds release tiny spores just as plants produce seeds. The spores settle on surfaces and, when conditions are favorable, they begin to consume organic material in their immediate vicinity. Molds can grow on cloth, carpet, leather, wood, wallboard, household dust, and on anything that is made of organic material. Sustained mold growth requires moisture, organic material (a food source), and a suitable temperature generally in the range of 40° to 100°F. When one or more of these three conditions are unsatisfactory, the mold colony will become dormant. When favorable conditions are restored, the dormant colony will resume its metabolic activity.

Molds can produce compounds that become airborne along with the mold spores. A toxic substance called mycotoxin can cling to the surfaces of spores; other substances may be found within spores. Molds also produce volatile bioaerosols that are released directly into the air. These compounds often have strong, unpleasant odors (a musty smell) that are commonly associated with molds.

3.9.2 HOW TO LIMIT MOLD GROWTH

The most practical approach to limit mold growth is early detection and prompt resolution of excessive moisture. If you can see mold or detect an earthy or musty odor, you can assume you have a moisture problem that must be resolved to achieve a permanent solution to arresting mold growth. Mold growth is found behind walls or under materials where water has damaged surfaces. Look for discoloration and mold on surfaces.

Controlling indoor air moisture will limit the probability of supporting mold growth from condensing water on interior surfaces; such as on walls, windows, and areas near air conditioning supply registers. Relative humidity is a measure of the amount of water vapor in air. Relative humidity meters are useful for detecting excessive moisture and they are available from most hardware stores. Moisture sources that increase indoor air relative humidity are: habitation (people release moisture), bathing, cooking, plants, washing and air-drying of dishes and clothes, unvented combustion appliances, humidifiers, and outdoor ventilation air in humid climates.

Another moisture source is water from leaks; such as from pipes, rain water leakage through windows, roof flashing, ice dams, etc.

Listed below are strategies that can help minimize mold growth.

i Take notice of musty odors in the home because they indicate the presence of mold. Look for visible signs of mold and abate the moisture source.

ii Watch for condensation and wet spots and eliminate sources of moisture.

iii Prevent moisture resulting from condensation by increasing surface temperatures or reducing moisture levels in the air. To increase the surface temperature, insulate or increase the circulation of heated air. To reduce moisture levels in the air, repair leaks, increase ventilation (if outside air is cold and dry), or dehumidify.

iv Keep the relative humidity as low as is comfortable during the wet season for houses in wet climates. Mold growth on interior surfaces of exterior walls can occur during the heating season. The combination of cool surfaces and excessive humidity can cause a high near-surface relative humidity and condensation. Experience has shown that an air moisture level below 40 percent relative humidity during the heating season will prevent condensation on surfaces. This level of humidity may not be appropriate for houses in severe cold climates. A sign of excessive humidity is condensation on the inside of windows. If condensation is

present for prolonged periods take steps to reduce the moisture source or increase ventilation.

v Clean and dry any wet or damp areas within 48 hours.

vi Provide drainage for roof rainwater and maintain the ground with a slope that drains water away from the foundation.

vii Repair water leaks in the building envelope as soon as possible.

viii Do not store organic materials such as paper, books, clothes, etc., in humid locations (such as in unconditioned basements).

3.9.3 MOLD ABATEMENT AND REMEDIATION

Common suggestions among the various documents include:

i Correct the source of excessive moisture.

ii Take care to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied area.

iii Non-porous (e.g., metals, glass, and hard plastics) and semi-porous (e.g., wood, and concrete) materials that are

structurally sound and are visibly moldy can be cleaned and reused.

iv Cleaning should be done using a detergent solution.

v Porous materials (e.g., ceiling tiles and insulation, and wallboard) with more than a small area of contamination should be removed and discarded. Porous materials that can be cleaned, can be reused, but should be discarded if possible.

vi All materials to be reused should be dry and visibly free from mold.

vii Periodic inspections should be conducted to confirm the effectiveness of remediation work

3.10 SUMMARY

Sources of water that affect buildings

i Rainwater

ii Condensation

iii Groundwater

iv Leakage from defualtive plumbing

Means of entry

i Cracks

ii Weak joints

iii Capillary action

Effect on buildings

i Damage to structural members

ii Damage to finishings and furniture

iii Growth of mold

iv Structural failure

Moisture penetration in walls

Factors influencing moisture penetration in walls

i Degree of exposure

ii Nature of wall material

Fig 3.5 Factors affecting moisture penetration in walls

This moisture finds its way through cracks, weak mortar joints or it is absorbed by wall units made of hygroscopic materials.

Preventive measures

i Provision of wide roof overhang

ii Provision of roof drainage system that collects and channels run-off away from wall surface and building.

iii Provision of protective surface such as stucco, lime mortar and water proof paints.

iv Use of materials that have a low level of absorption

Moisture penetration in roofs

Factors influencing moisture penetration in roofs

i Wind pressure

ii Standing water

Fig 3.6 Factors affecting moisture penetration in roofs

This moisture finds its way through cracks, by absorption and joints between roofing sheets.

Preventive measures

i Use of long span roofing materials

ii Provision of water proof material

iii Regular clearing of debris from roof gutters and low slope roofs

iv Provision of expansion joints to prevent cracking

Moisture penetration in foundations

Factors influencing moisture penetration in foundations

i Ground terrain

ii Rising water table

iii Poor surface drainage

Fig 3.7 Factors affecting moisture penetration in foundations

Preventive measures

i Raising the floor level by stepping up the building

ii Provision of damp proof membrane between hardcore and concrete

iii Use of water resistant floor finishes

iv Providing a concrete pavement round the perimeter of the building.

v Providing drainage for surface water

3.11 RECOMMENDATION

Specific attention should be given to methods of construction especially in areas with high amount of rainfall, humidity and high water table. Special considerations should be given to building materials in these areas; low level of absorption and a high resistance to moisture penetration should be major criteria for selection of materials. Precautionary measures should also be integrated in the design stage of buildings.

CHAPTER FOUR

4.0 CASE STUDIES

4.1 CASE STUDY ONE

LOW-COST HOUSING ESTATE, SATELLITE TOWN, LAGOS.

The low cost housing estate, satellite town is located in the Oriade Local Government area of Lagos State. The housing scheme was one of the projects initialed by General Olusegun Obasanjo in 1974. The project commenced in 1974 and the first phase was completed in 1978. The site on which the estate was built swampy and had to be sand filled. The second phase of the estate was not constructed.

The houses were allocated to civil servants and payment was made over a period of 15 years.

Facilities available include

i 2 bedrooms housing units

ii 3 bedrooms housing units

iii 4 bedrooms housing units

iv Health care centre

v Post Office

vi Police Station

vii 2 schools

In the original plan of the estate, there was no provision for the police station, post office and schools. The housing units are divided into closes. A close comprises of 14 houses four 2 bedroom, 4 three bedroom

and eight 4 bedroom housing units. The closes are connected by pedestrian gate at the ends of the closes.

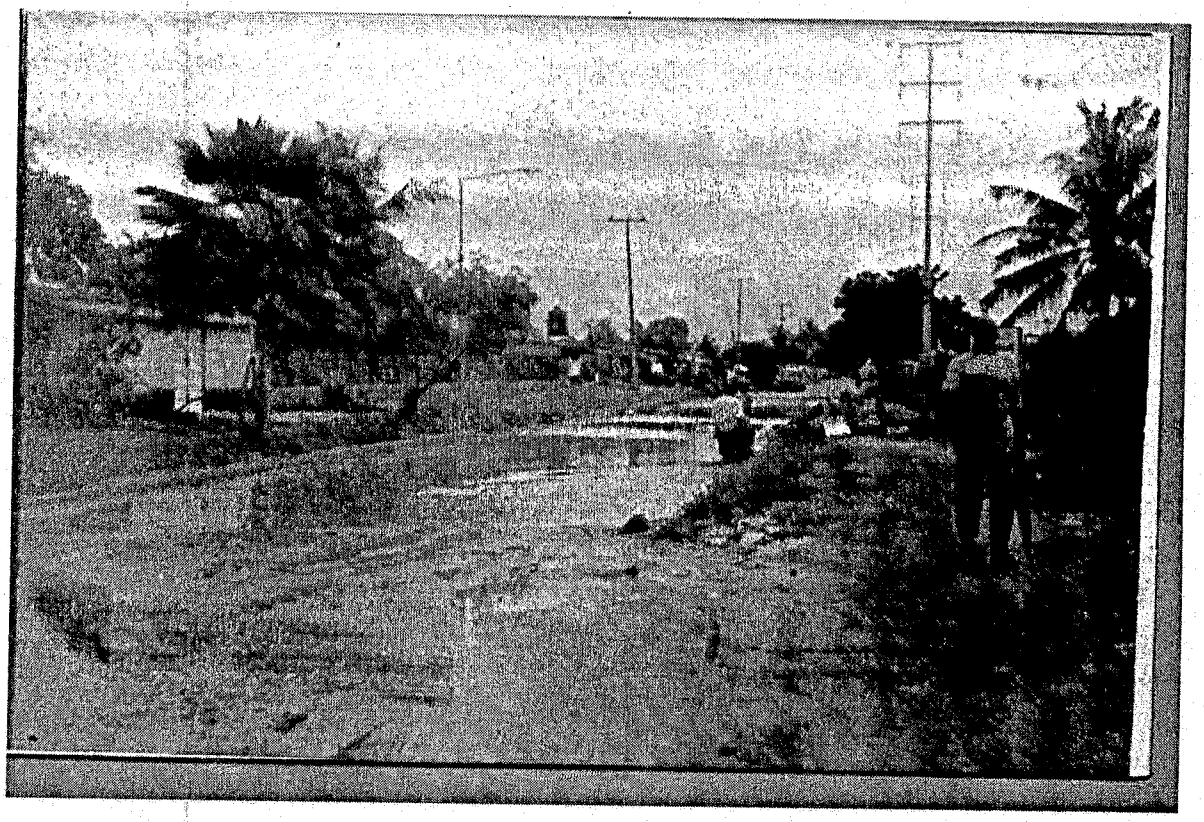


Plate 4.1 Road network within the estate

Plate 4.2 A close within the estate showing arrangement of houses

MERITS

i Provision of healthcare facilities and social services.

ii Standard size rooms within the houses.

iii Good road network

DEMERITS

i Headroom for houses is not up to 3 metres.

ii No provision for recreation within the estate

iii No provision for small-scale commercial activities

iv Inadequate drainage system both for surface and foul water

v Buildings are not aesthetically satisfying.

4.2 CASE STUDY TWO

CIVIL SERVANTS HOUSING ESTATE, OVOM, YENAGOA, BAYELSA STATE.

The civil servants housing estate is located in Ovom, Yenagoa. The housing scheme is one of the projects executed by the Bayelsa State Government. The housing scheme was executed in phases, phase 1, which comprises of three bedroom bungalows, phase 2 which comprises of 12 bungalows and an 11 storey building and phase 3 which comprises of 13 blocks of three bedroom flats and eighteen three bedroom bungalows.

The houses were allocated to civil servants of the estate on an owner-occupier basis. Payments will be made over a period of 20 years. Facilities available include:

i Civil servants clinic

ii Police Station

iii 3 bedroom-housing units.

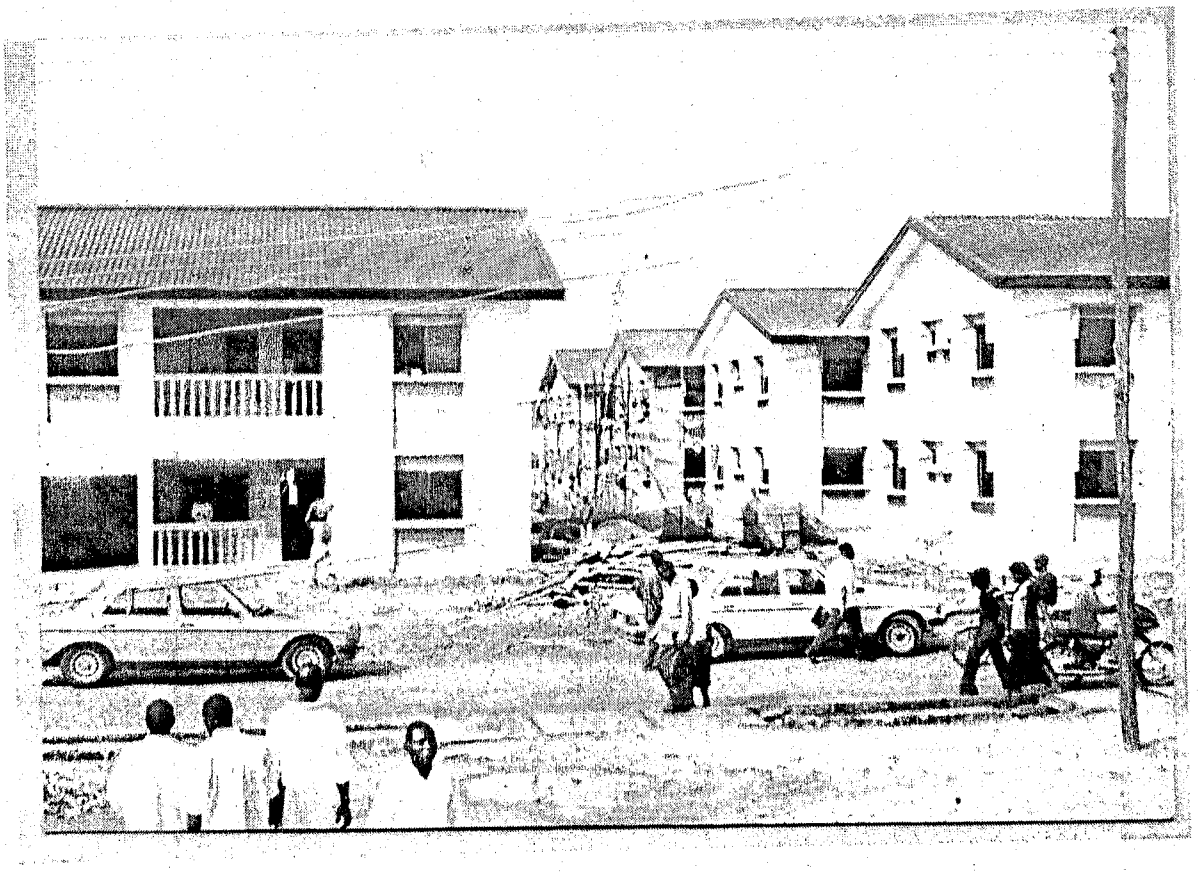


Plate 4.3 2-bedroom housing unit

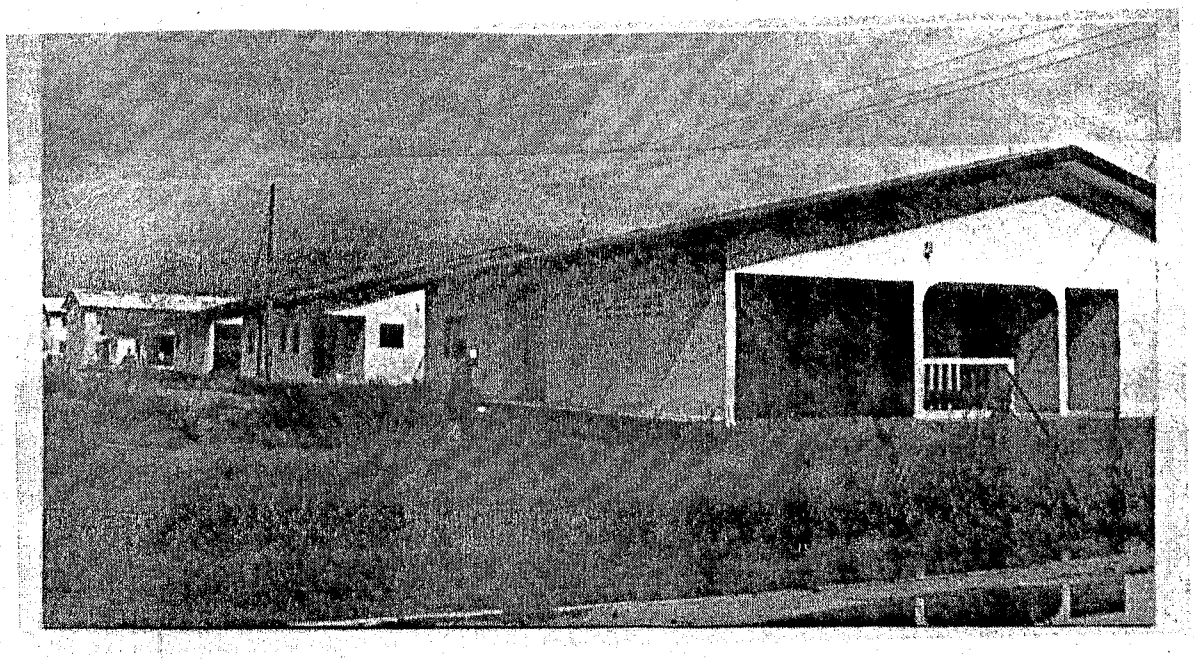


Plate 4.4 3-bedroom housing unit

MERITS

i Good road networks within the estate

ii Proper drainage channels to take care of surface water and foul water.

iii Standard size rooms within the housing units

iv Provision of health care facilities and social services

v Standard building practices were used during construction

DEMERITS

i No defined entrance and exit from the estate

ii No proper layout of the estate

iii No provision for small-scale commercial activity.

4.3 CASE STUDY THREE

NATIONAL PROVIDENCE FUND ESTATE, SATELLITE TOWN, LAGOS

The National Providence Fund Estate is located along Buba Marwa road, satellite town, Lagos. The estate was built on reclaimed land, which was allocated, to the establishment by the Federal Government. The estate is made up of four closes, which consist of 2 bedroom and 3 bedroom-housing units.

The Houses were allocated to staff or an owner –occupier basis with payments being made over a period of taxes year facilities available include;

i 2-bed room housing units

ii 3-bed room housing units

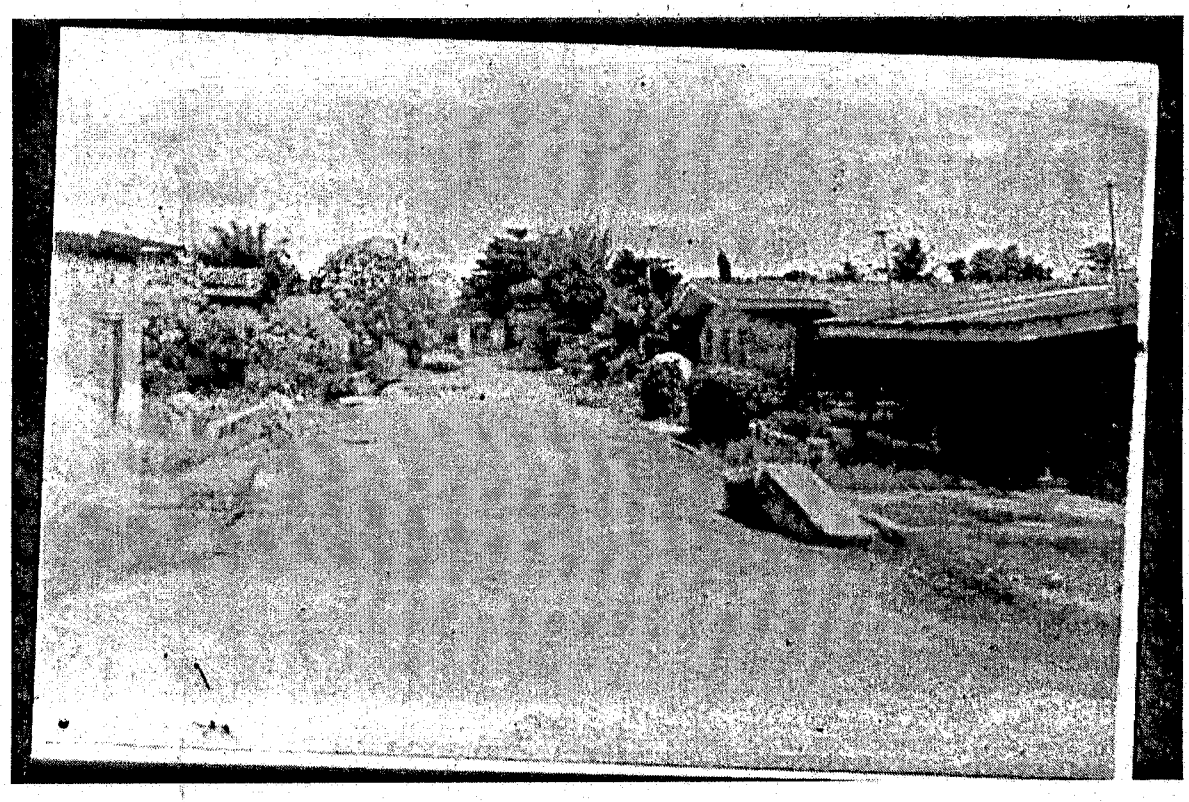


Plate 4.5 a close within the estate showing the arrangement of houses

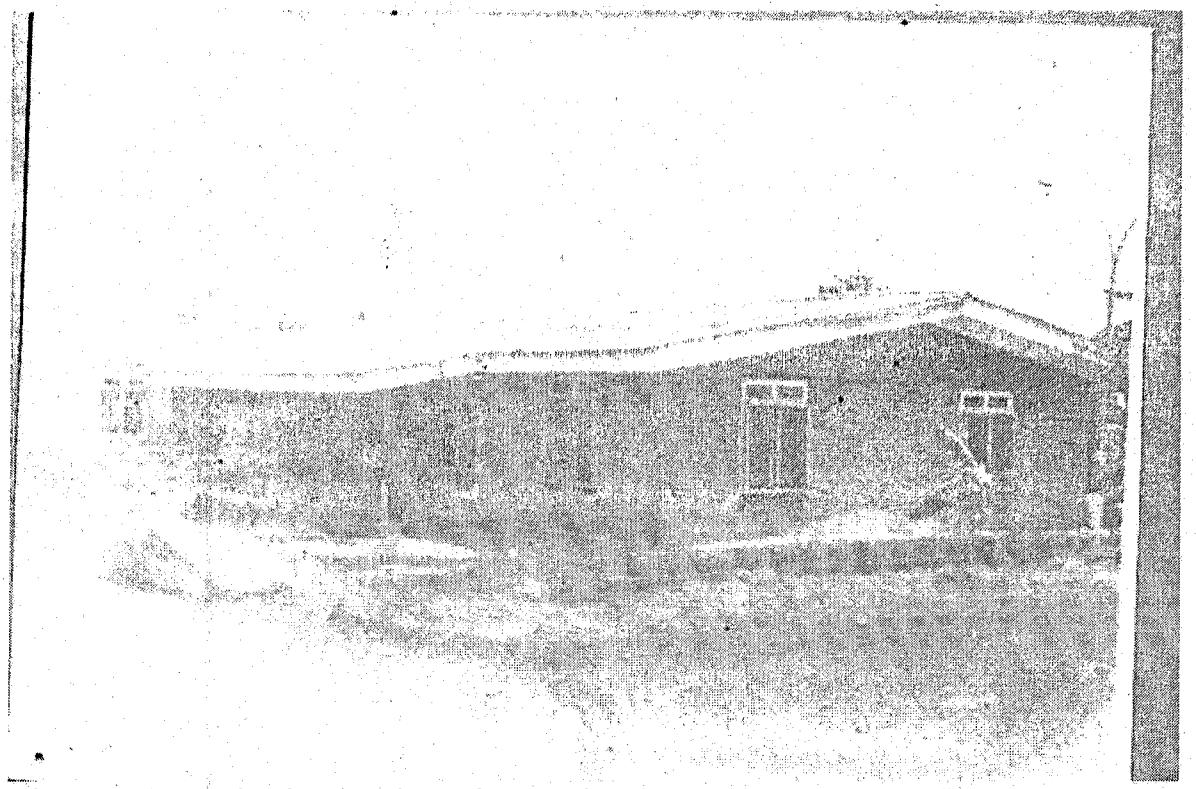


plate 4.6 3-bedroom housing unit

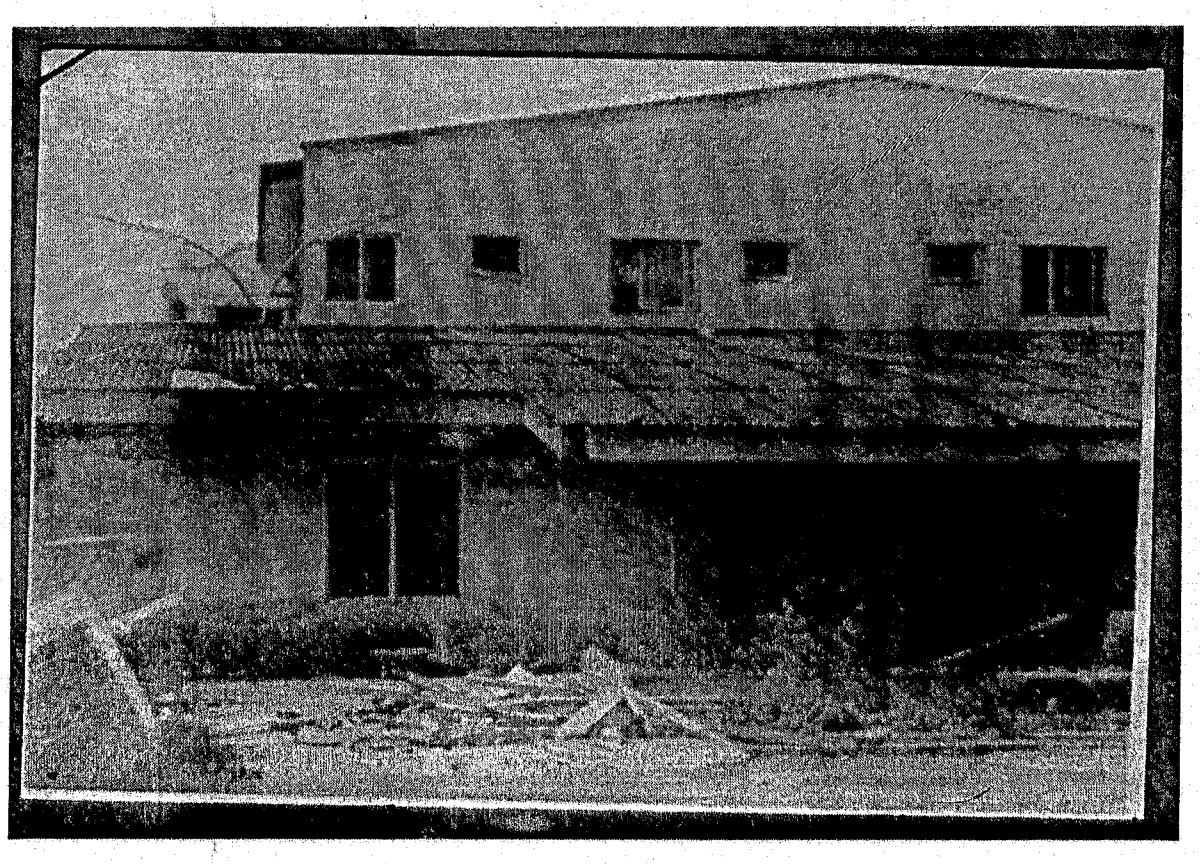


Plate 4.7 2-bedroom housing unit showing damage caused by rising damp

MERITS

i Defined exit and entrance for the estate.

ii Standard size rooms within the buildings

DEMERITS

i No drainage provided for surface water.

ii Substandard building practices were used in construction.

iii No provision for recreation within the estate.

iv Buildings are not aesthetically satisfying.

v No provision for small scale commercials activities

The area allocated for the estate was a low land which is liable to flooding because of high water table especially during the rainy season and the nature of the soil. This area required sand filling to raised the ground level and provide a soil with higher bearing capacity. This was not done. Initially, this did not pose a problem but after period of years some of the buildings started sinking and could not be inhabited. There is also the problem of flooding during the rainy season, which is compounded by no provision of drainages within the estate.

4.4 CASE STUDY FOUR

LEGISLATORS ESTATE AZIKORO, YENAGOA, BAYELSA

The Legislator's Estate Is Located in Azikoro, Yenagoa, Bayelsa State. The Bayelsa State Government executed the housing Scheme in 2001. The estate comprises of thirty-two 3-bedroom housing units.

MERITS

i Good Road Network within the Estate.

ii Provision of Drainage for Surface Water.

iii Standard Size Rooms within the Buildings.

iv Standard building practices where used during construction.

v Well-Defined Layout.

DEMERITS

i No Provision of Health Care Facilities.

CHAPTER FIVE

5.0 DATA COLLECTION

5.1 INTRODUCTION

General Sani Abacha created Bayelsa State on the 1st of October 1996. It was carved out of Rivers State. Bayelsa state is located in the heart of the Niger Delta, and it is the centre of the crude oil, which sustains Nigeria.

The state comprises the core of the present Niger delta, embracing the vast majority of rivers still directly discharging waters of the Niger into the Bight of Benin. Longitude 60 east and latitude 4030 north dissect Bayelsa State centrally. The state occupies a region of 12,000 square kilometers, most of which is water or wetland. Bayelsa State shaves its northern boundary with Delta State, its southern boundary with the Atlantic Ocean, its eastern boundary with Rivers State and its western boundary also with the Atlantic Ocean.

5.2 THE PEOPLE AND THEIR HISTORY

The Ijo ethnic group populates the Niger delta predominantly and Bayelsa State constitutes the largest concentration of Ijo communities however, there is small number of Urhobo and Isoko speakers. The diversity of languages spoken in Bayelsa State provides some indication

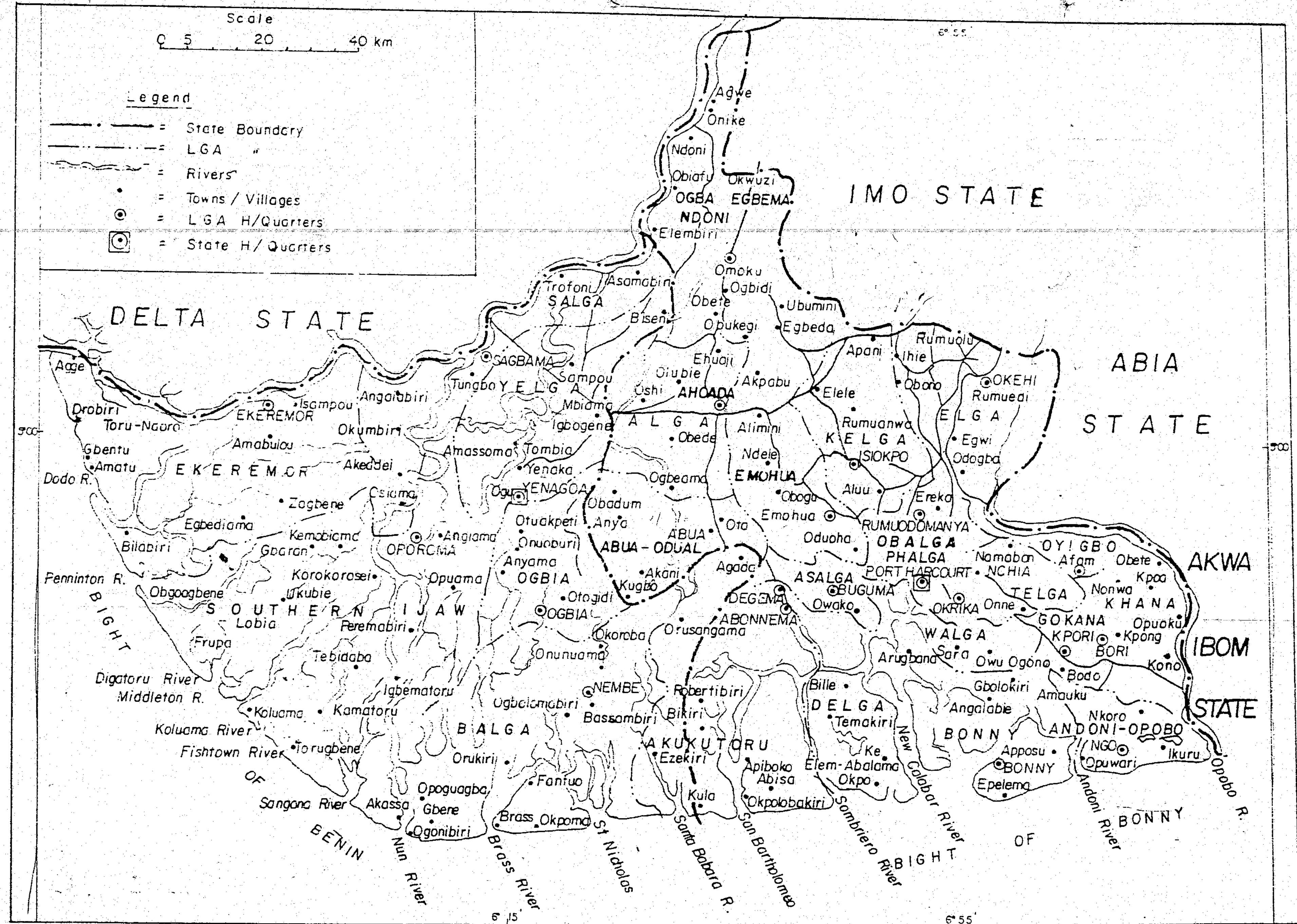


Fig. 1.1: Coastline and political map of Bayelsa and Rivers States

of the diversity of ethnic groups or communities living side by side in it. The languages are divided into:

- Nembe-Akaha, comprising the dialects of Nembe and Akaha (Akassa).
- Izon, comprising 19 dialects, namely, Bumo, Tarakiri (East), Tarakiri (West), Oporomo, Olodiama (East), Basan, Apoi (East),Ogboin, Ekpetiama, Gbarain, Kolokuma, Tungbo, Ibeni or Ogakiri, Kabou, Kumbowei, Mein, Ekeremo, Iduwim.
- Inland Ijo, comprising Biseni, Akita and Oruma or Tugbeni.
- Isoko, making up six communities of Sagbama local Government Area.
- Urhobo speakers found in Ofoni.

The various ethnic communities within the state have their various historical origins. Some of the ethnic communities have ancestral links with the Benin kingdom. This is as a result of migration and resettlement. Such communities include; Nembe, Okoroma, Ojakiri, Mein, Tarakiri, Kolokuma, Zarama, Akita, Biseni, Ekpetiama, Ogoin and Ogbia.

The other communities like Iduwini, Ekeremo, Kumbowei, Kabowei, Bumo, Apoi, Olodiama and Tugbene have indigincous roots. However, linguistic existence shows that the homeland of the Niger Congo languages, of which Ijo is a member, was the southwestern Highlands in the watershed of the Senegal, Gambia and Niger Rivers and the dispersal was by river routes. For the Ijo, this theory suggests the

River Niger as the major route of migration to the Niger delta in the pre-Christian era.

5.3 CLIMATE

The climate of Bayelsa State has been identified as a semi-hot humid equatorial climate of the Af type of koppen's system of climate classification. Weather conditions over the state are brought about by the moist tropical maritime air mass and the dry and dust laden tropical continental air mass. The farmer is prevalent during the rainy season while the latter originates from the high-pressure belt of the Sahara desert and blows over the state in the dry season.

The mean annual rainfall ranges from 2000 to 4000mm and spreads over 8 to 10 months of the year between March and November, which coincides with the wet season. There is a slight break between July and September (August break). The dry season last for three months from December to February. It is not uncommon to experience occasional rainy days and storms during the short dry season.

The direct effect of the extensive wet season is that over 70% of the total area of the State is inundated with floodwater. This condition is exacerbated by the semi-diurnal tidal regime, which ensures two high tidal floods and two ebb tides within the course of each day all over the state. Under these conditions bases are continuously elutriated from the surface to the subsurface layers of the soil.

5.3.1 TEMPERATURE

Temperature is fairly constant throughout the year over the entire state with a maximum of 30^{0}c. The highest temperature is recorded between the months of February and March each year while the lowest values occur at the peak of the rainy season in the months of June and July. Variation in temperature begins in the month of September only to decrease to 26^{0}c in November at the onset of the harmattan winds.

Sunshine hours are reduced to a minimum over the state because of uniform and continuous cloud cover. The region receives less tan twenty hours of sunshine per month between the months of June and September each year.

5.3.2 HUMIDITY

Relative humidity is comparatively uniform over the state because of the proximity of the region to the Atlantic Ocean. The months of June and October records a mean monthly value of over 80%. The dry season month of January records a lower value of 65%. This rises during the onset of the rains, peaking at 78% in the month of May.

Relative humidity is reduced considerably in December with values ranging between 55 and 65%.

5.4 GEOLOGY AND TOPOGRAPHY

The land surface of Bayelsa State slopes gently to the sea in a north-south direction. This topographic configuration has evolved from

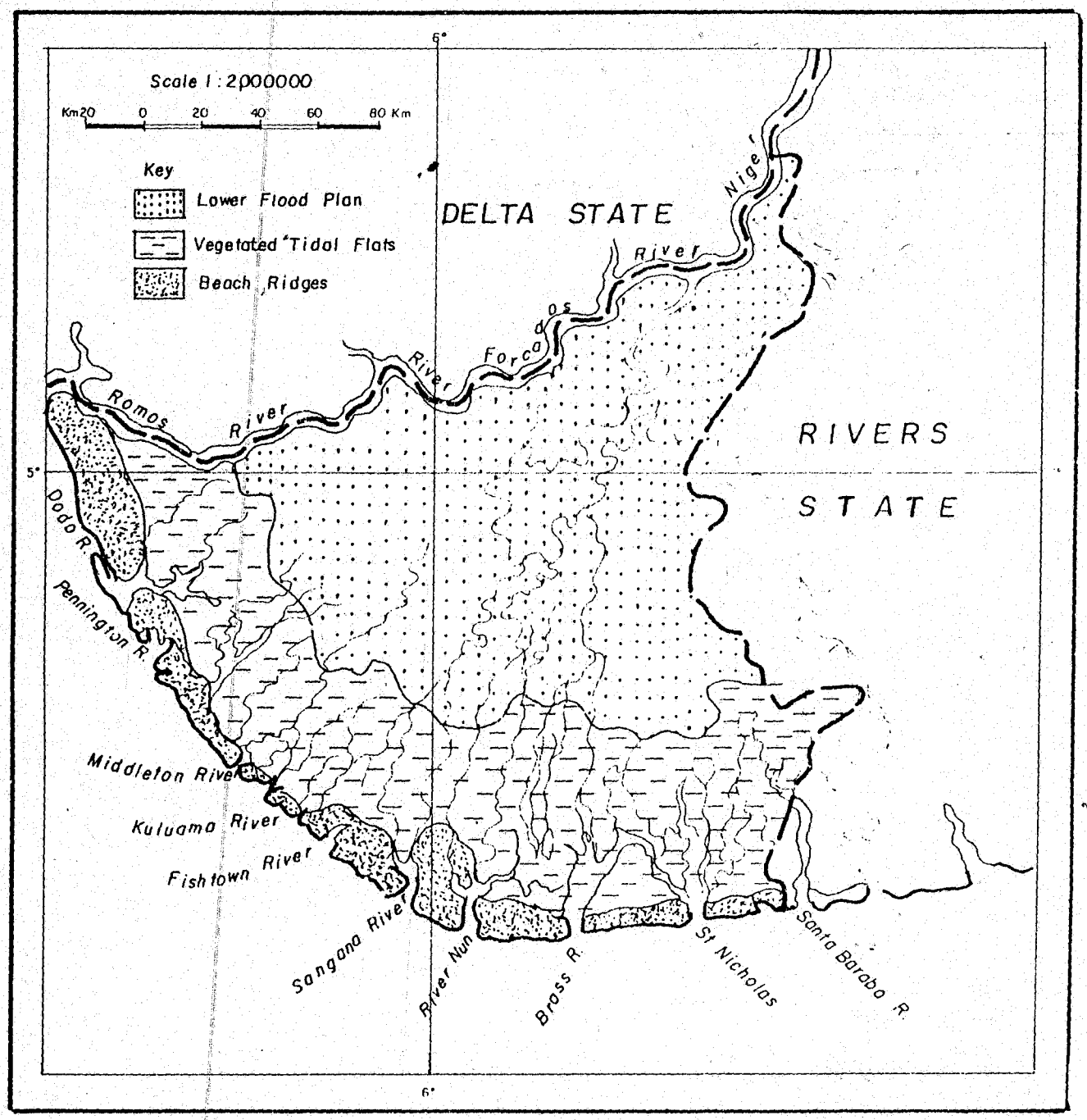


Fig. 3.2: Geomorphic units of Bayelsa State

the sedimentation patterns of the last 75,000 years (Allen, 1970). A close examination of the micro-relief of the region shows the plains as homoclinal geomorphic structures which trend westwards and southwestwards and is broken in many places by small hogback ridges and shallow basins. This trend is arrested at the west by sandy beach-ridge barriers lying between the tidal basins and open sea.

Bayelsa State consists of two broad morphologic regions identifiable as the older coastal sands of about cretaceous age making up the higher land and the relatively more recent deltaic plain sand associated with the Sombrerro-Warri plain. Theses more recent deposits are the outcome of a transgressive phase which occurred about 30,000 – 10,000 years before present, during a recessive stage in the Pleistocene ice-age (Nedeco, 1961 p.109).

5.5 VEGETATION

The Niger Delta is Africa's largest delta covering some 7,000 square kilometers. About one-third of this area is made up of wetlands, and it contains the largest mangrove forest in the world about 5,400 –6,000 km^2 (Afolabi, 1998). In addition, it consists of a number of distinct ecological zones such as coastal ridges, barriers, fresh water swamp forests and lowland rainforests.

Three major forest formations occur in Bayelsa State.

Theses include:

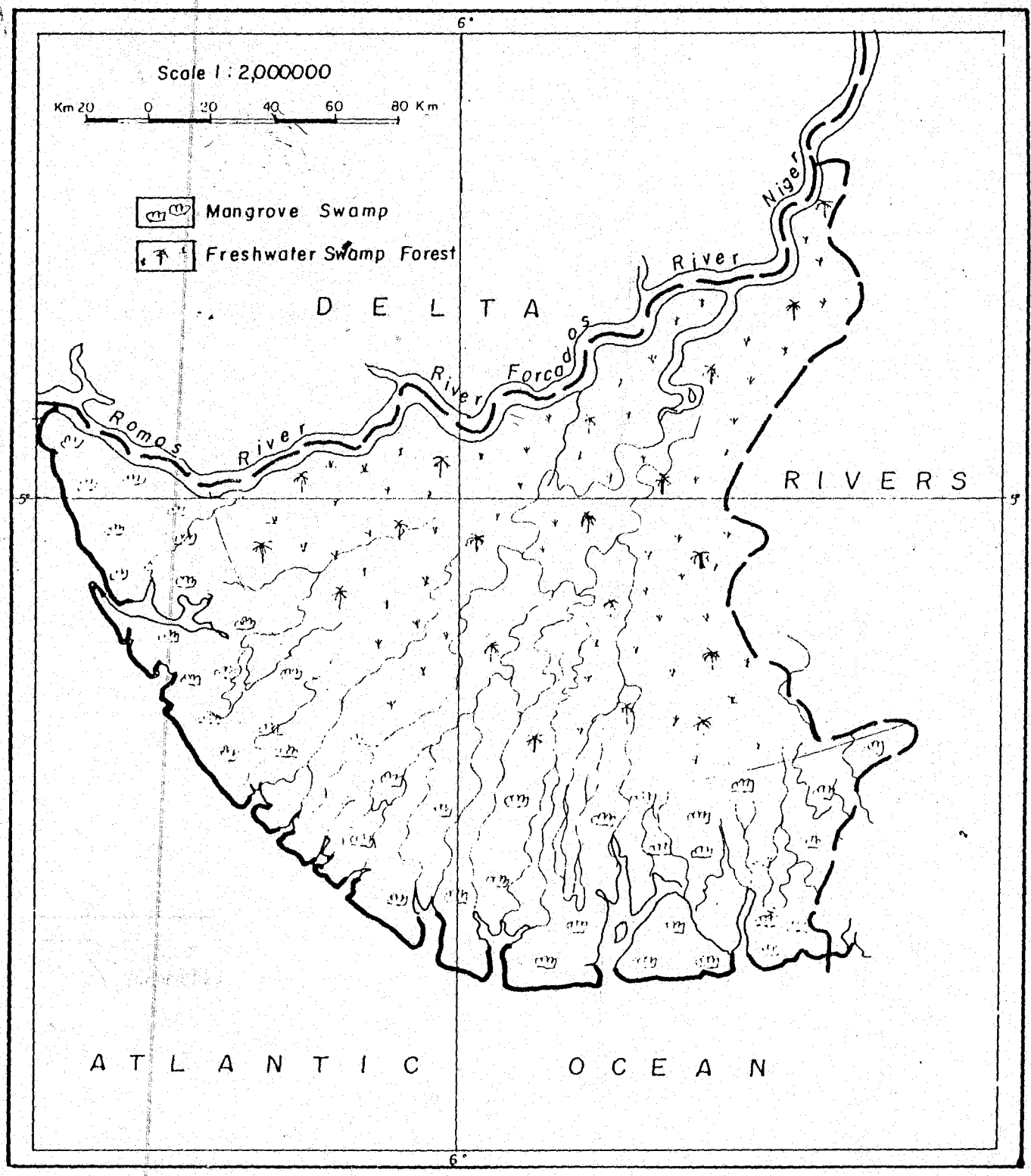


Fig. 4.1: Vegetation map of Bayelsa State

- Brackish water swamp forest (comprising mangrove forests and coastal vegetation).
- Fresh water swamp forests
- Riparian forests.

BRACKISH WATER SWAMP FORESTS

The mangrove forests of Bayelsa State occupy the brackish and marine river systems St. Nicholas, Brass, Nun, Sangana, Fishtown and Pennington, Ramos, Forcados and Santa Barbara. (see fig.) this comprises of species of the red mangrove and white mangrove, salt tolerant ferns and Meyer (Rhizophora racemosa).

FRESHWATER SWAMP FORESTS

Mangroves and associated plants are replaced by fresh water vegetation as one moves inland from the coast. The fresh water vegetation comprises of floating plant species, grasses and sedges, climbing palms, shrubs, lianas and ferns, raffia palm, African mango that produces ogbono, the oil palm, opepe, bau and number of other trees, water hyacinth, water lettuce, water lily and screw pine.

RIPARIAN FORESTS

This is the most complex in terms of species diversity number and structure of the tree types of vegetation available in the sate. The forest

has no dominant specie and it is multi-storeyed. As many as seven vegetation strata may be recognized.

Tree species that are present in this forest are as tall and big as could found anywhere. Theses trees include the African nutmeg, African breadfruit, mahogany, iroko, star apple, silk cotton tree, palm tree, abura, kuru. These and other tree species have given the evergreen character of the forest. Attached to the most of these trees are epiphytes and lianas bryophytes.

5.6 SOCIO-CULTURAL LIFE

The people of Bayelsa State have, in the process of adapting to their peculiar environment, created institutions which represent their unique life –ways, their organized approach to matters of kinship, marriage, inheritance, politics, economy, morality, justice, health and social welfare, mechanisms of socialization, aesthetics, recreation and the integrative forces of religion.

Bayelsa State is culturally heterogeneous. However, there have been similarities in historical experiences and cultural affinities. Fundamental structures of social relations that facilitated the maintenance of peace, order and tranquility in theses societies include the traditional mechanism of kinship regulation, rules of descent and marriage, and principles of inheritance. Theses institutions define patterns and strategies of social interaction and determine social actions and behaviour.

The social structure of most Bayelsa communities was composed of nuclear families, extended family units and lineage wards; a conglomeration of which made up a settlement. Monogamy symbolized social degradation and failure while polygamy symbolized success. The house of Elders was the highest traditional governing body. It consisted of nominees from the lineages.

5.7 DEMOGRAPHIC DATA

The total population of Bayelsa State as at 1991 was 1,121,693 people. 584,117 (52.9%) males and 537,576 (47.1%) females. This population is distributed over eight local governments.

Southern Ijaw L.G.A	267,371
Ogbia L.G.A	159,369
Nembe L.G.A	153,821
Brass L.G.A	120,000
Ekeremor L.G.A	120,000
Sagbama L.G.A	117,259
Yenagoa L.G.A	117,760
Kolokuma/Opokuma L.G.A	66,115

The most densely populated local governments in the state are Ogbia and Yenagoa with densities of 272 and 237 persons per square kilometer respectively. Almost 50% of the population is children aged

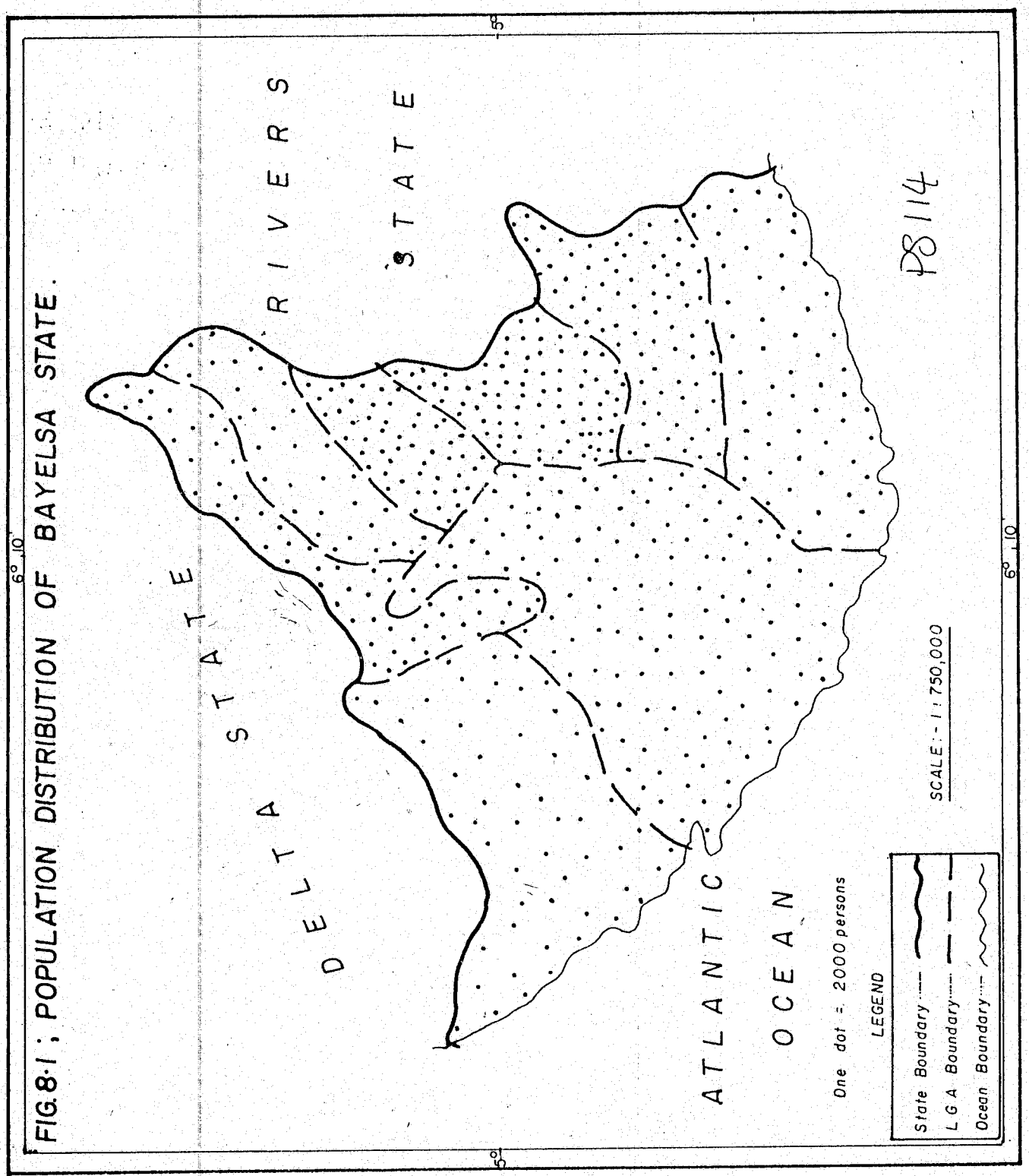


Fig. 8.1. Population Distribution of Bayelsa State

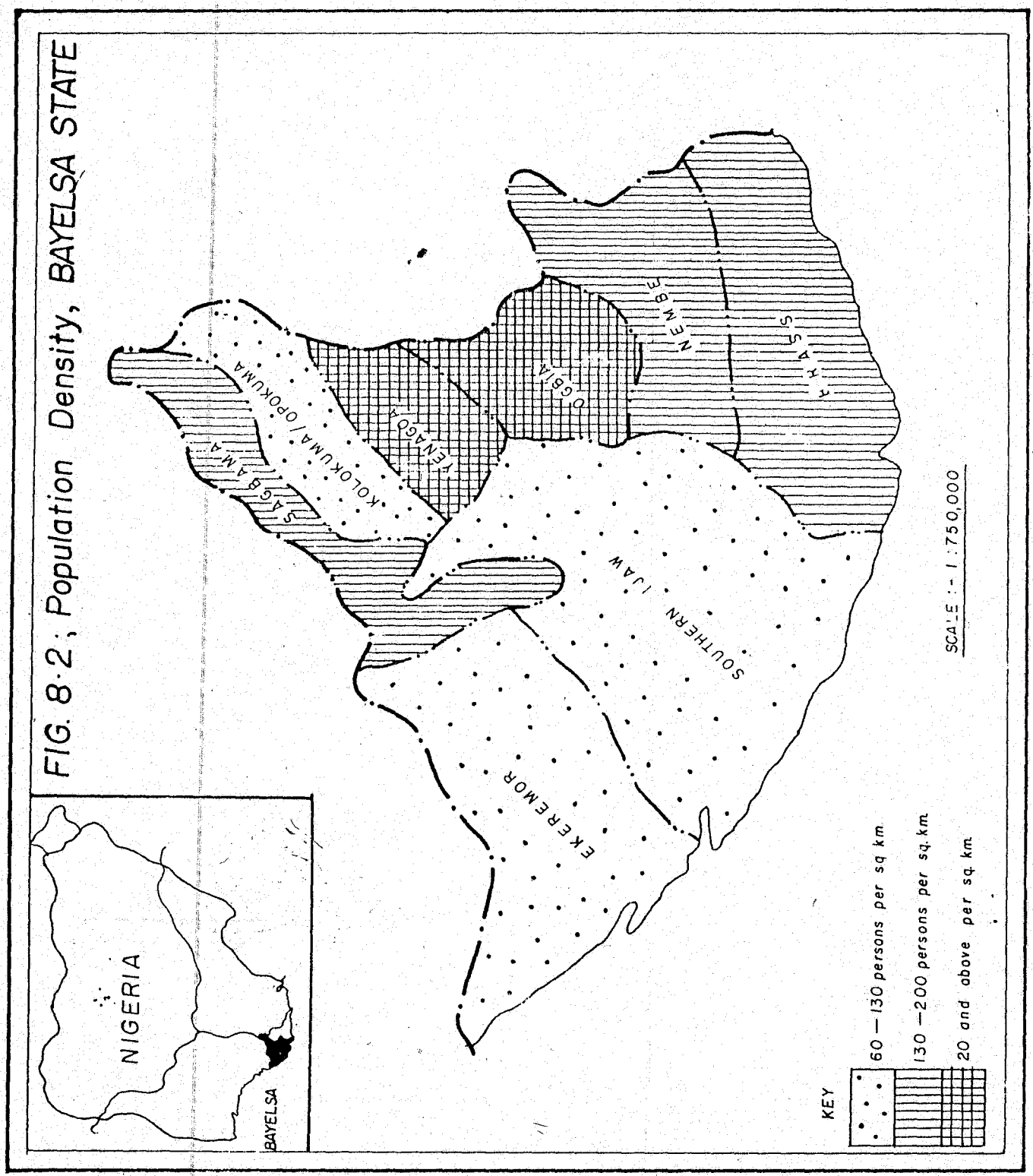


Fig. 8.2. Population density, Bayelsa State

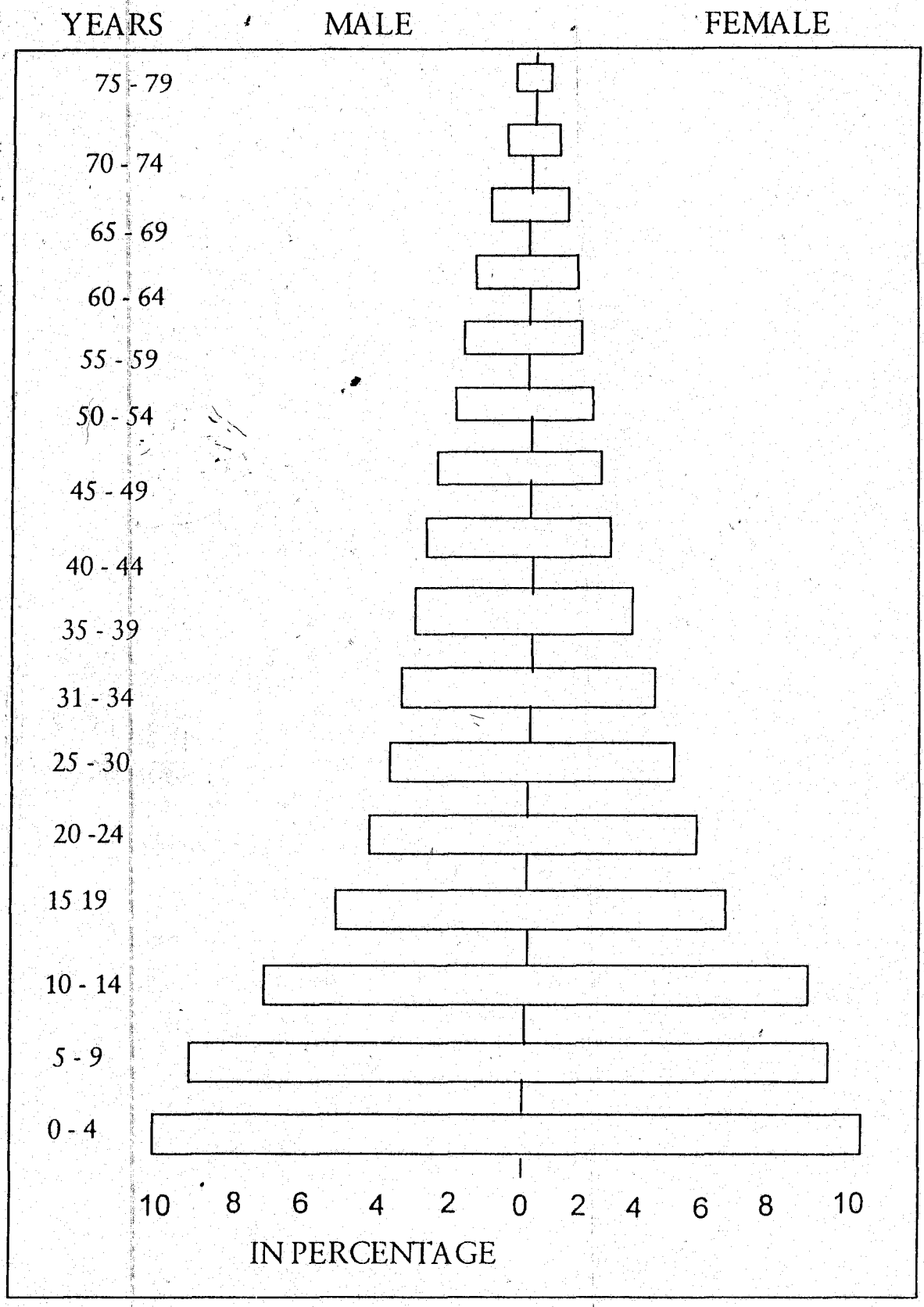


Fig. 8.3: Population Pyramid of Bayelsa State
(Source: National Population Commission (1991))

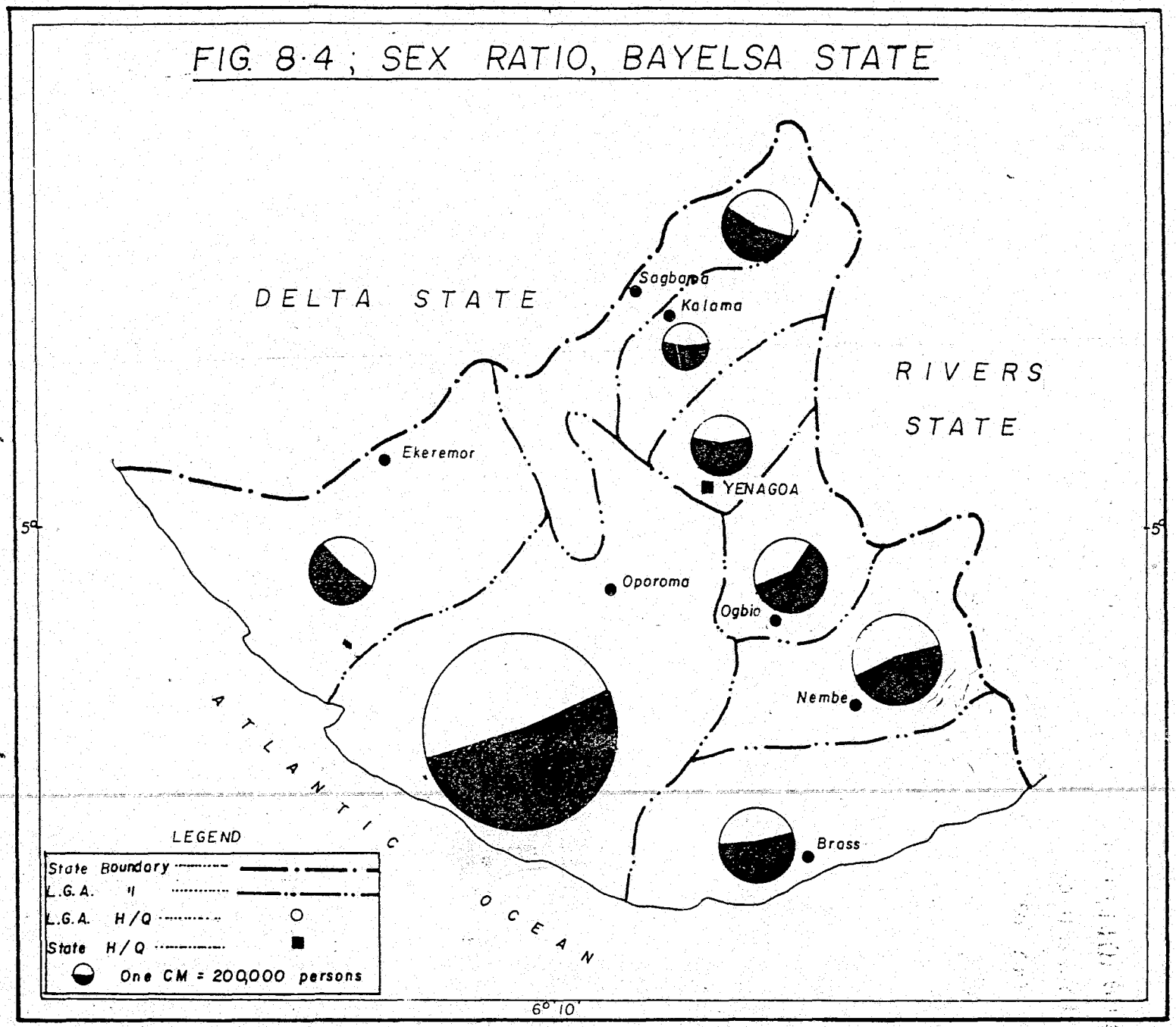


Fig 8.4: Sex ratio, Bayelsa State

Table 8.1
Population of Bayelsa State by LGAs

	LGA	Total	Male	Female	Sex Ratio
1.	Southern Ijaw	267,371 (23.8%)	139,821 [52.34%] (23.9%)	127,550 [47.7%] (23.7%)	109.6
2.	Ogbia	159,369 (14.2%)	91.459 [57.4%] (15.7%)	67,910 [42.1%] (12.7)	134.7
3.	Nembe	153,821 (13.7%)	72,227 [47.0%] (12.4%)	81,594 [53.0%] (15.2%)	88.5
4.	Brass	126,912 (11.3%)	65,440 [51.6%] (11.2%)	61,472 [48.4%] (11.4%)	106.5
5.	Ekeremor	124.279 (11.1%)	64,637 [52.0%] (11.1)	59,642 [48.0%] (11.1%)	108.4
6.	Sagbama	119,759 (10.7%)	62,163 [51.9%] (10.6%)	57,596 [48.1%] (10.7%)	107.9
7.	Yenagoa	104,061 (9.3%)	54,554 [52.4%] (9.3%)	49,507 [47.6%] (9.2%)	110.2
8.	Kolokuma/ Opokuma	66.115 (6.0%)	33,816 [51.1%] (5.8%)	32,299 [48.9%] (6.0%)	104.7
	Total	1,121,693	584,117[52.1]	537,576[47.9]	10.7

Source: National Population Commission (1997) Census '91 Final Results: Rivers State.

( ) Percentage distribution between Local Government Areas (LGAs)

[ ] Percentage distribution between sexes

Table 8.2

Percentage Land Area and Population Densities among LGAs in Bayelsa State 1991

	LGA	% Land Area	Persons/sq km Pop. Density
1.	Southern Ijaw	32.2	90
2.	Ogbia	6.4	272
3.	Nembe	9.4	179
4.	Brass	10.0	132
5.	Ekeremor	21.4	63
6.	Sagbama	8.0	163
7.	Yenagoa	4.8	237
8.	Kolokuma/Opokuma	7.8	92
	State	100	122

Source: Computed from field data

Table 8.3

Age-specific Literacy Rate: Rivers/Bayelsa States

	Age Group										
Rivers & Bayelsa	6-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50+	Total
Pop. in age group	558,235	638,165	549,980	412,662	371,140	293,757	204-029	174,800	114,612	286,641	3,604,101
Literature pop.	293,101	602,465	521,614	371,342	316,221	228,895	151,237	117,402	73,657	138,277	2,814,211
Literacy rate	52.2	94.4	94.8	90.0	85.2	77.4	74.1	67.1	64.3	48.2	78.1
Literacy rate (national)	42.0	77.2	75.0	66.5	61.5	53.9	52.7	44.2	43.9	28.9	56.7

Source: The 1991 Population Census of Nigeria (1997)

Table 8.4

Parameters of Employment for Rivers and Bayelsa States 1991

	Total Pop.	Total Pop 10+ Years	Labour force	Employed labour force	Employment Rate	Unemployment Population	Unemployment Rate
Rivers & Bayelsa State	4,309,557	3,045,866	1,399,639	1,223,425	87.4	176,214	12.6
Nigeria	88,992,220	60,147,873	27,936,926	26,624,926	95.3	1,311,603	4.7

Source: Extracted from Table 7.9A in The 1991 Population Census of Nigeria

between 0 –14 years. The percentage of old people aged 65 years above is very small, 4.7%. The working population, 15 – 64 years, makes up 47.3 % of the population.

5.8 ECONOMY AND COMMERCE

Bayelsa State is bereft of industries. Apart from the petroleum sub-sector with its numerous flow stations, oil wells and installations. An industrial and trade survey conducted in 1997 shows that the establishment employing about 5 to 10 persons include a few commercial banks, 2 sawmills, 3 hotels and 1 ironworks. The rest were single proprietorship businesses.

The state covers an area of 9,656 square kilometers of which 8,453 square kilometers is riverine where fish abounds. Smoke drying, wet smoking and salting are the traditional techniques for fish processing. The area is also popular for the tapping of palm wine from the raffia palm. This is also distilled into local gin.

The manufacture of ceramic pots, jars, bowls etc. used for cooking, water storage and fetching is carried out in Yenagoa local government area of the state. Mortars, pestles, neatly carved wooden plates and dishes as well as soupspoons are also made in the state.

Canoe carving is also a lucrative craft in the fresh water zone of the state. The canoe is made from logs, which are felled with axes or by means of fire and either processed on the spot or transported to the town for processing.

Agriculture, including fisheries and forestry, constitutes the major economic activity in Bayelsa state, with over 65% of the people engaged in it. Lumbering, hunting, gathering of wild fruits and tapping of the raffia palm constitute specific primary forestry economic activities; while fishing along the coastline and in the rivers and creeks rivulets, constitute primary economic activities in the area of fisheries. In addition, rotational cultivation of food and cash crops and the rearing of domestic animals are also undertaken.

5.9 TRAFFIC

The development of land-based transportation is very minimal in Bayelsa State. Bayelsa State is presently among the states with the shortest road length in Nigeria. Therefore, there is very light traffic (land) within the state as a whole. The majority of land traffic is concentrated within and around the state capital, Yenagoa.

There is a steady stream of traffic both morning and evening moving to and fro the central business district, which is housing most of the employees of labour. Population within the capital is not so high so there is never a heavy build up of traffic on the major roads, some of which are being expanded in anticipation of population growth.

5.10 EXISTING LAND USE AND FUTURE TRENDS

Bayelsa State occupies a land area of about 9,656 square kilometers. About % of the landmass of Bayelsa State consists of creeks, rivers and swamps.

The Bayelsa State ministry of lands housing is responsible for the use of land, both present and future land use allocation. The land use in Yenagoa, the capital city, is divided into industrial, commercial, residential, recreational and institutional development. Basic infrastructural facilities like good roads, drainage, water and electricity are being provided so that development would reach every area of the state.

CHAPTER SIX

6.0 SITE ANALYSIS

6.1 CRITERIA FOR SITE SELECTION

There were several factors, which led to the proposed site being chosen. There include:

i Environmental factors

ii Proximity

iii Availability of services

6.1.1 ENVIRONMENTAL FACTORS

The proposed site is a virgin land, which has not been affected by the effects of industrialization and overpopulation; however, the area shows signs of experiencing pockets of acid rain. This is caused by gas flaring within the area. The site experiences cold mornings and warm afternoons with temperatures not exceeding 29^{0}c.

6.1.2 PROXIMITY

Another factor which contributed to the choice of the site is the proximity to other areas which are already developed and also it closeness to the bypass which leads to the central business district. Residents can therefore avoid heavy traffic in the service roads.

6.1.3 AVAILABILITY OF SERVICES

Availability of public utilities is always considered when choosing or selecting a site. These services encourage development in the area. The services available include:

i Electricity

ii Water

iii Roads

iv Telecommunication

6.2 LOCATION OF THE SITE

The site is located along the INEC road, Kpansia-Epie in Yenagoa, Bayelsa State. It is about 5 kilometers from the eastern by-pass.

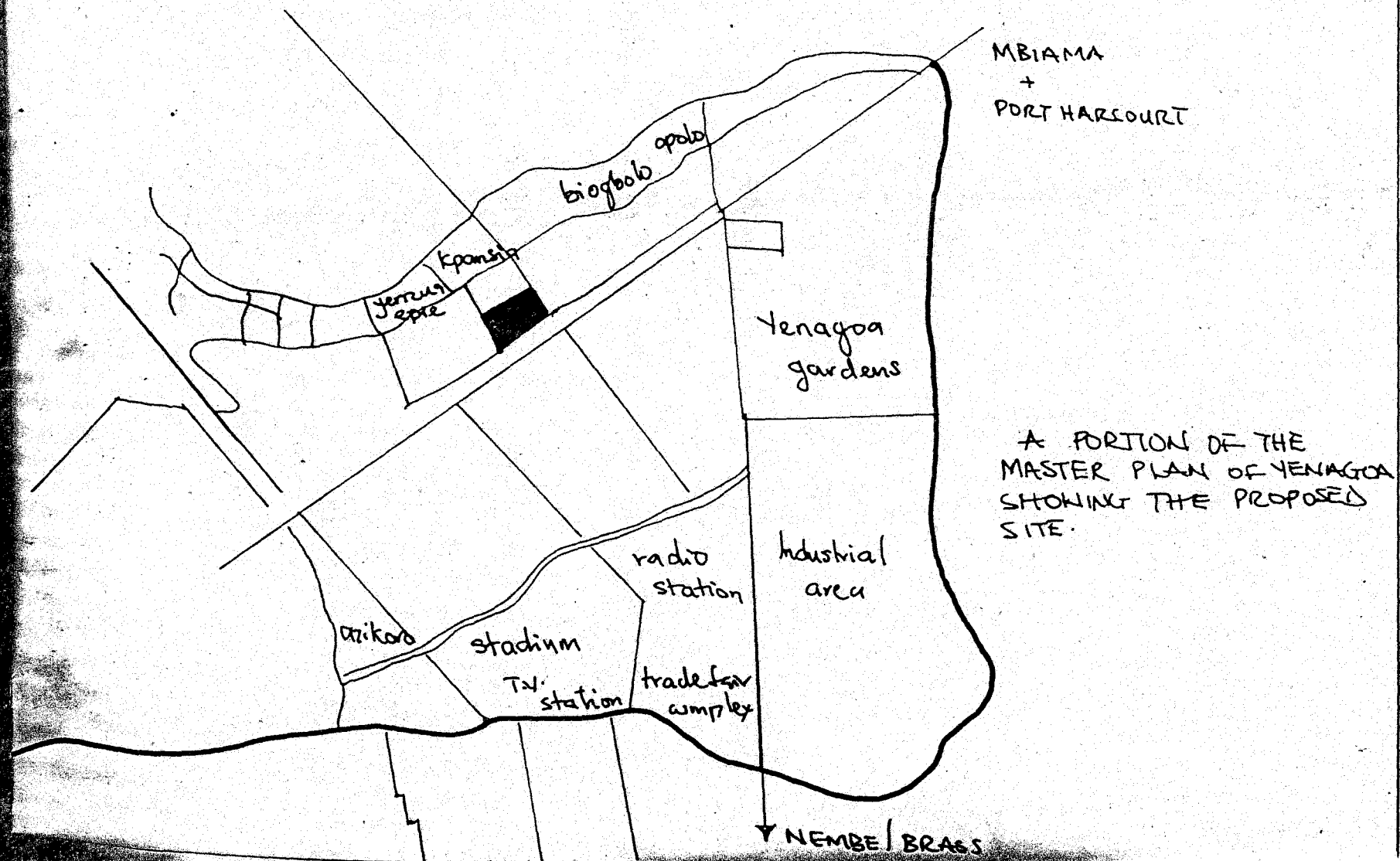
6.3 SITE CHARACTERISTICS

The site is a virgin land yet to be developed. It is covered with dense foliage; thick grasses, shrubs and large trees.

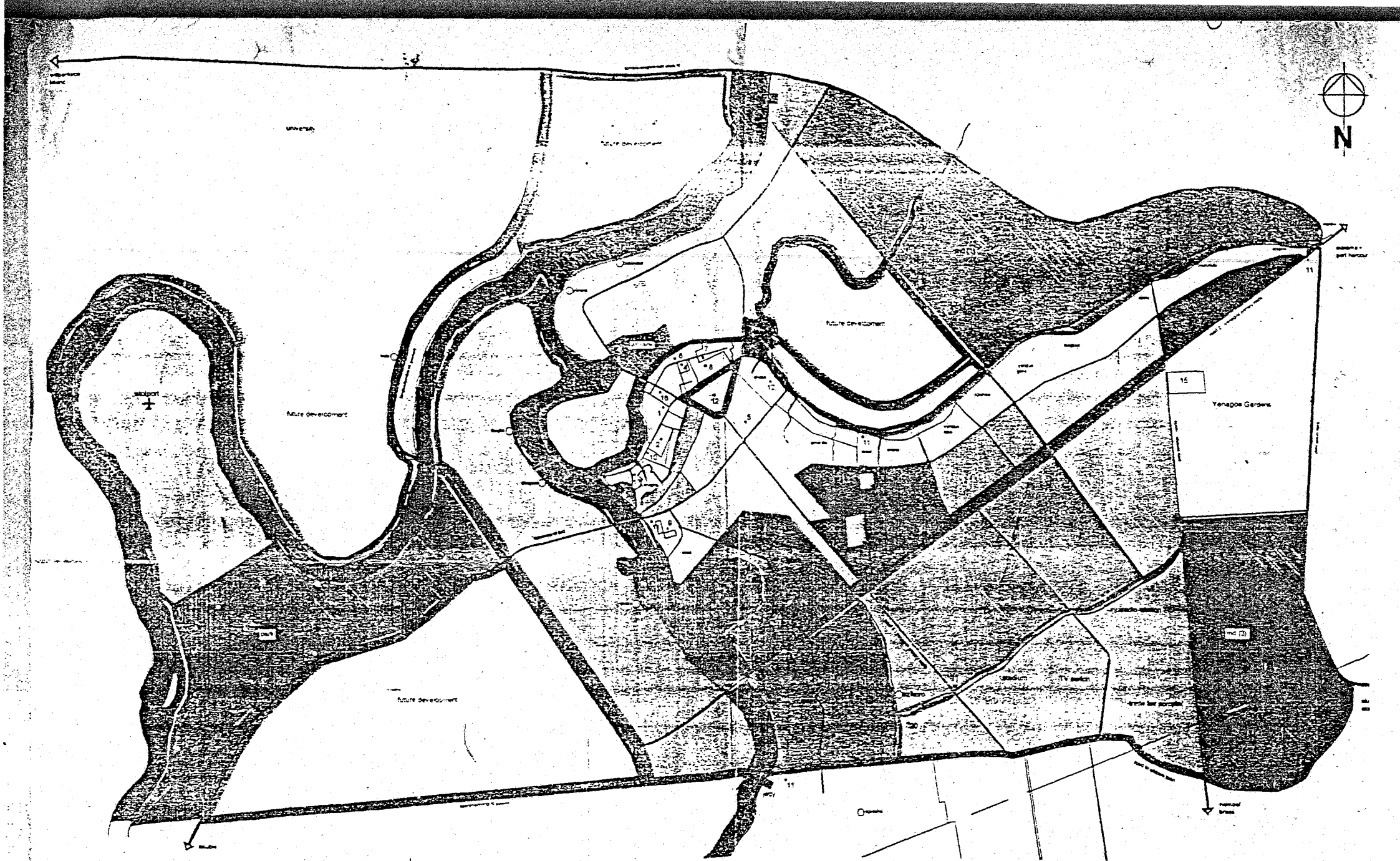
6.3.4 DRAINAGE AND TOPOGRAPHY

The site is regular shaped and slopes gently in a north-south direction. There are however some areas of the site that appear inundated. Theses areas can hold water and retard drainage of surface water.

AREA SHOWING THE CAPITAL CITY OF YENAGOA.



A PORTION OF THE MASTER PLAN OF YENAGOA SHOWING THE PROPOSED SITE.



LEGEND

1	SPORTS CENTRE	9	SMALL MARKET	17	ST PETERS CHURCH	RESIDENTIAL: LOW DENSITY	LEISURE + TOURISM
2	BISHOP DIMEARI SCHOOL	10	FIRE STATION	18	JUDICIARY	RESIDENTIAL: MEDIUM DENSITY	CENTRAL BUSINESS DISTRICT
3	RADIO BAYELSA	11	MOTOR PARK	19	FED. MIN. OF WORKS (HOUSING ESTATE)	RESIDENTIAL: HIGH DENSITY	FUTURE DEVELOPMENT
4	POLICE HEADQUARTERS	12	BAYELSA STATE HOUSE OF ASSEMBLY	20	CEMETERY	PUBLIC BUILDINGS	EXISTING SETTLEMENTS
5	GENERAL HOSPITAL	13	HOUSE OF ASSEMBLY QUARTERS		MAJOR ROAD	COMMERCIAL BUILDINGS	RIVER
6	FEDERAL MEDICAL CENTRE	14	HOUSING + PROPERTY ESTATE		SECONDARY ROAD	INDUSTRIAL	PIPELINE
7	[illegible]	15	[illegible]		[illegible] ROAD	GREEN SPACE	
8	[illegible]	16	[illegible]		[illegible]	GOVERNMENTAL	

YENAGOA MASTERPLAN

PROPOSED LAND USE MAP

Scale : [illegible]

6.3.2 SOIL

The proposed site is characterized by fresh water alluvial soils in the lower delta plain (levee crest soils). The levee crests of the lower delta plain are low with only about 1 metre above groundwater table. This rises during the rainy season.

6.3.3 RAINFALL

The site experiences a high amount of rainfall all year round especially during the rainy season.

6.3.4 WIND

The site influenced by two prevailing winds; the southwest trade winds and the northeast trade winds. However, the southwest trade winds are more prevalent for most part of the year.

6.3.5 SUNSHINE AND CLOUD COVER

Sunshine hours are reduced to a minimum because of a uniform and continuous cloud cover. The site receives about 2 – 3 hours of sunshine per day.

The sun rises in the east at about 6: 45 am and sets at about 6: 20 pm.

6.3.6 TEMPERATURE

The temperature ranges between 26^{0}C and 29^{0}C. This can be attributed to the cool sea breeze and continuous cloud cover.

6.4 ACCESS AND CIRCULATION

The site is accessible from the INEC Road, which links the proposed site with the area known as Kpansia-Epie. The road also links the by-pass, which leads into the central area and also out of the town.

6.5 UTILITIES

There are transmission lines, which run along the access road. These transmit power supply generated by the state owned gas turbines.

6.6 SCENERY/MAN-MADE FEATURES

The scenery is one dominated by thick vegetation all around. The few man-made features existing in the area are the access road and the electric poles that run alongside.

6.7 ANY ENVIRONMENTAL PROBLEMS (POLLUTION)

The proposed site is presently free of noise pollution, foul air and exhaust fumes, however it experiences small amounts of acid rain caused by gas flaring within the region.

CHAPTER SEVEN

7.0 THE DESIGN

7.1 CONCEPT AND DESIGN

This thesis work puts forward a design proposal for a low cost housing estate to be located at Yenagoa, Bayelsa state. This proposal among other things is to provide quality housing units on site to satisfy the needs of the low income earners.

The design is approached from the view that shelter is a basic need of man and its availability and quality ensure the well being and productivity of man. Low cost housing is a priority and majority of the populace fall under this category and cannot afford houses of their own. Special care therefore, has been taken to ensure the cost effectiveness and affordability of the design.the site layout is an adaptation of neighbourhood concept of planning. The site comprises of four interdependent units which consists of the 2-bedroom housing units, 3-bedroom housing units and corner shops. These can be regarded as self sustaining communities, however the four units share facilities such as health care centres, police post and a proposed nursery and primary school.

7.1.1 SITE ZONING

This shows how the facilities on the site are distributed. Zoning of functions means grouping of similar functions on the site. It could be

grouped as public, semi-public, and private areas or noisy, semi-noisy, and quiet areas.

7.2 MATERIALS

The choice of materials has been greatly influenced by the following:

i Availability

ii Cost effectiveness

iii Strength

iv Affordability

CONCRETE

It is a combination of several materials and it is only as strong as its weakest element. It is strong in compression and weak in tension. It is made up of cement, water and aggregate in standard ratio. Its strength is determined by weather resistance, durability and water tightness after setting.

CERAMIC TILES

This may be glazed or unglazed and are produced with various physical properties and surface finishes. Though this is expensive, it is very durable. Also broken pieces which are regarded as waste can still be utilized to achieve the same purpose.

GLASS LOUVERS

Glass is a transparent, hard and brittle material. Glass louvers will be used for windows.

PORTLAND CEMENT

In its broader meaning, applies to any material that will bind two or more non-adhesive substances together. Portland cement has the following basic composition:

i Lime 60-65%

ii Silica 10-25%

iii Iron oxide 2-4%

iv Alumina 5-10%

Most of the ingredients in Portland cement are found in nature. Limestone, shale, slate, clay, chalk, cement rock, oyster shells, silica sand, iron ore.

AGGREGATES

They make up approximately 66-78% of the volume of concrete. They range from fine sand to rocks 1.5 inch in diameter or larger. Natural aggregates such as sand and gravel are taken from river banks or gravel deposits. They are usually mixed with dirt or foreign substances which must be removed before they can be used.

WATER

Attention is seldom paid to the quality of water used in construction. Often water for drinking is specified. Drinking water is relatively free of chemicals or materials that could harm concrete. The water should be free of sulphates.

REINFORCED CONCRETE

It is a combination of steel and concrete, which takes advantages of high compressive strength of concrete and high tensile strength of steel.

BURNT BRICKS

It is made of natural sand and clays or shale. These clays are composed of silicate or alumina and small percentages of other materials. Various colours can be achieved with the use of different types of clay. It can be made locally by unskilled labour.

ALUMINIUM

It is highly resistant to weather and corrosive seacoast atmospheres. The metal is not weakened structurally.

PLASTER (PORTLAND CEMENT)

It is a combination of Portland cement, masonry cement, sand water and a plasticizing agent such as lime. It provides a hard and durable surface which is unaffected by water.

WOOD

The grain direction is the determining factor of wood as a structural material. timber roof trusses will be used for all structures.

PLASTICS

Plastics are divided into three categories:

i Thermosetting plastics, which harden when heated

ii Thermoplastics which become plastic when heated

iii Elastomers which are permanently elastic.

The beneficial characteristics of plastics in construction include:

i Water and corrosion resistance

ii Low maintenance

iii Low weight

iv High resistance to light

v Easy to work and process

vi Low thermal conductivity

Plastic products to be used in construction include:

i Pipes, tubes and accessories

ii Sealing materials

iii Furniture and accessories

iv Electrical installations and accessories

v Valves and sanitary accessories

vi Water tanks

PAINTS

This is an opaque or clear film form material that acts as a shield or barrier between the building material and those elements or conditions that may adversely affect it.

7.3 CONSTRUCTION

The construction of the housing estate will be carried out in phases. First of all, it is very important to construct the rod network within the estate first because it is from the road that that levels will be taken. If this is not done, there is a high probability that the roads will be higher than the ground level for the houses. This causes water to accumulate around the houses.

After the road construction has been completed, the construction of the housing units will begin. The sub-structure first, the super-structure, and then the roof.

The sub-structure comprises of the foundation up to and including the ground floor. Strip foundation will be used for the buildings.

The super-structure comprises of load bearing walls, non-load bearing walls, columns and beams.

Timber trusses will be used to roof all units on the site. This will be covered with long span aluminium roofing sheets.

Windows, doors, sanitary and electrical fittings will be fixed after basic construction work has been completed. Painting and finishes will come after other works have been completed.

Landscaping work will be carried out after other construction works have been completed.

7.4 SPACE REQUIREMENTS

Facilities to be provided on site include:

i 2-bedroom housing unit

ii 3-beddroom housing unit

iii healthcare centre

iv corner shops

v recreational areas

7.4.1 SCHEDULE OF ACCOMMODATION

2-bedroom unit	**Area (metre square)**
Living area	56
Kitchen	6
Master bedroom	16
Bedroom	12
Toilet and bath	4

3-bedroom unit

Carport	18
Living area	48
Kitchen	12
Master bedroom	20
Bedrooms	12
Toilet and bathroom	4
Health care center	
Carport	18
Waiting area	24
Consultancy	9
Card room	4
Store	4
Pharmacy	6
Treatment room	6
Observation room	24
Convenience	6

CHAPTER EIGHT

8.0 SERVICES

8.1 ELECTRICITY AND LIGHTING

The site will be serviced by power generated from the state owned gas turbines.

There are two methods of lighting namely natural and artificial. Both will be utilized in the buildings; natural during the day and artificial at night.

8.2 HEATING, COOLING AND VENTILATION

Heating, cooling and ventilation of the interior space of buildings is for the comfort of the occupants. As much as possible, natural means of achieving a reasonable level of thermal comfort will be utilized. Good environmental comfort stems from a relationship between air temperature and mean radiant temperature, air temperature and relative humidity, air temperature and air motion.

The buildings are oriented to maximize the flow of the prevailing wind which is the south west trade wind. This encourages the constant movement of wind between the buildings so there is a replacement of air which result in an almost stable air temperature. Also the use of building materials which provides a certain level of thermal insulation will be utilized to reduce heat gain and loss within the buildings.

-8.3 WATER SUPPLY

The site has a high water table this will be used to full advantage. Boreholes will be constructed to provide potable water on the site.

8.4 DRAINAGE AND SEWAGE DISPOSAL

Surface water drainage will be taken care of by laying paved area to a gradient towards channels that collect surface water and discharges through drains. Rain water fallen of roofs are collected by roof gutters and discharge through drain pipes to ground drainage.

Foul water drainage system collect discharges from water closet, baths, wash hand basins and sinks. Soil pipes will be connected to the foul water drain which will discharge waste into septic tanks and from there to soak away pits. This utilizes the natural process of decomposition to convert waste matter.

8.5 REFUSE DISPOSAL

The disposal of refuse is not dependent on any fixed system and can be done in many ways. However the separation of organic and inorganic matter, that is , decomposable and non-decomposable matter. The decomposable matter will be discharged in compost pits provided on the site while non-decomposable matter will be removed by refuse disposal trucks.

8.6 ACOUSTICS

Acoustic considerations in residential units are not many. This can be taken care of by soft furnishings.

8.7 FIRE SAFETY

Building regulations require that due consideration should be given to:

i the flammability of building materials

ii arrangement of fire prone areas

The aim is to prevent the start and spread of fire, stem the spread of smoke and facilitate rescue or escape of persons.

8.8 SECURITY

Security posts have been placed at both entrances to the site.

8.9 MAINTENANCE

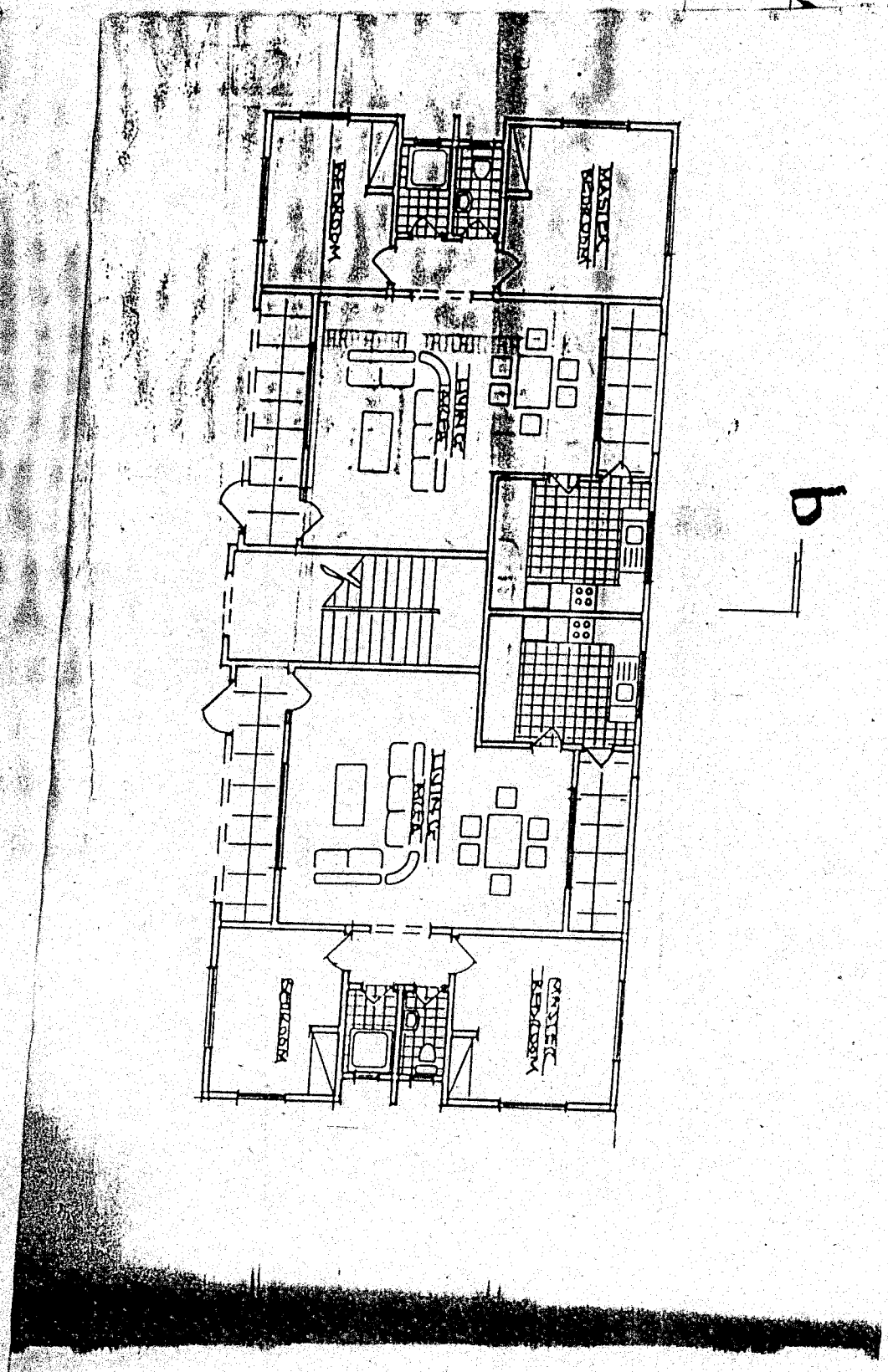
To ensure a high level of maintenance weekly sanitation activities will be carried out within the estate as well as inspection of properties.

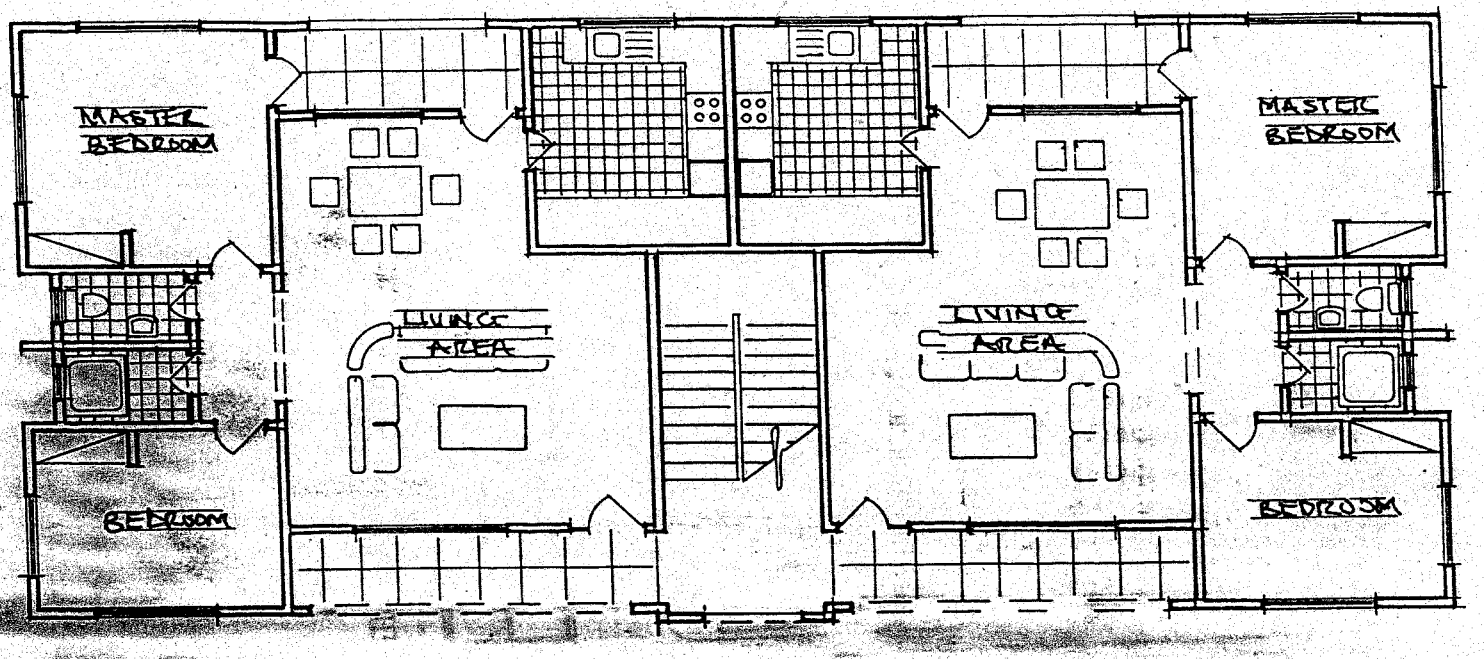
8.9.1 COMMUNICATION

The facilities on site will be connected to the services of the Nigerian telecommunications (NITEL). This will provide links between facilities on the site and the outside world.

8.9.2 SOLAR CONTROL

The longer sides of buildings will be oriented to the north to reduce wall area heated up by the sun. Also trees will be used as shading devices on site.

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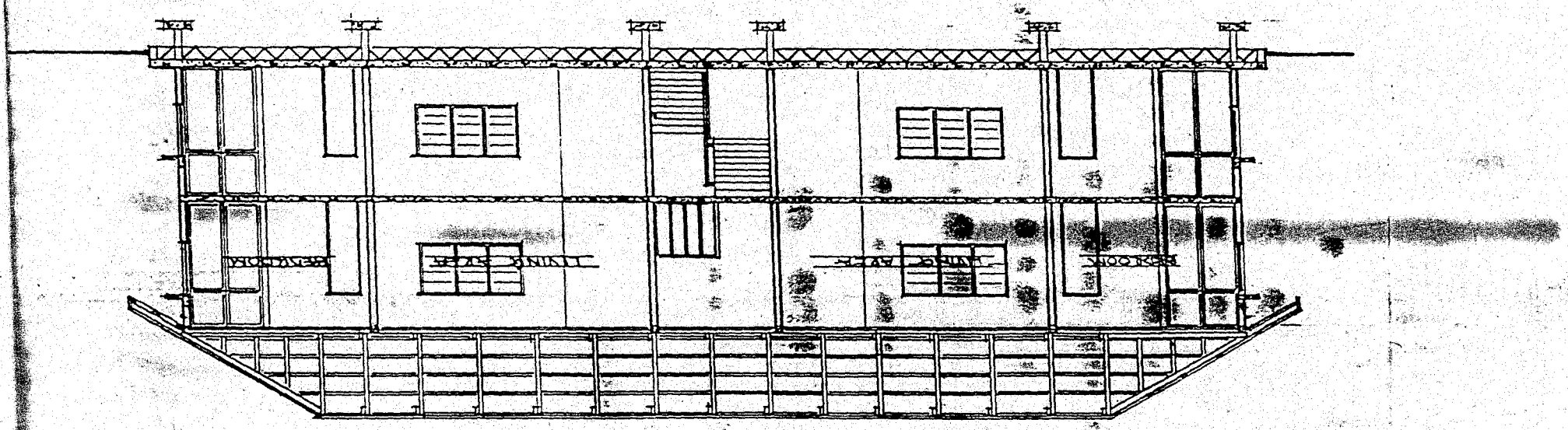
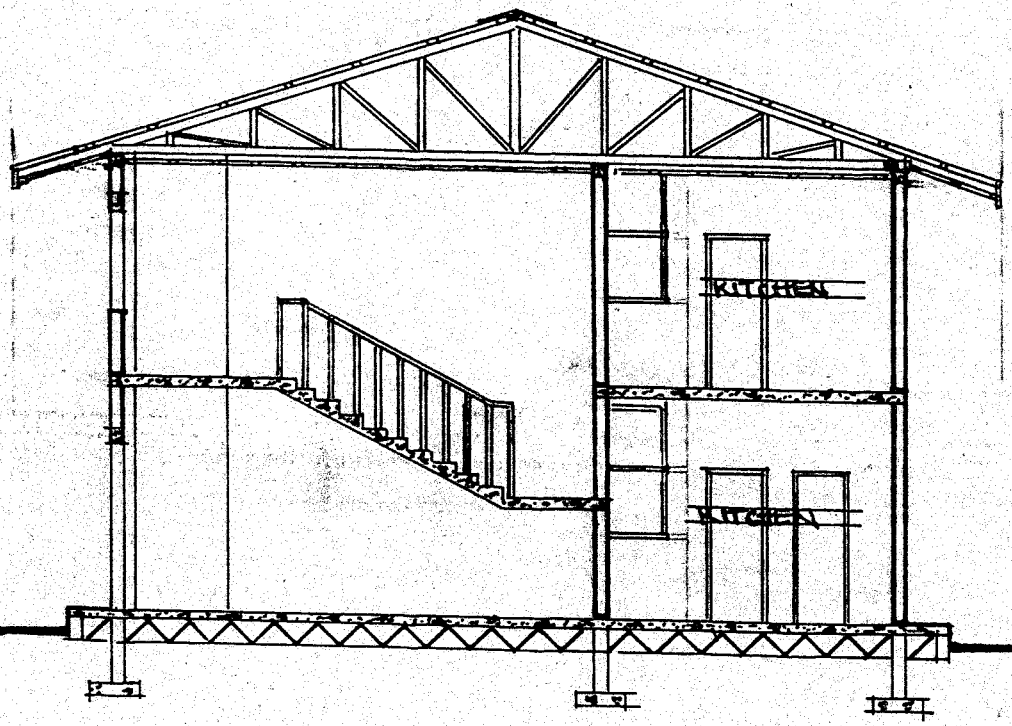
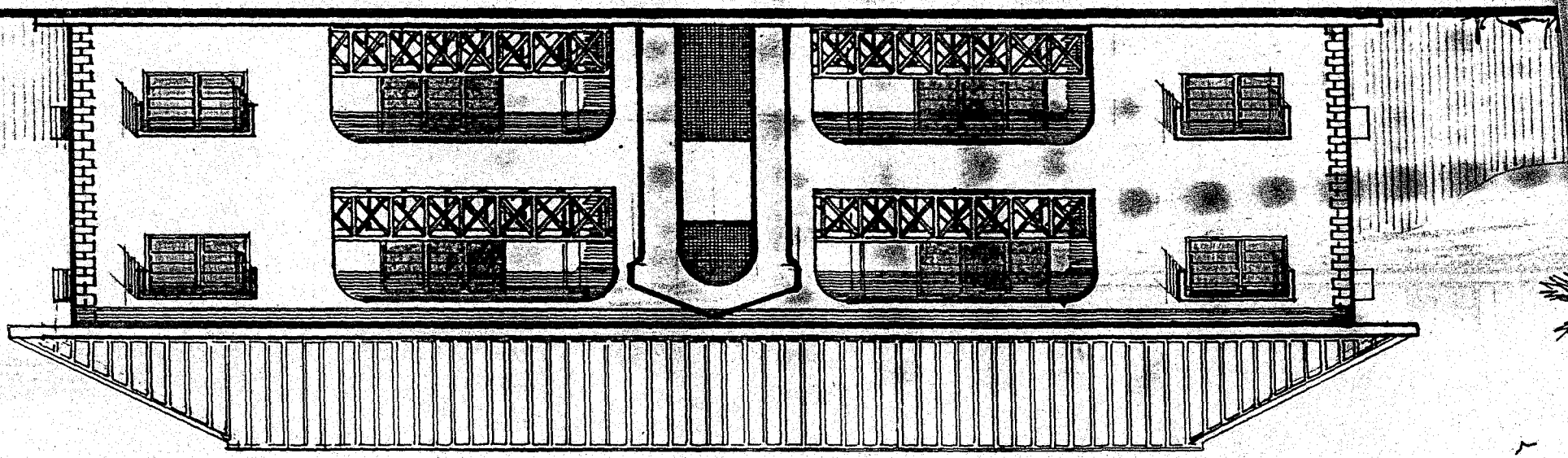
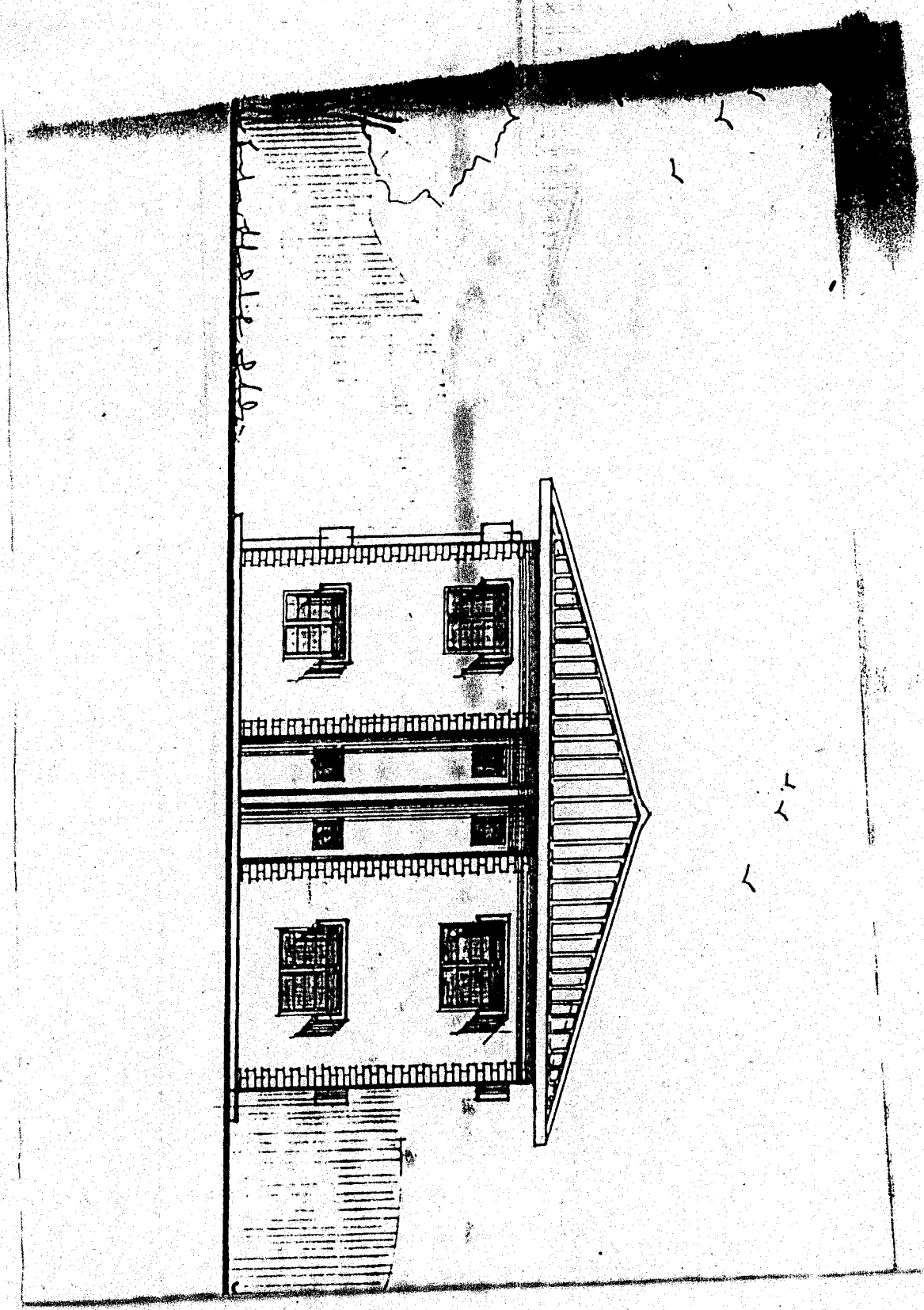



KITCHEN
KITCHEN





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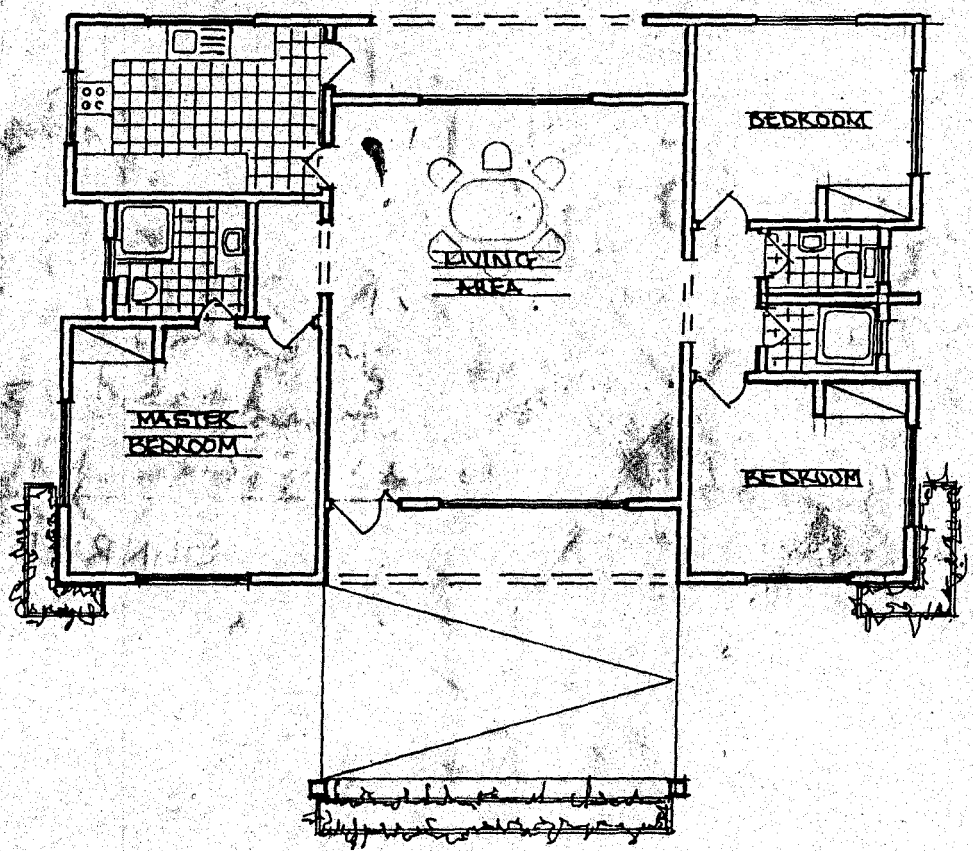

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floor plan

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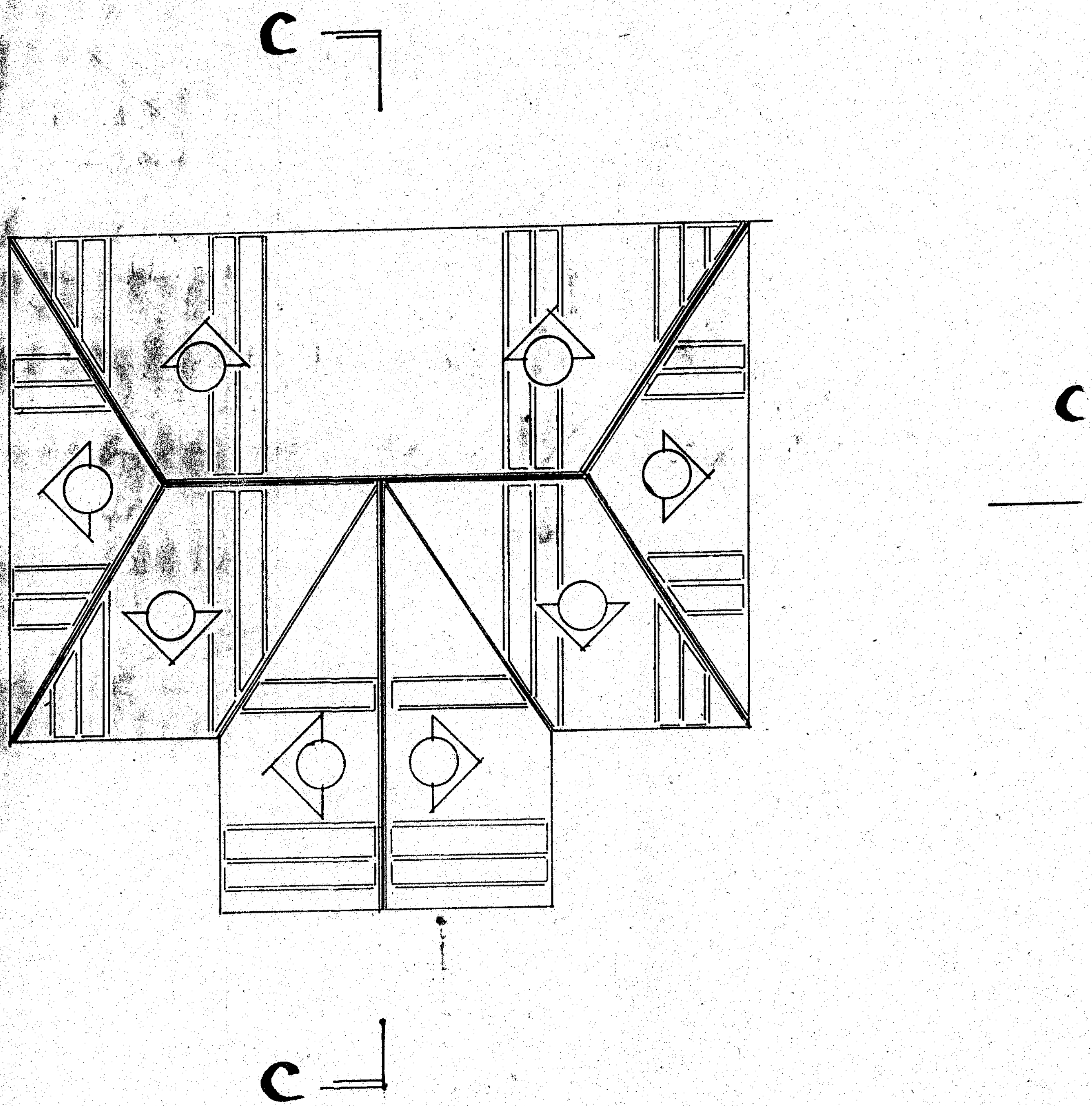
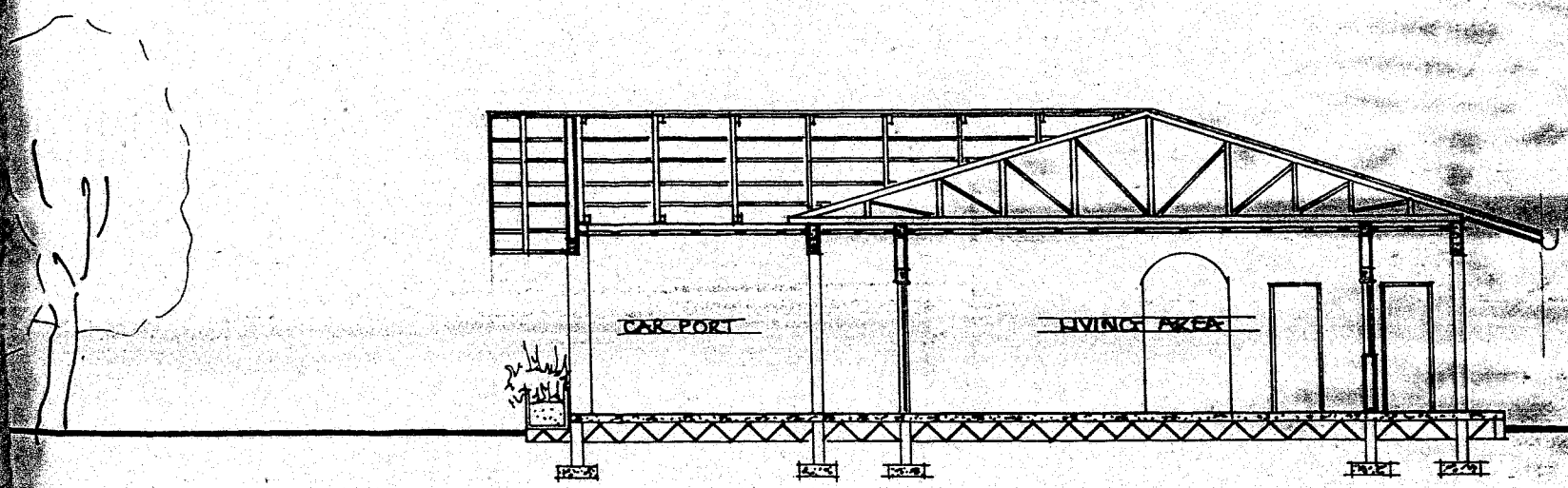
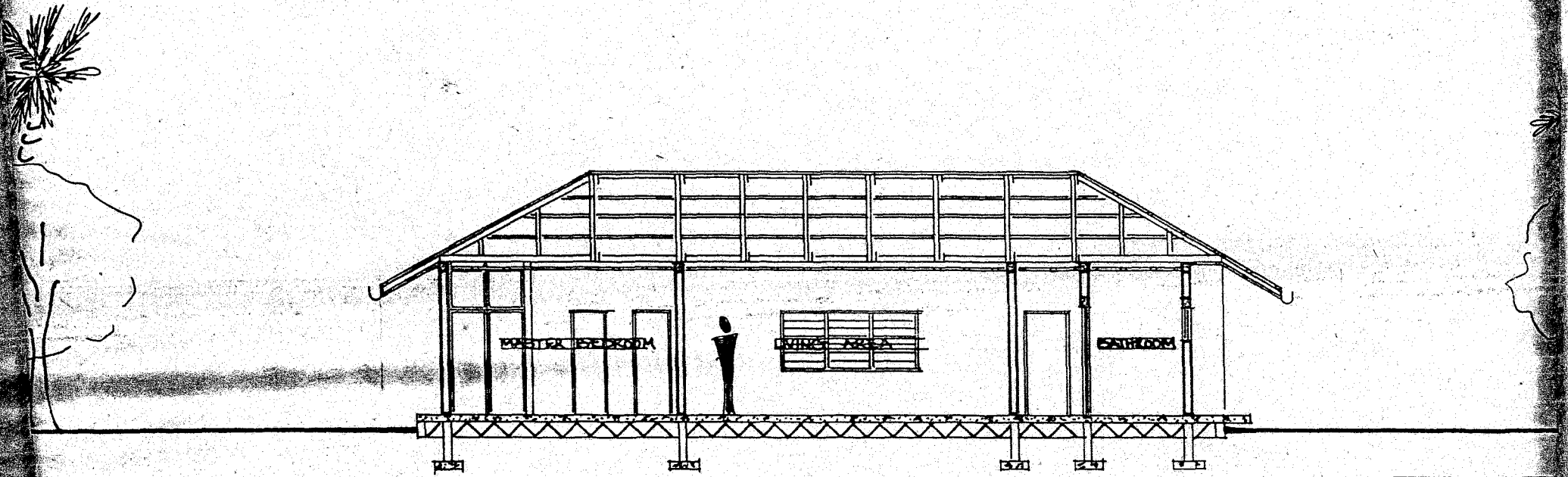


roof plan


CAR PORT
LIVING AREA



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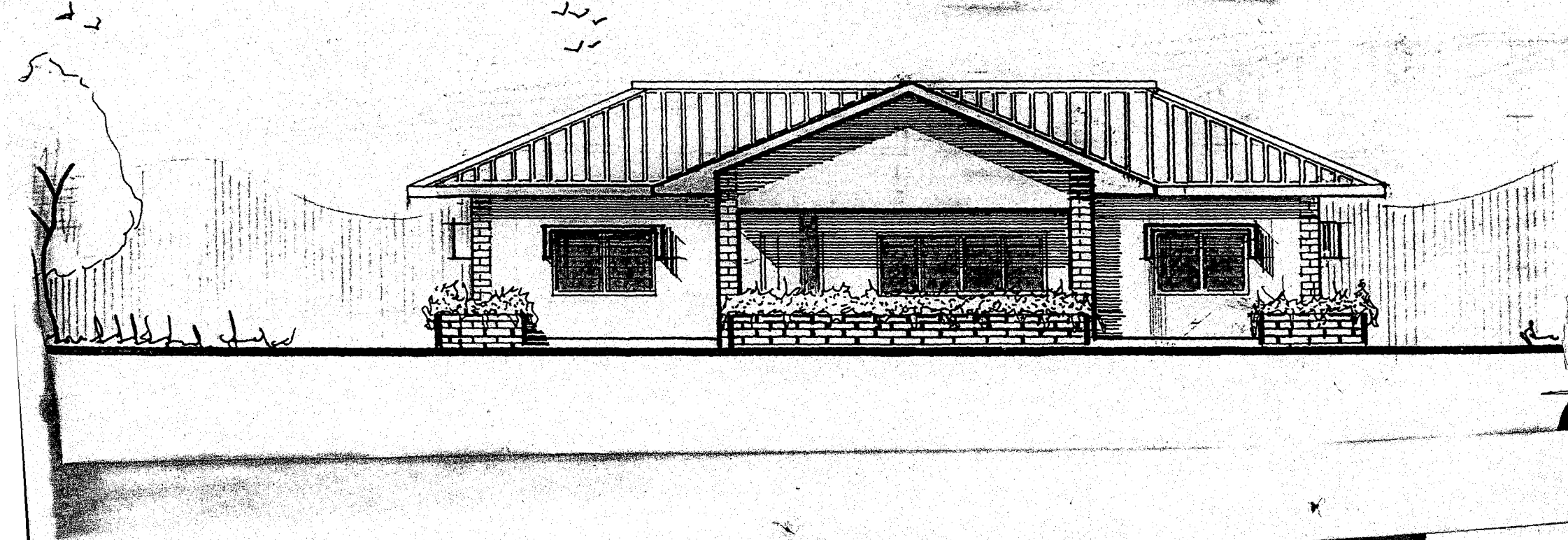

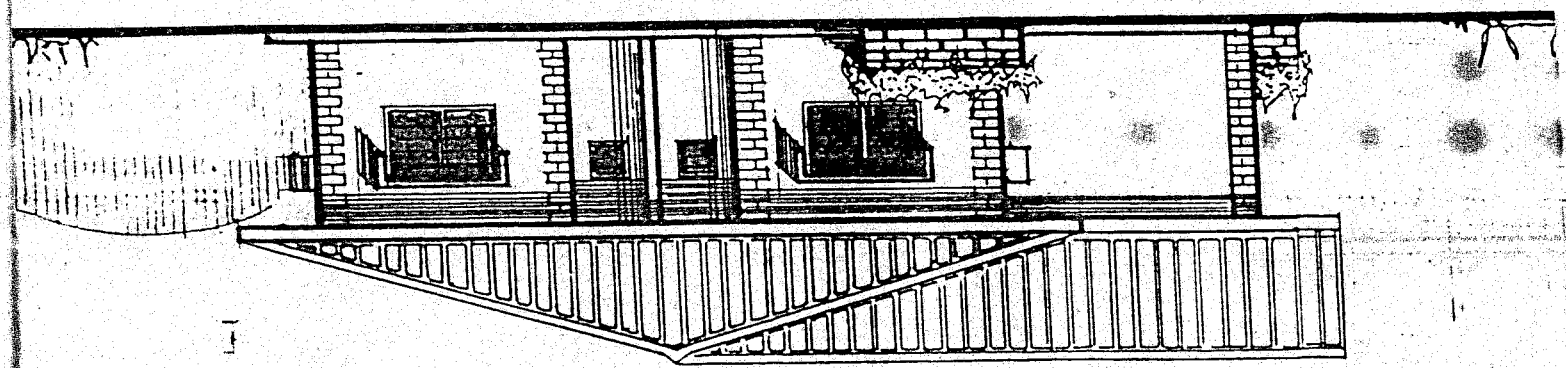

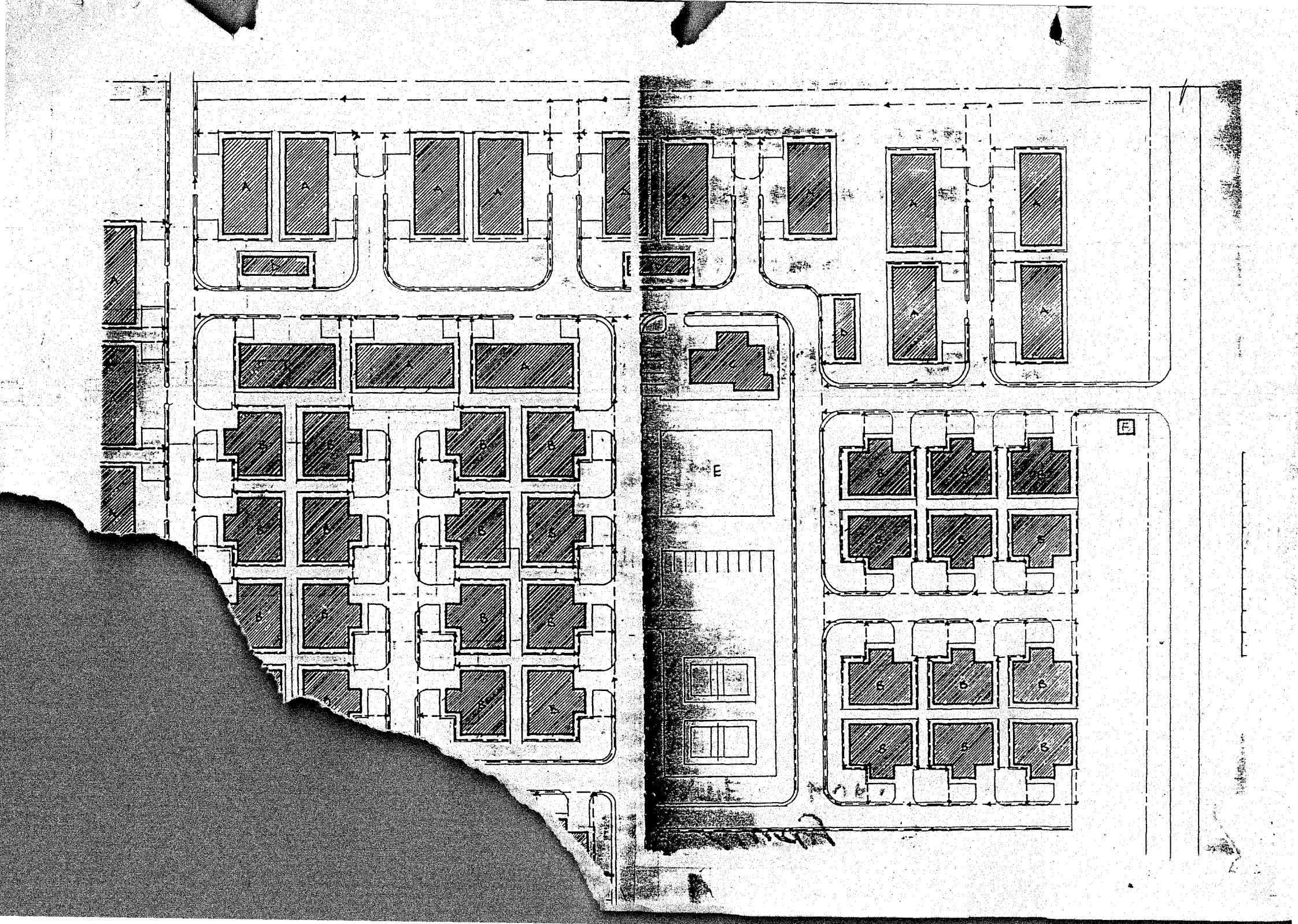
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