MINISTRY OF AGRICULTURE, FOOD AND FISHERIES
THE REPUBLIC OF ZAMBIA

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR MONGU RURAL DEVELOPMENT IN THE REPUBLIC OF ZAMBIA

MARCH 1997

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
TAIYO CONSULTANTS CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of Zambia the Government of Japan decided to conduct a basic design study on the Project for Mongu Rural Development and entrusted the study to the Japan International Cooperation Agency (JICA).

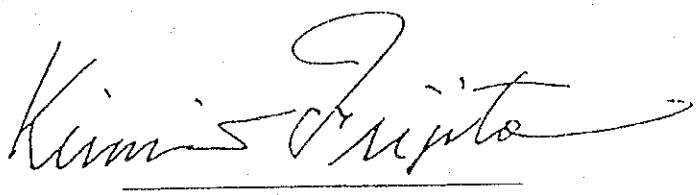
JICA sent to Zambia a study team from September 2 to October 6, 1996.

The team held discussions with the officials concerned of the Government of Zambia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Zambia in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Zambia for their close cooperation extended to the teams.

March 1997



Kimio Fujita
President
Japan International Cooperation Agency

March, 1997

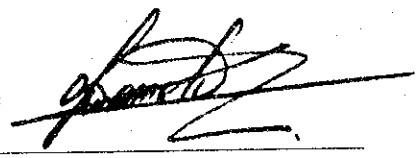
Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Mongu Rural Development in the Republic of Zambia.

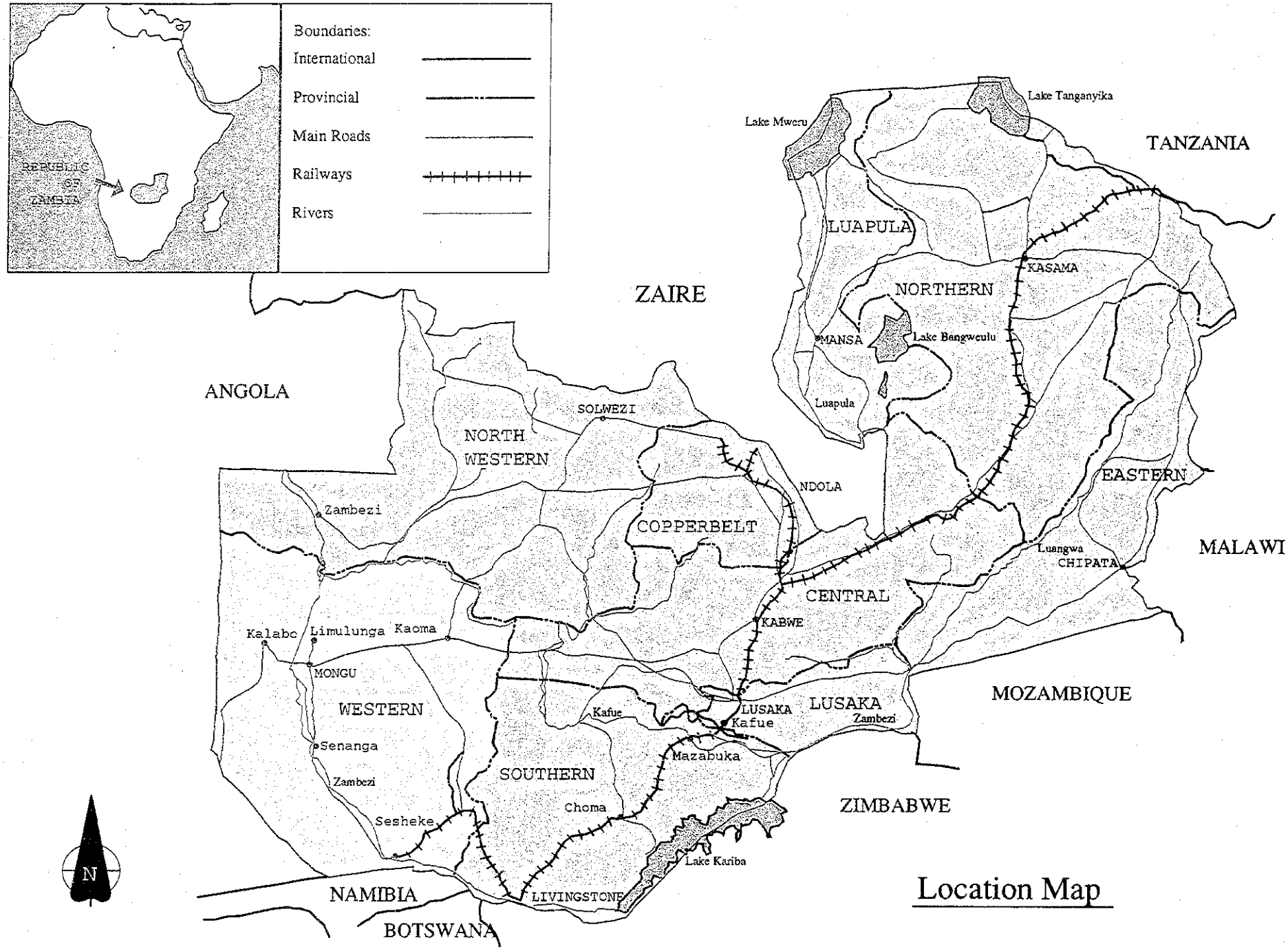
This study was conducted by Taiyo Consultants Co., Ltd., under a contract to JICA, during the period from August 19, 1996 to March 13, 1997. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Zambia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

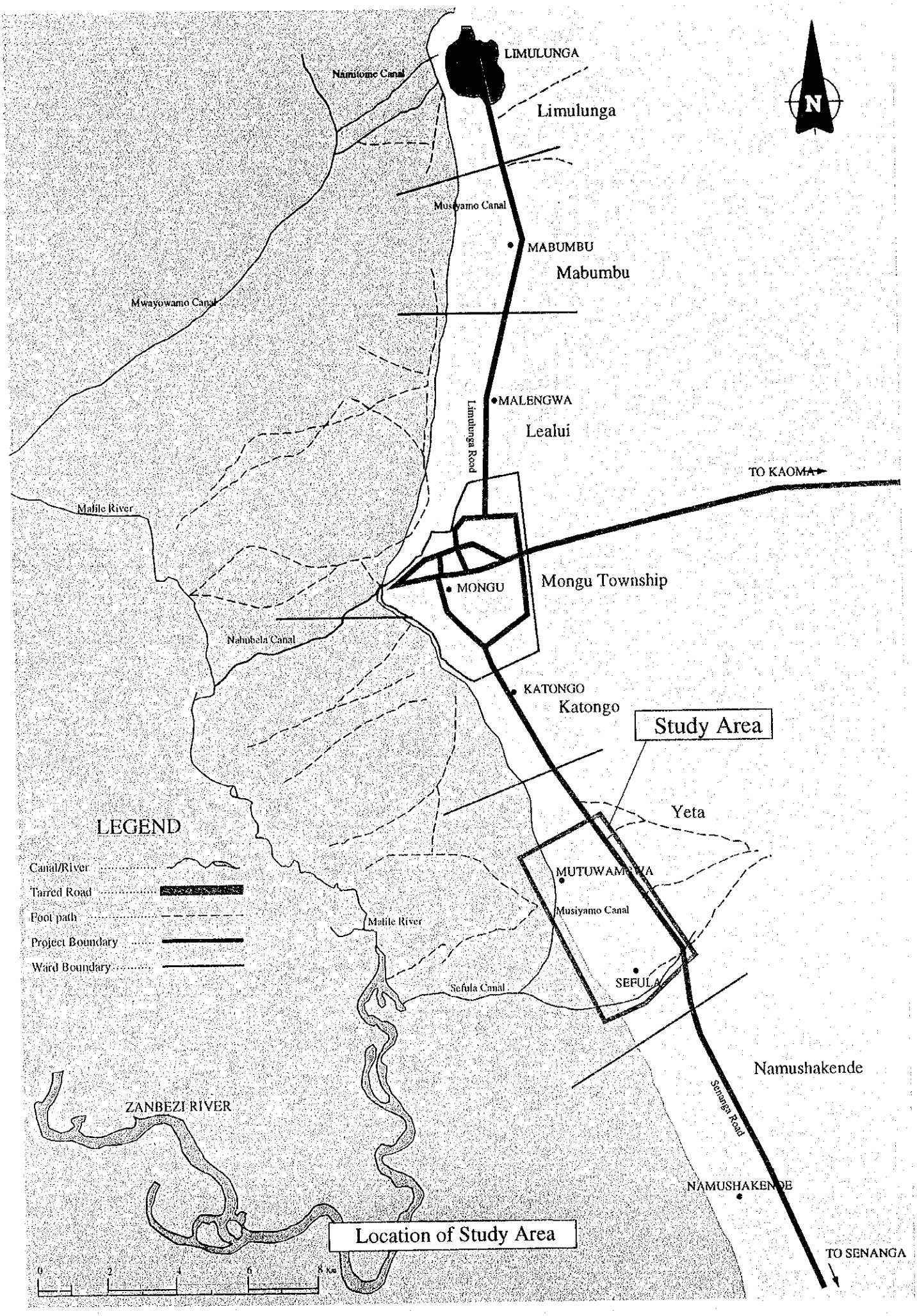
Very truly yours,

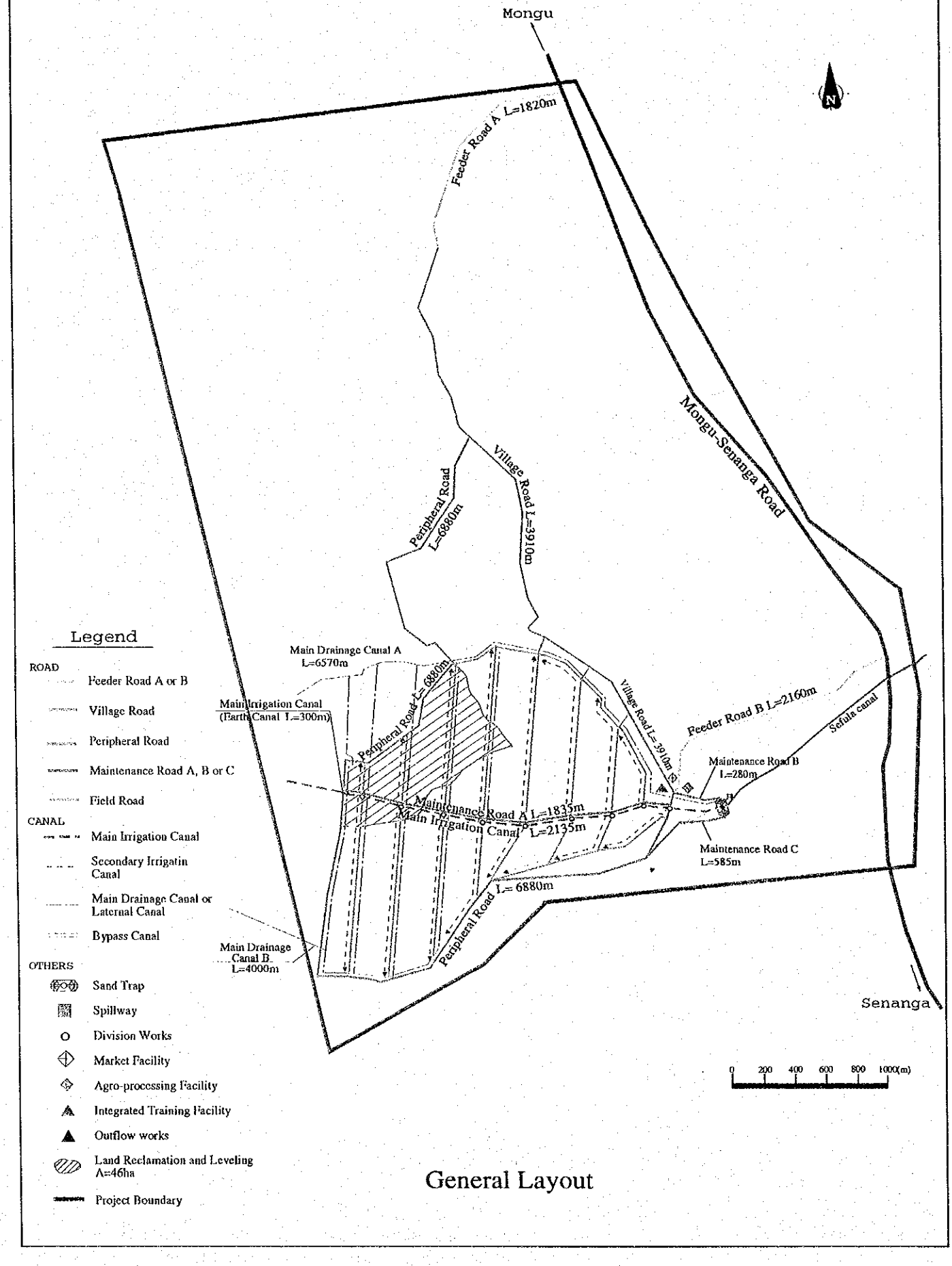


Akira Iwamoto
Project manager,
Basic design study team on
The Project for Mongu Rural Development
Taiyo Consultants Co., Ltd.

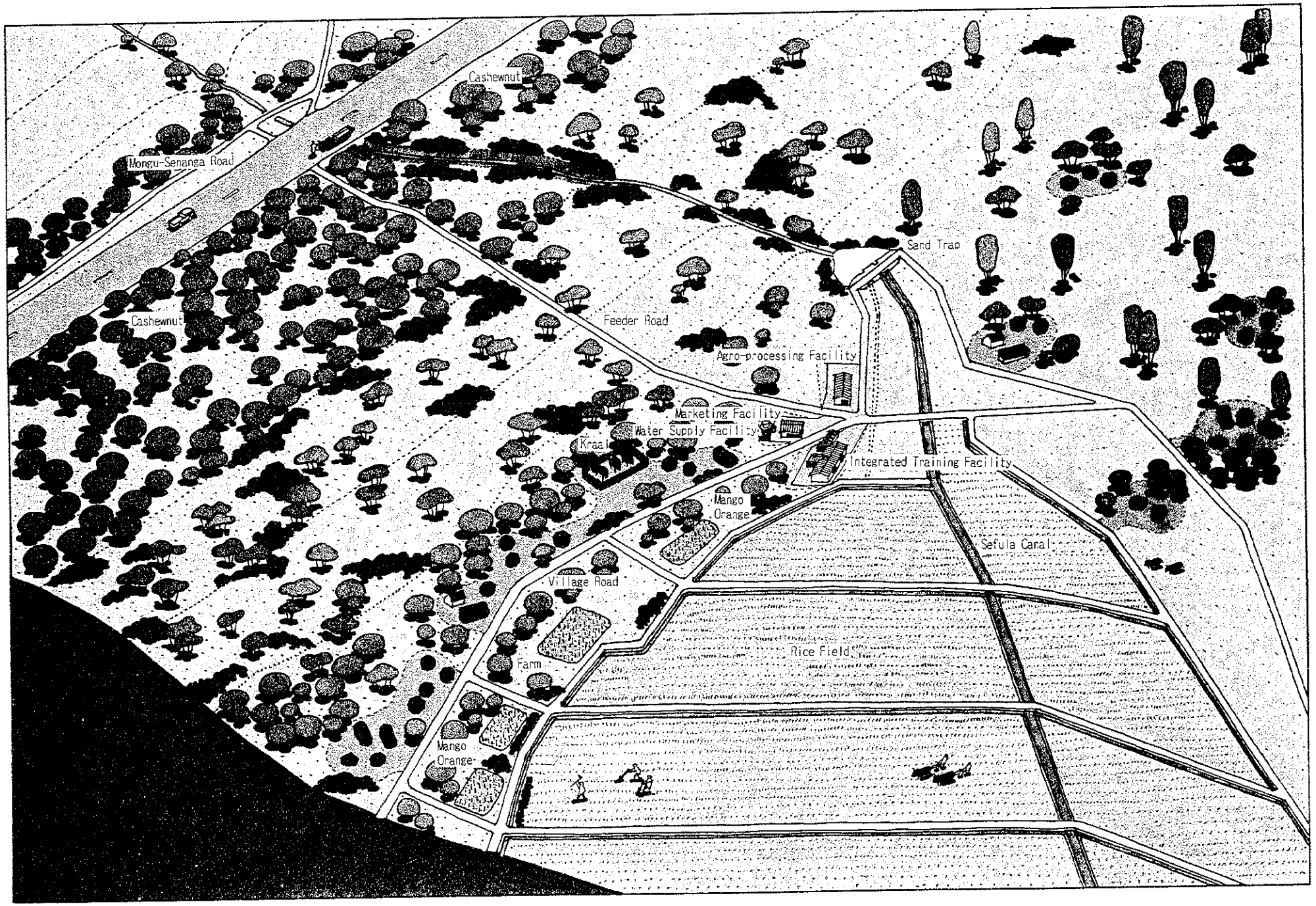


Location Map


LIMULUNGA
Namitome Canal
Limulunga
Musiyamo Canal
MABUMBU
Mabumbu
Mwayowamo Canal
MALENGWA
Lealui
Limulunga Road
TO KAOMA
Malile River
MONGU
Mongu Township
Nahubela Canal
KATONGO
Katongo
Study Area
Yeta
LEGEND
Canal/River
Tarred Road
Foot path
Project Boundary
Ward Boundary
MUTUWAMBWA
Musiyamo Canal
Malile River
SEFULA
Sefula Canal
Namushakende
ZANBEZI RIVER
Senanga Road
NAMUSHAKENDE
Location of Study Area
TO SENANGA
0
2
4
6
8 Km



General Layout


Cashewnut
Mongu-Senanga Road
Cashewnut
Sand Trap
Feeder Road
Agro-processing Facility
Marketing Facility
Water Supply Facility
Kraal
Integrated Training Facility
Mango
Orange
Sefula Canal
Village Road
Rice Field
Farm
Mango
Orange

Abbreviations

ADP	Animal Draught Power Programme
ASIP	Agricultural Sector Investment Pogramme
BHN	Basic Human Needs
DAO	District Agricultural Officer
DOA	Department of Agriculture
DWA	Department of Water Affairs
FAO	Food and Agriculture Organization of the United Nations
FMU	Financial Management Unit
FHH	Female Headed Household
GRZ	Government of the Republic of Zambia
HH	Headed Household
JICA	Japan International Cooperation Agency
LWMP	Land Water Management Project
MAFF	Ministry of Agriculture, Food, and Fisheries
MHH	Male Headed Household
MNG	Mongu Nutrition Group
NCDP	National Commission for Development Planning
NGO	Non-Government Organization
NORAD	Norwegian Agency for Development
PAO	Principal Agriculture Officer
PPP	People's Participation Project
PPS	People's Participation Service
RD	Roads Department
PHC	Primary Health Care
VEG	Village Extension Group

CONTENTS

Chapter 1 Background of the Project

1-1 Background of the Project

The Republic of Zambia (hereinafter referred to as Zambia) is an inland country of 753,000 km^2 situated in the South of Africa with the population of 9,188,000 (as of 1994) and population growth ratio of 2.83% (as of 1994). Under the climate of tropical savanna, this country is rich in mineral resources including copper and cobalt. However, the sluggish copper price since 1975 and global recession during 1980s have severely damaged the national economy which has depended on the copper export. As a solution, the Structural Adjustment Plan has been implemented since 1990 on the consensus of the World Bank and IMF. A tight-financing policy has been implemented to cope with the continuous financial deficit. Per capita GNP of Zambia is $380 US (as of 1993).

The Government of the Republic of Zambia (hereinafter referred to as GRZ) is promoting agriculture for the best use of the domestic resources to overcome the copper-dependent economic structure. In 1994, GRZ planned the Agricultural Sector Investment Programme (ASIP) until the year 2000 with the priorities in promotion of the market economy and supporting small-scale farmers.

The Mongu District, the subject area of this project, is located in the center of the Western Province. Among the nine provinces in Zambia, this province is poor in natural resources and has long depended on agriculture. Due to a lag in the establishment of the agricultural infrastructure, small-scale farming is dominant in this province. Such farming with poor and unstable productivity has caused difficulties in food self-sufficiency. The Western Province, therefore, is positioned as an area in urgent needs for the governmental development project from the perspective of BHN as well as that of the agricultural promotion policy.

1-2 Details of the Request

GRZ focused on the development potential of the Zambezi flood plain area and requested the Government of Japan to carry out the Agricultural Verification Study to prepare a basic guideline for the agricultural development. Consequently, the Japan International Cooperation Agency (hereinafter refereed to as JICA) conducted the Agricultural Verification Study and prepared the guideline for agricultural technology and infrastructure for small-scale farming between 1987 and 1992. Based on this guideline, GRZ asked the Government of Japan to carry out the Feasibility Study on Mongu Rural

Development Project in Zambezi Flood Plain Area. As a result, JICA conducted the Feasibility Study between 1993 and 1995. According to the result of this Study, GRZ requested Grant Aid to the Government of Japan for this Project.

Chapter 2 Contents of the Project

2-1 Objectives of the Project

The Project Area is located at the neighboring area to the Mongu Township which is the most densely inhabited area in the Western Province, and is one of the areas where rural development is exceedingly expected. The land and water resources in the Zambezi Flood Plain are not sufficiently used, and the agriculture is carried out in the form of rainfed extensive one. The objectives of the Project, under such miserable circumstances, are the betterment of farmers' living standard and the activation of regional economy through the improvement of small farmers' farming by means of implementation of the infrastructure for agricultural production and rural livelihood.

2-2 Basic Concept of the Project

Taking into account the farmers' level of technical acquaintance and the government supporting system, the basic idea shall be gradual development that is possible to be managed and maintained by the farmers in the area. Consequently, the basic concept of the Project is aiming at sustainable development, not expecting rapid growth of economic efficiency.

In compliance with the contents of the request and its priority order which were confirmed by the Preliminary Study, the discussions were made with GRZ on the necessity, scale and contents of the facilities. Consequently, the following components were selected as the implementing subjects of the Project, taking into account the result of the field study, the objectives of the Project and the basic idea.

(1) Rural Infrastructure

1) Rural Roads

Improvement and construction are necessary to the roads mentioned below.

(a) The roads connecting villages located on the edge of the Flood Plain and Mongu-Senanga Road (Feeder Roads)

The improvement of the roads connecting public facilities such as school, health center and market will contribute to the increase of not only agricultural benefit but also social one. From these points of view, two Feeder Roads are planned to be improved. One is the road passing Mutuwambwa Primary School at the northern boundary of the Target Area (Feeder Road A) and the other is the road connecting the

Market, the School for the Blind, the Secondary School and the Health Center located in Sefula Church area running along the Sefula River (Feeder Road B)

(b) The road connecting villages located along the Plain Edge (Village Road)

The improvement of the road connecting villages will contribute to a great deal of the promotion of agricultural extension activities, realization of closer communication, improvement of access to the public services and efficient transport of agricultural products and production materials. For these reasons, the improvement of existing foot path connecting villages is planned.

(c) The road to be constructed in the Flood Plain (Peripheral Road)

The Peripheral Road is planned to be constructed from Sefula Market to Namaenya Village along outer line of the proposed irrigable area in the southern part and along 1,012 m contour line in the northern part for the purpose of improving the transport of agricultural products and production materials.

(d) The roads to be constructed for the purpose of maintaining the irrigation and drainage facilities and getting into and out from the farming fields (Maintenance Roads and Field Roads)

Maintenance Roads are planned to be constructed in order to operate and maintain the main irrigation canal and the sand trap.

Field Roads are also planned to be constructed for the purpose of maintaining and operating the secondary irrigation canals and lateral canals, and transporting agricultural products and production materials.

2) Rural Water Supply

Two Deep Well Hand Pumps which will be substitutes of existing damaged facilities and were proposed as urgent necessity in the Master Plan Study are planned to be constructed. Additionally, a water supply facility equipped with a motor pump and an elevated water tank as the belongings of the Integrated Training Facility and Marketing Facility is planned to be implemented.

3) Extension Facilities

This Facility will be used for the sake of extension activities to the farmers on the improved farming methods and technologies, irrigation water management and promotion

of group farming activities and women's group activities in order to improve their rural life.

The potentiality of total output of rice production will be multiplied by three times of the present yield after the completion of the Project implementation. In order to attain to this target, the renovation of farmers' consciousness and acquisition of improved technologies are very important. Intensive training on the crop raising and farming to the relevant farmers is urgently required for the purpose of achieving the objectives, and organized behaving by the farmers' group will increase the effectiveness. The education and training on the importance of water management and technical practices are also indispensable, since the group irrigation by cooperative organization is the first experience for them.

The Proportion of Female Headed Households in the total Households is extremely high (68.5%) in the Target Area. The ratio of women organized into groups is also highest in the District (65.0%), and the groups are evaluated as the most active ones. A conference hall is planned to be built to offer a place where the women's various activities are practiced and supported for the purpose of improving their rural life.

4) Marketing Facilities

Construction of new Market House and Warehouse

The existing market is the only place of economic activities in the Area and is dealing with the living necessaries, agricultural products and processed agricultural products. The marketing building is, however, too old to maintain such as the walls are almost damaged by cracks. As the repair and expansion of the existing building are impossible, a Market House is planned to be newly built and an attached Warehouse is also planned to be constructed at the same time.

(2) Agricultural Infrastructure

1) Irrigation and Drainage Facilities

Implementation of irrigation and drainage facilities by which stable rainy season cropping and partial double cropping of rice production become possible using the water from the Sefula River is planned.

In order to overcome the unstable rainfed agriculture and establish steady farming, the introduction of irrigation facilities is indispensable. Improving Sefula River as the Main Irrigation Canal and implementing attached secondary canals are pertinent in order to realize the objectives. It was affirmed as the result of the discussion between GRZ that the construction of tertiary canals is carried out by relevant farmers themselves according to their necessity under the support of the Department of Agriculture, Western Province. At the same time, the following facilities are planned to be accompanied.

(a) A sand trap pond made of embankment used for preventing sand into the irrigation area.

(b) A bypass waterway used for bathing and washing by residents.

(c) Division Works used for dividing irrigation water from the main canal to secondary canals and used as cross paths of farmers, cattle and vehicles.

The Main Drainage Canals are planned along the both north and south edges of the Area, and the Secondary Drainage Canals are also planned in the Area.

Land Reclamation and Leveling added in the discussion of the Preliminary Study are not applied to the frequently cultivated fields but are applied only to the uncultivated area taking into account the possibility of loosing valuable top soil. The fields raising maize and upland crops in Mazulu (mound in the Flood Plain) are also eliminated from the subject of Reclamation and Leveling in the same manner.

2) Agro-processing Facilities

Implementation of Agro-processing Facility with Rice Polishers, a Hammer Mill and a Store Room is planned.

The potentialities of the yields per unit area of rice and maize will increase to three to four times of the present ones when the implementation of the Project will be completed. Besides, as the double cropping of rice becomes possible on a part of paddy fields, the total production of rice and maize is supposed to be more than three times of the present

one. The processing capacity of existing two facilities in the Target Area is too small to dispose the increased yields of rice and maize. Therefore, an additional installation of Rice Polisher and Hammer Mill is planned in order to raise the effect of the Project through efficient processing of increased amounts of rice and maize.

Although two facilities were proposed to install in Sefula Area and Namaenya Area at the initial stage of the Request, it is planned to implement only one in Sefula after examining reasons such as concentrating at one spot is easier to operate and manage facilities rather than dispersing to two places and an extension of electric cable is necessary in order to implement at Namaenya.

3) Inland Fishery Facilities

Although fish ponds as one of the Inland Fishery Facilities were requested, it was given lower priority as the result of the Preliminary study because of insufficient management, operation and maintenance system of fish ponds. The following results were obtained after conducting additional investigation at the Basic Design Study.

Western Province is not given priority of the important area in the Inland Fishculture Plan by the Department of Fisheries in the Ministry of Agriculture, Food and Fisheries. Only three Government Officials belonging to the Department of Fisheries are allocated in the Mongu Area (each one in Western Province, Mongu District and Namushakende Area respectively), and the administrative supporting system to extend new technologies to the local residents, who do not have experience on fishery culture, is not well provided. Moreover, it is necessary to ensure acquisition means of seeds since the development plan in the request is restricted only to the implementation of fish ponds. Although the production of seeds is being carried out in Kaoma District, the yield is not sufficient to fulfill the demands. At the same time, the transport of seeds that has to depend on the truck conveyance seems to have difficulty from the economical point of view. For the reasons mentioned above, the construction of fish ponds is eliminated from the request items. The implementation of this plan is desirable to be reconsidered when the circumstances such as broader expansion of raising practices through the technical cooperation and establishment of the official plan of the fish culture in the Target Area is sufficiently prepared.

The comparison between the Original Request and the Basic Plan of the Project and the outline of the Principal Facilities are as follows:

Table 2-1 Comparison Between Initial Request Component and Basic Design of the Project

Item	Description	Initial request	Basic design	Remarks
Road	Route of Peripheral Road	L=6,000m	L=6,880m	Route deviation in accordance with modification of proposed irrigation area
	Route of Feeder Road A	L=1,725m	L=1,820m	Route deviation for reduction of soil erosion
	Village Road	L=4,070m	L=3,910m	Owing to route deviation of Feeder road A
	Pavement	Laterite	Laterite mixed with Cement	Prevention of road surface erosion by rain water
	Borrow-pit of Laterite Gravel	Mawawa	Miulwe	On the basis of Analysis result concerning economy, qualities, or potentiality
Irrigation / drainage	Proposed Irrigation Area	A part of irrigable area is revised and modified. The area where rice crop is raised frequency is included newly, and the uncultivated area are deleted. The actual irrigable area after revision is also 200 ha just as same as the area before revision		
	Structure of Main irrigation canal	Cement Block Lining	Reinforced Concrete	Reduction of maintenance cost, prevention of leakage, prevention of brake down of maintenance road caused by leakage, prevention of differential settlement
	Length of Main Irrigation Canal	L=2.3km	L=2.4kn	Reinforced concrete canal L=2.1km, earth canal L=0.3km, to prevent inflow into the proposed irrigation area, sefula river located down stream of the irrigation area is improved as earth canal
	Secondary Irrigation Canal	250m intervals, N=15, L=10.4km	200m intervals, N=16, L=12.5km	Reduction of construction cost of tertiary canals taken by farmers' participation
	Spillway	2 places	1 place	1 place is enough to accommodate a flood discharge
	Bypass canal	Earth canal	Cement block lining	Reduction of conveyance loss
	Land reclamation and leveling	not including	including	On the basis of the initial request, A=46ha, the subject of land reclamation is restricted to a part of land located on the right bank where is uncultivated and not utilized for agriculture
Agro-processing	Components	Harvesting equipment, processing facilities, maintenance tools and accessories, building, others	Processing facilities (Rice polisher and hammer mill) and, building	Gradual improvement by long range collaboration
	Number	2 places	1 place	1 place installation not including Namaenya is recommendable taking into consideration operation and maintenance, Namaenya is necessary to extend electric power line
Rural water supply		Hand pump of 3 places	Hand pump of 2 places, and electric pump of 1 place	Water supply facility of extension facility is improved as electric pump
Others	Inland fishery	including	not including	Gradual improvement by long range collaboration
	Animal Husbandry	including	not including	Beneficiary is restricted to few people

2-3 Basic Design

2-3-1 Design Concept

(1) Irrigation and Drainage Facilities

The Irrigation and Drainage Facilities shall be designed for the system which draws water by gravity, taking into consideration the easy operation and management and appropriate technologies in the Target Area. Construction machinery and materials which can be easily procured in Zambia shall be basically used.

Concerning implements of water management, simpler ones such as fixed weirs and square lumbers which regulate the water flow are introduced rather than more complicated valves or gates. The designs of facilities are considered to be appropriately drawn based on the hydrological data corresponding to three to five-year return period as recommended in the Verification Study and the Feasibility Study for the sake of avoiding excessive construction expenditure.

(2) Roads

Design concept of the proposed roads is based on the followings.

1) Taking into consideration natural conditions in the Project Area, roads shall be the structures endurable to serious erosion by runoff of rainwater.

2) Any domestic standards for small scale roads such as proposed are not designed yet. Therefore, durable structure shall be determined on the basis of local using conditions and maintaining abilities.

3) Local materials shall be used as much as possible in order to reduce the construction costs.

4) Appropriate scale and structure for designed traffic of the roads shall be adopted.

5) Local technologies and construction methods adequate to the local constructors' abilities shall be adopted.

(3) Buildings

1) Plot Plan

So far as the plot plan of such three facilities as the Agro-processing, Market and Extension are concerned, it is appropriate to gather them in and around one place as much as possible from the viewpoint of operation and maintenance, so that these three facilities will be set up around Sefula Market. As Sefula Market, at present, deals in daily necessities, agricultural and fishery products and its processed goods to local residents, it has become the center of residents' daily lives and economic activities. Additionally, Sefula Market is located at the junction of the Village Road and the Feeder Road B proposed in this Project. Therefore, the site around Sefula Market is the most convenient plot for transportation.

The plot proposed is located on a slope with somewhat moderate angle from the Village Road and totally unused due to weeds and bushes all over. Consequently, the plot plan shall be designed preserving the present scenic beauty by leaving the present trees as much as possible, making the best use of much of its gradient and natural environment and being provided with superb design level, lighting and natural ventilation.

2) Building Standard

The design and construction of the facilities proposed shall be carried out in accordance with the "Drawing and Bills of Quantity (1984: Engineering Publication)" provided and enforced by the Ministry of Agriculture, Food and Fishery (then the Ministry of Agriculture and Water Resources). The finishing of the works shall be performed with the same level of similar structures around the plot.

3) Structure Plan

The structure of the facilities is of cement block wall structure and concrete pillars will be added where it is required. If walls are insufficient, buttress walls will be put and regarded as reinforced wall.

4) Finishing

Roofs are to be covered with corrugated slate plate on angle truss, and external walls are to be completed with troweled concrete then painted. For fittings, steel sash, which is most popular in Zambia, will be used.

Floors will be completed with troweled concrete, and internal walls are to be finished with troweled concrete then painted. For ceiling, plaster boards will be used only for the living rooms and painted.

5) Materials of the Works

All building materials, necessary to carry out the works, are to be procured in Zambia. However, the materials manufactured in Zambia is quite few, so that all the materials except cement, aggregate and timber are to be imported from South Africa and Zimbabwe. These materials have been continuously imported, so that there will not be any problems of their procurements.

6) Electric Plan

Drawing the designated power line of 400V/50hz from where a medical examination room in the church region is located (the cost of this work shall be borne by Zambia side), and using the service line support pillars, the power line will be connected to a power receiving panel, and then distributed to each switch board and power panel.

(4) Rural Water Supply Facilities

Inside the planned area, there are 26 local wells used at present by the residents, and most of them have been constructed by farmers using a traditional method. On account of contamination by rain water and excretions from livestock, those local wells are under seriously unhealthy conditions. As the result of recent water examination, all those local wells are proved to be contaminated by colon bacilli.

In the planned area, except a few villages, it is very difficult to secure enough clean water. Consequently, as being pointed out in the Feasibility Study, wells in Namaenya Area and Mutuwanbwa Primary School where the wells are urgently needed are proposed to be constructed for the use of local residents.

Additionally, a water supply facility equipped with a motor pump and an elevated water tank as the belongings of the Integrated Training Facility and Marketing Facility is planned to be implemented in order to secure clean water for the operation of these facilities.

2-3-2 Basic Design

(1) Irrigation and Drainage Facilities

1) General Plan

a) Hydrology

The hydrological data of Sefula River as the source of irrigation water is as follows based on the result of the Feasibility Study. The drought discharge shown here is used for the irrigation plan and the maximum discharge for drainage.

Discharges of Sefula River (at the point where the staff gauge is set up)

(m^3/s)

Item	Return Period			
	Two Years	Three Years	Five Years	Ten Years
Drought	0.29	0.27	0.25	0.24
Maximum	1.81	1.92	2.31	2.67

The drought discharge corresponding to three-year return period is 0.27 m^3/s at the point where the staff gate is set up (the area of the river basin is 40 km^2). As the area of the river basin at the proposed intake point is 44 km^2, the discharge to be used for the design of irrigation is presumed to be 0.30 m^3/s (refer to Table 2-2).

The flood water level in the Zambezi Flood Plain at the proposed irrigable area was calculated based on the observation data for 18 years which are practically usable among recent 20 years from 1976/77 to 1995/1996 at Senanga and Matongo (refer to Table 2-3). As the result, the basic year corresponding to three-year return period (67%) was determined to 1985/86 and the highest water level of the year was 1,011.91 m. Some 40 ha in the proposed irrigation area on the left bank of Sefula River are realized to be lower than the highest water level corresponding to three-year return period.

b) Irrigable Area

From the relationship between the gross irrigation requirement which will be discussed afterwards and the available water for irrigation use of Sefula River, the irrigable areas for rice cultivation are 200 ha in the rainy season and 100 ha in the dry season.

c) Proposed Irrigation Area

The proposed irrigation area in the Feasibility Study is the area of 250 ha expanding on both banks of Sefula River and its actual irrigable area is 200 ha. Although the design of the Feasibility Study is principally succeeded, a part of the irrigable area is revised and modified. The area on the left bank where rice crop is raised frequently is included newly and uncultivated areas on the right bank and on the southernmost area are deleted.

The actual irrigable area after the revision is also 200 ha just the same as the area before the revision. The route of the Peripheral Road surrounding the proposed irrigation area is also changed according to the revision of the area.

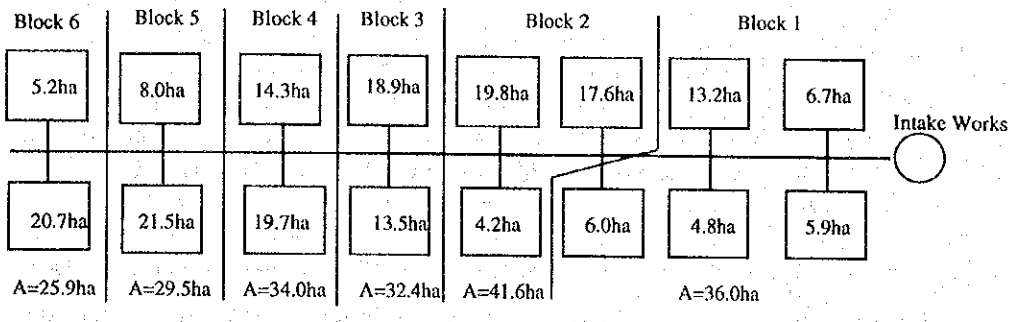
d) Method of Irrigation

At first, the method of irrigation was planned in the manner that the irrigation water was diverged from the main canal into secondary canals through the division works, and was drawn into paddy fields at any places using siphon tubes and then flew down towards lower fields by plot to plot irrigation. However, distribution of water to the whole irrigable fields by this method is difficult because of the topographical condition. It is required, therefore, to construct tertiary canals. Consequently, it is already agreed and confirmed among the parties concerned that the implementation of tertiary canals will be carried out by the farmers' own hands under the support of the Department of Agriculture, Western Province. Considering the circumstances when the tertiary canals are constructed, the allocating distance between secondary canals shall be changed from the proposed 250 m to 200 m in order to alleviate farmers' burden. The water shall be diverged to the tertiary canals by the siphon tubes.

Intermittent irrigation which has been proposed by the Verification Study shall be applied, and the irrigation interval shall be seven days.

e) Irrigation Blocks

The proposed irrigation area was divided into six irrigation blocks based on the allocated area of respective secondary canals. As the irrigation interval is seven days, six blocks shall be established in order to irrigate each block a day.



f) Drainage

The land around Namalanga Canal mainly consists of peat and muck soil, and the level of underground water is extremely high. For these reasons, Namalanga Canal is not functioning the role of drainage, and it makes the area poor drained. The Canal, therefore, shall be improved as the main drainage canal on the right bank. At the same time, the spillway of the sand trap shall be connected to this main drainage canal in order to drain flood water of Sefula River to outside of the area quickly.

Drainage canals in the Target Area are used for the purposes of draining flood water and eliminating excessive water in the soil. Although these functions do not work when the proposed irrigation area is inundated in the rainy season, the implementation of these canals is desirable in order to eliminate the flood water as fast as possible at the end of the rainy season. For these reasons, lateral drainage canals are planned to be implemented for the poor drainage areas at present and the areas inundated by flood water (EL=1,012 m and below).

The both main drainage canals are extended into the plain for gravitational drainage and are connected to Sefula River.

2) Irrigation Water Requirement

a) The Basic Year for Irrigation Plan

The basic year corresponding to three-year return period is 1985/1986 based on the conclusion of the Feasibility Study.

b) Water Requirement

The water requirement is defined as the amount of water required for rice cultivation in the period from the beginning of cultivation until harvesting, and is estimated as the sum of the amount consumed by crop and the amount percolating into the ground.

The amount consumed by crop is calculated multiplying the crop coefficient to the amount of evaporation of relevant crop obtained by Penman method. Ten day averages of the basic year observed by Mongu Meteorological Department were used in applying the Penman method. The amount of percolation is supposed to be 7.0 mm for the cropping in the dry season and 4.0 mm in the rainy season based on the results of the Agricultural Verification Study.

c) Water Requirement for Nursery Bed

The area of nursery bed is scheduled as one twentieth (20 ha) of the total paddy fields. The water requirement for nursery bed is calculated assuming crop coefficient of 1.00 and percolating amount of 7.0 mm.

d) Water Requirement for Puddling

The puddling is scheduled to be completed in 20 days and the amount of puddling water is estimated to be 150 mm. Transplanting is carried out on the next day of completing the puddling, and water requirement of the early stage of crop growing shall be applied after the transplanting.

e) Effective Rainfall

The effective rainfall was calculated by multiplying 80 %.to the precipitation.

f) Gross Water Requirement

The irrigable areas were determined 200 ha in the rainy season and 100 ha in the dry season in compliance with the gross water requirement for ten days calculated by deducting the effective rainfall from the crop water requirement and multiplying the irrigation efficiency of 85 %. For this calculation, transplanting was assumed to be carried out both in the rainy season and dry season. As the result of calculation, the maximum gross water requirement occurs at the period of puddling in either case of rainy season and dry season, and the figures shall be 0.30 m^3/s and 0.29 m^3/s respectively which correspond to the droughty water discharge of three-year return period (refer to Table 2-4).

3) Design Discharge

a) Main Irrigation Canal

The inflow of flood water into the main canal in the rainy season has to be dealt with cautiously in implementing Sefula River as the main irrigation canal. Improvement

with the large cross section that can discharge the whole flood water will cause difficulties, not only increasing the construction cost but also inconvenient water management such as diversion management due to its excessively large cross section as the irrigating facility. On the other hand, improvement with the cross section based on the gross water requirement will effect the water use, such as bathing and drinking by the cattle, after diversion for irrigation since the water will be all used for the irrigation. The design discharge of the Main Irrigation Canal, therefore, is designed subject to the medium flow or the base flow not including the water swollen right after the rainfall.

As the water level becomes nearly constant in several days after rainfalls according to the observed data of water levels by the Water Affair, the discharge at this time shall be estimated as the medium or base flow. The probability analysis on the annual maximum medium flow and base flow has obtained 0.85 m^3/s and 1.10 m^3/s as the discharges corresponding to three-year and five-year return periods respectively. In consequence, the design discharge for the main irrigation canal shall be 1.00 m^3/s (refer to Table 2-2).

b) Secondary Irrigation Canal

The design discharges of secondary irrigation canals are determined according to the water requirements for puddling. Since the puddling area a day is 10 ha, the maximum puddling area of each secondary canal a day is allotted to 5 ha.

The design discharges of secondary canals are from 0.05 to 0.10 m^3/s (refer to Table 2-5).

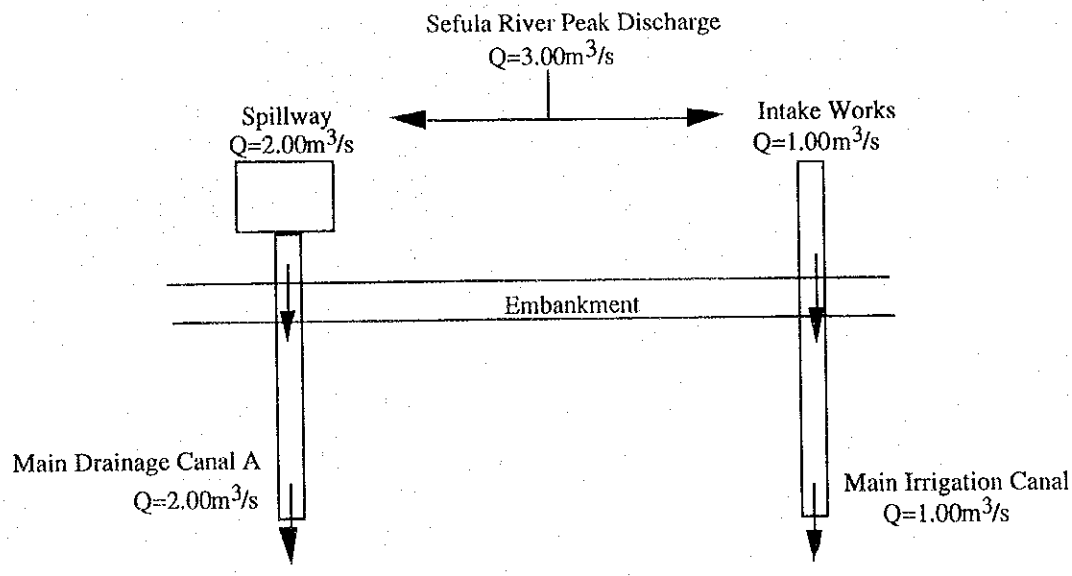
c) Spillway

The design discharge of the spillway shall be determined in compliance with the peak discharge of the river.

The flood discharges of Sefula River corresponding to the three-year and five-year return periods are calculated as 1.92 and 2.30 m^3/s respectively in accordance with the data of water levels by the Water Affair (refer to Table 2-2). The observation of water level at Sefula River, however, is carried out at the fixed times so that the peak discharge is hardly obtained.

Consequently, the peak discharges of Sefula River has been estimated taking into consideration the traces of the past floods and water levels obtained from residents by

As the design discharge of the main irrigation canal is 1.00 m^3/s, the design discharge of the spillway is determined as 2.00 m^3/s, which flows to the main drainage canal A.



d) Drainage Canal

The drainage discharge in the field shall be calculated by means of the Rational Formula mentioned below based on the idea of one day draining of one day rainfall.

$$Q = 1/360\ f\ r\ A$$

where,

Q : Runoff discharge of on-farm level (m^3/s)

f : Runoff percentage, this value is determined as 0.3 based on the table below

r : Average rainfall intensity (mm/hr) = 3.33 mm/hr
Daily rainfall corresponding 3 to 5 years return period is estimates as 80 mm according to the probability analysis of daily rainfall (refer to Table 3-6).
The concept od drain requirment is based on 24 hours rainfall and 24 hours drainage
Therefore, average rainfall intensity is determined as 3.33 (=80/24) mm

A : Catchment area (ha)

$$Q = 1/360 \times 0.30 \times 3.33 \times A$$

$$Q = 0.00278 m^3/s/ha = 2.78 \text{ lirrer /s/ha}$$

Standard Peak Runoff Coefficient

Land & Vegetation		Soil Texture		
		Sand	Clay - Silt	Hard Clay
Forest				
	Flat Land	0.10	0.30	0.40
	Sloping Land	0.25	0.35	0.50
	Steep Land	0.30	0.50	0.60
Pasture				
	Flat Land	0.10	0.30	0.40
	Sloping Land	0.16	0.36	0.55
	Steep Land	0.22	0.42	0.60
Farm Land				
	Flat Land	0.30	0.50	0.60
	Sloping Land	0.40	0.60	0.70
	Steep Land	0.52	0.72	0.82

Source : Engineering Manual for Farm Land Conservation Published by the Japanese Institute of Irrigation and Drainage

Flat land as 0 ~ 5 %, Sloping land as 5 ~ 10 % and Steep Land as 10 % ~ 30 % of ground slope

The result of the estimation, q=2.78 $m^3/s/ha$ has been obtained as unit area drainage discharge. The design discharges of lateral canals are determined using the unit area drainage discharge.

The design discharge of the main drainage canal is determined by the spillway discharge and the drainage discharges of lateral drainage canals.

4) Design of Facilities

a) Main Irrigation Canal

The cement block lining canal has been proposed in the Feasibility Study, but the probability of breakdown by cracking is fairly high and occurrence of water leaking is inevitable with this structure. It is afraid in this case that the pavements and the

filled up grounds of the maintenance road to be contracted along the canals will be destroyed by the inflow of leaked water. Moreover, the maintenance and management expenditure of the roads will increase quite a lot. Additionally, occurrence of leaking caused by differential settlement is also anticipated when the canal crosses on partly existing layers of humus soil. Therefore, the main canal is planned to be constructed by reinforced concrete which is superior in durability and less expensive in operation and maintenance. In this case, the structure of joint is strengthened by dowel bars and water stops in order to prevent the differential settlement and leakage.

b) Secondary Irrigation Canals

Secondary canals are planned to be lined with cement blocks due to the restriction of total construction cost. Therefore, it is necessary to lay sheets on the back of the cement blocks in order to prevent the destruction of farm roads to be constructed along the canals caused by leakage with cracking of cement blocks as in the case of the Main canal.

The secondary canals are allocated at intervals of 200 m taking into consideration that the tertiary canals are to be constructed by the farmers' own labor.

c) Division Works

The division works are implemented for the purpose of distributing irrigation water to the secondary canals. The flow through division works is regulated by stop logs. The division works are to be constructed by reinforced concrete on which people, cattle and light vehicles can pass over, since the area is separated into southern and northern parts by the main canal.

d) Sand Trap

The sand trap is implemented for the purpose of preventing the inflow of earth and sand eroded from the plateau side into the proposed irrigation area at flood time. The sand trap is constructed at the shifting point from the slope land to the flood plain, and it has a structure to secure the capacity of the sediment. The capacity is determined as the sediment in one year.

As the land where the sand trap is to be constructed partially consists of humus soil layer, the layer has to be removed in order to prevent embankment destruction by consolidation.

Impervious material such as clay shall be placed at the center, then embankment shall be carried out with sand. The surface shall be covered with humus soil for protecting the slope by vegetation. The slope gradient shall be around 1:2.5.

The sand trap shall be facilitate with intake works connecting to the main irrigation canal and a spillway for the excess flow.

e) Bypass Canal

Since Sefula River is improved as the main irrigation canal, the utilization of the River by residents for bathing and washing will be restricted. The construction of a bypass canal is necessary for the sake of solving this problem. The cement block structure is adopted for the bypass canal in order to prevent leakage as the canal is planned on the sandy ground. Intercepting the sight of bathing shall be taken into account and water drinking spot for cattle shall be constructed.

f) Land Reclamation and Leveling

The land reclamation and leveling will not be carried out on the area where farming is under operation at present, but carried out on a part of land located on the right bank of Sefula River which is uncultivated and unused for agriculture. The reasons are presented as follows:

- The land boundaries will become unclear when the land reclamation and leveling are carried out, which may cause land disputes among land holders (It is indicated in the Feasibility Study that the land disputes are frequently occurred among land holders because of unclear land boundaries).

- The land reclamation and leveling requires surface soil handling since the top soil layer is so thin having only 15 to 30 cm which is extreme important for the farmers. However, the surface soil handling will raise the construction cost quite a lot.

The area such as Mazulu (small mound) where maize or mango trees are planted will be eliminated from the subject. The construction of levees is excluded from the project schedule, and the determination of the form of farm blocks and field lots shall be planned by the farmers' organization.

Table 2-2 Water Level (Water Depth) and Discharge of Sefula River

Year	Minimum Water Level			Maximum Water Level			Base Flow Level		
	Reading of Stuff Guage		Actual Depth	Reading of Stuff Guage		Actual Depth	Reading of Stuff Guage		Actual Depth
	(ft.)	(cm)	(cm)	(ft.)	(cm)	(cm)	(ft.)	(cm)	(cm)
1976 / 1977	0.40	0.122	0.472	3.10	0.945	1.295	0.90	0.274	0.624
1977 / 1978	1.00	0.305	0.655	3.75	1.143	1.493	2.20	0.671	1.021
1978 / 1979	1.89	0.576	0.926	2.85	0.869	1.219	2.25	0.686	1.036
1979 / 1980	0.30	0.091	0.441	1.89	0.576	0.926	0.95	0.290	0.640
1980 / 1981	0.32	0.098	0.448	2.15	0.655	1.005	0.60	0.183	0.533
1981 / 1982	0.33	0.101	0.451	1.35	0.411	0.761	0.61	0.186	0.536
1982 / 1983	0.31	0.094	0.444	1.93	0.588	0.938	1.38	0.421	0.771
1983 / 1984	0.27	0.082	0.432	1.60	0.488	0.838	0.46	0.140	0.490
1984 / 1985	0.29	0.088	0.438	1.46	0.445	0.795	1.29	0.393	0.743
1985 / 1986	0.33	0.101	0.451	1.50	0.457	0.807	0.80	0.244	0.594
1986 / 1987	0.34	0.104	0.454	1.78	0.543	0.893	0.70	0.213	0.563
1987 / 1988	0.60	0.183	0.533	2.46	0.750	1.100	1.18	0.360	0.710
1988 / 1989	0.60	0.183	0.533	1.98	0.604	0.954	0.90	0.274	0.624
1989 / 1990	0.31	0.094	0.444	1.32	0.402	0.752	0.66	0.201	0.551
1990 / 1991	0.34	0.104	0.454	2.30	0.701	1.051	0.93	0.283	0.633
1991 / 1992	0.66	0.201	0.551	3.20	0.975	1.325	1.71	0.521	0.871
Probability Analysis of Water Depth (Unit : m)									
2-year			0.461			0.944			0.640
3-year			0.449			1.024			0.707
5-year			0.440			1.115			0.792
10-year			0.434			1.234			0.911
Probability Analysis of Discharge (Unit : m^3/s)									
2-year			0.289			1.801			0.671
3-year			0.269			1.923			0.850
5-year			0.254			2.305			1.099
10-year			0.248			2.668			1.496

Note : Dischage of Sefula river is calculated by using Rating Curve (Water Depth - Discharge) presented below.

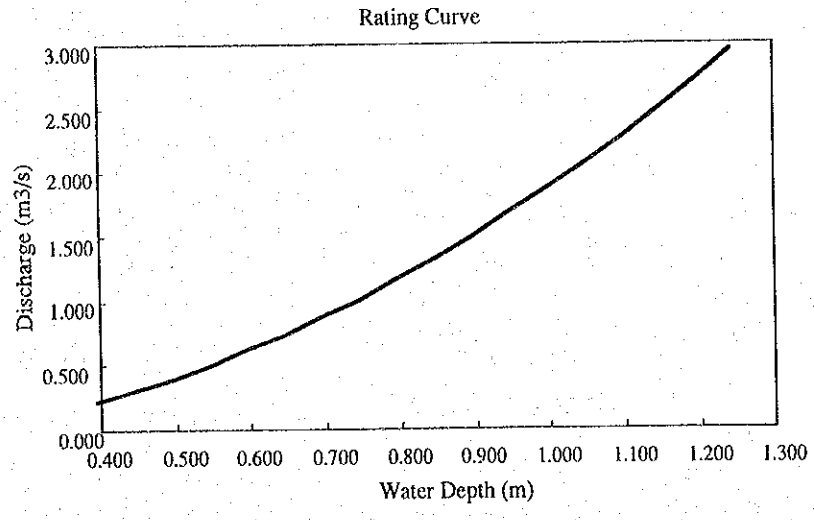


Table 2-3 Water Level of the Plain in the Study Area (1/2)

Year	Oct.			Nov.			Dec.			Jan.			Feb.			Mar.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1961/62	1007.50	1007.46	1007.43	1007.46	1007.67	1007.93	1008.10	1008.38	1009.23	1009.90	1010.56	1011.11	1011.30	1011.63	1012.05	1012.26	1012.25	1012.46
1962/63	1007.64	1007.57	1007.48	1007.48	1007.51	1007.81	1008.12	1009.05	1010.27	1011.00	1011.56	1011.92	1012.16	1012.23	1012.53	1012.87	1012.87	1012.67
1963/64	1007.66	1007.65	1007.65	1007.75	1007.99	1008.21	1009.02	1009.67	1010.09	1010.48	1010.61	1010.95	1011.13	1011.41	1011.76	1011.88	1011.72	1011.82
1964/65	1007.58	1007.54	1007.57	1007.61	1007.67	1007.71	1007.84	1008.02	1008.26	1008.97	1009.69	1010.44	1010.73	1011.29	1011.58	1011.83	1011.86	1011.92
1965/66	1007.50	1007.50	1007.46	1007.43	1007.49	1007.60	1007.73	1008.08	1008.45	1008.52	1008.96	1009.44	1009.80	1010.22	1010.81	1011.22	1011.84	1012.23
1966/67	1007.29	1007.25	1007.22	1007.22	1007.28	1007.32	1007.32	1007.40	1007.53	1007.78	1008.00	1008.66	1009.58	1010.28	1010.55	1010.78	1011.21	1011.60
1967/68	1007.42	1007.39	1007.44	1007.65	1007.79	1007.93	1008.48	1009.26	1010.02	1011.05	1011.63	1011.90	1012.20	1012.18	1012.19	1012.08	1012.12	1012.50
1968/69	1007.84	1007.78	1007.72	1007.71	1007.88	1008.15	1008.58	1009.14	1009.58	1009.93	1010.34	1010.84	1011.11	1011.93	1012.35	1012.64	1012.70	1013.05
1969/70	1008.15	1008.24	1008.33	1008.49	1008.65	1008.80	1009.12	1009.56	1010.13	1010.88	1011.08	1011.46	1011.93	1012.34	1012.51	1012.55	1012.51	1012.30
1970/71	1007.78	1007.78	1007.75	1007.75	1007.89	1008.24	1008.56	1008.94	1009.29	1009.71	1010.07	1010.59	1011.15	1011.56	1011.78	1012.01	1012.08	1011.95
1971/72	1007.61	1007.54	1007.62	1007.66	1007.74	1007.98	1008.05	1008.15	1008.44	1008.94	1009.30	1009.52	1009.53	1009.44	1009.48	1009.84	1010.35	1010.85
1972/73	1007.45	1007.45	1007.49	1007.52	1007.63	1007.58	1007.62	1007.86	1008.12	1008.39	1008.85	1009.21	1009.28	1009.40	1009.68	1010.19	1010.59	1010.78
1973/74	1007.16	1007.22	1007.16	1007.28	1007.39	1007.46	1007.57	1007.96	1008.15	1008.70	1009.21	1009.79	1010.45	1010.99	1011.38	1011.43	1011.33	1011.41
1974/75			1007.29	1007.34	1007.43	1007.57	1008.01	1008.45	1009.02	1009.75	1010.80	1011.24	1011.61	1011.80	1011.85	1011.93	1012.29	1012.46
1975/76	1007.51	1007.45	1007.39	1007.41	1007.40	1007.47	1007.68	1007.99	1008.34	1008.63	1008.95	1009.45	1009.92	1010.72	1011.38	1011.88	1012.15	1012.39
1976/77	1008.00	1008.04	1007.97	1007.95	1007.95	1008.01	1008.13	1008.46	1008.96	1009.19	1009.39	1009.77	1010.38	1010.95	1011.15	1011.39	1011.60	1011.77
1977/78	1007.70	1007.62	1007.52	1007.49	1007.50	1007.67	1007.95	1008.44	1009.01	1009.41	1009.84	1010.33	1010.68	1011.03	1011.28	1011.73	1012.16	1012.42
1978/79	1008.20	1008.09	1008.14					1009.31	1009.86	1010.42	1010.74	1011.01	1011.19	1011.48	1011.70	1011.96	1012.15	1012.32
1979/80				1008.32	1008.63	1008.99	1009.26	1009.68	1010.40	1011.14	1011.55	1011.58						
1980/81	1007.78	1007.68	1007.79	1007.93	1007.98	1008.27	1008.58	1008.74	1008.98	1009.18	1009.41	1009.54	1009.80	1010.29	1010.74	1011.38	1011.72	1011.89
1981/82	1007.72	1007.69	1007.64	1007.61	1007.63	1007.87	1008.10	1008.16	1008.26	1008.55	1008.93	1009.17	1009.41	1009.65	1009.98	1010.34	1010.73	1011.13
1982/83	1007.48	1007.53	1007.68	1007.71	1007.90	1008.36	1008.80	1009.08	1009.35	1009.49	1009.49	1009.73	1010.02	1010.40	1010.63	1010.74	1010.71	1010.68
1983/84							1007.86	1008.01	1008.46	1008.70	1009.04	1009.50	1010.00	1010.38	1010.88	1011.22	1011.40	1011.42
1984/85	1007.51	1007.51	1007.51				1007.95	1008.35	1008.74	1008.87	1009.05	1009.38	1009.68	1010.19	1010.60	1010.83	1011.08	1011.34
1985/86	1007.65	1007.58	1007.53	1007.58	1007.61	1007.60	1007.64	1007.83	1008.04	1008.21	1008.50	1008.77	1009.32	1009.88	1010.29	1010.52	1010.81	1011.27
1986/87	1007.67	1007.83	1008.02	1008.27	1008.58	1008.90	1009.19	1009.58	1009.85	1009.96	1010.23	1010.39	1010.60	1010.91	1011.21	1011.46	1011.71	1011.67
1987/88	1007.72	1007.71	1007.69	1007.68	1007.63	1007.67	1007.97						1009.60	1010.12	1010.51	1010.88	1011.01	1011.46
1988/89	1007.71	1007.66	1007.72	1007.84	1008.04	1008.15	1008.24		1008.80	1009.12	1009.57	1010.33	1010.99	1011.48	1011.80	1011.96	1011.94	1011.95
1989/90	1007.84	1007.87	1007.85	1007.82	1007.85	1007.77	1007.84	1007.93	1008.26	1008.66	1008.90	1009.21	1009.65	1010.15	1010.35	1010.51	1010.47	1010.30
1990/91					1007.58	1007.69	1007.90	1008.12	1008.46							1011.64	1011.55	1011.51
1991/92	1007.58	1007.56	1007.70	1007.77	1007.88	1007.99	1008.18	1008.42	1008.78	1009.09	1009.45	1009.78	1009.96	1010.23	1010.48	1010.47	1010.46	1010.44
1992/93																		
1993/94									1008.22	1008.57	1009.06	1009.52	1010.29	1010.77	1011.08	1011.34	1011.54	1011.56
1994/95	1007.38	1007.35	1007.36	1007.39	1007.40	1007.45	1007.54	1007.67	1007.84	1007.98	1008.11	1008.29	1008.53	1008.89	1009.48	1010.16	1010.82	1011.08
1995/96	1007.30	1007.26	1007.24	1007.33	1007.30	1007.35	1007.53	1007.63	1007.72	1007.89	1008.09	1008.36	1008.33	1008.42	1008.80	1009.42	1010.05	1010.36

Note : These data are calculated by using water level records at the site of Mongu and Senanga observed by Water Affairs

Table 2-3 Water Level of the Plain in the Study Area (2/2)

Year	Apr.			May			Jun.			Jul.			Aug.			Sep.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1961/62	1012.49	1012.40	1012.19	1011.91	1011.61	1011.26	1010.98	1010.77	1010.49	1010.29	1009.91	1009.29	1008.78	1008.47	1008.26	1008.05	1007.91	1007.75
1962/63	1012.53	1012.23	1011.88	1011.54	1011.25	1010.91	1010.57	1010.18	1009.80	1009.37	1008.88	1008.51	1008.24	1008.06	1007.91	1007.81	1007.74	1007.67
1963/64	1011.84	1011.66	1011.37	1011.02	1010.60	1010.00	1009.37	1008.79	1008.42	1008.21	1008.08	1007.96	1007.86	1007.80	1007.73	1007.69	1007.66	1007.62
1964/65	1011.84	1011.63	1011.39	1011.12	1010.77	1010.25	1009.62	1009.02	1008.54	1008.32	1008.00	1007.85	1007.75	1007.68	1007.64	1007.60	1007.57	1007.53
1965/66	1012.11	1011.83	1011.59	1011.35	1011.08	1010.71	1010.32	1009.72	1009.07	1008.61	1008.29	1008.05	1007.89	1007.77	1007.57	1007.48	1007.42	1007.33
1966/67	1011.83	1011.99	1011.81	1011.52	1011.37	1011.16	1010.87	1010.51	1009.89	1009.08	1008.51	1008.11	1007.92	1007.77	1007.67	1007.60	1007.53	1007.46
1967/68	1012.37	1012.13	1011.76	1011.55	1011.33	1011.00	1010.69	1010.35	1009.98	1009.50	1009.18	1008.75	1008.54	1008.35	1008.19	1008.10	1008.03	1007.94
1968/69	1013.06	1012.65	1012.29	1011.95	1011.60	1011.28	1010.99	1010.71	1010.43	1010.15	1009.85	1009.45	1009.11	1008.86	1008.64	1008.47	1008.33	1008.21
1969/70	1012.11	1011.79	1011.44	1011.15	1010.81	1010.48	1010.14	1009.64	1009.25	1009.00	1008.76	1008.59	1008.47	1008.38	1008.23	1008.12	1007.88	1007.81
1970/71	1011.71	1011.46	1011.24	1011.11	1010.90	1010.63	1010.20	1009.65	1009.20	1008.87	1008.62	1008.41	1008.25	1008.14	1007.99	1007.89	1007.81	1007.72
1971/72	1011.11	1011.28	1011.25	1011.13	1010.99	1010.75	1010.36	1009.79	1009.14	1008.69	1008.47	1008.23	1008.07	1007.91	1007.79	1007.67	1007.56	1007.49
1972/73	1010.81	1010.88	1010.88	1010.76	1010.28	1009.66	1008.87	1008.43	1008.15	1008.00	1007.85	1007.73	1007.64	1007.52	1007.43	1007.34	1007.27	1007.19
1973/74	1011.49	1011.66	1011.66	1011.44	1011.15	1010.77	1010.33	1009.74	1009.18	1008.74	1008.45	1008.23	1008.08					
1974/75	1012.47	1012.16	1011.83	1011.47	1011.18	1010.90	1010.56	1010.17	1009.67	1009.23	1008.82	1008.52	1008.27	1008.10	1007.99	1007.82	1007.71	1007.61
1975/76	1012.28	1012.24	1012.30	1012.12	1011.82	1011.45	1011.14	1010.79	1010.43	1010.03	1009.57	1009.12	1008.77	1008.52	1008.30	1008.13	1007.97	1007.89
1976/77	1011.79	1011.82	1011.93	1011.86	1011.50	1011.12	1010.79	1010.34	1009.89	1009.42	1009.02	1008.68	1008.47	1008.30	1008.15	1007.97	1007.80	1007.74
1977/78	1012.63	1012.72	1012.53	1012.31	1011.99	1011.61	1011.27	1010.89	1010.54	1010.16	1009.72	1009.27		1008.89	1008.68	1008.59	1008.46	1008.33
1978/79	1012.62	1012.58	1012.46	1011.84	1011.44	1011.06	1010.74	1010.31	1009.91									
1979/80				1011.59	1011.29	1010.88	1010.49	1010.05	1009.62	1009.25			1008.62	1008.43	1008.26	1008.12	1007.98	1007.87
1980/81	1011.97	1012.12	1012.05	1011.68	1011.31	1010.92	1010.51	1010.04	1009.57	1009.18								
1981/82	1011.16	1011.02	1010.86	1010.74	1010.53	1010.17	1009.59					1008.21	1008.07	1007.96	1007.83			
1982/83	1010.74	1010.79	1010.68	1010.48	1010.26	1009.71	1009.01	1008.67	1008.44	1008.29	1008.14	1008.02	1007.91	1007.82	1007.78	1007.69	1007.66	1007.46
1983/84	1011.34	1011.22	1011.02	1010.74	1010.39	1009.70	1009.07	1008.60	1008.37	1008.19	1008.05	1007.99	1007.90	1007.80	1007.72	1007.65	1007.60	1007.55
1984/85	1011.48	1011.53	1011.56	1011.36	1011.06	1010.68	1010.21	1009.58	1009.05	1008.73	1008.49	1008.32				1007.89	1007.80	1007.75
1985/86	1011.74	1011.91	1011.62	1011.33	1011.05	1010.67	1010.22	1009.58	1009.00	1008.69	1008.47	1008.27	1008.16	1008.05	1007.95	1007.84	1007.75	1007.67
1986/87	1011.52	1011.41	1011.25	1010.99	1010.64	1010.11	1009.57	1009.15	1008.84	1008.62	1008.48	1008.33	1008.22	1008.10	1007.98	1007.85	1007.77	1007.70
1987/88	1011.80	1011.69	1011.49	1011.27	1011.00	1010.61	1010.20	1009.59	1009.17	1008.84	1008.58	1008.38	1008.24	1008.10	1008.00	1007.95	1007.88	1007.80
1988/89	1012.05	1012.18	1012.22	1012.03	1011.72	1011.34	1010.98	1010.58				1008.88	1008.65					
1989/90	1010.28	1010.45	1010.75	1010.80	1010.68	1010.34	1009.83			1008.54	1008.35	1008.18	1008.06	1007.95	1007.88	1007.77	1007.71	1007.65
1990/91	1011.48	1011.43	1011.30	1011.00	1010.58	1009.96	1009.32	1008.84	1008.51	1008.32	1008.18	1008.07	1007.98	1007.91	1007.83	1007.74	1007.67	1007.62
1991/92	1010.40	1010.43	1010.42	1010.28	1009.80	1009.14	1008.71	1008.46	1008.27	1008.11	1008.01		1007.85	1007.77	1007.69			
1992/93																		
1993/94	1011.27	1010.91	1010.47	1009.86	1009.32	1008.84	1008.46	1008.25	1008.13	1008.02	1008.00	1007.93	1007.78	1007.72	1007.66	1007.57	1007.49	1007.42
1994/95	1011.13	1010.94	1010.95	1010.23	1009.40	1008.71	1008.30	1008.04	1007.92	1007.83	1007.75	1007.70	1007.64	1007.58	1007.51	1007.43	1007.38	1007.35
1995/96	1010.55	1010.62	1010.52	1010.22	1009.59	1008.85	1008.37	1008.13	1007.96	1007.85	1007.77	1007.61	1007.54	1007.48	1007.42	1007.34	1007.29	1005.73

Note : These data are calculated by using water level records at the site of Mongu and Senanga observed by Water Affairs

Table 2-4 Gross Irrigation Requirement (Wet Season 200ha, Dry Season 100ha)

Decade		Days	KC	ET Crop (mm/day)	Loss (mm/day)	Puddling Area (ha)	Nursery Bed (ha)	Irrigation Area (ha)	Puddling Water (mm)	Puddling Water (m³)	ET Crop (m³)	Rainfall (mm)	Effective Rainfall (m³)	Net Water Require. (m³)	Gross Irrigation Requirement (m³)	Gross Irrigation Requirement (m³/s)	Cropping
12	2	10	1.00	3.2	7.0		5.0	0.0			5,100	88.9	3,556	1,544	1,816	0.002	
12	3	11	1.00	4.2	7.0		15.0	0.0			18,480	65.5	7,860	10,620	12,494	0.013	
1	1	10	1.00	3.7	7.0		15.0	0.0			16,050	70.1	8,412	7,638	8,986	0.010	
1	2	10	1.00	4.9	7.0		5.0	0.0			5,950	70.2	2,808	3,142	3,696	0.004	
1	3	11	1.00	3.9	4.0	100.0		100.0	150.0	150,000	86,900	87.5	70,000	166,900	196,353	0.207	
2	1	10	1.00	3.6	4.0	100.0		200.0	150.0	150,000	152,000	51.0	81,600	220,400	259,294	0.300	
2	2	10	1.10	4.8	4.0			200.0			185,600	53.7	85,920	99,680	117,271	0.136	
2	3	8	1.10	4.2	4.0			200.0			137,920	43.9	70,240	67,680	79,624	0.115	
3	1	10	1.08	4.9	4.0			200.0			185,840	27.5	44,000	141,840	166,871	0.193	Wet
3	2	10	1.08	4.6	4.0			200.0			179,360	60.8	97,280	82,080	96,565	0.112	Season
3	3	11	1.05	4.2	4.0			200.0			185,020	72.7	116,320	68,700	80,824	0.085	
4	1	10	1.05	6.4	4.0			200.0			214,400	18.1	28,960	185,440	218,165	0.253	
4	2	10	1.05	5.7	4.0			200.0			199,700	0.0	0	199,700	234,941	0.272	
4	3	10	1.05	6.3	4.0			200.0			212,300	28.3	45,280	167,020	196,494	0.227	
5	1	10	1.00	6.9	4.0			200.0			218,000	0.0	0	218,000	256,471	0.297	
5	2	10	1.00	6.7	4.0			200.0			214,000	0.0	0	214,000	251,765	0.291	
5	3	11	0.95	6.9	4.0			200.0			232,210	12.0	19,200	213,010	250,600	0.264	
6	1	10	0.95	6.2	4.0			100.0			98,900	0.0	0	98,900	116,353	0.135	
6	2	10		5.9				0.0			0	0.0	0	0	0	0.000	
6	3	10	1.00	6.0	7.0		2.5	0.0			3,250	0.0	0	3,250	3,824	0.004	
7	1	10	1.00	5.9	7.0		7.5	0.0			9,675	0.0	0	9,675	11,382	0.013	
7	2	10	1.00	4.8	7.0		7.5	0.0			8,850	0.0	0	8,850	10,412	0.012	
7	3	11	1.00	5.9	7.0		2.5	0.0			3,548	0.0	0	3,548	4,174	0.004	
8	1	10	1.00	6.3	7.0	50.0		50.0	150.0	75,000	66,500	0.0	0	141,500	166,471	0.193	
8	2	10	1.00	6.9	7.0	50.0		100.0	150.0	75,000	139,000	0.0	0	214,000	251,765	0.291	
8	3	11	1.00	7.1	7.0			100.0			155,100	0.0	0	155,100	182,471	0.192	
9	1	10	1.13	6.8	7.0			100.0			146,840	0.0	0	146,840	172,753	0.200	
9	2	10	1.13	6.9	7.0			100.0			147,970	0.0	0	147,970	174,082	0.201	Dry
9	3	10	1.13	6.6	7.0			100.0			144,580	0.0	0	144,580	170,094	0.197	Season
10	1	10	1.25	6.9	7.0			100.0			156,250	0.0	0	156,250	183,824	0.213	
10	2	10	1.25	5.7	7.0			100.0			141,250	17.4	13,920	127,330	149,800	0.173	
10	3	11	1.25	5.3	7.0			100.0			149,875	16.0	12,800	137,075	161,265	0.170	
11	1	10	1.25	5.6	7.0			100.0			140,000	0.0	0	140,000	164,706	0.191	
11	2	10	1.13	5.6	7.0			100.0			133,280	0.0	0	133,280	156,800	0.181	
11	3	10	1.13	4.7	7.0			100.0			123,110	33.8	27,040	96,070	113,024	0.131	
12	1	10	1.00	4.7	7.0			50.0			58,500	69.8	27,920	30,580	35,976	0.042	
Total		365		198.9								887.2					

Table 2-5 Design Discharge of Secondary Irrigation Canal

Rotation (Irrigation) Block		RB1					RB2			RB3		RB4		RB5		RB6		Total
S.I.C.		SIC1	SIC2	SIC3	SIC4	SIC5	SIC6	SIC7	SIC8	SIC9	SIC10	SIC11	SIC12	SIC13	SIC14	SIC15	SIC16	
Area (ha)		5.9	6.7	4.8	13.2	6.0	17.6	4.2	19.8	13.5	18.9	19.7	14.3	21.5	8.0	20.7	5.2	
Days		Puddling Area (ha)																
1		5.0	5.0															10.0
2		0.9	1.7	2.4	5.0													10.0
3				2.4	5.0	2.6												10.0
4					3.2	3.4	3.4											10.0
5							5.0	4.2	0.8									10.0
6							5.0		5.0									10.0
7							4.2		5.0	0.8								10.0
8									5.0	5.0								10.0
9									4.0	5.0	1.0							10.0
10										2.7	5.0	2.3						10.0
11											5.0	5.0						10.0
12											5.0	5.0						10.0
13											2.9	5.0	2.1					10.0
14												2.4	5.0	2.6				10.0
15													5.0	5.0				10.0
16													2.2	5.0		2.8		10.0
17														5.0		5.0		10.0
18														3.9	1.1	5.0		10.0
19															5.0	4.0	1.0	10.0
20															1.9	3.9	4.2	10.0
Total		5.9	6.7	4.8	13.2	6.0	17.6	4.2	19.8	13.5	18.9	19.7	14.3	21.5	8.0	20.7	5.2	200.0
Analysis of Design Discharge																		
Puddling Area (Max.)	ha/day	5.0	5.0	2.4	5.0	3.4	5.0	4.2	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.2	
Puddling Water	mm/day	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	
Design Discharge	m^3/s	0.102	0.102	0.049	0.102	0.069	0.102	0.086	0.102	0.102	0.102	0.102	0.102	0.102	0.102	0.102	0.086	

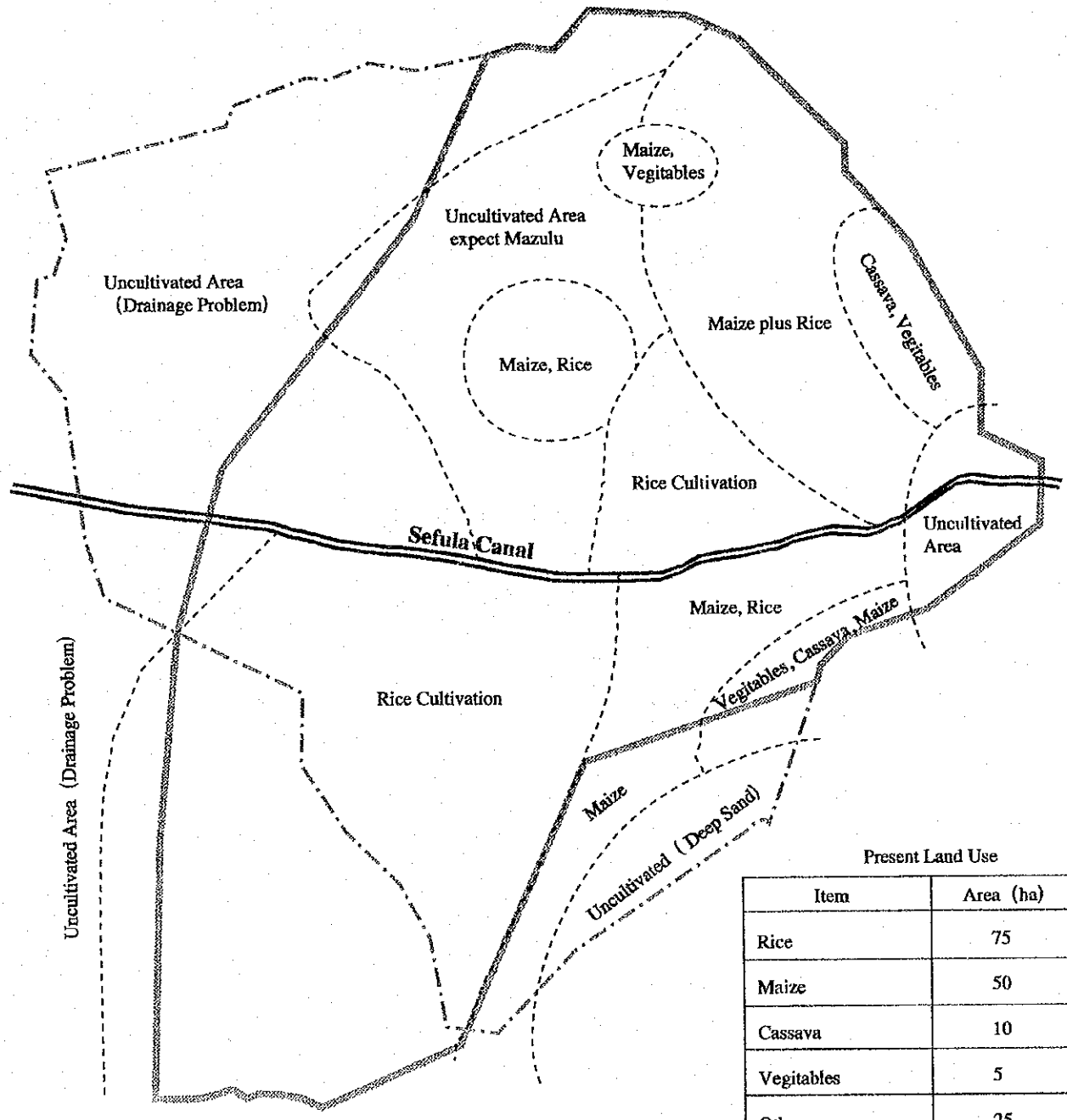
Design discharge of secondary irrigation canal is determined by puddling water.

As shown table above, maximum puddling area a day is determined as 2.4 to 5.0 ha.

Design discharge, therefore, is calculated as "(150mm) x (2.4～5.0ha) / (irrigation efficiency 0.85) / (86400second) = (0.049～0.102m^3/s) "

Table 2-6 Probability Analysis of Daily Rainfall

Year	Month	Day	Rainfall (mm)
52/53	Feb.	12	52.6
53/54	Dec.	41	50.8
54/55	Jan.	29	50.0
55/56	Apr.	20	51.1
56/57	Feb.	22	108.0
57/58	Jan.	24	84.6
58/59	Nov.	30	71.1
59/60	Dec.	23	48.8
60/61	Mar.	19	52.3
61/62	Jan.	13	81.8
62/63	Dec.	30	83.1
63/64	Dec.	6	79.5
64/65	Dec.	7	34.3
65/66	Jan.	11	67.8
66/67	Jan.	22	37.8
67/68	Apr.	16	104.4
68/69	Feb.	17	224.0
69/70	Oct.	18	53.3
70/71	Jan.	22	61.7
71/72	Jan.	6	74.4
72/73	Feb.	13	65.0
73/74	Feb.	17	103.5
74/75	Dec.	28	49.9
75/76	Mar.	22	66.5
76/77	Mar.	5	59.5
77/78	Dec.	20	85.5
78/79	Jan.	28	45.9
79/80	Dec.	14	101.3
80/81	Feb.	23	97.7
81/82	Feb.	27	56.6
82/83	Nov.	27	48.1
83/84	Jan.	12	35.5
84/85	Dec.	13	37.8
85/86	Dec.	2	66.4
86/87	Dec.	9	48.2
87/88	Mar.	5	66.5
88/89	Feb.	21	81.7
89/90	Jan.	12	64.5
90/91	Feb.	9	89.2
91/92	Jan.	22	68.9
92/93	Apr.	12	106.4
Formula Log(X+22.383)=1.95186+0.17336 x Ksi			
Return Period	Ksi	Log(X+22.383)	X (mm/day)
2-year	0.0000	1.9519	67.1
3-year	0.3045	2.0050	78.7
5-year	0.5951	2.0557	91.1
10-year	0.9062	2.1100	106.1



Present Land Use

Item	Area (ha)
Rice	75
Maize	50
Cassava	10
Vegitables	5
Others	25
Uncultivated Area	60
Total	225

Boundary of Proposed Irrigation Area(New)

Boundary of Proposed Irrigation Area(Old)

Figure 2-1 Present Condition in Proposed Irrigation Area

(2) Roads

1) Route Plan

The proposed route shall be based on the Feasibility Study. However, some portions of the Feeder Road A and Peripheral Road are modified as follows based on the sight inspection.

The Peripheral Road shall be constructed around the proposed irrigation area due to the essential function. According to the modified boundary of the irrigation area, the route of Peripheral Road is also amended.

A portion of Feeder Road A, between Plateau and Plain across a steep slope, is shifted, since the area is used as cassava fields and excavation work of large scale causes a serious slope damage. The new route proposed is on the existing small road with dull slope, and this existing road will be improved. All the proposed routes are avoiding large mango trees and cassava fields.

2) Longitudinal Design

The proposed roads are constructed along the existing roads or in the flood plain. Their longitudinal slopes except some portions of Feeder Road A and B are so gentle that it is appropriate to apply them as the proposed alignment. The portions between Plateau and Plain, however, have to be improved carefully keeping the longitudinal slopes less than 8%. This will protect serious erosion by rainwater and allow vehicles to pass smoothly.

3) Cross Sectional Design

Specifications on the cross sectional design are described on the following based on the Feasibility Study.

Item	Objects of transportation	Traffic	Effective width (m)	Total width (m)
Feeder Road	Agricultural products, materials, and necessaries of life	Trucks and 4WD-vehicles	3.00	4.00
Village Road	Agricultural products, materials, and necessaries of life	Oxcarts and light vehicles	2.50	3.50
Peripheral Road	Agricultural products, materials, and necessaries of life	Oxcarts and light vehicles	2.50	3.50
Maintenance Road	Agricultural products, materials, and necessaries of life	Oxcarts and light vehicles	2.50	3.50
Field Road	Agricultural products and materials	Oxcarts	2.00	3.00

Road shoulder is very important to protect pavement. National Roads in Zambia have width of the shoulders about 1.0-2.0m generally. However, it is difficult to build such wide shoulders from the viewpoint of land acquisition and scale of the roads. Therefore, 0.5m width on each shoulder is secured as a maximum possibility.

Cross slope of 5 % is secured to make drainage of the road surface easy and to prevent surface erosion by rainwater.

4) Structural Design

The domestic design standard for small scale such as the proposed roads is not established. Therefore, the structure of the road is proposed on the basis of natural conditions, actual use and maintenance ability as follows.

a) The Foundation

The ground is composed of sand including peat muck or composed of peat soil. Peat soil shall be removed and replaced with the material of the filled up ground to prevent serious subsidence. The sand including peat muck is very loose in present condition, but it can get enough strength and trafficability as the foundation of road after compaction under suitable moisture control.

b) Filled Up Ground

Filled up ground shall be made of Brotse Sand. This Brotse Sand is called Yellow Sand or Brown Sand and exists in large quantities under about 2 m depth in the plain and the plateau around the project area. It can be obtained easily from the borrow pits made for the construction works of the national road.

c) Subgrade

Subgrade shall be made of Brotse Sand mixed with cement to keep enough strength and to prevent surface erosion by rainwater. This construction method is already generalized in Zambia and very effective to reinforce road materials. The thickness of subgrade is adopted as 20 cm basically except some portion in sloping area where thickness of 30 cm is adopted. The shoulder shall be made of the same material of subgrade.

d) Pavement

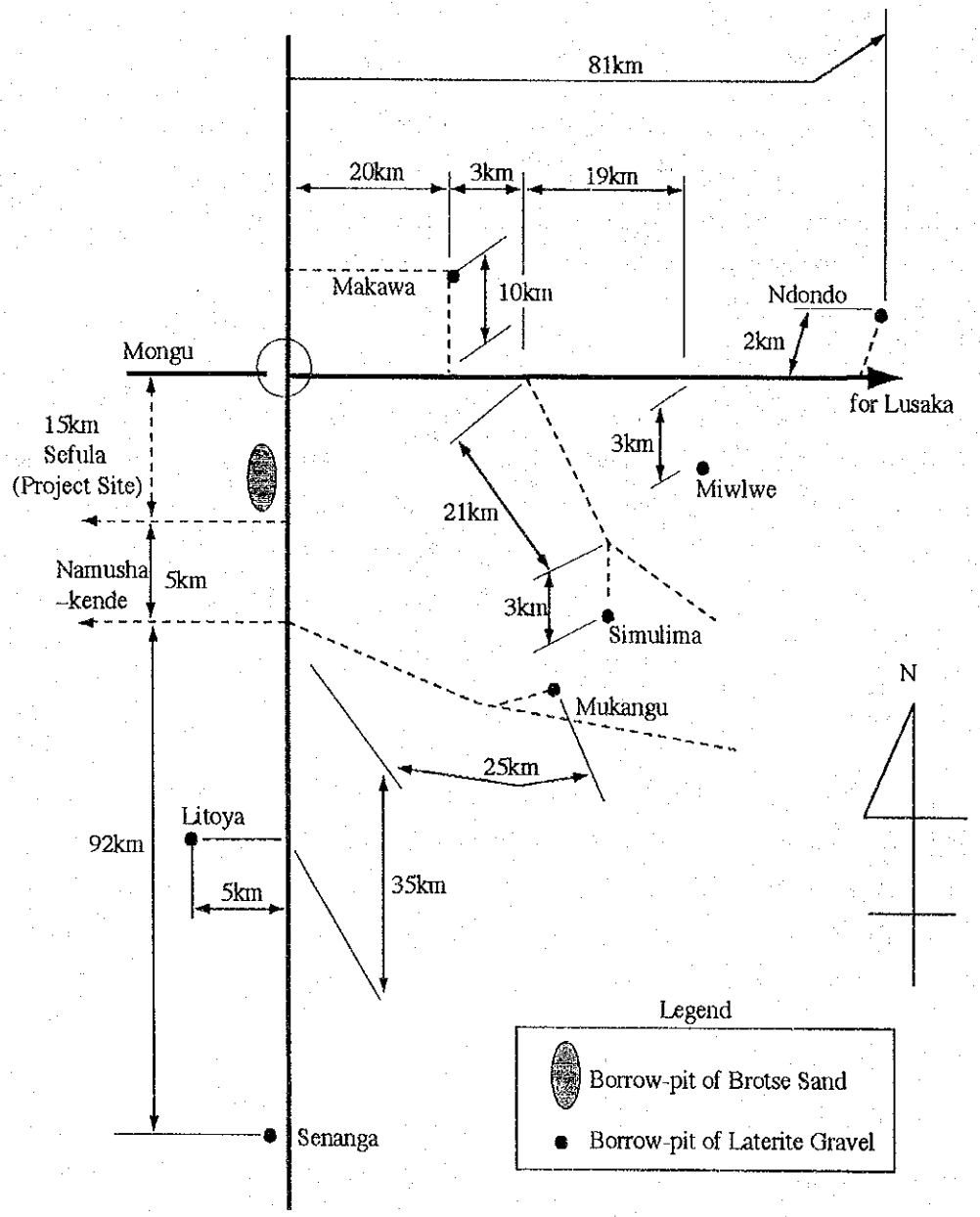
Pavement shall be made of Lateritic clay soil mixed with cement. The place of production for Lateritic clay soil is restricted and is about 30-100 km away from the Project Area. On the basis of the analysis concerning economy, quality and potentiality among seven borrow-pits, Miulwe located 60 km away is determined as the most advantageous.

e) Erosion Protection

Protection against surface erosion by runoff is necessary. Drainage gutters lined with cement block shall be constructed in sloping area. Cut Off Walls made of simple concrete shall be installed in the steep sloping portions of the Feeder Roads. In addition, Slope Protection Works made of cement block or vegetation will be set on the side slope of the roads.

f) Related Structures

Cross Culverts shall be installed at the crossing points of canals and streams and at longitudinally depressed points. Turnouts are planned at intervals of 200m for vehicles passing.



Location Map of Road Materials

Comparison of Borrow-pit for Laterite Gravel

Borrow-pits	Distance to Project Site				Quality of Material		Land Ownership	Estimated Cost per 1,000m (US$)					Priority
	Total (km)	Tarred (km)	Gravel (km)	Mending (km)	Grade	Fracture Works		Excava-tion	Trans-potation	Road Mending	Fracture Works	Total	
Mawawa	45	35	10	10	C	Unnece.	Govern.	1,540	22,005	45,500	0	69,045	
Litoya	45	40	5	5	C	Unnece.	Govern.	1,540	22,005	22,750	0	46,295	
Miulwe	60	57	3	1	A	Necessary	Induna	1,660	29,340	4,550	3,200	38,750	1
Ndondo	83	81	2	2	C	Unnece.	Govern.	1,540	40,587	9,100	0	51,227	
Mukangu	30	5	25	25	C	Unnece.	Induna	1,540	14,670	113,750	0	129,960	
Simulima	62	38	24	12	A	Unnece.	Govern.	1,660	30,318	54,600	0	86,578	3
Senanga	97	97	0	0	A	Necessary	Govern.	1,660	47,433	0	3,200	52,293	2

(3) Agro-processing Facility

Hammer mills and rice polishers installed already in the Project Area and Mongu Township are all made in India, except the one installed in MNG, which was made by SATAKE in Japan. It is said that they have problems for operations and maintenance of Satake made machines due to difficulty of obtaining spare parts. In contrast, machines made in India can be easily repaired as those repair parts are easily provided through an agent at Lusaka. Therefore, these mechanical equipment made in India will be applied for these planned facilities.

At first, the construction of two facilities at both Sefula area and Namenya area were requested, but it is planned to implement only one in Sefula after examining reasons such as concentrating at one spot is easier to operate and manage facilities rather than dispersing to two places and an extension of electric cable is necessary in order to implement at Namaenya.

As far as the power supply of machines are concerned, electric machines and especially independently movable machines will be selected from the viewpoint of cheaper driving cost and easiness of its repairing and good durability.

As to the scale of these facilities, modest scale shall be adopted due to maintenance cost and the anticipated quantity of harvest at the time when this plan is actually invited.

1) Rice Polisher

Because there is no rice polishers installed at the Project Area at present, disposal scale is decided in accordance with the quantity of the planned harvest.

a) Planned Quantity to be Disposed

According to the Farming Plan in the Feasibility Study, the anticipated quantity of rice harvest is as follows;

The Planned Harvest of Rice

		Planned area	Harvest as per unit area	Total harvest	Total quantity	Days needed for disposition
Crop during dry season	Irrigated area	100 ha	4.5 t/ha	450 ton	450 ton	182 days
Crop during rainy season	Irrigated area	200 ha	4.0 t/ha	800 ton	1115 ton	156 days
	Rain fed area	90 ha	3.5 t/ha	315 ton		

b) Scale Decision

According to this table, the peak of disposed quantity for harvested rice is just after the completion of the harvest during rainy season. The anticipated quantity to be disposed will amount to 1,115 ton, of which, after dry processing, is to be processed as cleaned rice during the period of 6 months, from July till December before the next rainy season harvest would begin.

Number of working days for a month = 30 days - 4 days (Sundays) = 26 days
Number of disposal days for 6 months = 26 days x 6 months = 156 days

Provided that the disposal hour in a day is 8 hours, and machine operating efficiency is 60%, the necessary disposal capacity per one hour would be;

= 1,115 ton/(156 days x 8 hr/day x 60%) = 1.49 ton/hr.

Taking its operations and maintenance into consideration, in case the two same type machines are installed, the disposal ability per one machine would be 0.7 ton/hr. Accordingly, two rice polishers, which have 0.7 ton/hr disposal capacity each, will be installed according to this plan.

2) Hammer mill

Because two hammer mills have already been installed in the region at the planned area, the disposal capacity of facility proposed shall be an excess of the existing capacity among the planned harvest quantity.

a) Planned Disposal Quantity

In the Farming Plan of the Feasibility Study, the Planned crops of maize are as follows:

Planned Maize Crop

		Planned area	Harvest as per unit square	Total products	Total quantity	Days needed for disposition
Harvest during rainy season	Rain fed	16 ha	2.5 t/ha	40 ton	40 ton	78 days
Harvest during dry season	Rain fed	75 ha	2.0 t/ha	150 ton	212.5 ton	78 days
	Bucket irrigation	25 ha	2.5 t/ha	62.5 ton		

b) Scale decision

According to this table, the peak of disposal quantity for hammer milling comes just after the completion of harvest during dry season. The quantity anticipated to be disposed will amount to 212.5 ton, of which, through the adjustment processing after its harvest, it would be sent to hammer mill for processing for a period of 3 months, from April till June, when, after the completion of rainy season harvest, rice milling would begin.

Working days for a month = 30 days - 4 days(Sundays) = 26 days
Disposal days for 3 months = 26 days x 3 months = 78 days

As a result of actual investigation, the disposal capacity of hammer mill installed already there amount to average 700 kg a day per unit, so that the disposal capacity of the already installed two flour mills for the working days would amount to; 0.7 ton x 2 x 78 days = 103.3 ton. Thus, necessary disposal capacity for hammer milling on this project would be calculated as follows;

212.5 ton - 109.2 ton = 103.3 ton.

Provided that the disposal hours a day is 8 hr, and the operating efficiency of hammer milling is 60%, then necessary disposal capacity per one hr will be;

= 103.3 ton/(78 days x 8 hr/day x 60%) = 0.28 ton/hr.

Based on information obtained by the result of above calculation, a hammer mill which has a 0.3 ton/hr capacity is to be installed for this plan.

3) Storage Warehouse

The storage house of this plan is to be constructed in order to promote sales efficiency to brokers along with smooth operation of the rice polishers and the hammer mill. Therefore, the storing capacity of the warehouse must be designed to have the capability to store each three day's products, before and after its disposal;

Storage capacity = (0.7 ton x 2 machines + 0.3 ton) x 8 hr x 60% x 3 days x 2 (before and after disposal) = 49.0 ton

Referring to Zambia's guide line of storage warehouse, it is stipulated that a storage house with a 100 ton storing capacity needs about 100 m^2 floor space. Accordingly, the floor space of the storage warehouse of this plan is of 50 m^2.

4) Planned Space

Considering working behavior of such times when unhulled rice and polished rice are incoming and outgoing from a rice polishing room and a hammer mill, we'll install the entrance and exit of a rice milling house and hammer mill facing to the village road and also a platform is to be placed facing the roads. On the north side of the village roads, a storage warehouse and a office room will be constructed. The floor spaces for the rice polishers and the hammer mill are to be 30 m^2 for the rice polishers, and 15 m^2 for the hammer mill providing sufficient space around machines for operator's smooth workability and maintenance. Also an office room, in which such clerical works as the control of incoming and outgoing products and the levy of disposal charges will be disposed, and a storage warehouse, which is to store the spare parts of machines to repair, will be constructed, each of which has 25 m^2 floor space.

5) Facility Plan (Electric Equipments)

The rice polishers and the hammer mill are to be supplied necessary power for disposition by distribution lines leading from power receiving panel through power panel. Also lighting fixtures and outlets will be installed in each room and provided with distribution lines. Regarding to lighting fixtures, we'll prepare fluorescent lamps. The following table shows the figures indicating the targeted luminous intensity of each room;

Targeted luminous intensity of Agricultural Products Processing Facilities

Place	Luminous intensity (lx)
Office room	300 ~ 500
Storage room for materials and equipment parts	200
Storage room	150 ~ 200
Rice mill room and hammer mill room	300
Platform	100 ~ 150

Also Electric Power Equipments will be provided with 380V/3PH through distribution lines and its capacities are shown hereunder;

Power capacity of a rice mill and hammer mill

Place	Power capacity
Rice mill	11.2 kw x 2
Hammer mill	11.8 kw x 1

(4) Market Facility

The market is the sole center of economic activity in the Project Area, and deals in such commodities as marine products, its processed products(dried fish), agricultural products, dairy products(sour milk), fruits, daily necessities, and edible oil.

The market is of concrete block structure, however, because of its age and deterioration, many cracks can be seen about the structure. Consequently, we decided, it is very difficult to repair the market building partially, and overall repair is the only choice for us regarding to the market building. However, the structure and finishing touch of the market building after repair will remain at the same level as before.

1) Scale Decision

Present facilities have been consisted of a shopping space, which has a 60 m^2 space, and storing warehouses(two rooms), which have 80 m^2 space each. However, as far as the storing warehouses are concerned, only one fourth of the storing warehouses capacity have been used. Regarding to the shopping space, they deal in only agricultural products and marine products inside the market and other commodities, for instance, daily necessities and others, have been sold outside the market building at present. Therefore, in order to include these present outside-market-transaction in the planned market space, the planned space for the shopping space in the market will be 90 m^2, which is to be 50% increase of the present space.

As for storing warehouses, we'll construct three rooms for the storing warehouses, each for marine products, green grocery, and daily necessities, whose construction scale and spaces are shown hereunder taking the frequency of its use at present into consideration.

Space of present storing warehouse
= 80 m^2 x 1/4 ÷ 2 items (present status) x 3 items (Plan) = 30 m^2

2) Construction Plan

The planned market facility is to be constructed on the north side of the intersection between Village Road and a Feeder Road B of this plan, whose shopping space will be placed at the convenient plot for those who will come in an out from the road. The planned market is of the structure having no walls on its east, south, and west sides, namely open structure and people can pass through freely from its east, south, and west sides. And the north side of the market is to be adjacent to the storing warehouse.

3) Facility Plan

a) Electric Equipments

Lighting fixtures and outlets will be installed in each room and provided with distribution lines through a switch board. Regarding to lighting fixtures, we'll prepare fluorescent lamps. The following table shows the figures indicating the targeted luminous intensity of each room.

Targeted luminous intensity of Market Facility,
Luminous intensity(lx)

Place	Luminous intensity (lx)
Shopping space	300
Storage room	150 ~ 200

b) Supply Water and Drainage Facilities

The facilities for tapping water supply and sewerage are to be installed. The tap water will be supplied to such places as washstands and show cases at the shopping space and also shopping space for its floor clearing, through a elevated water tank built on the top of the building.

Drainage tanks, which will dispose its sewage from each washstand and others by means of underground permeation method, will be installed as its sewerage.

(5) Extension Facilities

A multiple-purpose facility is to be constructed, which will houses such rooms as offices(for extension officers), a meeting room, a training room, a women's training room, lecturers' room(for members of the Japan Overseas Cooperation Volunteers).

1) Scale Decision

a) Office Room

Office rooms are composed of two rooms, one room for extension officers from the Department of Agriculture, Western Province and the other for officials from the Farmers Organization Secretariat for the disposal of their clerical works, of which each, fundamentally, has a 5 square meters space as per one person according to the Zambia's official office room measure as under.

Office room for extension officer = for 3 persons (extension officers and members of J.O.C.V.) x 5 m^2 = 15 m^2 ≒16 m^2

Office room for farmers organization secretariat = 4 persons (members of executive committee) x 5 m^2 = 20 m^2

b) Conference Hall

The promotion plan, which will be carried out using this room, will be, on this plan, done according to such schedules as the orientation of study which is to be implemented as per each promotion zone, regular general meetings of Farmers Organization and work consultation and arrangement meetings as per its each section, village headmen's meetings of each region, agricultural product exhibitions and others. Furthermore, this room will used as a meeting room for local residents, approved by officials the Department of Agriculture, Western Province, for mutual intercourse, and recreation. Among them, the general meetings of Farmer Organization may be attended by about 250 of its members, the biggest meeting, in contrast, the number of attendants of other meetings may be about 100 persons at most, so that the general meeting of Farmer Organization will be opened with attendants' squat down style. And the meetings using its desk and chair will be held in case of about 100 attendants(necessary space = 2 m^2/as per one person). Provided that the actual participants is 70% of above calculation, the appropriate scale will be calculated as follows:

Multipurpose Conference room floor space
= 100 persons x 70% x 2 m^2/ as per one person = 140 m^2

c) Training Room

According to this plan, the training room is to be used for such study and training purposes for male headed households as water management, irrigation, rice cultivation, vegetable and fruits cultivation, farm management, fertilizing, the processing of agricultural products, and the promotion of livestock use for farm work, and also for such a meeting as the executive committee of Farmer Organization and the representatives' meeting of any other organizations. Among them, except the meetings of Farmer Organization, the fundamental research meetings relating to agricultural industry must be opened about 8 weeks, during every March, April, October and November, which are farmers' slack seasons. Except above mentioned seasons, farm industry is in most busy seasons, so that only for farmers wanted especially training, application study may be performed in afternoons. The participants for training meetings will be 245 persons, accepting one person as per

one household of 245 male headed households. According to the schedule of training meeting, it is consisted of training 2 items for 5 days as per one week, and the training of all items will be completed within four years. In so doing, we think, the training of 8 items may be possible twice a year. Anticipated number of attendants as per one training item is as follows:

Anticipated attendants as per one training item
= 245 persons / 4 years / 2 times as per one year = 30.6 persons ≒ 31 persons

In order to promote the earlier realization of the effect, in case there are farmers who are impossible to attend these training meetings, we will adjust the order of its participation in order to increase the number of its attendants, so that, we wish, if the ratio of absentee for these training meeting can be lowered within 10% of total possible attendants, the objectives of these training meetings will be achieved according to original schedules. The necessary space for these meeting are calculated as follows:

Training room floor space
= 31 person x 90% x 2 m^2 as per one person = 56 m^2

d) Women's Training Room

According to this plan, the women's training room is to be used for such training purposes for female headed households as water management, irrigation, rice cultivation, vegetable and fruits cultivation, life style and nutrition improvement, fertilizing, the processing of agricultural products, and the promotion of livestock use for framework. Among them, the fundamental research meetings relating to farming must be opened about 8 weeks, during every March, April, October and November, which are farmers' slack season. Except above mentioned seasons, farming is in most busy seasons, so that only for farmers wanted especially for training, application training may be performed in afternoons in those seasons. The participants for these training meetings will be 324 persons, accepting one person as per one household of 324 female headed households. According to the schedule of training meeting, it is consisted of training 2 items for 5 days a week, the training of all items will be completed within four years. Thus, we consider, the training of 8 items may be possible twice a year. Anticipated number of attendants as per one training item is as follows:

Anticipated attendants as per one training meeting
= 324 persons ÷ 4 years ÷ 2 times as per one year = 40.5 persons ≒ 41 persons

With regards to the training for females such as that of nutrition improvement and flour milling of maize by using hand mill(the training of the processing of agricultural products), the training will be performed using equipments frequently, so that we can't expect good efficiency in study and training in case there are many attendants in one occasion. Taking this into consideration, we'll carry out these training by dividing attendants into two groups, and using two separate rooms. Provided that the ratio of absentee for these training meetings can be lowered within 10% of total possible attendants, the objectives of these training meetings can be achieved according to the original schedule. Reserving 10% of the floor space to install equipments, the necessary space for women's training rooms are to be calculated as follows;

Women's training room floor space
= 41 persons x 90% x 110% x 2 m^2 as per one person = 81.2 m^2(2 rooms)

Floor space as per one room = 81.2 m^2 ÷ 2 rooms = 40.6 m^2 ≒ 42 m^2

Additionally, except the study for members of female headed house holds, we need a workshop room to support female group activities (include some males), for instance the activities for village groups. In doing so, a room to support female group activities for the manufacturing of dried mango or handicrafts is to be installed. As to the space scale of the room for female group activities, the average number of the household in each village groups, from zone one to zone four, which have the most numerous households, is calculated as follows:

21.3 household
= (17 households + 20 households + 23 households + 25 households) ÷ 4 zones.

Accordingly, based on the same calculation applied to women's training room, the floor space can be calculated as 42 m^2.

e) Lecturers' Room

We'll prepare the lecturers' room which will be used as a workshop for study and training preparation of lecturers who are delegated from Japan Overseas Cooperation Volunteers and other officials of the Department of Agriculture, Western Province, of which three rooms are to be provided each with toilets, washstands, and shower room for their overnight stay. The floor space of each room will be 24 m^2 according to the single room measure of local Civil Servant overnight accommodations.

2) Planned Space

Entering westward into from the intersection between the Village Road and the Feeder Road B of this plan, the entrance will be located on the south side of this facility. An office is to be completed on the east side of the entrance, a meeting room will be placed on the west side, and other rooms will be located to a fan like directions from the office.

Each room will be designed in the space plan to face a road, thus taking in enough lighting and ventilation. Between office rooms, meeting room and training room, an opening space for facility users as a public space, which leads to a patio, is to be installed.

3) Facility Plan

a) Electric Equipments

Lighting fixtures and outlets will be installed in each room and provided with distribution lines through a switch board. Regarding to lighting fixtures, we'll prepare fluorescent lamps. The following table shows the figures indicating the targeted luminous intensity of each room.

Targeted luminous intensity of Extension Facilities, Luminous intensity(lx)

Place	Luminous intensity (lx)
Office room	300 ~ 500
Meeting room	300
Training room	300
Lecturers' room	300
Other public space	100 ~ 150

2) Supply Water and Drainage Facilities

Tap water will be supplied to such places as a shower room and a washstand of a lecturers' room, toilets and its washstand, women's training rooms including number one and number two room, and a washstand for female group activity room, through a elevated water tank built with planned Rural Water Supply facilities.

Drainage tanks, which will dispose its sewage from each washstand and others by means of underground permeation method, are to be installed as its sewerage.

(6) Rural Water Supply System

We'll prepare the plan to install hand pump wells -easy for its operations and maintenance- for local residents under the technical cooperation of the Water Affair. Wells to be accommodated as additional facilities to Market, Extension Facilities are with motor operated pumps, because of its easy operation and control. And through an elevated water tank of the water supply system, tap water is to be supplied to necessary places.

Table 2-7 Outline of Facilities

Road Facilities

Item / Description	Length (km)	Road Width		Pavement	Appurtenant Facilities			Remarks
		Total (m)	Effective (m)		Drainage (m)	Cross Culvert (nos.)	Turnout (nos.)	
Feeder Road A	1,820	4.0	3.0	Laetrile with Cement	2,820	5	5	
Feeder Road B	2,160	4.0	3.0	Ditto	920	3	3	
Village Road	3,910	3.5	2.5	Ditto	3,910	9	19	
Peripheral Road	6,880	3.5	2.5	Ditto	0	17	13	
Maintenance Road A	1,860	3.5	2.5	Ditto	0	0	0	Along with Main Irrigation Canal
Maintenance Road B	280	3.5	2.5	Ditto	0	3	1	Along with Main Drainage Canal A
Maintenance Road C	585	3.5	2.5	Ditto	0	2	2	
Field Road	12,640	3.0	2.0	Barotse Sand	0	0	0	Along with Secondary Irrigation Canal, N=16

Irrigation and Drainage Facilities

Item / Description	Components, etc.
Main Irrigation Canal	L=2,435m, Q=1.00m^3/s, BxH=1.5mx0.75m, Canal Bed Slope=1/500, Reinforced Concrete Canal(2135m) + Earth Canal(300m)
Sec. Irrigation Canal	N=16, L=12,465m, Q=0.05Å`0.10m^3/s, BxH=0.5mx0.5m, Cement Block Lining Canal
Division Works	Water Distribution to Secondary Canal, N=9,, 200m Intervals Installation, Reinforced Concrete Structure, Water Level Controller made of Log or Timber
Sand Trap	Earth Embankment Structure, Installation of Intake Works and Spillway, Sediment Volume 2,200m^3/year, Connect to Maintenance Road B and C
Bypass Canal	Installation for Bathing or Washing, L=600m, B=0.3m, Cement Block Lining Canal
Land Leveling	Area=46ha, Land Clearing and Leveling
Main Drainage Canal A	Improvement of Namalanga Canal(Right Bank Side), L=6,000m, Connect to Spillway, Earth canal and Cement Block Lining Canal
Main Drainage Canal B	Installation at Left Bank Side, L=4,000m, Unit Drain Discharge Q=2.78liter/s/ha, Earth Canal
Lateral Canal	N=9, L=8,680m, Earth Canal, Unit Drain Discharge Q=2.78liter/s/ha

Agro-processing Facilities, Market Facilities, Extension Facilities, Rural Water Supply Facilities

Item / Description	Components, etc.
Agro-processing Facilities	Rice Polishers 0.7ton/hr x 2, Hammer Mill 0.3ton/hr x 1 (Electric Driven) Floor Area (Rice Polisher Room A=30m^2, Hammer Mill Room A=15m^2, Store Room A=50m2, Supply Room / Office A=25m^2)
Market Facilities	Market (Floor Are A=90m^2), Storage(Floor Area A=30m^2)
Extension Facilities	Extension Office(A=20m^2), Farmers' Group Office(A=30m^2), Conference Office(A=140m^2), Training Room(A=56m^2), Women's Training Room(A=40.6 x 2 m^2) Women's Group Working Room(A=40.6m^2), Lecturer's Room(A=24 x 3m^2)
Rural Water Supply	Hand Pump Water Supply for Village People, 2 Places (Namaenya, Mutuwanbwa), Indian Mark II, Apron and Drain Electric Pump Water Supply for Market and Extension Facilities, Q=3~5liter/second, Water Tank