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REPUBLIC OF KENYA  
MINISTRY OF AGRICULTURE  
NATIONAL IRRIGATION BOARD

BURA IRRIGATION  
SET-UP PROJECT

PROJECT PLANNING REPORT

VOLUME 5 ANNEXES

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The Bura Irrigation Settlement Project,  
Project Planning Report, comprises the following volumes:

- 1        Main Report  
  
          Annexes
- 2        Soils  
          Hydrology  
          Agricultural Planning
- 3        Livestock  
          Fisheries  
          Wildlife and Ecology  
          Forestry
- 4        Sociology and Settlement  
          Public Health  
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- 5        Village Planning and Design  
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- 6        Principles and Criteria for Development  
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BURA IRRIGATION SETTLEMENT PROJECT  
PROJECT PLANNING REPORT  
VILLAGE PLANNING AND DESIGN ANNEXE

**BURA IRRIGATION SETTLEMENT PROJECT**  
**PROJECT PLANNING REPORT**

**VILLAGE PLANNING AND DESIGN ANNEXE**

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### *Rural Centre Structure Plan*

Two alternative conceptual structure plans, reflecting the spatial dimensions and location of various land uses within the administrative entity, were prepared. The land-use components include a primary school, irrigation pump house (NRI) workshop, a Regional Transport Service (RTS) stand, institutional servicing plants and schools. In addition, an administrative zone, a commercial district, a health centre, and recreational areas are proposed. These are illustrated in Figures 4.1 and 4.2.

The Rural Centre would consist between 5 000 and 10 000 inhabitants at the mid-term stage of Phase I of the project. Expansion space has however, been allocated for internal rural population growth, natural increases, and for the possibility that Phase II of the project is initiated.

## SUMMARY

The purpose of the village planning review in the context of the Project Planning Report of the Bura Irrigation Settlement Project was to identify and analyse previously established planning criteria, to amend these if required, to develop a theoretical and functional network of tenant villages, and to prepare conceptual designs for various types of centres. On the basis of site visits, of a review of relevant documents, and after meetings with the authorities concerned, a statement of goals and objectives was derived, and was followed by the determination of a series of planning parameters for site selection and village design. A project structure plan, conceptual village layouts, and a land-use plan for an administrative centre were the ultimate results of the studies.

The conclusions and recommendations from these studies indicate the following:

### *Centre Network*

A maximum population of 2 500 persons is recommended for villages, for health, sociological and administrative reasons. This parameter coupled with a maximum walking distance by tenants to their holdings led to the conclusion that at least 23 villages will be required in Phase I of the project, to accommodate the expected population. These villages would form a hierarchy of centres of three economic orders, namely: 4 market centres, 8 local centres, and 11 sub-local centres. Their respective functions would vary in terms of educational, health, commercial and administrative resources, yet their population sizes would be approximately equal.

### *Village Locations*

The sites for the 23 villages were identified within the context of the following parameters: soils suitability, walking distances to holdings, relationship to the proposed transportation infrastructure, relationship to each other, and cost of servicing runs. Wherever possible and feasible, villages were grouped together, so that services and roads could cater for one or more sites.

In general, the villages would be located near branch or block canals, at the perimeter of irrigation fields.

### *Rural Centre Location*

To meet the specialised economic and administrative requirements of the project, and to accommodate associated industrial, educational and residential uses, an administrative or Rural Centre is required. This should be centrally located, accessible, near the scheme, and include sufficient space to allow for all anticipated uses and for expansion. A suitable location for this urban area was identified north of the Pumwani branch canal, east of the main canal. It is accessible from the relocated Garsen - Garissa trunk road and from all villages, and commands sufficient space to contain all anticipated uses.

### *Rural Centre Structure Plan*

Two alternative conceptual structure plans, reflecting the spatial dimensions and location of various land uses within the administrative centre, were prepared. The land-use components include a ginnery, a National Irrigation Board (NIB) workshop, a National Youth Service (NYS) yard, infrastructural servicing plants, and schools. In addition, an administrative zone, a commercial district, a health centre, and residential areas are proposed. These are illustrated in Figures 4.1 and 4.2.

The Rural Centre would contain between 8 000 and 10 000 inhabitants at the mature state of Phase I of the project. Expansion space has, however, been allocated for informal sector population growth, natural increases, and for the eventuality that Phase II of the project is initiated.

The Rural Centre shown in the alternative designs, is easily accessible from the Garsen - Garissa Road as well as from villages within the project area. Industrial traffic would not be routed through the town, but bypass it by the Pumwani branch canal road.

### *Village Design*

To avoid the monotony and dilution of spaces experienced in the grid-iron patterned villages of the Hola Irrigation Scheme, a new concept, based on the proposed procedure of settling smallholders, is envisaged. This concept is grounded on a hierarchical system of units, cells, modules and wards, assembled in increments of six houses. Thus, two units of six houses would compose a cell, arranged around a central courtyard. Two cells of twelve houses would, in turn, make up one module. Three modules would form one ward of 72 houses and a complete village would be composed of four residential wards (see Figures 3.1 to 3.4).

The residential wards would be symmetrically aligned along a central village axis. Basic commercial, administrative, social and educational amenities would be located at the centre of the village, on either side of the central axis. These non-residential uses and the central axis would thus separate the settlement into residential quadrants.

The advantages of this conceptual layout are as follows:

- (a) Each village would be introspectively oriented and walking distances to the central area be equalized due to the concentric pattern.
- (b) A compact village structure, in harmony with climatic design criteria for hot arid regions, would result.
- (c) The modular arrangement would foster the creation of a hierarchy of spaces for play, meetings, aesthetic enhancement and orientation. The monotony of grid-layouts would be avoided.
- (d) Water supply to standpipes in the courtyards of the cells would be relatively economical.
- (e) The proposed plot sizes of 392 square metres per house would permit easy extension of structures within the plot.
- (f) The layout concept could be generally applied to all villages required for the project, with modifications in response to preferred village orientation, desired population capacity, given site configuration, required non-residential land use components and prevailing physical characteristics.

It is emphasised that the site selection and design of centres, outlined in this report, is preliminary and conceptual only. Field verification of proposed sites, and detailed designs for each village must be undertaken prior to implementation of the project.

## CHAPTER 1 INTRODUCTION

### GENERAL BACKGROUND

#### 1.1 Scope of Work

In the long term the Bura Project may comprise development of both the western bank (Stage I) and the eastern bank (Stage II) of the Lower Tana River. Immediate development of part of the western bank (Stage I, Phase I), some 6 700 hectares is currently proposed. A further development of about 5 500 hectares of the western bank (Stage I, Phase II) may occur if soils prove suitable: this Phase II would comprise two separate areas, about 1 600 hectares north of the Laga Hiran and about 3 900 hectares adjacent to the existing Hola Irrigation Scheme. This report is primarily concerned with the planning of the 6 700 hectares of Stage I, Phase I of the project, but also demonstrates how the development of Phase II would be integrated with that of Phase I.

The first phase of the Bura Project, approximately 6 700 net hectares of irrigation land, is to be developed for intensive agricultural production and to be settled by tenant smallholders selected from all regions of Kenya. It is envisaged that these tenants will be housed in a number of villages located within a reasonable walking distance of their holdings, and containing a limited range of social, educational and infrastructural facilities, generally associated with the rural life style. Also included in the villages would be services and housing for administrative personnel and for an affinitive non-agricultural population, likely to be composed of shopkeepers, medical personnel, teachers and others.

Previous work on housing and village planning for the Bura Project has been limited to a preliminary identification of a network of service centres, and some cost estimates of several settler housing types. These studies (1) undertaken as part of a feasibility study completed in 1975, are now outdated, because the scope of the project has been substantially reduced. Criteria and conceptual or prototypical designs for villages have thus far not been formulated for the project.

Housing and associated facilities represent a major cost component of the Bura Project. In addition, the success of the project can be greatly dependent on the level of satisfaction achieved by individual tenants in their home life. It is thus of paramount importance that functional yet economical housing be developed on the project and that settlements suited for the climatic, topographic and economic characteristics of the area, be planned. In this context, it is the primary purpose of this part of the Project Planning Study to:

- (a) Review the criteria, base data, conclusions and recommendations of previous work on village planning and design for the Bura Project.
- (b) Determine the theoretical number and types of towns and villages required to accommodate the population estimated for the reduced scheme.
- (c) Select sites for the towns and villages
- (d) Prepare a general structure plan, outlining the relationship between Phase I (6 700 hectares net irrigable land) and Phase II (5 500 hectares net irrigable land), including village sites and roads.
- (e) Prepare conceptual designs for various types of settlements, including a settler village and the main rural (administrative) centre of the project. These layouts should include a functional integration of land-use components and adhere to established design criteria regarding climate aesthetics, social convenience and engineering feasibility.

## 1.2 Study Method

The village planning studies for the Project Planning Report are based to a large degree on the previous work performed by ILACO, the National Irrigation Board (NIB) and the Physical Planning Department of the Ministry of Lands and Settlement. The Yellow Cover Report of the World Bank (IBRD) further served as a framework for the identification of tenant requirements. The most relevant planning criteria resulting from these preliminary studies are summarised and discussed in Chapters 2 and 3 of this Annexe.

As part of the familiarisation with the proposed project, field visits to the site and to other similar projects were undertaken by the village planning team. Particular attention was paid to the Hola Irrigation Scheme, which, due to its propinquity and location, was deemed to provide a good indication of conditions likely to develop at Bura.

The field studies included visits to, and preliminary soil sampling of, various potential sites for settlements, discussions with NIB personnel and existing tenants, examination of tenants houses and administrative buildings, as well as a brief identification of available construction materials. This information coupled with data from previous studies and with a recent survey conducted by the NIB, was then analysed critically, resulting in a matrix of planning and design parameters. These were subsequently applied to the ultimate village site selection and conceptual layouts.

An examination of the available base data ultimately resulted in the definition of the desired ends to be achieved for the Bura Project, in terms of village site selection and design. These are:

(a) *Goal*

To develop a hierarchical network of service centres and villages for the tenants and staff of the Bura Project, maximising socio-economic and infrastructural services, minimising project costs, and emphasising aesthetic quality.

(b) *Objectives*

(1) To provide convenient, spacious, and dignified housing for the tenants, staff and affinitive population, within the constraints posed by materials availability and costs.

(2) To develop an interesting village fabric, maximising administrative ease, a community spirit and identity, individual expression, thermal comfort, public and personal spaces, social services and infrastructural components, and minimising health hazards, ecological disruption, distances to fields and services, and capital costs.

(3) To formulate a hierarchical structure plan in conformance with the Republic of Kenya Development Plan, 1974-1978, incorporating a nesting procedure for the distribution of goods and services.

(4) To provide space for the immediate needs and eventual expansion of tenants, affinitive population and all concerned private and stataal agencies.

(5) To optimise the location of service centres, houses and project-related structures in terms of soils suitability, social and educational services, water supply, the irrigation fields and the region as a whole.

(6) To optimise access to, and internal circulation within, villages and the project as a whole.

(7) To plan the required network of service centres for the first phase of the Bura Project so that it can be easily integrated with centres required for Phase II of the project.

The observation of planning principles throughout the study enabled these goals and objectives to be generally attained. To this end, various basic criteria were developed by members of the multi-disciplinary study team, and applied by the physical planners towards the development of a theoretical land-use programme for villages and centres of diverse orders. In particular, the contributions of the sociologist, municipal engineers, management, and institutions and services specialists, as well as pedologists, health consultants and architects, were extremely useful in the derivation of realistic design parameters for villages and the regional structure as a whole.

Base data about the study area, relating to physical and climatic features, locational characteristics and the infrastructural components of the project, have been amplified in several previous reports, including the ILACO Feasibility Study and the IBRD Yellow Cover Report, and need not be repeated here. For detailed information regarding the sociological, demographic, institutional, administrative and other technical considerations, the reader is referred to the appropriate annexes of the Project Planning Report. Only the information directly related to site selection and land-use planning of service centres is summarised in this annexe.

- (a) A network of service centres housing unskilled project staff and an effective population will be established, consisting of urban rural, market, local and sub-local centres and providing a descending order of services.
- (b) To encourage the evolution of a community spirit and a rustic atmosphere, the average population size of the villages (market, local and sub-local centres) would range between 2 000 and 3 000 persons.
- (c) The anticipated territorial size of the villages range between 50 and 80 hectares, including vegetable garden plots. Village areas are calculated on the basis of 2 000 square metres of land per tenant family.
- (d) The agricultural holding of each tenant should be located within a walking distance of less than two kilometres from his village.
- (e) The agricultural holdings of tenants from a given village should preferably be consolidated by irrigation units adjoining the village.
- (f) Villages should contain nursery schools, health service delivery units, social halls and primary schools. More advanced social and educational services would be provided in centres of higher order, such as market and rural centres.
- (g) Centres should be located in non-irrigable land, exhibiting good drainage characteristics.
- (h) Centres should be interconnected by the internal transportation network contiguous to the canal system.
- (i) Water treatment plants are envisaged for clusters of centres and for project compounds. Communal water points should be provided in each of the centres. Water consumption was assumed to be 100 litres per head per day.

In the original Bura Irrigation Project proposals outlined in the ILACO Feasibility Study (1975), 38 towns and villages would be required to serve a project area of about 14 000 hectares. According to the criteria outlined in the Republic of Kenya Development Plan, 1974-1978, the diverse centres of various ranks, each type offering an increasingly specialised degree of commercial and administrative assistance to a larger population, would be dispersed as shown in Table 2.1 below.

## CHAPTER 2 THE VILLAGE NETWORK

### PLANNING CRITERIA

#### 2.1 Previous Proposals

In the feasibility study prepared by ILACO (1975), an array of criteria defining the number and location of service centres, was proposed. These criteria, generally accepted by the NIB and the IBRD, are briefly summarised as follows:

- (a) Each tenant family selected for the project will obtain 1.25 hectares of irrigable land for the production of cotton and food crops.
- (b) Each tenant family will receive one vegetable garden plot measuring 500 square metres for the production of food crops for personal consumption or sale.
- (c) A network of service centres housing tenants, project staff and an affinitive population will be established, consisting of urban, rural, market, local and sub-local centres and providing a descending order of services.
- (d) To encourage the evolution of a community spirit and a rustic atmosphere, the average population size of the villages (market, local and sub-local centres) should range between 2 000 and 3 000 persons.
- (e) The anticipated territorial size of the villages ranges between 50 and 80 hectares, including vegetable garden plots. Village areas are calculated on the basis of 2 000 square metres of land per tenant family.
- (f) The agricultural holding of each tenant should be located within a walking distance of less than two kilometres from his village.
- (g) The agricultural holdings of tenants from a given village should preferably be consolidated in irrigation units adjoining the village.
- (h) Villages should contain nursery schools, health service delivery units, social halls and primary schools. More elaborate social and educational services would be provided in centres of higher order, such as market and rural centres.
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- (j) Centres should be interconnected by the internal transportation network contiguous to the canal system.
- (k) Water treatment plants are envisaged for clusters of centres and for project compounds. Communal water points would be provided in each of the centres. Water consumption is assumed to be 100 litres per head per day.

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Table 2.1 - Service Centre Requirements, Original Bura Irrigation Project

Centre level	Quantity	Service Area (population)
Urban	1	100 000 to 120 000
Rural	2	30 000 to 40 000
Market	4	10 000 to 15 000
Local	12	3 000 to 5 000
Sub-local	19	less than 3 000

If the criteria developed in the ILACO Feasibility Study are applied to the present Bura Project (Phase I - 6 700 hectares of irrigable land) then 33 500 settlers and their families could be expected, plus an affinitive population of project personnel, shopkeepers, teachers and others. Assuming that the affinitive inhabitants represent 25 per cent of the population (as originally estimated by ILACO), then approximately 42 000 people would settle on the project. Theoretically, this would result in the following breakdown of dispersed service centres: One rural centre, three market centres, five local centres and nine sub-local centres.

## 2.2 Revised Criteria

After the review of the criteria proposed in the ILACO Feasibility Study, and of the irrigation sector layout recently submitted by the same consultant, it was concluded that at least 24 service centres, would be required for the settlement of farmers and the affinitive population. This conclusion is based on the following revised planning parameters:

### (a) Village size

The population of villages, including market, local and sub-local centres, should not exceed 2 500 persons. This threshold is deemed to be the most appropriate for the provision of health care delivery, for the administration of the centre by unskilled volunteer personnel, and for instilling a community spirit into the tenants. In addition, walking distances to agricultural plots are inversely proportional to the number of villages provided. Thus, the greater the number of villages, the shorter the walking distances.

Other reasons for proposing a theoretical village population limit of 2 500 persons are:

- (1) A territorial reduction of individual village sites by increasing their number.
- (2) Delivery of primary education in accordance with standards of the Physical Planning Department, Ministry of Lands and Settlement (one school for every 5 000 persons).
- (3) Ease of design and implementation through standardisation.

It is emphasised that while a village size of 2 500 persons is deemed to be the guiding upper limit for reasons summarised here and outlined in greater detail in the Public Health, and Sociology and Settlement Annexes, some flexibility of this figure would be permitted. Although a population expansion factor has been included in this threshold population, marginal deviations must be accommodated on account of changes in economic and demographic conditions.

### (b) Household Size

Each village would contain tenants and an affinitive population consisting of project staff, shopkeepers, and other personnel, including their families. It has been estimated that this support population represents approximately ten per cent of village inhabitants (see Table 3.1).

Theoretically, this would permit the inclusion of 2 250 tenants into a given village. At the

originally assumed household size of seven persons, 321 tenant families could thus be accommodated in each settlement. However, a household size estimate of seven persons may be conservative. Experience in the Hola Irrigation Scheme has shown that household sizes have increased to 10 to 12 persons over a few years due to natural growth and immigration of 'permanent visitors', relatives, and itinerant labourers (2). This was corroborated in discussions with representatives of the Physical Planning Department; in detailed population projections for the present project, outlined in the Sociology and Settlement Annexe; and in the results of population analyses described in the Public Health Annexe.

Assuming an ultimate household size of 10 persons, probably reached after approximately 10 to 12 years from inception of settlement, only 225 tenant households could be accommodated in each village of 2 500 inhabitants. If it is further assumed that the affinitive population, which is likely to exhibit a lower rate of natural increase than the tenants, has an average household size of six persons (including bachelors), then an additional 36 households would result for each village. Thus, a total of 261 households, each requiring a residential unit, must be incorporated into each service centre.

*(c) Number of Villages*

If each village contains 225 tenant families, then 225 agricultural plots and vegetable gardens, each totalling 1.3 hectares should be available for cultivation contiguous to the settlement. Thus, 292.5 hectares of net irrigable land should be allocated to each village. Since 6 700 hectares of net irrigable land are available in the first phase of the project, 23 villages, each containing 225 tenant families, are theoretically required. In Phase II, an additional 1 600 hectares of irrigable land could be appropriated for agricultural production in the Yedi branch canal command requiring a further six villages north of Laga Hiranman.

*(d) Hierarchy of Centres*

In conformance with the hierarchy advocated by the Government of Kenya, the following urban centre pattern would result for Phase I:

Urban Centre	0
Rural Centre	1
Market Centres	4
Local Centres	8
Sub-local Centres	11

Should Phase II be implemented, the 1 600 hectares of the Yedi branch canal command would be served by one market centre, two local centres, and three sub-local centres.

It is assumed that the existing conurbation at Hola will continue to serve as the urban centre for the Tana watershed between Nanigi and villages to the south, as envisaged in the Regional Development Plan for Coast Province (3). It would thus contain the District Headquarters, District Hospital and other institutional services, at least for the foreseeable future. A change in the status of Hola could occur, if the current project is expanded to include Stage I, Phase II, or if the proposed Bura Project, Stage II, east of the Tana River, is implemented. In that eventuality, the weighting of service centres would probably require amendment. For example, the proposed rural centre would likely be upgraded to an urban centre, while one or two market centres might become rural centres. These possibilities must be taken into account during the space allocation process within centres of various orders.

*(e) Population Estimates*

From the previous discussions it becomes apparent that the population likely to be settled during Phase I of the project will include 5 150 tenant families, as well as an affinitive population. The latter would be distributed throughout the service centres, primarily in a main administrative town or Rural Centre.

If 23 villages are established, 57 500 tenants and supporting population would be accommodated. In addition, a population of 8 000 to 10 000 persons is anticipated for a Rural Centre, (see Chapter 4). For planning purposes, the total population of Phase I of the Bura Project is thus estimated at 67 000 persons. Should Phase II of the project be implemented it is envisaged that the area of about 3 900 hectares adjacent to the Hola Irrigation Scheme would be incorporated in that scheme, and the area of about 1 600 hectares north of Phase I and the Laga Hiranman would be incorporated in Phase I. In this case the total expected population for the enlarged Phase I would be approximately 80 000.

## SITE SELECTION OF SERVICE CENTRES

### 2.3 Basic Considerations

Eleven sites for the placement of service centres were selected by ILACO for Phase I of the present project and four sites for the northern sector of Phase II (Yedi). These sites vary in area from 30 to 130 hectares and, in some cases, could accommodate more than one village. A site for a Rural Centre and project compound was not identified.

A maximum walking distance of two kilometres from a tenant's house to his holding has been proposed as a guiding principle in previous studies. This was initially deemed to be excessive, in view of prevailing climatic conditions under which harvests have to be transported to villages. To review the locational suitability of the eleven village sites selected by ILACO for Phase I of the project, the two kilometre criterion was, however, applied in a theoretical analysis of village holding catchment areas. This resulted in the identification of several shadow zones, containing agricultural holdings more than two kilometres from any village. In some cases, walking distances to a holding exceed 3.5 kilometres from the nearest village. Particularly holdings south of the Pumwani branch canal were found to be accessible only by overcoming relatively large distances. Similar difficulties were identified with regard to the villages selected for Stage I, Phase II of the project, north of the Phase I area. A re-distribution of village sites, designed to minimise walking distance to holdings, was thus initiated.

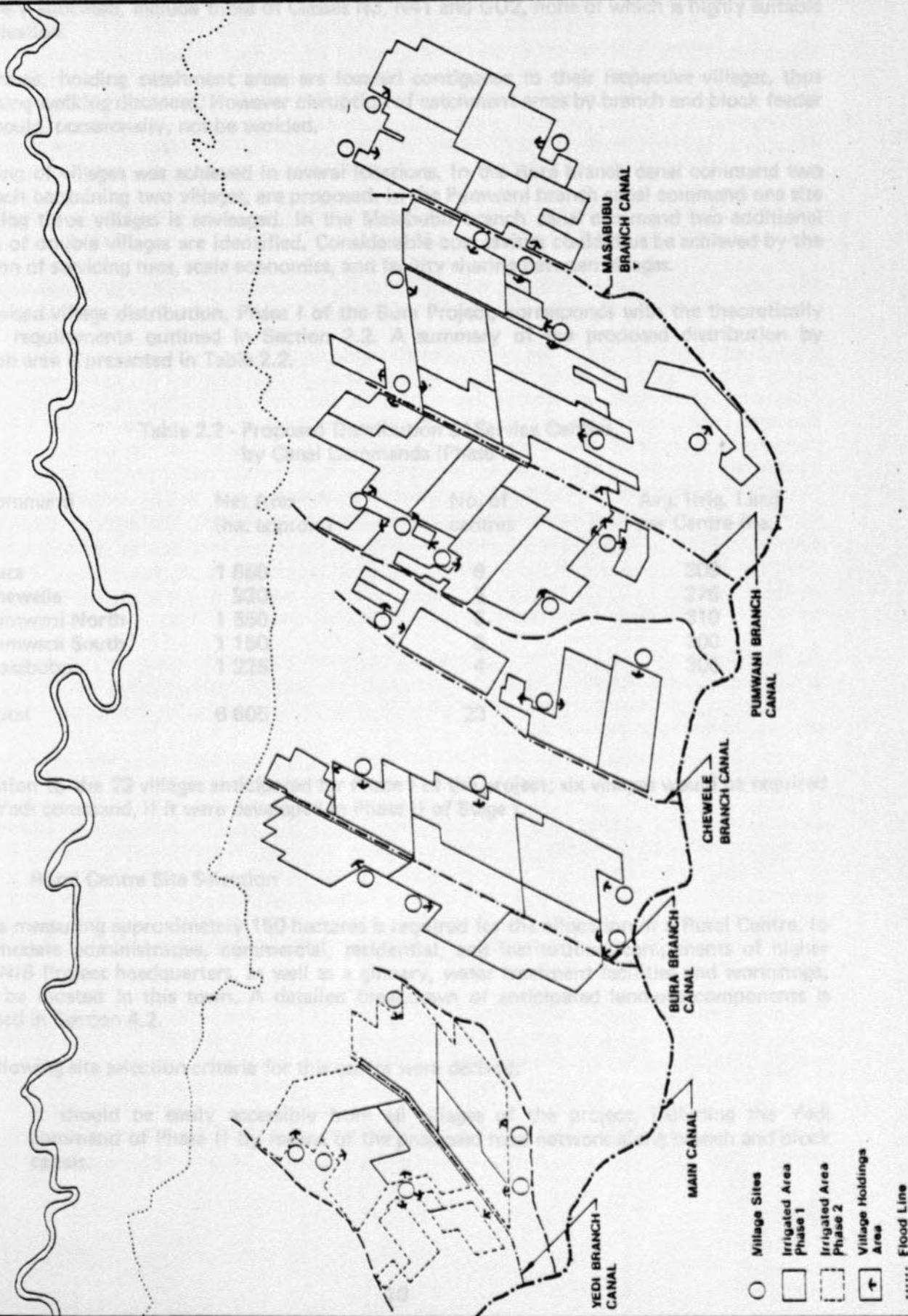
### 2.4 Village Allocation

In distributing sites for tenant villages, the following guidelines were applied:

- (a) Each village should be located contiguous to approximately 290 to 300 hectares of net irrigable land, within a minimum walking distance of two kilometres. Conversely, all irrigable land should be located within two kilometres walking distance of a settlement.
- (b) Villages must be located above floodplain lands.
- (c) Sites for villages selected by ILACO should be retained wherever feasible, because they are generally situated on non-irrigable land and well-drained soils.
- (d) Crossing of branch canals by tenants walking to their fields should be minimised.
- (e) Villages should be located preferably on typic soils (Classes PR; N1, N2) not ideally suitable for irrigation, but exhibiting good drainage characteristics.
- (f) Villages should be clustered wherever possible, to achieve cost savings in servicing and to permit sharing of facilities such as schools, post offices and administrative offices.
- (g) Villages should relate to the proposed road and irrigation networks.

The results of this procedure are illustrated conceptually in Figure 2.1. As can be seen, 23 sites for service centres (villages) have been allocated to the Phase I area and six to the northern part

# CONCEPTUAL VILLAGE NETWORK



of the Phase II area (Yedi branch canal command). With one exception, all sites proposed by ILACO have been retained. However, to cover the previously identified shadow zones not within a walking distance of two kilometres from any settlement, several additional sites have been selected.

The village sites are primarily located on marginally arable land of Class N2. These soils are sandy and exhibit good drainage characteristics. Other soils, on which sites for centres have been tentatively allocated, include those of Classes N3, N41 and GU2, none of which is highly suitable for cultivation.

In all cases, holding catchment areas are located contiguous to their respective villages, thus minimising walking distances. However disruption of catchment areas by branch and block feeder canals could, occasionally, not be avoided.

Clustering of villages was achieved in several locations. In the Bura branch canal command two sites, each containing two villages, are proposed. In the Pumwani branch canal command one site containing three villages is envisaged. In the Masabubu branch canal command two additional clusters of double villages are identified. Considerable cost savings could thus be achieved by the reduction of servicing runs, scale economies, and facility sharing between villages.

This revised village distribution, Phase I of the Bura Project, corresponds with the theoretically derived requirements outlined in Section 2.2. A summary of the proposed distribution by irrigation area is presented in Table 2.2.

Table 2.2 - Proposed Distribution of Service Centres, by Canal Commands (Phase I)

Command	Net Area (ha. approx.)	No. of centres	Avg. Irrig. Land per Centre (ha.)
Bura	1 850	6	308
Chewelle	830	3	276
Pumwani North	1 550	5	310
Pumwani South	1 150	5	300
Masabubu	1 225	4	306
Total	6 605	23	

In addition to the 23 villages anticipated for Phase I of the project, six villages would be required in the Yedi command, if it were developed in Phase II of Stage I.

## 2.5 Rural Centre Site Selection

An area measuring approximately 150 hectares is required for the allocation of a Rural Centre, to accommodate administrative, commercial, residential, and institutional components of higher order. NIB Project headquarters, as well as a ginnery, water treatment facilities and workshops, would be located in this town. A detailed breakdown of anticipated land-use components is presented in Section 4.2.

The following site selection criteria for this centre were derived:

- (a) It should be easily accessible from all villages of the project, including the Yedi command of Phase II by means of the proposed road network along branch and block canals.

- (b) It should be as centrally located as possible, in relation to all villages, to equalise travel distances.
- (c) It should be located within the project area, east of the main canal, to reduce the length of servicing runs, walking, and driving distances.
- (d) It should be located near the main canal for easy water supply.
- (e) It should be located near a branch drainage channel for disposal of treated effluent and storm drainage water.
- (f) It should be located near already proposed roads to achieve cost savings.
- (g) It should be located above the floodplain on gently sloping and well-drained land, with sub-surface conditions favourable for construction.
- (h) It should be located in the vicinity of the Garsen - Garissa Road, soon to be re-routed to the west of the proposed main canal.
- (i) It should be located on a site defined by established physical boundaries, to instill a recognisable identity and to minimise urban sprawl.

Several alternative sites for the Rural Centre were identified and evaluated in relation to the above criteria. Possible locations included one site on the west of the main canal near the Pumwani branch canal, one east of the main canal and south of the Pumwani branch canal, and one east of the main canal and north of the Pumwani branch canal. All three sites exhibit soil characteristics suitable for drainage and construction and each has various advantages and constraints. The latter site, however, appears to combine most positively the requirements of accessibility, distance minimisation in relation to centres water supply, storm drainage, and definition of edges. It was thus selected as the optimum location for the Rural Centre within the context of the project area.

## 2.6 The Structure Plan

To identify the relative placement of centres of different orders within the context of the project as a whole, a Structure Plan, illustrated in Figure 2.2, was prepared. It represents a combination of the conceptual village allocation discussed in Section 2.4 and of the theoretical hierarchy of centres, developed in Section 2.2.

### *Service Centres*

Centres of various orders, such as the rural centre, market centres, local centres and sub-local centres, are identified in their preferred locations, not only in relation to suitable sub-surface conditions, but also respecting obstacles such as canals, drains and roads. All market, local and sub-local centres cover approximately 30 hectares of land, thus meeting the requirements outlined in Chapter 3. In addition, the nesting pattern has been arranged so that the inhabitants of sub-local centres can reach specialised services located only in local and market centres, by walking less than 1.5 kilometres.

Wherever possible, market centres have been centralised to serve two or three other centres of lower order. Centre 1-3, located at the junction of the main canal and the Bura branch canal would, for example, supply services, such as health care, education and specialised shopping, to all villages in the Bura command (see Figure 2.2). It is conveniently accessible along the branch canal roads. Similarly, Centre 1-10 would serve villages in the northern part of the Pumwani command. In the southern part of the latter command, specialised services would be provided by the rural centre.

Centres 1 - 19 and 1 - 23 would serve the southern commands of the irrigation project. The latter village in particular, would be easily accessible from the existing Garsen - Garissa Road and could thus achieve considerable importance as a commercial node.

The construction phasing of the service centres will, in general, take place in harmony with the proposed north to south development of the irrigation commands. The northerly villages (1-1 to 1-6) will thus probably be constructed first, followed by villages 1-7 to 1-23, in a southerly progression.

The rural centre, discussed in Section 2.5 is identified in the Structure Plan in the dimensions anticipated for its ultimate state of development. It would serve as a supply centre for the project as a whole, and also contain the administrative and industrial components of the project. It would thus include housing for junior, senior and subordinate staff and would be complemented by commercial, institutional and recreational facilities designed to fulfil the specialised requirements of the inhabitants of the entire project.

#### *Experimental Farm and Prison Compound*

Other proposed land uses within the project area are a research and experimental farm and a prison farm. Both would be located south of the Pumwani branch canal between the main canal and the South Pumwani irrigation fields (Figure 2.2).

The prison would include a fenced compound for staff and inmates. Approximately 150 hectares of irrigable land would be associated with this institution. This is discussed further in the Institutions and Services Annex.

#### *Transportation*

The transportation network proposed for the Bura Project is outlined in the ILACO Feasibility Study (1975) and the World Bank Yellow Cover Report. Briefly, this consists of surfaced roads (width 4.5 metres) parallel to either side of branch canals and the main canal, unsurfaced roads along block feeder canals, and unsurfaced roads along unit feeders. Block feeder roads leading to villages would be surfaced. It is also proposed that the existing Garsen - Garissa Road be re-located outside the project area, some distance west of the main canal.

In conformity with these proposals, a conceptual road network, reflected in Figure 2.2 was developed. All villages would be connected to the branch canal roads by surfaced feeder roads. In addition, adjoining villages would be linked directly by short, surfaced roads, where required.

Two internal north-south linkages are proposed. The first and most easterly, would permit a direct connection from Centre 1-22 to the most northerly irrigation sector. It would thus link Centres 1-22, 1-21, 1-17, 1-15, 1-9, 1-10 and 1-2 by means of block feeder roads and, in places, by branch canal roads. The second, westerly, internal route would originate at Centre 1-23 and follow block feeder and branch canal roads linking Centres 1-20, 1-19, 1-18, 1-16 1-14, the rural centre, and villages further north. It is anticipated that these internal routes would cater for local traffic only. Regional traffic would by-pass the project along the re-located Garissa Road. Intensive lorry traffic associated with the project during harvests would be directed to villages via the Garsen - Garissa Road and the branch canal roads, from the rural centre.

In places, the old Garsen - Garissa Road, within the project area, would be preserved for active use. For example, sections of this road would be retained to link Centres 1-23 and 1-18, as well as Centres 1-14 and 1-7. Similarly the existing road and bridge over Laga Hiranman could be preserved to connect Centres 1-7 and 1-6. Should Phase II of the project be implemented, Centres 1-2 and 2-6 could also be joined by an existing section of the Garsen - Garissa Road.

The re-alignment of the Garsen - Garissa Road outside the project area is recommended to be fixed at least two kilometres to the west of the proposed main canal. This would permit

flexibility on site for the final alignment of the canal, without disruption of traffic, and would not necessitate bridges. Near the rural centre, the road would be aligned within 200 metres of the main canal, for easy access to facilities in the town.

A local airfield, for the convenience of visitors and for purposes of crop-dusting, is envisaged on the vacant land west of the rural centre and west of the proposed Garsen - Garissa Road. One runway of approximately 1 000 metres in length would be aligned in a northerly direction, thus facing the prevailing winds. It would be surfaced, and connected to the road linking the rural centre with the new Garsen - Garissa road. Its location would minimise overflight of populated areas in the rural centre.

## CHAPTER 3 VILLAGE DESIGN

### PLANNING CONSIDERATIONS

#### 3.1 General Background

As discussed in Chapter 2, the tenants of the project, in addition to project staff and an affinitive population, are to be accommodated in a series of villages dispersed throughout the study area. It is proposed that the tenants be assigned a housing plot within a village site and proceed to construct their homes with the help of other tenants. Materials, loans and technical assistance would be provided by the NIB.

To ensure the creation of self-contained villages, not only housing, but also other facilities and services, such as schools, health-care units, and social halls, normally associated with rural communities, must be planned and eventually established.

In Chapter 2, it was proposed that the ultimate population of the villages should ideally be limited to 2 500, and that, consequently, 260 households of tenants and affinitive inhabitants could be accommodated in each village. It was further identified that the taxonomy of villages, advocated by the Physical Planning Department, and including market, local and sub-local centres, should be applied in the project.

A hierarchy of centres, at the village level, facilitates the economical distribution of goods and services in rural areas. Based on Central Place Theory, the economic importance of a given centre in the hierarchy is not necessarily a function of population size. Thus a market and sub-local centre could have equal populations, yet the former would fulfill a higher degree of economic and social functions. In theory then, all three types of villages (market, local and sub-local centres) could be inhabited by equal populations. However, the internal land-use components of each type of centre would vary in accordance with specific assigned functions.

Because the design of all required villages was beyond the scope of this phase of the study, only the identification of planning parameters for prototypical village designs was attempted. These concepts could, with site-specific modifications, be used for the detailed design of all villages, including market, local and sub-local centres. Design flexibility could be achieved through the functional segregation of self-contained housing areas within villages, from other types of land uses, varying from centre to centre.

#### 3.2 The Hola Experience

Several villages of the Hola Irrigation Scheme were studied during site visits, because the proximity of this scheme to Bura suggests that it is likely to be a valid indicator of what might occur on the proposed project. In addition, a survey conducted recently by the NIB (2), reporting in some detail on the villages at Hola, was thoroughly analysed.

Villages at Hola are not categorised in terms of market, local and sub-local centres. They are generally smaller than the villages envisaged for the present project, containing on the average less than 100 tenant households. However, the existing household size ranges from 10 to 12.6. This is higher than that anticipated for Bura.

All houses at Hola are arranged in a rigid grid or labour line pattern and are constructed of mud and wattle with galvanised corrugated iron (GCI) roofs. Vegetation within the villages is virtually absent, creating dust problems and a very sterile appearance.

Roads within the villages are difficult to define, not only owing to the dearth of vehicles but also the generous spaces between houses. This looseness, coupled with the absence of structured central places or activity nodes, appears to hinder the emergence of a village identity.

Other dispersed land uses at Hola include livestock pens, primary schools, nursery schools, staff quarters, places of worship, shops and restaurants. Water supply facilities consist of communal waterpoints (one for 25 households) and of communal shower blocks. Pit latrines, one for each house, are located approximately 10 metres behind each structure.

In general 'the wide open areas between the long lines of houses, the sandy surroundings, the absence of trees as well as any landmarks, provide a picture of a monotonous, barren environment. The absence of trees makes the rows of pit latrines an undesirable dominant feature. This overall picture is common for all villages with Bahati as a noteworthy exception (2).

The above description demonstrates that a variety of deficiencies influencing the quality of life, manifested in villages at Hola, and should be avoided in the Bura Project. In this regard, the NIB has recommended that the following be taken into consideration during the planning and design for villages in the present project (2):

- (a) Each village should be composed of groups of houses, to avoid monotony.
- (b) The village layouts should be based on simple geometric patterns. Long through-line should, however, be avoided, for climatic and aesthetic reasons.
- (c) The village layouts should be in accordance with the climatic requirements for the area.
- (d) An open, public meeting space should be established.
- (e) Shops, workshops and 'hotelis' should be located within a defined area of the village.
- (f) Roads should be provided with surface water drains.
- (g) Windbreaking screens of trees should be planted at the periphery of villages, as protection against strong winds and dust storms.
- (h) Granting of tenure of houses and plots should be considered as an inducement for tenants to maintain their homes to high standards.
- (i) The plot size and configuration should allow for a courtyard-type of development.
- (j) Each plot should, from the start, be provided with its own pit latrine.

### 3.3 Village Planning Criteria

On the basis of the recommendations of the NIB, and after the review and application of village planning principles used in Kenya and in other parts of the world, the following criteria were developed for incorporation in the design:

#### (a) Plot Size

In hot, dry semi-desert areas such as the proposed Bura Project, compact housing alignments permitting through-circulation of winds and maximising shade, are recommended.

'Housing sites in the Semi-Desert Zone should be located close to work places, shops, schools and other community facilities so as to keep distances within human settlements down to a minimum'.

'Housing layouts should be urban in nature as is traditional to desert settlements. Compact inward-looking settlements help shield themselves and their occupants from the fierce sun

Compact planning minimises the solar exposure of individual houses, and as a result, minimises solar heat gains by providing mutual shading and by reducing external surface areas. Compact layouts keep down windspeeds and thereby considerably reduce the sand and dust content of the air within settlements during sandstorms. The close grouping of houses also usefully reduces walking distances between buildings besides minimising the length and cost of service runs' (4).

This suggests that housing plots should be reduced to a minimal size, while still remaining within the regulations of the Ministry of Health, and within Grade II By-Laws.

At the same time, each plot should be able to accommodate the following components:

- (1) the core house
- (2) a house extension
- (3) a storage shed
- (4) a pit latrine
- (5) a cotton drying area
- (6) a verandah
- (7) an interior courtyard

To accommodate these facilities, and particularly to keep the pit latrine at least 9 metres from the nearest habitable room (Grade II By-Laws), a plot size of 350 to 400 square metres is required. While this plot size would initially, before the extension of houses lead to a relatively loose village structure, not entirely in harmony with the recommendations contained in 'Design for Climate' it represents a compromise between the functional requirements of the tenants, and the ideal type arrangement recommended in that publication. For design purposes a plot size of 392 square metres, with the dimensions of 14 metres by 28 metres, was used. This was derived through a theoretical placement of various house types into plots of diverse dimensions.

#### (b) Number of Plots

As mentioned in Chapter 2, approximately 260 housing plots would be required in each village, to accommodate a population of 2 500 persons. At 392 square metres per plot this would result in a net residential area of 10.2 hectares for each village.

#### (c) Exposure to Winds

Erosion, and exposure to wind and dust should be minimised in all villages. Since the prevailing winds in the study area originate in the north and north-east in the hot-season, trees and other plant materials should be retained or planted near the northern edges of villages. This would result in the disruption of lower, dust-carrying winds and still permit the influx of higher, particle-free breeze into the village areas.

#### (d) Alignment of Houses

To minimise insolation onto individual houses, the structures should be so arranged that the smallest external wall areas face the south or south-east.

#### (e) Landscaping

The provision of landscaped areas and trees along roads and communal places would raise the aesthetic quality of villages and provide shade and protection from dust.

#### (f) Irrigation Canals

To contain the effects of schistosomiasis, irrigation canals and ditches should not be introduced into the village areas. To discourage settlers, particularly young children, from bathing in canals, intervening bilharzia-free bathing opportunities should be provided in or near each village. Similarly, facilities for washing, such as showers and clothes washing basins, are required. These are described in detail in the Public Health and Utility Services Annexes.

(g) Village Location

In addition to the locational criteria for the overall placement of villages outlined in Chapter 2 the sites selected should be well-drained and located on soils suitable for house construction.

(h) Allotment Gardens

To minimise health hazards irrigation water will not be provided to the villages, and the garden plots must be sited at the perimeters of villages, wherever possible.

(i) Water Supply

A continuous water supply for domestic purposes must be ensured and a greater number of water points per village should be provided than is the current practice at Hola. In addition, water supply systems should be designed to such capacity that the option of individual connections to houses is left open for the future.

(j) Internal Structure

For aesthetic and thermal comfort reasons, villages should not be composed of monotonous rows of houses, but of diverse modular arrangements. In addition, activity nodes, open spaces and palaver points should be provided, thus fostering a communal identity.

(k) Roads

Roads to, and within, the villages are not expected to carry heavy vehicular traffic. In discussions with members of the Physical Planning Department it was agreed that reserves of 12 metres would be sufficient for main village roads. Widths of six to nine metres for secondary roads would also be acceptable. Walkways should be three metres wide. This network would ensure vehicular access to all structures and would be harmonious with a compact internal village layout.

(l) Primary Schools

The current criterion of The Department of Physical Planning for the provision of primary schools is one per 5 000 persons. However, studies and analyses of the distribution of age groups of tenant population detailed in the Institutions and Services and Sociology and Settlement Annexes demonstrate that the proportion of children for the Bura Project will be much higher than that for Kenya as a whole. After discussions with the Department of Physical Planning and the Ministry of Education it was agreed that provision would be made for one primary school for each village type.

### 3.4 Land-use Components

The three types of villages, market, local and sub-local centres, would each provide a different level of social and economic services: consequently the land uses in each could vary considerably.

To determine the ultimate territorial extent of a given village, and to facilitate layout and design, anticipated land-use components for diverse types of villages were identified and are listed in Table 3.1.

All types of villages would contain centralised social and commercial facilities as well as a multi-purpose complex composed of offices, a cotton collection yard, a community hall and a primary school. Nursery schools and churches would also be included in each type of village. However these latter facilities would not be centralised, but dispersed throughout residential districts.

It is envisaged that ponds of approximately 0.5 hectares be constructed in all villages for purposes

of bathing, aesthetic enhancement, and recreation. These ponds would be treated against schistosomiasis and be located as intervening opportunities between contaminated canals and the villages. They should not be regarded as substitutes for shower and washing facilities, but rather as complementary recreation resources designed to decrease the levels of infection from waterborne diseases.

Facilities such as health sub-centres, police posts and post offices would only be located in market centres. Primary schools would be provided in market, local and sub-local centres. Sub-local centres would be limited to basic social and shopping facilities. Any specialised requirements by residents of sub-local centres would be fulfilled in centres of higher order.

The institutional and administrative land uses are discussed in some detail in the Institutions and Services Annexe. For planning purposes, it has, however, been calculated (see Table 3.1) that approximately six hectares of land should be reserved for non-residential uses in market centres, and five hectares in local and sub-local centres.

Affinitive population estimates, based on the land-use tabulation for villages, indicate that in market centres, over 75 households would contain non-tenants. In local centres 45 households are expected to be non-tenants, while in sub-local centres the number decreases slightly to 42. It is emphasised that these figures are hypothetical and that, at this stage of the project, they must be regarded only as flexible criteria for conceptual design.

Table 3.1 - Proposed Land Uses for Villages

(A) Market Centres

Facility	Number Required	Space (hectares)	Employees	Population (x 6)
Post Office	1	0.2	3	18
Tel. Exchange	1	-	2	12
Churches	4	0.4	2	12
Nursery Schools	4	0.4	-	-
Shops	12	0.6	12	72
Market	1	0.4	-	-
Multi-purpose complex:	1	0.5	-	-
Coop. Office	(1)	-	2	12
Comm. Dev. Office	(1)	-	1	6
Forestry Office	(1)	-	1	6
Vet. Office	(1)	-	2	12
Social Hall	(1)	-	-	-
NIB Office	(1)	-	12	72
Ass. Chief Office	(1)	-	8	48
Health Sub-centre *	1	0.8	5	30
Primary School	1	2.0	16	96
Lorry Park	1	0.2	-	-
Village Pond	1	0.5	-	-
Total	-	6.0	66	396

\*This space allocation permits possible future upgrading of the Health Sub-centre to a Health Centre.

Table 3.1 - Proposed Land Uses for Villages (cont)

(B) Local Centres

Facility	Number Required	Space (hectares)	Employees	Population (x 6)
Primary School	1	2.0	16	96
Churches	4	0.4	2	12
Nursery School	4	0.4	-	-
Shops	10	0.5	10	60
Market	1	0.4	-	-
Pond	1	0.5	-	-
Multi-purpose complex:	1	0.5	-	-
Coop. Office	(1)	-	2	12
Comm. Dev.	(1)	-	1	6
NIB Office	(1)	-	8	48
Social Hall	(1)	-	-	-
Asst. Chief Office	(1)	-	1	6
Health Unit	(1)	-	1	6
Total	-	4.7	41	246

(C) Sub-local Centres

Facility	Number Required	Space (hectares)	Employees	Population (x 6)
Primary School	1	2.0	16	96
Churches	4	0.4	2	12
Nursery Schools	4	0.4	-	-
Shops	8	0.4	8	48
Market	1	0.4	-	-
Village Pond	1	0.5	-	-
Multi-purpose complex:	1	0.5	-	-
Health Unit	(1)	-	1	6
Project Office	(1)	-	8	48
Social Hall	(1)	-	-	-
Coop. Office	(1)	-	2	12
Comm. Dev. Office	(1)	-	1	6
Total	-	4.6	38	228

## INTERNAL VILLAGE STRUCTURE

### 3.5 Modular Composition

A modular arrangement of the proposed villages is envisaged, in adherence to the village planning criteria and the land-use requirements established in the previous section. This would consist of the assembly of housing groups into a curvilinear geometric system.

On the basis of the proposed initial settlement and house-construction procedure, in which six tenants would help to build each others houses, it seems logical to use this group as a foundation for a settlement structure. By treating the six houses built by this group of tenants as a unit arranged in a semicircle and by adding another unit of six structures to this configuration, a cell of twelve houses would result. This cell, illustrated in Figure 3.1, would be accessible from two sides and contain an interior courtyard. Through the addition of another cell, a module of 24 houses could be created. It would thus contain 2 cells of 12 houses, facing inwards to interior courtyards, and be accessible from several sides. This progression would be continued by arranging three peanut-shaped modules into one ward of 72 structures.

Several advantages of this modular concept are evident. By using the initial group of six tenants as a basic component of the tenant hierarchy in the construction and alignment of their homes, a cohesive, cross-tribal comradeship may develop and continue to exist after construction. The arrangement of two units into one circular cell is in conformity with African building traditions and prevents the emergence of a rigid grid-iron pattern. At the same time, the interior courtyard created by this configuration facilitates a spatial identity at a fundamental level. The courtyard could serve as a focal point of each cell, particularly if provided with a waterpoint, shower block and laundry slabs. These essential functions, treated with plant materials for shade, would lend each courtyard a special position in the village hierarchy of spaces, namely that of a palaver point and communal outdoor living room (see Figure 3.2).

The arrangement of the three modules into one ward, illustrated in Figure 3.3 would result in another communal space at the entrance to the central module. The nodal space could be used for the construction of a shop, a nursery school and a place of worship, each serving the ward. The provision of these decentralised services would minimise walking distances since the residents would not be required to travel to the village centre for their most basic social and economic needs.

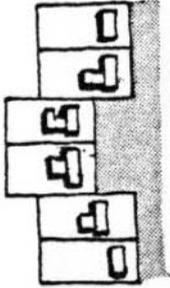
Other advantages of the proposed modular system would be:

- (a) Water supply would be relatively inexpensive. Feeder pipes to the water points in each cell could be easily laid from a trunk main at the base of the ward. The need for circular mains would thus be eliminated.
- (b) An interior walkway system, meandering through the ward and connecting the three modules, could be easily created, as shown in Figure 3.3.
- (c) Access to the irrigation fields from each module would be assured.
- (d) The modular arrangements, coupled with variations in building setbacks, would prevent the monotony of linear arrangements.
- (e) The staggered alignment of houses would permit circulation of refreshing winds. Breezes would not be blocked by long lines of structures.

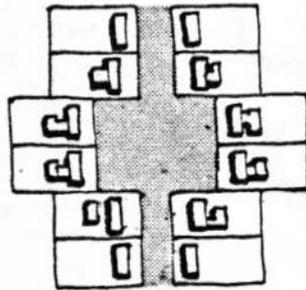
# Figure 3.1 Internal Village Structure

Scale 1:2500

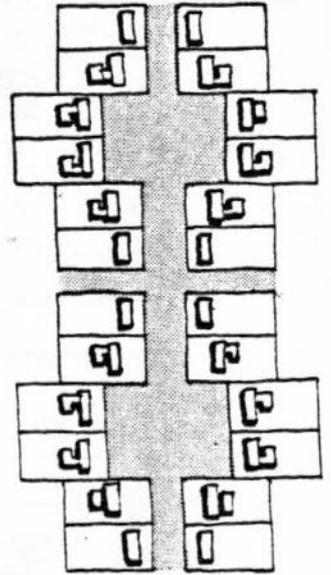
**UNIT**  
6 Houses



**CELL**  
12 Houses  
1 Water Point  
1 Shower Block



**MODULE**  
24 Houses  
2 Water Points  
2 Shower Blocks



**WARD**  
72 Houses  
6 Water Points  
6 Shower Blocks  
1 Nursery School  
1 Shop

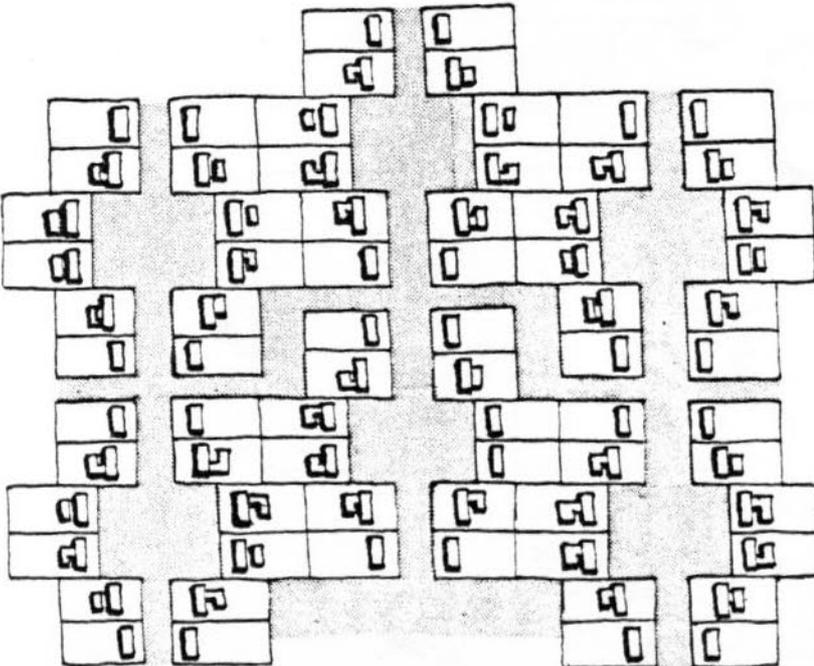


Figure 3-2

Typical Village Module

Scale 1:750

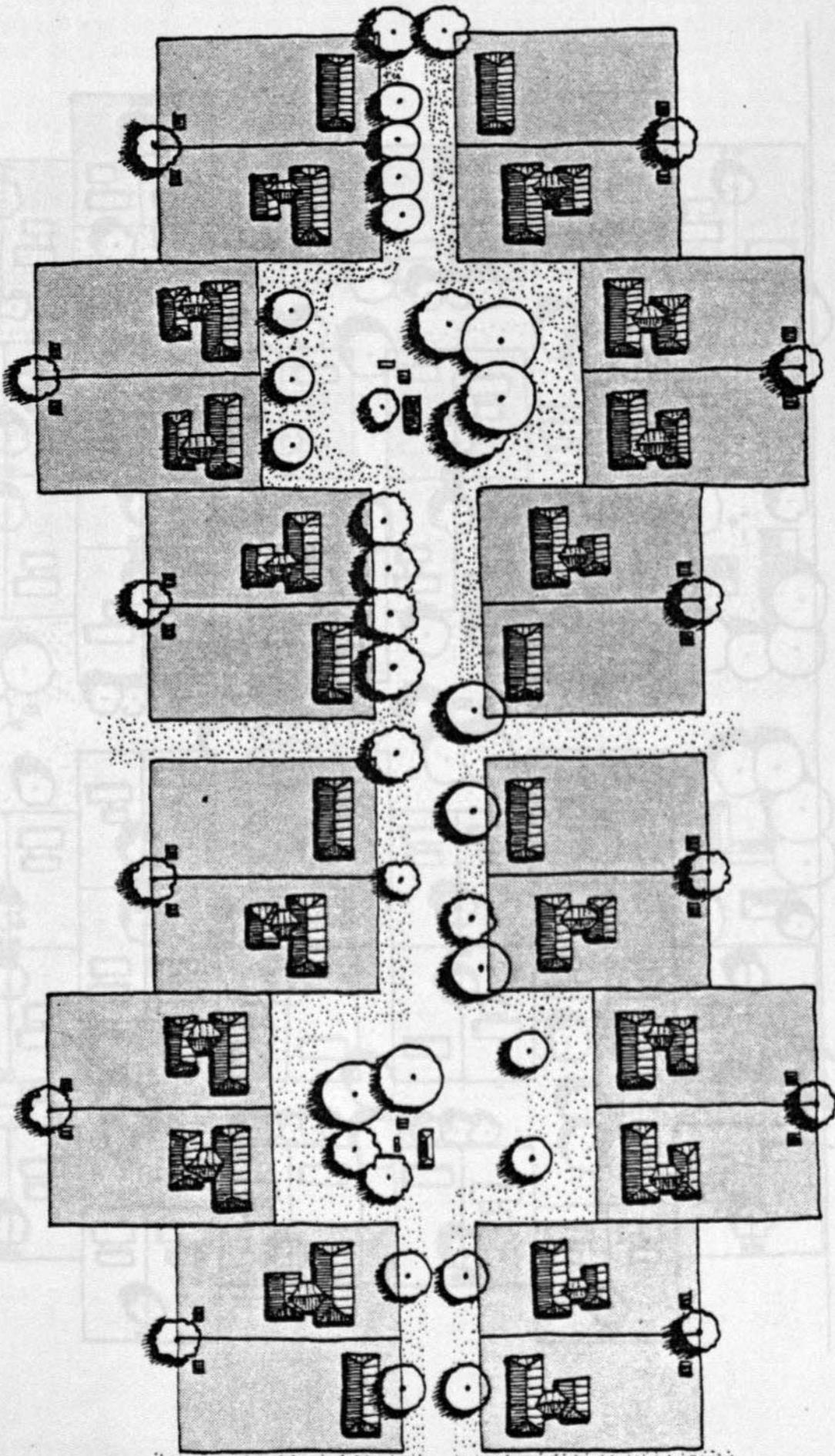
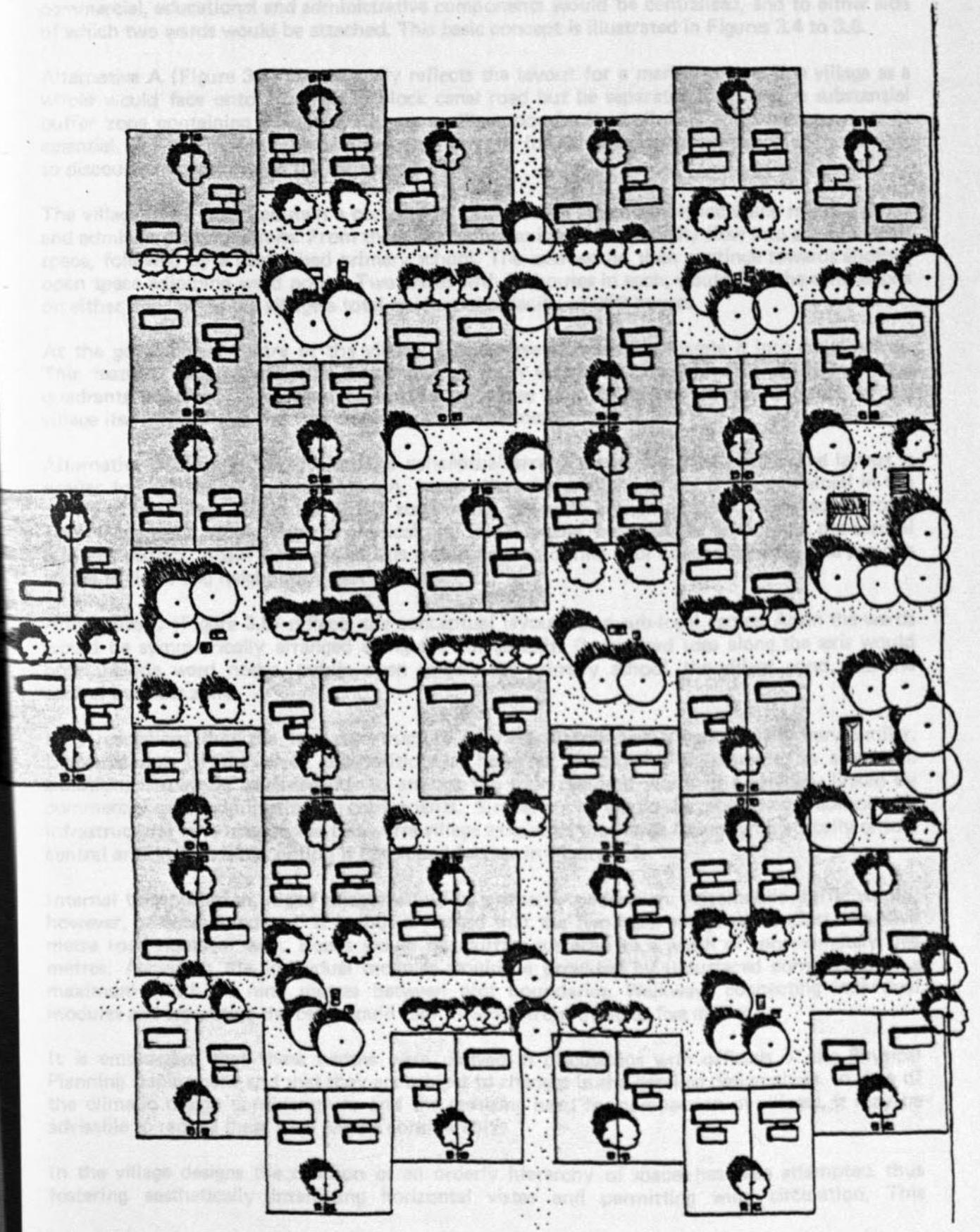


Figure 3.3 -

Typical Village Structure

Scale: 1:1250



### 3.6 Village Design Concepts

The orderly arrangement of residential wards and infrastructural land uses into a cohesive settlement unit depends, to a large degree, on the social and economic functions of a given village. In general, however, it is envisaged that each village would include an axis within which commercial, educational and administrative components would be centralised, and to either side of which two wards would be attached. This basic concept is illustrated in Figures 3.4 to 3.6.

Alternative A (Figure 3.4) conceptually reflects the layout for a market centre. The village as a whole would face onto a branch or block canal road but be separated from it by a substantial buffer zone containing amenities such as a village pond, a football field and a cemetery. It is essential that this buffer zone be protected from any formal or informal expansion of the village, to discourage intrusion into the canal right of way.

The village itself would contain a commercial district near its entrance, including market, shops and administrative functions. From there the central axis would gradually flow into a public open space, followed by a centralised primary school. The axis would then continue towards another open space adjoining ward nodes. Two wards with 72 houses in each, would face the central axis on either side, giving the village a total residential capacity of 288 houses.

At the geographical centre of the village, a transverse axis would separate it into equal halves. This feature, coupled with the perpendicular main village axis, would thus result in village quadrants containing one ward each. The transverse axis would permit easy entrance to the village itself from fields and from neighbouring settlements.

Alternative B (Figure 3.5) depicts the conceptual arrangement of a local centre. The layout is similar to that shown in Alternative A, except that the primary school is not contained in the centre of the village but in the buffer zone below the main branch or block feeder access road. The village pond would form a physical and visual buffer between the school and the central business district. Again a transverse axis would help to define four equal quadrants, and provide access to fields and neighbouring settlements.

Alternative C (Figure 3.6) reflects the conceptual layout for a sub-local centre. Again the wards would be symmetrically arranged along the village axis. Centralised uses along the axis would only include ward nodes, public open spaces, the primary school, the village pond, and the central business zone.

It is recognised that the land-use structure of these alternatives is conceptually very similar. Diversification of the basic composition is, however, possible. For example, in a specific situation, it may be advantageous to arrange the four required wards in a catenary linked by commercial and administrative components. Similarly, it would be possible to consolidate infrastructural land uses on the transverse village axis, with the wards facing symmetrically onto a central artery. This latter option is developed further in Figure 3.7.

Internal transportation in the villages would be primarily pedestrian. Automobile traffic would, however, be accommodated. It is thus envisaged that the two main village axes consist of twelve metre road rights of way. Roads would be murrum-surfaced to a width of approximately five metres. Access to the individual modules would be provided by unsurfaced corridors with a maximum width of nine metres between plot boundaries. Walkways connecting individual modules and separating the cells would vary in width from three to five metres.

It is emphasised that these widths were derived in discussions with officials of the Physical Planning Department and that they are subject to changes in the detailed design phase. In view of the climatic design considerations and the resulting need for compaction of villages, it may be advisable to reduce these road widths considerably.

In the village designs the creation of an orderly hierarchy of spaces has been attempted, thus fostering aesthetically interesting horizontal vistas and permitting wind circulation. This

Figure 3.4 Concept B  
Village Concept A  
Market Centre -

CANAL ROAD

CANAL ROAD

BUFFER ZONE

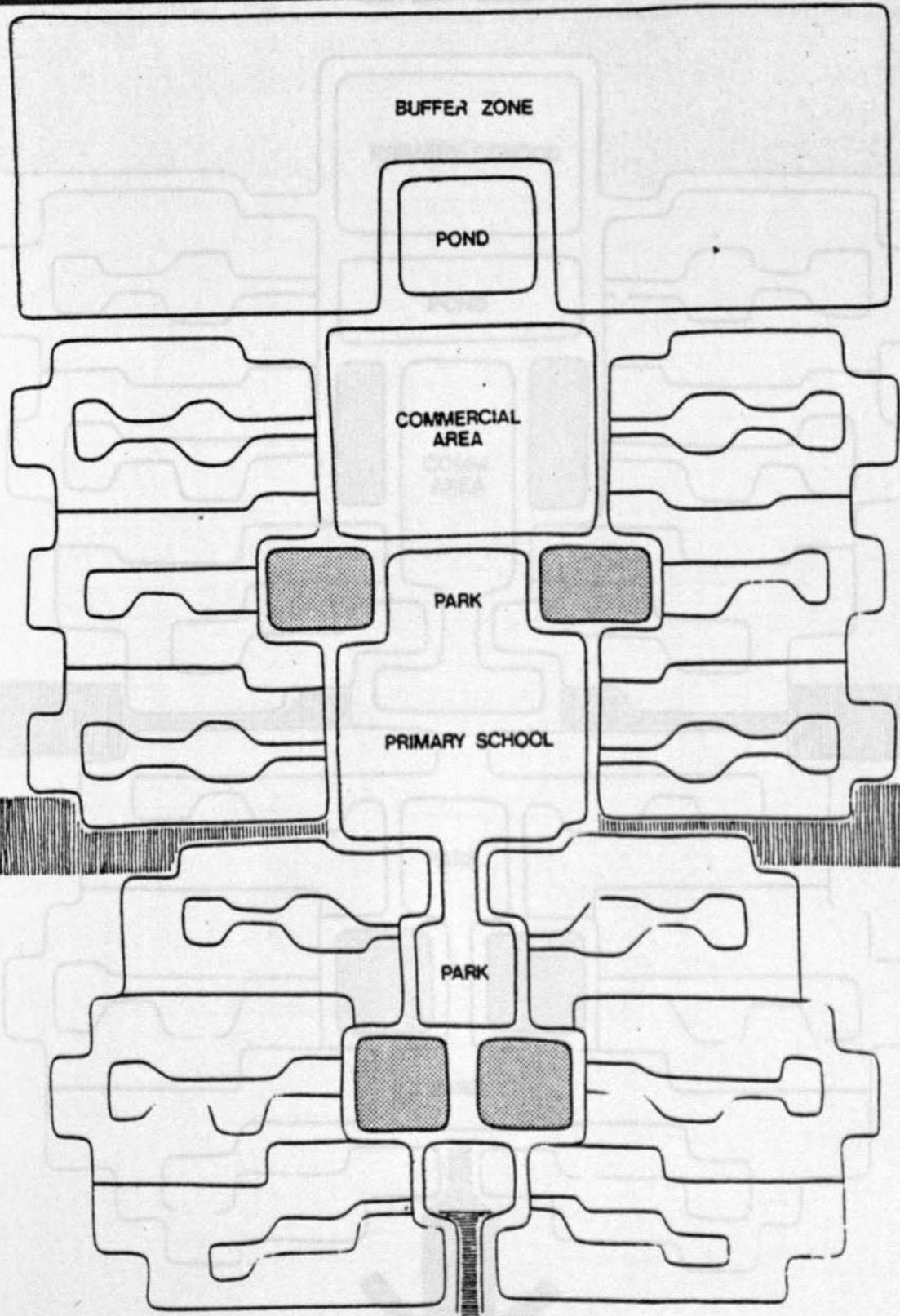
POND

COMMERCIAL AREA

PARK

PRIMARY SCHOOL

PARK



**Figure 3.5**  
**Village Concept B**  
**Local Centre**

CANAL ROAD

BUFFER ZONE

PRIMARY SCHOOL

POND

COMM. AREA

PARK

PARK

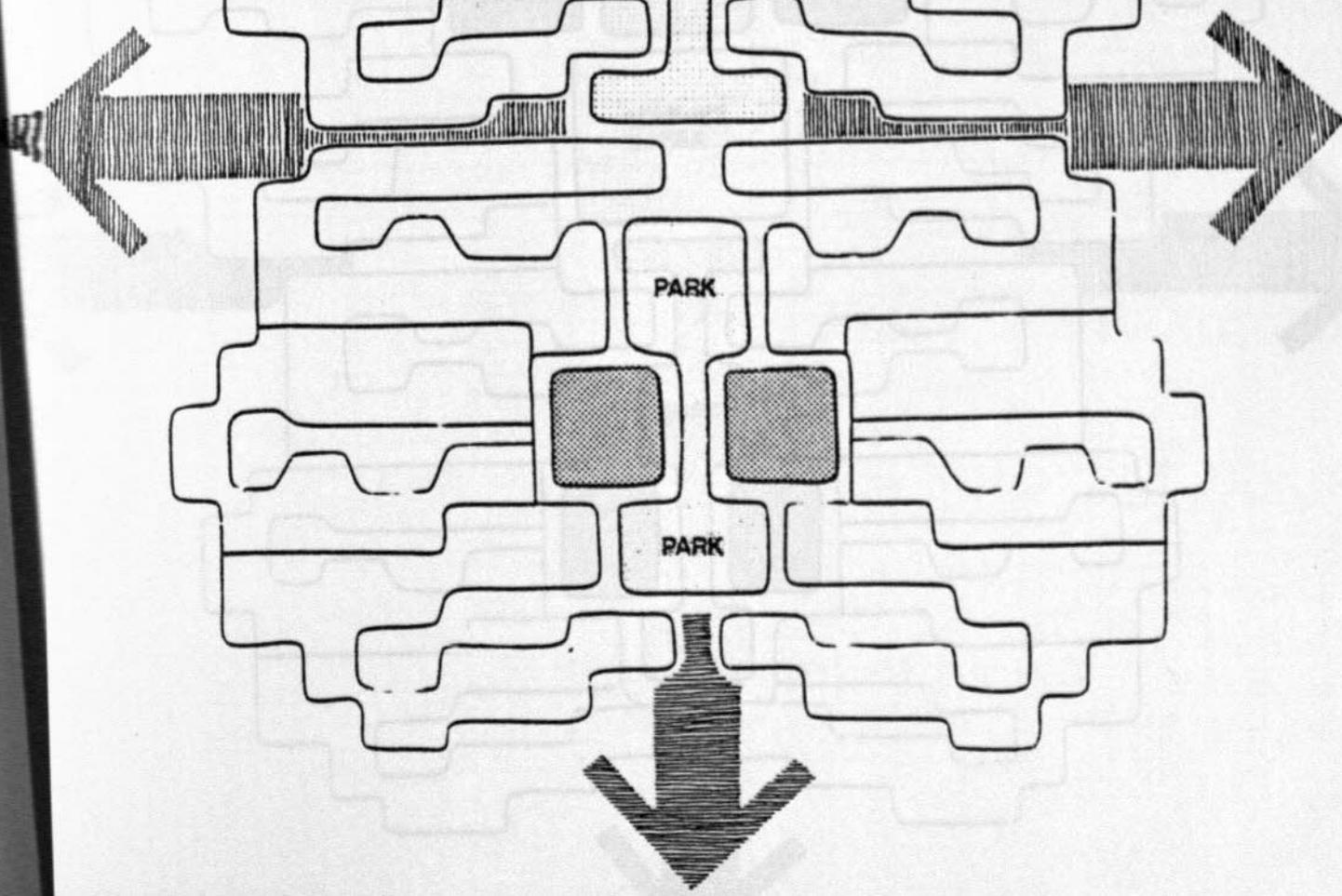


Figure 3.6  
Stage Concept C  
b - Local Centre

CANAL ROAD

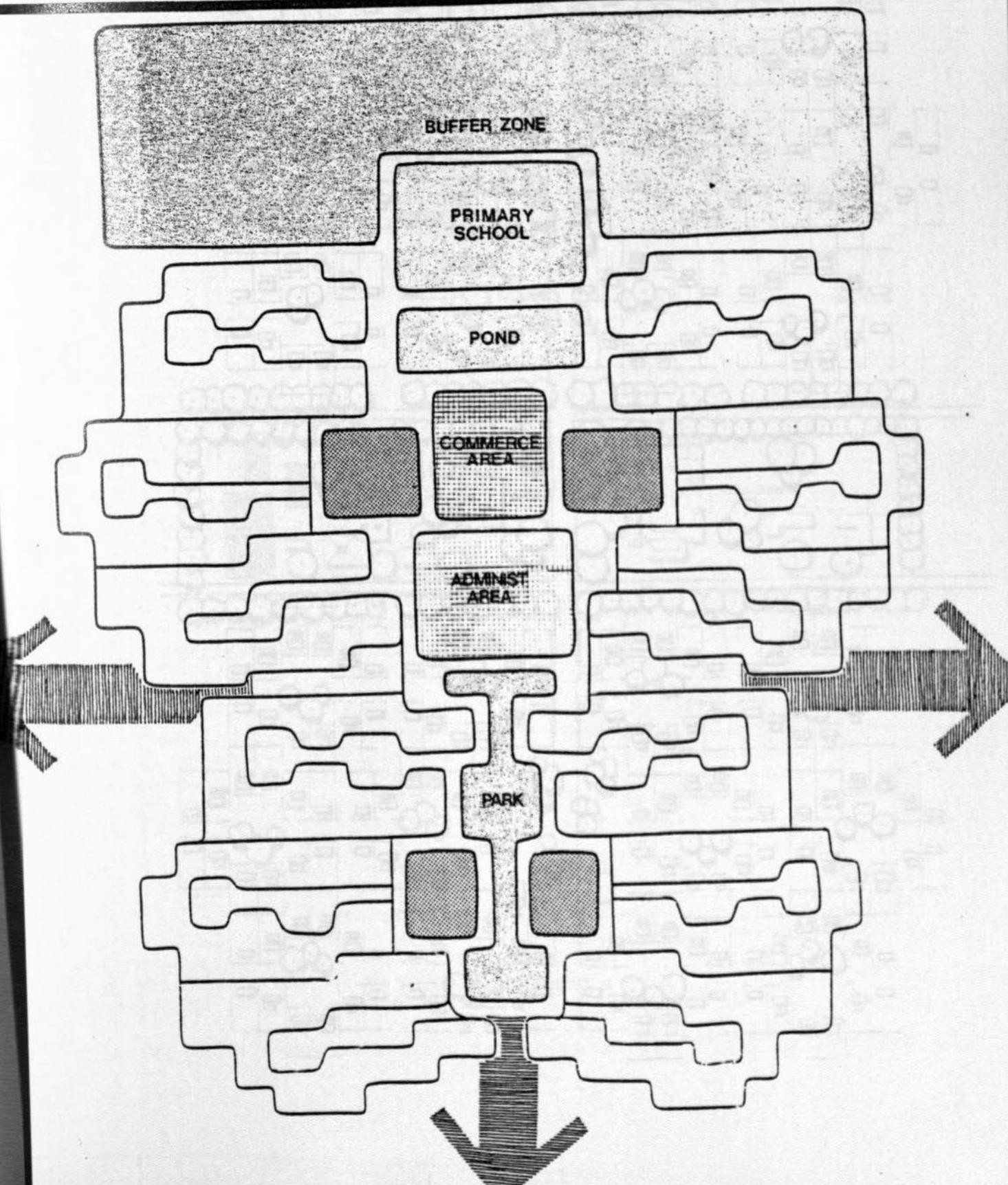
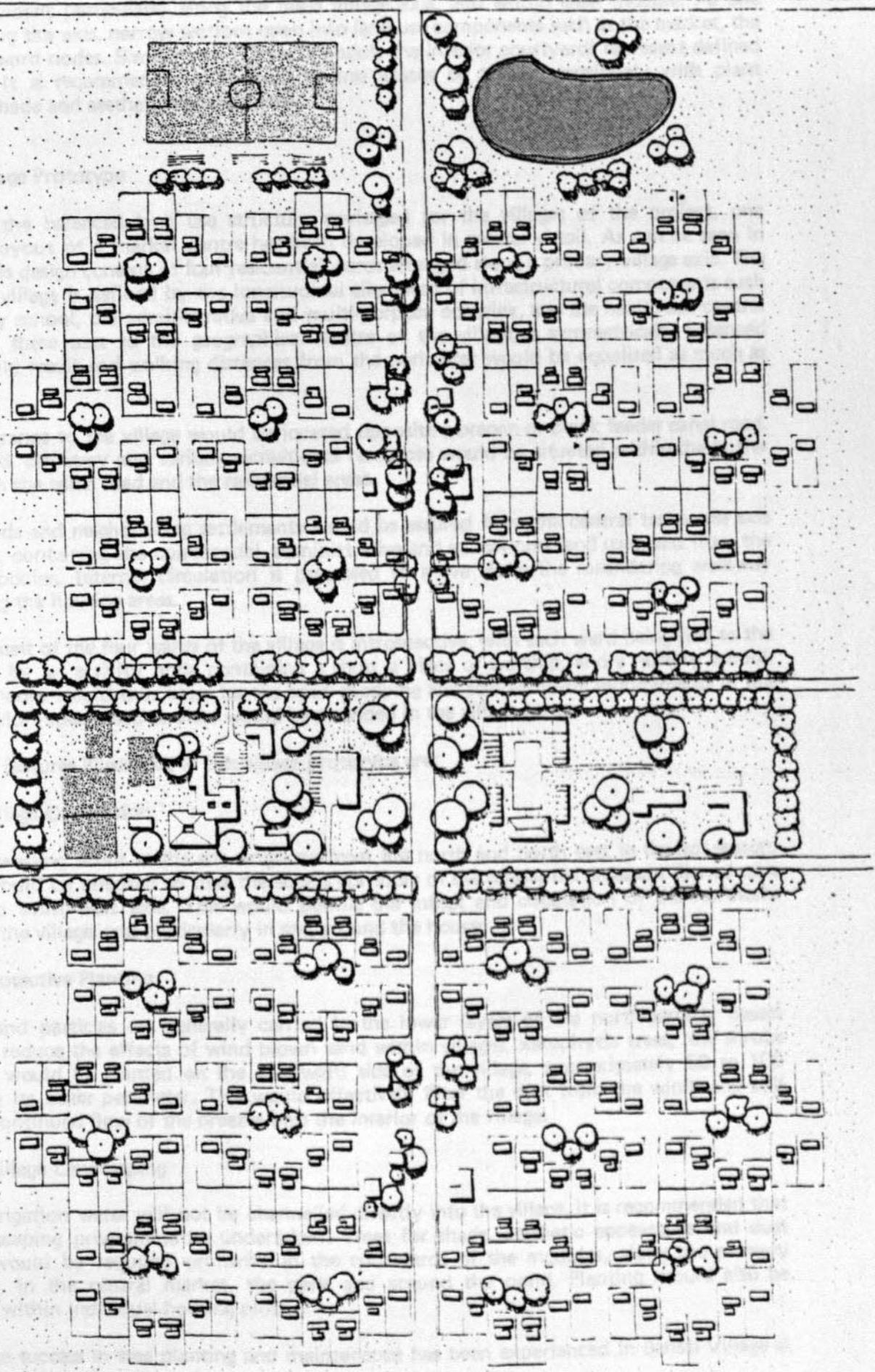
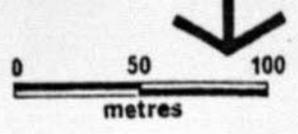


Figure 3.7  
Age Prototype



hierarchy is evident particularly along the main village axis, and within each module. As one progresses along the axis, narrow sections open into land use components such as the market, the park and the ward nodes. Similarly within each module the interior courtyards represent defined open spaces. It is recommended that these diverse spaces be treated sensitively with plant materials for shade and aesthetic enhancement.

### 3.7 Village Prototype

To illustrate the balanced land use structure envisaged for the villages of the project, one prototypical layout of a market centre has been developed in greater detail. As can be seen in Figure 3.7, this design consists of four residential wards arranged along a primary village axis. The centre of the village is defined by the longitudinal alignment of infrastructural components such as the primary school, the administrative and multi-purpose complex, and the health sub-centre. By allocating these uses to the geographical centre of the village, a symmetrically balanced structure would result and walking distances from the perimeter would be equalised as much as possible.

The main entrance to the village would be located opposite a branch or block feeder canal road. A village pond, cemetery and various recreational resources would be situated within the buffer zone, between the canal road and the residential areas.

Access to fields and neighbouring settlements would be assured from the central transverse axis of the village, containing the commercial, administrative and educational land uses, and from the individual modules. Internal circulation is proposed to move along the meandering walkway system joining the housing areas.

The arrangement of the four wards of the village is introspective, with each ward being tied to the central spine by an activity node containing a shop, a place of worship, and a nursery school. These ward nodes would thus cater for the basic shopping and socio-cultural requirements of the inhabitants. More specialised services would be provided in the village core.

Other design features illustrated in this village prototype are:

#### (a) Village Orientation

Since the prevailing winds at the site originate from the north and north east in the hot season, the village would be oriented so that the access corridors of the residential areas are aligned on a north-east to south-west axis. This would permit the influx and circulation of the northerly breezes into the village, and particularly in and around the houses.

#### (b) Protective Planting

Dust and sand particles are generally carried in the lower layers of the north-easterly desert breezes. To reduce the effects of wind blown sand within villages, xerophytic trees, low shrubs and hedges would be planted on the windward side of the village, approximately 50 to 100 metres from its outer perimeter. This would effectively filter the dust from the winds and still permit the continued flow of the breezes into the interior of the village.

#### (c) Village Landscaping

Although irrigation water will not be channelled directly into the village, it is recommended that a full landscaping programme be undertaken. Trees for shade, aesthetic appearance and dust collection would be required primarily in the courtyards of the modules, along the primary village axes, in the central market, the park and around the pond. Planting should also be encouraged within individual housing plots.

Considerable success in tree planting and maintenance has been experienced in Bahati Village at

Hola. In that example, trees are watered regularly by tenants, with waste water. Particularly near water points, waste water could be easily diverted through narrow furrows to irrigate individual trees. Where watering of plant materials through furrows or ditches is impracticable, manual irrigation methods could be applied on a tree-by-tree basis. This would be the responsibility of the individual tenants.

#### (d) Water Supply

A trunk main is envisaged to follow the village spine, feeding branch pipes leading off to the water points contained in the courtyards of the modules, 24 waterpoints would be established.

Individual water connections could be provided in the future to those wishing to subscribe to such a service, if the design diameter of the pipes were raised from inception.

In addition to the waterpoints in the courtyard of each cell, it is proposed that the two shower units, one for females and one for males be constructed in the centre of each cell. The provision of clothes washing slabs in each courtyard should also be considered.

For a more detailed discussion of infrastructural services in the villages, reference should be made to the Utility Services Annexe.

#### (e) Alignment of Houses

Depending on village location and orientation, the setback and alignment of houses within a plot could be varied, for three main reasons. First, variable setbacks could result in a circular pattern around the internal courtyards of the modules. Second, variable setbacks would expose a greater number of structures directly to the refreshing effects of the prevailing winds. Third, the houses could be aligned diagonally to the plot boundaries so that the most narrow walls of the houses would face the direction of the mid-day sun, thus minimising frontal insolation.

#### (f) Roads

As already outlined the main road reserves would be 12 metres. Access corridors to the modules would vary in width from six to nine metres. The walkways, inter-connecting the modules, would be three to five metres wide.

#### (g) Staff Housing

The staff housing within villages would cater for junior and subordinate staff only. Depending on the ultimate requirements, to be identified during the more detailed planning phase, one or two modules would be reserved for staff housing. The plot sizes for these structures would be similar to those of settler houses. However, the design of staff houses would conform to the standards stipulated by the concerned Ministries, such as Education, Social Services and Health, and are detailed in the Housing and Building Annexe.

#### (h) Sewage Disposal

Each plot would be supplied with a pit latrine situated at least nine metres from the nearest habitable room of the house in accordance with the Grade II By-laws.

It is emphasised that the prototypical design illustrated in Figure 3.7 is conceptually applicable to all village sites selected in Chapter 2, but that changes in alignment of roads, houses and other land uses will be required to adapt to specific site conditions. During the detailed design phase soils, topographic characteristics and proposed canal rights of way must thus be studied further and the results be incorporated in the ultimate layout of each village.

## CHAPTER 4 THE RURAL CENTRE

### DESIGN PARAMETERS

#### 4.1 Basic Functions

The administrative or rural centre of the Bura Project would form the distributive hub of the project. As such, it should be centrally located, easily accessible by road and pedestrian paths, and contain specialised services which cannot be sustained economically in centres of lower order. In addition, it would include the NIB project headquarters consisting of offices, workshops and staff housing. Other Ministries concerned with the project would also require office space and housing for their staff.

In general, the administrative centre should be planned so that it could eventually also serve the Yedi command of Phase II of the project. This could entail the upgrading of the town from a rural to an urban centre. Expansion space for this eventuality should thus be available.

#### 4.2 Design Criteria

The considerations regarding the design for climate, outlined in Chapter 3, are also applicable to the design of the rural centre. Compaction of land-use components is thus a guiding principle. In addition, the village planning criteria concerning landscaping, internal structure, irrigation canals within a centre, and alignment of houses are also applicable in this context and need not be repeated here (see Section 3.3). However, the following considerations are of specific concern in the planning of the rural centre:

##### (a) Location

The preferred site for the centre has been identified north of the Pumwani branch canal, east of the main canal and south of the Pumwani branch drain.

##### (b) Buffer Zones

The settlement areas should not be located contiguous to the canals but be separated from the latter by buffer zones. The widths of these buffer zones should be: 100 metres from the main canal, 80 metres from the branch canal, 80 metres from the branch drain, and 50 metres from the block feeders.

##### (c) Roads

Main roads in the town should be 15 metres wide. Secondary collector roads should have a width of 12 metres and tertiary collectors a width of 9 metres. Main roads should be paved while secondary and tertiary collectors should be surfaced with murrum. Drainage ditches should be provided on both sides of all roads. These road widths have been derived in consultation with the staff of the Physical Planning Department.

In the allocation of land uses for the centre, lorry traffic within the town should be minimised to reduce the effects of noise and dust.

##### (d) Vegetation

To minimise the dust content of winds, and to increase shade, vegetation should be preserved or planted strategically, particularly in parks and activity nodes, and along roads. Because irrigation ditches are not to be introduced into the town for fear of bilharzia contamination, the watering of plant materials must be undertaken by tanker trucks and other manual techniques.

(e) Ponds

Similar to the previously discussed villages, it is envisaged that a series of ponds, free of schistomiasis contamination, be created to permit clean bathing and recreation.

(f) Housing

Various types of housing, for senior, junior and subordinate staff, and also for the affinitive population, will be required in the rural centre. All housing should be grouped strategically in relation to employment areas. Adequate space for the future expansion of the housing sector should also be provided.

In anticipation of an unknown informal employment sector component, a housing area designed to cater for this influx should also be included in the town.

(g) Industry

Sufficient space for the accommodation of workshops, construction yards, a ginnery, and other industrial land uses should be provided. To minimise noise and odour caused by these components, they should be located in the lee of the town and as far removed from housing areas as possible.

(h) Other Land Uses

A centralised commercial district, schools, community centres, staff clubs and recreational resources should be provided, to meet the special demands of this administration-oriented town, and to fulfil the requirements and guidelines established by the Physical Planning Department.

#### 4.3 Proposed Land-use Components

The site selected for the location of the rural centre measures over 350 hectares. To determine the space requirements for housing and other components, the anticipated land uses for the centre, in the first phase of the project, have been identified, (see Table 4.1). The applied land-use standards were derived in consultation with the Physical Planning Department and other Ministries. For more details regarding the institutional components of the rural centre, the reader is referred to the Institutions and Services Annexe.

Table 4.1 shows that over 71 hectares of land would be required to accommodate anticipated administrative, institutional, recreational, commercial and industrial uses in the rural centre. In addition, housing areas and roads must be provided. The net area for residential use has been tentatively calculated for planning purposes on the basis of the following plot sizes:

Senior Housing	—	500 m <sup>2</sup> per plot
Junior Housing	—	350 m <sup>2</sup> per plot
Subordinate Housing	—	288 m <sup>2</sup> per plot

In harmony with the principles of design for semi-desert climatic conditions, these plot sizes have been reduced from the standards generally accepted in Kenya for specific senior, junior and subordinate housing types. It may thus be necessary to amend the configuration and size of standard staff house designs for these plot sizes. Should this be regarded as impracticable, the proposed theoretical plot sizes could be increased during the detailed design phase to accommodate the standard designs of the Kenya Ministry of Works.

Table 4.1 - Proposed Land Use Components for the Rural Centre

(a) Administrative Uses

Type	Required Number	PPD Standard (ha)	Suggested Standard (ha)	Number of Employees	Total Population (x 6)
Police Station	1	3.2	0.3 *	40	240
Post Office	1	0.2	0.1 *	7	42
Telephone Exchange	1	0.405	0.05 *	3	18
Town Hall	1	0.405	0.4	8	48
Coop. Development	1	-	0.1	12	72
Community Development	1	-	0.1	12	72
Ministry of Agriculture	1	-	0.2	18	108
Forestry	1	-	0.3	41	246
Vet. and Livestock	1	-	0.2	8	48
Wildlife	1	-	0.2	9	54
NIB Administration	1	-	3.0	85	510
D O Office	1	0.4	0.4	29	174
Fisheries	1	-	-	15	90
Contingency	1	-	1.0	10	60
<b>Sub Total</b>			<b>6.35</b>	<b>297</b>	<b>1 782</b>

\* The residential land requirements of these components are not included in these space standards.

Table 4.1 (cont)

*(b) Institutional Uses*

Type	Required Number	PPD Standard (ha)	Suggested Standard (ha)	Number of Employees
Health Centre	1	0.810	0.80	17
Secondary School	1	14.16	8.00	31
Primary School	2	1.89	2.00(x2)	32
Nursery Schools	5	0.405	0.3 (x5)	—
Churches	4	0.405	0.2 (x4)	4
Social Halls	3	0.810	0.2 (x3)	—
NIB Guest House	1	—	0.2	4
Sub Total			15.9	88

*(c) Recreational Uses*

Type	Required Number	PPD Standard (ha)	Suggested Standard (ha)	Number of Employees
Parks and Playground	3	—	0.8 (x3)	2
Ponds	3	—	1.0 (x3)	—
Staff Clubs	3	—	0.5 (x3)	6
Sub Total			6.9	8

Table 4.1 (cont)

(d) Commercial Uses

Type	Required Number	PPD Standard (ha)	Suggested Standard (ha)	Number of Employees	Total Population (x 6)
Shops	35	0.05	0.05 (x35)	35	210
Market	1	0.04	0.04	2	12
Bank	1	0.05	0.05	5	30
Petrol Station	2	0.2	0.2 (x2)	6	36
Cinema / Theatre	1	0.2	0.2	3	18
Bus Depot	1	0.4	0.4	2	12
Hotel	1	—	0.5	10	60
Sub Total			3.7	63	378

(e) Industrial Uses

Type	Required Number	PPD Standard (ha)	Suggested Standard (ha)	Number of Employees	Total Population (x 6)
Abattoir	1	0.3	0.3	7	42
Water Works	1	—	1.0	8	48
Refuse Disposal Yard	1	—	0.2	15	90
MOW	1	0.8	0.8	3	18
Ginnery	1	—	10.0	31	186
Generating Plant	1	—	1.0	8	48
NIB Workshop	1	—	5.0	235	1 410
Sewage Treatment Plant	1	—	15.0	8	48
NYS Yard	1	—	5.0	3	18
Sub Total			38.3	318	1 908

ABSOLUTE TOTAL

71.15

774

4 644

As shown in Table 4.2, nearly 33 net hectares of land would be required for the accommodation of staff and affinitive population. In addition, approximately 25 per cent of the total area of the centre would consist of roads, walkways and other rights of way. Thus the total land requirements for the rural centre would exceed 130 hectares in Phase I.

Table 4.2 - Net Residential Land Requirements,  
Rural Centre - Phase I

Housing Type	Number Required	Plot Size (m <sup>2</sup> )	Net Area (hectares)
Senior	73	500	3.65
Junior	367	350	12.85
Subordinate	568	288	16.40
<b>TOTAL</b>	<b>1 008</b>		<b>32.90</b>

In terms of population, it has been calculated that over 1 000 employees, such as project staff, civil administrators, labourers and commercial entrepreneurs, would be accommodated in the centre, as part of the first phase. Others likely to reside in the town would include approximately 1 500 to 2 000 secondary and technical school students and some ancillary personnel such as servants, itinerant farm labourers and visitors. In addition, it is anticipated that the inherent economic magnetism of the rural centre will attract an informal sector population element, likely consisting of nomadic tribesmen, artisans and casual workers. For purposes of this study, and based on estimates derived from an analysis of similar rural towns in Kenya, (Garissa, Holo Garsen), it can be expected that between 1 000 and 1 500 persons would settle informally in the rural centre, to take advantage of economic opportunities. Therefore, a nomadic and informal sector housing reserve of 10 to 15 hectares should be incorporated into the land use plan for the centre. This is discussed in greater detail in the Sociology and Settlement Annexe.

In summary, approximately 8 000 to 10 000 persons can be expected to settle in the rural centre at maturity of the first phase of the Bura Project (see Table 4.3). Should Phase II of the project be initiated, an additional population of 2 000 to 3 000 persons would likely be attracted to the centre.

Table 4.3 - Estimated Gross Population,  
Rural Centre - Phase I

Population Type	Estimated Number
Employees (incl. families)	6 000
Students	1 500
Servants and Itinerant Labourers	1 000
Nomadic and Informal Sector	1 500
<b>TOTAL</b>	<b>10 000</b>

## RURAL CENTRE DESIGN

### 4.4 Proposed Structure Plan

The land requirements of the various functions identified in Table 4.1 represent the contextural framework for the conceptual structure plans shown in Figures 4.1 and 4.2. Both alternatives depict the general arrangement of the proposed land uses delimited by the defined boundaries of the selected site. The two alternatives differ primarily in their respective road alignments. The specific boundaries of various land uses, and the alignment of residential roads, must be determined during the detailed planning of the town.

#### *Alternative A*

In this preferred proposal, the rural centre is generally aligned along an east - west axis formed by a major artery connecting the town to the re-located Garsen - Garissa Road west of the main canal. The administrative offices and the health centre would be situated at the entrance to the town. The central business district consisting of parks, shops, and the market, would be reached as one continued east on the main road.

Residential areas would surround the centre of the town. This arrangement would facilitate access to commercial, educational and employment areas located in the centre, from all sides.

The industrial employment areas, such as the ginnery, NIB workshops, NYS Yard and abattoir, would be situated in the south-eastern quadrant of the town, thus being in the lee. This location is advantageous, because it permits lorry traffic to by-pass the central area by moving east on the Pumwani branch canal road, and thence entering the industrial area through a southern access point.

Other features of Alternative A are briefly summarised as follows:

#### (i) Road Alignment

The transportation network embodies a curvilinear design approach, intended to offer changing vistas to the moving pedestrian and automobile traveller. The non-rigid alignment of the roads also reduces travel speeds, thus increasing public safety. In general, this transportation skeleton would decrease the horizontal monotony usually associated with flat semi-desert areas, and would provide greater opportunities for the designer in the configuration and allocation of various land-use components.

Road widths would vary between 9 metres (right of way) for residential access roads, to 15 metres (right of way) for the primary arteries.

#### (ii) Residential Subdivisions

Various housing types are situated in relation to intended employment zones. Thus, senior housing areas are placed in proximity to the administration zone, junior housing areas in relation to the central business district, the administration zone and the industrial reserve, and labour housing areas primarily in propinquity to the industrial zone. All residential areas are conveniently served by schools of various types.

#### (iii) Open Space Network

A continuous network of open spaces consisting of parks, schools and a stadium, is designed to link the northern and southern residential areas with each other and with the central business district. It is envisaged that considerable vegetative cover should be fostered in these open spaces, to provide shade, aesthetic enhancement, dust filtering and a high textural quality to the town. In particular, shrubs and trees would help to break the spatial monotony so frequently associated with semi-desert environments.

The irrigation of the plant materials in the open spaces presents a difficult problem, both technical and financial. It is considered impractical to introduce irrigation ditches and feeder canals into the urban area, for health and safety reasons. Therefore, it is envisaged that only xerophytic plants be introduced into the rural centre, and that these be watered by means of tanker trucks, and by manual methods, from specific waterpoints fed by the main and branch canals.

(iv) Schools

Several schools, including a secondary school, two primary schools, and a technical school have been incorporated in the design. The primary schools would serve only the residents of the town. The other, higher level, institutions would serve both the population of the 23 villages and of the rural centre.

(v) Health Centre

Although by Government planning standards only 0.8 hectares of land would be required for a health centre, over 4 hectares have been allocated in the plan. The apparent excess has been proposed to cover the eventuality of the expansion of the health centre to a hospital. The site for the health centre is centrally located, to be easily accessible from within and outside the town.

(vi) Churches, Clubs and Community Centres

Sites for these amenities have been dispersed throughout the town, in relation to surrounding residential and employment areas. Nursery schools have not been identified spatially as this would require a more detailed knowledge of population profiles, not available during this phase of planning.

(vii) Ponds

A series of bilharzia-free ponds is envisaged to be located at the perimeter of the town, near the main and branch canals. These facilities would serve the adjoining residential areas by providing opportunities for uncontaminated swimming, and for other forms of recreation. Their strategic location would detract inhabitants from bathing in the canals.

(viii) Infrastructural Services

A sewage treatment plant, a water treatment plant, and a generating station have been allocated in the plan. The sewage treatment plant would be located on the north-eastern extremity of the rural centre, near the branch drain. This would facilitate the discharge of treated effluent. The generating plant would be located in the industrial zone in the south-eastern quadrant. This would permit electrical supply to the ginnery and the town as a whole.

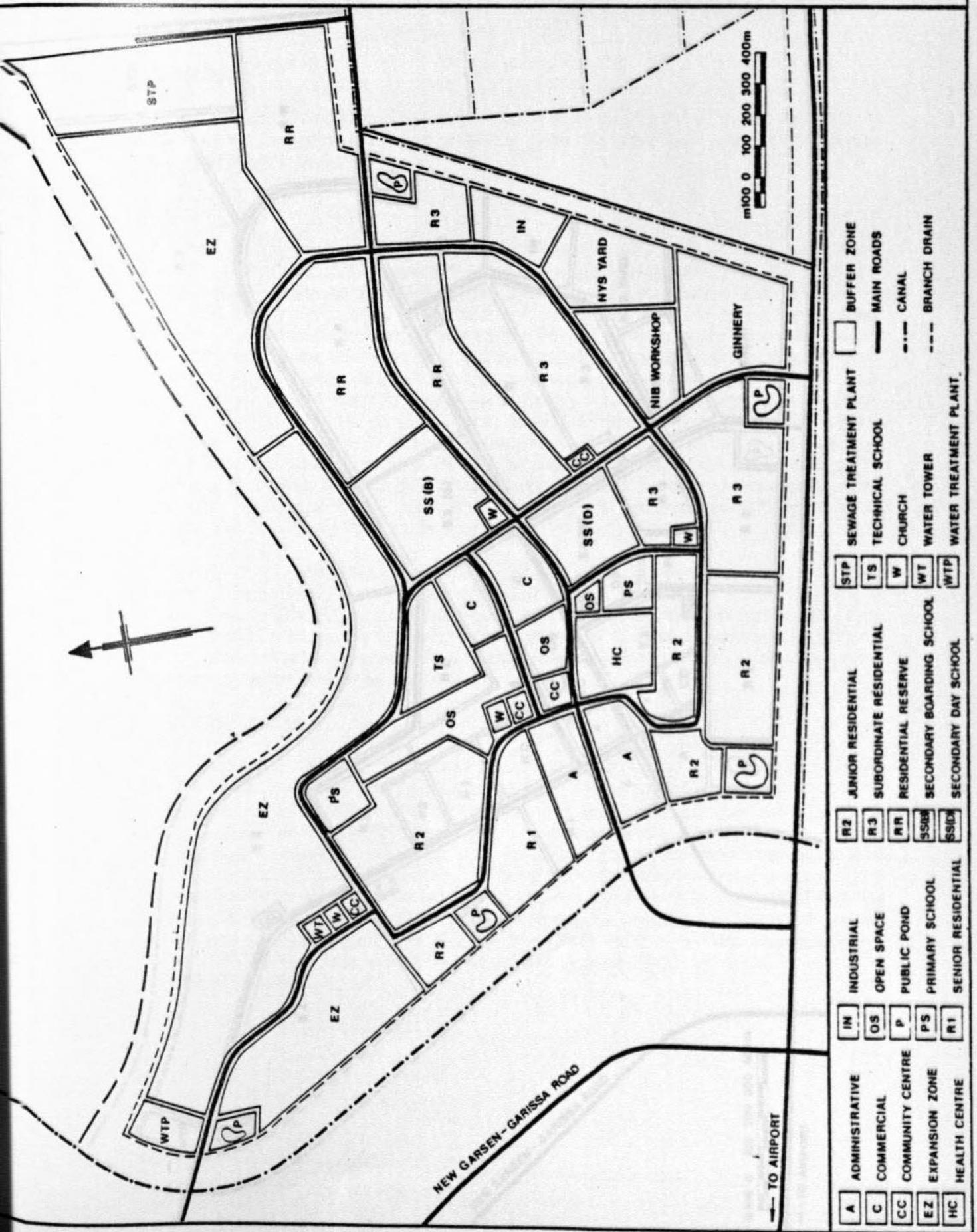
Infrastructural services are discussed in greater detail in the Utility Services Annexe.

(ix) Informal Sector Reserve

In anticipation of the growth of population through in-migration of informal settlers, an area of 15 hectares has been reserved in the north-eastern sector of the town for squatters, nomads and casual labourers. Housing in the area would neither be funded by the NIB nor any other Government Agency. However, to prevent health hazards, a water supply network of public kiosks is envisaged. It is emphasised that strict development control guidelines must be prepared prior to the implementation of the project, to govern construction of houses in this reserve, and in fact, in the town as a whole. Similarly, an enforcement framework must be established.

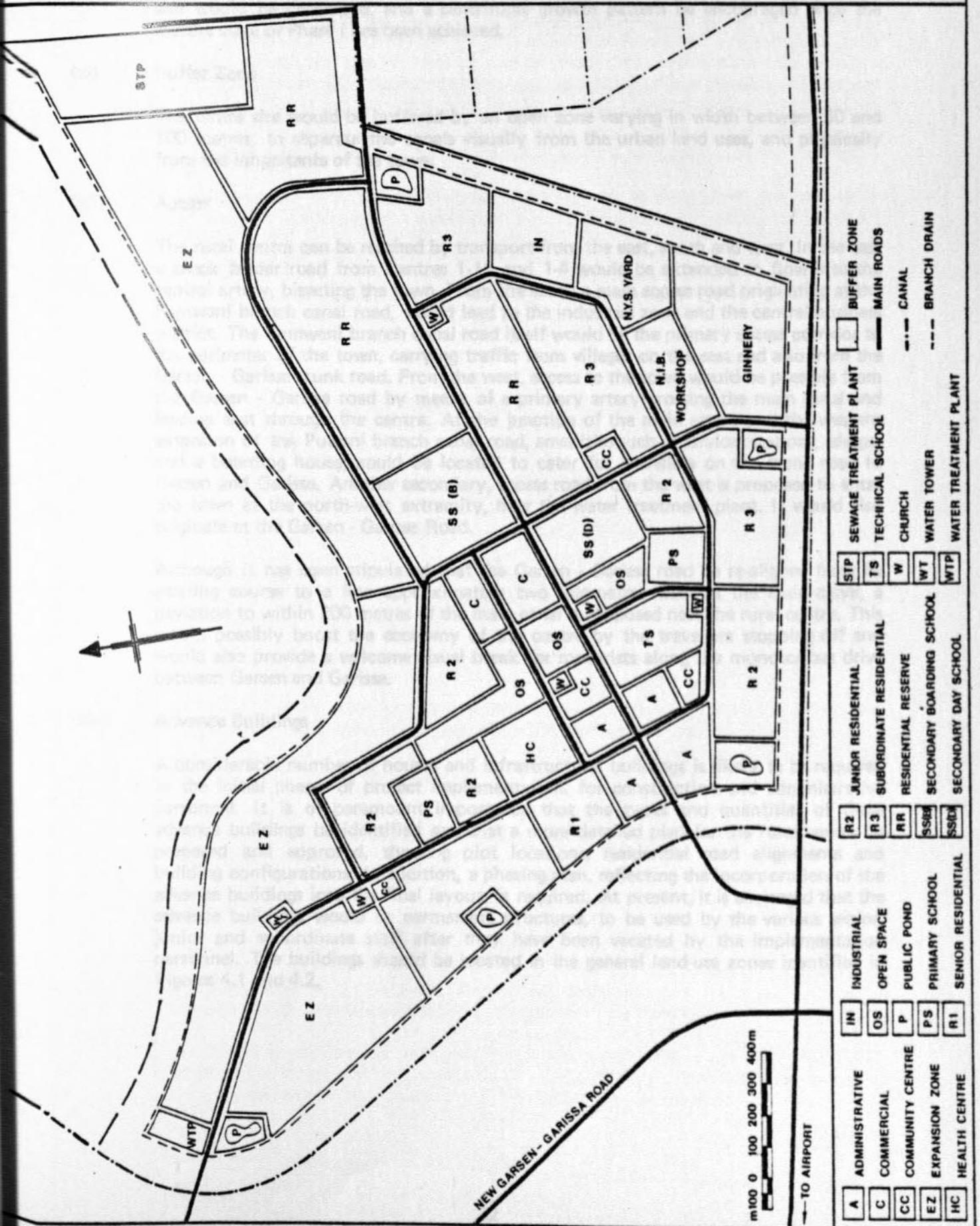
# RURAL CENTRE STRUCTURE PLAN

## ALTERNATIVE A



<b>A</b>	ADMINISTRATIVE	<b>R2</b>	JUNIOR RESIDENTIAL	<b>STP</b>	SEWAGE TREATMENT PLANT		BUFFER ZONE
<b>C</b>	COMMERCIAL	<b>R3</b>	SUBORDINATE RESIDENTIAL	<b>TS</b>	TECHNICAL SCHOOL		MAIN ROADS
<b>CC</b>	COMMUNITY CENTRE	<b>RR</b>	RESIDENTIAL RESERVE	<b>W</b>	CHURCH		CANAL
<b>EZ</b>	EXPANSION ZONE	<b>SS(B)</b>	SECONDARY BOARDING SCHOOL	<b>WT</b>	WATER TOWER		BRANCH DRAIN
<b>HC</b>	HEALTH CENTRE	<b>SS(D)</b>	SECONDARY DAY SCHOOL	<b>WTP</b>	WATER TREATMENT PLANT		
<b>IN</b>	INDUSTRIAL						
<b>OS</b>	OPEN SPACE						
<b>P</b>	PUBLIC POND						
<b>PS</b>	PRIMARY SCHOOL						
<b>R1</b>	SENIOR RESIDENTIAL						

# RURAL CENTRE STRUCTURE PLAN ALTERNATIVE B



<b>A</b>	ADMINISTRATIVE	<b>R2</b>	JUNIOR RESIDENTIAL	<b>STP</b>	SEWAGE TREATMENT PLANT	<b>□</b>	BUFFER ZONE
<b>C</b>	COMMERCIAL	<b>R3</b>	SUBORDINATE RESIDENTIAL	<b>TS</b>	TECHNICAL SCHOOL	<b>—</b>	MAIN ROADS
<b>CC</b>	COMMUNITY CENTRE	<b>RR</b>	RESIDENTIAL RESERVE	<b>W</b>	CHURCH	<b>- - -</b>	CANAL
<b>EZ</b>	EXPANSION ZONE	<b>SS(B)</b>	SECONDARY BOARDING SCHOOL	<b>WT</b>	WATER TOWER	<b>- - -</b>	BRANCH DRAIN
<b>HC</b>	HEALTH CENTRE	<b>SS(D)</b>	SECONDARY DAY SCHOOL	<b>WTP</b>	WATER TREATMENT PLANT		
<b>IN</b>	INDUSTRIAL						
<b>OS</b>	OPEN SPACE						
<b>P</b>	PUBLIC POND						
<b>PS</b>	PRIMARY SCHOOL						
<b>R1</b>	SENIOR RESIDENTIAL						

m 100 0 100 200 300 400m

TO AIRPORT

(x) Expansion Zone

To cope with any future growth of the rural centre, such as may occur if Phase II of the project is implemented, or if other regional projects are to be serviced by this centre, expansion spaces for housing and other uses has been allocated in the northern sector of the town. Thus, in the foreseeable future, only the southern half of the entire site would be developed, and a centrifugal growth pattern be encouraged once the mature state of Phase I has been achieved.

(xi) Buffer Zone

The entire site would be buffered by an open zone varying in width between 50 and 100 metres, to separate the canals visually from the urban land uses, and physically from the inhabitants of the town.

(xii) Access

The rural centre can be reached by transport from the east, south and west. In the east a block feeder road from Centres 1-12 and 1-4 would be extended to flow into the central artery, bisecting the town. From the south a main access road originating at the Pumwani branch canal road, would lead to the industrial zone and the central business district. The Pumwani branch canal road itself would be the primary access corridor to the perimeter of the town, carrying traffic from villages on the east and also from the Garsen - Garissa trunk road. From the west, access to the town would be possible from the Garsen - Garissa road by means of a primary artery crossing the main canal and leading east through the centre. At the junction of the main artery and the western extension of the Pumwani branch canal road, amenities such as service stations, shops, and a boarding house, could be located to cater for travellers on the trunk road to Garsen and Garissa. Another secondary, access road from the west is proposed to enter the town at the north-west extremity, near the water treatment plant. It would also originate at the Garsen - Garissa Road.

Although it has been stipulated that the Garsen - Garissa road be re-aligned from its existing course to a line approximately two kilometres west of the main canal, a deviation to within 200 metres of the main canal is proposed near the rural centre. This would possibly boost the economy of the centre by the travellers stopping off and would also provide a welcome visual break for motorists along the monotonous drive between Garsen and Garissa.

(xiii) Advance Buildings

A considerable number of houses and infrastructural buildings is likely to be required in the initial phases of project implementation. for construction and administrative personnel. It is of paramount importance that the types and quantities of these advance buildings be identified and that a more detailed plan for the rural centre be prepared and approved, showing plot locations, residential road alignments and building configurations. In addition, a phasing plan, reflecting the incorporation of the advance buildings into the final layout, is required. At present, it is envisaged that the advance buildings would be permanent structures, to be used by the various senior, junior and subordinate staff after they have been vacated by the implementation personnel. The buildings should be located in the general land-use zones identified in Figures 4.1 and 4.2.

## Alternative B

In this proposal, a land-use structure very similar to that envisaged in Alternative A is proposed. However, the road network would, in general, be more rigid and symmetrical. Although this feature offers advantages in the ease of surveying and rectangular plot allocation, it also entails several disadvantages. Visual interest would be difficult to preserve along the straight roads because new vistas would not be presented to the traveller. The monotony of the long tunnel-like arteries would be aesthetically undesirable and this constraint could be compounded by problems of speeding traffic.

The arrangement of the land uses in Alternative B is based on the same consideration as in Alternative A. The central business and administrative district would be joined to the surrounding residential zones by a central open space system consisting of parks, schools, and clubs and the industrial zone would again be situated in the south-east quadrant, in the lee of the town.

In general the description of the residential subdivisions, the open space network, schools, the health centre, ponds, and other features in Alternative A, also apply to this conceptual structure plan.

## CHAPTER 5 GENERAL CONCLUSIONS

The purpose of the village planning and design studies within the context of the Project Planning Report of the Bura Project was to review previously established criteria, to develop functional planning principles for the site, to identify a theoretical and practical village network, and to prepare conceptual designs for various types of centres. On the basis of an analysis including site visits, study of relevant documents and meetings with authorities concerned, a statement of goals and objectives was derived, and was followed by a series of planning parameters for site selection and village design. Subsequently, a project structure plan, conceptual village layouts, and land-use plans for an administrative centre were prepared. The following is a summary of the results of the study:

### (a) Centre Network

Based on an optimal village population size of 2 500 persons and on a minimum walking distance to agricultural holdings of two kilometres, it was determined that a total of 23 villages would be required to accommodate the expected population. These villages would be centres of several economic orders, namely 4 market centres, 8 local centres, and 11 sub-local centres. In addition, one rural centre would be required for administration and servicing of the scheme as a whole.

### (b) Village Location

The sites for the villages were identified in relation to soil conditions and to agricultural holding catchment areas. In general, the villages would be located on the perimeter of irrigation sectors, oriented towards branch or block canals.

### (c) Rural Centre Location

To meet the specialised economic requirements of the project population, and to accommodate administrative, industrial and servicing uses associated with the scheme, an administrative town or rural centre is proposed. A suitable location for this urban area was identified in relation to regional considerations, distances to population nodes, and specific site conditions.

### (d) Rural Centre Structure Plan

Conceptual land-use plans for the rural centre, based on specific space components and on population estimates, were prepared. Between 8 000 and 10 000 persons are expected to reside in the rural centre in the mature state of Phase I, thus requiring residential space. Expansion space for future population growth was also allocated.

The plans allow for the development of industrial, commercial, administrative, recreational, educational and residential uses, and ensure access, traffic circulation, and the definition of spaces.

### (e) Village Design

To avoid the monotony and dilution of spaces, experienced in the grid-iron villages at the Hola Irrigation Scheme, a new concept, based on the proposed procedure of settling smallholders, is proposed. This concept is founded on a hierarchical system of units, cells, modules and wards, built in increments of six houses.

Each village would include basic commercial, administrative, social and educational amenities. The internal structure of each village would be introspectively oriented, and a symmetrical yet non-rigid alignment of residential units be achieved.

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*BURA IRRIGATION SETTLEMENT PROJECT*

*PROJECT PLANNING REPORT*

*HOUSING AND BUILDING ANNEXE*

# BURA IRRIGATION SETTLEMENT PROJECT

## PROJECT PLANNING REPORT

### HOUSING AND BUILDING ANNEXE

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There is thought to be adequate supplies of Makuti wood but the amount of mangrove poles available is limited. There is sufficient time to stockpile mangrove poles in advance to mitigate supply problems but mudbrick walls may have to be considered for some villages preferably where gypsum and material is available nearby. This will incur problems of foundations to overcome swelling of the mud-bricks and would add substantially to costs. Clearly there is a pressing need for information on the supply of materials and possible foundation problems at various village sites.

There are two major objections to the use of thatch. One is the risk of fire, particularly when cooking is traditionally done inside the house. The second objection is much less tangible but of considerable social importance, namely, that a corrugated galvanized iron (CGI) roof has a much higher social status in Kisumu than thatch, even though the latter is much cooler and cheaper, and would have a life of 10 to 15 years if well constructed of good materials. It may well be argued that the tenant could at some later date at his own expense replace his thatch with CGI, but the general consensus of opinion in Kisumu suggests that the tenants would prefer their houses to be roofed with CGI.

The lowest estimates of tenant houses vary from K Sh 2 700 to 4 400 for standard mud and wattle type and from about K Sh 5 000 to 7 700 for mudbrick type, the range of prices reflecting materials used and options adopted. The estimated cost of corrugated iron roofing is about K Sh 1 700, a third of the total basic cost of a mud and wattle type without options, and just over one-fifth for a similar mud-brick type.

Recommendations

In the context of the Bura Project it would be well worthwhile preparing two economic staff housing designs to match up to design standards, the local climate and particular conditions, including good staff grades. Good staff housing and recreational facilities are essential for encouraging qualified and experienced staff to live and work in remote areas.

Good staff housing does not necessarily mean heavy or expensive dwellings. Some six or seven basic economic designs could be prepared with one or two variations; the lower the design the

## SUMMARY AND RECOMMENDATIONS

### Summary

In accordance with the terms of reference for this report, architectural and quantity surveying reviews were made of a considerable number of government designs for staff and tenant housing and buildings, supplied by the National Irrigation Board (NIB). Generally, most of the staff house designs were prepared for upland or coastal areas and were not suitable for the climatic conditions and particular requirements at Bura. Despite considerable attempts at modification, no really satisfactory modified designs were achieved at economic costs.

At present there appears to be no local code of practice or regulations relating government house types and sizes to staff grades. With the very large number of staff houses required for the Bura project some system of house grading will be necessary.

A good deal of work has already been done to design cheap but effective tenant houses. Preference is given to the double banked type house which could be extended by the tenant at a later date to form a courtyard, and to provide some family privacy. The cheapest form of tenant house would be pole-framed with mud and wattle walls, pole rafters and purlins, and thatch: gabled ends with vents would be desirable to increase ventilation. The poles must be termite resistant and the most suitable material is mangrove poles grown on the coast. Some local thatch is available but is not termite resistant: Makuti reed from the coast is much more suitable and should be transported to site. Transportation costs are therefore a substantial portion of total costs.

There is thought to be adequate supplies of Makuti reed but the amount of mangrove poles available is limited. There is sufficient time to stockpile mangrove poles in advance to mitigate supply problems, but mud-brick walls may have to be considered for some villages preferably where suitable mud material is available nearby. This introduces problems of foundations to minimise cracking of the mud-bricks and would add substantially to costs. Clearly there is at present insufficient information on the supply of materials and possible foundation problems at particular village sites.

There are two major objections to the use of thatch. One is the risk of fire, particularly where cooking is traditionally done inside the house. The second objection is much less tangible but of considerable social importance, namely, that a corrugated galvanised iron (CGI) roof has a much higher social status in Kenya than thatch, even although the latter is much cooler and cheaper, and would have a life of 10 to 15 years if well constructed of good materials. It may well be argued that the tenant could at some later date at his own expense replace his thatch with CGI, but the general consensus of opinion in Kenya suggests that the tenants would prefer their houses to be roofed with CGI.

The latest estimates of tenant houses vary from K Sh 3 700 to 5 400 for essentially mud and wattle type and from about K Sh 6 000 to 7 700 for mud-brick type: the range of prices reflecting materials used and options adopted. The estimated cost of corrugated iron roofing is about K Sh 1 700, a third of the total basic cost of a mud and wattle type without options, and just over one-fifth for a similar mud-brick type.

### Recommendations

In the context of the Bura Project it would be well worthwhile preparing new economic staff housing designs to match up-to-date living standards, the local climatic and particular conditions, and staff grades. Good staff housing and recreational facilities are essential prerequisites for encouraging qualified and experienced staff to live and work in remote areas.

Good staff housing does not necessarily mean lavish or expensive dwellings. Some six or seven basic economic designs could be prepared with one or two variations: the fewer the designs the

cheaper and easier construction will be, although variety and planning concepts must be borne in mind. The NIB staff are very familiar with the climatic and particular conditions of the area and have already prepared several conceptual designs. They should prepare all the basic conceptual designs which would then be developed into working designs and tender documents.

All staff housing would be constructed by contract after international competitive bidding. Two contracts are envisaged: one dealing with the advance staff housing and buildings required in the three first villages and the rural centre before the arrival of the first tenants, and which would include the sewage system and house connections for the rural centre advance houses; the second would deal with the remaining staff houses and buildings, the treated water supply, the electrical power generation and the electrical distribution system in the rural centre. These contracts are considered to be of sufficient value to attract good contractors.

The co-financers have stipulated that their funding of tenant houses would be limited to a basic cost of K Sh 4 000 per house excluding physical and price contingencies: any additional expenditure would be financed by the Government of Kenya. The cost of the tenant house is to be recovered from the tenant over a ten year period. The Government can therefore finance any additional expenditure within its finance and cash flow capabilities knowing that it will eventually recover the costs, although probably without interest: such a decision must rest with the Government.

However, Government will have many calls on its financial resources during the implementation period of the project and should not undertake unnecessary expenditure, nor should the tenant be burdened with excessive repayment costs in the initial years of development. We would therefore suggest that the aim as far as the tenant houses are concerned should be to provide a basically sound, cheap structure which could be improved by the tenant when he so wishes. Thus we would recommend adopting wherever possible the mangrove pole framed, mud and wattle walled house, with pole rafters and purlins, thatch roofing and with two of the life expectancy options, that is, bituminising the bases of mangrove poles of the frame, adding lime or cement to the mud plaster and lime washing the mud and wattle walls, but not treating the ground with termite protection chemicals which would only have a limited life of effectiveness. This would give a basic cost of about K Sh 4 080 for this type of house.

If CGI roofing is socially desirable, the tenant will have adequate incentive to replace his roof thatching early, a relatively simple operation not affecting the structural soundness of the dwelling.

The vast majority of the tenants will construct their own houses using materials supplied by the NIB and under the supervision of the proposed building section of NIB (see the Implementation Annexe). To ensure that the supplied materials are of a suitable quality and adequate in quantity, and the standard of construction is satisfactory, a Clerk of Works employed to supervise the housing and building contracts will inspect both materials and workmanship and issue certificates of acceptance.

To provide temporary accommodation for the first group of tenants for each village before they build their houses, 8 to 12 tenant houses will be required in advance in each village. These advance tenant houses for the first three villages will be built as part of the advance housing contract and the remaining advance tenant housing under the second housing contract. The tenants who will not have to build their own houses would construct primary schools and community halls.

There are a number of matters of the housing aspect which require further study. These include the available supplies of suitable mangrove poles, Makuti thatch, suitable muds and sands adjacent to the village sites and trial borings to determine foundation problems. These studies should be undertaken as quickly as possible so that housing proposals can be finalised and fully detailed.

## CHAPTER 1 INTRODUCTION

### 1.1 Background

In Kenya, Government staff housing is normally designed and constructed by the Ministry of Works (MOW). However, some parastatal government organisations have designed and constructed their own housing, occasionally obtaining MOW approval of their designs.

Over the years a number of MOW house designs have been evolved. Most of these are for upland climatic conditions, but one or two have been developed for coastal conditions. There appears to be no local code of standard practice specifically relating either house design to particular climatic conditions or house standards to staff grades.

The terms of reference for the Project Planning Report stipulated that the following tasks should be carried out in co-operation with the National Irrigation Board (NIB):

'Review of the programme and design for project housing and buildings, as well as for villages and rural centres, and prepare recommendations if required.

Prepare the cost estimates for project housing and buildings as well as for infrastructure for villages and rural centres up to feasibility study standards.'

To facilitate the review, the NIB supplied a number of drawings, bills of quantity and other related information, covering MOW staff houses, NIB tenant houses and buildings, and various government infrastructural buildings: these are listed in Appendix A. The architectural review covered the housing and NIB buildings only, whereas the quantity surveying also included the infrastructural buildings.

### 1.2 Basis of the Review

The documents supplied differed in such aspects as degree of completion, detailed information and specification, scales and system used (imperial or metric), presentation and original source. Moreover, the review material had in most cases been developed for climates and conditions other than those at Bura.

To provide a common basis for the review, criteria were formulated for both the architectural and quantity surveying aspects: these are set out in Appendices B and C.

Bearing in mind that the terms of reference were to 'review' as opposed to 'design' or 're-design', some difficulty was experienced in deciding the extent to which to modify a given design to achieve suitability for Bura without increasing costs. For the majority of the designs provided there was a strong inclination to prepare new designs that would satisfy climatic requirements whilst achieving functional and economic solutions. Where it was considered necessary to make extensive modifications to designs the supplied and recommended, modified versions exhibit marked differences.

The modification of some of the buildings has involved extra costs. Although these have been kept to a minimum, the suitability for the climate and function achieved by modification would justify such extra costs.

### 1.3 Presentation

For ease of reference and comparison between the material presented for review and its modified form, the following presentation has been adopted:

## Figures

— All drawings of houses and NIB buildings were reduced, generally to the scale of 1:200, and placed at the top-right-hand corner of the Figure. The recommended modifications were then drawn up, generally to the scale of 1:100, and form the main body of the Figure. The reference or title description of the NIB drawing appears below the 1:200 drawing, at the top-right-hand corner, while the amended 1:100 drawing is referenced by the reference of the original drawing prefixed with the letter 'R' for revision, e.g. (R-MBX/80). It has not been found necessary nor was there the time to present in graphic form, sections and elevations of buildings. Where necessary, these have been discussed in the text accompanying each Figure.

## Costing

— The quantity surveying estimates for the original design and the modified version, appear on one page in two columns. The cost estimates and plinth area of the original design appear on the third column on the page, while those of the modified design appear on the last column.

At the bottom of the page appear the unit cost and the estimated savings or extras.

## CHAPTER 2 REVIEW FINDINGS

### 2.1 Architectural Review

The architectural review covered the following houses and buildings:

- 2 Principal staff houses
- 10 Senior staff houses
- 7 Junior staff houses
- 2 Subordinate staff houses
- 2 Guest houses
- 5 Tenant houses
- 4 NIB buildings

#### *Staff Houses*

The detailed findings of the architectural review concerning staff houses are summarised in Table 2.1. Many of the houses were not suitable for the climatic conditions at Bura and would require extensive modification or re-design. Even after these modifications, the resultant designs are generally not ideal.

The general conclusion reached was that the staff housing designs were not in keeping with the climatic conditions of the project area nor were the special concepts in accordance with present-day conditions in Kenya.

In addition to the climatic and functional requirements overall planning concepts affect the orientation of the buildings, and a close liaison was maintained during the review with the planners preparing the village and rural centre structural plans. The climate at the project area is semi-desert with prevailing north-east winds during the local summer period (the European winter), and south-east winds during the cooler local winter months. Details of the climatic conditions are given in Appendix B, the Architectural Review.

Table 2.1 - Summary of Architectural Review, Staff Houses

Staff House Type	Number of Bedrooms	Comments	Cost (1,000 K Sh)	
			Original	Modified
<b>PRINCIPAL</b>				
DC House (18/51361/20)	3	RM	248	243
Manager's House (MBX/43)	3	SM	212	200
<b>SENIOR</b>				
(MAX 8)	3	SM	204	179
(MAX 9)	3	SM	181	196
(MBX 20)	2	SM	95	101
(MBX 78)	3	RM	129	133
(MBX 80)	3	RM	137	138
(TAPI/46)	2	NS	180	170
(D - Lowland)	4	NS	125	125
(E - Lowland)	3	NS	94	92
(F - Lowland)	2	SM	60	60
(C - Lake)	3	RM	126	140
<b>JUNIOR</b>				
(MBX/41 semi-detached)	3	NS	81	87
(MBX/66)	3	NS	40	49
(MBX/89)	3	NS	48	47
(MBX/95)	3	SM	49	51
(TAPI/6)	2	NS	94 **	94 **
(TAPI/48)		NS	65	68
(MAX/5)		Insufficient information		
<b>SUBORDINATE</b>				
(MBX/40) 4 attached units	4	SM	52	58
(MAX/3)		Insufficient information		
<b>GUEST HOUSES</b>				
PC G House	2	NS	78	74
(MBX/39)	2	SM	86	81

Notes:

- RM - Recommended after modification
- SM - Suitable after modification
- NS - Not suitable
- \*\* - Includes servants quarters and kitchen unit

## Tenant Houses

Table 2.2 summarises the findings of the Architectural Review of the tenant houses. The alternatives refer to different materials used in construction, i.e. mangrove pole frame, rafters and purlins, mud and wattle walls and CGI roofing; mangrove pole frame, mud and wattle walls, sawn podo timber rafters and purlins, and CGI roofing; and, thirdly, mud-brick walls, sawn podo timber rafters and purlins and CGI roofing. Modifications were cement rendering walls internally and externally and dwarf wall for cooking verandah. In no design was thatch roofing contemplated. Four of the five sets of designs were considered suitable after modification.

Table 2.2 - Summary of Architectural Review, Tenant Houses

Tenant House	Number of Bedrooms	Comments	Cost (K Sh)	
			Original	Modified
K11/83 (43 m <sup>2</sup> )	2	RM		
Alternative 1			4 425	5 505
Alternative 2			5 348	6 428
Alternative 3			7 642	8 722
K11/83 (modified)	—	RM		
Alternative 1	2		4 254	5 105
Alternative 2			5 217	6 067
Alternative 3			6 265	7 110
NIB Amended Hola Tenant House	2	RM		
Alternative 1			4 818	5 738
Alternative 2			5 974	6 894
Alternative 3			8 247	9 167
Tenant House (MBX/77)	2	NS	20 145	24 272
Tenant House (MBX/14)	2	RM		
Alternative 1			5 008	6 642
Alternative 2			6 059	7 822
Alternative 3			6 835	7 655

Note: RM - Recommended after modification  
NS - Not suitable even after modification

## Other Buildings

The other buildings considered in the Architectural Review required modifications before they would be suitable for use at Bura. Some of the building drawings provided could not be reviewed adequately because insufficient information was provided.

The provision of offices and other buildings at the site will require further consideration at the detailed stage, and it is likely that new designs will be required to suit the detailed requirements of the project.

The following items will be included:

Administrative Offices:	
NIB	640 sq.m
Government	330 sq.m
Workshops and Service Bays	1 478 sq.m
Storage and Machinery Sheds at Rural Centre and Villages	5 050 sq.m

## 2.2 Quantity Surveying Review

Cost estimates were prepared for all buildings for which Bills of Quantities were provided or for which sufficient information for taking off purposes was contained in the drawings. Those for the staff houses and tenant houses are summarised in Tables 2.1 and 2.2, respectively.

The cost estimates were based on current tender prices in Nairobi and the additional costs of construction at Bura were calculated. These additional costs include additional transportation, difficulties in obtaining aggregates and other building materials locally, additional contractors' overheads for the provision of camps for building workers and other costs involved in working in a remote area. These costs varied between about 30 and 45 per cent depending on the type of building and the quantity of materials to be transported to site. A figure of 40 per cent was adopted overall to simplify matters. This figure represented the increased costs of the majority of housing and building types likely to be required at the project area.

Reductions in costs as the result of modifications in design only generally occurred for the more expensive senior staff houses. Junior and subordinate staff house costs were generally increased when the designs were modified.

Tenant house costs were also increased as a result of modifications. However, the use of thatch instead of CGI roofing would considerably reduce costs (see Chapter 3).

The Quantity Surveying Review is included as Appendix C of this Annex.

## 2.3 Conclusions

Few of the staff house designs could be wholeheartedly recommended even after modifications, and these resulted in increased costs except for one or two senior houses.

The large numbers of staff houses required for the Bura Project, particularly the junior and subordinate staff types, justify a complete reconsideration of house design for the project. To achieve a proper solution to the climatic and functional problems arising in the Bura situation in an economic way, new staff house designs are required. The solution of these problems is discussed in the following chapters.

## CHAPTER 3 HOUSING AND BUILDING RECOMMENDATIONS AND PROJECT COSTS

### 3.1 Introduction

In addition to the problems created by the unsuitability of a number of the reviewed designs, the remoteness of the site and the need to keep costs of construction to a minimum, there are other factors to be considered including the housing requirements at the project site.

A large number of staff will be required to move to the area to administer NIB and other Government agency operations. A mixture of housing types is required to suit the grading of these staffs and their family requirements. Provision has also to be made for servants quarters, garaging and other requirements where necessary.

In the case of tenants' housing, the house has to be designed to be an economic core dwelling, capable of being built by the tenant, and capable of being extended by him in the future to meet increased domestic needs or aspirations.

A number of these problems can only be properly solved at the detailed design stage, and it is necessary to make assumptions here to assess realistic cost estimates for project planning purposes. The assumptions that have been made in determining cost estimates based on present recommendations are discussed in this chapter, and details of the organisation of construction proposed are given in the following chapters.

### 3.2 Staff Grades, House Types and Unit Costs

The practice of the National Irrigation Board is to allocate grades of housing in accordance with the position of the member of staff concerned in the NIB salary scale structure. The practice of other government agencies is similar except that a points system is used to take into account the size and structure of a staff member's family and other factors. There are also generally only three grades of housing considered in government house grading, although there are variations in house type within any one grade.

Staff family sizes and other such factors are indeterminate at this stage of the project, and allocation of housing has been made only by reference to staff salary grades. The allocation of house types by grade is shown in Table 3.1.

The house types currently recommended and used to prepare the cost estimates are design concepts developed by the National Irrigation Board (NIB) staff for construction at the Hola Scheme, or derivatives of such designs. The range comprises seven basic types which are described below. It is anticipated that if for any reason these designs are not acceptable for the occupation of government agency staff as well as NIB staff, alternative designs for government agency staff could be developed which would be of a similar cost.

Table 3.1 - Total Housing Requirements at Site - Summary<sup>3</sup>

Housing at Site	A	B	C	D	E	F	G
House Type							
Area (m <sup>2</sup> )	160	118	105	80	56	40	40
Cost (K Sh 1 000)	310	200	165	110	58	14	10
	NIB Scale						
Staff Scales	H	E to G	C & D	A & B	I & II	III & IV	V
	Grade/Median Scale (K Sh 1 000)						
Agency	Principal 70	Senior 1 55	Senior 2 40	Senior 3 27	Junior 1 15	Junior 2 8	Subordinate 6
NIB operational staff	1	9	27	18	28	298	109
Livestock	—	—	3	—	—	6	1
Fisheries	—	—	1	1	7	6	—
Wildlife	—	—	—	—	1	12	—
Forestry	—	—	2	—	6	37	—
Processing	—	2	2	—	16	11	—
Marketing	—	—	—	3	7	3	1
Research	—	—	1	—	—	—	—
Education <sup>4</sup>	—	—	1	8	83	239	25
Health	—	—	—	4	13	18	25
Social Services	—	1	—	5	—	25	—
Communications	—	—	—	1	4	22	11
Infrastructure	—	—	3	—	9	12	—
District and Local Administration	1 <sup>1</sup>	2 <sup>2</sup>	3	3	23	104	22
Total Housing at Site (Total Staff) <sup>5</sup>	2 (2)	14 (15)	43 (53)	43 (55)	197 (248)	793 (850)	194 (251)

Notes:

<sup>1</sup> House type A allowed for Senior District Officer

<sup>2</sup> House type B allowed for Police Inspector and Agricultural Officer

<sup>3</sup> Total housing and building project costs are given in the Project Costs Annexe

<sup>4</sup> Educational housing allows for some teachers as married couples, see Institutions and Services Annexe

<sup>5</sup> Figures in brackets are total staffing at Site and Nairobi: housing allowances for Nairobi based staff provided in operational costs, see Project Costs Annexe

The characteristics of the house types are given in Table 3.2 below.

Table 3.2 - Recommended Staff Houses and Estimated Costs  
(K Sh 1 000)

House Type		Unit Cost
<b>A: Principal Staff House</b>		310
NIB Staff Grade:	H upwards	
Plinth area:	160 sq.m	
Materials:	Roof - painted CGI sheeting Ceilings - painted soft boards Walls - concrete blockwork, plastered and painted internally and externally Floors - coloured cement screed, trowelled smooth and polished	
Services:	Electricity, piped water to kitchen, bath, toilets, outdoor splash area, sanitary connections to public sewer or septic tank	
Rooms:	4 bedrooms, 1 living room, 1 dining room, 4 others	
<b>B: Senior Staff House</b>		200
NIB Staff Grade:	E to G	
Plinth area:	118 sq.m	
Materials:	as per House Type A	
Services:	as per House Type A	
Rooms:	3 bedrooms, 1 living/dining room, 4 others	
<b>C: Senior Staff House</b>		165
NIB Staff Grade:	C to D	
Plinth area:	105 sq.m	
Materials:	Roof - CGI sheeting Ceilings - painted soft boards Walls - concrete blockwork, rendered inside and out Floor - coloured cement screed, trowelled smooth and polished	
Services:	as per House Type A	
Rooms:	3 bedrooms, 1 living room, 3 others	
<b>D: Senior Staff House</b>		110
NIB Staff Grade	A to B	
Plinth area:	80 sq.m	
Materials:	Roof - CGI sheeting Ceilings - painted soft boards Walls - concrete blockwork, cement/sand rendering inside and outside Floors - coloured cement screed, trowelled smooth and polished	
Services:	as per House Type A	
Rooms:	3 bedrooms, 1 living room, 3 others	
<b>E: Junior Staff House</b>		58
NIB Staff Grade	I, II	
Plinth area:	56 sq.m	
Materials:	Roof - CGI sheeting Ceilings - none Walls - concrete blockwork, rendered and painted internally and externally Floor - cement screed, trowelled smooth	
Services:	Piped water in kitchen and shower, pit latrine	
Rooms:	3 bedrooms, 1 living room, 2 others	

**F: Junior Staff House**

NIB Staff Grade: III, IV  
Plinth area: 43 sq.m  
Materials: Roof - CGI sheeting  
Ceilings - none  
Walls - mud-brick, cement rendered inside and out  
Floor - cement screed, trowelled smooth  
Foundation - 2 sand/cement block courses below ground level with bituminous felt d.p.c.  
Services: Pit latrine, pipe water supply  
Rooms: 2 bedrooms, 2 others

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**G: Subordinate Staff House**

NIB Staff Grade: V  
Plinth area: 43 sq.m  
Materials: Roof - CGI sheeting  
Ceilings - none  
Walls - mud and mangrove poles, mud surface, cement plastered and lime washed  
Floor - cement screed, trowelled smooth  
Services: Pit latrine, pipe water supply  
Rooms: 2 bedrooms, 2 others

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### 3.3 The Tenant House and Costs

A great deal has already been done to design cheap but effective tenant houses, various designs have been developed and discussed by the NIB, the project consultants and World Bank advisors. Preference is given to the double banked type house which could be extended by the tenant at a later date to form a courtyard and to provide some family privacy, see Figure 3.1.

The latest typical costs of alternative forms of tenant houses are given in Table 3.3.

Table 3.3 - Tenant House Types and Costs  
(K Sh)

Type	Costs
<b>A : Mangrove poles and mud and wattle walls</b>	
Basic Cost	
Frame and roof poles	3 193
Makuti thatch	500
CGI roofing	1 668
Life expectancy options (LEP)	529
Total Cost	
With thatch	3 693
Thatch with LEP	4 222
With CGI roofing	4 861
CGI roofing with LEP	5 390
<b>B : Mud-brick walls and roofing poles</b>	
Basic Costs	
Walls and roofing poles	5 459
Makuti thatch	500
CGI roofing	1 668
Life expectancy options	529
Total Costs	
With thatch	5 959
Thatch with LEP	6 488
With CGI roofing	7 127
CGI roofing with LEP	7 656

- Notes: (a) Life expectancy options (LEP) are:
- (i) bituminising bases of frame poles as protection against termites (K Sh 50)
  - (ii) use of lime or cement in mud plaster and limewash to the outside of walls (K Sh 335)
  - (iii) treating soil for termite protection (k Sh 144)
- (b) Above costs include labour for construction and for latrine superstructure, costs of augered pit latrine and its concrete slab included in village infrastructure costs.

The cheapest form of tenant house would be pole framed with mud and wattle walls, pole rafters and purlins, and thatch: gabled ends with vents would be desirable to increase ventilation. The poles should as far as possible be resistant to termites and the only material offering some degree of protection is mangrove poles grown on the coast. Some local thatch is available but it is subject to termite attack, and it would be much more preferable to use the more resistant Makuti reed, also obtainable from the coast. With both poles and thatch being brought from the coast, transport costs will be a substantial portion of the total house costs.

There are two major objections to the use of thatch. One is the risk of fire, particularly where cooking is traditionally done inside the house. The second objection is much less tangible, but of considerable social importance; namely, that a corrugated galvanised iron (CGI) roof has a much higher social status in Kenya than thatch, even though the latter is much cooler and cheaper, and would have a life of 10 to 15 years if well constructed of good materials. It may well be argued that the tenant could at some later date at his own expense replace his thatch with CGI, but the general consensus of opinion in Kenya suggests that the tenants would prefer their houses to be roofed with CGI.

The estimated cost of corrugated galvanised iron roofing is about K Sh 1 700, about a third of the total basic cost of a mud and wattle type house without options, and just over one-fifth for a similar mud-brick type.

The co-financers have stipulated that their funding of tenant houses would be limited to a basic cost of K Sh 4 000 per house excluding physical and price contingencies: any additional expenditure would be financed by the Government of Kenya. The cost of the tenant house is to be recovered from the tenant over about a ten year period. The Government can therefore finance any additional expenditure within its finance and cash flow capabilities knowing that it will eventually recover the costs, although probably without interest. Such a decision must rest with the Government.

However, the Government will have many calls on its financial resources during the implementation period of the project and should not undertake unnecessary expenditure, nor should the tenant be burdened with excessive repayment costs in the initial years of development. We would therefore suggest that the aim, as far as the tenant houses are concerned, should be to provide a basically sound, cheap structure which could be improved by the tenant when he so wishes. Thus we would recommend adopting wherever possible the mangrove pole, mud and wattle type with thatch roofing and two of the life expectancy options; that is, bituminising the bases of mangrove poles of the frame, adding lime or cement to the mud plaster and lime washing the mud and wattle walls, but not treating the ground with termite protection chemicals which would only have a limited life of effectiveness. This would give a basic cost of about K Sh 4 080 for this type of house, including the costs of labour paid to the tenants while constructing their houses.

If CGI roofing is socially desirable, the tenant will have adequate incentive to replace his roof thatching early, a relatively simple operation not affecting the structural soundness of the dwelling.

An overall basic cost of the K Sh 4 000 per tenant house has been used in the project estimates, with an additional allowance of 20 per cent for physical and price contingencies.

There is thought to be adequate supplies of Makuti reed, but the amount of mangrove poles available is limited. There is sufficient time to stockpile mangrove poles in advance to mitigate supply problems, but mud-brick walls may have to be considered for some villages, preferably where suitable natural mud is available nearby. This however introduces problems of foundations to minimise cracking of the sun-baked mud-bricks and would add substantially to costs.

Clearly there is at present insufficient information on the supply of materials and possible foundation problems at particular village sites, and an investigation is required into the availability of these and other construction materials, such as mudding soil and sands. This should be carried out as soon as possible, and will involve liaison with the Ministry of Works and the NIB materials consultants. Soil testing will be required at the village sites.

### 3.4 Summary of Recommendations

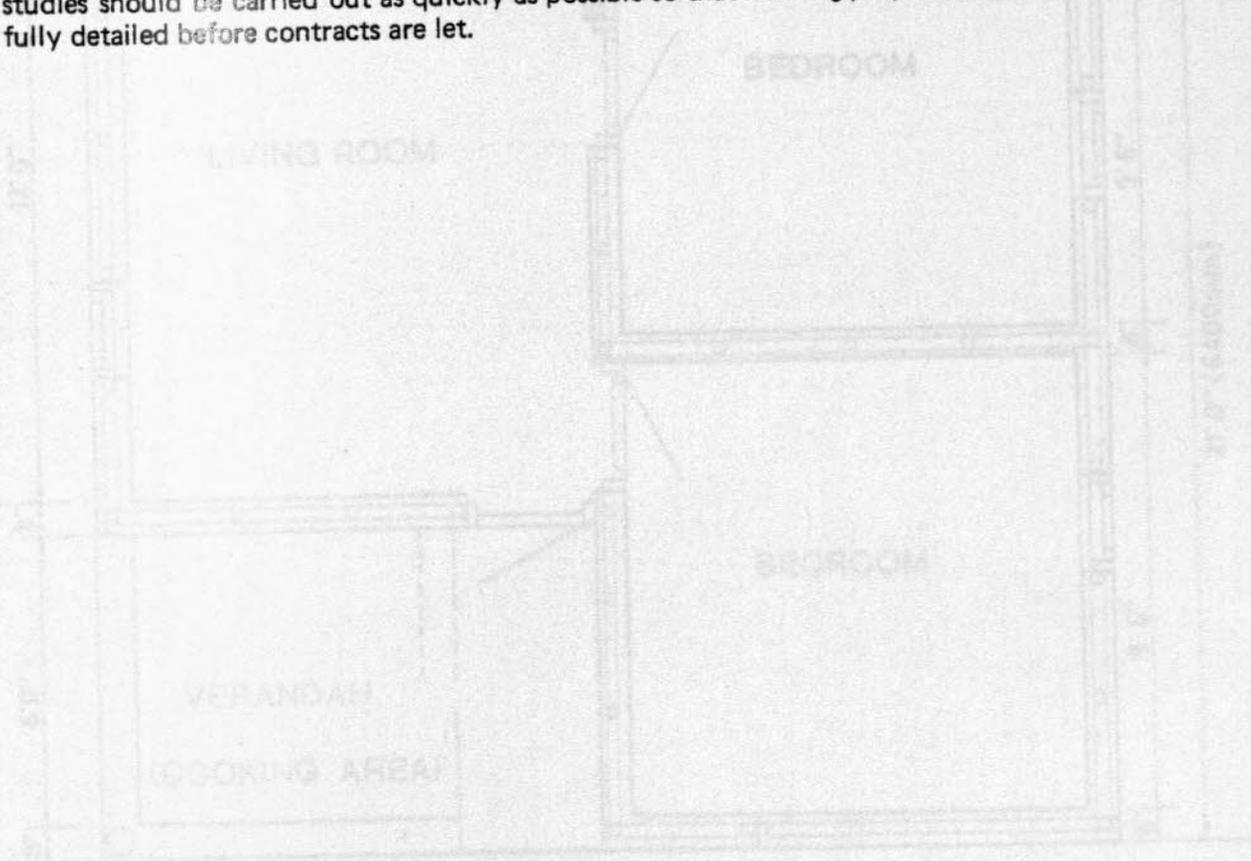
In the context of the Bura Project, it would be well worthwhile preparing new economic staff housing designs to match up-to-date living standards, the local climatic and particular conditions

and staff grades. Good staff housing and recreational facilities are essential prerequisites for encouraging qualified and experienced staff to live and work in remote areas.

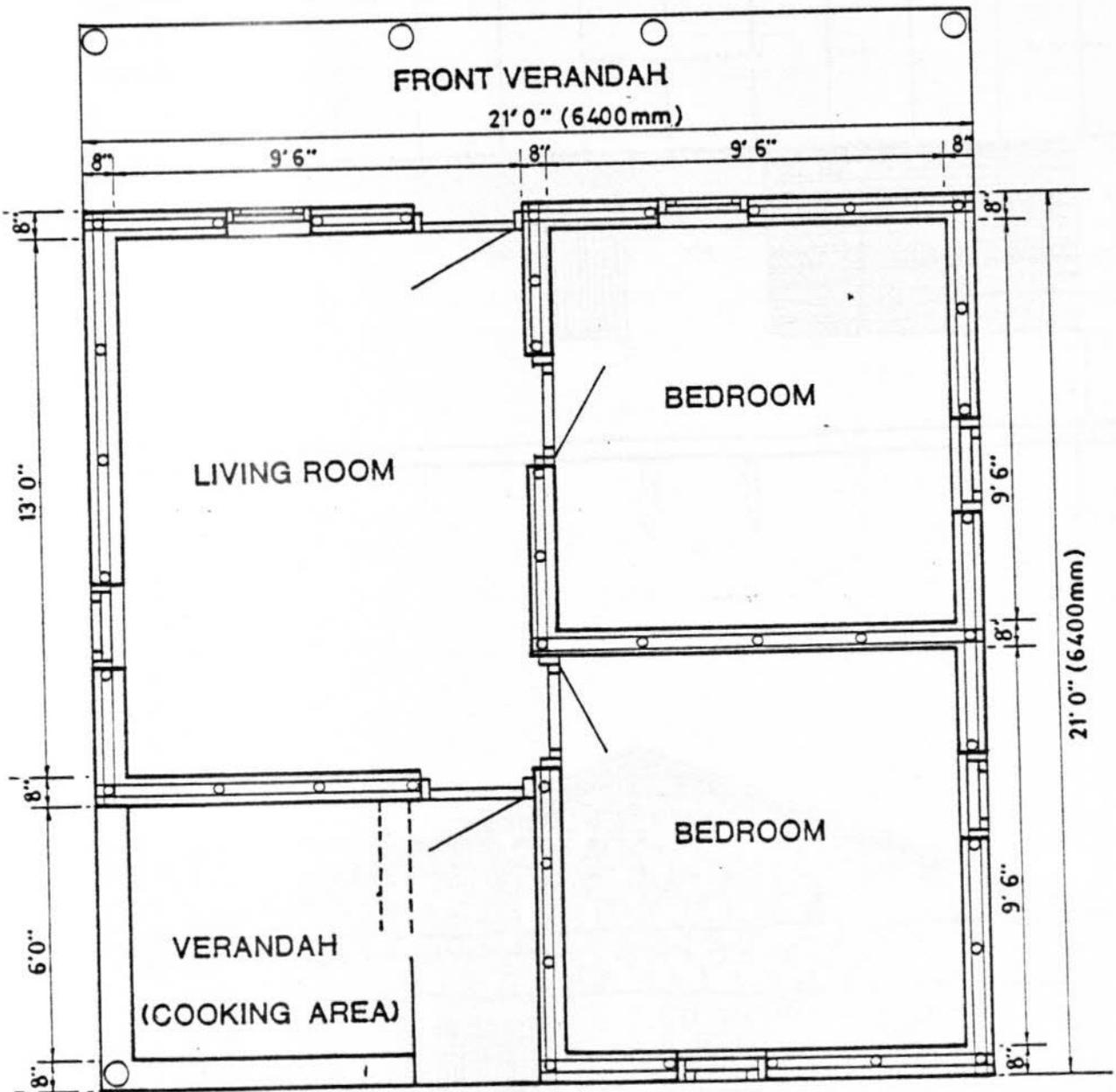
Good staff housing does not necessarily mean lavish or expensive dwellings. Some six or seven basic economic designs could be prepared with one or two variations: the fewer the designs the cheaper and easier construction will be, although variety and planning concepts must be borne in mind. The NIB staff are very familiar with the climatic and particular conditions of the area and have already prepared several conceptual designs. They should prepare all the basic conceptual designs which would then be developed into working designs and tender documents.

For tenant houses it is recommended that wherever possible the mangrove pole frame type house with mud and wattle walls, mangrove pole rafters and purlins and Makuti reed thatch be adopted, together with two life expectancy options, namely bituminising the butt ends of the mangrove poles of the frame, adding lime or cement to the mud plaster and lime washing the mud and wattle walls externally. This would have a basic cost of about K Sh 4 080.

There are a number of matters of the housing aspect which require further study. These include the available supplies of suitable mangrove poles, Makuti thatch, suitable muds and sands adjacent to the village sites, and trial borings to determine foundation problems. These additional studies should be carried out as quickly as possible so that housing proposals can be finalised and fully detailed before contracts are let.



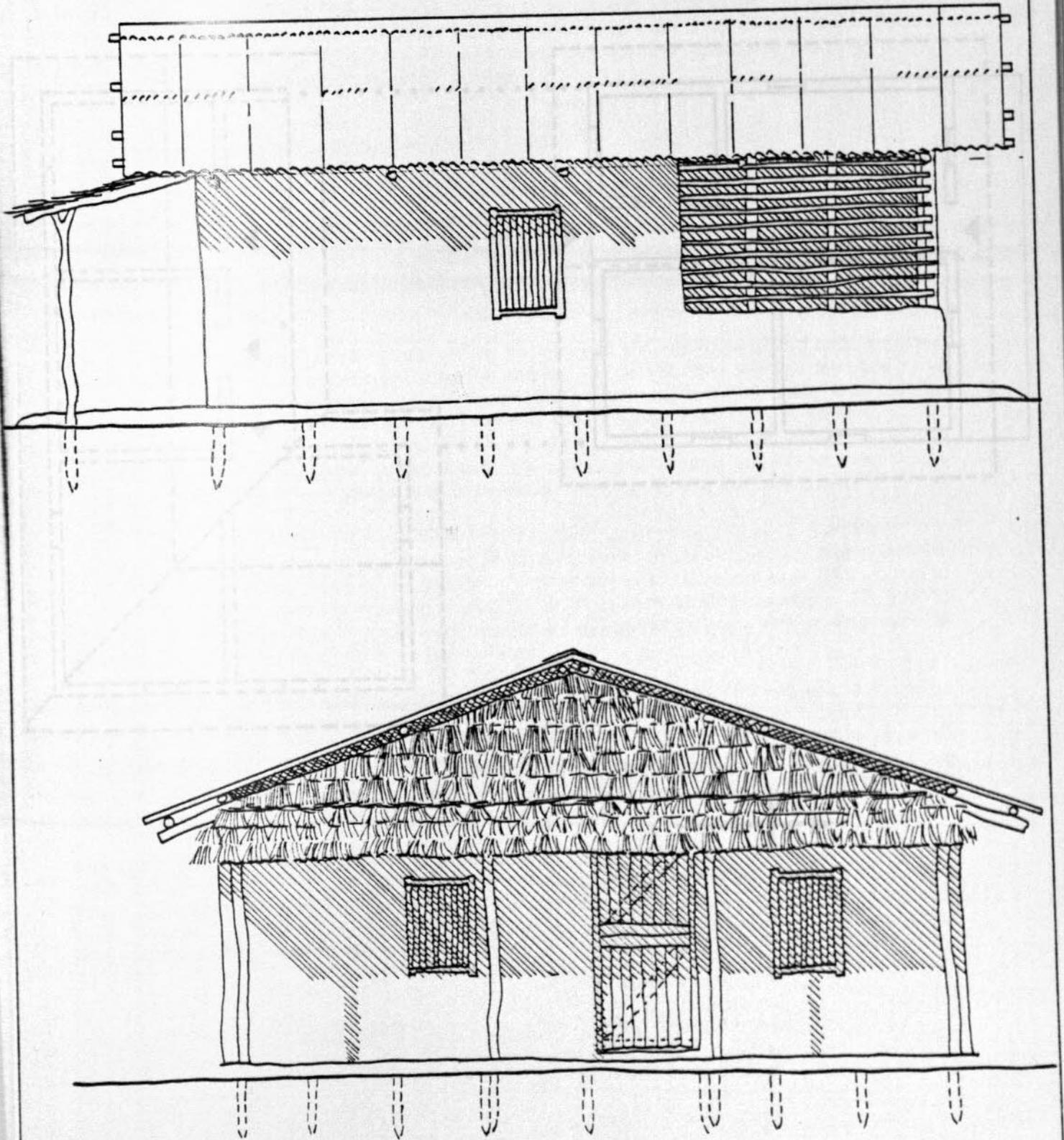
# PROTOTYPE TENANT HOUSE PLAN



PLINTH AREA 441 SQR FT (41m<sup>2</sup>)



# PROTOTYPE TENANT HOUSE ELEVATION

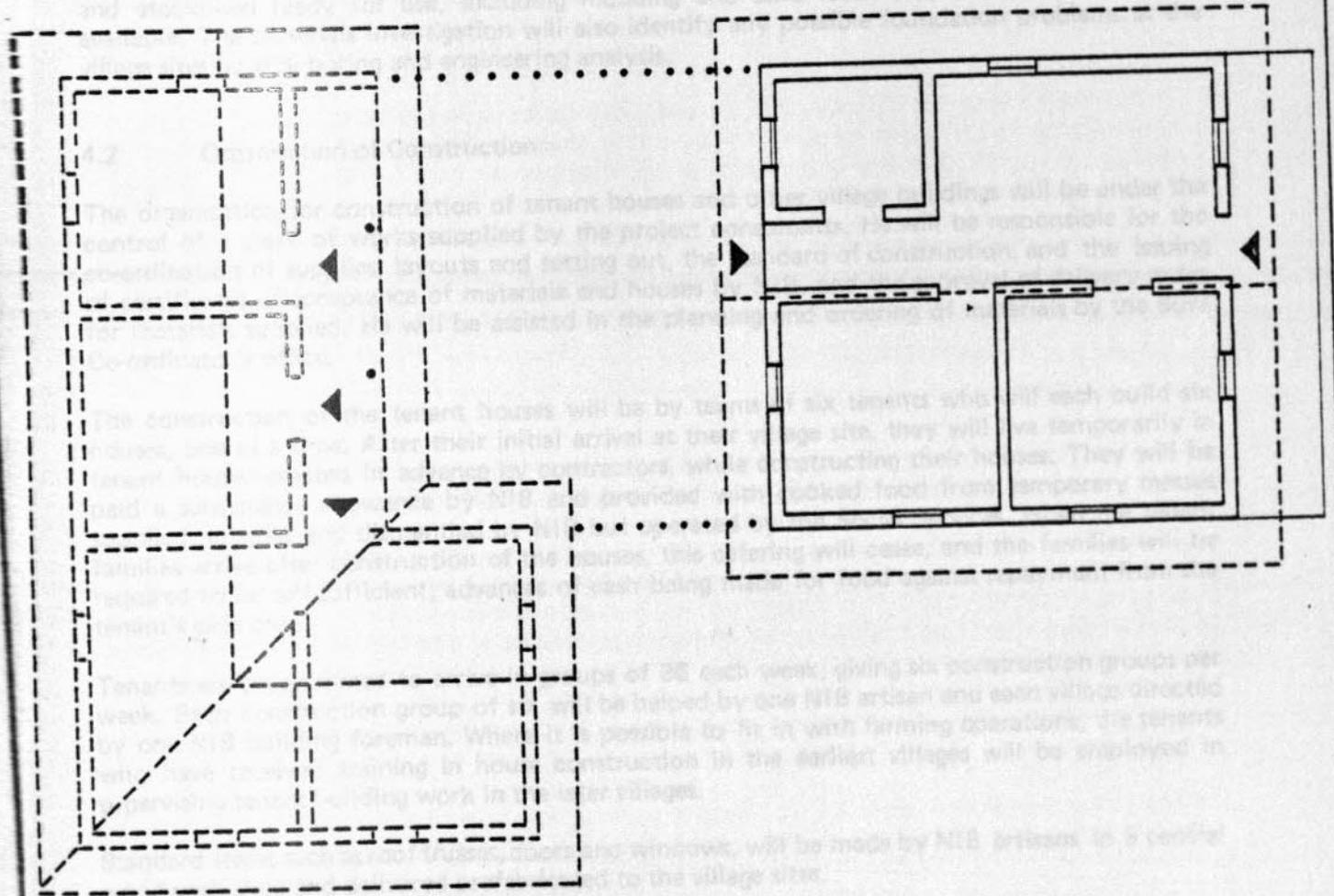


SCALE 1:50

NATIONAL IRRIGATION BOARD

JUNE 1977

# PROTOTYPE TENANT HOUSE DESIRABLE METHOD OF EXTENSION



On completing the construction of their houses, the tenants will proceed under supervision to the demolition of the village school buildings and the multi-purpose halls, to complete the village development.

The exact number of staff required to supervise the tenants during their construction work will depend on the actual rates of settlement and house construction achieved, but will amount to about 2 permanent, 30 temporary and permanent employee artisans and working out staff. These staff will be from the NIB Building Section, described in the Organization, Management and Training Annex.

## CHAPTER 4 TENANT HOUSE CONSTRUCTION

### 4.1 Materials

The study of construction materials noted in Section 3.3 will be carried out before designs for tenant housing are finalised. The materials for construction will be transported to the village site and stockpiled ready for use, including mudding and sand loads where these materials are available. The materials investigation will also identify any possible foundation problems at the village sites by trial boring and engineering analysis.

### 4.2 Organisation of Construction

The organisation for construction of tenant houses and other village buildings will be under the control of a clerk of works supplied by the project consultants. He will be responsible for the co-ordination of supplies, layouts and setting out, the standard of construction, and the issuing of certificates of acceptance of materials and houses by NIB, and the approval of delivery notes for materials supplied. He will be assisted in the planning and ordering of materials by the Bura Co-ordinator's office.

The construction of the tenant houses will be by teams of six tenants who will each build six houses, one at a time. After their initial arrival at their village site, they will live temporarily in tenant houses erected in advance by contractors, while constructing their houses. They will be paid a subsistence allowance by NIB and provided with cooked food from temporary messes supplied, erected and dismantled by NIB but operated by the Social Services. When the tenant families arrive after construction of the houses, this catering will cease, and the families will be required to be self-sufficient; advances of cash being made for food against repayment from the tenant's cash crop.

Tenants are programmed to arrive in groups of 36 each week, giving six construction groups per week. Each construction group of six will be helped by one NIB artisan and each village directed by one NIB building foreman. Where it is possible to fit in with farming operations, the tenants who have received training in house construction in the earliest villages will be employed in supervising tenant building work in the later villages.

Standard items such as roof trusses, doors and windows, will be made by NIB artisans in a central woodwork shop and delivered prefabricated to the village sites.

On completing the construction of their houses, the tenants will proceed under supervision to the construction of the village school buildings and the multi-purpose halls, to complete the village development.

The exact number of staff required to supervise the tenants during their construction work will depend on the actual rates of settlement and house construction achieved, but will amount to about 2 permanent foremen, 30 temporary and permanent employee artisans, and setting out staff. These staff will be from the NIB Building Section, described in the Organisation, Management and Training Annexe.

## CHAPTER 5 STAFF HOUSING CONSTRUCTION

### 5.1 General

As previously described, outline design for all houses will be done by the NIB architectural adviser, and detailed drawings and contract documents prepared by the project consultants, after consultation with the Ministry of Works, as appropriate. A similar procedure is proposed for the offices and other buildings, except that the project consultants will have a greater participation at the outline design stage.

It is proposed that the construction of all staff housing, both for NIB and government agencies, shall be under the control of NIB. Because of the organisation for the provision of government housing described earlier, it may be necessary for an appropriate agreement to be made between the Ministry of Works and the National Irrigation Board. This agreement should also extend to the control by NIB of the construction of government offices and other buildings.

In the case of public health service buildings, a similar arrangement for NIB control should be made with the Ministry of Health.

### 5.2 Contracts

The arrangement of contracts for construction work is detailed in the Implementation Annexe. Two contracts are proposed for all the staff housing in the villages and the rural centre.

The first contract will be an advanced contract for NIB and government houses. This will meet the demands of staff migrating to the project area early in the implementation period before the arrival of the first tenants, and provide housing for the project consultants' site staff, which will ultimately be occupied by NIB or government staff on completion of the construction works. It will also provide about 30 advance tenant houses as temporary accommodation for the first tenants of the first three villages until they have built their houses. The contract would include the NIB rural centre office, workshops and staff clubs, together with the rural centre sewage works and sewer connections to the contract rural centre houses.

The second contract would cover the remaining houses and buildings, including advance tenant housing to the remaining 20 villages, the treated water supply system and the electrical power generation and distribution system for the rural centre.

APPENDIX A

LIST OF DRAWINGS AND DOCUMENTS PROVIDED BY NIB FOR REVIEW

1. HOUSES DRAWINGS

(a) PRINCIPAL STAFF HOUSE

- (i) 18/51361/30 - D.L.S. House
- (ii) 18/51361/31 - Manager's Bungalow

(b) SENIOR STAFF HOUSE

HOUSING AND BUILDINGS ANNEX

APPENDIX A

LIST OF DRAWINGS AND DOCUMENTS PROVIDED

BY NIB FOR REVIEW

- (i) 18/51361/1 - M.O.W. Type 'E' 2 Bedrooms
- (ii) 18/51361/2 - M.O.W. Type 'F' 1 Bedroom
- (iii) 18/51361/3 - M.O.W. Type 'G' 1 Bedroom
- (iv) 18/51361/4 - M.O.W. Grade 5(C) 3 Bedrooms

(c) JUNIOR STAFF HOUSE

- (i) 18/51361/5 - Junior Staff House
- (ii) 18/51361/6 - 3 Bedrooms Junior Staff House - 2 units
- (iii) 18/51361/7 - 3 Bedrooms Junior Staff House
- (iv) 18/51361/8 - 3 Bedrooms Junior Staff House
- (v) 18/51361/9 - 3 Bedrooms Junior Staff House
- (vi) 18/51361/10 - Type house at Gales
- (vii) 18/51361/11 - Junior Staff House for Research Training Centre

(d) SUPERVISORY STAFF HOUSE

- (i) 18/51361/12 - Supervisory Staff House - 4 units
- (ii) 18/51361/13 - Supervisory Staff House

(e) BEST CLASS

- (i) 18/51361/14 - 3 Bedrooms
- (ii) 18/51361/15 - M.O.W. BEST CLASS

APPENDIX A

LIST OF DRAWINGS AND DOCUMENTS PROVIDED BY NIB FOR REVIEW

I HOUSES DRAWINGS

(a) PRINCIPAL STAFF HOUSE

- (i) 18/51361/20 - D.C.s House
- (ii) MBX/43 - Manager's Bungalow

(b) SENIOR STAFF HOUSE

- (i) MBX/78 - 3 Bedroom House for Ass. Mill Manager
- (ii) MBX/80 - 3 Bedroom Senior Staff House
- (iii) MBX/20 - 2 Bedroom Staff House
- (iv) MAX/8, MAX/9 - 3 Bedroom Mill Manager's House
- (v) TAPI/46 - 2 Bedroom Senior Staff House
- (vi) 18/6058/1 - M.O.W. Type 'E' 2 Bedroom
- (vii) 18/6057/1 - M.O.W. Type 'D' Lowland - 4 Bedroom
- (viii) 18/6059/1 - M.O.W. Type 'F' Lowland
- (ix) 18/50462/4 - M.O.W. Grade 5(C) 3 Bedroom

(c) JUNIOR STAFF HOUSE

- (i) MAX/5 - Junior Staff House
- (ii) MBX/41 - 3 Bedroom Junior Staff House - 2 Units
- (iii) MBX/66 - 3 Bedroom Junior Staff House
- (iv) MBX/89 - 3 Bedroom Junior Staff House
- (v) MBX/95 - 3 Bedroom Junior Staff House
- (vi) TAPI/6 - Type House at Galde
- (vii) TAPI/48 - Junior Staff House for Research Training Centre

(d) SUBORDINATE STAFF HOUSE

- (i) MBX/40 - Subordinate Staff House - 4 Units
- (ii) MAX/3 - Subordinate Staff House

(e) GUEST HOUSES

- (i) MBX/39 - 2 Bedrooms
- (ii) 18/51252/6 - P.C.'s GUEST HOUSE

(f) SETTLER (TENANT) HOUSE

- (i) K11/83 - 2 Bedroom Tenant House in West Kano
- (ii) MAX/2 - 2 Roomed Unit - Not clear
- (iii) MBX/14 - Modified Tenant House
- (iv) MBX/71 - 2 Bedrooms
- (v) MBX/77 and MBX/77 A - 2 Bedroom Tenant House
- (vi) N.I.B Proposal - 2 Bedroom

II OTHER N.I.B. DRAWINGS

- (i) MBX/53 - Standpipe detail
- (ii) MBX/56 - Garage
- (iii) MBX/65 - Shower Cubicles
- (iv) MBX/69 - w.c. for Junior Staff
- (v) TAPI/43A - Tenant Village Water Supply
- (vi) TAPI/43A - Tenant Village Water Supply
- (vii) TAPI/47 - Research Training Centre Toilet Block
- (viii) K11/60 - Typical Cross Section of Scheme Roads
- (ix) K11/108 - Servants Quarters Senior Staff House Shower room detail
- (x) K11/104 - Site Plan - West Kano
- (xi) K11/84 - Pit latrine - 2 units
- (xii) K11/11 - General layout of H/Q and Staff Housing

III INSTITUTIONAL BUILDINGS DRAWINGS

- (i) MBX/50 - B.M.C. Office and Store
- (ii) MBX/50A - B.M.C. Office detail
- (iii) TAPI/21 - Cotton weighing Centre
- (iv) TAPI/45 - Research Training Centre
- (v) TAPI/23 - Cotton Store
- (vi) MBX/44 A - Site Plan
- (vii) MBX/37 A - Contour
- (viii) TAPI/49 - Site Plan

## INFRASTRUCTURE BUILDINGS DRAWINGS

(i)	(9-) 1000	- ENDARASHA Rural Demonstration Health Centre
(ii)	(99) 3005	TYPE POLICE STN B
(iii)	(99) 3004	- TYPE POLICE STN B
(iv)	(39) 3001	- TYPE POLICE STN B
(v)	5575	- MSALE Rural teaching health Centre
(vi)	(9-) 1000 5830	PORT VICTORIA Health Centre
(vii)	19/51899/48	TYPE DIVISIONAL OFFICE
(viii)	BBK 773/A	KWALE POST OFFICE AND TELEPHONE EXCHANGE
(ix)	- -	CATTLE & PIG SLAUGHTER HOUSES + OFFICE
(x)	MAL/2	MALINDI TOWN HALL
(xi)	NAR/3C	NAROK MARKET
(xii)	BBK 656	KWALE NEW P.O. AND TEL. EXCH.
(xiii)	BBK 943	KANGEMA NEW P.O. & TEL. EXCH.
(xiv)	BBK 937	SAGANA P.O. & TEL. EXCH.
(xv)	BBK 936	SAGANA P.P. & TEL. EXCH.
(xvi)	BBK 997	KANGEMA P.P. & TEL. EXCH.
(xvii)	10/50943/5	KILIFI DISTRICT HOSPITAL
(xviii)	19/51899/3	TYPE DIVISIONAL OFFICE

DOCUMENTS

V BILLS OF QUANTITIES FOR:

- (i) MECHANICAL WORKSHOP 3
- (ii) STANDARD DETAILS MANUALS
- (iii) PUBLIC HEALTH
- (iv) UNIVERSITY OF NAIROBI,  
HOUSING RESEARCH AND DEVELOPMENT UNIT
- (v) TOWN PLANNING DEPARTMENT,  
SETTLEMENT SCHEMES: TOWNSHIPS, ROADS AND SCHOOLS
- (vi) SECTION L HOUSING INTRODUCTION  
THE LONG TERM GOVERNMENT POLICY
- (vii) UNIVERSITY OF NAIROBI, HOUSING RESEARCH AND DEVELOPMENT  
UNIT ROOF STRUCTURES, FOR LOW-COST HOUSING  
COST COMPARISON FOR VARIOUS ROOFING MATERIALS
- (viii) NATIONAL IRRIGATION BOARD  
REVISED LAYOUT OF VILLAGES I AND II
- (ix) NATIONAL IRRIGATION BOARD  
LAYOUT OF VILLAGES
- (x) NATIONAL IRRIGATION BOARD  
GENERAL LAYOUT OF HEAD QUARTERS AND STAFF HOUSING
- (xi) NATIONAL IRRIGATION BOARD  
WANGURU H/Q AND STAFF HOUSING SITE
- (xii) KIARUKUNGU VILLAGE - HOLA IRRIGATION SCHEME - TECHNICAL  
SURVEY - OCT. 1976. NATIONAL IRRIGATION BOARD
- (xiii) NATIONAL IRRIGATION BOARD  
SITE PLAN

VI OTHERS

- (i) LIST OF LOCATION DRAWINGS FOR TYPE  
MECHANICAL WORKSHOPS - (99) 3800
- (ii) SERVICE BUILDING - ELEVATION - (99) 3830
- (iii) WORKSHOP/OFFICE BLDG- ELEVATION - (99) 3861
- (iv) STORE BUILDING - ELEVATION - (99) 3862
- (v) MECHANICAL WORK BAY BLDG ELEVATION - (99) 3879

APPENDIX B THE ARCHITECTURAL REVIEW

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1.2 Functional Design

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- 2.8 NIB Buildings

## 1.0 ARCHITECTURAL REVIEW CRITERIA

## 1.1 PREVAILING CLIMATIC CONDITIONS AND REQUIREMENTS

One of the most important factors dictating design in Bura is its climate - Semi Desert Zone. The following are the climatic characteristics of this Zone.

- High temperatures in day and night, with mean max: 33.5-35°C  
mean min: 22.0-24°C
- Rainfall  
annual mean 150-500 mm
- Winds  
generally light but persistent. At times strong dust laden winds are experienced.
- Humidity  
annual mean relative humidity at 1500 hrs. is between 35% to 45%
- Vegetation  
desert type scrub to dry bushed grasslands and leafless woodland.

Against this background of climatic factors, the designs of houses and other buildings presented by N.I.S. will be reviewed to determine their efficient functioning for maximum body comfort and weathering qualities of the materials specified.

In particular, attention will be focussed on the following aspects:

## (i) Suitability of designs for adoption in Bura

The ideal house plan for Bura is one that allows maximum air movement through the rooms for cross ventilation.

The positioning of windows, p.v.s and their sizes will determine effectiveness of air movement within the house. The 'Design for Climate' guidelines recommend provision of outdoor

living areas for both day and night uses, and allowance for roof overhangs for both shading of walls and minimisation of solar heat gains. Such indoor living areas can be achieved an inward facing plan to form a courtyard which will create a micro-climate within the house plot.

(ii) Suitability of materials:

The most suitable materials for the climate of Bura are those that will minimise heat gains in the day and maximise heat losses at night.

The thermal characteristics of materials used in construction will determine the degree of heat gain during the day and heat loss during the night.

Walling and roofing materials specified for the building will be tested against their thermal qualities of minimising heat gains during the day and maximising heat loss at night.

(iii) Orientation:

The ideal orientation of buildings is the one with the openings facing north and south to avoid direct solar incidence from the east and west sun. The early morning sun is tolerated as it is high enough by the time it gets hot. This permits south-east orientation. The west afternoon sun must be avoided wherever possible. Minor rooms such as toilets and stores may face west without undue indoor discomfort as they are seldom used.

The positioning of windows and doors of the houses will be tested against this requirement as well as that of need to achieve cross ventilation in a room.

The climatic characteristics outlined above will to some fair extent dictate the preferred design approach. There is need to examine the designs further to ascertain other functions complementary to climatic requirements in the fulfilment of good design.

(i) Separation of Functions:

Any good design should successfully isolate differing functions and at the same time facilitate their successful integration and interaction. Unless this is achieved, good circulation, privacy and economies are sacrificed.

Day and night rooms should be separated by grouping bedrooms together and living room, kitchen and dining together. These two areas share common facilities such as toilets which become the areas of interaction. Proper isolation of functions with well thought out circulation or 'traffic lines', ensures privacy to occupants walking from bedrooms to the bathroom. It further maximises utilization of space by avoiding traffic across the living room.

It is also desirable to create separate external spaces. The front verandah is used for entertainment of guests and the rear as a backyard for kitchen and related activities.

(ii) Services:

Services to a house or building constitute a great proportion of the costs. Its inadequacy would lower the comfort of the occupants of the house. Over provision would result in under-utilisation and hence uneconomic.

The designs with 'in-house' sanitary facilities will be reviewed to establish their achievement in economic grouping of facilities to minimise costs and the adequacy or otherwise of the amenities.

(iii) Room Sizes:

Minimum bedroom sizes should be determined by the expected room occupancy, and the air changes per hour required. Minimum areas of living rooms is a function of the economic level of the family and their social characteristics and cultural habits.

While it is possible, time allowing and given the room occupancy, to determine minimum room sizes based on air changes required, it is near impossible to base the size on such variables as ability to afford furniture and social habits of each family.

There is need to have a greater minimum room size for this climate than would be acceptable in other cooler climates. However, in the absence of more research, it is recommended that a minimum bedroom size should accommodate two single beds. An allowance should be made for circulation and for the hot climate. The Consultants have assumed 100% more area for these two aspects. The minimum bedroom area therefore used in the review is to theoretically hold four beds whereas in actual physical placement of beds it may only hold two beds.

### 1.3 MATERIALS AND CONSTRUCTION

Bura being very far from the main urban areas and not having much to offer in way of building materials, the materials proposed for use in the N.I.B. specifications will be reviewed to determine the following characteristics and consequently, their suitability.

#### - Availability:

Are the materials proposed or specified easily available on site and what other substitutes are there?

#### - Durability:

Considering the climate of Bura, the non-easy-availability of materials for replacement and repair, the materials used initially must have the best durability within financial constraints.

#### - Costs:

Alternative suitable and available building materials will be considered and with the assistance of the Q.S. recommend the most economical.

#### - Structural Soundness:

Construction of houses, particularly of settler houses must be of a nature that will require minimum of skilled labour. During the review, the suggested mode of construction will be discussed relative to the experience background of the settlers.

The easier it is to construct the house the better it will be for both the settlers and indeed the whole scheme.

Inspection of buildings at Hola revealed excessive cracking of walls and floors. This is attributed to the sandy-clayed soils. In the absence of detailed soil tests to determine specific characteristics of the soils and their behaviour with regard to buildings, the Consultants have decided to follow construction

observed in progress at Bura for foundations. All designs are therefore assumed to be on soils with characteristics of black cotton soil. Excavation is taken to one meter deep over the whole site.

After reviewing each design, the Consultants have recommended its suitability or non-suitability for the scheme. The final selection of the designs for adoption would be carried out at the next stage of the programme. It is recommended that the criteria used for the final selection should include:

- most suitable after review
- accommodation offered
- costs

In the course of the review and formulation of the criteria reference was made to the recommendations of the Housing Research and Development Unit of the University of Nairobi, 'Design for Climate' and to the NIB 'Technical Field Survey on Hola' by Otto Keszner. The Consultants supplemented the design guidelines given in these two publications with their own design criteria particularly the functional aspects of design and experience of living habits of the people.

To ensure conformity of the review material with the official standards, the Republic of Kenya 'Building Code' was used to determine such aspects as minimum plot size, minimum room size, building lines and set backs. In particular, Grade II by-laws 'Scheduled Special Areas and Special Buildings', sections of the code were consulted.

#### 1.4 THE SETTLER HOUSE: SPECIAL CASE

Because of the large number of settler houses, and the need to keep their costs per unit as low as possible, the Consultants have done the review of settler houses in greater detail than was done for other buildings.

Since the basic assumption is that the core house will act as a nucleus around which extensions will form the completed house a design should be conceived as a complete unit with the possibility of building it up in phases. It should after extensions retain P.Vs, windows and entrance points at convenient locations for each habitable room.

The Technical Field Survey indicates a great desire by tenants to extend their houses to cater for the large number of occupants in their extended families particularly in cases where there are more than one wife and grown up daughters nursing their own children. A settler house should have ample possibility for extension without blocking existing windows and P.Vs. The design of the core house should dictate the size, nature and direction of extensions. This can be achieved by ensuring that the end of building to be added onto has enough of plot space and that the extensions would not block windows or other openings.

Seven designs of settler houses were supplied to the Consultants by N.I.B. One of the seven was at a very early design stage and therefore in the form of a rough sketch. This settler house type was not reviewed as its design concept, materials and construction had not been developed to the full.

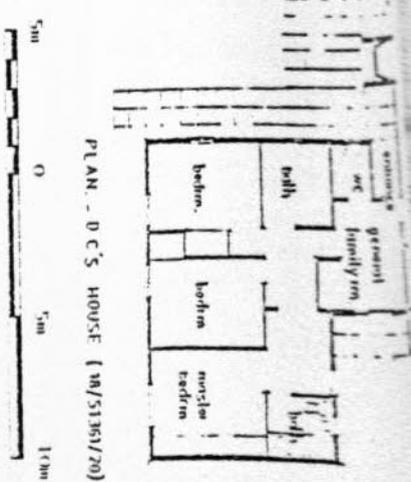
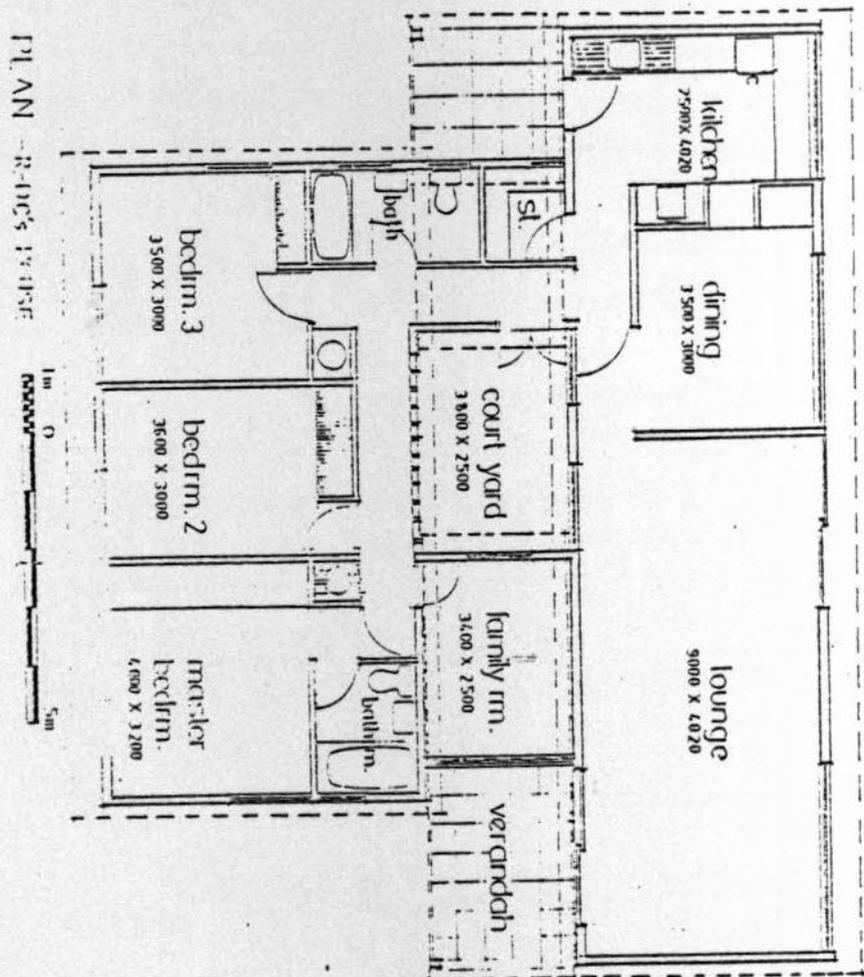
Out of the remaining six N.I.B. settler house prototypes, two were in mud and wattle construction and the other four in concrete blocks.

The review of the settler houses was then done as follows:

- All N.I.B. prototypes in concrete block walling were reviewed architecturally and cost estimates done for the original and modified versions.

- All N.I.B. prototypes in mud and wattle walling were reviewed architecturally and cost estimates done for each before and after modifications and in three alternative materials: Mud and wattle, mud and wattle plastered, and sun dried mud blocks.

Figure B.1



## 2.0 DETAILED REVIEW

### 2.1 House designs

The house plans handed to the Consultants for review and recommendations where appropriate have been designed for climatic zones other than the semi-desert zone and no consideration was given to the very sensitive climatic conditions prevailing in Bura. Very few of the plans would be used in Bura without modifications. Where a design calls for modifications, this has been incorporated as best as possible going by the design criteria earlier established.

The disposition of the various major spaces which affects the utilisation of the available space has also been carefully considered and modifications recommended while trying to keep the cost as low as possible by keeping to the given plinth area.

Four categories of staff houses were identified, and the N.I.B designs placed in these categories accordingly:

- (i) Principal houses for project manager and general manager.
- (ii) Senior Staff houses.
- (iii) Junior Staff houses.
- (iv) Subordinate Staff houses.

In the review process, it was observed that some aspects of the design are common in all cases. Such aspects as, materials, construction, structural soundness, orientation and ventilation.

To avoid repetition therefore, these aspects will be discussed once only and this will be representative of all cases reviewed.

### 2.2 PRINCIPAL STAFF HOUSES

#### 2.2.1 D.Cs. House - (A-D.Cs. House) - (18/51361/20) (Figure B.1)

##### (i) Climatic Aspects

Through air movement is adequate but not so in all bedrooms.

The fireplace would not be necessary in Bura.

The paved external spaces are not adequately roofed up and would not be used regularly because of the strong sun during the day.

The shape of the roof exposes large portions of the walls and windows thus raising the indoor temperatures appreciably. Big roof overhangs would help in cutting out the direct afternoon sun.

Introduction of a courtyard would facilitate sufficient air movement in all rooms at the same time provide a protected outdoor activity area, usable at night for sleeping.

The specified materials for construction are concrete block or stone and tiled roof on timber carcassing.

Concrete block walling has better thermal qualities as it does not retain as much heat as stone walling does, and is therefore recommended. The walling should be plastered and possibly painted white externally to increase reflectivity.

For economy, the roof can be in asbestos or g.c.i. sheeting and in order to lower indoor temperatures, softboard ceiling is recommended.

Adjustable louvred windows are recommended as they can be used to direct air into rooms.

The aspect of orientation cannot be discussed now as the siting of the house on the plot has not been identified. However, the ideal orientation is one where the main windows face north and south to avoid direct insolation particularly from the afternoon west sun.

The morning east sun is usually high enough before it gets very hot and therefore a north-east or south-east orientation is tolerable.

This ideal orientation is difficult to compromise with need for cross ventilating all rooms which calls for

windows on opposite walls.

Where a conflict exists between this desired orientation and the requirement for cross ventilation, it is recommended that the former should be upheld. If however, the rooms affected do not have to have much natural lighting, a system of opaque louvres should be designed in a way that no direct sun would be admitted.

(ii) Functional Aspects:

The day and night areas are successfully separated. The location of the entrance is concealed behind the fireplace and is not obvious to visitors. The entrance leads direct into the Family Room thereby denying the room privacy and maximum utilisation of space.

Room sizes are considered adequate.

The services are economical in the way they are grouped but their location, at the entrance is not ideal.

It is recommended that one w.c. be omitted from the house.

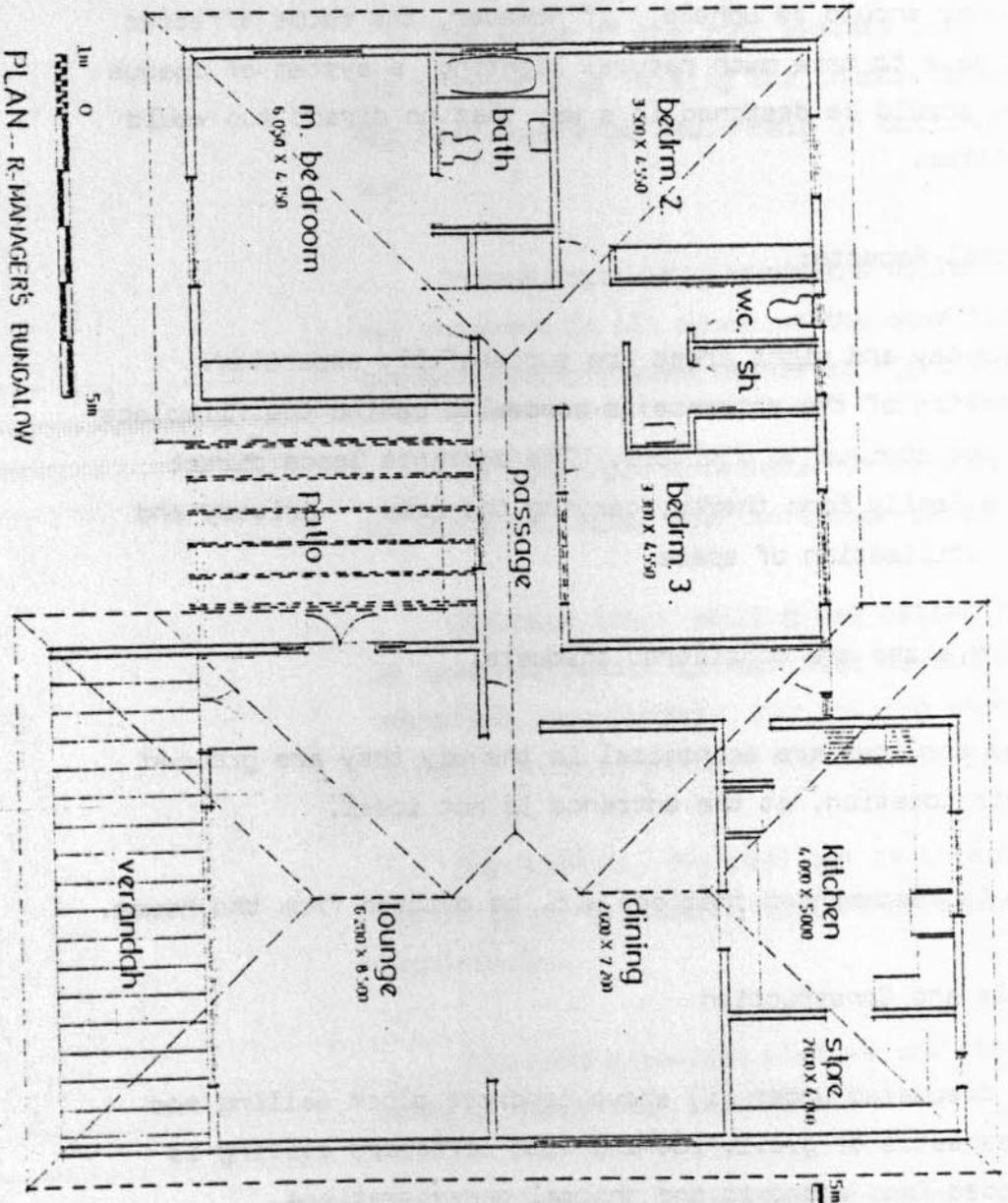
(iii) Materials and Construction

As discussed under (i) above concrete block walling and either asbestos or g.c.i. roofing with softboard ceiling is recommended from economic and thermal considerations. Concrete blocks can be made on site with aggregate obtained from Wayu. Cement and asbestos or g.c.i. would have to be imported but this would not be a constraint. Besides no other alternative exists.

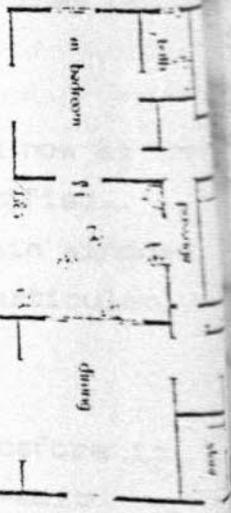
The Consultants have introduced two lower roofs which act as link between the two wings and provide covered verandahs to the front and back of the house.

Suitability

This design is recommended as suitable after the modifications suggested.



PLAN - R. HAINIGER'S HUNGAI OW



PLAN HAINIGER'S HUNGAI OW



(i) Climatic Aspects

Air circulation is good in all rooms except in one bedroom which can be cross ventilated through the passage and onto the courtyard by means of ventilating fixed louvres or bricks.

(ii) Functional Aspects

The kitchen should be next to the dining area

The traffic through the living room and the dining area make utilisation of the space uneconomic and could be re-arranged as shown on the revised layout.

The big hall at the rear entrance can be reduced resulting in increased dining area.

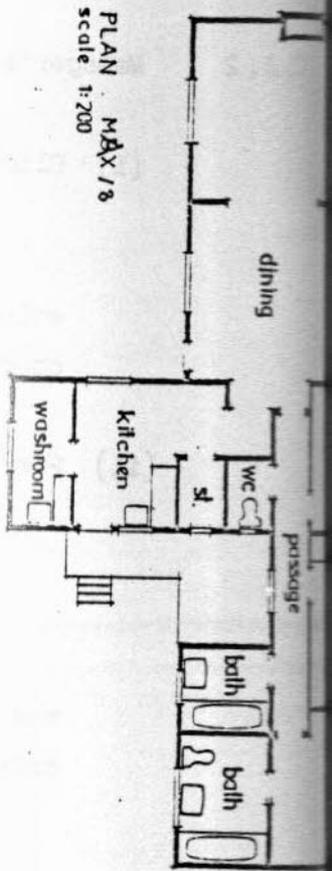
The door to the master bedroom can be moved further down the corridor resulting in increased cupboard space. The cupboard space for the other two bedrooms can similarly be increased by re-location of doors.

Omission of one w.c., 2 wash hand basins result in savings and increased lounge area.

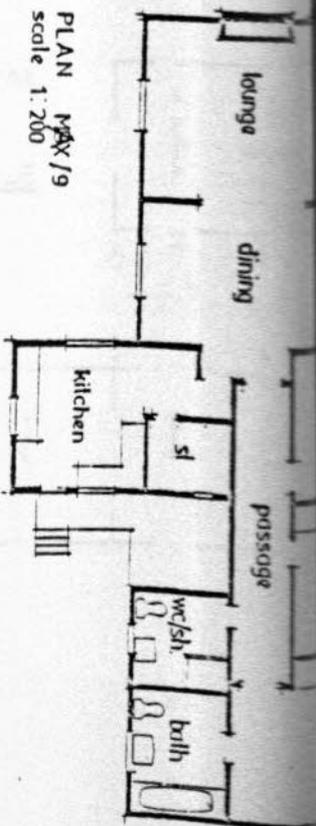
Suitability

This design would be suitable if modified as suggested.

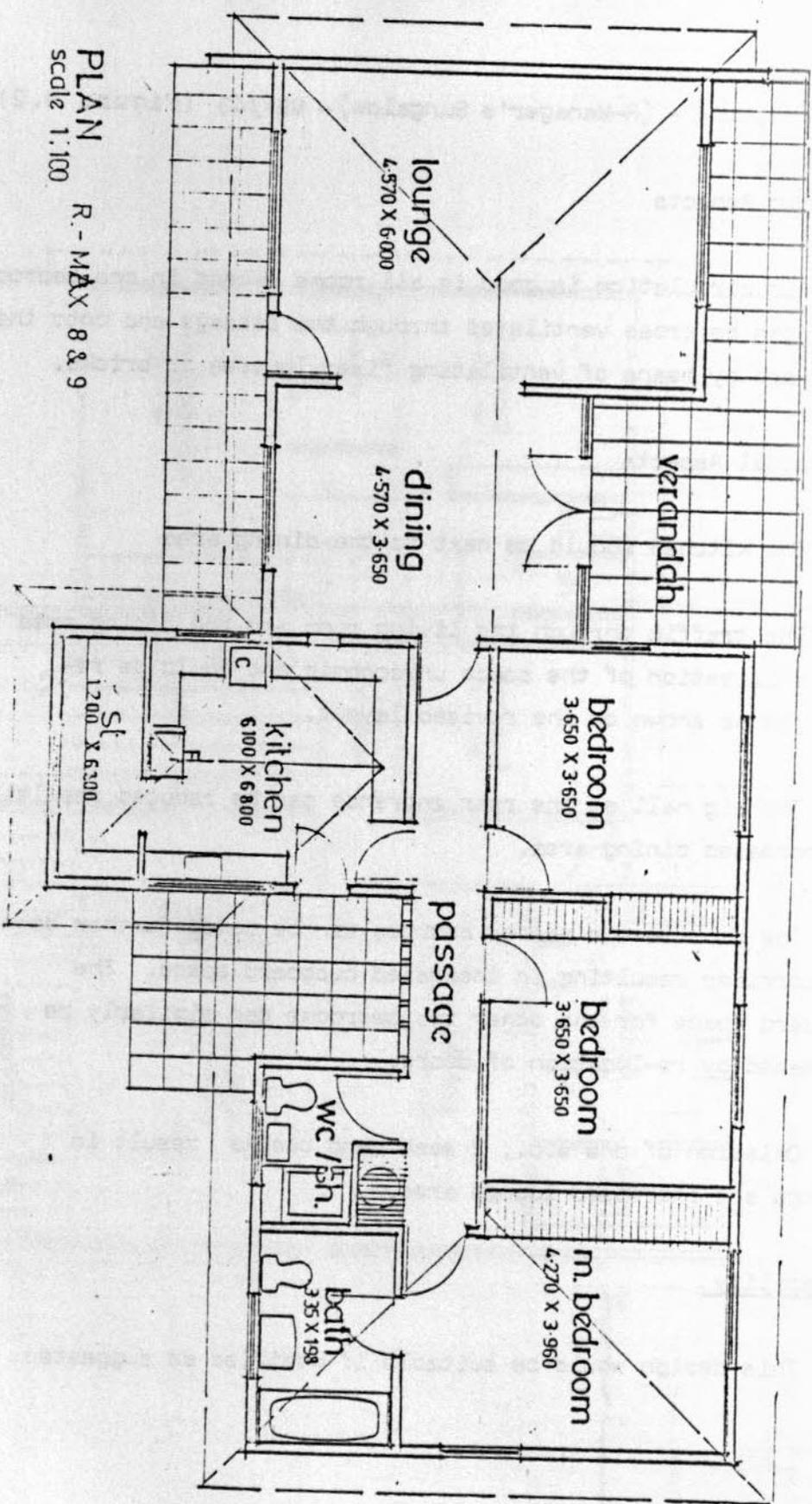
PLAN MAX/8  
scale 1:200



PLAN MAX/9  
scale 1:200



PLAN R - MAX 8 & 9  
scale 1:100



## 2.3 SENIOR STAFF HOUSING.

### 2.3.1 Drawing no. MAX'8 and 9 - (R - MAX/8 and 9) (Figure B3)

#### (i) Climatic Aspects

All habitable rooms are well cross ventilated and the enclosed verandah to the front and patio to the back form useful outdoor activity areas.

#### (ii) Functional Aspects:

The circulation of the kitchen and dining area is poor and could be improved as suggested in the revised layout.

The location of the kitchen store and w.c. make the kitchen remote from the dining and the route cumbersome.

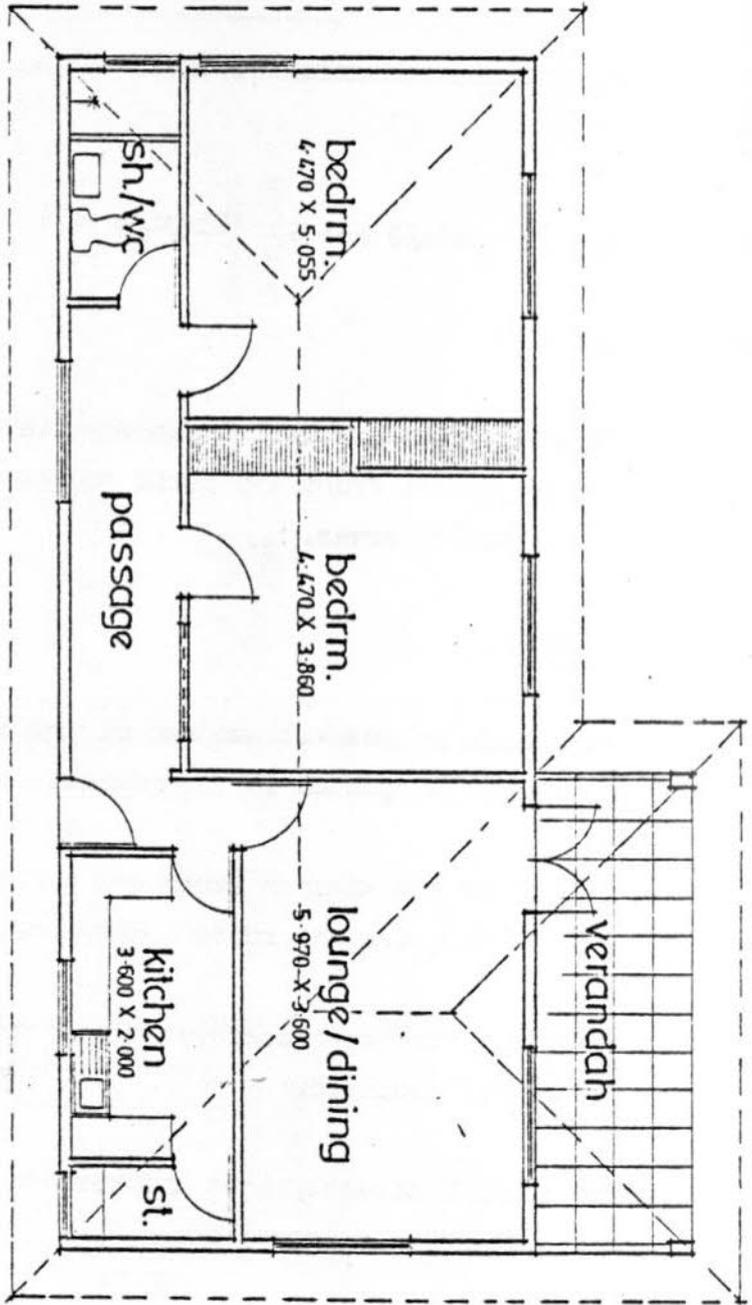
The second w.c. can be incorporated into the second bathroom and savings realised.

Washroom opening directly into the kitchen is not recommended and could be omitted altogether.

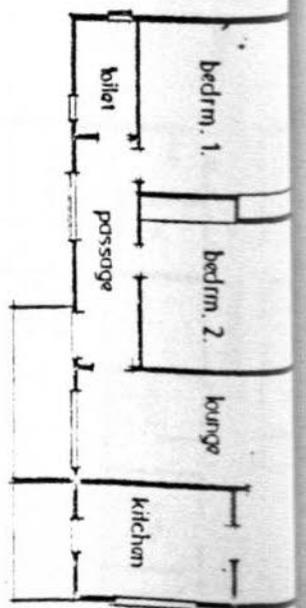
Room sizes are adequate.

#### Suitability

With the amendments proposed in the revision, the design is suitable for Bura.



PLAN - R-MBX/20  
 scale 1:100



PLAN MBX/20  
 scale 1:200

2.3.2 Drawing no. MBX/20 - (R - MBX/20) (Figure B.4)

(i) Climatic Aspects:

Cross ventilation is achieved in all rooms.  
G.C.I roof should have a softboard ceiling to lower indoor temperatures.

The overhang should be increased to at least 600 mm.

(ii) Functional Aspects:

No distinction is apparent between front and back of the house as both front and rear entrances are on same side.

Main entrance should be on opposite side.

Bathroom should be accessible from the kitchen without going through the lounge or by going out first.

The shape of the lounge in relation to the dining is awkward and the part of the lounge at entrance door cannot be utilised well.

A kitchen store could be provided.

The kitchen/dining sliding door could be replaced with a hatch to effect savings.

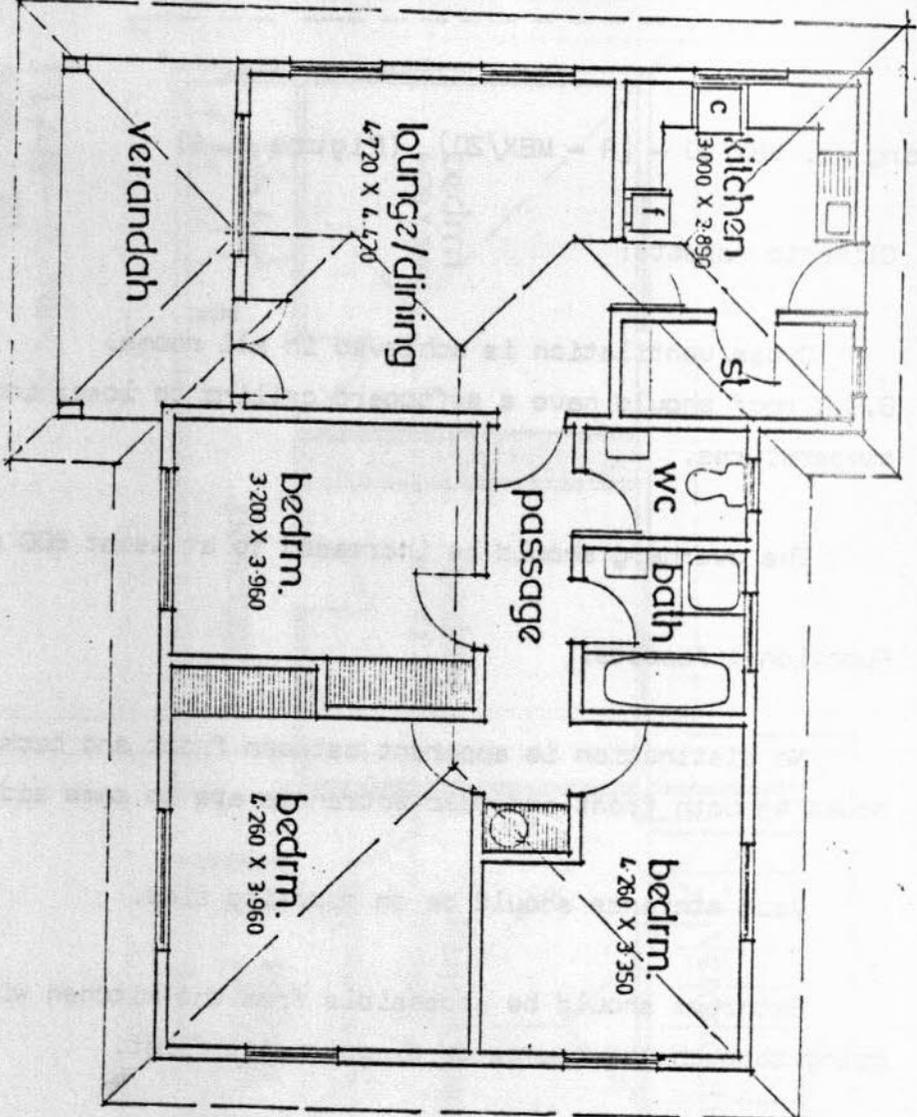
The 3" block wall between lounge and bedroom no. 2 would be unstable and should be changed to 6".

Steel roof construction could be replaced with timber to achieve savings.

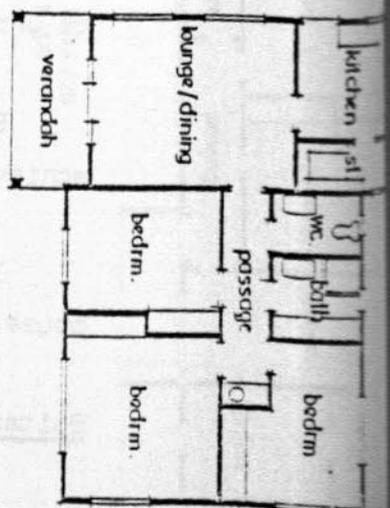
Increased roof pitch should improve aesthetics of the house. Room sizes are considered adequate.

Suitability:

As revised, this layout would be suitable.



PLAN R - MBX / 78  
 scale 1:100



PLAN - MBX / 78  
 scale 1:200

2.3.3 Drawing no. MBX/78 - (R-MBX/78) (Figure B.5)

(i) Climatic Aspects:

Ventilation of the bedroom next to the living room is poor.

The verandah to the front is welcome but should be complemented with one to the back.

(ii) Functional Design:

The design is well thought out with successful grouping of functions achieved.

The kitchen door should be re-positioned to the back of the house to offer privacy to kitchen-related activities and if funds permitted, a kitchen yard introduced.

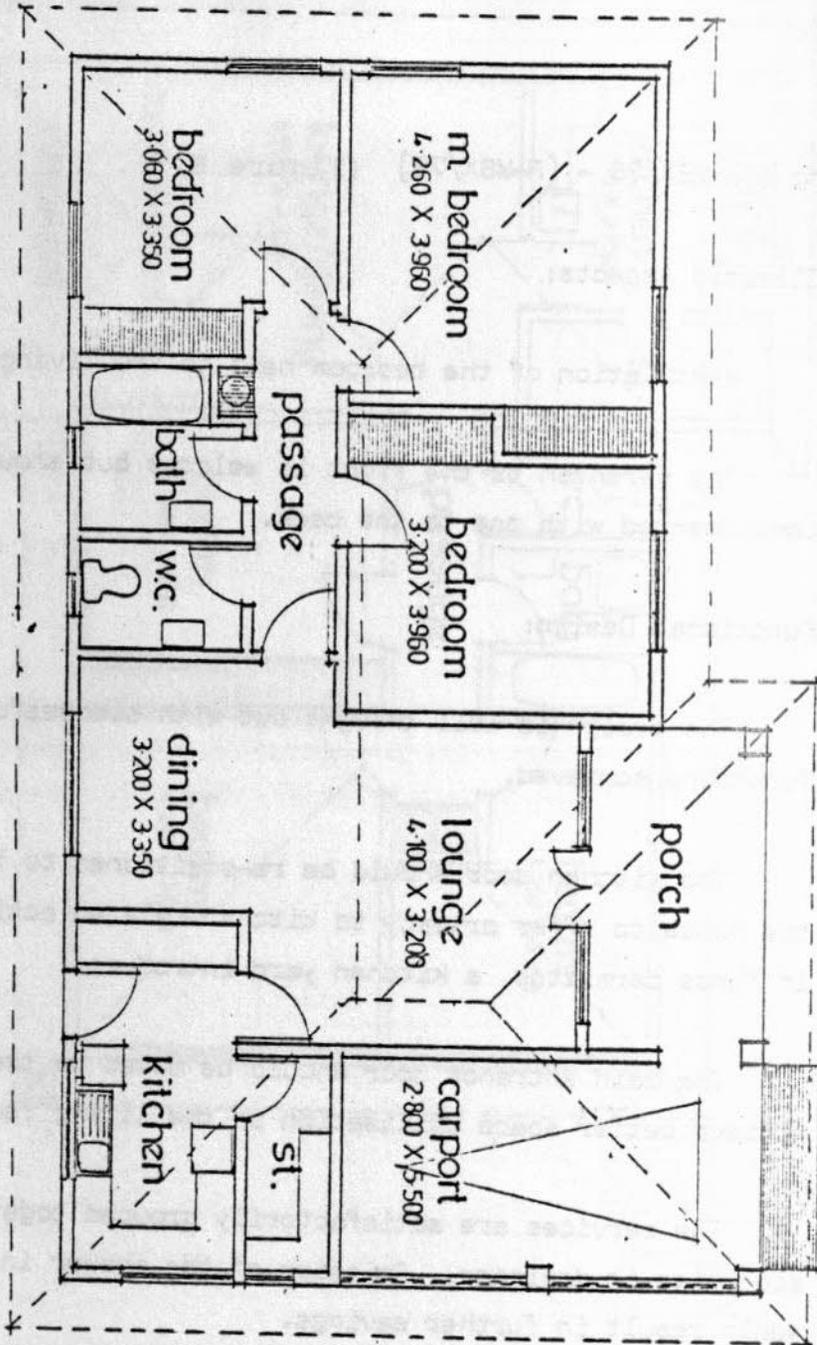
The main entrance door should be moved to the right to achieve better space utilisation in the living room.

The services are satisfactorily grouped together to achieve economies in drainage. Omission of the shower in the bathroom would result in further savings.

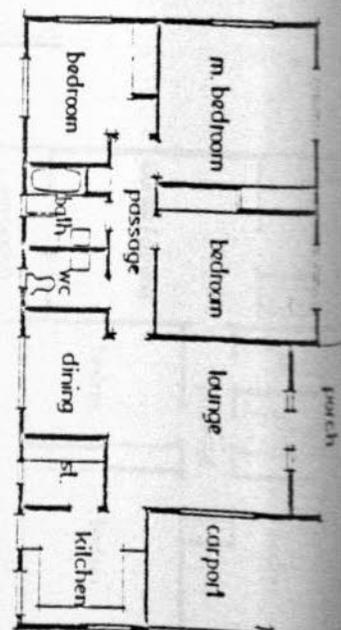
Room sizes are considered adequate.

Suitability

The design revised as proposed is recommended for adoption.



PLAN - R-MBX / 80  
scale 1 : 100



PLAN - MBX / 80  
scale 1 : 200

2.3.4 Drawing no. MBX/80 - (R-MBX/80) (Figure B.6)

This design is almost similar to drawing no. MBX/78 discussed previously.

(i) Climatic Aspects:

All rooms except one bedroom have adequate cross ventilatio,  
Observation made for drawing no. MBX/79 with regard to  
climate considerations apply in this case.

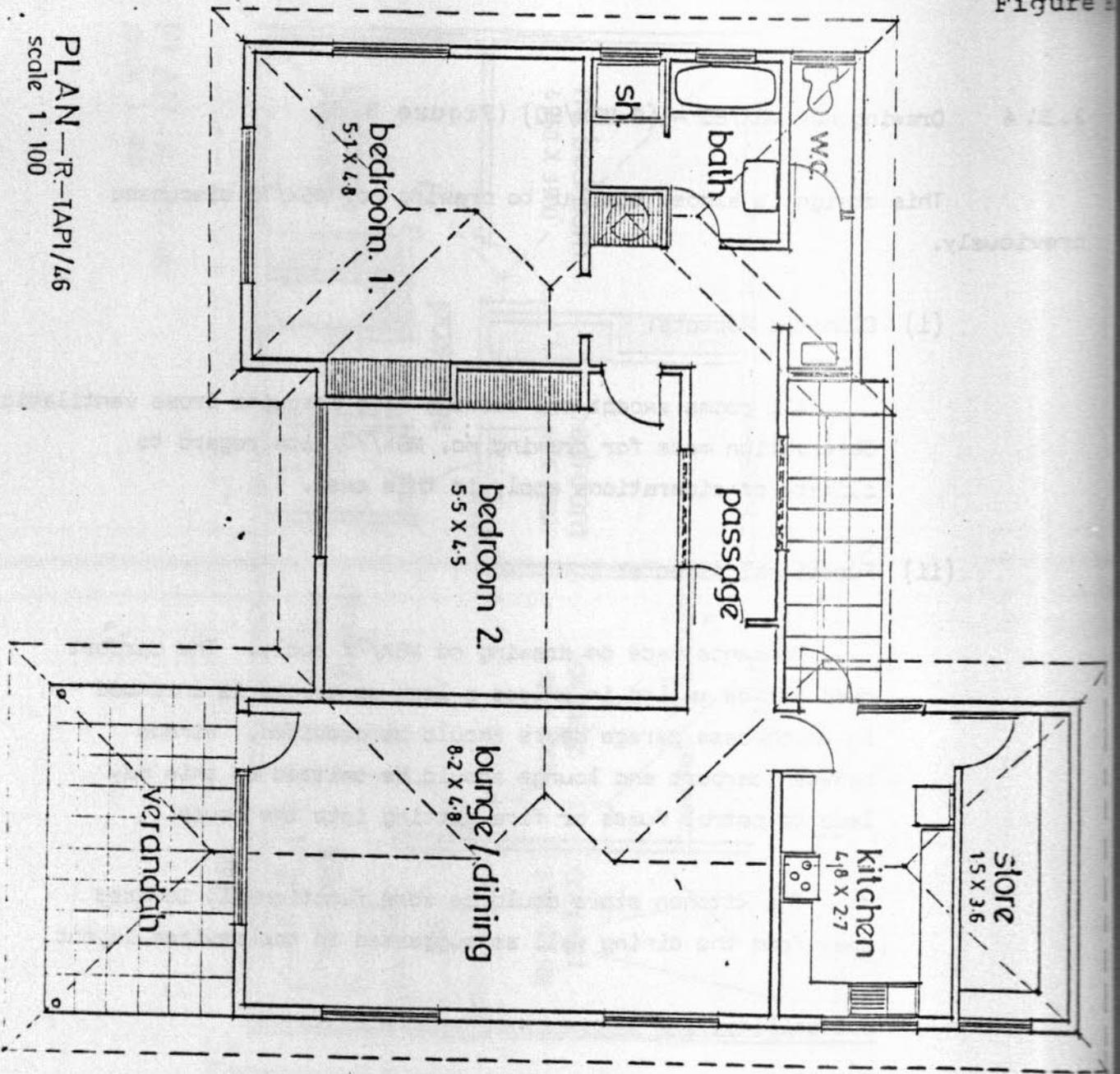
(ii) Functional Aspects:

Comments made on drawing no MBX/79 apply. The carport  
need not be walled in unless a lock-up garage is intended  
in which case garage doors should be provided. Window  
between carport and lounge should be omitted as this may  
lead to petrol fumes or fire getting into the house.

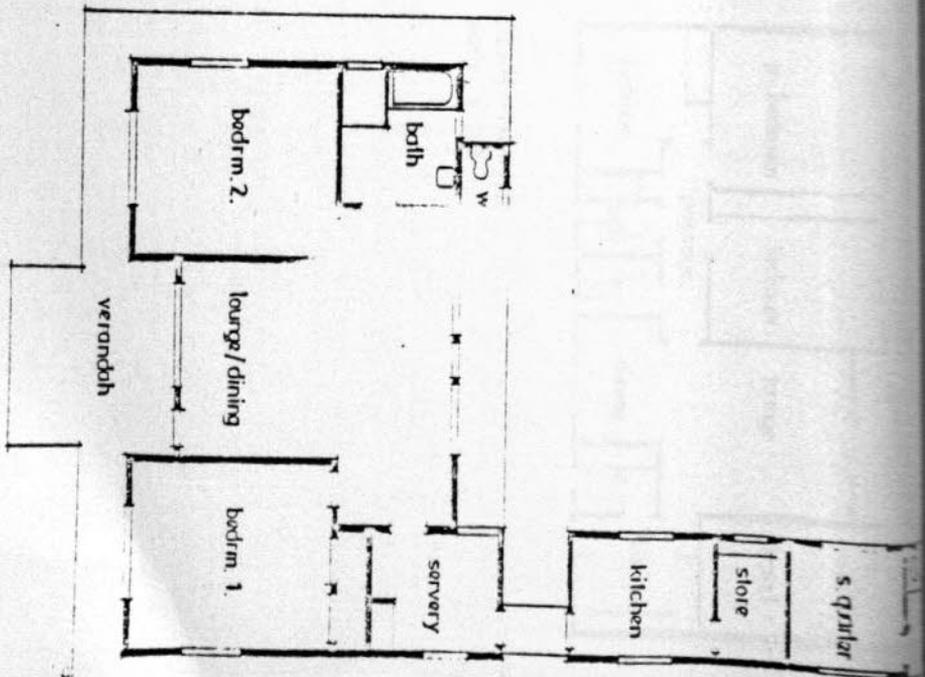
The kitchen store could be more functionally located  
away from the dining wall as suggested in the revised layout.

Suitability:

With modifications, this design is recommended.



PLAN-R-TAPI/46  
scale 1:100



PLAN-TAPI/46  
scale 1:200

2.3.5 Drawing no. TAPI/46 - (R-TAPI/46) (Figure B.7)

(i) Climatic Aspects:

Cross ventilation is achieved in all habitable rooms. The 4ft. overhang specified is adequate for protection of walls from weathering and sun.

(ii) Functional Aspects:

There is lack of distinction between day and night areas. Bedroom no. 1 should have access to the bathroom and the w.c. without going through the living room.

The bathroom and w.c. should not open onto the lounge. Bedroom no. 2 should have a cupboard.

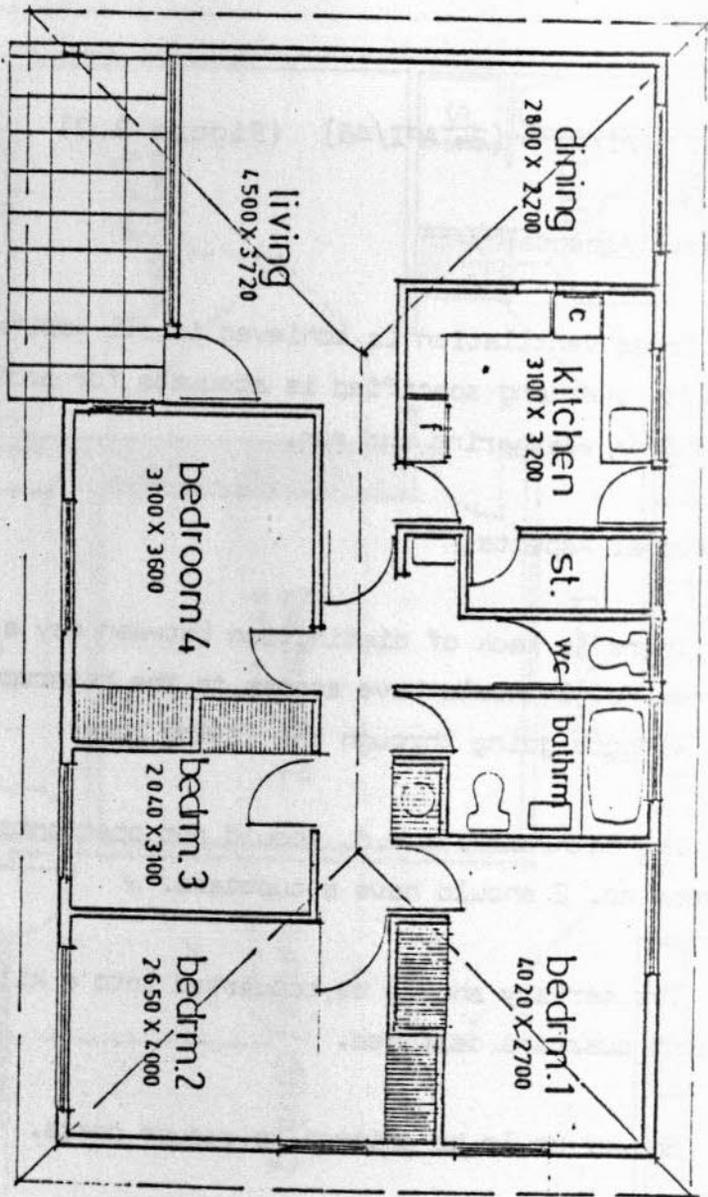
The servery should be converted into a kitchen and the servant quarters detached.

Shower could be omitted to reduce costs.

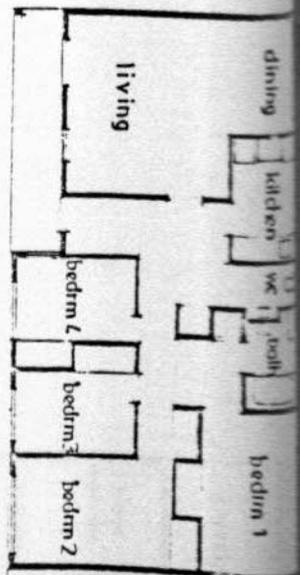
Room sizes are considered adequate.

Suitability:

Without very major modifications as recommended in the revised layout, this design is unsuitable.



PLAN, R - TYPE D LOWLAND  
scale 1:100



PLAN - TYPE - D - LOWLAND (No. 18/6057/1)  
scale. 1:200

2.3.6 Drawing Type D - LOWLAND - (R - D-LOWLAND) - (18/6057/1) (Figure B.8)

(i) Climatic Aspects:

Bedroom no. 3 cannot be cross ventilated. All other habitable rooms can be ventilated properly through windows on opposite walls.

There should be a back yard partially roofed for outdoor activities related to the kitchen.

(ii) Functional Aspects:

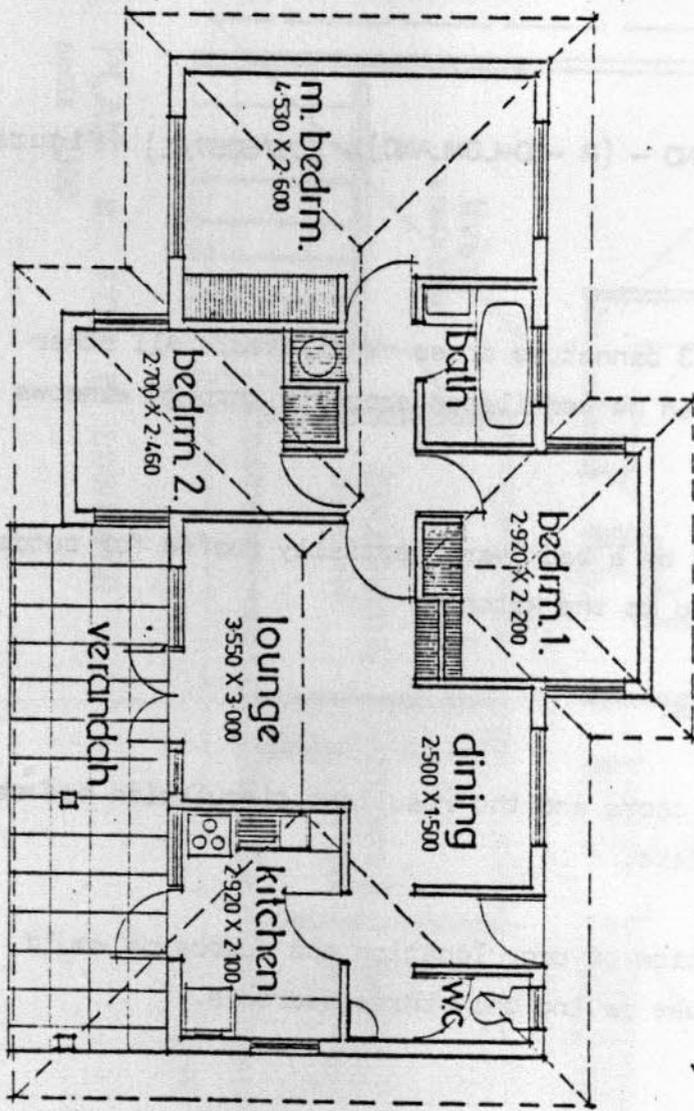
Location of doors and the resultant circulation has reduced the usable space.

Re-organisation of door location and cupboards would result in the house having only three bedrooms.

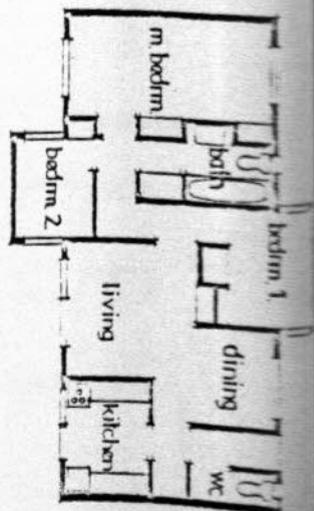
Suitability:

As the recommended revisions result in reduction of accommodation, this design is not recommended.

Figure B.9



PLAN—R-TYPE E—LOWLAND  
scale 1:100



PLAN—TYPE 'E' LOWLAND No 18/6058/1  
scale 1:200

(i) Climatic Aspects:

All habitable rooms are well cross ventilated.

A covered front verandah and a kitchen yard would be desirable for outdoor activities.

(ii) Functional Aspects:

The location of the second w.c. is both uneconomical and awkward as it is next to the kitchen.

The relationship of the kitchen to the dining area is inefficient as the two are separated by a traffic route to the w.c. and outside.

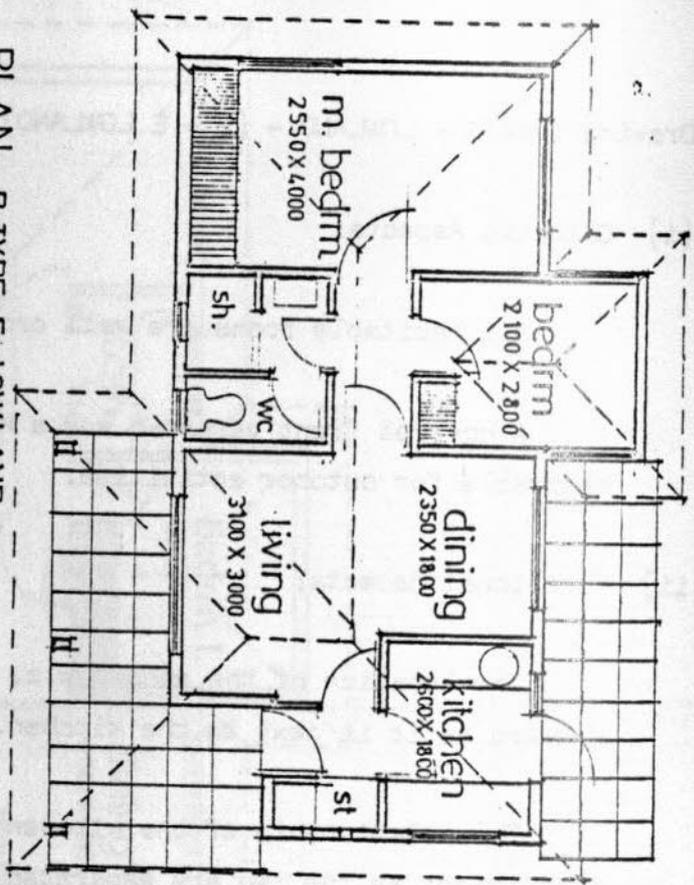
External kitchen door should be to the back of the house.

Bedroom number 2 is too small.

Suitability

Although the design satisfies the climatic aspects, it does not satisfy other design factors even after revision.

This design is therefore not recommended for adoption.



PLAN - R-TYPE F-LOWLAND.  
scale 1:100



PLAN - TYPE F - LOWLAND (18/6039/1)  
scale - 1:200

2.3.8 Drawing TYPE F LOWLAND - (R-F LOWLAND) - (18/6059/1) (Figure B.10)

(i) Climatic Aspects

All habitable rooms have adequate cross ventilation. More external covered area would be desired.

(ii) Functional Aspects:

Circulation is satisfactory and isolation of functions has been achieved.

Bedroom cupboard space could be increased resulting in more functional storage facility and in increased area of the small bedroom.

Location of kitchen store in relation to the entrance is unsatisfactory and could be improved by screening the store.

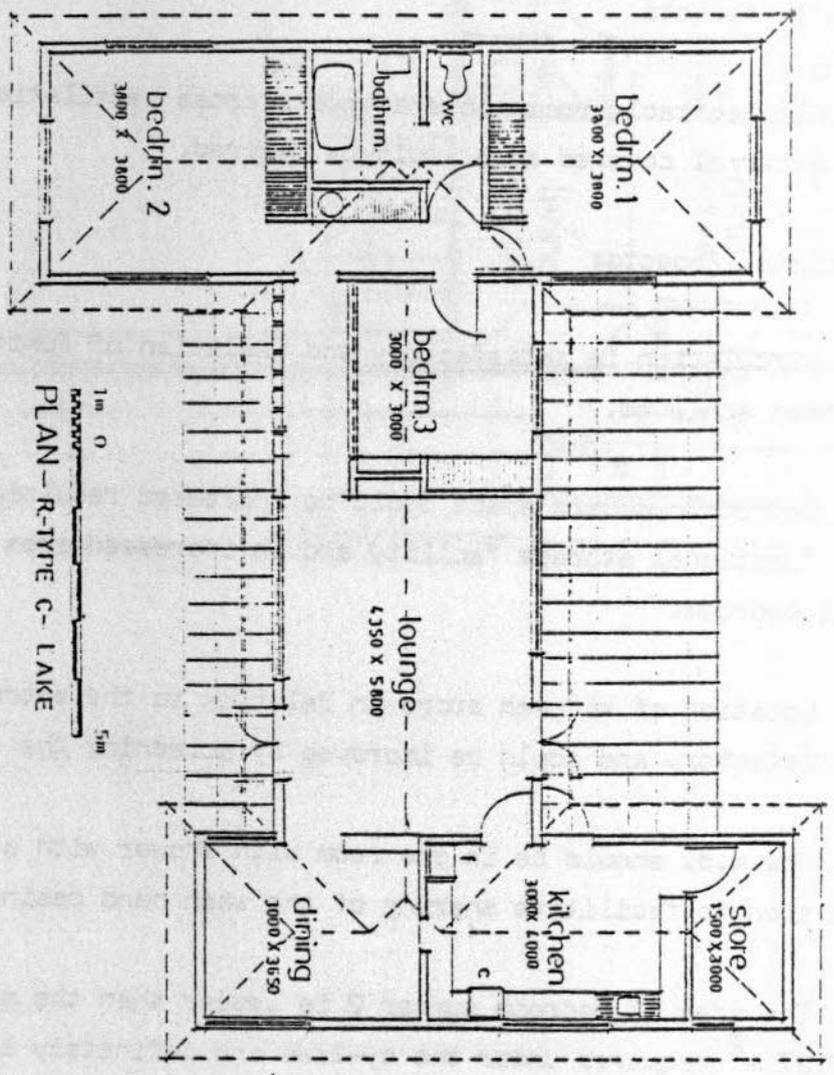
The w.c. should be in one room with shower with a partition to facilitate sharing of the wash hand basin.

The area of bedroom number 2 is lesser than the minimum of 6.97 m<sup>2</sup> required under the by-laws and definitely lesser than our desired minimum outlined earlier.

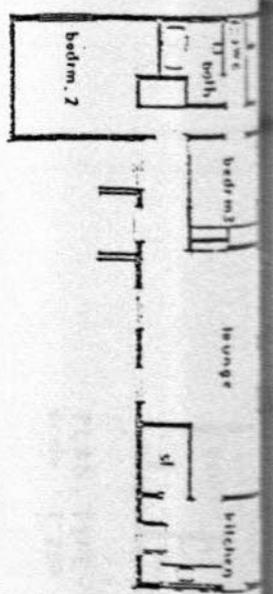
Suitability:

Increase of area of bedroom number 2 would make this design suitable.

Figure 3.1



PLAN - R-TYPE C-LAKE



PLAN - TYPE C-LAKE No. 18/50627/c



2.3.9 Drawing Type C - Lake - (R-18/50462/4) (Figure B.11)

(i) Climatical Aspects:

Air movement is good in all rooms. Proposed overhang of 18" is small and could be increased to 60 cm for better shading of walls.

The proposed roofing tiles have good thermal qualities but could be proved to be too expensive for this category of house. Asbestos cement sheets with a ceiling is cheaper and achieves the same insulation purposes. A hipped roof would increase the shading on the end walls.

(ii) Functional Aspects:

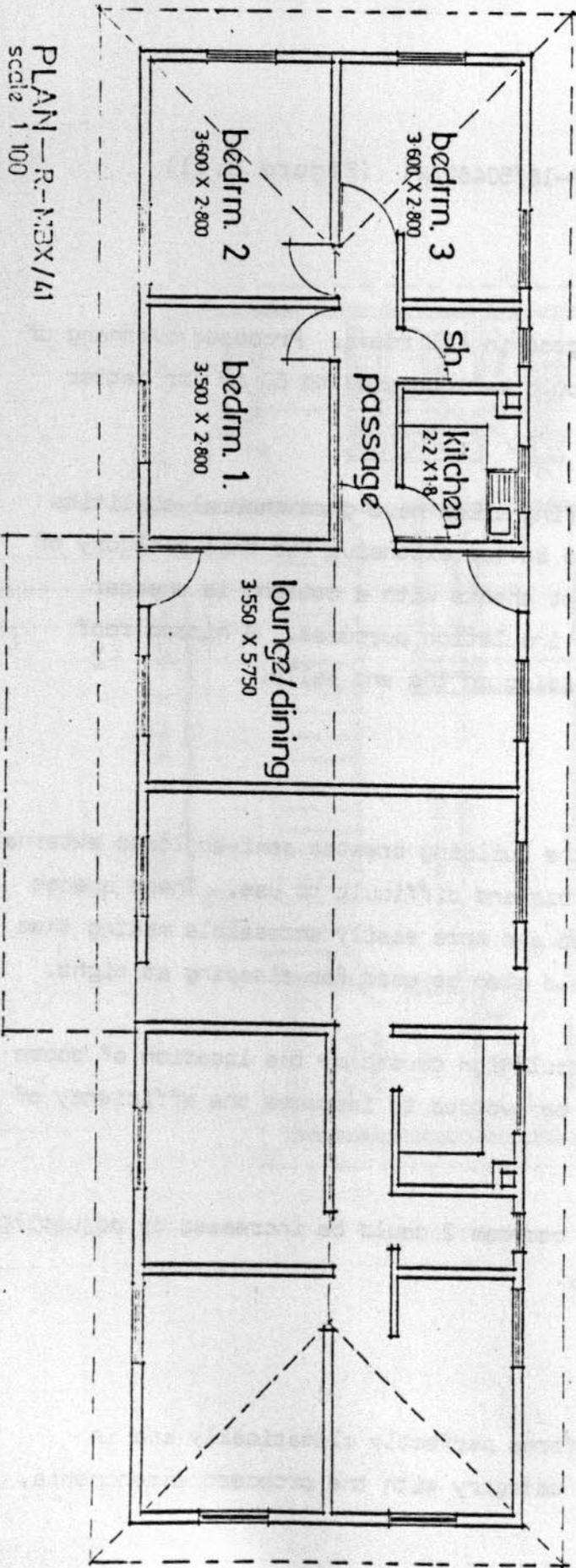
The T-shape of the building creates semi-enclosed external spaces which are too big and difficult to use. These spaces could be more enclosed and more easily accessible making them useful by day and could also be used for sleeping at night.

The diagonal circulation caused by the location of doors in the kitchen could be avoided to increase the efficiency of the kitchen.

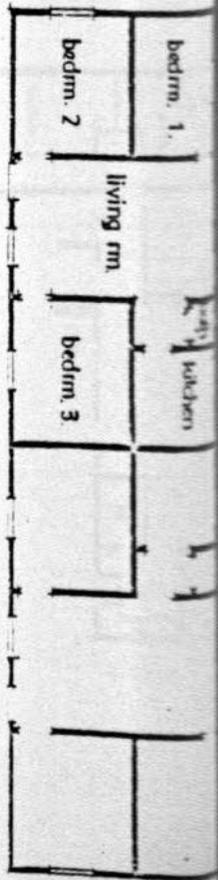
The wardrobe in bedroom 2 could be increased by adjusting the bathroom slightly.

Suitability:

This design performs perfectly climatically and is recommended for this category with the proposed ammendments.



PLAN - R-MBX/L1  
scale 1:100



PLAN - MBX/L1  
scale 1:200

## 2.4 JUNIOR STAFF HOUSES:

2.4.1 Drawing no. MBX/41 - (R - MBX/41) (Figure B.12)

### (i) Climatic Aspects:

Through air movement in bedrooms should be induced by providing two windows wherever possible. Living room has good air movement but lacks outdoor covered areas.

Overhand should be increased to a minimum of 600 mm to protect wall from insolation.

A hipped roof instead of a gable one would reduce solar heat gains on end walls.

Specified g.c.i, roof without ceiling can become too hot. If no ceiling is intended, an asbestos roof covering could be used as it has better thermal qualities.

P.Vs should be provided above and under windows and on the ridge if no ceiling is to be fixed.

### (ii) Functional Aspects:

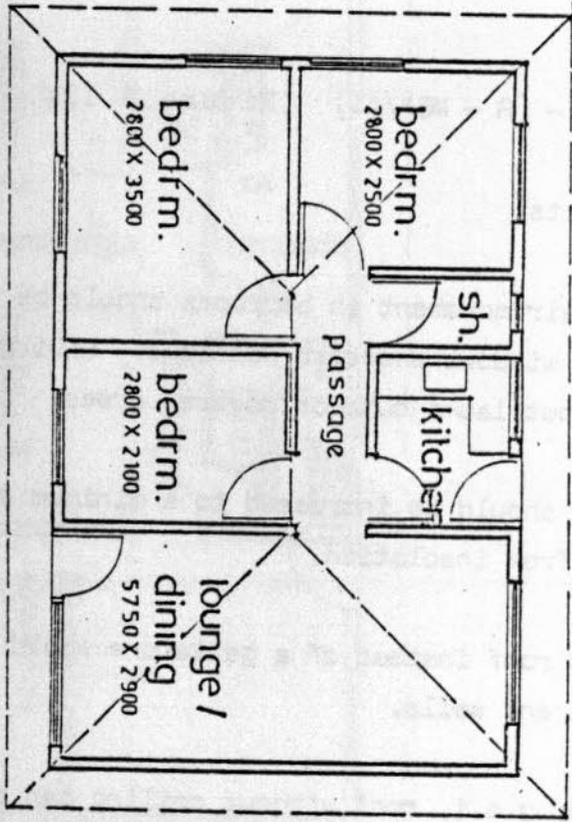
The living room is rendered inefficient by the large number of doors opening into it.

The bedrooms and bathroom have no privacy as they open directly into living room.

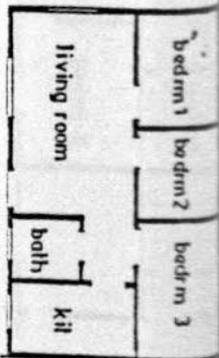
Day and night activities should be separated by introducing a corridor.

### Suitability:

This type though not answering all climatic requirements is recommended only because it is semi - detached resulting in saving of one wall.



PLAN. R-MBX/66  
 scale 1:100



PLAN. MBX/65  
 scale 1:200

2.4.2 Drawing no. MBX/66 - (R - MBX/66) (Figure B.13)

(i) Climatic Aspects:

Bedrooms are poorly ventilated as they have only one window. Consider p.v.s above and below windows. G.c.i roof without ceiling as proposed is not suitable for this climate.

Consider the use of asbestos sheets and designing ridge to have ridge vent.

Overhang specified is not adequate to provide sufficient cover for the walls and should be increased to a minimum of 600 mm.

A hipped roof would provide better protection of walls from sun than the proposed gable roof.

(ii) Functional Aspects:

Bedrooms 1 and 2 have no privacy as they open directly into the living room. A bedroom corridor should be introduced.

The kitchen should have separate access to the rear other than through the living room.

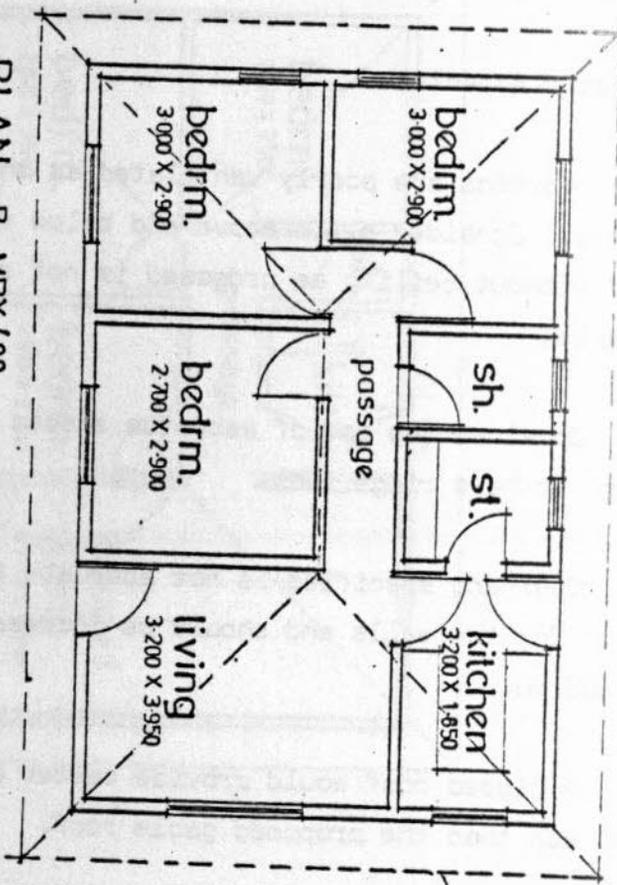
The kitchen and not the bathroom should be adjacent to the living room.

Bedrooms could have cupboards depending on the cost.

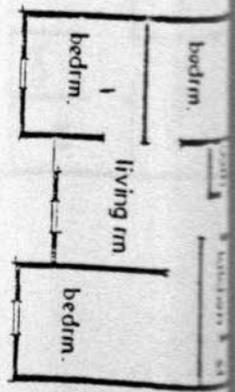
Suitability:

As this unit is completely detached it would require larger plot and no savings would be realised on end walls. It is therefore not recommended.

PLAN—R.—MBX/89.  
scale 1:100.



PLAN MBX/89.  
scale 1:200



2.4.3 Drawing no. MBX/89 - (P-MBX/89) (Figure B.14)

(i) Climatic Aspects:

Proper air movement through rooms is not possible since windows are provided only on one side of each habitable room.

P.v. between two bedrooms is not allowed by building by-laws. The overhang should be minimum 600mm and covered external space for outdoor living provided.

Proposed g.c.i. roof is unsuitable without ceiling. Consider using asbestos cement sheets and providing a p.v. on ridge to increase air circulation.

A hipped roof would have better protective qualities.

More p.v.s should be provided above windows and doors.

(ii) Functional Aspects:

The living room has too many doors opening into it thus reducing the effective usable area.

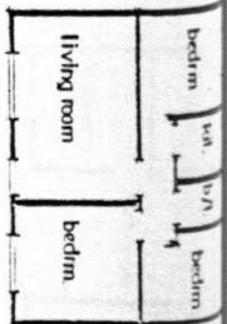
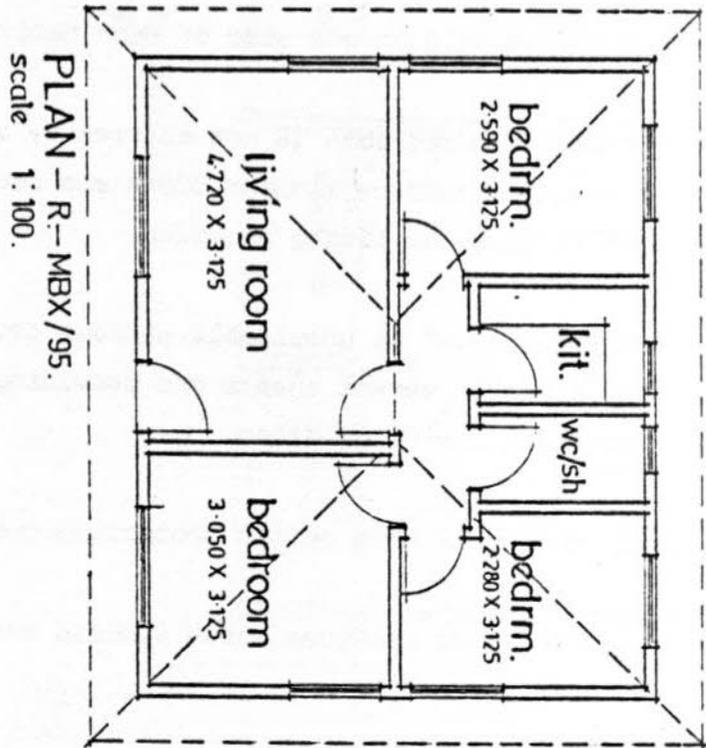
The size of the living room could be increased by adding to it, the recessed area, and projecting a verandah in front of it.

Bedrooms should have more privacy.

Laminated timber beam over verandah is not necessary.

Suitability:

Climatically this design is unsuitable for Sura. Being completely detached no savings are realised on end walls. The design is therefore not recommended.



PLAN MBX/95  
scale 1:200

2.4.4 Drawing no. MBX/95- (R- MBX/95) (Figure B.15)

(i) Climatical Aspects:

There is insufficient air movement in all rooms as windows appear only on one wall. Proposed overhang of 2' is sufficient for wall shading.

A hipped roof would provide better cover for walls than the gable roof proposed. A ceiling would improve the thermal comfort greatly.

(ii) Functional Aspects:

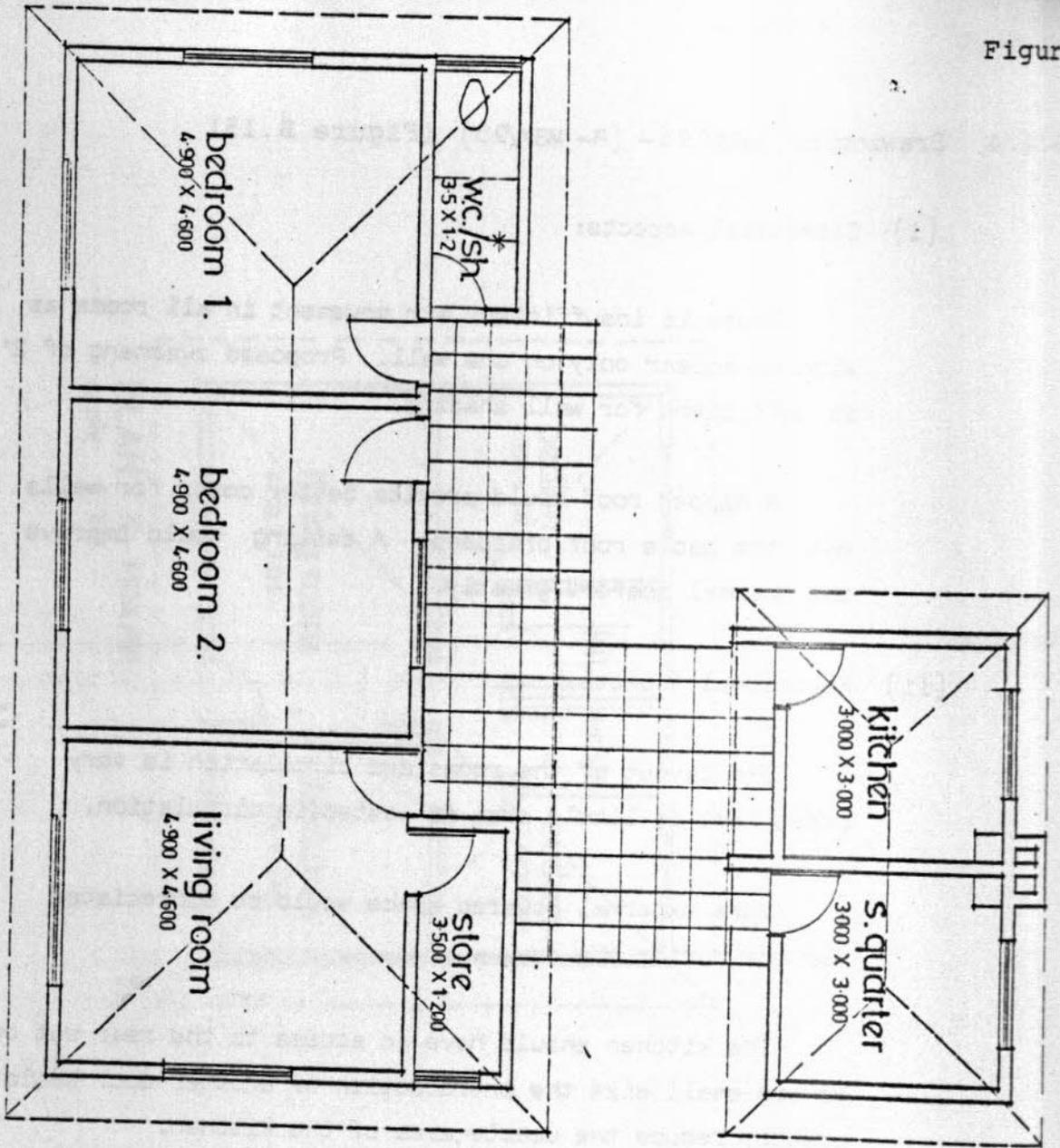
The layout of the rooms and circulation is very convenient as little area is wasted in circulation.

More external covered space would be appreciated for use during the day.

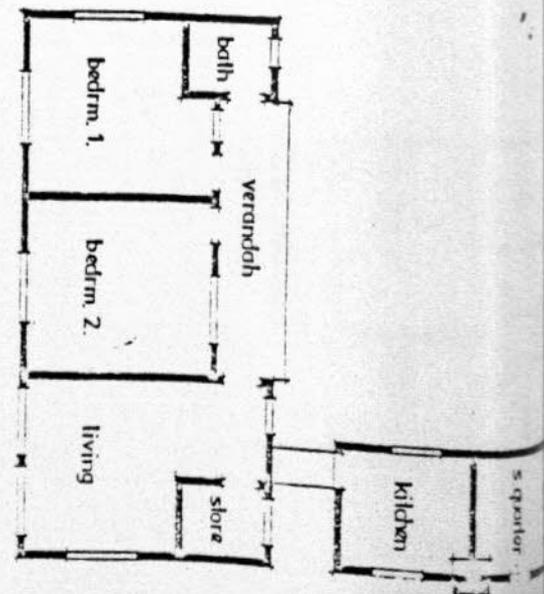
The kitchen should have an access to the rear but owing to its small size the introduction of another door would greatly reduce the usable area of the kitchen.

Suitability:

From a climatic point of view this design is considered suitable.



PLAN R. TAPI/5.  
 scale 1:100



PLAN—TAPI/5.  
 scale 1:200.

2.4.5 Drawing no. TAPI/6 - (R - TAPI/6) (Figure B.16)

(i) Climatic Aspects:

Provision of windows on more than one wall in each room ensures ample air movement. The specified overhang on hipped roof of 3ft. provides sufficient shading on the walls and provides cool outdoor covered working spaces around the building.

A ceiling should be provided if g.c.i. sheets are to be used on roof. Consider using asbestos cement sheet roofing which has better insulation qualities.

(ii) Functional Aspects:

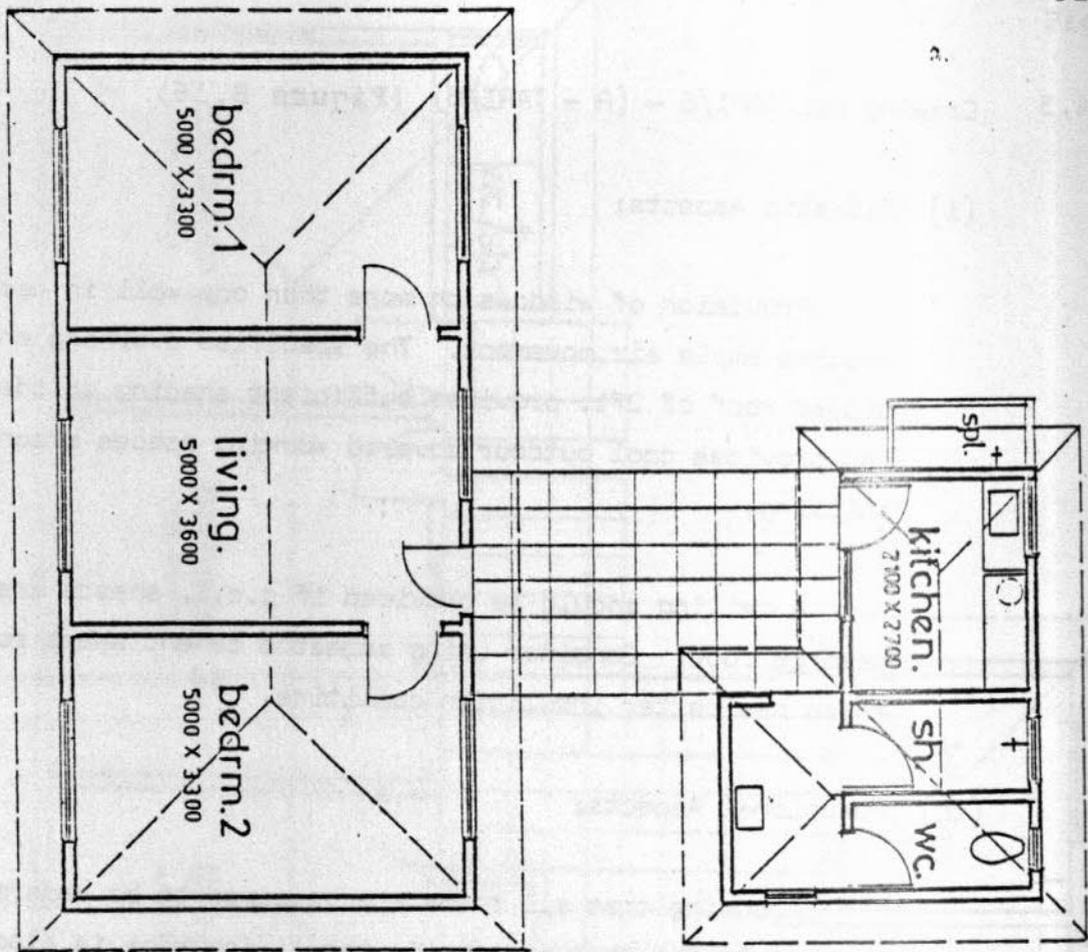
Assuming that all rooms are required to be separately accessible and that a store in the living room is also required, a more straight forward arrangement is possible which would make construction easier and circulation in the living room more convenient. It should be noted that separate external access to rooms are not allowed by the laws. The orientation of the servants quarter/kitchen block could be altered to provide a more enclosed outdoor living area between kitchen and the main house.

The passage between kitchen and main house does not seem to be serving any purpose as it stops on a blank wall.

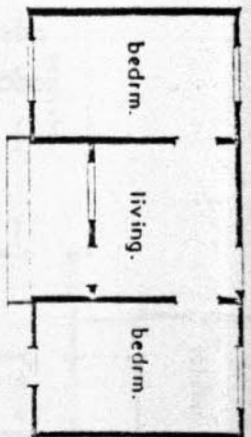
Suitability:

Separation of kitchen from the main house make this design expensive and inconvenient to occupants. The rooms doors do not allow the desired occupation by one household.

This design is not therefore recommended.



PLAN. R - TAPI /4,8  
 scale 1:100



PLAN. TAPI /4,8  
 scale 1:200

2.4.6 Drawing no. TAPI/48 - (R - TAPI/48) (Figure B.17)

(i) Climatic Aspects:

Cross air movement is good in all rooms, through windows and p.v.s below the windows.

Overhang specified should be increased to at least 600 mm.

More covered space between main house and the kitchen would be appropriate as it would provide useful outdoor living area and possibly sleeping areas too.

End walls are exposed to the sun and this could be corrected by using hipped roof instead of the proposed gable ended roof.

(ii) Functional Aspects:

The effective area of the living room is minimised by the location of doors in the already small room.

Consideration could be given for the provision of wardrobes.

The kitchen block with toilets and showers could be connected to the main building.

The toilet and shower compartments could be designed to have more privacy.

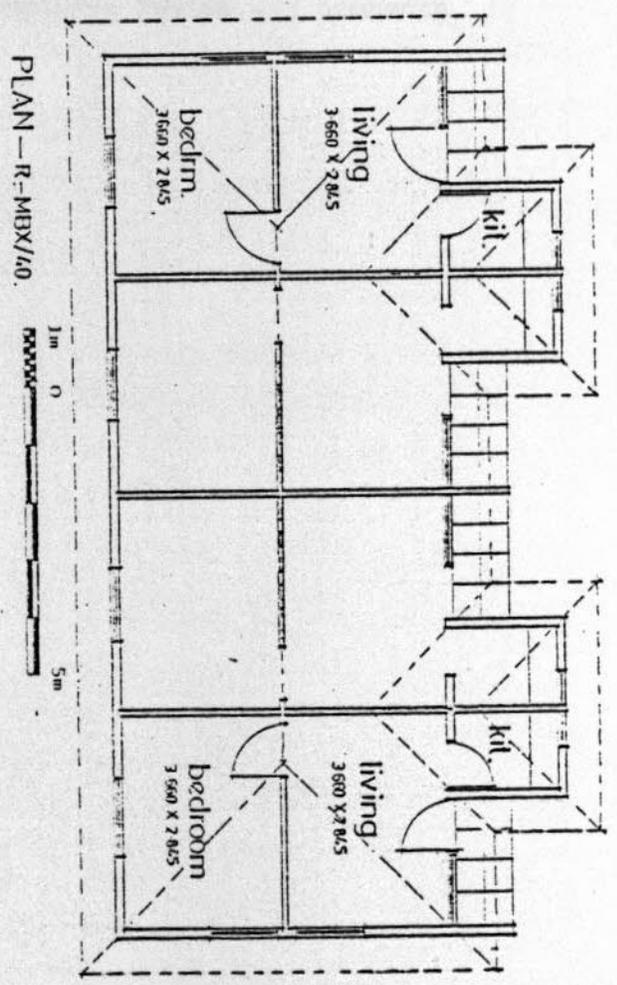
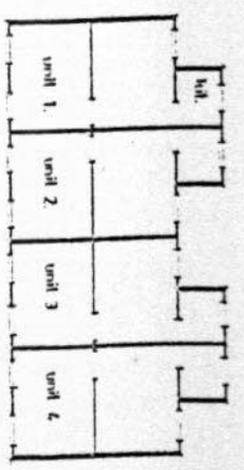
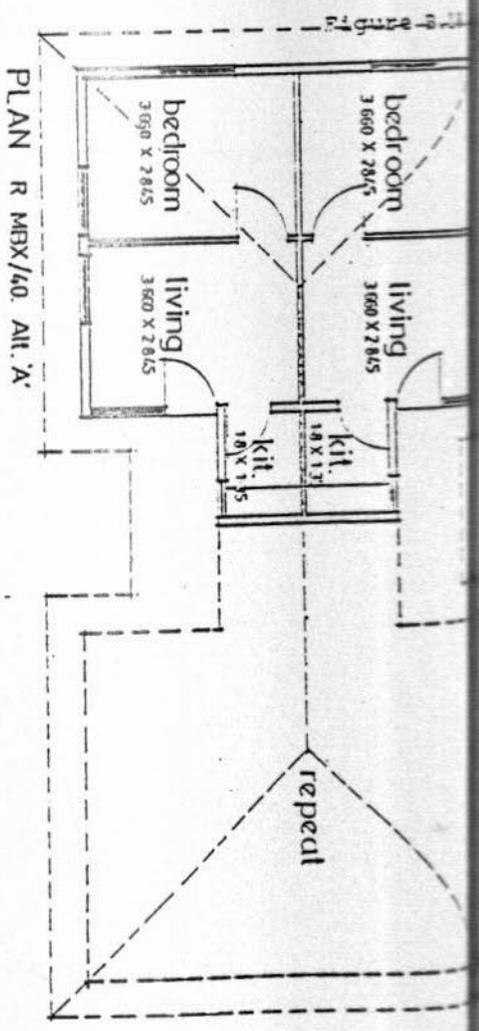
Laminated timber roof trusses could be avoided.

Suitability:

Separation of kitchen and toilets from the house make this design expensive and inconvenient for occupants. It is therefore not recommended.

2.4.7 Drawing no. MAX/5 - Junior Staff House

This drawing did not carry enough information for a thorough architectural review and comments.



## 2.5 SUBORDINATE STAFF HOUSES:

2.5.1 Drawing no. MBX/40 - (R - MBX/40) (Figure B.18)

### (i) Climatic Aspects:

Ventilation is inadequate due to double banking of rooms this can be improved only in the end units as they have two external walls which can have windows. If this block of four is to be adopted for this category the roof ridge should be used as a permanent vent and the ceiling omitted.

Further cooling of the building could be achieved by increasing the eaves length to 600 mm. and using a hipped roof instead of the specified gable roof.

Further improvement of air movement could be achieved by connecting each two units by the kitchen walls thus giving every room possibility for two windows (see drawing number R-MBX/40).

### (ii) Functional Aspects:

Location of kitchen is unsuitable as it can only be accessible through bedroom.

External recesses should be covered and made accessible from the house to provide cool outdoor living areas.

Ceiling height should be increased or pitch lowered to increase the minimum eaves level of 6' - 4".

### Suitability:

This block is recommended on account of its economy. From a climatic point of view it is unsuitable unless it is modified as per our revised version.

2.5.2 Drawing no. MAX/3

The drawing presented to the Consultants was not clear enough for review and comments.

2.6 GUEST HOUSES

2.6.1 P.C's Guest House - (A - P.C's. Guest House) - (18/51252/6) (Figure B.19)

(i) Climatic Aspects:

The two bedrooms are not adequately ventilated having windows only on one wall but the living room has ample air movement.

The concrete flat roof specified for this unit has very good thermal qualities but would be an unnecessarily expensive. A g.c.i. roof with a ceiling below is convenient and is much cheaper than the proposed flat roof. The middle bedroom cannot be improved climatically unless it is ventilated through the corridor and ridge.

(ii) Functional Aspects:

The spaces are well organised for a two bedroom house and there is sufficient privacy for the bedrooms.

Even though this is a guest house it should have a small kitchen for occasional cooking.

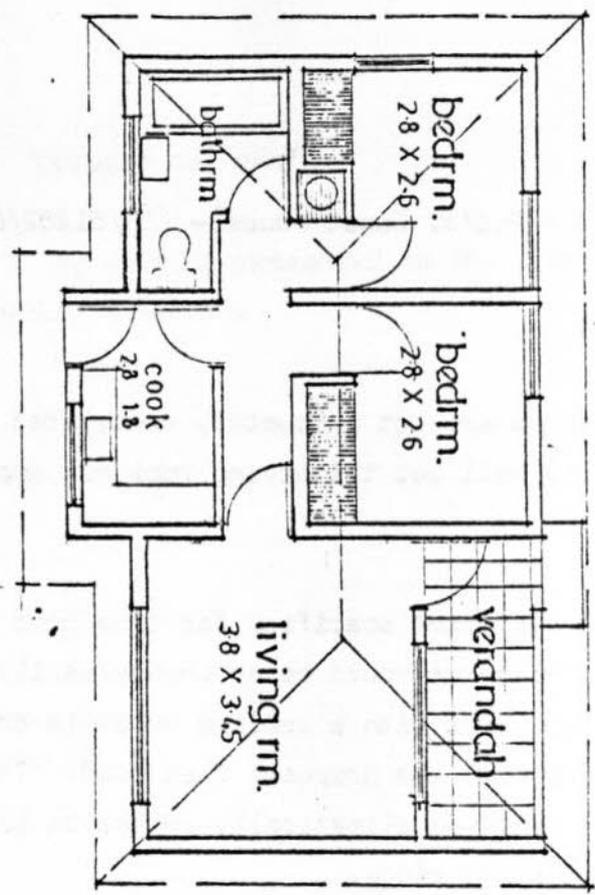
If the roof was made accessible it could be used for sleeping at night.

The bedrooms are too small to accommodate two beds comfortably.

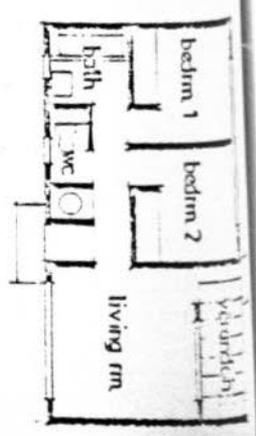
Suitability:

If the modifications above are incorporated, this design would be suitable for the Bura climate but as a guest house it has too small bedrooms and without a kitchen it is not sufficiently convenient.

Figure B.19

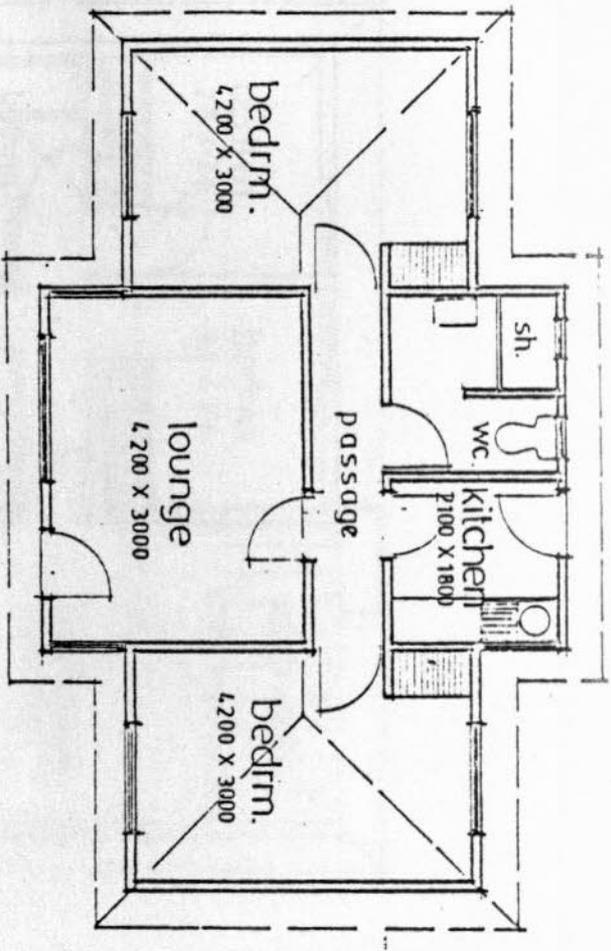


PLAN. R - P. C's GUEST HOUSE  
scale 1:100

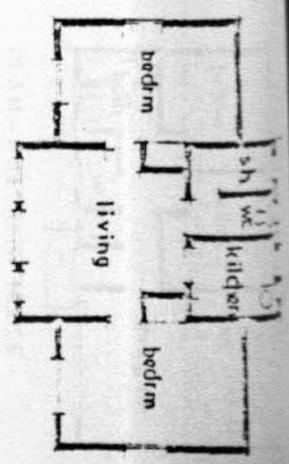


PLAN - P.C's GUEST HOUSE  
scale 1:200

Figure B.20



PLAN.—R-MBX / 39.  
scale: 1:100



PLAN — MBX / 39.  
scale: 1:200

(i) Climatic Aspects

Bedrooms have sufficient air movement but the living room is not well ventilated as it has windows on one wall only.

Overhang specified with hipped roof is adequate but a covered verandah should be added. The passage could be ventilated through a roof vent if there is no ceiling. There should be p.v.s above window and door openings.

(ii) Functional Aspects:

Privacy for bedrooms is minimised by openings then straight into the living room. The four doors opening into the living room reduce the usable area of the living room.

The passage leading to shower and toilet is wasteful of space while not providing access to the bedrooms.

The bedroom sizes are adequate.

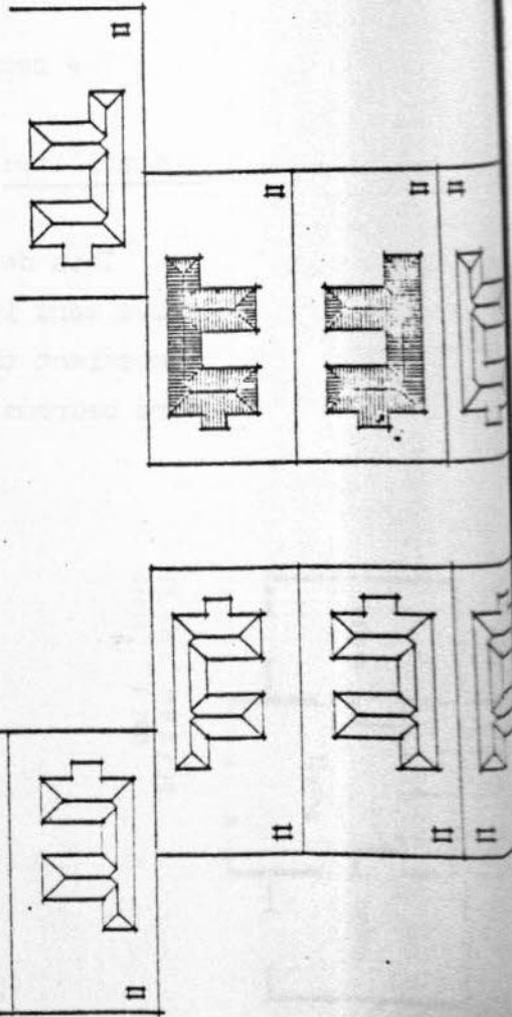
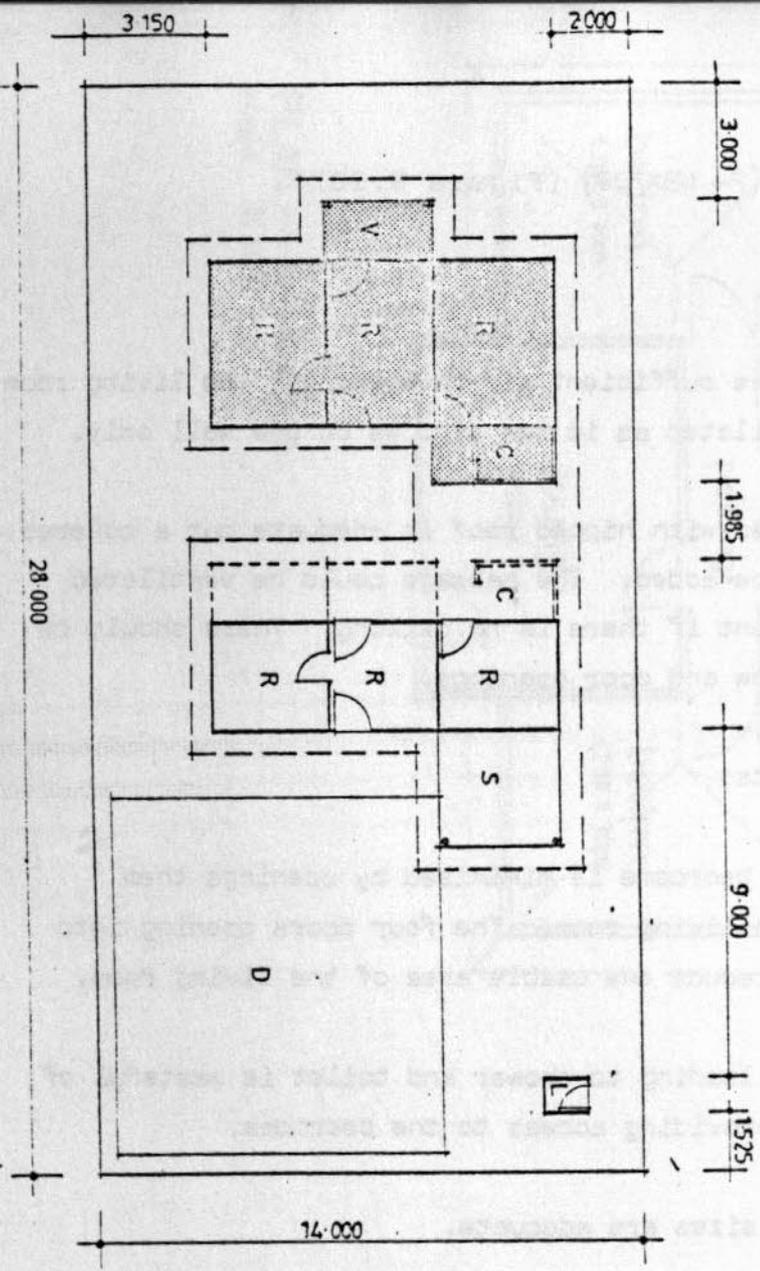
Suitability:

This design could be suitable for Bura if the modifications above were incorporated. As a guest house this design is more convenient than the P.Cs guest house as it has a kitchen and more bedroom area.

Figure B.21

- C COOK
- D DRYING AREA
- L LATRINE
- R ROOM
- S STORAGE SHED
- V VERANDAH

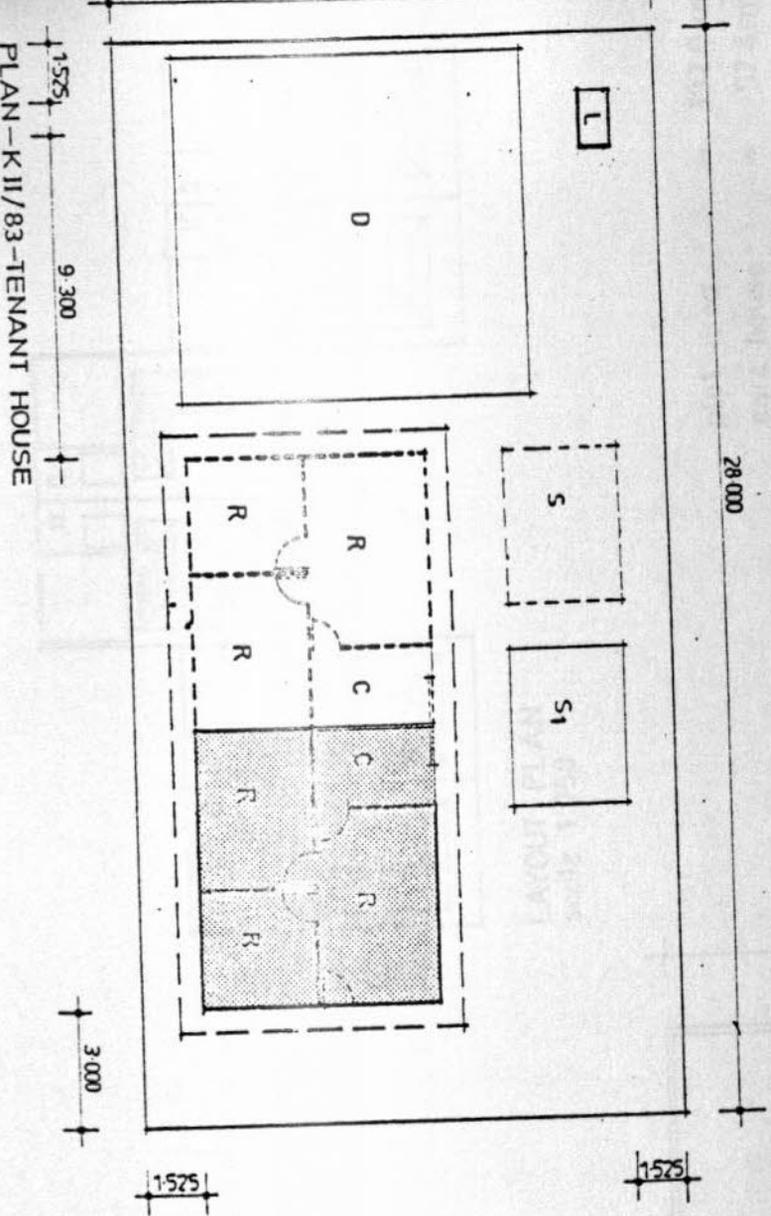
PLAN - TENANT HOUSE - R-N.I.B. PROPOSAL  
 scale 1:200



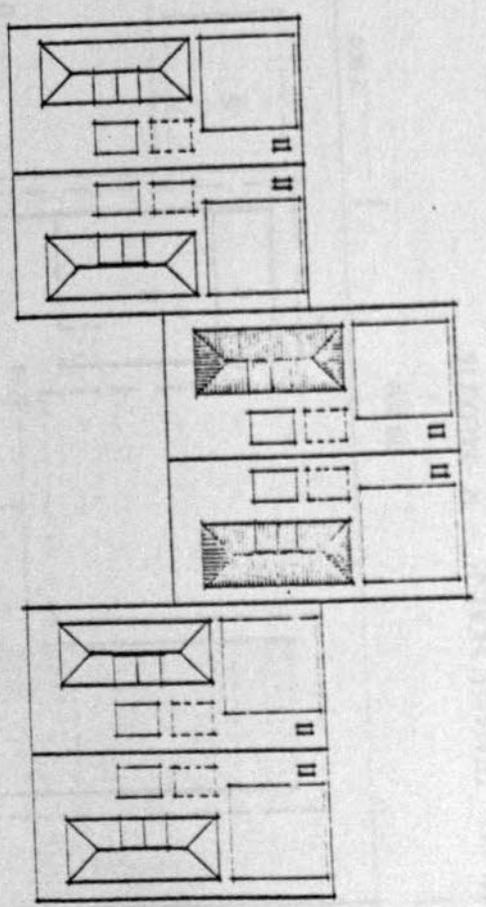
LAYOUT PLAN  
 scale 1:750

plot area	=	392.0 m <sup>2</sup>
core house	=	40.4 m <sup>2</sup>
100% extension	=	40.2
storage shed	=	12.0 m <sup>2</sup>
pit latrine	=	1.4 m <sup>2</sup>
total area	=	94.2 m <sup>2</sup>
ultimate coverage	=	24.03%

- C COOK
- D DRYING AREA
- L LATRINE
- R ROOM
- S STORAGE SHED
- S1 ALTERNATIVE STORAGE SHED

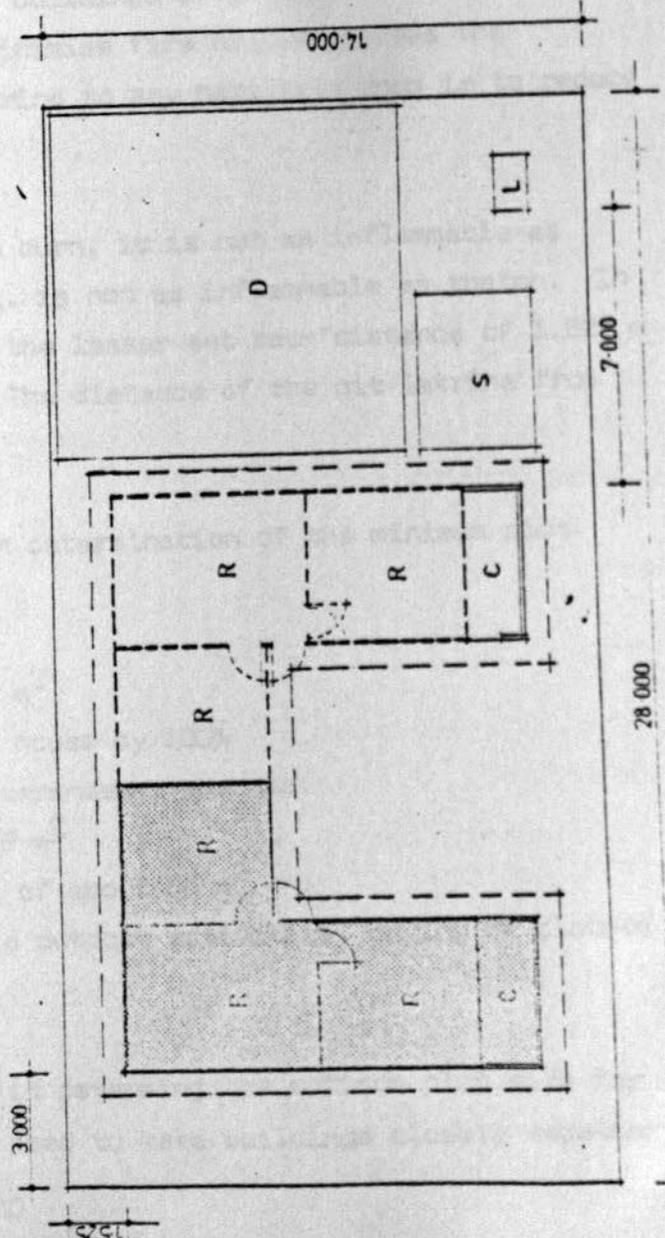


LAYOUT PLAN  
scale 1:750

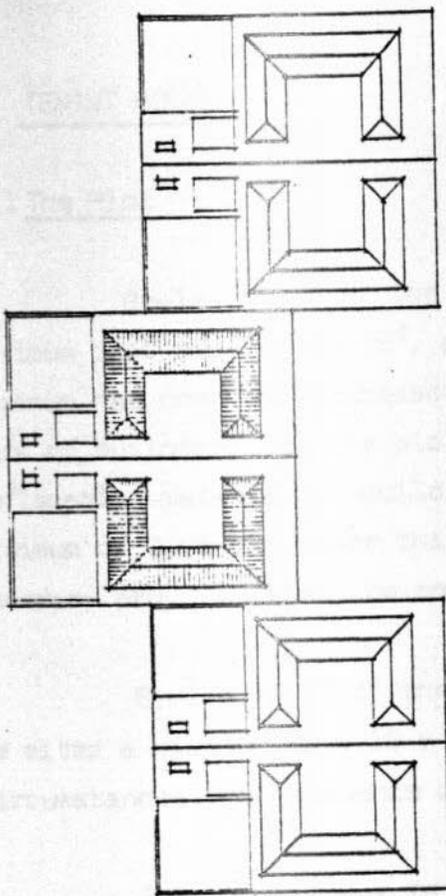


plot area	=	392.0 m <sup>2</sup>
core house	=	44.6 m <sup>2</sup>
100% extension	=	44.6 m <sup>2</sup>
storage shed	=	12.0 m <sup>2</sup>
pit latrine	=	1.4 m <sup>2</sup>
total area	=	<u>102.6 m<sup>2</sup></u>
ultimate coverage	=	26.17%

- C COOK
- D DRYING AREA
- L LATRINE
- R ROOM
- S STORAGE SHED



LAYOUT PLAN  
scale 1:750



plot area	=	392.0 m <sup>2</sup>
core house	=	52.8 m <sup>2</sup>
100% extension	=	52.8 m <sup>2</sup>
storage shed	=	12.0 m <sup>2</sup>
pit latrine	=	1.4 m <sup>2</sup>
total area	=	119.0 m <sup>2</sup>
ultimate coverage	=	30.35%

PLAN TENANT HOUSE - R-MBX/14  
scale 1:200

## 2.7 TENANT HOUSE

### 2.7.1 The Plot

By-law no. 7 of the Grade II Building By-laws stipulates a minimum plot size of 260 m<sup>2</sup>, and a maximum plot coverage of 25%. This maximum has now been increased to 50%. The same by-law requires a set back of building from the plot boundary of 1.525 m for buildings of non-inflamable materials. Buildings of inflammable materials shall be set back a minimum of 3.05 m. Under this by-law, the latrines may be built on the plot boundary provided they are combined with other latrines on adjoining plot.

By-law no. 8 of the Grade II Building By-laws requires the latrine be sited a minimum of 9.15 m from habitable rooms. In exceptional circumstances this distance could be reduced.

The requirement to set back buildings of inflammable materials by 3.05 m from the plot boundary is to minimise fire hazard whereas the minimum distance of 9.15 from the latrine to any habitable room is to reduce health hazard and odour.

Although mud and wattle can burn, it is not as inflammable as untreated wood. The roofing of g.c.i. is not as inflammable as thatch. In establishing the plot size therefore the lesser set back distance of 1.525 m from the plot boundary was adopted. The distance of the pit latrine from habitable rooms was taken as 9 m.

Other aspects considered in determination of the minimum plot size were:

- The core house of 40-45 m<sup>2</sup>
- Need to extend the core house by 100%
- Outdoor covered areas; verandahs, porches.
- Cotton storage shed of 9 m<sup>2</sup>
- Cotton drying open area of about 50 m<sup>2</sup>
- Area for normal domestic outdoor activities, drying of clothes etc.

Two other guiding factors in determining the optimum plot size for the settler house were the climatic need to keep buildings closely together,

implying small plots and the limiting of areas taken up for building in order to utilize as much of the land as possible for cultivating.

Three of the settler core houses were used to establish the minimum plot size as illustrated in plates      and      . A plot size of 392 m<sup>2</sup> and dimensions of 14 m wide and 28 m. long was established to be adequate to accommodate the functions stated and still remain within the requirements of Grade II By-laws. For the core house on plate      the distance of latrine from the habitable rooms would have to be reduced from 9 m to 7 m . This provision is allowed in exceptional circumstances.

## 2.7.2 The House

In the review of the settler houses the Consultants have considered the special characteristics the design of the house must have for successful performance. Some of these characteristics are as follows:-

- The design
- The Climate
- The Construction and Level of Technology
- The House Growth and Living Habits
- The Materials and Availability
- The potential for upgrading

### Design

The designs reviewed and recommended are not traditional in the sense of origin. However, they are widely used in the rural areas all over the country and have been used in other settlement schemes and therefore the Consultants have accepted the concept of a three roomed core house as traditional. This acceptance is rational as more 'traditional' would result in the design of many types of houses one for each tribe in Kenya as the scheme will attract settlers from all over the country.

Even with this anomaly, it is true that the method of construction and materials used, particularly for walling is almost universal and therefore traditional. The living and entertaining habits of Africans is almost similar in all tribes and this has helped the Consultants formulate a criterion on these aspects of the settler house.

### Climate:

The climatic considerations for the settler house are similar to those stated earlier for other houses: The need to have cross-ventilation in rooms, outdoor covered areas and so on. However, as the houses will be erected by the settlers themselves, there is likelihood of omitting p.v.s and windows.

The Consultants recommend that doors and windows which would be sold to the settlers as pre-fabricated components of the houses be designed with louvred vents to ensure ventilation in rooms that may not be ventilated or inadequately ventilated owing to bad workmanship or negligence.

### 2.7.3 House Growth and Living Habits

The settler house must be extendable primarily for two reasons. The core house is inadequate for the average settler family and two, the traditional way of living with ageing parents, brothers and cousins commonly referred to as 'extended family'. Customarily, grown up children live semi-independently and the parently must have the option of how best to house their children once grown up, within the plot. Of course there is the second or third wife to house on the plot, and here again, they must be independent and yet within the plot.

The ideal settler core house then must be the one with the greatest potential for extensions without sacrificing the other desired aspects of ventilation, circulation and privacy.

Traditionally, men are entertained separately from women who are would be entertained in the kitchen. Combination of the two sexes during entertainment is becoming more popular and it may be unrealistic to require the settler house to provide separate entertainment areas for the men and women. The duties of the housewife, in the kitchen result in the housewife entertaining visiting women in the kitchen, thereby leaving the husband to entertain men in the house.

There are two factors however, that the Consultants consider underplay the need for large entertainment of visitors in settler houses in Bura. Firstly the climate being very hot, house owners and guests would tend to sit outdoors and hence the need for verandahs and courtyards. Secondly, the settlers would be out in the fields for the better part of the day and when they return home, it is time for the housewives to go about house-keeping duties and the men would probably go out to work in the family shambas or such other duties. The level of entertainment and visiting is therefore bound to be very low.

### 2.7.4 Construction and Technology

To achieve maximum economies in the construction of settler houses, it is required that the settlers form work gangs to erect their own houses. These will be only the 'core' and shall comprise three rooms, a kitchen or roofed up cooking area, and a verandah. The individual settler will, over time, extend his own house to suit the need of his family. The need to

extend the houses is demonstrated by the extensions completed and underway in Hola settlement.

These two aspects of the house, the need to extend and minimal skilled labour (self-built) require that the design shall be easy to set out, and have minimum of complicated construction details. The design of the core house and the siting must allow and dictate the direction of the extensions. Locations of windows and doors must be carefully considered to avoid the likelihood of blocking these openings which would result in lack of cross ventilation or undesired circulation through other rooms.

Traditionally, the houses are constructed by the house owner with the help of neighbours and after the skeleton structure is completed, the wife, again assisted by neighbours or her children, do the mud plastering and thatching. The construction of the reviewed houses is similar to the traditional method except for the roof (g.c.i) and the climatic need for ample ventilation. Construction for the other elements of the house must be what the settler is used to. It is suggested that strong cords, if available, should replace nails to fix the framework.

#### 2.7.5 Materials: Cost, Availability and Durability

The choice of the most suitable materials for construction of the settler house depends on cost, availability, durability, technical skill and previous experience of the settlers. The cost is paramount to the others and it eliminates a wide range of materials from consideration.

For flooring, the cheapest alternative is compacted earth. This finish is readily available on-site at almost no cost. However, its use has disadvantages as it constantly wears out when the floor is swept out particularly if the housewife splits fire wood on the floor or places heavy objects with sharp edges onto it. If good clay were available on site, the floor could be finished with a thin layer of clay which would make the floor semi-hard. Compacted earth flooring would be difficult to rid of fleas and such other human parasites. Dust when sweeping out the house becomes a nuisance to the occupants. The problems of parasites and dust can be overcome by sprinkling water on the floor everyday, particularly if the floor is finished with a top layer of good clay as suggested.

In the Quantity Surveying Review, the Consultants have proved that mud and wattle walling is the cheapest compared to concrete blocks or even sun-dried mud blocks.

At a little extra cost, mud and wattle can be cement plastered for increased life. Cement plastering would also protect the walling from termite attacks and rid them of human pests. It would also increase fire resistance and minimise weathering in addition to offering a better finish.

The uprights are attacked by termites and are bound to rot below ground. This can be overcome by dipping the poles in molten bitumen or casting the poles in concrete below ground.

Mud and wattle walling is therefore an obvious choice as it is cheaper, easier to erect by the settlers as they are used to the construction and most of its shortfalls can be overcome as discussed above. The only constraint on this walling is one of availability in large quantities.

The mangrove poles are obtained in Lamu which is a long way from Bura. The present costs are reasonable but there are fears of insufficient supply to meet the expected demand. There is also the possibility of the cost going up with peak demand. Careful planning and co-ordination with the Department of Forestry during implementation may ensure constant adequate supply of the poles while some form of controlled price may keep prices affordable by the settlers.

The designs reviewed and recommended, have g.c.i roofing on mangrove poles. This roofing material is more expensive to buy and put up compared to the traditional thatch. However, the use of thatch has three disadvantages. Firstly, it is a big fire hazard, secondly it requires periodic replacement as it rots and is attacked by worms and thirdly it is not available in large quantities. The source of suitable thatch material would be along the banks of canals and its use would result in erosion.

#### 2.7.6 Upgrading

Mud and wattle houses with compacted earth floors and g.c.i roofs can be upgraded later by the settler himself as his income level rises.

The floor can be finished with about 75 mm. concrete, walls cement plastered if not initially plastered and a ceiling of reed matting

or softboard fixed to lower indoor temperatures.

### General Aspects

The air movement is a direct result due to double pane windows. The large size of windows.



The room is not suitable without a ceiling. The ceiling is to be obtained from panels that are suitable for protection. It is also a fire hazard.

The ceiling is provided. If no ceiling is provided the design is not suitable. Consider the possibility of built-in panels at the bottom of doors and windows.

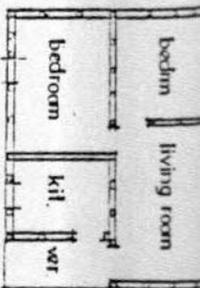
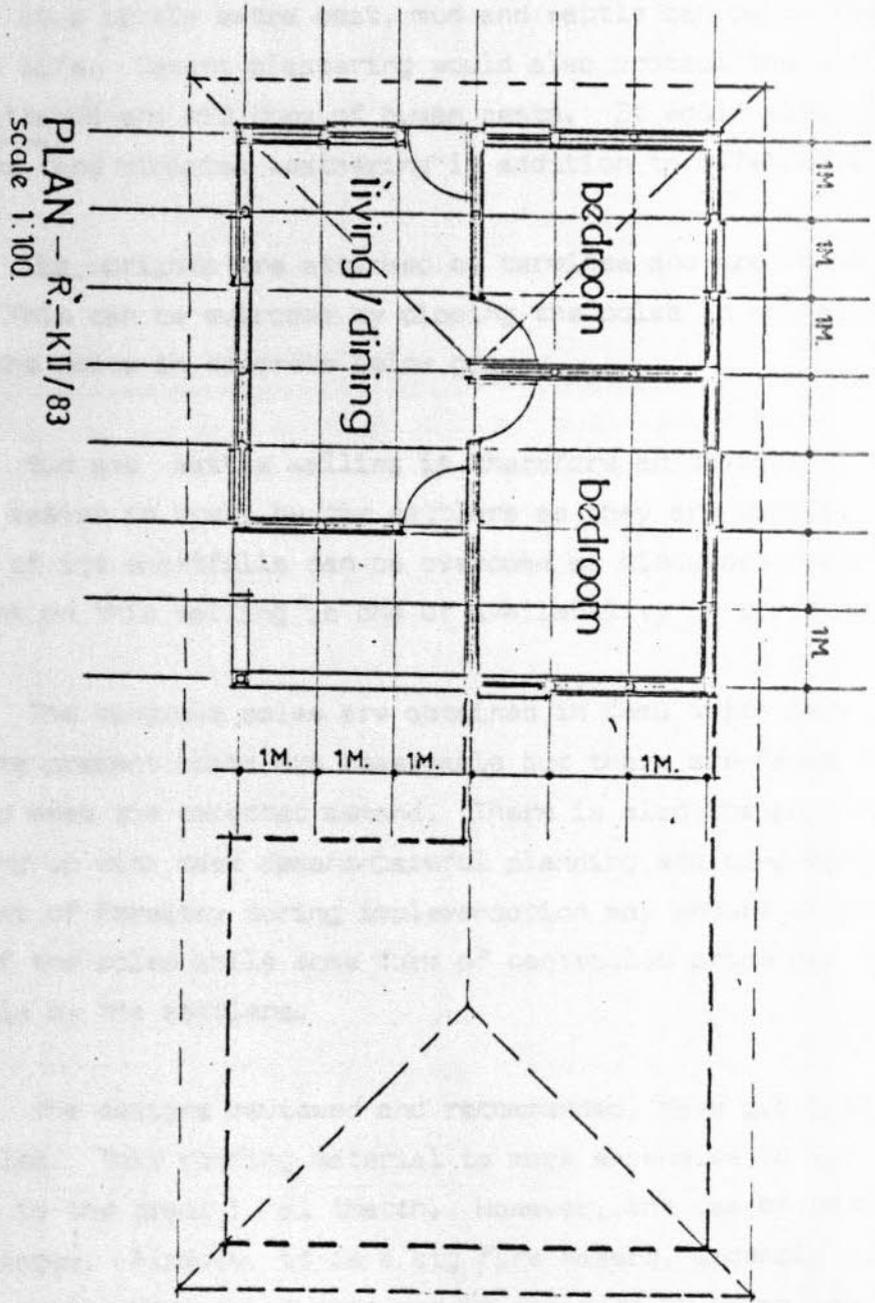
The quality of materials are good but proper finishing should be given to avoid excessive water damage.

General aspects: A single improvement can be done in this design as it involves the minimum requirements for a room of its size and type of material and construction.

Though it would be desirable to increase the privacy of the room, the provision of a corridor would facilitate the use of the unit.

It is possible however to open the kitchen into the living room for added activity and ease of communication.





PLAN KII/83  
scale 1:200

2.7.7.1 Drawing no. K11/83- (A - K11/83) (Figure B.24)

(i) Climatical Aspects

Cross air movement is extremely limited due to double banking of rooms made even worse by the small size of windows.

The overhang specified of 610 mm is considered adequate for protection of walls both from solar insolation and weathering. It could be increased for further protection and shading of external working area but this may reduce headroom at the eaves.

G.c.i. roof specified is not suitable without a ceiling. Thatch is preferable for thermal insulation but may be unavailable and if it was to be obtained from canals this would expose canals to erosion. It is also a fire hazard.

No p.v.s are provided. If no ceiling is envisaged the ridge could be designed with a continuous p.v. Consider mud block p.v.s for walls, and a possibility of built-in p.v.s at top and bottom of doors and windows.

Thermal qualities of mud are good but proper finishing should be given to avoid excessive weathering.

(ii) Functional aspects.

Little improvement can be done on this design as it provides the minimum requirements for a house of its size and type of material and construction.

Though it would be desirable to increase the privacy of the bedrooms, the provision of a corridor would escalate the cost of the unit.

It is possible however to open the kitchen into the living room for added security and ease of communication.

The potential for expansion for this design is minimum as any attempt to do so would close off the existing windows and would necessitate external accesses to individual rooms.

(iii) Materials and Construction

The proposed material - mud and wattle unrendered is susceptible to weathering unless the overhang is long enough to completely eliminate this risk. Where clay is available the walls should be rendered with it.

No foundations are specified and the poles are exposed to rotting and termite attack. The poles should be founded in concrete or be dipped in molten bitumen or similar to discourage termites and rotting. This may be expensive but it is more logical to incur this initial extra cost than to have to replace poles or even the roof.

If poles are used, the wall plate specified will not be necessary.

The size of the upright poles may be reduced from 6"-5" to 4"-3" which would reduce wall thickness and is more economical.

Pole spacing could be standardised at 1 metre instead of the random spacing specified. This would facilitate larger windows openings and may result in cost savings.

Poles could also be used for roof construction instead of the specified sewn timber.

Sewn timber is specified for walls but poles could be used which may be cheaper depending on availability.

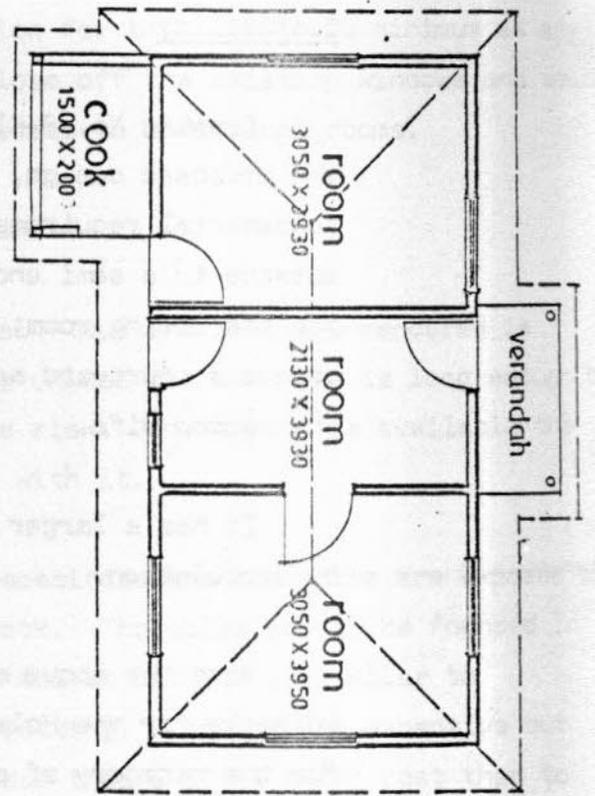
Fitoes shown on drawing should go through to the exterior of walls for increased stability.

## Suitability

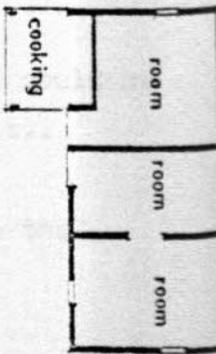
Drawing No. P-K11/83 shows a possible modification to the proposed design, which would achieve most of the fundamental requirements stated above. Cooking would be done outside in a semi enclosed space which also acts as a porch for the living room. An extension of another unit would create a courtyard and having a separate access may be used by the second wife.

It has a larger living room and a minimum of space is taken by circulation.

With the above modifications this design would be very suitable for the Hola climate and has a very great potential for the category of people it is intended for.



PLAN. R - TENANT CORE HOUSE  
scale. 1:100



PLAN. TENANT CORE HOUSE  
scale 1:200

## 2.7.7.2 Amended NIB Hola Tenant House (Figure B.25)

The plan is a revised version of the present tenant core house in the Hola Irrigation Scheme Village.

### (i) Climatological Aspects:

Ventilation of the three habitable rooms would be greatly improved by providing windows in at least two external walls in each room. The overhang indicated seems adequate for solar protection.

### (ii) Functional Aspects:

The central habitable room which will act as the living room has too many doors and may be difficult to use.

Its size in comparison to other habitable rooms is very small.

The separation of the front verandah and the rear kitchen yard is good but more covered space in the rear would improve the house tremendously. The cooking area provided is desirable but it has some disadvantages:

- It reduces the size of the bedroom
- It introduces extra construction joints and is difficult to set out by settlers
- Not usable during strong winds
- Exposes walls to burning risk.

If a dwarf wall is provided, wind and storm disturbances would be minimised.

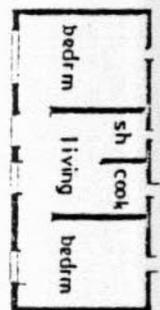
### (iii) Materials and Construction:

The materials for this design are assumed to be mud and wattle. Refer to notes on this as given for drawing K11/83.

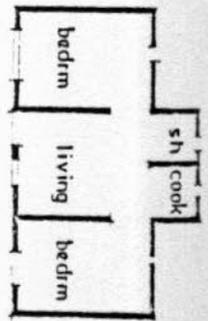
Suitability:

Extensions could be by building a separate unit which may or may not be connected to the first building.

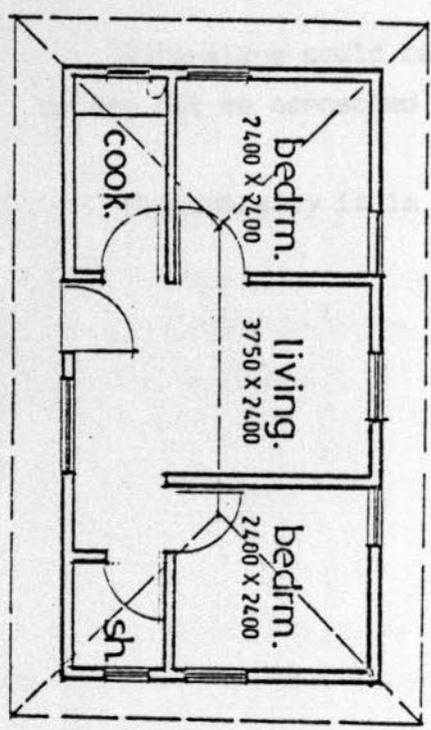
Climatically it is suitable if it is modified as above.



PLAN. MBX-77 TENANT HSE  
scale 1:200



PLAN. MBX-77A TENANT HSE  
scale 1:200



PLAN. R-MBX-77 AND 77A TENANT HSE.  
scale 1:100

2.7.7.3 Drawings nos. MBX/77 - (R- MBX/77) (Figure B.26)  
and MBX/77A - (R- MBX/77A)

(i) Climatical Aspects:

The provision of windows on one side of the bedrooms and a p.v. on the other side ensures a continuous air movement through these rooms but the small sizes of the windows does not provide the amount of air necessary for thermal comfort.

The living room cannot be sufficiently ventilated through the kitchen and bath.

The overhang of 2' - 7" specified is sufficient for wall protection from sun and also could provide ample shaded areas around the building for daily outdoor activities.

The roof should be hipped as this ensures that all walls are protected from thermal insolation.

Proposed block wall has good thermal qualities but is too expensive for this category of house.

(ii) Functional Aspects:

The location of the bathroom and kitchen in relation to the living room is totally unacceptable.

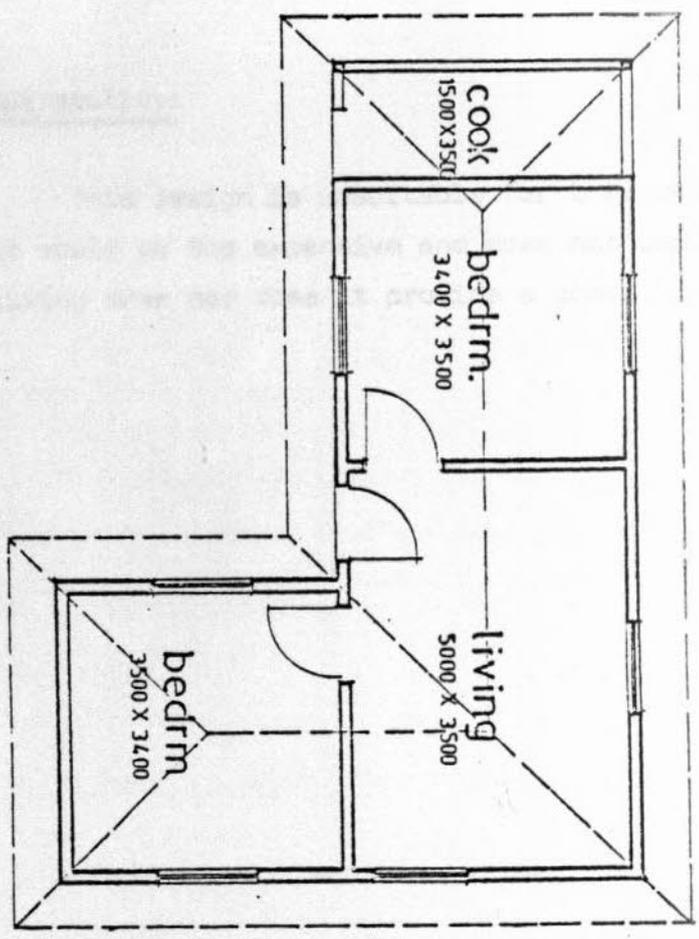
The size of the living room is reduced to a minimum by the circulation through the doors that open into it.

The 6' - 6" high wall separating kitchen from shower should be increased to the wall plate level.

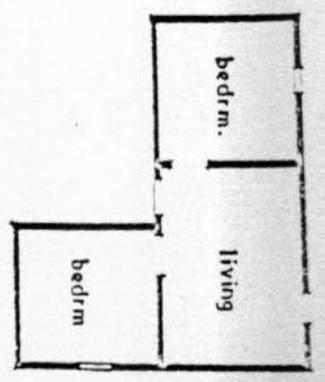
Suitability:

This design is unsuitable for this category of house as it would be too expensive and does not provide sufficient living area nor does it provide a convenient growth pattern.





PLAN. R - MBX /14 - TENANT HOUSE  
scale. 1:100



PLAN. MBX /14 - TENANT HOUSE  
scale 1:200

2.7.7.4 Drawing no. MBX/14 (Figure B.27)

(i) Climatical Aspects:

The rooms are very inadequately ventilated having very small windows on one side only.

The proposed hipped roof with about 60 cm. overhand is considered adequate for solar protection of walls.

(ii) Functional Aspects:

The circulation for this three roomed unit is most economical. Though more privacy for bedrooms would be desirable attempts to introduce a corridor would introduce extra costs which could be avoided.

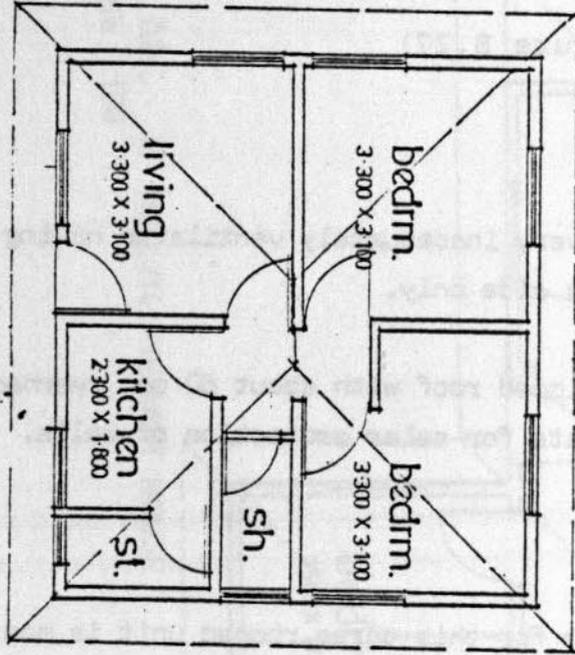
It is possible to extend this building in two distinct directions without blocking window and p.v.s.

The shape of this unit provides a very convenient partly enclosed external space suitable for day activities which could even be improved by the extensions.

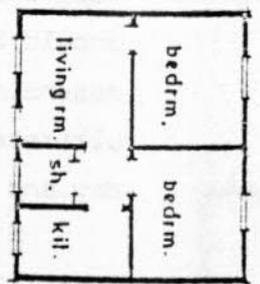
A kitchen should be provided by constructing a dwarf wall and extending the roof to cover this area. The roof should be gable to facilitate extensions in either direction depending on layout on site. Such extensions would ultimately create a courtyard which would be very useful for day and night activities.

Suitability:

This design is easy to set out and is a straight forward one with a lot of potential for this category. We consider it a suitable type with the proposed modifications. If constructed of mud and wattle (drawing does not show material) it could present an economical solution.



PLAN R - MBX / 71  
scale 1:100



PLAN - MBX/71  
scale 1:200

2.7.7.5 Drawing no. MBX/71 - (R - MBX/71) (Figure B.28)

(i) Climatical Aspects:

There is no proper cross ventilation since windows are provided only on one wall in each habitable room. The windows should have p.vs. below and above them.

The overhang specified of 18" is too small and should be increased to a minimum of 60 cm.

The g.c.i. sheet roof proposed is unsuitable without ceiling. Asbestos cement sheet roof could be considered if it remains within the acceptable cost bracket.

The proposed gable roof is not suitable as it exposes the end walls to the sun. Consider using a hipped roof.

(ii) Functional Aspects:

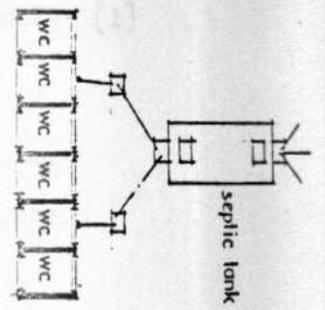
The effective usable area in the living room is reduced by the presence of too many doors in the room.

Bedroom 1 has not got sufficient privacy as it opens directly into the living room.

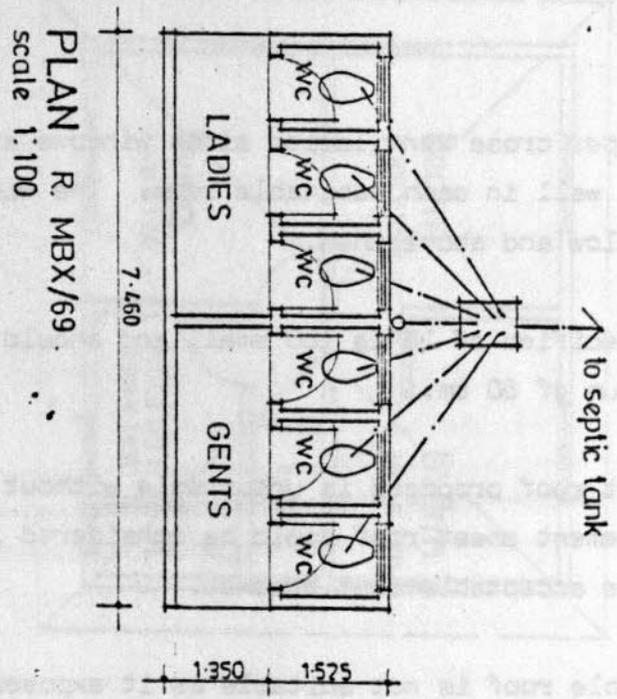
A food store should be provided for the kitchen but this increases costs. This design cannot be expanded without blocking the windows and p.vs.

Suitability:

The materials proposed for this design are beyond what is anticipated for this category i.e. mud and wattle. As this design can not be conveniently extended it is considered unsuitable and is not recommended for this category.



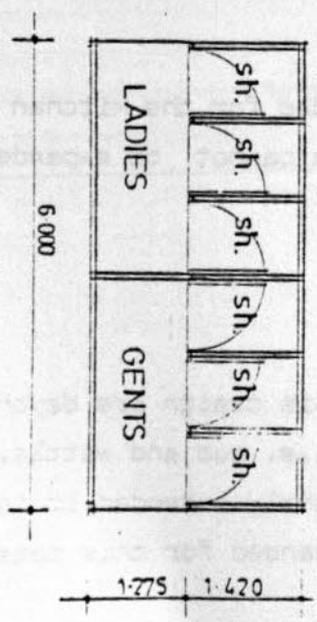
PLAN MBX/69  
scale 1:200



PLAN R. MBX/69  
scale 1:100



PLAN MBX/65  
scale 1:200



PLAN R. MBX/65  
scale 1:100

## 2.8 N.I.B. BUILDINGS

### 2.8.1 Drawing MBX/69 - (R-MBX/69) (Figure B.29) - MBX/65 - (R-MBX/65)

The toilet and shower cubicles with doors straight in the open have no provision for privacy either between male and female or from the surrounding activities. A screen wall should be provided introducing a passage accessible from the one side by male and the other by female users.

If the drains leading from the cubicles are directed to one manhole there would be a saving of two manholes and one vent pipe.

2.8.2 Drawing MBX/50 - B.M.C. OFFICES AND STORES

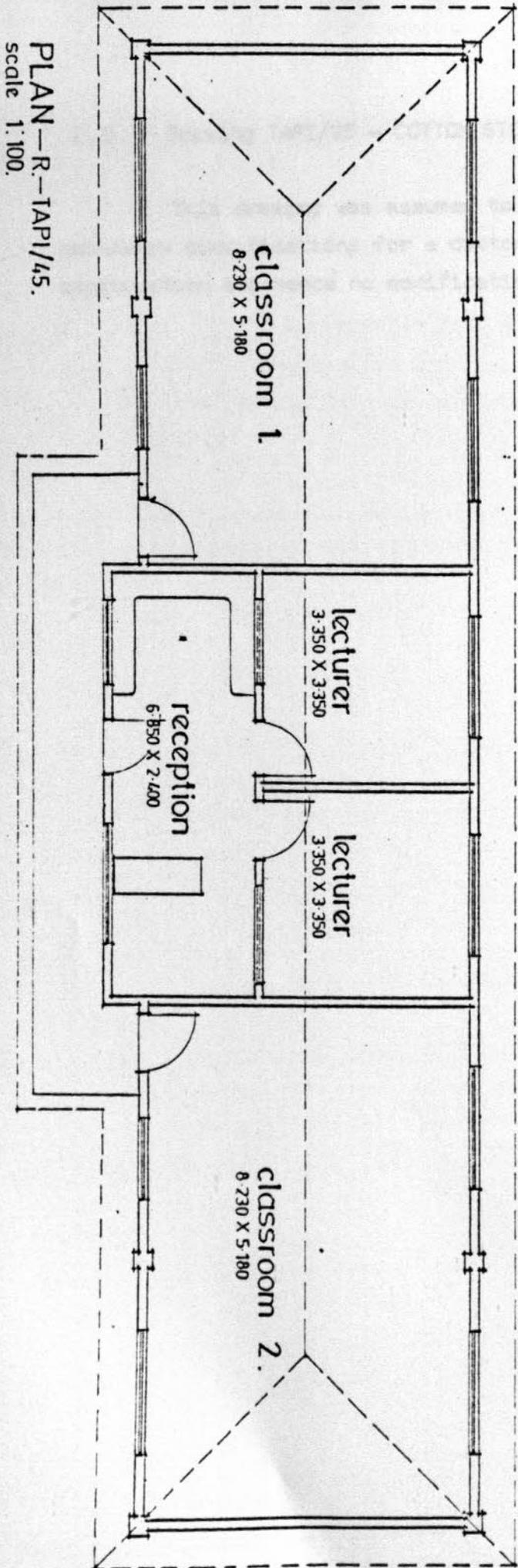
Cross air movement is adequate in the offices and the stores have also the necessary ventilation.

The drawing does not indicate what materials are used either for the walls or for the roof. If the walls are of concrete blocks, it is necessary to introduce columns so that no section of a 6" wall is longer than 12 ft.

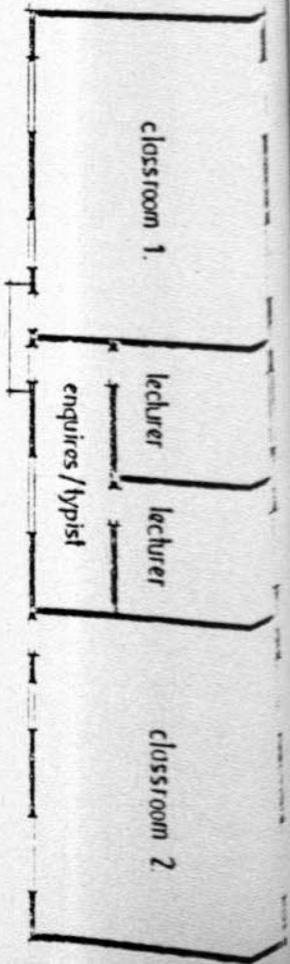
If the roofing material is G.C.I. the rooms marked offices could get uncomfortably hot and a ceiling should be introduced in them.

2.8.3 Drawing TAPI/25 - COTTON STORE

This drawing was assumed to have been done according to the necessary specifications for a cotton store in size, materials and construction and hence no modification was attempted.



PLAN—R—TAP1/45.  
scale 1:100.



PLAN—TAP1/45.  
scale 1:200

2.8.4 Drawing no. TAPI/45 - (R-TAPI/45) (Figure B.30)

(i) Climatical Aspects:

The classrooms are well ventilated but the lecturer's offices would need to have a p.v. in the wall separating them from the receptionists office.

A hipped roof would provide better cooling for the walls particularly if the overhangs are increased to a minimum of 60 cm.

(ii) Functional Aspects:

Assuming that the classrooms and the lecturers' offices are of the required size, the typists office could be organised in a more convenient way to provide an ample waiting space and a larger space for the typist.

Suitability

The proposed classroom block with modifications above would be very suitable for Bura climate.

- 2.8.5 Drawing no. (99) 3800 - Mechanical Workshops  
(99) 3830 - Service Building  
(99) 3861 - Workshop/office Building  
(99) 3862 - Store Building  
(99) 3879 - Mechanical Workshop

From the information contained in this set of drawings it was not possible to give any architectural review but the consultants assumed that the designs and materials proposed, are the suitable ones for these mechanical workshops.

THE QUANTITY SURVEYING REVIEW

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Plan

Section

of House

Plan

Section

APPENDIX C THE QUANTITY SURVEYING REVIEW

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## 1.0 QUANTITY SURVEYING REVIEW CRITERIA

## 1.1 ESTIMATES

The material presented by the N.I.B. for review by the Quantity Surveyor comprise the settler and staff houses, other N.I.B. buildings, infrastructure buildings and copies of blank bills of quantities for some of the buildings.

While some of the drawings are in sketch form others were complete working drawings and details.

The extent of the quantity surveying review and cost breakdown will therefore depend on the level of information provided, that is whether sketches or working drawings, and whether bills of quantities were provided or not. Where no bills of quantities were provided, attempts will be made to breakdown approximate quantities and pricing of these will be done.

All houses and N.I.B. buildings will be costed twice: Once before they are architecturally reviewed, and after incorporating any architectural amendments.

Estimated costs of each building under review will be broken down into the following building elements:

- Foundation (substructure) work
- External walling
- Internal walling
- Roof construction
- Roof covering
- Windows
- Doors
- Plumbing
- Electrical Installations
- Ceiling Finishes
- Wall Finishes
- Floor Finishes
- Fittings
- Labour.

In addition to the above estimated elemental costing of the building, allowances will be made for external works within each plot boundary, drainage, preliminaries and transportation.

This breakdown of the costs into element would facilitate identification and elimination of an element if need be.

## 1.2 SETTLER HOUSES: SPECIAL CASE

Among the drawings supplied to the Consultants by N.I.B. were seven prototype proposals for the Settler House, one of which was not reviewed for lack of completeness as stated earlier.

Each of the six settler house prototypes proposed by the N.I.B. will be broken down into the elements given above and each costed twice i.e. as proposed and after the architectural amendments. Estimated costs of each of the three prototypes originally in mud and wattle, in three different materials mud and wattle, mud and wattle plastered and sun dried mud blocks, will be compared.

The prototype proposed by the Consultants will be costed once for each material as no architectural review will have been carried out.

### 1.3 OTHER N.I.B. BUILDINGS INCLUDING STAFF HOUSES

Two sets of costing will be done for this category.

- houses and buildings as presented by N.I.B.
- houses and buildings as reviewed and modified after architectural review.

### 1.4 INFRASTRUCTURE BUILDINGS

Since no architectural review is required for this category of buildings their costing will be based on the given drawings and bills of quantities (if available).

### 1.5 GENERAL

All costing will be based on current prices and these can be adjusted according to the implementation schedule.

Attempts will be made to identify the foreign component of a classic example of the buildings which can then be applied over the whole scheme.

On completion of the costing as outlined above, a comparative analysis between given or estimated costs of the given designs with the revised estimates will be given.

Where no drawings of certain buildings have been supplied by N.I.B. spatial requirements and preferred materials and construction will be formulated based on acceptable standards, to arrive at estimated costs.

BRIEF NOTES ON ESTIMATES FOR BUILDINGS

(1) Detailed estimates have been prepared for all buildings whose adequate design information or Bills of Quantities were available. Estimates for other buildings at outline sketch design stage have also been assessed and updated. All estimates for buildings have been updated to first quarter of 1977 and are based on prevailing Nairobi tender prices. Transportation element from Nairobi to Bura has been assessed at approximately 40 % over and above given estimates.

(2) Financial provision has also been made for external works within plot boundary and drainage up to sewer line or septic tank. Works beyond plot boundaries have been taken care of in infrastructure services sections.

(3.) Proportionate cost of infrastructure services e.g. water supply sewers, power supply, roads etc. will be additional to estimated cost of each building.

## 2.2 PRINCIPAL HOUSE

## 2.2.1

DETAILED ESTIMATEREVISED TYPE D.C.'s HOUSE (1975)DRAWING NO. 18/51361/20 & R-18/51361/20

HOUSE PLINTH AREA	=	147 m <sup>2</sup>	150 m <sup>2</sup>
VERANDAH COVERED AREA	=	5 m <sup>2</sup>	15 m <sup>2</sup>
TOTAL FLOOR AREA	=	<u>152 m<sup>2</sup></u>	<u>165 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	22,892	90	23,849	80
2.	EXTERNAL WALLS	17,698	25	18,110	00
	- FIRE PLACE AND CHIMNEY STACK	3,341	00	NIL	
3.	INTERNAL WALLS	9,130	75	8,030	00
4.	ROOF CONSTRUCTION	6,509	75	6,509	75
5.	ROOF COVERING	11,262	00	11,033	35
6.	WINDOWS	15,820	00	16,080	00
7.	DOORS	13,600	00	13,680	00
8.	PLUMBING	16,300	00	14,120	00
9.	ELECTRICAL INSTALLATION	13,500	00	13,500	00
10.	FITTINGS CUPBOARDS, SHELVING etc.	16,460	00	16,060	00
11.	CEILING FINISHINGS	8,480	00	9,205	00
12.	INTERNAL WALL FINISHINGS	19,921	80	18,760	00
13.	EXTERNAL WALL FINISHINGS	7,795	20	8,430	00
14.	FLOOR FINISHINGS	13,243	45	14,375	60
		195,955	10	191,743	50
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	9,798	00	9,587	00
16.	DRAINAGE	9,798	00	9,587	00
		215,551	10	210,917	50
17.	PRELIMINARIES	10,778	00	10,546	00
18.	CONTINGENCY	21,555	00	21,092	00
19.	COST DIFFERENCE → SHS 5,328/60	247,884	10	242,555	50
20.	COST PER m <sup>2</sup>	1,630/82		1,470/03	

2.2.2

DETAILED ESTIMATE  
MANAGER'S HOUSE  
DRAWING NO. MBX/43  
& R/MBX/43

HOUSE PLINTH AREA	=	212 m <sup>2</sup>	194 m <sup>2</sup>
COVERED VERANDAH AREA	=	19 m <sup>2</sup>	40 m <sup>2</sup>
TOTAL FLOOR AREA		231 m <sup>2</sup>	234 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	29,076	95	28,455	00
2.	EXTERNAL WALLS	10,397	50	9,234	00
	- FIRE PLACE AND CHIMNEY STACK	NIL		NIL	
3.	INTERNAL WALLS	6,943	00	6,317	50
4.	ROOF CONSTRUCTION	7,390	00	8,018	00
5.	ROOF COVERING	17,324	50	15,320	00
6.	WINDOWS AND STEEL DOOR	17,240	00	12,969	30
7.	DOORS - EXTERNAL AND INTERNAL	6,300	00	7,844	00
8.	PLUMBING	14,490	00	11,876	00
9.	ELECTRICAL INSTALLATION	8,800	00	8,300	00
10.	FITTINGS - CUBOARDS SHELVES etc.	6,700	00	9,897	50
11.	CEILING FINISHINGS	10,329	10	9,076	78
12.	INTERNAL WALL FINISHINGS	14,023	20	13,050	00
13.	EXTERNAL WALL FINISHINGS	4,629	60	4,085	10
14.	FLOOR FINISHINGS	13,752	00	13,073	00
		167,395	85	157,516	18
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	8,369	60	7,875	80
16.	DRAINAGE	8,369	00	7,875	80
		184,134	45	173,267	78
17.	PRELIMINARIES	9,206	70	8,863	40
18.	CONTINGENCY SUM	18,413	00	17,326	80
19.	COST DIFFERENCE - SHS 12,296/17	211,754	15	199,457	98
20.	COST PER m <sup>2</sup> (TOTAL AREA INCLUDING VERANDAH AND PAGOLA AREA)		916/68		852/38
20.	COST PER m <sup>2</sup> (EXCLUDING OPEN VERANDAH)		998/54		1,078/13

2.3 SENIOR STAFF HOUSE

DETAILED ESTIMATE

2.3.1.

MILL MANAGER'S HOUSE

DRWG. NO. MAX/8 & P-MAX/8

HOUSE PLINTH AREA	=	164 m <sup>2</sup>	144 m <sup>2</sup>
COVERED VERANDAH AREA	=	26 m <sup>2</sup>	10 m <sup>2</sup>
TOTAL FLOOR AREA	=	<u>190 m<sup>2</sup></u>	<u>154 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	30,873	45	24,349	60
2.	EXTERNAL WALLS	10,467	00	8,896	90
3.	- FIRE PLACE AND CHIMNEY STACK	2,225	00	NIL	
3.	INTERNAL WALLS	6,172	00	6,072	00
4.	ROOF CONSTRUCTION	7,798	00	6,518	00
5.	ROOF COVERING	13,890	65	11,640	00
6.	WINDOWS	14,039	25	12,317	50
7.	DOORS-EXTERNAL & INTERNAL	7,517	00	6,420	00
8.	PLUMBING	11,950	00	11,950	00
9.	ELECTRICAL INSTALLATION	7,700	00	7,700	00
10.	FITTINGS-CUPBOARDS, SHELVES etc.	4,575	00	8,760	00
11.	CEILING FINISHINGS	11,280	30	9,034	00
12.	INTERNAL WALL FINISHINGS	15,495	30	13,870	75
13.	EXTERNAL WALL FINISHINGS	4,868	10	3,894	00
14.	FLOOR FINISHINGS	12,319	50	9,975	40
		161,170	55	141,398	15
15.	EXTERNAL WORKS WITHIN PLOT BOUNDARY	8,059	00	7,070	00
16.	DRAINAGE AND SEWER CONNECTION	8,059	00	7,070	00
		177,288	55	155,538	15
17.	PRELIMINARIES	8,864	00	7,777	00
18.	CONTINGENCIES	17,700	00	15,500	00
19.	COST DIFFERENCE - SHS 25,037/40	203,852	55	178,815	15
20.	COST PER m <sup>2</sup>	1,072/91		1,161/14	

2.3.2

DETAILED ESTIMATE  
MILL MANAGER'S HOUSE  
DRAWING No. MAX/9 & R/MAX/9

HOUSE PLINTH AREA	=	137 m <sup>2</sup>	135 m <sup>2</sup>
COVERED VERANDAH AREA	=	19 m <sup>2</sup>	43 m <sup>2</sup>
TOTAL FLOOR AREA	=	156 m <sup>2</sup>	178 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	25,602	40	28,865	50
2.	EXTERNAL WALLS	8,879	00	10,017	60
3.	- FIRE PLACE AND CHIMNEY STACK	2,200	00	NIL	
3.	INTERNAL WALLS	5,318	30	6,000	30
4.	ROOF CONSTRUCTION	6,585	90	6,430	50
5.	ROOF COVERING	11,617	30	13,107	10
6.	WINDOWS	14,339	35	14,339	35
7.	DOORS-EXTERNAL & INTERNAL	7,012	00	7,012	00
8.	PLUMBING	11,750	60	11,750	60
9.	ELECTRICAL INSTALLATION	7,500	00	7,500	00
10.	FITTINGS-CUPBOARDS, SHELVES etc.	4,575	00	8,875	00
11.	CEILING FINISHINGS	9,382	00	10,585	10
12.	INTERNAL WALL FINISHINGS	12,887	70	13,005	00
13.	EXTERNAL WALL FINISHINGS	4,868	10	4,868	10
14.	FLOOR FINISHINGS	10,248	00	11,562	20
		142,765	65	154,938	35
15.	EXTERNAL WORKS WITHIN PLOT BOUNDARY	7,138	00	7,747	00
16.	DRAINAGE AND SEWER CONNECTION	7,138	00	7,747	00
		157,041	65	170,432	35
17.	PRELIMINARIES	7,852	00	8,522	00
18.	CONTINGENCIES	15,704	00	17,043	00
19.	COST DIFFERENCE + SHS 15,399.70	180,597	65	195,997	35
20.	COST PER m <sup>2</sup>	1,157 / 65		1,101 / 11	

2.3.3

DETAILED ESTIMATE2- BEDROOMED STAFF HOUSEDRAWING NO. MBX/20 & R/MBX/20

HOUSE PLINTH AREA	121 m <sup>2</sup>	121 m <sup>2</sup>
VERANDAH COVERED AREA	12 m <sup>2</sup>	12 m <sup>2</sup>
TOTAL FLOOR AREA	<u>133 m<sup>2</sup></u>	<u>133 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	14,338	15	14,578	15
2.	EXTERNAL WALLS	6,880	00	6,768	00
3.	INTERNAL WALLS	1,777	50	1,999	50
4.	ROOF CONSTRUCTION	5,250	00	5,250	00
5.	ROOF COVERING (26G)	9,153	05	9,153	05
6.	WINDOWS	6,756	60	7,755	60
7.	DOORS-EXTERNAL AND INTERNAL	3,421	80	5,831	80
8.	PLUMBING	6,475	00	6,475	00
9.	ELECTRICAL INSTALLATION	4,150	00	4,150	00
10.	FITTINGS CUPBOARDS, SHELVING etc.	5,960	00	6,207	50
11.	CEILING FINISHINGS	NIL		NIL	
12.	INTERNAL WALL FINISHINGS	6,628	50	7,195	00
13.	EXTERNAL WALL FINISHINGS	2,446	00	2,521	80
14.	FLOOR FINISHINGS	1,877	75	1,877	75
		75,114	35	79,763	15
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	3,756	00	3,988	00
16.	DRAINAGE	3,756	00	3,756	00
17.		82,626	35	87,507	15
17.	PRELIMINARIES	4,131	00	4,375	00
18.	CONTINGENCY SUM	8,262	00	8,750	00
19.	COST DIFFERENCE +SHS 5,612/80	95,019	35	100,632	15
20.	COST PER m <sup>2</sup>	714/43		756/53	

2.3.4

DETAILED ESTIMATE  
ASSISTANT MILL'S MANAGER HOUSE

DRAWING NO. MBX/78

& P-MBX/78

GROSS FLOOR AREA	=	102 m <sup>2</sup>		102 m <sup>2</sup>
GROSS COVERED AREA	=	10 m <sup>2</sup>		10 m <sup>2</sup>
GROSS TOTAL FLOOR AREA	=	112 m <sup>2</sup>		112 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	18,217	35	18,327	30
2.	EXTERNAL WALLS - FIRE PLACE	5,337	00	5,077	00
3.	INTERNAL WALLS	NIL		NIL	
4.	ROOF CONSTRUCTION	5,228	00	5,228	00
5.	ROOF COVERING - ("_G)	5,278	25	6,024	25
6.	WINDOWS	8,144	40	8,910	00
7.	DOORS - EXTERNAL AND INTERNAL	9,278	00	8,948	00
8.	PLUMBING	4,703	60	5,103	60
9.	ELECTRICAL INSTALLATION	10,970	00	10,870	00
10.	FITTINGS, CUPEOARDS, SHELVING etc.	6,213	00	6,213	00
11.	CEILING FINISHINGS	8,245	00	9,832	00
12.	INTERNAL WALL FINISHINGS	7,945	75	7,945	75
13.	EXTERNAL WALL FINISHINGS	8,688	90	8,604	90
14.	FLOOR FINISHINGS	1,497	85	1,422	35
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	2,677	00	2,677	00
16.	DRAINAGE	102,324	10	105,183	15
17.	PRELIMINARIES	5,116	20	5,259	15
18.	CONTINGENCY SUM	5,116	20	5,259	15
19.	COST DIFFERENCE + SHS.3,616/70	112,556	50	115,701	45
20.	COST PER m <sup>2</sup>	5,627	80	5,785	05
		11,255	65	11,570	15
		129,439	95	133,056	65
		1,155/71		1,188/00	

2.3.5

DETAILED ESTIMATE3-BEDROOMED SENIOR STAFF HOUSEDRAWING NO. MBX/80

HOUSE PLINTH AREA	=	106 m <sup>2</sup>	106 m <sup>2</sup>
VERANDAH COVERED AREA	=	27 m <sup>2</sup>	27 m <sup>2</sup>
TOTAL FLOOR AREA	=	133 m <sup>2</sup>	133 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	18,326	50	18,326	50
2.	EXTERNAL WALLS	6,101	00	6,101	00
3.	INTERNAL WALLS	5,230	00	5,640	00
4.	ROOF CONSTRUCTION	5,359	30	5,359	30
5.	ROOF COVERING	10,051	70	10,051	70
6.	WINDOWS	10,960	50	11,080	00
7.	DOORS	6,000	00	6,000	00
8.	PLUMBING	7,280	00	7,280	00
9.	ELECTRICAL INSTALLATIONS	5,800	00	6,000	00
10.	FITTINGS CUPBOARDS etc.	7,716	00	7,616	00
11.	CEILING FINISHINGS	8,100	00	8,220	10
12.	INTERNAL WALL FINISHINGS	8,120	10	8,340	00
13.	EXTERNAL WALL FINISHINGS	3,070	40	3,070	40
14.	FLOOR FINISHINGS	6,260	00	6,260	00
		108,375	50	109,345	00
15.	EXTERNAL WALL (WITHIN PLOT BOUNDARY)	5,419	00	5,467	00
16.	DRAINAGE (SEWER CONNECTION) etc.	5,419	00	5,467	00
		119,213	50	120,279	00
17.	PRELIMINARIES	5,961	00	6,013	00
18.	CONTINGENCIES	11,921	00	12,028	00
19.	COST DIFFERENCE =+SHS.1,224/50	137,095	50	138,320	00
20.	COST PER m <sup>2</sup>	1,030/79		1,040/00	

2.3.6

DETAILED ESTIMATE  
TWO EEDROCMED SENIOR STAFF HOUSE  
DRAWING NO. TAPI/46 & R-TAPI/46

HOUSE PLINTH AREA	=	201m <sup>2</sup>	175 m <sup>2</sup>
(INCLUDING S/Q & KITCHEN)			
VERANDHA COVERED AREA	=	6m <sup>2</sup>	16 m <sup>2</sup>
TOTAL AREA		<u>207m<sup>2</sup></u>	<u>191 m<sup>2</sup></u>

ITEM	ELEMENT	ORINGAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	32,465	20	29,956	00
2.	EXTERNAL WALLS	15,454	90	14,160	00
3.	INTERNAL WALLS	6,595	00	7,843	60
4.	ROOF CONSTRUCTION	6,828	70	4,420	40
5.	ROOF COVERING	13,273	75	12,247	00
6.	WINDOWS	10,571	00	8,480	00
7.	DOORS	7,200	00	6,800	00
8.	PLUMBING	7,188	50	7,188	50
9.	ELECTRICAL INSTALLATION	6,500	00	6,500	00
10.	FITTINGS CUPBOARDS, SHELVING	5,390	00	6,896	00
11.	CEILING FINISHINGS	10,709	00	9,889	10
12.	INTERNAL WALL FINISHINGS	10,773	00	9,881	25
13.	EXTERNAL WALL FINISHINGS	5,926	50	5,411	00
14.	FLOOR FINISHINGS	3,326	50	3,088	00
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	142,202	05	134,760	85
16.	DRAINAGE	7,110	00	6,738	00
		7,110	00	6,738	00
17.	PRELIMINARIES	156,422	05	148,236	85
18.	CONTINGENCIES	7,820	00	7,412	00
		15,600	00	14,800	00
19.	COST DIFFERENCE =SHS 9,393/20	179,842	05	170,448	85
20.	COST PER m <sup>2</sup>	868	80	892	40

2.3.7

DETAILED ESTIMATE

TYPE 'D' LOWLAND

DRAWING NO. 18/6057/1 & R/18/6057/1

HOUSE PLINTH AREA	=	95	m <sup>2</sup>	95	m <sup>2</sup>
VERANDAH COVERED AREA	=	9	"	9	"
TOTAL FLOOR AREA	=	104	"	104	"

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	13,570	90	13,570	90
2.	EXTERNAL WALLS - FIRE PLACE AND CHIMNEY STACK	7,984	00	7,984	00
3.	INTERNAL WALLS	4,081	00	3,958	55
4.	ROOF CONSTRUCTION	9,630	85	9,871	65
5.	ROOF COVERING	10,088	00	10,088	00
6.	WINDOWS	11,594	30	11,594	30
7.	DOORS	4,293	30	4,722	65
8.	PLUMBING	6,936	00	6,936	00
9.	ELECTRICAL INSTALLATION	5,600	00	5,600	00
10.	FITTINGS CUPBOARDS, SHELVING ETC.	7,167	35	7,167	35
11.	CEILING FINISHINGS	6,576	50	6,576	50
12.	INTERNAL WALL FINISHINGS	10,913	50	10,586	10
13.	EXTERNAL WALL FINISHINGS	3,003	50	3,003	50
14.	FLOOR FINISHINGS	2,043	75	2,043	75
		103,482	95	103,703	25
15.	EXTERNAL WORKS(WITHIN PLOT BOUNDARY)	5,174	00	5,185	00
16.	DRAINAGE(SEWER CONNECTION)	5,174	00	5,185	00
		113,830	95	114,073	25
17.	PRELIMINARIES	5,692	00	5,704	00
18.	CONTINGENCIES	5,692	00	5,704	00
19.	COST DIFFERENCE = +SH.266.30	125,214	95	125,481	25
20.	COST PER M <sup>2</sup>	1,203	99	1,206	55

2.3.8

DETAILED ESTIMATETYPE E LOWLANDDRAWING NO. 18/6058/1 & R/18/6058/1

HOUSE PLINTH AREA	71 m <sup>2</sup>	71 m <sup>2</sup>
VERANDAH COVERED AREA	-	9 "
TOTAL AREA	<u>71 m<sup>2</sup></u>	<u>80 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS.	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	10,535	65	10,535	65
2.	EXTERNAL WALLS - FIRE PLACE AND CHIMNEY STACK	6,060	00	6,060	00
3.	INTERNAL WALLS	3,431	00	3,087	90
4.	ROOF CONSTRUCTION	6,253	40	6,409	75
5.	ROOF COVERING	6,852	00	6,852	00
6.	WINDOWS	7,884	60	7,884	60
7.	DOORS	3,603	10	3,603	10
8.	PLUMBING	5,637	35	5,037	35
9.	ELECTRICAL INSTALLATION	5,500	00	5,500	00
10.	FITTINGS CUPBOARDS, SHELVING ETC.	4,397	05	4,397	05
11.	CEILING FINISHINGS	4,780	00	4,780	00
12.	INTERNAL WALL FINISHINGS	8,973	50	8,076	15
13.	EXTERNAL WALL FINISHINGS	3,000	30	3,000	30
14.	FLOOR FINISHINGS	517	35	517	35
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	77,425	30	75,741	20
16.	DRAINAGE (SEWER CONNECTION)	3,871	00	3,787	00
		3,871	00	3,787	00
17.	PRELIMINARIES	85,167	30	83,315	20
18.	CONTINGENCIES	4,258	00	4,166	00
		4,258	00	4,166	00
19.	COST DIFFERENCE - Shs.2,036.10	93,683	30	91,647	20
20.	COST PER M <sup>2</sup>	1,319.48		1,145	59

2.3.9

DETAILED ESTIMATETYPE F LOWLANDDRAWING NO. 18/6059/1 & R-18/6059/1

HOUSE PLINTH AREA	=	49 m <sup>2</sup>	49 m <sup>2</sup>
VERANDAH COVERED AREA	=	2 m <sup>2</sup>	10 m <sup>2</sup>
		<u>51 m<sup>2</sup></u>	<u>59 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	6,297	35	6,297	35
2.	EXTERNAL WALLS - FIRE PLACE AND CHIMNEY STACK	4,822	00	4,822	00
3.	INTERNAL WALLS	1,054	00	1,093	55
4.	ROOF CONSTRUCTION	5,692	00	5,692	00
5.	ROOF COVERING	4,138	00	4,138	00
6.	WINDOWS	5,752	50	5,752	50
7.	DOORS	2,839	20	2,839	20
8.	PLUMBING	4,845	00	4,845	00
9.	ELECTRICAL INSTALLATION	2,925	00	2,925	00
10.	FITTINGS CUPBOARDS SHELIVING ETC.	2,248	15	2,248	15
11.	CEILING FINISHINGS	2,840	50	2,840	50
12.	INTERNAL WALL FINISHINGS	3,015	50	3,128	60
13.	EXTERNAL WALL FINISHINGS	2,204	00	2,204	00
14.	FLOOR FINISHINGS	824	25	824	25
		49,497	45	49,650	10
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	2,475	00	2,483	00
16.	DRAINAGE (SEWER CONNECTION)	2,475	00	2,483	00
		54,447	45	54,616	10
17.	PRELIMINARIES	2,722	00	2,731	00
18.	CONTINGENCIES	2,722	00	2,731	00
19.	COST DIFFERENCE = + SHS. 186/65	59,891	45	60,078	10
	COST PER m <sup>2</sup>	1,174	34	1,018	27

DETAILED ESTIMATE

2.3.10

TYPE 'C' LOWLAND

DRAWING No. 18/50462/4 & R/1850462/4

HOUSE PLINTH AREA	=	131 m <sup>2</sup>	133 m <sup>2</sup>
VERANDAH COVERED AREA	=	17 m <sup>2</sup>	-
TOTAL AREA		<u>148 m<sup>2</sup></u>	<u>133 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	15,203	85	18,130	60
2.	EXTERNAL WALLS - FIRE PLACE AND CHIMNEY STACK	9,090	20	10,362	85
3.	INTERNAL WALLS	4,521	00	4,521	00
4.	ROOF CONSTRUCTION	9,378	70	10,879	30
5.	ROOF COVERING	11,084	00	12,857	45
6.	WINDOWS	11,762	00	13,408	70
7.	DOORS	3,293	30	3,293	30
8.	PLUMBING	6,253	50	6,253	50
9.	ELECTRICAL INSTALLATION	6,380	00	7,018	00
10.	FITTINGS CUPBOARDS, SHELVING etc.	5,721	35	6,007	40
11.	CEILING FINISHINGS	7,243	50	8,221	35
12.	INTERNAL WALL FINISHINGS	8,496	50	8,496	50
13.	EXTERNAL WALL FINISHINGS	3,289	50	3,750	05
14.	FLOOR FINISHINGS	2,266	50	2,572	40
		103,983	90	115,772	40
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	5,199	00	5,789	00
16.	DRAINAGE (SEWER CONNECTION)	5,199	00	5,789	00
		114,381	90	127,350	40
17.	PRELIMINARIES	5,719	60	6,368	00
18.	CONTINGENCIES	5,719	00	26,368	00
19.	COST DIFFERENCE =+ 14,266/50	125,819	90	140,086	40
20.	COST PER m <sup>2</sup>		850/13		1,053/63

## 2.4 JUNIOR STAFF HOUSING

DETAILED ESTIMATE

## 2.4.1

3 - BEDROOMED JUNIOR STAFF HOUSETWO SEMI-DETACHED UNITSDRAWING NO. MBX/41

HOUSE PLINTH AREA	=	136 m <sup>2</sup>	136 m <sup>2</sup>
VERANDAH COVERED AREA	=	-	-
TOTAL FLOOR AREA	=	<u>136 m<sup>2</sup></u>	<u>136 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS.	CTS
1.	SUBSTRUCTURE WORK	18,368	50	18,368	50
2.	EXTERNAL WALLS	5,959	00	5,863	00
	- FIRE PLACE AND CHIMNEY STACK	662	90	1,072	20
3.	INTERNAL WALLS	4,852	00	5,604	00
4.	ROOF CONSTRUCTION	3,162	00	4,362	00
5.	ROOF COVERING	7,625	70	8,360	00
6.	WINDOWS	2,534	00	3,074	00
7.	DOORS	5,160	00	5,160	00
8.	PLUMBING	500	00	500	00
9.	ELECTRICAL INSTALLATION				
10.	FITTINGS (PRECAST CONCRETE WORK TOPS)	-		475	00
11.	CEILING FINISHINGS	NIL		NIL	
12.	INTERNAL WALL FINISHINGS	9,315	00	9,843	00
13.	EXTERNAL WALL FINISHINGS	3,485	70	3,330	00
14.	FLOOR FINISHINGS	2,467	50	2,467	50
		64,092	30	68,479	20
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	3,205	00	3,424	00
16.	DRAINAGE	3,205	00	3,424	00
		70,502	30	75,327	20
17.	PRELIMINARIES	3,525	00	3,766	00
18.	CONTINGENCY	7,050	00	7,533	00
19.	COST DIFFERENCE + SHS. 5,548/90	81,077	30	86,625	20
20.	COST PER m <sup>2</sup>	596/16		636/96	

2.4.2

DETAILED ESTIMATE  
3-BEDROOMED JUNIOR STAFF HOUSE  
DRAWING NO. MBX/66 &R/MBX/66

HOUSE PLINTH AREA	=	56 m <sup>2</sup>		56 m <sup>2</sup>
VERANDAH COVERED AREA	=	-		-
		56 m <sup>2</sup>		56 m <sup>2</sup>
FLOOR FLOOR AREA	=	56 m <sup>2</sup>		56 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	7,374	00	3,534	00
2.	EXTERNAL WALLS	3,845	00	3,082	00
	- FIRE PLACE AND CHIMNEY STACK AND CONCRETE SHELF	910	25	910	25
3.	INTERNAL WALLS	2,908	00	3,338	30
4.	ROOF CONSTRUCTION	1,215	00	2,173	50
5.	ROOF COVERING	3,177	90	3,460	00
6.	WINDOWS	1,626	50	2,220	90
7.	PLUMBING - TO SHOWER AND KITCHEN	500	00	2,800	00
8.	DOORS	2,509	50	2,936	20
9.	ELECTRICAL INSTALLATION	2,500	00	2,750	00
10.	FITTINGS CUPBOARDS, SHELVING etc	NIL		NIL	
11.	CEILING FINISHINGS	NIL		3,017	60
12.	INTERNAL WALL FINISHINGS	2,995	70	3,035	00
13.	EXTERNAL WALL FINISHINGS	1,209	30	1,022	10
14.	FLOOR FINISHINGS	784	50	784	50
		31,555	65	39,064	35
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	1,578	00	1,950	00
16.	DRAINAGE	1,578	00	1,950	00
		34,711	65	42,964	35
17.	PRELIMINARIES	1,736	00	2,148	00
18.	CONTINGENCIES	3,470	00	4,296	00
19.	COST DIFFERENCE + SHS.10,180/45	39,917	65	49,408	35
20.	COST PER m <sup>2</sup>	712/82		882/29	

2.4.3

DETAILED ESTIMATE3-BEDROOMED JUNIOR STAFF HOUSETWO SEMI-DETACHED UNITSDRAWING NO. MBX/89 & R-MBX/89

HOUSE PLINTH AREA	=	60 m <sup>2</sup>	=	60 m <sup>2</sup>
VERANDAH COVERED AREA	=	-	=	-
TOTAL FLOOR AREA	=	60 m <sup>2</sup>	=	60 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	9,705	30	9,705	30
2.	EXTERNAL WALLS	4,987	00	4,927	00
	- FIRE PLACE AND CHIMNEY STACK	443	00	NIL	
3.	INTERNAL WALLS	2,807	20	3,015	00
4.	ROOF CONSTRUCTION	1,215	00	1,215	00
5.	ROOF COVERING	3,477	60	3,477	60
6.	WINDOWS (WOOD SHUTTERS)	938	10	1,362	00
7.	DOORS	2,940	00	2,550	40
8.	PLUMBING	500	00	500	00
9.	ELECTRICAL INSTALLATION	2,500	00 1	2,500	00
10.	FITTINGS(PRECAST CONCRETE WORK TOPS)	NIL		540	00
11.	CEILING FINISHINGS	NIL		NIL	
12.	INTERNAL WALL FINISHINGS	6,085	00	6,085	00
13.	EXTERNAL WALL FINISHINGS	1,444	00	1,444	00
14.	FLOOR FINISHINGS	973	00	973	00
		38,015	20	37,294	30
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	1,905	00	1,865	00
16.	DRAINAGE	1,905	00	1,865	00
		41,825	20	41,024	30
17.	PRELIMINARIES	2,090	00	2,151	00
18.	CONTINGENCY	2,090	00	4,102	00
19.	COST DIFFERENCE= - SHS. 817/70	48,095	00	47,277	30
20.	COST PER m <sup>2</sup>	801/58		787/96	

2.4.4

DETAILED ESTIMATE  
3-BEDROOMED JUNIOR STAFF HOUSE  
DRAWING NO. MBX/95 & R/MBX/95

HOUSE PLINTH AREA	=	55 m <sup>2</sup>		55 m <sup>2</sup>
VERANDAH COVERED AREA	=	-		-
TOTAL FLOOR AREA	=	<u>55 m<sup>2</sup></u>		<u>55 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	8,910	00	8,910	00
2.	EXTERNAL WALLS	3,991	00	3,991	00
	- FIRE PLACE AND CHIMNEY STACK	479	00	479	00
3.	INTERNAL WALLS	3,264	00	3,264	00
4.	ROOF CONSTRUCTION	1,078	40	1,078	40
5.	ROOF COVERING	3,187	80	3,187	80
6.	WINDOWS	2,874	90	4,494	90
7.	DOORS	2,758	00	2,758	00
8.	PLUMBING	1,179	00	1,179	00
9.	ELECTRICAL INSTALLATION	2,500	00	2,500	00
10.	FITTINGS CUPBOARDS, SHELVING (CONCRETE WORK TOP TO KITCHEN)	NIL		110	00
11.	CEILING FINISHINGS	NIL		NIL	
12.	INTERNAL WALL FINISHINGS	6,037	20	6,037	20
13.	EXTERNAL WALL FINISHINGS	1,235	40	1,235	40
14.	FLOOR FINISHINGS	891	00	891	00
		38,385	70	40,115	70
15.	EXTERNAL WORKS(WITHIN PLOT BOUNDARY)	1,919	30	2,006	00
16.	DRAINAGE (SEWER CONNECTION)	1,919	30	2,006	00
		42,224	30	44,127	70
17.	PRELIMINARIES	2,110	00	2,210	00
18.	CONTINGENCY	4,222	00	4,413	00
19.	COST DIFFERENCE =+SHS2,194/40	48,556	30	50,750	70
20.	COST PER m <sup>2</sup>	882/84		922/74	

2.4.5.1

DETAILED ESTIMATE  
3-ROOMED HOUSE  
DRAWING NO. TAPI/6  
& R/TAPI/6

HOUSE FLINTH AREA	=	84 m <sup>2</sup>	84 m <sup>2</sup>
VERANDAH COVERED AREA	=	13 m <sup>2</sup>	13 m <sup>2</sup>
TOTAL FLOOR AREA		97 m <sup>2</sup>	97 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1	SUBSTRUCTURE WORK	15,615	00	15,615	00
2.	EXTERNAL WALLS	6,756	00	6,756	00
3:	INTERNAL WALLS	2,482	00	2,482	00
	FIRE PLACE AND CHIMNEY STACK	NIL		NIL	
4.	ROOF CONSTRUCTION	4,484	00	4,484	00
5.	ROOF COVERING	7,123	05	7,123	05
6.	WINDOWS	3,654	70	3,654	70
7.	DOORS	1,955	00	1,955	00
8.	PLUMBING	2,140	00	2,140	00
9.	ELECTRICAL INSTALLATION	2,500	00	2,500	00
10.	FITTING CUPBOARDS, SHELVING etc.	NIL		NIL	
11.	CEILING FINISHINGS	NIL		NIL	
12.	INTERNAL WALL FINISHINGS	6,350	40	6,350	40
13.	EXTERNAL WALL FINISHINGS	3,477	60	3,477	60
14.	FLOOR FINISHINGS	2,449	70	2,449	70
		58,987	45	58,987	45
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	2,950	00	3,450	00
16.	DRAINAGE	2,950	00	2,950	00
17.	PRELIMINARIES	64,887	45	65,387	45
17.	PRELIMINAIRES	3,244	00	3,274	00
18.	CONTINGENCIES	6,489	00	6,489	00
19.	COST DIFFERENCE SHS	74,620	45	75,150	45
20.	COST PER m <sup>2</sup>	769	28	774	75

2,4,5:2

DETAILED ESTIMATE  
SERVANT QUARTER AND KITCHEN UNIT  
DRAWING NO. TAPI/6 & R/TAPI/6

HOUSE PLINTH AREA	= 22 m <sup>2</sup>	22 m <sup>2</sup>
VERANDAH COVERED AREA	= -	-
TOTAL AREA	= 22 m <sup>2</sup>	22 m <sup>2</sup>

ITEM	ELEMENTS	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	3,555	00	3,665	00
2.	EXTERNAL WALLS	2,094	00	2,242	00
	- FIRE PLACE AND CHIMNEY STACK	796	50	796	50
3.	INTERNAL WALLS	440	50	440	50
4.	ROOF CONSTRUCTION	919	50	919	50
5.	ROOF COVERING	1,801	80	1,801	80
6.	WINDOWS	1,506	00	1,156	00
7.	DOORS	788	00	788	00
8.	PLUMBING	NIL		NIL	
9.	ELECTRICAL INSTALLATION	750	00	750	00
10.	FITTINGS CUPEARDS, SHELVING etc	NIL		NIL	
11.	CEILING FINISHINGS	NIL		NIL	
12.	INTERNAL WALL FINISHINGS	1,706	40	1,706	40
13.	EXTERNAL WALL FINISHINGS	1,204	20	1,312	00
14.	FLOOR FINISHINGS	402	90	402	90
		15,964	80	15,980	60
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	798	00	798	00
16.	DRAINAGE	NIL		NIL	
		16,762	00	16,778	60
17.	PRELIMINARIES	838	00	838	00
18.	CONTINGENCIES	1,676	00	1,678	00
19.	COST DIFFERENCE + SHS. 17/80	19,276	80	19,294	60
20.	COST PER m <sup>2</sup>	876 · 18		877 · 03	

DETAILED ESTIMATE3 ROOMED JUNIOR STAFF HOUSE WITH DETACHEDKITCHEN AND SHOWER BLOCKDRAWING No. TAPI/48 & R/TAPI/48

HOUSE PLINTH AREA	= 60 m <sup>2</sup>	58 m <sup>2</sup>
KITCHEN PLINTH AREA	= 14 m <sup>2</sup>	19 m <sup>2</sup>
VERANDAH COVERED AREA		
TOTAL FLOOR AREA	= 74 m <sup>2</sup>	77 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	12,239	05	12,735	20
2.	EXTERNAL WALLS	4,881	00	4,530	00
	- FIRE PLACE AND FLUE PIPE	668	00	528	00
3.	INTERNAL WALLS	1,226	00	1,206	00
4.	ROOF CONSTRUCTION	3,532	80	4,163	00
5.	ROOF COVERING	5,707	70	6,563	85
6.	WINDOWS	3,570	00	4,620	00
7.	DOORS	3,500	00	3,150	00
8.	PLUMBING	1,452	00	1,876	00
9.	ELECTRICAL INSTALLATION	3,750	00	4,050	00
10.	FITTINGS CUPBOARDS, SHELVING etc	400	00	NIL	
11.	CEILING FINISHINGS	3,946	00	4,106	00
12.	INTERNAL WALL FINISHINGS	3,453	80	3,340	00
13.	EXTERNAL WALL FINISHINGS	1,858	90	1,801	00
14.	FLOOR FINISHINGS	1,179	60	1,227	00
		51,364	85	53,896	05
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	2,568	00	2,695	00
16.	DRAINAGE (SEWER CONNECTION)	2,568	00	2,695	00
		56,500	85	59,286	05
17.	PRELIMINARIES	2,825	00	2,964	00
18.	CONTINGENCIES	5,650	00	5,929	00
19.	COST DIFFERENCE + SHS.3,203/20	64,975	85	68,179	05
20.	COST PER m <sup>2</sup>	878/05		885/44	

DETAILED ESTIMATE

SUBORDINATE STAFF HOUSE - 4 UNITS

DRAWING NO. MBX/40

& R/MBX/40

HOUSE PLINTH AREA	=	106 m <sup>2</sup>		106 m <sup>2</sup>
COVERED VERANDAH AREA				10 m <sup>2</sup>
		106 m <sup>2</sup>		116 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	14,542	50	17,626	00
2.	EXTERNAL WALLS	3,059	00	3,133	50
	- CHIMNEY STACK AND FIRE PLACE	NIL		NIL	
3.	INTERNAL WALLS	3,932	00	3,932	00
4.	ROOF CONSTRUCTION	2,168	50	2,294	50
5.	ROOF COVERING	6,617	25	7,680	40
6.	WINDOWS	4,020	00	4,020	00
7.	DOORS EXTERNAL AND INTERNAL	1,520	00	1,520	00
8.	PLUMBING	NIL		NIL	
9.	ELECTRICAL INSTALLATION	NIL		NIL	
10.	FITTINGS, CUPBOARDS SHELVING etc.	NIL		NIL	
11.	CEILING FINISHINGS	NIL		NIL	
12.	INTERNAL WALL FINISHINGS	4,307	95	4,307	95
13.	EXTERNAL WALL FINISHINGS	954	10	1,270	30
14.	FLOOR FINISHINGS	1,857	00	1,857	00
		42,978	30	47,641	65
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	2,148	92	2,382	00
16.	DRAINAGE (WITHING PLOT BOUNDARY)	NIL		NIL	
		45,127	22	50,023	65
17.	PRELIMINARIES	2,256	00	2,500	00
18.	CONTINGENCY SUM	4,513	00	5,000	00
19.	COST DIFFERENCE = SHS 5,627/43	51,896	22	57,523	65
20.	COST PER m <sup>2</sup>	489	59	495	39

## 2.6 . GUEST HOUSE

DETAILED ESTIMATE

## 2.6.1

2- BEDROOMED PROVINCIAL COMMISSIONER'S GUEST HOUSEDRAWING NO. 18/51232/6

HOUSE PLINTH AREA	=	54 m <sup>2</sup>	56 m <sup>2</sup>
VERANDAH COVERED AREA	=	-	-
GROSS TOTAL FLOOR AREA	=	<u>54 m<sup>2</sup></u>	<u>56 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS.	CTS.	SHS.	CTS.
1.	SUBSTRUCTURE WORK	8,925	50	9,155	50
2.	EXTERNAL WALLS	3,180	00	3,324	00
3.	INTERNAL WALLS	1,827	00	1,497	00
4.	ROOF CONSTRUCTION	15,127	00	4,893	30
5.	ROOF COVERING	2,934	00	8,017	00
6.	WINDOWS	3,300	00	3,700	00
7.	DOORS	<del>2,447</del>	00	<del>2,447</del>	00
8.	PLUMBING	6,325	00	6,825	00
9.	ELECTRICAL INSTALLATION	4,300	00	4,300	00
10.	FITTINGS CUPBOARDS, SHELVING etc.	2,900	00	3,850	00
11.	CEILING FINISHINGS	1,558	30	2,558	00
12.	INTERNAL WALL FINISHINGS	4,005	00	3,573	50
13.	EXTERNAL WALL FINISHINGS	2,100	60	2,028	80
14.	FLOOR FINISHINGS	2,475	00	2,566	70
		61,404	40	58,735	80
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	3,070	00	2,936	80
16.	DRAINAGE	3,070	00	2,936	80
		67,544	40	54,609	40
17.	PRELIMINARIES	3,377	20	3,230	50
18.	CONTINGENCIES	6,754	45	6,461	00
19.	COST DIFFERENCE - SHS. 3,375/15	77,576	05	74,300	90
20.	COST PER m <sup>2</sup>	1,438/45		1,326/80	

DETAILED ESTIMATE  
TWO BEDROOMED GUEST HOUSE  
DRAWING NO. MBX/39 & R/MBX/39

HOUSE PLINTH AREA	=	60 m <sup>2</sup>	60 m <sup>2</sup>
VERANDA COVERED AREA	=	-	-
TOTAL FLOOR AREA		<u>60 m<sup>2</sup></u>	<u>60 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	9,917	20	9,917	20
2.	EXTERNAL WALLS	4,086	30	3,986	00
3.	INTERNAL WALLS	3,388	00	3,258	00
4.	ROOF CONSTRUCTION	5,437	50	3,840	00
5.	ROOF COVERING (26G)	8,590	50	7,158	75
6.	WINDOWS	3,128	00	2,890	60
7.	DOORS-EXTERNAL AND INTERNAL	4,247	00	3,247	00
8.	PLUMBING	8,780	00	8,780	00
9.	ELECTRICAL INSTALLATION	5,470	00	5,470	00
10.	FITTINGS CUPEOARDS, SHELVING etc.	1,600	00	2,520	00
11.	CEILING FINISHINGS	2,741	25	2,731	00
12.	INTERNAL WALL FINISHINGS	4,995	00	4,455	00
13.	EXTERNAL WALL FINISHINGS	2,436	00	2,342	00
14.	FLOOR FINISHINGS	3,314	00	3,321	00
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	68,130	75	63,916	55
16.	DRAINAGE	3,406	53	3,192	00 -
		3,406	53	3,192	00
17.	PRELIMINARIES	74,943	81	70,300	55
18.	CONTINGENCIES	3,747	00	3,515	00
		7,494	40	7,030	00
19.	COST DIFFERENCE - SHS 5,340/00	86,185	21	80,845	55
20.	COST PER m <sup>2</sup>	1,436/42		1,347/42	

HOUSE PLINTH AREA = 40 m<sup>2</sup>COVERED VERANDAH = 3 m<sup>2</sup>TOTAL = 43 m<sup>2</sup>

R - K11/83

TOTAL AREA = 42 m<sup>2</sup>

BRIEF SPECIFICATION AND ESTIMATED COST		
Alternative - 1	Alternative - 2	Alternative - 3
Walls Mangrove poles, fittoes and mud	Walls Mangrove poles, fittoes and mud	Walls Mangrove Mud bricks
<u>Roof Construction</u> Mangrove rafters and purlins	<u>Roof Construction</u> Sawn podo rafters	<u>Roof Constr.</u> Sawn podo rafters
<u>Roof Covering</u> 30G. - G.c.i. Sheets	<u>Roof Covering</u> 30G. - G.c.i. Sheets	<u>Roof Covering</u> 30G. - G.c.i. Sheets
<u>Doors / Windows</u> Wood shutters	<u>Doors/Windows</u> Wood shutters	<u>Doors/Windows</u> Wood shutters

ITEM	ITEM DESCRIPTION	Shs. Cts.	Shs. Cts	Shs. Cts
1.	Walls Construction	366.20	366.20	1,476.00
2.	Roof Construction	245.50	1,202.60	1,202.60
3.	Roof Covering	1,752.25	1,752.25	1,752.25
4.	Doors	747.00	747.00	771.00
5.	Window Shutters	302.80	302.80	314.80
6.	Nails and screws	184.11	184.11	163.71
7.		3,598.85	4,555.06	5,680.36
7.	Allowance for waste	180.40	227.75	284.00
		3,779.26	4,782.81	5,964.36
8.	Mudding soil	75.00	75.00	-
9.	Sand loads	40.00	40.00	-
		3,894.26	4,897.81	5,964.36
10.	Water charges	50.00	50.00	50.00
11.	Labour charges	481.15	400.00	1,628.00
		4,425.41	5,347.81	7,642.36

MODIFICATIONS

1. Extra cost for cement rendering walls both sides + 1,080.00 + 1,080.00

N.8. Alternative - 3 No allowance in cost has been made for any foundations to sun dried mud brick walls.

HOUSE PLINTH AREA	=	35 m <sup>2</sup>
COVERED VERANDAH	=	4 m <sup>2</sup>
TOTAL AREA	=	39 m <sup>2</sup>

BRIEF SPECIFICATION AND ESTIMATED COST				
		Alternative - 1	Alternative - 2	Alternative - 3
		<u>Walls</u> Mangrove poles at 1m.ctrs max. fittoes and mud.	<u>Walls</u> Mangrove poles at 1m.ctrs max. fittoes and mud.	<u>Walls</u> Sun-dried mud bricks
		<u>Roof Construction</u> Mangrove rafters and purlins	<u>Roof Construction</u> Sawn podo rafters	<u>Roof Construction</u> Sawn podo rafters and purlins
		<u>Roof Covering</u> 30G. - G.c.i. sheets	<u>Roof Covering</u> 30G. - G.c.i. sheets	<u>Roof Covering</u> 30G. - G.c.i. sheets
		<u>Doors &amp; Windows</u> Wood shutters	<u>Doors &amp; Windows</u> Wood shutters	<u>Doors &amp; Windows</u> Wood shutters
ITEM	ITEM DESCRIPTION	Shs. Cts	Shs. Cts.	Shs. Cts.
1.	Walls Construction	326.15	326.15	1,409.00
2.	Roof Construction	246.50	1,163.80	1,163.80
3.	Roof Covering	1,752.25	1,752.25	1,752.25
4.	Doors	747.00	747.00	771.00
5.	Window Shutters	302.80	302.80	314.80
6.	Nails, screws, etc.	180.00	180.00	156.00
		3,554.70	4,472.00	5,566.85
7.	Allowance for waste	177.74	223.60	278.34
		3,732.44	4,695.60	5,845.19
8.	Mudding soil	68.75	68.75	-
9.	Sand loads	40.00	40.00	-
		3,841.19	4,804.35	5,845.19
10.	Water charges	50.00	50.00	50.00
11.	Labour charges	363.00	363.00	1,370.00
		4,254.19	5,217.35	6,265.19

#### MODIFICATIONS

- Extra cost for cement rendering to both sides of walls

+ 850.50

+ 850.00

N.B. - Alternative - 3 No allowance in cost has been made for any foundations to sun dried mud brick walls.

HOUSE PLINTH AREA = 39 m<sup>2</sup>  
 COVERED VERANDAH = 7 m<sup>2</sup>  
 TOTAL AREA = 47 m<sup>2</sup>

## BRIEF SPECIFICATION AND ESTIMATED COST

		Alternative - 1	Alternative - 2	Alternative - 3
<u>Walls</u> Mangrove poles, fittoes			Walls Mangrove poles, fittoes and mud	<u>Walls</u> Sun-dried Mud bricks
<u>Roof Construction</u> Mangrove rafters and purlins			<u>Roof Construction</u> Sawn podo rafters.	<u>Roof Construction</u> Sawn podo rafters and purlins
<u>Roof Covering</u> 30G. - G.c.i. sheets			<u>Roof Covering</u> 30G. - G.c.i. Sheets	<u>Roof Covering</u> 30G. - G.c.i. Sheets
<u>Doors &amp; Windows</u> Wood shutters			<u>Doors &amp; Windows</u> Wood shutters	<u>Doors &amp; Windows</u> Wood shutters
Item	ITEM DESCRIPTION	Shs. Cts.	Shs. Cts	Shs. Cts.
1.	Walls Construction	319.65	319.65	1,586.50
2.	Roof Construction	288.00	1,448.95	1,448.95
3.	Roof Covering	2,188.35	2,178.35	2,188.35
4.	Doors	753.50	753.50	777.50
5.	Window Shutters	277.10	227.10	236.10
6.	Nails, Screws, etc.	190.00	190.00	166.71
		4,016.60	5,117.55	6,404.11
7.	Allowance for waste 5%	200.80	255.85	320.21
		4,217.40	5,373.40	6,724.32
8.	Mudding soil	74.00	74.00	-
9.	Sand loads	40.00	40.00	-
		4,331.40	5,487.40	6,724.35
10.	Water charges	50.00	50.00	50.00
11.	Labour charges	437.00	437.00	1,472.40
		4,818.40	5,974.40	8,247.75

MODIFICATIONS

1. Rendering to mud walls both sides + 870.00 + 870.00
2. Additional cost for dwarf wall to cooking verandah without recess + 50.37 50.37

N.B. -- Alternative - 3 - No allowance has been made for any foundations to sun dried mud brick walls.

2.7.4.

DETAILED ESTIMATE2- BEDROOMED TENANTS'S HOUSEDRAWING NO. MBX/77 & R/MBX/77

HOUSE PLINTH AREA	=	28 m <sup>2</sup>	32 m <sup>2</sup>
COVERED VERANDAH	=		
TOTAL FLOOR AREA	=	<u>28 m<sup>2</sup></u>	<u>32 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	3,899	70	4,606	00
2.	EXTERNAL WALLS	3,313	50	3,386	00
	- CHIMNEY STACK AND FIRE PLACE	750	00	443	00
3.	INTERNAL WALLS	754	50	1,221	00
4.	ROOF CONSTRUCTION	745	00	771	20
5.	ROOF COVERING	2,012	40	2,069	55
6.	WINDOWS (IN WOOD SHUTTERS)	450	00	770	00
7.	DOORS - EXTERNAL AND INTERNAL	1,476	00	2,156	00
8.	PLUMBING (SHOWER ONLY)	NIL		500	00
9.	ELECTRICAL INSTALLATION	NIL		NIL	
10.	FITTINGS, CUPBOARDS, SHELVING, etc	NIL		97	50
11.	CEILING FINISHINGS	NIL		NIL	
12.	INTERNAL WALL FINISHINGS	1,573	25	1,986	00
13.	EXTERNAL WALL FINISHINGS	943	95	840	00
14.	FLOOR FINISHINGS	765	00	874	30
		16,683	30	19,720	55
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	834	17	986	00
16.	DRAINAGE (WITHIN PLOT BOUNDARY)	NIL		400	00
		17,517	47	21,106	55
17.	PRELIMINARIES	875	80	1,055	00
18.	CONTINGENCIES	1,751	75	2,111	00
19.	COST DIFFERENCES =+SHS 4,302/29	20,145	02	24,272	55
20.	COST PER m <sup>2</sup>	719/47		758/52	

2.7.5.

DETAILED ESTIMATE  
2-BEDROOMED TENANT'S HOUSE  
DRAWING No. MBX/77A

HOUSE PLINTH AREA	=	32 m <sup>2</sup>		32 m <sup>2</sup>
VERANDAH COVERED AREA	=	-		-
TOTAL FLOOR AREA	=	<u>32 m<sup>2</sup></u>		<u>32 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	4,456	00	4,606	00
2.	EXTERNAL WALLS	3,466	10	3,386	00
	- FIRE PLACE AND CHIMEY STACK	443	00	443	00
3.	INTERNAL WALLS	965	00	1,221	00
4.	ROOF CONSTRUCTION	771	20	771	20
5.	ROOF COVERING	2,069	55	2,069	55
6.	WINDOWS (WOOD SHUTTERS)	600	00	770	00
7.	DOORS - EXTERNAL AND INTERNAL	1,476	00	2,156	00
8.	PLUMBING	NIL		500	00
9.	ELECTRICAL INSTALLATION	NIL		NIL	
10.	FITTINGS CUPBOARDS, SHELIVING etc.	NIL		97	50
11.	CEILING FINISHINGS	NIL		NIL	
12.	INTERNAL WALL FINISHINGS	1,677	30	1,986	00
13.	EXTERNAL WALL FINISHINGS	965	70	840	00
14.	FLOOR FINISHINGS	874	30	874	30
		17,764	15	19,720	55
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY )	888	00	986	00
16.	DRAINAGE	NIL		400	00
		18,652	15	21,106	55
17.	PRELIMINARIES	933	00	1,055	00
18.	CONTINGENCIES	1,865	00	2,111	00
19.	COST DIFFERENCE = +SHS2,822/40	21,450	15	24,272	55
20.	COST PER m <sup>2</sup>	670/32		758/52	

HOUSE PLINTH AREA = 50 m<sup>2</sup>  
 COVERED VERANDAH = - m<sup>2</sup>  
 TOTAL AREA = 50 m<sup>2</sup>

## BRIEF SPECIFICATION AND ESTIMATED COST

ITEM	ITEM DESCRIPTION	BRIEF SPECIFICATION AND ESTIMATED COST		
		Alternative - 1	Alternative - 2	Alternative - 3
		Walls Mangrove poles at lm. ctrs max. fittoes and mud	Walls Mangrove poles at lm. ctrs max. fittoes and mud.	Walls Mangrove mud bricks
		Roof Construction Mangrove rafters and purlins	Roof Construction Sawn podo rafters	Roof Construct Sawn podo rafters and purlins
		Roof Covering 30G. - G.c.i. Sheets	Roof Covering 30G. - G.c.i. Sheets	Roof Covering 30G. - G.c.i. Sheets
		Doors & Windows Wood shutters	Doors & Windows Wood shutters	Doors & Windows Wood shutters
		Shs. Cts	Shs. Cts	Shs. Cts
1.	Walls Construction	396.10	396.10	1,711.90
2.	Roof Construction	284.35	1,285.20	1,295.20
3.	Roof Covering	2,050.10	2,050.10	2,050.10
4.	Doors	747.00	747.00	771.00
5.	Window shutters	454.20	454.20	472.20
6.	Nails, screws, etc.	230.00	230.00	210.00
		4,161.75	5,162.60	6,510.40
7.	Allowance for waste	208.10	258.10	325.50
		4,369.85	5,420.70	6,835.90
8.	Mudding soil	83.50	83.50	-
9.	Sand loads	40.00	40.00	-
		4,493.35	5,544.20	6,835.90
10.	Water charges	50.00	50.00	50.00
11.	Labour charges	465.40	465.40	
		5,008.75	6,059.60	6,835.90

## MODIFICATIONS

- |    |                                                                  |            |        |
|----|------------------------------------------------------------------|------------|--------|
| 1. | Extra cost for cement rendering to both sides of walls +1,033.00 | + 1,033.00 |        |
| 2. | Additional cost for additional cooking room of 6 m <sup>2</sup>  | 600.90     | 820.30 |

N.B. - Alternative - 3 No allowance in cost has been made for any foundations to sun dried mud brick walls.

DETAILED ESTIMATE2- BEDROOMED TENANT HOUSE

DRAWING NO. MBX/71 &amp; R/MBX/71

HOUSE PLINTH AREA	=	43 m <sup>2</sup>	43 m <sup>2</sup>
VERANDAH COVERED AREA	=	-	-
TOTAL FLOOR AREA		<u>43 m<sup>2</sup></u>	<u>43 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS.	CTS
1.	SUBSTRUCTURE WORK	5,982	95	6,282	00
2.	EXTERNAL WALLS	3,640	50	3,568	00
	- FIRE PLACE AND CHIMNEY STACK	779	20	779	20
3.	INTERNAL WALLS	2,226	00	3,051	00
4.	ROOF CONSTRUCTION	758	50	1,348	00
5.	ROOF COVERING	2,302	65	2,632	00
6.	WINDOWS	894	00	1,317	00
7.	DOORS	1,880	00	2,260	00
8.	PLUMBING (SHOWER, KITCHEN etc.)	500	00	2,800	00
9.	ELECTRICAL INSTALLATION	2,250	00	2,500	00
10.	FITTINGS CUPBOARDS, SHELVING etc	NIL		NIL	
11.	CEILING FINISHINGS	NIL		2,350	80
12.	INTERNAL WALL FINISHINGS	2,535	30	2,980	00
13.	EXTERNAL WALL FINISHINGS	1,112	90	1,002	00
14.	FLOOR FINISHINGS	1,005	95	1,005	95
		25,867	95	33,875	95
15.	EXTERNAL WORKS(WITHIN PLOT BOUNDARY)	1,293	40	1,693	80
16	DRAINAGE	1,293	40	1,693	80
		28,454	75	37,263	55
17.	PRELIMINARIES	1,423	00	1,863	00
18.	CONTINGENCY	2,845	00	3,726	00
19.	COST DIFFERENCE + SHS. 10,129/80	32,722	75	42,852	55
20.	COST PER m <sup>2</sup>	760/99		996/57	

2.7.8.

DETAILED ESTIMATEONE BLOCK OF 3 NO. SHOWERS FOR TENANTSDRAWING NO. TAPI/43 & R - TAPI/43DRAWING NO. MBX/53FOR 2 NO. STAND PIPES

HOUSE PLINTH AREA	=	6 m <sup>2</sup>	6 m <sup>2</sup>
VERANDAH COVERED AREA	=	-	-
TOTAL FLOOR AREA	=	6 m <sup>2</sup>	6 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS.	CTS.	SHS.	CTS.
1.	SUBSTRUCTURE WORK	1,178	10	1,178	10
2.	EXTERNAL WALLS	741	50	741	50
	- SCREEN WALL	NIL		555	40
3.	INTERNAL WALLS	264	50	264	50
4.	ROOF CONSTRUCTION	53	30	53	30
5.	ROOF COVERING	388	80	388	80
6.	WINDOWS	NIL		NIL	
7.	DOORS	1,020	00	1,020	00
8.	PLUMBING	428	50	428	50
9.	ELECTRICAL INSTALLATION	NIL		NIL	
10.	FITTINGS, SUPBOARDS, SHELVING ETC.	NIL		NIL	
11.	CEILING FINISHINGS	NIL		NIL	
12.	INTERNAL WALL FINISHINGS	496	80	496	80
13.	EXTERNAL WALL FINISHINGS	104	00	104	00
14.	FLOOR FINISHINGS	76	50	76	50
		4,752	00	5,307	40
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	250	00	265	00
16.	DRAINAGE (WASH WATER OPEN DRAIN IN CONCRETE)	454	75	454	75
		5,456	75	6,027	15
17.	PRELIMINIARIES	273	00	301	00
18.	CONTINGENCIES	546	00	603	00
19.		6,275	75	6,931	15
20.	COST PER m <sup>2</sup>	1,045	96	1,155	19
21.	TENANTS WASHING PLACE AS PER DRAWING NO. TAPI/43	= SHS.	331	50	
22.	TENANTS VILLAGE STAND PIPES AS PER DRAWING NO. TAPI/43	= SHS.	544	60	
23.	TENANTS VILLAGE WATER STAND PIPES AS PER DRAWING NO. MBX /53 - NO. STAND PIPES	= SHS.	613	00	

2.8 Miscellaneous Buildings

DETAILED ESTIMATE

2.8.1

GARAGE FOR MANAGER'S HOUSE

DRAWING NO. MEX/56

GARAGE PLINTH AREA	=	35 m <sup>2</sup>
VERANDAH COVERED AREA	=	NIL
TOTAL FLOOR AREA		<u>35 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN	
		SHS	CTS
1.	SUBSTRUCTURE WORK	4,387	05
2.	EXTERNAL WALLS	2,016	00
3.	INTERNAL WALLS	NIL	
4.	ROOF CONSTRUCTION	924	50
5.	ROOF COVERING	1,109	95
6.	WINDOWS	1,425	50
7.	DOORS	2,600	00
8.	PLUMBING	NIL	
9.	ELECTRICAL INSTALLATION	880	00
10.	FITTINGS CUPBOARDS, SHELVING etc.	NIL	
11.	CEILING FINISHINGS	NIL	
12.	INTERNAL WALL FINISHINGS	1,170	00
13.	EXTERNAL WALL FINISHINGS	NIL	
14.	FLOOR FINISHINGS	565	80
		15,078	80
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	520	00
16.	DRAINAGE	NIL	
		15,598	80
17.	PRELIMINARIES	700	00
18.	CONTINGENCIES	1,400	00
19.	NIL	17,698	80

20. COST PER m<sup>2</sup>

505/68

DETAILED ESTIMATESHOWER CUBICLES FOR SUBORDINATE STAFFDRAWING NO. MBX/65 & R/MBX/65

SHOWER BLOCK PLINTH AREA	=	9 m <sup>2</sup>	9 m <sup>2</sup>
VERANDAH COVERED AREA	=	-	-
TOTAL FLOOR AREA	=	<u>9 m<sup>2</sup></u>	<u>9 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS.	CTS	SHS.	CTS
1.	SUBSTRUCTURE WORK	1,063	10	1,063	10
2.	EXTERNAL WALLS OF 26 GAUGE G.C.I. SHEETS	2,761	00	2,761	00
3.	INTERNAL WALLS - ditto	-	-	1,673	71
3.(a)	SCREEN WALL	-	-	266	50
4.	ROOF CONSTRUCTION	487	50	487	50
5.	ROOF COVERING	NIL	-	NIL	-
6.	WINDOWS	858	60	858	60
7.	DOORS	619	00	619	00
8.	PLUMBING	NIL	-	NIL	-
9.	ELECTRICAL INSTALLATION	NIL	-	NIL	-
10.	FITTINGS CUPBOARDS, SHELVING etc.	NIL	-	NIL	-
11.	CEILING FINISHINGS	NIL	-	NIL	-
12.	INTERNAL WALL FINISHINGS	NIL	-	NIL	-
13.	EXTERNAL WALL FINISHINGS	123	10	123	10
14.	FLOOR FINISHINGS	6,178	80	7,852	51
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	309	00	392	00
16.	DRAINAGE (OPEN CONCRETE CHANNEL)	309	00	392	00
17.	PRELIMINARIES	6,796	80	8,636	51
18.	CONTINGENCIES	340	00	432	00
19.	COST DIFFERENCE + SHS. 2,115/71	680	00	864	00
20.	COST PER m <sup>2</sup>	7,816	80	9,932	51
		868/53		1,103/61	

DETAILED ESTIMATEPROPOSED W.C.'s FOR JUNIOR STAFF HOUSING6 No. W.C. CUBICLES IN ONE BLOCKDRWG. NO. MBX/69 & R/MBX/69

TOILET BLOCK PLINTH AREA	=	11 m <sup>2</sup>	11 m <sup>2</sup>
COVERED VERANDAH AREA	=	-	-
TOTAL FLOOR AREA	=	11 m <sup>2</sup>	11 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	2,008	80	2,008	80
2.	EXTERNAL WALLS	1,360	00	1,360	00
	- SCREEN WALL	NIL		1,110	80
3.	INTERNAL WALLS	588	00	588	00
4.	ROOF CONSTRUCTION	152	00	152	00
5.	ROOF COVERING (30 G.C.1)	619	65	619	65
6.	WINDOWS (see doors)	NIL		NIL	
7.	DOORS	1,882	30	1,882	30
8.	PLUMBING	4,402	00	4,402	00
9.	ELECTRICAL INSTALLATION	NIL		NIL	
10.	FITTINGS-CUPBOARDS, SHELVES etc.	NIL		NIL	
11.	CEILING FINISHINGS	NIL		NIL	
12.	INTERNAL WALL FINISHINGS	792	00	792	00
13.	EXTERNAL WALL FINISHINGS	NIL		NIL	
14.	FLOOR FINISHINGS	168	00	168	00
15.	DRAIN PIPE CONNECTIONS FROM W.C.'s TO FIRST MANHOLES (3 No. M.H. INCLUDED)	2,419	00	2,419	00
		14,391	75	15,502	55
16.	EXTERNAL WORKS WITHIN PLOT BOUNDARY	719	00	775	00
17.	DRAINAGE (SEWER CONNECTION)	755	00	813	00
		15,865	75	17,090	55
18.	PRELIMINARIES	793	00	855	00
19.	CONTINGENCIES	1,586	00	1,709	00
20.	COST DIFFERENCE+SHS 1,409/80.	18,244	75	19,654	55
21.	COST PER m <sup>2</sup>	1,658.61		1,726.73	

2.8.4

DETAILED ESTIMATETOILET BLOCKDRAWING NO. TAPI/47

HOUSE PLINTH AREA	=	15 m <sup>2</sup>
VERANDAH COVERED AREA	=	-
TOTA AREA	=	<u>15 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS	CTS	SHS	CTS
1.	SUBSTRUCTURE WORK	1,200	00		
2.	EXTERNAL WALLS - FIRE PLACE AND CHIMNEY STACK	1,181	05		
3.	INTERNAL WALLS	304	80		
4.	ROOF CONSTRUCTION	203	80		
5.	ROOF COVING	1,197	90		
6.	WINDOWS	540	00		
7.	DOORS	640	00		
8.	PLUMBING	3,815	50		
9.	ELECTRICAL INSTALLATION	1,200	00		
10.	FITTING CLPBOARDS SHELVING ETC.	-	-		
11.	CEILING FINISHINGS	-	-		
12.	INTERNAL WALL FINISHINGS	967	95		
13.	EXTERNAL WALL FINISHINGS	825	75		
14.	FLOOR FINISHINGS	177	50		
		12,254	25		
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	613	00		
16.	DRAINAGE (SEWER CONNECTION)	613	00		
		13,480	25		
17.	PRELIMINARIES	674	00		
18.	CONTINGENCIES	1,348	00		
19.	NIL	15,502	25		
	COST PER m <sup>2</sup>	1,033	48		

2.8.5

DETAILED ESTIMATEBMC OFFICEDRAWING NO. MBX. 50HOUSE PLINTH AREA = 401 m<sup>2</sup>

VERANDAH COVERED AREA =

TOTAL AREA 401 m<sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN	
		SRS.	CTS
1.	SUBSTRUCTURE WORK	33,046	85
2.	EXTERNAL WALLS	24,574	60
3.	INTERNAL WALLS	8,094	00
4.	ROOF CONSTRUCTION	11,041	50
6.	ROOF COVERING	44,371	60
6.	WINDOWS	2,100	00
7.	DOORS	6,037	60
8.	PLUMBING	-	-
9.	ELECTRICAL INSTALLATION	12,000	00
10.	FITTINGS CLPBOARDS SHELIVING ETC.	-	-
11.	CEILING FINISHINGS	3,413	20
12.	INTERNAL WALL FINISHINGS	26,269	00
13.	EXTERNAL WALL FINISHINGS	2,830	50
14.	FLOOR FINISHINGS	6,123	00
		179,901	85
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	8,995	10
16.	DRAINAGE (SEWER CONNECTION)	NIL	NIL
		188,896	95
17.	PRELIMINARIES	9,445	00
18.	CONTIGNCIES	18,890	00
19.	NIL	217,231	95
20.	COST PER m <sup>2</sup>	541	73

DETAILED ESTIMATE  
RESEARCH TRAINING CENTRE  
DRAWING NO. TAPI/45 & R-TAPI/ 45

BUILDING PLINTH AREA	=	124 m <sup>2</sup>	129 m <sup>2</sup>
VERANDAH COVERED	=	-	-
TOTAL FLOOR AREA	=	124 m <sup>2</sup>	129 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS.	CTS	SHS.	CTS.
1.	SUBSTRUCTURE WORK	18,250	55	18,912	05
2.	EXTERNAL WALLS	6,360	20	6,452	00
3.	INTERNAL WALLS	1,582	00	1,582	00
4.	ROOF CONSTRUCTION	6,084	80	6,330	15
5.	ROOF COVERING	9,350	90	9,736	30
6.	WINDOWS	9,391	00	9,391	00
7.	DOORS	2,619	00	2,619	00
8.	PLUMBING	1,800	00	1,800	00
9.	ELECTRICAL INSTALLATION	5,000	00	5,000	00
10.	FITTINGS CUPBOARDS, SHELVING ETC.	550	00	700	00
11.	CEILING FINISHINGS	7,147	00	7,435	00
12.	INTERNAL WALL FINISHINGS	6,188	00	6,380	00
13.	EXTERNAL WALL FINISHINGS	3,372	30	3,564	00
14.	FLOOR FINISHINGS	2,225	00	2,314	00
		79,948	75	82,215	50
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	3,997	00	4,111	00
16.	DRAINAGE	3,997	00	4,111	00
		87,942	75	90,437	50
17.	PRELIMINARIES	4,397	00	4,522	00
18.	CONTINGENCIES	8,800	00	9,040	00
19.	COST DIFFERENCE + SHS. 2,859.75	101,139	75	103,999	50
20.	COST PER m <sup>2</sup>	815	64	806	20

DETAILED ESTIMATECOTTON STOREDRAWING NO. TAPI/23

HOUSE PLINTH AREA	=	141 m <sup>2</sup>
VERANDAH COVERED AREA	=	-
TOTAL AREA		<u>141 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN		MODIFIED DESIGN	
		SHS.	CTS.	SHS.	CTS.
1.	SUBSTRUCTURE WORK	13,257	95		
2.	EXTERNAL WALLS -	11,471	65		
3.	INTERNAL WALLS	-	-		
4.	ROOF CONSTRUCTION	20,158	00		
5.	ROOF COVERING	15,158	00		
6.	WINDOWS	-	-		
7.	DOORS	7,992	00		
8.	PLUMBING	-	-		
9.	ELECTRICAL INSTALLATION	-	-		
10.	FITTINGS CUPBOARDS SHELVING ETC	-	-		
11.	CEILING FINISHINGS	-	-		
12.	INTERNAL WALL FINISHINGS	-	-		
13.	EXTERNAL WALL FINISHINGS	-	-		
14.	FLOOR FINISHINGS	2,912	00		
		70,849	60		
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	3,542	45		
16.	DRAINAGE	-	-		
		74,392.	05		
17.	PRELIMINARIES	3,720	00		
18.	CONTINGENCIES	7,440	00		
19.	NIL	85,552	05		
20.	COST PER m <sup>2</sup>	606	75		

DETAILED ESTIMATEPOLICE STATION TYPE B DRW/No. (39)3001AS PER BILLS OF QUANTITIES

BUILDING PLINTH AREA	=	315 m <sup>2</sup>
VERANDAH COVERED AREA	=	- "
TOTAL FLOOR AREA	=	<u>315 m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN	
		SRS	CTS.
1.	SUBSTRUCTURE WORK	63,200	70
2.	EXTERNAL WALLS } INTERNAL WALLS }	46,480	90
3.			
4.	ROOF CONSTRUCTION	28,434	00
5.	ROOF COVERING	23,051	50
6.	WINDOWS	10,325	00
7.	DOORS	15,056	50
8.	PLUMBING	20,886	50
9.	ELECTRICAL INSTALLATION	16,500	00
10.	FITTINGS CUPEARDS etc.	10,320	50
11.	CEILING FINISHES		
12.	INTERNAL WALL FINISHINGS } EXTERNAL WALL FINISHINGS }	56,761	00
13.			
14.	FLOOR FINISHINGS	291,016	60
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY	14,128	00
16.	DRAINAGE (SEWER CONNECTION etc.)	13,726	00
		318,870	60
17.	PRELIMINARIES	16,500	00
18.	CONTINGENCIES	25,000	00
19.	NIL	360,370	60
20.	COST PER m <sup>2</sup>	1,144/03	

2.8.9

DETAILED ESTIMATEHEALTH SUB-CENTREDRAWING NO.

BUILDING PLINTH AREA	=	116
VERANDAH COVERED AREA	=	167 m <sup>2</sup>
TOTAL AREA	=	<u>283</u>

ITEM	ELEMENT	ORIGINAL DESIGN	
		Shs	Cts
1.	SUBSTRUCTURE WORK	43,761	60
2.	EXTERNAL WALLS	11,744	00
3.	INTERNAL WALLS	6,555	00
4.	ROOF CONSTRUCTION	17,559	00
5.	ROOF COVERING	21,300	00
6.	WINDOWS	9,036	00
7.	DOOR	10,655	50
8.	PLUMBING	16,500	00
9.	ELECTRICAL INSTALLATION	13,633	70
10.	FITTINGS CUPBOARDS SHELVING etc.	7,200	00
11.	CEILING FINISHINGS	10,264	00
12.	INTERNAL WALL FINISHINGS	8,550	00
13.	EXTERNAL WALL FINISHINGS	5,550	00
14.	FLOOR FINISHINGS	5,941	00
		188,249	80
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	9,200	00
16.	DRAINAGE	9,200	00
		206,649	80
17.	PRELIMINARIES	10,200	00
17.	PRELIMINARIES	20,000	00
18.	CONTINGENCIES		
19.	COST PER m <sup>2</sup> = SHS. 836/93	236,849	80

DETAILED ESTIMATE  
HEALTH CENTRE  
DRAWING NO.

BUILDING PLINTH AREA	=	168 m <sup>2</sup>
VERANDAH COVERED AREA	=	198 m <sup>2</sup>
TOTAL AREA		<u>366</u>

ITEM	ELEMENT	ORIGINAL DESIGN	
		SHS.	CTS
1.	SUBSTRUCTURE WORK	60,641	00
2.	EXTERNAL WALLS	13,628	80
3.	INTERNAL WALLS	15,040	00
4.	ROOF CONSTRUCTION	21,660	00
5.	ROOF COVERING	28,300	00
6.	WINDOWS	13,550	00
7.	DOORS	18,725	00
8.	PLUMBING	22,925	00
9.	ELECTRICAL INSTALLATION	20,000	00
10.	FITTINGS CUPBOARDS, SHELVING etc.	21,700	00
11.	CEILING FINISHINGS	16,396	00
12.	INTERNAL WALL FINISHINGS	15,600	00
13.	EXTERNAL WALL FINISHINGS	8,750	00
14.	FLOOR FINISHINGS	6,864	00
		283,779	80
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY	14,000	00
16.	DRAINAGE	14,000	00
		311,779	80
17.	PRELIMINARIES	15,000	00
18.	CONTINGENCIES	29,000	00
19.	COST PER m <sup>2</sup> SHS. 972/08	355,779	80

2.8.11

DETAILED ESTIMATE  
IN-PATIENT DEPARTMENT  
DRAWING NO.

BUILDING PLINTH AREA	=	319 m <sup>2</sup>
VERANDAH COVERED AREA	=	-
TOTAL AREA	=	319 m <sup>2</sup>

ITEM	ELEMENT	ORIGINAL DESIGN	
		SHS	CTS
1.	STRUCTURE WORK	52,178	65
2.	EXTERNAL WALLS	22,187	50
3.	INTERNAL WALLS	24,558	80
4.	ROOF CONSTRUCTION	9,435	00
5.	ROOF COVERING	26,124	00
6.	WINDOWS	24,096	00
7.	DOORS	14,378	00
8.	PLUMBING	27,440	00
9.	ELECTICAL INSTALLATION	23,500	00
10.	FITTINGS, CUPBOARDS, SHELVING ect.	14,750	00
11.	CEILING FINISHINGS	20,854	50
12.	INTERNAL WALL FINISHINGS	37,584	00
13.	EXTERNAL WALL FINISHINGS	10,710	00
14.	FLOOR FINISHINGS	8,788	00
		316,584	45
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	16,000	00
16.	DRAINAGE	16,000	00
		348,584	45
17.	PRELIMINARIES	17,500	00
18.	CONTINGENCIES	31,000	00
19.	COST PER m <sup>2</sup> = SHS. 1,244/78	397,084	45

DETAILED ESTIMATEDISPENSARYDRAWING NO .

BUILDING PLINTH AREA	=	84	m <sup>2</sup>
VERANDAH COVERING AREA	=	32	m <sup>2</sup>
		<u>116</u>	<u>m<sup>2</sup></u>

ITEM	ELEMENT	ORIGINAL DESIGN	
		SHS	CTS
1.	SUBSTRUCTURE WORK	26,158	85
2.	EXTERNAL WALLS	7,799	50
3.	INTERNAL WALLS	3,620	60
4.	ROOF CONSTRUCTION	8,472	00
5.	ROOF COVERING	13,453	00
6.	WINDOWS	5,522	00
7.	DOORS	2,444	20
8.	PLUMBING	6,200	00
9.	ELECTRICAL INSTALLATION	3,500	00
10.	FITTINGS CUPBOARDS, SHELVING ETC.	7,950	00
11.	CEILING FINISHINGS	3,276	00
12.	INTERNAL WALL FINISHINGS	4,800	00
13.	EXTERNAL WALL FINISHINGS	3,630	00
14.	FLOOR FINISHINGS	3,756	00
		100,582	15
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	4,500	00
16.	DRAINAGE	5,000	00
		110,082	15
17.	PRELIMINARIES	5,500	00
18.	CONTINGENCIES	11,000	00
19	COST PER M <sup>2</sup> = SHS. 1,091.23	126,582	15

	INFRASTRUCTURE BUILDING/SERVICE	FLOOR AREA IN m <sup>2</sup>	COST PER m <sup>2</sup>	SHS.
1.	COTTON WEIGHING CENTRE IN LIGHT STEEL FRAME STRUCTURE	60	563.00	33,780.
2.	SLAUGHTER HOUSE AND ONE OFFICE BLOCK	238	1,890.00	449,820.
3.	TOWN HALL	334	2,305.39	770,000.
4.	POST OFFICE AND TELEPHONE EXCHANGE FOR URBAN CENTRE	299	2,600.00	777,400.
5.	POST OFFICE AND TELEPHONE EXCHANGE FOR RURAL CENTRE	231	2,600.00	600,600.
6.	POST OFFICE CENTRE AT MARKET CENTRES	43	1,395.00	59,985.
7.	OPEN AIR MARKET - CONSISTING OF 33 NO. VARIOUS STALLS MARKET OFFICER'S OFFICE: AND TOILET BLOCKS	507.	1,380.67	700,000.
8.	8 BAY MECHANICAL WORKSHOP	697	1,829.27	1,275,000.
9.	TENANTS WASHING PLACE DRAWING NO. TAPI/43	-	-	331.
10.	TENANTS VILLAGE WATER STAND PIPES DRG. NO. TAPI/43			544.
11.	TENANTS VILLAGE WATER STAND PIPES DRG. NO. MBX/53			613.
12.	DOUBLE SETTLERS PIT LATRINE/MATERIALS AND LABOUR ONLY DRAWING NO. K11/84			1,214.

2.8.14

DETAILED ESTIMATE  
DIVISIONAL ADMINISTRATION BLOCK  
DRAWING NO. 19/51899/48

BUILDING PLINTH AREA	=	209
VERANDAH COVERED AREA	=	-
TOTAL AREA	=	209

ITEM	ELEMENT	ORIGINAL DESIGN	
		SHS	CTS
1.	SUBSTRUCTURE WORK	31,679	50
2.	EXTERNAL WALLS	12,151	50
3.	INTERNAL WALLS	14,570	50
4.	ROOF CONSTRUCTION	12,678	00
5.	ROOF COVERING	15,620	00
6.	WINDOWS	8,165	00
7.	DOORS	14,513	00
8.	PLUMBING	10,901	50
9.	ELECTRICAL INSTALLATION	16,500	00
10.	FITTINGS CUPBOARDS, SHELVING etc.	12,500	00
11.	CEILING FINISHINGS	10,536	00
12.	INTERNAL WALL FINISHINGS	15,930	00
13.	EXTERNAL WALL FINISHINGS	4,864	00
14.	FLOOR FINISHINGS	7,411	00
		188,020	00
15.	EXTERNAL WORKS (WITHIN PLOT BOUNDARY)	6,000	00
16.	DRAINAGE	5,000	00
17.	PRELIMINARIES	199,020	00
17.	PRELIMINARIES	10,000	00
18.	CONTINGENCIES	20,000	00
19.	COST PER m <sup>2</sup> = SHS 1,095/79	229,020	00

Drawing or Sketch Drawing Reference	Type of Building	Cost Per m <sup>2</sup>	LOCAL MATERIALS 1. Cement 2. Sand 3. Aggregate 4. Timber 5. Miscellaneous	IMPORTED MATERIALS COMMENT:- 1. Plumbing materials 2. Electrical Materials 3. Steel reinforcement 4. Iron mongary etc. 5. Glass	Labour	Builders Establishment Charges and Profit	Transport Nairobi/Bura (i.e. ADDITION ON ESTIMATED COST OF EACH BUILDING
R/MEX/20	2 - Bedroom Staff House	756/63	40 %	13 %	27 %	20 %	40 %
R/MEX/40	Subordinate Staff House	495/89	42 %	11 %	27 %	"	"
R/TAP/48	3 - Bedroomed Junior Staff House	885/44	42 %	11 %	27 %	20 %	40 %
R/MEX/65	3 - Bedroomed Junior House	862/29	42 %	11 %	27 %	20 %	40 %
R/MEX/71	2 - Bedroomed Tenant House	996/57	43 %	10 %	27 %	20 %	40 %
R/MEX/41	3 - Bedroomed Junior House	635/96	41 %	12 %	27 %	20 %	40 %
R/MEX/95	3 - Bedroomed Junior House	922/74	43 %	10 %	27 %	20 %	40 %
R/TAP/1/6	3 - Bedroomed House	774/75	43 %	10 %	27 %	20 %	40 %
R/MEX/09	3 - Bedroomed Staff House	787/96	43 %	10 %	27 %	20 %	40 %
R/MEX/77	3 - Bedroomed Tenant House	758/52	43 %	10 %	27 %	20 %	40 %
R/MEX/39	2 - Bedroomed Guest House	1347/42	41 %	12 %	27 %	20 %	40 %
R/MEX/78	Assistant Mill's Manager House	1188/00	37 %	16 %	27 %	20 %	40 %
R/MEX/43	Manager's House	1078/13	33 %	20 %	27 %	20 %	40 %
R/TAP/1/46	2 - Bedroomed Senior Staff House	892/40	38 %	15 %	27 %	20 %	40 %
R/MAX/8	Mill Manager's House	1161/14	37 %	16 %	27 %	20 %	40 %
R/MAX/9	Mill Manager's House	1001/11	37 %	16 %	27 %	20 %	40 %
R/1851232/161	2 Bedroom P.C's Guest House	1326/80	39 %	14 %	27 %	20 %	40 %
R/1851361/20	Revised D.C's House (1975)	1470/03	33 %	20 %	27 %	20 %	40 %
R/185046/4	Type 'C' Lowland House	1053/63	40 %	13 %	27 %	20 %	40 %
R/186057/1	Type 'D' Lowland House	1206/55	40 %	13 %	27 %	20 %	40 %
R/186058/1	Type 'E' Lowland House	1145/59	40 %	13 %	27 %	20 %	40 %
R/186059/1	Type 'F' Lowland House	1018/27	40 %	13 %	27 %	20 %	40 %
MEX/80	3 - bedroomed Senior Staff House	1040/00	40 %	13 %	27 %	20 %	40 %
18751829/48	Administration Block	1095/79	37 %	16 %	27 %	20 %	40 %
R/TAP/1/45	Research Training Centre	806/20	37 %	16 %	27 %	20 %	40 %
MEX/50	B.M.C. Office	541/73	37 %	16 %	27 %	20 %	40 %
R/TAP/1/23	Cotton Store	606/75	20 %	40 %	20 %	20 %	40 %
TAP/1/21	Cotton weighing Centre	563/03	20 %	40 %	20 %	20 %	40 %
TAP/1/43	One Block of 3 showers	1155/19	33 %	20 %	27 %	20 %	40 %
MW/2	Town Hall	2305/39	36 %	17 %	27 %	20 %	40 %
.....	Slaughter House	1890/00	37 %	16 %	27 %	20 %	40 %
MW/3C	Open Air market	1380/67	35 %	18 %	27 %	20 %	40 %
(39) 3000	Police Station Type B	1144/03	37 %	16 %	27 %	20 %	40 %
(99) 3000	B - Bay Mechanical Workshop	1829/27	23 %	30 %	27 %	20 %	40 %
773/A	Post Office and T.E. for Urban Centre	2600/00	32 %	21 %	27 %	20 %	40 %
773/A	Post Office and T.E. for Rural centre	2600/00	32 %	21 %	27 %	20 %	40 %
BILL/936	Post Office Centre at Markets	1395/00	35 %	18 %	27 %	20 %	40 %
K11/83	Settler mud and wattle house	103/00	43 %	48 %	9 %	NIL	NIL

N.B. (1) Materials, goods and fittings which are manufactured locally whose raw materials are imported have been considered as imported  
 (11) The above percentages for foreign exchange content do not include any equipment.

BURA IRRIGATION SETTLEMENT PROJECT  
PROJECT PLANNING REPORT  
UTILITY SERVICES ANNEXE

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## INTRODUCTION

This Annex describes the utility services proposed for the settlement centres in Stage I, Phase I of the Bura Irrigation Settlement Project. The physical planning considerations involved in locating the village settlements and the rural centre are described in the Village Planning and Design Annex, together with the description of the roads network within the project area.

The services covered by this Annex include the treated water supply and the sanitation proposals for the settlement villages and the rural centre, and the development of electricity generation for industrial, administrative and domestic use at the rural centre. Proposals for the cotton ginning installation are described in the Processing Annex.

The proposed electricity supply system for the Bura Irrigation Settlement Project is a transmission line to carry electric power from the national grid to the project area. It is therefore recommended that initially electric power be generated at the rural centre to serve its industrial and residential development. An electricity sub-station would be provided for any of the project villages. Overall power requirements for the project are estimated to be 1.5 MW. The capital cost of the electricity supply system is estimated to be K 2.5 million and operating costs K 2.1 million per annum. The average cost of power generated is estimated to be one K 2.5 per unit. The price per unit to be charged to the project is a matter for government decision.

## CHAPTER 1 WATER SUPPLY SYSTEM

### 1.1 Introduction

The supply of treated water to the 23 villages and the Rural Centre could be provided in several ways, by individual treatment works, by a central system or by a combination of the two. Each method has its advantages and disadvantages. Before discussing these it is worthwhile to establish the relative costs of the main methods of supply, because costs may be an important factor in the choice of system.

Two alternative outline design systems have therefore been considered for costing purposes. The first is based upon a separate supply to each of the 23 settlement villages which would have its own treatment works served by an intake from a tertiary canal and a low level water tower for the storage of treated water for distribution to the village by gravity: the Rural Centre would also have its individual supply system using raw water from the main canal, which, after treatment, would be stored in a water tower designed to feed the rural centre distribution system by gravity. The second system is designed to have a central water treatment plant for the whole of the project area located near the Rural Centre. The raw water supply would be obtained from the main canal and after treatment would be pumped to a central water tower for storage. The treated water would be distributed through the project area by a system of distribution mains. The main water tower would serve ancillary village storage towers for distribution by gravity.

The detailed criteria for the two outline designs are given in the following section.

### 1.2 Design Criteria for Individual Village and Separate Rural Centre Treatments

- (a) All water supply to be fully treated
- (b) Alum dosing of raw water at about 50 milligrammes per litre (mg/litre) to accelerate deposit of sediment.
- (c) Upward flow sedimentation units with a flow rate of between 1.0 and 1.5 metres per hour (m/hr).
- (d) Downward flow rapid gravity filters with a rate of filtration of about 4 cubic metres per square metre per hour ( $\text{m}^3/\text{m}^2/\text{hr}$ ). Filters to be backwashed from pressure mains provided from the water tower.
- (e) Chlorination of treated water before entry into clear water storage reservoir at the rate of 2 to 4 mg/litre to give a residual chlorine of at least 0.4 mg/litre at furthest point of each system. Calcium chloride or calcium hypochlorite to be used as chlorinating agent.
- (f) The chlorination of treated water will prevent bilharzia but as an additional precaution treated water will be stored for at least 48 hours. This storage will also ensure continuity of supply when raw water channels are closed for cleaning (a re-assessment to be made of size of storage at final design) and will be designed to minimise short circuiting.
- (g) Where necessary, dosing of treated water with soda ash to correct pH value.
- (h) All distributive piping would be uPVC.
- (i) Each village precinct of 12 household plots will be provided with one communal water point with 2 No.12 mm deadman bibcocks and 2 showers, 1 for women and 1 for men.

- (j) Distribution piping will be sized to enable each village household plot to take a future individual connection.
- (k) Water-borne sewage will not be provided for villages.
- (l) Consumption of water in the villages based upon 100 litres per head per day (l/h/d) and 2 500 persons per village.
- (m) Each village will require a screened intake from a tertiary channel, a low lift diesel pump to provide raw water to a small treatment works, a high lift diesel pump to carry clean water from a treated water reservoir, containing at least 48 hours storage, to a water tower holding 4 hours storage and servicing the village by gravity.
- (n) Screens would be stationary, in duplicate, and will be cleaned by hand daily or more frequently as required. Hose connection to village water supply tower for cleaning screens.
- (o) No duplicate pumps and engines will be sited at villages, all stand-by equipment will be retained at the rural centre. Similarly stand-by chemical equipment and emergency stores of chemicals would be retained centrally.
- (p) Water-borne sewage at the rural centre together with individual household clean water connections; consumption based upon 150 l/h/d at a rural centre population of 8 000.
- (q) An additional amount of 20 per cent has been allowed for wastage, leakage and operation of treatment works for the individual villages, and 25 per cent has been provided for the separate rural centre works to cover these items.
- (r) The separate treatment works at the rural centre would be served by electric power and operated on a 24 hour basis, utilising raw water from the main canal.

### 1.3 Design Criteria for Central Treatment Works

The design criteria (a) to (m) and (p) to (r) of the previous section also apply to the central system. In addition the following criteria be applicable:-

- (s) The central treatment system will be located near the main canal and the rural centre, utilising the natural slope of the ground to minimise pumping costs.
- (t) A central water tower approximately 10 metres to the base of the tank will contain four hours supply to balance supply and demand at peak period.
- (u) The central system will serve by gravity a number of lower level balancing water towers each serving a group of villages.

### 1.4 Comparative Costs of Individual and Central Systems

Comparative capital and operating costs of the two systems are summarized in Table 1.1 below. Details are set out in Appendix I.

Table 1.1 - Comparative Capital and Operating Costs of Alternative Water Supply Systems (K Sh millions)

Individual System	Cost	Central System	Cost
<b>Capital Costs:</b>		<b>Capital Costs:</b>	
Cost per village including 10% contingencies K Sh 1.144 million		Cost including all distribution piping and 10% contingencies	
Cost of 23 villages	26.312		
Cost of Rural Centre, including 10% contingencies	4.173		
<b>TOTAL</b>	<b>30.485</b>	<b>TOTAL</b>	<b>29.711</b>
<b>Operating Costs per annum:</b>		<b>Operating Costs per annum:</b>	
Per village	0.014		
Cost of 23 villages	0.330		
Cost of Rural Centre	0.110		
<b>Cost of Individual Systems</b>	<b>0.440</b>	<b>Cost of Central System</b>	<b>0.354</b>

Thus the capital costs of the central system are slightly less than those of the individual system, but the operating costs of the former are much cheaper. The total costs of the central system over the anticipated project life of 50 years would be K Sh 47.4 million compared with K Sh 52.5 million for the individual system.

### 1.5 Discussion of Alternative Systems

The importance of a reliable clean water supply to the project has been stressed in the Public Health Annex. Clean water is considered to be the prime factor in the health of the project population, not only because of the prevention of bilharzia but also the elimination of intestinal diseases, particularly in young children, both propagated by untreated drinking water.

Individual village treatment works are by their nature scattered around the project requiring experienced operators at each village. In developing countries it is difficult to obtain the requisite number of operators and mechanics and to maintain the distribution arrangements for fuel and chemicals. Moreover, experience of individual village treatment works on other irrigation schemes in Kenya has demonstrated that they are seldom properly maintained and operated and the village water supply is commonly not only untreated but also available only for a very short period each day. Part of the problem of intermittent supply is due to the limited availability of water in the tertiary channels.

By centralising the water supply system the number of skilled staff is minimised and control and maintenance are more feasible. The argument often made against centralisation is that in the event of breakdown the whole system is affected, but with a small number of skilled operators under good control this is much less likely to happen and if it does repairs would be effected quickly because everybody would be affected. Using the main canal as a raw water source would also ensure continuity of supply. Cross regulation can be used to pond supplies in addition to the 48 hour reserve when the main canal is being maintained.

## 1.6 System Recommended

The lower overall costs and the greater certainty of a reliable clean water supply with its great benefit of improved public health postulate that a central treatment system should be adopted, and we strongly recommend a central treatment system.

The location of the works should be close to the main canal and near to the rural centre. Because the project area falls to the east at a rate of about one metre per kilometre, a gravity supply system can serve the whole area from a central water tower about 10 metres high at the treatment works. Lower level water towers located at intervals along the distribution system would act as 'stand pipes', filling at periods of low demand to provide additional supply and head at periods of peak demand.

The central treatment plant will be supplied from an intake off the main canal, ensuring continuity of supply. Cross regulators will be constructed to control flow in the main canal and these will be used to pond adequate raw water supplies when the main canal is closed for maintenance for a few days each year.

Screening and screen cleaning will be mechanised and the treatment works and central tower will be served by electrically powered pumps; stand-by generation will be provided for continuous operation. The distribution system would be constructed in uPVC pipe which has superior hydraulic characteristics to either concrete or metal piping, and is easier to transport and lay. The water mains would be entrenched in the verges of the project area roads for ease of laying and access for maintenance.

The central treatment works should be operated and maintained by the Ministry of Water Development.

## CHAPTER 2 SANITATION

### 2.1 General

Pit latrines are the most satisfactory form of sanitation in the villages where household plot sizes will be of the order of 400 square metres. However, pit latrines on previous irrigation schemes in Kenya have been hand dug and have tended to be too shallow and too large in plan. In consequence they have been hygienically unsatisfactory and the sealing concrete slabs have tended to collapse because the sides of the pits have not been stable.

From hygienic considerations a pit latrine should be deep, and to avoid collapse of the sides of the pit the excavation should be of only limited diameter. Augered pit latrines are therefore strongly recommended; they should be at least 7 metres deep and not more than 30 centimetres in diameter. These could be bored by hand but a power operated chassis mounted auger is greatly to be preferred because of the large number and widespread distribution of the latrines. Attention to detail is essential for the proper construction of the pit latrines, an essential requisite for a healthy village.

The density of development within the rural centre is too great for pit latrines, for septic tanks or other individual sewage treatment methods. There will be industrial effluents from the ginnery, abattoir and other possible industrial developments. In such a situation the provision of full sewer reticulation with treatment facilities for domestic and industrial sewage has been examined.

### 2.2 Rural Centre Sewerage

The rural centre will be located on a gently sloping site with ground falls of the order of 1:400. It is not possible to provide a full gravity system because of the flat slopes, and some pumping will be required. One pump station is proposed to pump directly to a treatment works.

It is proposed that the pumping station be located adjacent to the commercial sector of the rural centre. This will accommodate sewage flows from all development proposed under Phase I Stage I of the project. Future residential development along the northern boundary of the rural centre will require the construction of an additional pumping station. Due to topographical constraints it is not possible to locate a single pumping station which will accommodate both initial and future proposed development.

Preliminary estimates for the pumping requirements have been based on a peak flow of 60 litres per second (l/sec) arriving at the pumping station and the installation of one duty and one 100 per cent stand-by submersible sewage pump at the pump station.

### 2.3 Sewage Treatment

Domestic sewage will be generated by residential, commercial and institutional development within the rural centre. For the appraisal of treatment requirements a contributing population of 8 000 persons has been taken as applicable to Phase I Stage I of the development. Provision should be made at the treatment plant for extensions to treatment capacity to accommodate population increases within any subsequent development.

An overall sewage output of 80 per cent of the 150 litres per day per caput water demand is assumed, and sewage strengths are calculated on the basis of 55 grammes of BoD<sub>5</sub> and 80 grammes of suspended solids per head per day.

Thus sewage characteristics are as follows:-

Average sewage flow - 960 m<sup>3</sup>/day

Average total BoD<sub>5</sub> - 440 kg  
 Average total suspended solids - 640 kg

The major industrial complexes in the rural centre will be a ginnery and an abattoir. The ginnery will not generate any industrial water-borne discharge of appreciable quantity. Minor light industry and workshops have been assumed to contribute a total sewage flow of 50 m<sup>3</sup>/day with a strength equivalent to domestic sewage.

Wastes from the abattoir will have a high content of organic matter and large solids. To prevent blockages within the public sewer system the effluent will be screened prior to discharge and to reduce peak loads at the pumping station a flow balancing system will be installed. After this pretreatment the waste will have a BoD<sub>5</sub> load of the order of 1 500 milligrammes per litre (mg/l). The average waste flow from the abattoir is assumed to be 100 cubic metres per day.

The total flows and pollutant loads on which the preliminary estimates for Phase I sewage treatment have been based are as follows:-

	Average dry weather flow (m <sup>3</sup> /day)	BoD <sub>5</sub> (kg)
Domestic	960	440
Industry:		
General	50	23
Abattoir	100	150
<b>TOTAL</b>	<b>1 110</b>	<b>613</b>

Thus the average sewage strength arriving for treatment is 552 mg/l.

## 2.4 Sewage Treatment Plant

The prime requirements of a sewage treatment plant at the Bura location are as follows:-

- (a) low construction and maintenance costs;
- (b) simple to operate and having a minimum risk of treatment failure;
- (c) minimum of construction materials and treatment equipment transported to the site from elsewhere in Kenya and overseas;
- (d) adaptability for future extension.

The perennially high air temperatures and high level of solar radiation in the Bura area provide ideal plant operating conditions for open waste stabilisation ponds.

These ponds are simple earthwork structures and satisfy all the prime requirements more readily than any alternative form of treatment. The ponds are open to the sun and air and treatment is achieved primarily by the release of oxygen to the waste waters from algae photosynthesis. The plant is extremely robust in its ability to withstand shock pollutant loads without risk of treatment failure and because the system operates with little loss of head through the plant it is well suited for the flat ground prevalent in the area. This form of treatment is therefore recommended.

The treatment plant should be sited to the east of the rural centre adjacent to the branch drain forming the northern boundary of the Phase I Stage I development. This siting will facilitate the initial filling of the ponds and will enable a gravity outfall for treated effluent to be constructed to the branch drain. Additionally, in the unlikely event of treatment failure, the prevailing wind direction will ensure no odour nuisance to the residential area.

The required standards of treated effluent discharged to the branch drains are taken to be as follows:-

- 5 day biochemical oxygen demand - 20 mg/l
- Suspended solids - 30 mg/l
- Coliform bacteria not to exceed - 5 000 organisms/100 ml

A three-ponds-in-series system is proposed to achieve these standards. The first and second ponds will produce the required  $BoD_5$  and suspended solid reductions, and the final pond will provide the additional retention time required to achieve the coliform criterion. The total retention time will be 37 days and the approximate area required for the treatment plant will be 14 hectares. This latter figure includes for expansion of the plant to accommodate future increases in the sewage flows from an additional population of 2 000 persons.

## 2.5 Costs Estimates

The estimated costs of sewerage at the rural centre include for main public sewers only. Minor private sewers within residential plots or commercial administrative and institutional areas have been included in the building estimates elsewhere.

The estimated costs of the sewerage and sewerage works are shown in Table 2.1. The capital costs amount to 11.1 million Kenya shillings and the recurrent costs 180 thousand Kenya shillings per annum.

**TABLE 2.1**  
**Budgetted Expenditure - Rural Centre Sewerage System**

Item	Unit Cost	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Capital Costs:							
Housing		-	-	340	-	-	-
Trunk Sewers		-	2 000	3 583	-	-	-
Branch Sewers		-	1 000	1 800	-	-	-
Pumping Station		-	-	300	-	-	-
Treatment Works		-	500	1 500	-	-	-
Vehicle: 4 WD Pick-Up		-	-	77	-	-	-
Total Base Cost		-	3 500	7 600	-	-	-
Physical Contingencies		-	525	1 140	-	-	-
<b>TOTAL COST</b>		-	4 025	8 740	-	-	-
Recurrent Costs:							
Salaries		-	-	99	99	99	99
System Maintenance		-	-	24	24	24	24
Pumps Operation		-	-	30	30	30	30
Vehicle Operation		-	-	27	27	27	27
Total Base Cost		-	-	180	180	180	180
Physical Contingencies		-	-	18	18	18	18
<b>TOTAL COST</b>		-	-	198	198	198	198

Note: Housing on same scale as water supply staff.

## CHAPTER 3 ELECTRICITY GENERATION

### 3.1 General

The costs of providing a transmission line to carry power from the national grid to the project area are too high to be borne by the initial Phase I Stage I development of the Bura Project. It is therefore proposed that electric power will be initially generated at site to serve all industrial and residential development of the rural centre, and no provision has been made for supplies to any of the villages in the project area. The generation of power on site will be reviewed when further development of the Lower Tana River Basin, notably the east bank, is to be undertaken.

The generation and distribution systems proposed have been based on studies made for electricity generation in a number of rural townships in Kenya and on discussions with the East African Power and Light Company.

The domestic power requirements have been assessed on the assumption that electrical power will only be provided for lighting and for unit air conditioners in one bedroom in each senior and principal grade house.

### 3.2 Generation

A number of combinations of machine capacities are possible, dependent on the final definition design and loading data, but this study has been based on 2 No. 500 kVA sets plus 2 No. 250 kVA set giving an installed capacity of approximately 1 500 kVA. The generation would be at 415 volts with the generating station located adjacent to the cotton ginnery. This arrangement provides the maximum flexibility and maximum utilisation of plant and personnel because the ginnery season would be limited to a spread of about 24 weeks. No allowance has been made for additional generating capacity for Hola, because such capacity and its costs would not be chargeable to the Bura Project.

### 3.3 Distribution

Distribution to the township would be at 11 kV using step-up transformers located at the generating station. Distribution at 415 volts would not be practicable as the distances involved are up to 2 kilometres. A number of pole mounted substations would be located at the load centres in this residential and commercial areas for final distribution at a voltage of 415/240V. The distribution system would be combined HV/MV overhead lines sharing common poles on major routes with 4 wire 415 volt systems on minor roads. A fifth wire street lighting control would be provided for pole mounted street/security lighting in all strategic areas. Where possible in residential areas house services would be via underground cable from the nearest available pole.

### 3.4 Generating Compound

This would comprise a main generating hall with workshops, toilets, offices, etc., together with a switchroom and transformer compound.

Housing would be provided within the compound for operating staff. This would comprise one senior grade, two junior grades, and eight subordinate grade houses.

### 3.5 Cost Estimates

The total capital cost estimate for electricity generation for 1 500 kVA maximum load is 7.0 million Kenya Shillings (US \$ 0.84 million).

Total annual recurrent costs for operating the plant, including plant maintenance, labour, and fuel costs amount to 1.15 million Kenya Shillings (US \$ 0.14 million).

An itemised costs summary is shown in Table 3.1, and budgeted expenditure is shown in Table 3.2.

TABLE 3.1  
Itemised Costs Summary

Item	Quantity	Unit Price (KSh)	Total Cost (KSh)
Generator	1	7,000,000	7,000,000
Transformer	1	1,000,000	1,000,000
Control Panel	1	500,000	500,000
Wiring	100	100,000	10,000,000
Labour	100	100,000	10,000,000
Maintenance	100	100,000	10,000,000
Fuel	100	100,000	10,000,000
Other	100	100,000	10,000,000
<b>Total</b>			<b>70,000,000</b>

TABLE 3.2  
Budgeted Expenditure

Category	Amount (KSh)
Capital Expenditure	7,000,000
Operating Costs	1,150,000
<b>Total</b>	<b>8,150,000</b>

TABLE 3.1

## Itemised Cost Summary - Electricity Generation

Item	Unit	Quantity	Unit cost	Kenya Shillings '000		US \$ '000			% Foreign Exchange	
				Local	Foreign	Total	Local	Foreign		Total
				Capital Costs:						
Generators and Switchgear				400	2 800	3 200	48	335	383	
Buildings and Transformer Compound				600	800	1 400	72	96	168	
Distribution System				400	1 200	1 600	48	144	192	
Staff Housing				255	85	340	31	10	41	
Street Lighting and Miscellaneous				83	300	383	10	36	46	
Four Wheel Drive Pick-Up				38	39	77	4	5	9	
Total Base Cost				1 776	5 224	7 000	213	626	839	
Physical Contingencies				266	784	1 050	32	94	126	
TOTAL COST				2 042	6 008	8 050	245	720	965	75
Recurrent Costs (per annum):										
Salaries				198	12	210	24	1	25	
Plant Spares, etc.				120	200	320	14	24	38	
Fuel Costs				56	506	562	6	61	67	
Vehicle Running Costs				15	12	27	2	1	3	
Building Maintenance				26	6	32	3	1	4	
Total Base Cost				415	736	1 151	49	88	137	
Physical Contingencies				41	74	115	5	9	14	
TOTAL COST				456	810	1 266	54	97	151	64

**TABLE 3.2**  
**Budgetted Expenditure — Electricity Generation (1 000 K Sh)**

Item	Unit Cost	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Capital Costs:							
Generators and Switchgear		1 000	—	1 000	1 200	—	—
Other Electrical Installations		100	300	2 000	983	—	—
Staff Housing		—	86	254	—	—	—
Four Wheel Drive Vehicle		—	77	—	—	—	—
Sub Total Base Cost		1 100	463	3 254	2 183	—	—
Physical Contingencies		110	46	326	218	—	—
<b>TOTAL CAPITAL COST</b>		<b>1 210</b>	<b>509</b>	<b>3 580</b>	<b>2 401</b>	<b>—</b>	<b>—</b>
Recurrent Costs:							
Salaries		—	30	166	210	210	210
Plant Operating Costs		—	100	400	882	882	882
Vehicle Running Costs		—	27	27	27	27	27
Building Maintenance Costs		—	—	2	32	32	32
Sub Total Base Cost		—	157	595	1 151	1 151	1 151
Physical Contingencies		—	16	60	115	115	115
<b>TOTAL RECURRENT COST</b>		<b>—</b>	<b>173</b>	<b>655</b>	<b>1 266</b>	<b>1 266</b>	<b>1 266</b>

APPENDIX I  
 ALTERNATIVE CAPITAL AND OPERATING COSTS  
 FOR ALTERNATIVE WATER SUPPLY SYSTEMS

HOUSE SUPPLY AND SEPARATE RURAL CENTRE SUPPLY

House supply	2 500
House supply	2 500 x 100 l/h/d.
House supply	250 m <sup>3</sup> /d.
House supply	
House supply	300 m <sup>3</sup>
House supply	
House supply	$\frac{200 \times 24}{10}$
House supply	
House supply	730 m <sup>3</sup> /d

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House supply	$\frac{200 \times 24}{10}$
House supply	$\frac{200 \times 24}{10}$
House supply	20 m <sup>3</sup>
House supply	
House supply	$\frac{200 \times 24}{10}$
House supply	
House supply	7.5 m <sup>3</sup>
House supply	
House supply	2 x 300 m <sup>3</sup>
House supply	
House supply	650 m <sup>3</sup>
House supply	
House supply	20
House supply	
House supply	100

The water supply should be 100 mm diameter for 100 m length of pipe. The water should be supplied from the water treatment works. The water should be supplied from the water treatment works. The water should be supplied from the water treatment works.

**APPENDIX I  
COMPARATIVE CAPITAL AND OPERATING COSTS  
OF ALTERNATIVE WATER SUPPLY SYSTEMS**

**1. INDIVIDUAL VILLAGE SUPPLIES AND SEPARATE RURAL CENTRE SUPPLY**

**A CAPITAL COSTS**

**(a) Individual Village Supply**

Village population 2 500  
Estimated consumption =  $2\ 500 \times 100 \text{ l/h/d.}$   
250 m<sup>3</sup>/d.

Add 20% for wastage, leakage,  
operation of treatment works etc.  
Daily demand = 300 m<sup>3</sup>

If pumps operate for 10 hours per day  
then the filtration rate will be =  $\frac{300 \times 24}{10}$

Or 720 m<sup>3</sup>/d

Screens must be sized accordingly.

Area of sedimentation tanks (minimum) =  $\frac{720 \times 1}{24 \times 1.5}$

= 20 m<sup>2</sup>

Area of filter beds =  $\frac{720 \times 1}{24 \times 4}$

= 7.5 m<sup>2</sup>

Capacity of clear water storage  
(2 compartments) (48 hours) = 2 x 300 m<sup>3</sup>

= 600 m<sup>3</sup>

Capacity of water tower (4 hours) =  $\frac{300}{6}$

= 50 m<sup>3</sup>

It is considered that the intake pipe work should be 150 mm diameter, the rising main to the water tower 150 mm diameter, but that the outlet from the water tower should be 100 mm (all in uPVC piping except where exposed when galvanised steel piping to be used).

Individual Village Scheme (for 2 500 people)		(1 000 K Sh)
(1)	Intake and services	10
(2)	Pump house and chemical etc. storage	20
(3)	Diesel engine pumps (2 No.)	60
(4)	Sedimentation tanks	150
(5)	R.C. filter unit	60
(6)	Alum, soda ash and chlorine dosing, etc.	10
(7)	Filtered water storage (48 hours)	400
(8)	Associated pipework and valves (Treatment Works)	50
(9)	Pipeline - intake to village (average)	80
(10)	Site works - fencing, ground layout, etc.	20
(11)	Elevated storage tank (4 house storage)	100
(12)	Village distribution system	80
Total per village		1 040
Total for 23 villages		23 920

(b) Separate Rural Centre

Water Requirement

$$\begin{array}{l} \text{Population 8 000} \\ \text{@ 150 l/h/d water} \end{array} = 1\,200 \text{ m}^3/\text{d.}$$

But allow 25% addition to cover commercial supplies, leakage, wastage and water treatment usage.

$$\text{Daily usage} = 1\,500 \text{ m}^3/\text{d}$$

As it is the intention to generate electrical power the treatment works can operate on a 24 hour basis. However all equipment should be duplicated.

Treatment

(1) Screens can be rotary or band self-cleansing.

$$\begin{array}{l} \text{(2) Sedimentation tanks area} \\ \text{(minimum)} \end{array} = \frac{1\,500 \times 1}{24 \times 1.5}$$

$$= 41.67 \text{ m}^2$$

$$\begin{array}{l} \text{(3) Filter beds area} \\ \text{(minimum)} \end{array} = \frac{1\,500 \times 1}{24 \times 4}$$

$$= 15.63 \text{ m}^2$$

$$\text{Capacity of clear water storage} = 3\,000 \text{ m}^3$$

$$\text{Capacity of water tower} = \frac{1\,500}{6} = 250 \text{ m}^3$$

Diameter of piping from intake to water tower and from tower into main distribution should be 150 mm.

Separate Rural Centre (8 000 persons + commercial subjects)		(1 000 K Sh)
(1)	Intake and services	24
(2)	Pump house and chemical storage	40
(3)	Electric pump, and ancillary electrical equipment	200
(4)	Sedimentation tanks	500
(5)	Filter unit (incl. more sophisticated equipment)	400
(6)	Alum soda ash, chlorine dosing etc.	100
(7)	Filtered water storage (48 hours)	1 400
(8)	Associated pipework, valves etc. (treatment)	200
(9)	Pipeline intake and water tower	120
(10)	Site works, fencing, layout etc., incl. attendants' quarters	150
(11)	Water tower (4 hours storage)	160
(12)	Internal distribution system	500
	<b>Total</b>	<b>3 794</b>

(c) Summary of Capital Costs

Individual village systems:

23 @ K Sh 1.144 million  
Rural Centre

Total  
Add 10% contingencies

Total

(K Sh millions)

23 920

3 794

27 714

2 771

30 485

## B OPERATING COSTS

### (a) Individual Village Supply

The system is designed to be simple but as far as possible automatic. One man is appointed to operate each village unit, with skilled maintenance assistance from the rural centre.

Individual village unit	(1 000 K Sh)
Salaries and expenses	6.3
Chemicals	0.8
Plant operating costs	4.6
Miscellaneous maintenance	2.6
<b>Total per village</b>	<b>14.3</b>
<b>Total for 23 villages</b>	<b>329.7</b>

### (b) Separate Rural Centre

The water superintendent is based at the rural centre, with a mobile mechanical inspector and mechanics. A meter clerk and permanent and casual labour are appointed for general maintenance.

Separate Rural Centre	(1 000 K Sh)
Salaries and expenses	73.0
Chemicals	2.6
Plant operating costs	25.1
Miscellaneous maintenance	9.5
<b>Total for separate rural centre</b>	<b>110.2</b>

(c) Summary of Operating Costs	(1 000 K Sh)
Individual village systems 23 @ K Sh 14.33 thousand	329.7
Rural Centre	110.2
<b>Total</b>	<b>439.9</b>

## 2. CENTRAL WATER TREATMENT SYSTEM

### A CAPITAL COSTS

#### Water Requirements

Rural Centre water requirements	=	1 500 m <sup>3</sup> /d
Village water requirements 300 m <sup>3</sup> /d x 23	=	6 900 m <sup>3</sup> /d
Total	=	8 400 m <sup>3</sup> /d

#### Treatment

(1) Screens - rotary or band screens, self cleansing	=	233.3 m <sup>2</sup>
(2) Sedimentation area $\frac{8\,400 \times 1}{24 \times 1.5}$	=	105 m <sup>2</sup>
(3) Filtration area: $\frac{8\,400 \times 1 \times 1.2}{24 \times 4}$	=	16 800 m <sup>3</sup>
Capacity of storage: 2 x 8 400	=	1 400 m <sup>3</sup>
Capacity of water tower $\frac{8\,400}{6}$	=	

Because the area under consideration is relatively flat, to maintain adequate pressure in outlying villages and to keep water main diameters to an economic size, individual village water towers will be required containing 12 hour storage, which can fill up overnight when the diminished draw-off will permit the pressure in the trunk mains to rise. The detailed final design may permit the capacity and numbers of these water towers to be reduced.

Water Supply from Central Treatment Plant	(K Sh 1 000)
(1) Intake and screens (mechanically operated and self cleansing)	60
(2) Pump house and chemical storage	50
(3) Electric pumps and associated electrical equipment	300
(4) Treatment works, including sedimentation, filtration, chemical dosing, monitoring equipment etc. for 8 400 m <sup>3</sup> /d output	6 000
(5) Filtered water storage (48 hours)	3 500
(6) Water tower (4 hours storage)	1 000
(7) Pipework from intake to works and works to water tower	160
(8) Site works, fencing, staff quarters, administrative quarters etc.	300
(9) Internal distribution system for Rural Centre	500
(10) Internal distribution system for 23 No. villages	1 840

(11)	Water towers to individual villages	2 300
(12)	Main distribution trunk main to villages from Rural Centre	11 000
	Sub Total	27 010
	Add 10% contingencies	2 701
	Total	29 711

## B OPERATING COSTS

There are no staff at village level, no mobile mechanics, but a small increase in the maintenance staff to service the distribution mains.

Central treatment plant	(1 000 K Sh)
Salaries and expenses	166.0
Chemicals	21.0
Plant operating costs	100.1
Miscellaneous maintenance	67.5
Total	354.5

**BURA IRRIGATION SETTLEMENT PROJECT  
PROJECT PLANNING REPORT  
PROCESSING ANNEXE**

**BURA IRRIGATION SETTLEMENT PROJECT**  
**PROJECT PLANNING REPORT**  
**PROCESSING ANNEXE**

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PART I

COTTON GINNING

## BACKGROUND

### 1.1 Introduction

The production and processing of cotton seed is a complex operation involving many inter-related factors. The variety of cotton to be grown on Stage I Phase I of the Bura Project and the method of processing may depend not only upon the future requirements of the textile industry but also upon the financial return to the individual project tenant. To permit an informed decision to be made, Cotton Specialists, Mr L. Slack of the British Cotton Growing Corporation, were asked to undertake a comprehensive study of the subject.

### 1.2 Objectives of Reference

The principal reference for the study of cotton production and processing was as follows:-

To determine the requirements of spinners likely to use cotton produced at Bura covering the following aspects:-

- Lint quality requirements
- Lint yield
- Linture demand patterns

To make an evaluation of the relative merits of 'new' versus 'roller' ginning systems which might be employed for the project, including capital and operating costs and economic requirements.

### PART 1

### COTTON GINNING

The study was based upon the above specifications and covered:-

- variety of cotton to be grown
- systems of ginning to be adopted and the scale of operations, i.e. one large plantery or a number of smaller ginneries either located in the same building or distributed in the project area

Two detailed financial estimates for the following:-

- primary construction (including phasing according to project production build-up) with detailed specification
- operating cost of the proposed facilities
- staffing and man-power requirements of the programme including estimated period required and salary scales of experienced staff grades and experience the local staff involved in technical or skilled jobs.

To assess the total covered storage required for cotton seed and to evaluate the relative merits of total storage requirement at the ginners or partial storage at ginners and ginneries. To prepare financial estimates for costs involved of storage.

To consider the present capacity of cotton seed oil extracting industry in relation to anticipated Bura surplus seed and to make recommendations on the necessity of any processing factory at Bura.

### 1.2 Present Cotton Production in Kenya

Production of cotton in Kenya falls short of seed lint requirements by some 20,000 gins per year at present (400 lbs of cotton lint per bale), a situation attributable to the fact that all the seed purchased from neighbouring Uganda and Tanzania, together with the low grade

## CHAPTER 1 BACKGROUND

### 1.1 Introduction

The production and processing of cotton seed is a complex operation involving many inter-related factors. The variety of cotton to be grown on Stage I Phase I of the Bura Project and its method of processing may depend not only upon the future requirements of the textile industry but also upon the financial return to the individual project tenant. To permit an objective assessment to be made a Cotton Specialist, Mr I. Black of the British Cotton Growing Association, was asked to undertake a comprehensive study of the subject.

### 1.2 Terms of Reference

The terms of reference for the study of cotton production and processing were as follows:

- I Assess the requirements of spinners likely to use cotton produced at Bura covering such aspects as:
  - (a) lint quality requirements
  - (b) variety
  - (c) future demand patterns
- II Make an evaluation of the relative merits of 'saw' versus 'roller' ginning systems which might be employed for the project, including capital and operating costs and economic assessments.
- III Based upon the above assessments recommend:
  - (a) variety of cotton to be grown
  - (b) system of ginning to be adopted and the scale of operations (i.e. one large ginnery or a number of smaller ginneries either located in the same building or distributed in the project area)
- IV Prepare detailed financial estimates for the following:
  - (a) ginnery construction (including phasing according to project production build up) with detailed specification
  - (b) operating cost of the proposed facilities
  - (c) staffing and man-power requirements of the programme including estimated period required and salary scales of expatriate staff grades and experience for local staff involved in technical or skilled jobs.
- V To assess the total covered storage required for cotton seed and to evaluate the relative merits of total storage requirement at the ginnery or partial storage at ginnery and villages. To prepare financial estimates for each method of storage.
- VI To consider the present capacity of cotton seed oil extracting industry in relation to anticipated Bura surplus seed and to make recommendations on the necessity of any oil processing factory at Bura.

### 1.3 Present Cotton Production in Kenya

Production of cotton in Kenya falls short of local textile mill requirements by some 30 000 bales per annum at present (400 lbs of cotton lint per bale), a situation acceptable in the past when Kenya could purchase from neighbouring Uganda and Tanzania, sufficient cotton in low grades

fully to supply its own textile industry while exporting the better grades of cotton produced in Kenya.

With the reduction in cotton production in Uganda from crops in the region of 450 000 bales per annum to less than 100 000 bales per annum, there is no appreciable quantity of Uganda cotton available for Kenya, and until such time as Uganda cotton production recovers to something approaching its normal level, this situation will prevail.

The recent deterioration in relationships between Kenya and Tanzania resulting in the closure of the borders between the two countries, and the cessation of trading which includes the supply of cotton from Tanzania for Kenya's textile mills, has left Kenya short of cotton for its own textile industry and with no exportable surplus. Supplies of cotton will now have to be imported from other countries, and already some Sudan Acala and Argentinian cottons have reached Kenya.

It is apparent that little was done in past years to encourage cotton production because supplies were adequate and other crops rightly required development priority. The position has changed and the Government of Kenya is fully aware that Kenya can no longer depend on its neighbouring states for supplies of cotton, and now the policy of Government is to remedy this state of affairs by encouraging and promoting cotton production with the target being complete self-sufficiency in cotton at the earliest possible date.

Production of cotton must be increased to about 70 000 bales per annum to obtain numerical self-sufficiency in bales from now to 1979. From 1980 textile mill requirements are expected to increase and may reach 130 000 bales by 1984.

Already the Government's drive for increased cotton production has been rewarded by exceptional demand for planting seed this year and a large increase in acreage planted to cotton. It is possible that the 70 000 bales required by the textile mills could be produced in Kenya this coming season. It is too early in the season to give accurate forecasts and therefore the production projections given in Table 1.1 are deliberately conservative. The recent increase in the producer price from K Sh 2.40 per kg to K Sh 3.20 per kg for the higher grade AR cotton (+ 28 per cent) and from K Sh 1.25 per kg to K Sh 1.55 per kg for the lower grade BR cotton (+ 24 per cent), will provide considerable stimulus to production.

Referring to Table 1.1, it is clear that the bulk of production will be of the variety UKA, at present in the ratio of 6 bales UKA to 1 bale of BPA. It is unlikely that the rain-grown cotton crop will change much from this pattern in the short term and production of irrigation-grown UKA cotton will proportionately increase over BPA during the next few years. The present research policy however, is directed towards increasing production of BPA cotton by the multiplication of the imported BPA75 seed, the introduction of BPA75 into existing rain-grown BPA seed areas, and the replacement of UKA seed with BPA75 seed in much of the existing rain-grown UKA areas. With the exception that areas with insufficient rainfall will be supplied with a quick-maturing, drought-tolerant cotton, probably short staple, 28/32 inches to 33/32 inches, which could be readily saleable to local textile mills.

It is interesting to note that production of cotton in Kenya, numerically by bales, could meet the requirements of the local textile industry by 1979 (see Table 1.1), and that the production planned for Phase I, Stage I of the Bura Project will not necessarily be required for local consumption.

The type of cotton produced is generally of better quality than local mills require and while production of bales could numerically meet the requirement of the mills, it is good marketing policy to export the better quality higher priced cotton and import cheaper but adequate lower quality types of cotton, and this policy should prevail when Kenya produces numerically the quantity of bales required for the local industry.

**Table 1.1 - Geographical Distribution of Cotton in Kenya by Variety and Production to Date, Future Production Projections, Present Projected Local Mill Requirements and Ginnery Capacities (Bales)\***

Area	Variety (1977)	Production to Date	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	Present Ginnery Capacity
Western	BPA	10 000	12 000	14 000	15 000	16 000	17 000	18 000	20 000	26 000
Nyanza	UKA	3 000	6 000	10 000	12 000	13 000	13 000	14 000	14 000	14 000 <sup>1</sup>
East Central	UKA	12 000	24 000	36 000	42 000	60 000	68 000	75 000	80 000	26 500 <sup>2</sup>
Coast	UKA	3 000	5 000	7 000	8 000	9 000	10 000	11 000	12 000	13 250
Hola (Irr)	UKA	4 000	4 000	4 000	4 000	4 000	6 000	6 000	6 000	4 500
Bura (Irr)	?	—	—	—	2 000	8 000	20 000	30 000	40 000	— <sup>3</sup>
<b>TOTAL</b>		<b>32 000</b>	<b>51 000</b>	<b>71 000</b>	<b>83 000</b>	<b>110 000</b>	<b>134 000</b>	<b>154 000</b>	<b>172 000</b>	<b>84 250</b>
Estimated Local Mill Requirements	MISC	62 000	71 000	71 000	83 000	100 000	114 000	120 000	130 000	—
Shortfall		30 000	20 000	—	—	—	—	—	—	—
Excess		—	—	—	—	10 000	20 000	34 000	43 000	—

\* 400 lbs of cotton lint per bale

<sup>1</sup> By 1977/78

<sup>2</sup> Including Meru (1977/78)

<sup>3</sup> Ginnery to be provided for Bura by 1979, capacity 40 000 bales minimum

Notes:

#### 1.4 The Hola Irrigation Scheme

The Hola Irrigation Scheme is located some 30 kilometres south of Bura on the bank of the Tana River on soils generally similar to those of Bura but productively slightly inferior. Part of the Hola Scheme has been in production since 1956, but during the first ten years the Scheme had little success until in 1966 technical assistance was provided and cotton yields increased from about 1 200 kg/ha in 1966 to 2 000 by 1976, of which 99 per cent was graded AR, the higher of the two grades currently used in Kenya.

The variety grown in bulk at Hola is UKA (UK 51), apart from various trials. The vigour of the UKA variety results in excessive stem and leaf growth at times which tends to reduce boll formation. This variety is essentially for rain-grown conditions and was not bred for irrigation. Similarly the other main commercial variety grown in Kenya - BPA, was bred for rain-grown conditions and not for irrigation farming, BPA would be expected to show excessive leaf and stem growth also.

Trials were carried out at Hola to determine a variety more suitable to the climatic conditions of the Lower Tana River Basin and to irrigated conditions. These trials continued over a period of three years on Upland African and American varieties with UKA and BPA comparative trials. Several upland varieties were proven superior in yield and lint outturn to UKA and BPA, and only susceptibility to bacterial blight was in question, when the trials were unaccountably discontinued prior to reaching a conclusion.

At present the variety trial programme is in an indeterminate state and achieving little, but as a result of meetings at the offices of the National Irrigation Board in Nairobi and a visit to the Hola Scheme and the Research Unit, a revision of the research programme was agreed along more constructive lines.

The first and most obvious variety to be given a more intensive trial under irrigation is BPA, for surprisingly no BPA cotton was under trial at Hola at present. It was arranged that a supply of improved BPA75 seed from Kibos would be made available for Hola at the earliest opportunity and trials and multiplication of this seed could commence next season. It was also agreed that a continuation of trials was necessary on those upland varieties already proven as regards yield and lint outturn, with particular emphasis on bacterial blight resistance.

It was recommended that a 'blackarm' resistant Acala seed material should be sought from the Sudan for trial and bulking at Hola. There is evidence to suggest that the climate and environmental conditions at Hola would not in any case be conducive to bacterial blight, and in particular the minimum incidence of rain-splash conditions. This view was expressed by the National Irrigation Board's plant pathologist and is in our opinion substantially correct. Nevertheless it would be desirable to test a 'blackarm' resistant Acala at Hola and also in an area where bacterial blight is prevalent at present.

Further research should continue elsewhere in Kenya on improving the UKA and BPA varieties, and a drought-tolerant, quick-maturing variety, should be found for those areas with low and/or short rainfalls, preferably with a staple length of 32/32 inches, which would meet some of the demand from local mills for the material required to spin low counts.

## CHAPTER 2 EFFECTS OF COTTON VARIETY

### 2.1 Lint Quality

The textile industry in Kenya, as in most developing countries, sells all its products internally and the bulk of the market demand is for the cheaper range of textiles for the lower income groups. Consequently the industry mainly requires cotton in the short to medium staple range in the lower quality grades.

The current cotton mill requirements were discussed with the Director of Thika Cloth Mills, the largest textile mill in Kenya; with the General Manager of Wanyuki Mill operated by David Whitehead and Company, of Lancashire (part of the Loneho Group); with cotton importing and exporting agencies; and the General Manager of the Cotton Lint and Seed Marketing Board (CLSMB). The total mill requirements for internal consumption were approximately 70 000 bales per annum, provided each mill was in full production, which many were not. A list of the main textile factories is attached as Appendix I, with their annual requirements.

The present total Kenya cotton crop is about 30 000 bales of cotton lint leaving a shortfall around 40 000 bales. This numerical deficit in bales has in the past been met by imports of cotton from Uganda and Tanzania.

In addition the better grades and staples of Kenya's own cotton crops BP AR grade and UK AR grade have been exported, while the lower grades BK BR and UK BR have been used internally, and the remaining shortfall made up from Uganda and Tanzania BR grade types.

With supplies from Uganda negligible as a result of a drastic reduction in production, and the closure of the border with Tanzania and the cessation of trading, the Kenya textile industry is embarrassingly short of cotton, and is in the position at present where it must find the quantity of bales required from -

- (a) Better grade and staple types from its own production which are in excess of their spinning requirements and more costly as they must purchase this higher value cotton at public auction in competition with overseas buyers, or,
- (b) import cotton of types more suitable for their spinning requirements, at world market prices, plus shipping and freight costs. In addition imported cotton carries an import duty which the manufacturers hope will be refunded this year.

The Marketing Board has not given textile mills carte-blanche importation licences, but at present have allowed specific quantities of cotton to be imported on a no-objection basis.

It is extremely difficult to define exactly what types and quantities of each are required by the industry, particularly when there are shortages in supplies of the requisite types, such conditions tend to give a false impression of the mills' needs. Nevertheless with many mills spinning low counts from 10S to 24S the bulk of cotton required must be in the effective fibre length range of 28/32 inches to 34/32 inches. Even BP BR must be too good for counts below 20S while UK BR would be suitable for the lower counts, but both these BR grade types require to be mixed with better and cleaner grades to ensure a reasonable quality of product. East African BR grades are notoriously dirty and contain much trash and stained cotton, but account for less than 10 per cent of the total crop production. The textile mills in Kenya have already imported cotton this year from the Sudan, Argentina and Turkey, in the 33/32 inches - 34/32 inch range of effective staple length.

It is apparent that for many years to come good quality 32/32 inch cotton will be in demand in Kenya by the industry, but whether this should be grown in Kenya or imported is another question. Certain mills such as Rivatex, Fine Spinners, and Kenya Rayon require some cotton in

the medium staple ranges 34/32 inches to 36/32 inches and can use some UKA and BPA to fill these requirements.

It is calculated that the Industry's requirements of 70 000 bales would be met from:-

Say	54 000 bales 31/32 inches - 33/32 inches staple
	10 000 bales 34/32 inches - 35/32 inches staple
	6 000 bales 36/32 inches and over staple.

## 2.2 Effect of Variety on the Milling Industry

The main varieties of cotton grown in Kenya at present are from Uganda BP and Tanzanian UK seed material, apart from a small sector growing Tanzanian IL (Ilonga) seed material.

Most of this seed is old in the sense that its issue as planting material from the respective research stations in Uganda and Tanzania dates back 10 to 14 years, and adulteration of the main varieties, particularly BPA, has occurred over the years.

The textile mill industry is not over-concerned about the varieties used, as long as the grades and staples required can be obtainable either from Kenya's own production or from cheap imports.

Mills which at present are using Sudan Acala cotton are satisfied with the spinning quality of this variety, although there are localised problems with honeydew on some Sudan cotton. However, this is not a varietal fault but an agricultural one, specifically insufficient pest control. Honeydew secretion on cotton lint fibres is due to a late attack of aphids on opening cotton bolls prior to harvesting. The mills using Acala are mixing it with UK BR and BP BR, and obtain a satisfactory mix for spinning and weaving.

With regard to the likely use by the textile manufacturers of the cotton produced at Bura if the variety grown was UKA, only a proportion of higher AR grade would be used but all UK BR would be taken. However the amount of BR produced in an irrigation scheme could be as little as one per cent of the crop, e.g. The Hola Irrigation Scheme during the season 1975/76 produced 2 490 000 kg AR seed cotton and only 20 000 kg BR seed cotton, less than one per cent being BR.

Making allowance for non-marketing of BR by farmers, or non-harvesting of seed cotton damaged, diseased, immature, and of 'B' Grade, it is unlikely that Stage I Phase I of the Bura Project would produce more than 600 bales per annum in 'B' grades, except in the event of some disaster.

The better grade and staple of UKA, AR if offered under auction open to both local textile mills and overseas buyers, would probably find a market overseas during periods when world market prices were firm and higher than average. During these periods it would be to the advantage of local mills to purchase lower grade and shorter staple cotton from outside Kenya if this cotton can be obtained at a price lower than UKA AR.

If the BPA variety is introduced at Bura as the main commercial variety, the position would be even more biased towards overseas markets, because the world market demand for this cotton is remarkably strong at present, and this situation will prevail until such time as the Uganda cotton crop recovers to something like its previous average.

If an upland variety such as Acala were chosen for Bura, more would be used internally, a but a considerable quantity would be exportable if the world market price was average or higher than average, and mills could import alternative cheaper grades and shorter staples.

There is the other alternative of growing a shorter staple upland variety such as an Albar derivative, higher yielding, but about 32/32 inches to 33/32 inches staple and this would probably all be taken by local mills.

Our opinion is that irrigation projects are so costly that the economics of a successful operation demands the production of the cotton variety which will give the best return to:-

- (a) The tenant farmers;
- (b) The project as a complete unit;
- (c) The country as a whole - i.e. the local textile industry and the marketing organisation.

This means inevitably that the choice of variety must be a compromise between interests as follows:-

- (a) Short staple, high yielding varieties will be more rewarding to the farmers, and will provide a cheaper, plentiful source of supply for the local textile industry, but the value of the product will not provide a good economic return for the capital cost of an irrigation project, nor will it give the best return on the country's investment relative to the marketing potential of irrigation-grown cotton.
- (b) Obversely the choice of a long staple, low yielding variety, will penalise the farmers, perhaps to a mere subsistence return for their endeavours, and will be of little interest to local mills, as it will be too good for their use, and too costly. The project as a unit might not be economically viable, because the cash return for seed cotton produced would be less, i.e. the price of seed cotton is the same for long staple as it is for short staple, and the lower yield and lower lint outturn would reduce the annual income from seed cotton production and from ginning operations. The country would however export all the long staple variety at a high price, and the local industry would import cheaper varieties, thus ensuring a favourable foreign exchange position.
- (c) The compromise, is the choice of a medium staple variety, high yielding and of high lint outturn, which will provide a satisfactory return to the farmers, and a middle range cotton which local industry could use as a substantial part of its cotton mixes, and if overseas supplies were difficult to obtain or expensive then more of this variety could be used. It would be a cotton that the local industry would evolve into, i.e., as the demand for better quality cloths increases gradually the mixes will include more medium staple cotton. The project as a unit will benefit from increased cotton production and high lint outturn to a viable position. The country would benefit almost as much as with the longer staple cotton varieties, during world market "highs" and do better during market "lows". The extra yield and extra lint outturn would represent, in additional bales for sale, sufficient cotton to erode the price differential for longer staple cotton except in the most exceptional market "highs", and would provide a better return and balance of payments position at all other times.

### 2.3 Effect of Variety on Tenants Income

The position at present is that the variety UKA as grown in commercial quantities at the Hola Irrigation Scheme is reasonably successful agriculturally, and provides farmers with an average yield in normal conditions of around 2 800 kg/ha. The lint outturn of UKA is low at 32 per cent, and field trials of Acala and other upland varieties have indicated that farmers yields could be increased to 3 500 kg/ha average, and lint outturn to 37 per cent or more.

BPA showed similar yields to UKA under trial conditions and when related to commercial growing by tenant farmers would be expected to yield slightly less than UKA, say 2 600 kg/ha under similar conditions. The lint outturn is very low being under 32 per cent, possibly 31.5 per cent.

From the farmers viewpoint Acala or a similar upland variety, would provide more income, between K Sh 2 000 and K Sh 2 500 per ha per annum at no additional cost, and with probable savings on insecticides due to less vigorous leaf and stem growths, water regimes may also be more economical.

Looking at the success of the project as a whole, the Acala or similar upland variety would be of greater benefit to the tenant farmers and would provide the project with additional lint of between 6 and 8 per cent in excess of the outturns of BPA and UKA varieties on a greater yield of seed cotton.

For example, if we assume a UKA/BPA yield of 2 800 kg/ha and Acala or similar at 3 300 kg/ha, a difference of 500 kg/ha at lint outturn of 31 and 38 per cent, respectively, UKA/BPA would provide 868 kg lint per ha and Acala or similar 1 254 kg lint per ha. If we assume a price of US \$ 2 per kg for BPA lint only and US \$ 1.80 per kg for Acala lint, the return on BPA is \$ 1 736 per ha and for Acala \$ 2 257, a difference of some K Sh 4 200 per ha in favour of the upland variety, or some K Sh 25 million per year extra for the project. These are conservative figures, but outturn and yields could surpass those quoted for the upland varieties.

It is unlikely that price differentials between BPA and Acala lint would exceed US 20 cents per kg in favour of BPA, except for short periods, and in the long-term Acala or similar varieties would prove more rewarding to the project.

In addition there would be savings on ginning costs both to the Marketing Board and to the project if Acala or similar seed was chosen because Acala could be saw-ginned, while BPA would require to be roller-ginned. Saw-ginning factories cost less, both as regards capital expenditure, and operating costs, see Chapter 3.

#### **2.4 Future Textile Industry Demand Patterns**

The textile industry will continue to expand its capacity and demand for cotton. Estimates vary, but mills have expansion plans for increased capacity, which if followed would provide capacity for a throughput of 130 000 bales by 1983.

It is probably more realistic to assume that this capacity will not be fully utilised, but even so, as a conservative estimate a supply of 100 000 bales will be required in the early 1980s for the industry.

The Government plan to encourage cotton production to a numerical self-sufficiency in bales is under weigh, and without the Bura Project production of rain-grown cotton is expected to reach the numerical requirements of the industry by the early 1980s. This assumes, however, a remarkable increase in production of cotton in the Nyanza area and in East Central particularly Meru District, and cautious observers who have experienced the vagaries of cotton production in Kenya in the past are sceptical of the rain-grown production targets ever being reached in this period of time - if ever. Nevertheless with the inclusion of Bura production of some 40 000 bales, numerical self-sufficiency in bales could be achieved in the early eighties.

## CHAPTER 3 A COMPARISON OF SAW AND ROLLER GINNING

### 3.1 General Comparison of Systems

Saw ginning systems are generally used for processing short and medium staple cottons up to about 40/32 inch staple lengths, although there are exceptions to the rule depending on the type and character of the cotton. Cotton over 40/32 inch staple can be saw-ginned satisfactorily if certain conditions pertain, such as optimum moisture content and suitable fibre strength. Roller ginning systems are used for long staple cottons 48/32 inches and over, and also generally for staple lengths between 40/32 inches to 48/32 inches, and under certain conditions for medium staple lengths around 36/32 inches to 37/32 inches. There is, therefore, an overlap situation in the medium staple range where either system can be used relative to the condition and character of the cotton. Saw ginning systems are highly productive and are necessary where large quantities of short and medium staple cottons must be processed within a six-month or less ginning season. The bulk of world production of cotton is saw-ginned being in the short to medium staple range.

Saw-ginning systems provide as a general rule a much cleaner lint than roller gins, and are readily integrated into pneumatic conveyance systems, extra cleaning equipment for mechanically harvested cottons, and with drying and moisture conditioning systems.

By comparison saw-gin installations cost less to operate than roller-gin installations of similar throughput capacity, for example:-

To process 20 000 tons of seed cotton (Bura Stage I, Phase I estimated crop production) a stand of 3 saw gins would be sufficient to process the crop in 24 weeks, while 88 double roller gins would be required to process this same quantity in the same period of time.

Three gin machinery operatives plus a supervisor would be required for a saw-gin stand, while about 50 would be needed for a roller gin unit (assuming one operator can feed two roller gins) plus at least four mechanical supervisors who would be employed to keep the machines correctly adjusted and fully productive, and two supervisors per shift. The number employed outside the respective ginneries, feeding with seed cotton moving and stacking bales, and bagging and stacking cotton seed would be similar, although seed cotton feeds to saw-gin units can be more readily mechanised through pneumatic feed systems reducing labour intensiveness as a result. The baling systems for each would be similar, although the conveyance systems of lint from saw-gin units to press are more efficient and less expensive installations.

Machine-harvested cottons are generally saw-ginned but many countries with hand-picked cotton crops saw-gin the entire crop, e.g., Nigeria, Tchad, Mozambique, Malawi, Ethiopia, and Afghanistan. In the USA and USSR the bulk of the crop is saw-ginned. In the Sudan the upland Acalas are saw-ginned.

If the UKA variety were chosen this would saw-gin satisfactorily, and even BPA in the dry conditions of the project area could be successfully saw-ginned. However from a marketing view point, East Africa has provided roller-ginned BPA and UKA cotton for many years and overseas buyers have become accustomed to BPA and UKA roller-ginned. It would not be prudent to saw-gin these varieties as long as Uganda and Tanzania offer the market roller-ginned BPA and UKA cotton. There is a market prejudice in favour of roller ginning these varieties at present.

## COST COMPARISONS

### 3.2 Capital Costs

Production of seed cotton from Stage I, Phase I of the Bura Project is taken to be 20 000 tonnes (say 40 000 bales of lint) and it is assumed that this will be processed in a 24 week period. The comparative capital costs of saw-gin and roller-gin installations to cope with the above rate of production and based on 1977 prices are summarised in Table 3.1 below. Full details are in Appendix II.

**Table 3.1 - Comparative Capital Costs of Saw and Roller Ginning Installations for Phase I, Stage I Bura Production (40 000 bales\*)**

Item	Cost (1 000 K Sh)	
	Saw ginning	Roller ginning
Ginning equipment and baling press	4 000	8 800
Electrical equipment and distribution system	750	1 300
Installation of ginning and electrical equipment	340	640
Building to house equipment	355	1 300
Foundations and building erection costs	285	570
CIF costs on imported items	850	1 400
Total capital cost	6 580	14 010

\* 400 lbs of cotton lint per bale

Thus, the estimated capital cost of roller ginning is more than twice that of saw ginning. The main reason for this considerable difference in price is the relative size of the required equipment. The saw ginning installation would comprise three units (see Appendix II) which could be housed in a much smaller building and would require much less electrical equipment with a corresponding more compact electrical distribution system. The roller ginning installation would comprise 88 units needing a very much bigger building to house them, with a considerably greater amount of electrical equipment and a much more widespread distribution system.

All costs are based on supplying ginning machinery of reliable and reputable manufacture. A saving of about K Sh 900 thousand on the capital costs of roller ginning equipment could be attained if roller gins of Indian manufacture were accepted, bringing the capital costs of the roller ginning installation down to K Sh 13.11 million. However, such equipment is not made under licence and there could be no guarantee of performance and the purchase of such equipment could not be recommended (see Annexe II).

### 3.3 Operating Costs

The comparative operating costs for one season's production by the two types of ginning installation, covering such items as permanent and temporary staff, power costs, maintenance and depreciation are summarised in Table 3.2: full details are given in Appendix II.

Table 3.2 - Comparative Operating Costs of Saw and Roller Ginning for Phase I, Stage I Bura Production (40 000 bales of lint per annum)

Item	Cost (1 000 K Sh)	
	Saw ginning	Roller ginning
Salaries and wages	682	1 119
Power	1 584	1 901
Maintenance	280	350
Sub total	2 546	3 370
Plus depreciation	439	934
Net operating cost	2 985	4 304

From the above table it is clear that saw ginning is also considerably cheaper in terms of operating costs. The major causes of the greater operating costs of roller ginning would be the additional labour required and the extra power, maintenance and depreciation costs of the larger number of ginning units.

The difference in cost per bale of lint cotton produced would be just under K Sh 33 in favour of saw ginning or about Kenya cents 8 per lb of lint cotton. While saw ginning is considerably cheaper both in capital and production costs, the greater cost of roller ginning could be recovered by selling lint at a premium above saw-ginned lint, provided international prices permitted.

#### 4.3 Timing of Construction

If there is to be a delay before deciding on the various choice of cotton for Phase I, Stage I of the Bura Project, it would be possible to provide a ginnery building of required dimensions for a full season's work, and place in this building for one or two years, 10 or 20 roller gins to process the small quantities expected in the first two productive years. Thereafter the roller gins could be shifted elsewhere and a saw-gin unit installed in their place. The hydraulic baling press and pump units should be initially installed of sufficient capacity for 40 000 bales per season of 26 weeks.

Alternatively a small roller-gin factory could be kept at Bura for ginning selected cottons of variety trials, and the main production plant would be a saw-gin unit.

However, we consider that there are sufficient grounds for deciding on the construction of one saw-gin plant, comprising three units, for the full capacity of 40 000 bales right from the start, and to defer this decision.

#### 4.4 Storage

Time did not permit a detailed examination of the location of storage for seed cotton. However, to avoid excessive delivery to the ginning factory and overloading of its facilities, and to provide some village storage for drying and safe-keeping of assigned tenants' crop there appear to be good reasons for providing some secure and dry cotton seed storage.

## CHAPTER 4 CONCLUSIONS

### 4.1 Variety

It is essential that the tenants of the Bura Project obtain as high a return as possible for the production of their cotton crops, particularly with a holding size of only 1.25 hectares. This single factor, which we cannot stress sufficiently in importance convincingly supports our recommendation that a high-yielding high-lint outturn variety should be planted, such as a 'blackarm' resistant Acala or similar upland variety.

The high lint outturn coupled with high yield will ensure that any price differential for roller-ginned cotton will be deleted in all but exceptional marketing circumstances and that in the majority of years an Acala type cotton will be more profitable to all concerned.

### 4.2 Choice of Ginning Equipment

An upland variety of cotton such as Acala or similar is eminently suitable for saw-ginning, and if this were the choice we recommend the installation of a saw-gin factory, with attendant savings in capital cost and operation. Details of the estimated capital and operating costs are outlined in Chapter 3 and detailed in Appendix II.

### 4.3 Phasing of Construction

If there is to be a delay before deciding on the varietal choice of cotton for Phase I, Stage I of the Bura Project, it would be possible to provide a ginnery building of required dimensions for a full saw-gin plant, and place in this building for one or two years, 16 or so, roller gins to process the small crops expected in the first two productive years. Thereafter the roller gins could be utilised elsewhere and a saw-gin unit installed in their place. The hydraulic baling press and pump units must however be initially installed of sufficient capacity for 40 000 bales per season of 26 weeks.

Alternatively a small roller-gin factory could be kept at Bura for ginning selected cottons or variety trials, and the main production plant would be a saw-gin unit.

However, we consider that there are sufficient grounds for deciding on the construction of one saw-gin plant, comprising three units, for the full capacity of 40 000 bales right from the start, and we favour this decision.

### 4.4 Storage

Time did not permit a detailed examination of the location of storage for seed cotton. However, to avoid excessive delivery to the ginning factory and overloading of its facilities, and to provide some village storage for drying and safe-keeping of weighed tenants crop there appear to be good reasons for providing some secure and dry cotton seed storage.

## CHAPTER 5. SECONDARY PROCESSING INDUSTRIES

### 5.1. Cotton Seed Oil Milling

At present there is substantial over-capacity in oil-milling plants in Kenya. However, if and when the rain-grown cotton production reaches 100 000 bales, the increased seed production will take up the existing milling capacity. It would seem, therefore, that until Phase I, Stage I of the Bura Project is approaching full production, and say 10 000 tonnes of seed are available for crushing, the seed for milling should be sent to Mombasa for processing.

The conclusion that as a general principle it is sound economic practice to install oil-milling facilities adjacent to large producing ginneries. It is therefore recommended that the construction of an oil mill at the Bura centre of the Bura Project should be considered once full cotton production is reached in Phase I, Stage I of the project. If this mill were a joint Government/Tenants Co-operative effort, the tenants would benefit from a share in the oil-milling profits and the project as a whole would have a greater economic viability.

### 5.2. Other Secondary Processing Industries

There are a large number of small secondary processing industries which could become established at Phase I, Stage I of the Bura Project. These include decanting of maize, maize grain crushing, processing of crop and animal residues for livestock and fish feed, groundnut shelling, groundnut kernel grading and crushing etc.

#### PART 2

The development of these small secondary processing industries should be left to the private sector which may evolve according to market requirements.

#### OTHER PROCESSING

## CHAPTER 5 SECONDARY PROCESSING INDUSTRIES

### 5.1 Cotton Seed Oil Milling

At present there is substantial over-capacity in oil milling plants in Kenya. However if and when the rain-grown cotton production reaches 100 000 bales, the increased seed production will take up the slack in milling capacity. It would seem, therefore, that until Phase I, Stage I of the Bura Project is approaching full production, and say 10 000 tonnes of seed are available for crushing, the seed from Bura should be sent to Mombasa for processing.

We consider that as a general principle it is sound economic practice to install oil milling facilities adjacent to large producing ginneries. It is therefore recommended that the construction of an oil mill at the rural centre of the Bura Project should be considered once full cotton production is reached on Phase I, Stage I of the project. If this mill were a joint Government/Tenants Co-operative effort, the tenants would benefit from a share in the oil-milling profits and the project as a whole would have a greater economic viability.

### 5.2 Small Secondary Processing Industries

There is a large number of small secondary processing industries which could become established at Phase I, Stage I of the Bura Project. These include: decobbing of maize, maize grain crushing, processing of crop and animal residues for livestock and fish feed, groundnut shelling, groundnut kernel packaging and crushing etc.

The development of these small secondary processing industries should be left to the private sector so that they evolve according to local demands.

APPENDIX I  
TEXTILE INDUSTRY - KENYA

Year	Production (kg)	1977/78	1982/83
1977/78		1977/78	1982/83
1978/79	21 000	21 000	25 000
1979/80	12 500	12 500	30 000
1980/81	12 500	12 500	17 000
1981/82	12 000	12 000	15 000
1982/83	3 000	3 000	5 000
1983/84	3 000	3 000	5 000
1984/85	3 000	3 000	5 000
1985/86	1 500	1 500	5 000
1986/87	1 500	1 500	5 000
1987/88	75 000	75 000	200 000

**APPENDIX I**

**APPENDIX I**  
**TEXTILE INDUSTRY - K ENYA**

**Textile Mills and Capacities  
(400 lb bales of cotton lint)**

	1977/78	1982/83
Thika Cloth Mill (main extension programme complete)	20 000	25 000
Rivatex - Edoret	12 500	20 000
Nanyuki Textile Mills Ltd, Nanyuki	12 500	17 000
Kisumu Cotton Mills	12 000	15 000
U.T.I. Kenya Ltd	3 000	5 000
Kenya Rayon, Mombasa	3 000	6 000
Fine Spinners	3 000	5 000
Sunflag Textile and Knitwear, Nairobi	3 000	5 000
Miscellaneous small mills	1 000	5 000
<b>Total capacity</b>	<b>70 000</b>	<b>103 000</b>

Estimated Costs of Roller Ginning Installation

Cost  
(11 000K Sh)

151 - Middleton Double Roller Ginn Model 5 with  
hydraulic conveyance from stores to Separator/  
Cotton Opener unit, Partial Seed Cotton  
distribution system, Seed and Lint conveyance  
to Bale Box, 20 inches x 41 inches High Density  
Safing Press, with transport and auto-feed system  
(with Lint Cleaning)

Cost Manufacture by Platt\*  
(UK £ 1 000 000 fob)

8 000

Electrical distribution, switchgear,  
cables, lighting, etc.  
(UK £ 90 000 fob)

1 300

Installation of machinery and electrical  
(UK £ 45 000)

540

Building for Roller Ginn Plant - Main Hall  
100 ft x 40 ft x 21 ft steel structure and  
cladding

**APPENDIX II**

(UK £ 75 000 fob) approx  
Press Room - 50 ft x 50 ft x 24 ft  
Warmer Room - 50 ft x 20 ft x 21 ft  
Baler Rooms etc 40 ft x 40 ft x 21 ft  
(UK £ 15 000 fob)

Plant Building Structures  
(UK £ 90 000)

1 300

Civil work, floors, foundations, erection etc.  
(UK £ 40 000)

570

Costs of CIF on imported  
machinery, electrical, steel  
(UK £ 100 000)

1 400

Transport to site and port charges not included

TOTAL COST (UK £ 1 002 000)

14 010

NOTE: These Gins of Indian manufacture could be procured at a cheaper price, giving a reduction in the above price of about K Sh 900 000 to about K Sh 11-110, 000. These gins are copies of the Platt, Middleton Ginn and are not manufactured under licence for Platt as the Indian manufacturer claims. There can be no guarantee of performance with these gins comparable with the guarantee provided by Platt UK.

The Hydraulic Safing Press and Pulper should be to the equipment specification for the Ginn Ginn Plant and manufactured either in the USA or UK.

## 2. Capital Costs of Roller Ginning Installation

	Cost (1 000K Sh)
88 – Middleton Double-Roller Gins Model 5 with pneumatic conveyance from stores to Separator/Cleaner-Opener unit. Partial Seed Cotton distribution system. Seed and Lint conveyance Double Box, 20 inches x 41 inches High Density Baling Press, with trampers and auto-feed system Motors and starters. (No Lint Cleaning)	
UK Manufacture by Platts* (US \$ 1 100 000 fas)	8 800
Electrical distribution, switchgear, cables, lighting, etc. (UK £ 90 000 fob)	1 300
Installation of machinery and electrics (UK £ 45 000)	640
Building for Roller Gin Plant - Main Hall 430 ft x 40 ft x 21 ft steel structure and cladding (UK £ 75 000 fob) approx Press Room 50 ft x 50 ft x 24 ft Cleaner Room 50 ft x 50 ft x 21 ft Seed Rooms etc 40 ft x 40 ft x 21 ft (UK £ 15 000 fob) Total Building Structures (UK £ 90 000)	1 300
Civil work, floors, foundations, erection etc. (UK £ 40 000)	570
Costs of CIF on imported machinery, electrics, steel (UK £ 100 000)	1 400
(Transport to site and port charges not included)	
<b>TOTAL COST (UK £ 1 002 000)</b>	<b>14 010</b>

Notes: \* 88 Gins of Indian manufacture could be procured at a cheaper price, giving a reduction in the above price of about K Sh 900 000 to about K Sh 13 110, 000. These gins are copies of the Platt, Middleton Gins and are not manufactured under licence for Platts as the Indian manufacturer claims. There can be no guarantee of performance with these gins comparable with the guarantees provided by Platts UK.

The Hydraulic Baling Press and Pumps should be to the equivalent specification for the Saw Gin Plant and manufactured either in the USA or UK.

## APPENDIX II

### CAPITAL AND OPERATING COSTS OF SAW AND ROLLER GINNING INSTALLATIONS FOR A CAPACITY OF 40 000 BALES

#### 1. Capital Costs of Saw Ginning Installation

Saw Gin Factory to process 20 000 tonnes of seed cotton in 24 weeks  
(say 40 000 bales of lint).

	Cost (1 000 K Sh)
(a) 3 - Saw Gins with Inclined Cleaner 3 - Extractor Feeder/Cleaner 1 - Seed Cotton Distributor Seed and Trash conveyance systems Seed Cotton pneumatic conveyance 1 - Double-Box, 20 inches x 41 inches High Density Baling Press, with automatic Trampers and Feed systems, and humidification unit, complete with Motors and Starters (Without Lint Cleaners) (Approx US \$ 500 000 fas)	4 000
(b) Electrical distribution, cable, switchgear, capacitors, lighting, etc. (UK £ 53 500 fob)	750
(c) Installation of machinery and electrics (UK £ 23 500)	340
(d) Building for above plant, 120 ft x 40 ft high steel structure and steel cladding (UK £ 25 000 fob)	355
(e) Civil work - foundations, floors, erection of steel, etc. (UK £ 20 000)	285
(f) Cost to CIF on imported elements, Machinery, electrics, and steel (This could be reduced perhaps by purchasing locally) (UK £ 60 000)	850
(Transport to site and port charges not included)	
<b>TOTAL COST (£ 475 000)</b>	<b>6 580</b>

### 3 . Operating Costs of Saw Ginning Installation

Salaries and Wages Permanent Staff and Labour	Payment Units (U)
1 General Manager	5 000
1 Production Engineer (alternatively the above could be filled by 1 Engineer/Manager @ U 6 000)	5 000
1 Accountant	4 000
1 Cashier	2 000
2 Accounts clerks = 2 x U 800 Av	1 600
2 Clerks = 2 x U 700 Av	1 400
1 Typist	500
2 Shift Engineers = 2 x U 3 000 Av	6 000
1 Storekeeper/Timekeeper	800
1 Assistant Storekeeper (nights)	600
2 Stores Labourers = 2 x U 450 Av	900
3 Fitter/Machinists = 3 x U 1 000 Av	3 000
3 Machine Operators = 3 x U 600 Av	1 800
2 Press Operators = 2 x U 750 Av	1 500
1 Welder/Blacksmith*	1 000
1 Turner*	1 000
1 Electrician*	1 000
1 Loading and Storage Clerk	500
2 Watchmen 2 x U 400 Ave.	800
2 Sweeper/Cleaners 2 x U 400 Ave.	800
4 Operators (Semi-skilled) 4 x 500	2 000
1 Cotton Classer/Grader	23 000
Total Permanent Staff (approximately 35)	44 200

Notes: \* Could be shared with central workshops. † Payment Units have been used because some costs would be in local currency and some in foreign currency. For Kenya a Payment Unit is taken to be equivalent to K Sh 10.

	Payment Units (U)
Seasonal Labour Outside Factory	
(a) Seed Cotton: Handlers, unloaders, feeders etc. 18 for day shift and 10 for night shift inclusive of overtime (operating two shifts). 28 Men @ U 250 average for season	7 000
(b) Lint Bales: Handlers, stackers, markers, stitchers, etc. 10 days/6 nights = 16 x U 250 Ave. (using grab-lift trucks)	4 000
(c) Cotton Seed: Bagging seed, stitching, stacking, handling, etc. 12 days/6 nights = 18 x U 250 Ave. (using conveyors and elevators)	4 500
(d) Miscellaneous Labour (Trash etc.) 4 days/2 nights = 6 x U 250 Ave.	1 500

**Inside Factory**

(e)	Seasonal production team baling, feeding etc. 5 days/5 nights = 10 mult s U 250	2 500
(f)	Seasonal Cleaners 2 days = 2 x U 250	500
(g)	Semi-skilled seasonal 6 men = 6 x U 400	2 400
(h)	Seasonal Tally Clerks 4 men = 4 x U 400	1 600
	Seasonal Total approx	24 000
	Permanent Staff and Labour - Brought forward	44 200
	<b>Total Cost of Salaries and Wages to Operate Saw Gin per Annum</b>	<b>68 200</b>

#### 4. Operating Costs of Roller Ginning Installation

	Payment Units (U)
Salaries and Wages	
Permanent Staff and Labour	
1 General Manager	5 000
1 Production Engineer	5 000
(alternatively 1 - Engineer/Manager @ U 6 000)	
1 Accountant	4 000
1 Cashier	2 000
2 Accounts Clerks = 2 x U 800	1 600
1 Typist	500
4 Shift supervisory Engineers = 4 x U 3 000	12 000
1 Storekeeper/Timekeeper	800
1 Assistant Storekeeper (nights)	600
3 Stores Labourers = 3 x U 450	1 350
8 Fitter/Machinists = 8 x U 1 000	8 000
12 Permanent Machine Operators = 12 x U 600	7 200
2 Press Operators = 2 x U 750 Av	1 500
1 Welder/Blacksmith*	1 000
1 Turner*	1 000
1 Electrician*	1 000
2 Clerks = 2 x U 500	800
2 Watchmen = 2 x U 400	2 400
6 Sweeper/Cleaners = 6 x U 400	4 000
8 Operators semi-skilled = 8 x U 500	3 000
1 Cotton Classer/Grader	63 750
Total Permanent Staff - approx 56 @ Total	

NOTE: \* Could be shared with Central Workshop

	Payment Units (U)
Seasonal Labour - Roller Gin Factory	
Outside Factory	
(a) Seed Cotton: Handlers, unloaders, feeders, etc. 24 day and 12 night shift = 36 x U 250	9 000
(b) Lint Bales: Handlers, stackers, markers, etc. 10 days/6 nights = 16 x U 250	4 000
(c) Cotton Seed: Bagging, stitching, stacking, etc. 12 days/6 nights = 18 x U 250	4 500
(d) Miscellaneous Labour: 8 days/4 nights = 18 x U 250	3 000
Inside Factory	
(e) Seasonal Production team 44 Gin Operators (1 for 2 gins) each shift = 88 x U 300 Baling seed teams etc. = 10 x U 250	26 400 2 500

(f)	Seasonal cleaners 4 days = 4 x U 250	1 000
(g)	Semi-skilled Seasonal 6 men = 6 x U 400	2 400
(h)	Seasonal Tally Clerks 6 men = 6 x U 400	2 400
	<b>Total</b>	<b>55 200</b>
	<b>Permanent Staff and Labour - Brought Forward</b>	<b>63 750</b>
	<b>Total Cost Roller Gin Factory</b>	
	<b>Salaries and Wages per Annum</b>	<b>118 950</b>

NOTE: For Kenya Multiply U by K Sh 10/= for local currency value.

5.

**Power Costs**

**Saw Gin Factory**

Installed HP

- Machinery - without lint cleaners  
pollution control units, fire pumps
- Lighting and Workshop (52 + 30)
- Miscellaneous
- Total

- 650 hp or 595 kW
- 82 hp or 61 kW
- 18 hp or 14 kW
- 750 hp or 670 kW

**Roller Gin Factory**

Installed HP

- Machinery - without lint cleaners  
pollution control unit and fire pumps
- Lighting and workshop (150 + 30)
- Miscellaneous
- Total

- 995 hp or 750 kW
- 180 hp or 135 kW
- 25 hp or 18 kW
- 1 200 hp or 903 kW

Power required for saw gin season at  
80% efficiency =  $750 \times 80\%$   
x 22 hours x 5 days x 24 weeks  
@ K Sh 1/per unit of power

600 kW  
1 584 000 kWh  
K Sh 1 584 000

Power required for Roller Gin Season at  
80% efficiency =  $900 \times 80\%$   
x 22 hours x 5 days x 24 weeks  
@ K Sh 1/per unit of power

700 kW  
1 900 800 kWh  
K Sh 1 900 800

**6. Miscellaneous Production Costs**

	K Sh
Maintenance - Saw Gins	280 000 p.a.
etc. - Roller Gins	350 000 p.a.
Baling materials Saw Gins and Roller Gins	Same

Miscellaneous Administration costs etc.

Assuming similar costs for roller and saw ginning with the exception of:

Depreciation	K Sh	K Sh
Saw Gin Factory 15 years straight line	<u>6 500 000</u>	= 438 666 p.a. 15
Roller Gin Factory 15 years straight line	<u>14 010 000</u>	= 934 000 p.a. 15

7. **Difference in Operating Cost of Saw Gins and Roller Gins and Plants**

40 000 bales of lint p.a. capacity

	K Shillings	
	Saw Ginning	Roller Ginning
Salaries and wages	682 000	1 118 950
Power	1 584 000	1 900 800
Maintenance etc.	280 000	350 000
	2 546 000	3 369 750
Depreciation	438 666	934 000
	2 984 666	4 303 750

Difference in cost per bale produced = K Sh 32.98 per bale in favour of saw ginning  
 or US. \$ 4 per bale of 400 lbs lint approx  
 or 1 US cent per lb lint.

NOTE: If premium for roller ginning is at least 1 US cent per lb lint extra ginning costs are recovered.

APPENDIX III

APPENDIX III  
PROCESSING ANNEXE

Power Generation Costs

Based on cost of electrical power per kWh (unit).

Estimated generating cost of 1 MW Power Station K Sh. 1.98 million

Consumption:

Spinning Factory - 1.75 million kWh (unit) per annum

Township - 0.55 million kWh (unit) per annum

Cost of Generation = \$1.7 cents (K) per kWh (unit)

The above unit cost compares with the cost of supplying Garissa Township in 1974 at 22.48 cents per unit, allowing 20 per cent increase for fuel cost to 1977, but note, Garissa, has no other consumer such as the cotton ginning factory at Fura. Essentially, therefore, the cost of electricity here should be less as distribution cost to the ginning factory, which will consume 75 per cent of the annual consumption in only six months, will be less.

The spinning factory consumption based on a single installation and 20 000 tonnes per annum steel bottom throughput. If 20A installation = 1.2 million units per annum.

**APPENDIX III**

Capital Cost and Depreciation

	K Sh. million
Generators and Switchgear	4.00
Building and Transformer etc.	2.10
Overhaul	1.40
	7.50

Staff Housing - wiring, etc., not included.

Depreciation - per kWh

The financial cost of Plant, Building and Depreciation is calculated on a 20 year lifetime, assuming the cost, this being the World Bank's rate of depreciation for generation plant that the depreciation provides the depreciation cost per kWh.

(1)	Capital Cost, estimate K Sh. 375 000 = K Sh. 7 400 000	
	20 years = K Sh. 370 000 p.a.	
	To be recovered by charging on kWh generated	
	Factory consumption etc.	1 780 000 kWh p.a.
	Town consumption etc.	500 000 kWh p.a.
	Total consumption	2 300 000 kWh p.a.
	Depreciation requirement at 1.5%	370 000
		2 300 000
	= 16 cents (K) per kWh	
	Add generation cost = 22 cents (K) per kWh	
	Total charge per unit = 38 cents (K) per kWh	



If the cost of annual depreciation is recovered from the factory consumption only, then the cost per unit would be:

$$\text{K Sh } \frac{370\,000}{1\,750\,000} = 21 \text{ cents (K) per unit}$$

Add generation cost = 82 cents (K) per unit  
Total cost = K Sh 1.03 per kWh

- (iii) If depreciation calculated at rate applied by East African Power and Light Corporation of 6.33 per cent p.a. on a straight-line basis under the Kenya Electric Power Act, and EAPL will be the managers of the generating station, then the following cost per unit will apply.

$$\begin{aligned} \text{Annual depreciation} &= \text{K Sh } 7\,400\,000 \times 6.33\% \\ &= \text{K Sh } 468\,420 \text{ p.a.} \end{aligned}$$

If recovered from factory and township consumption

$$\begin{aligned} \text{Depreciation cost} \\ &= \text{K Sh } \frac{468\,420}{2\,300\,000} = 20 \text{ cents (K) per unit} \end{aligned}$$

Add generation cost = 82 cents (K) per unit  
Total cost K Sh 1.04 per unit

#### Summary:

If calculation (b) (i) is accurate the total cost per unit could be about one shilling, but after further consideration of the ginnery plant, it would be possible to reduce annual consumption at the factory to 1 500 000 units per annum, by elimination of lint cleaning equipment and other items. However, if the power station is equipped to generate 2 MW, there would be net saving in total unit cost, but if the generating plant is scaled to consumption and installed in related units, e.g. say, 3 x 500 kVA sets = 2 for the factory: 1 for the town (town generator on full load at night, could be on stand-by during day, and alternated daily between the three sets). During the off-season, only one set in three would operate at night.

1 x 250 kVA set for day-time use for the township would be a useful economic addition.

NOTE: The above is a rough outline of the power station design but kVA are indicative only, and must be calculated against actual loads for factory and town. The power station building should be constructed large enough or readily extendable in the first instance to allow for future additional generating units and switchgear - i.e. for additional factories, and/or for extension of supply to Hola.