Figures

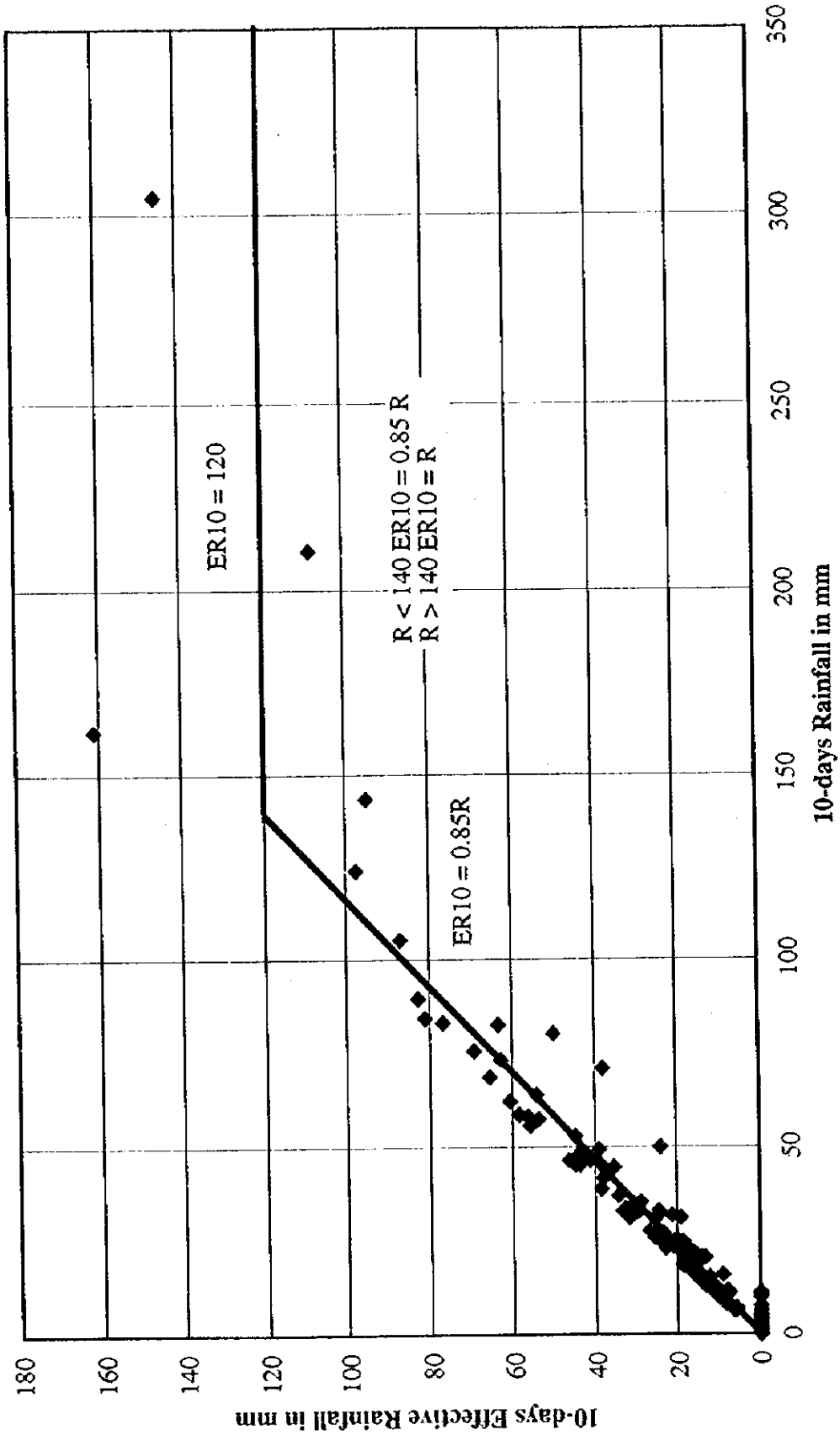


Figure K.3.1
10 days Rainfall - Effective Rainfall Curve at Chekereni Station

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

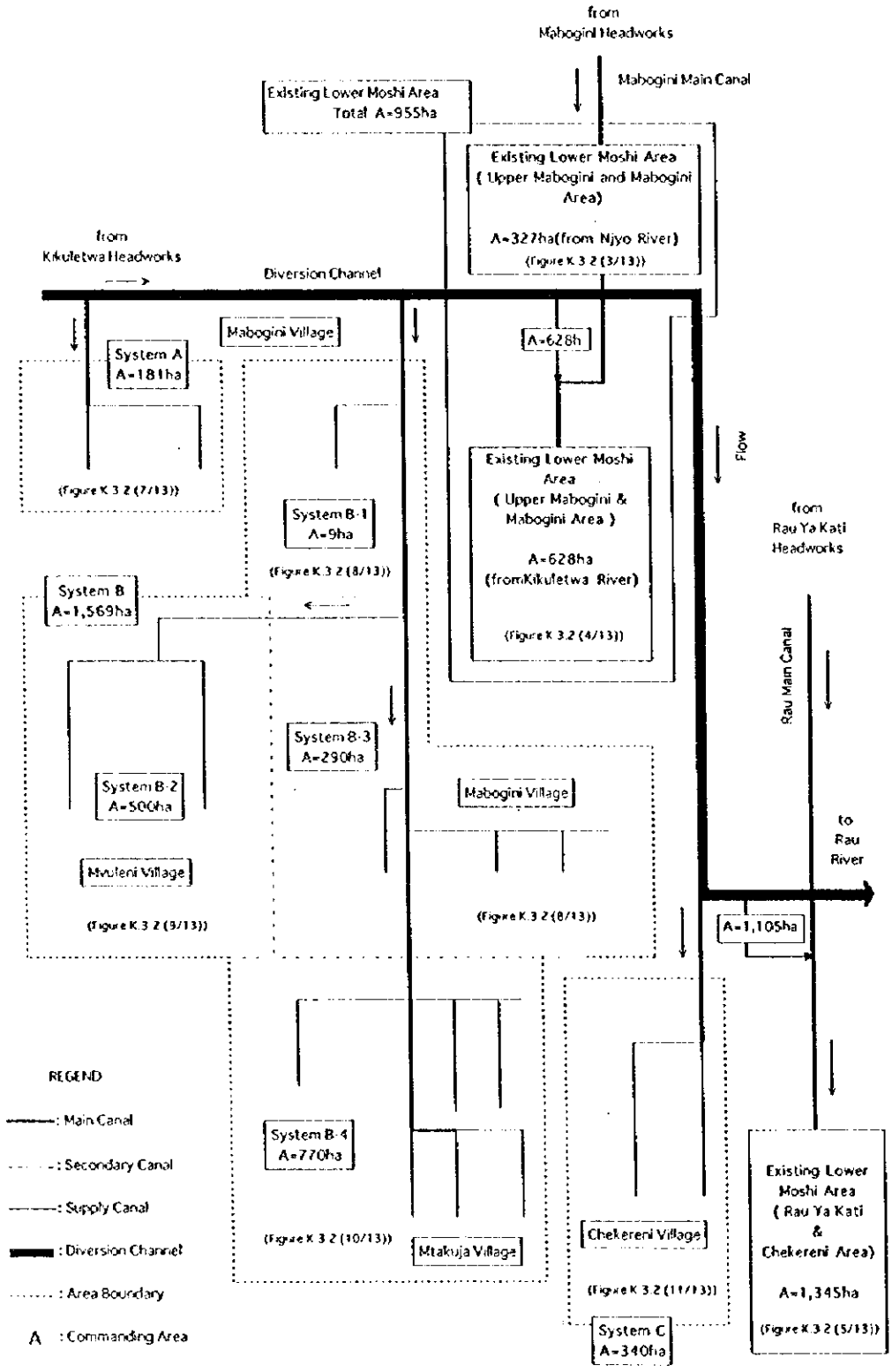


Figure K.3.2 Irrigation Water Distribution Diagram (1/13)	The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania Japan International Cooperation Agency

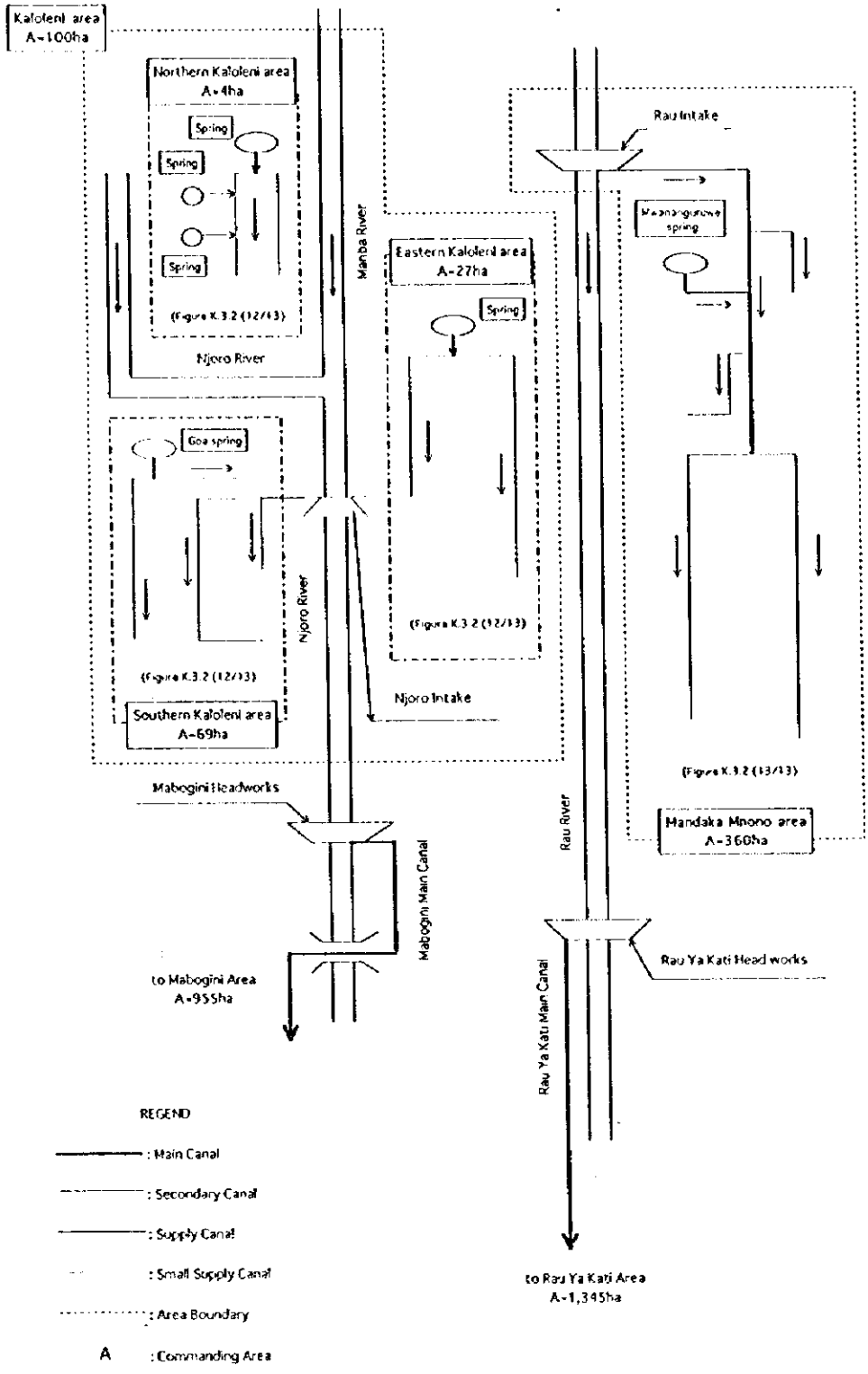


Figure K.3.2 Irrigation Water Distribution Diagram (2/13)	The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania Japan International Cooperation Agency

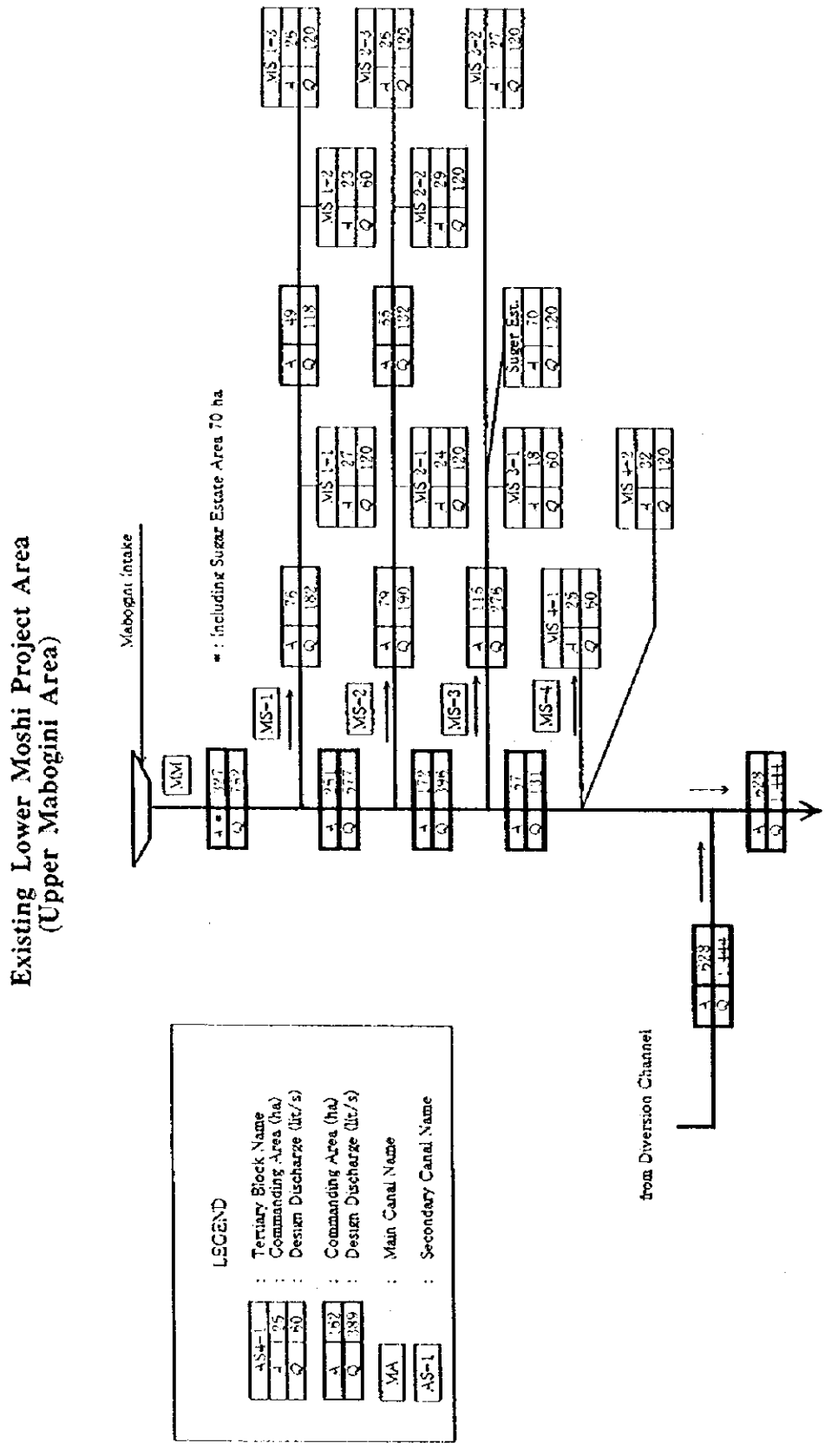


Figure K.3.2

Irrigation Water Distribution Diagram (3/13)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

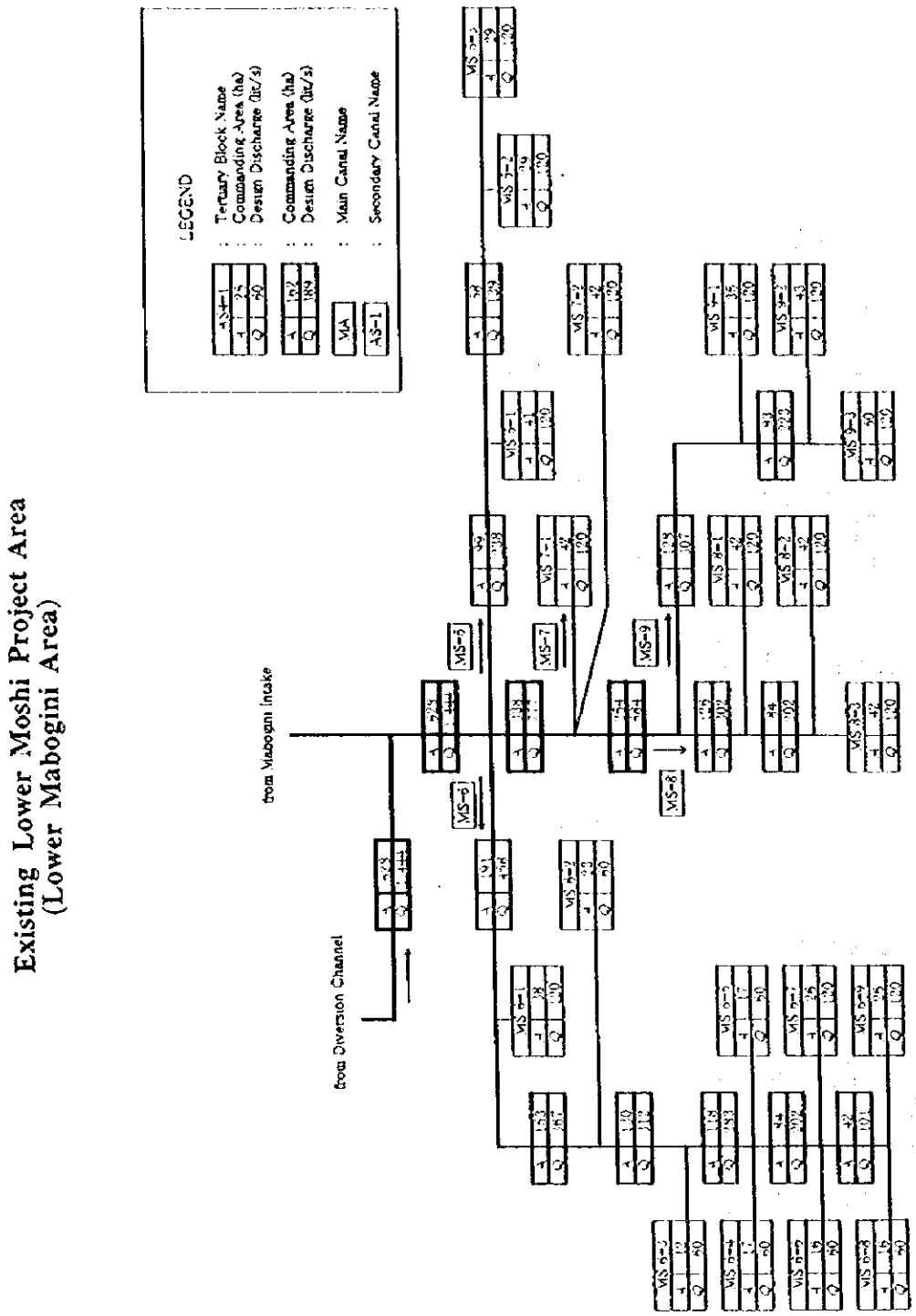


Figure K.3.2
Irrigation Water Distribution Diagram (4/13)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

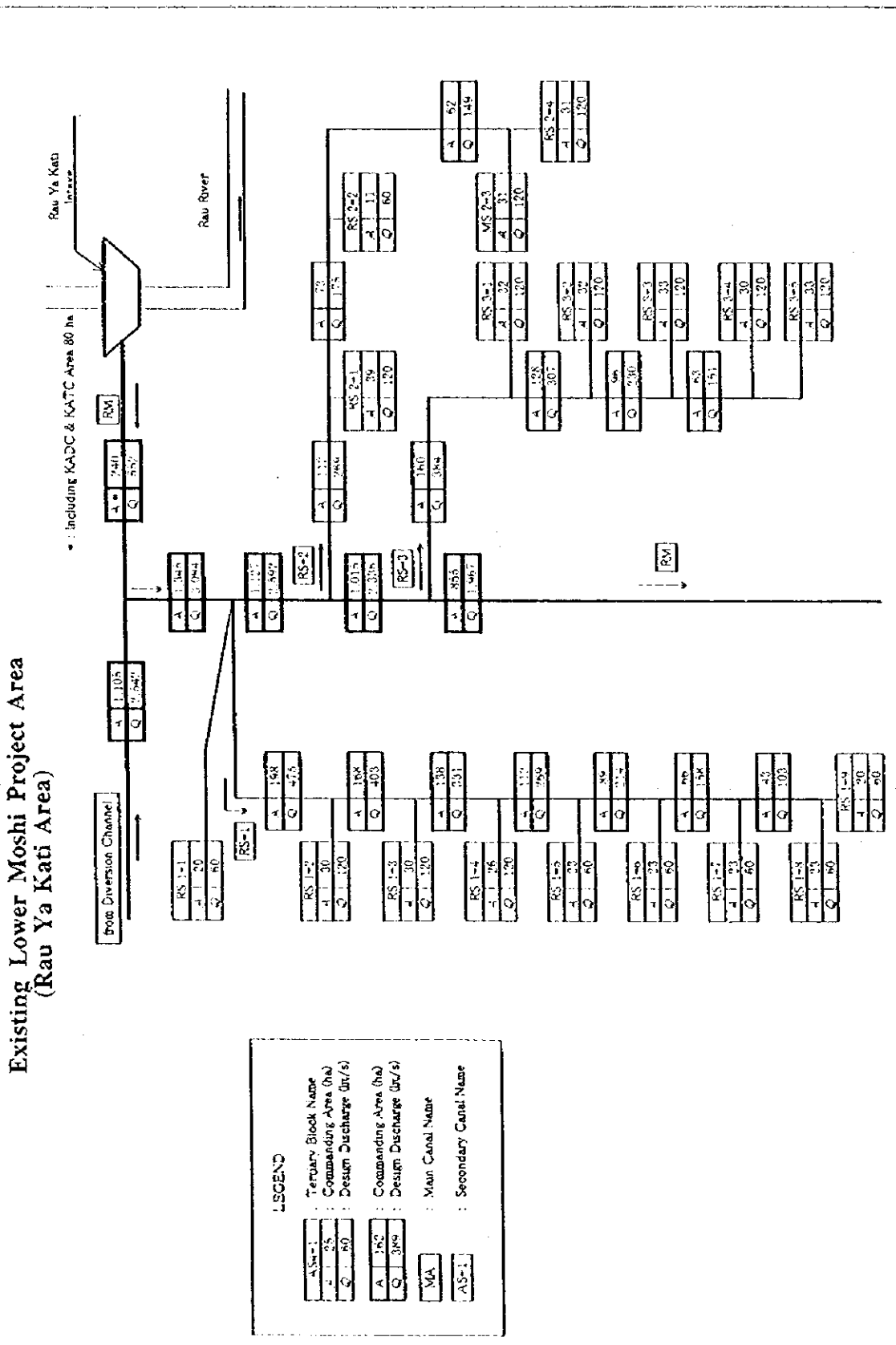


Figure K.3.2
Irrigation Water Distribution Diagram (5/13)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

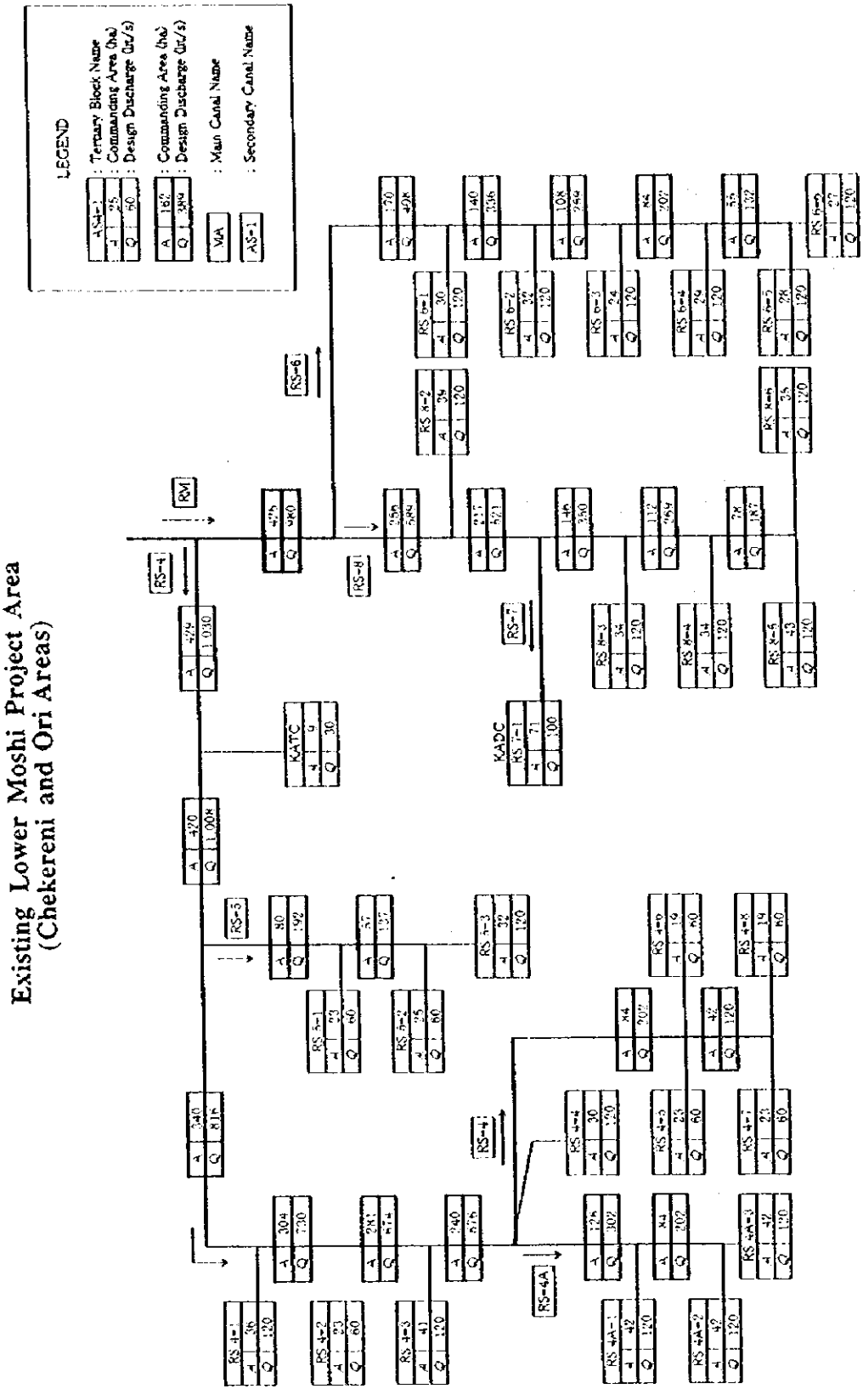


Figure K.3.2
Irrigation Water Distribution Diagram (6/13)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

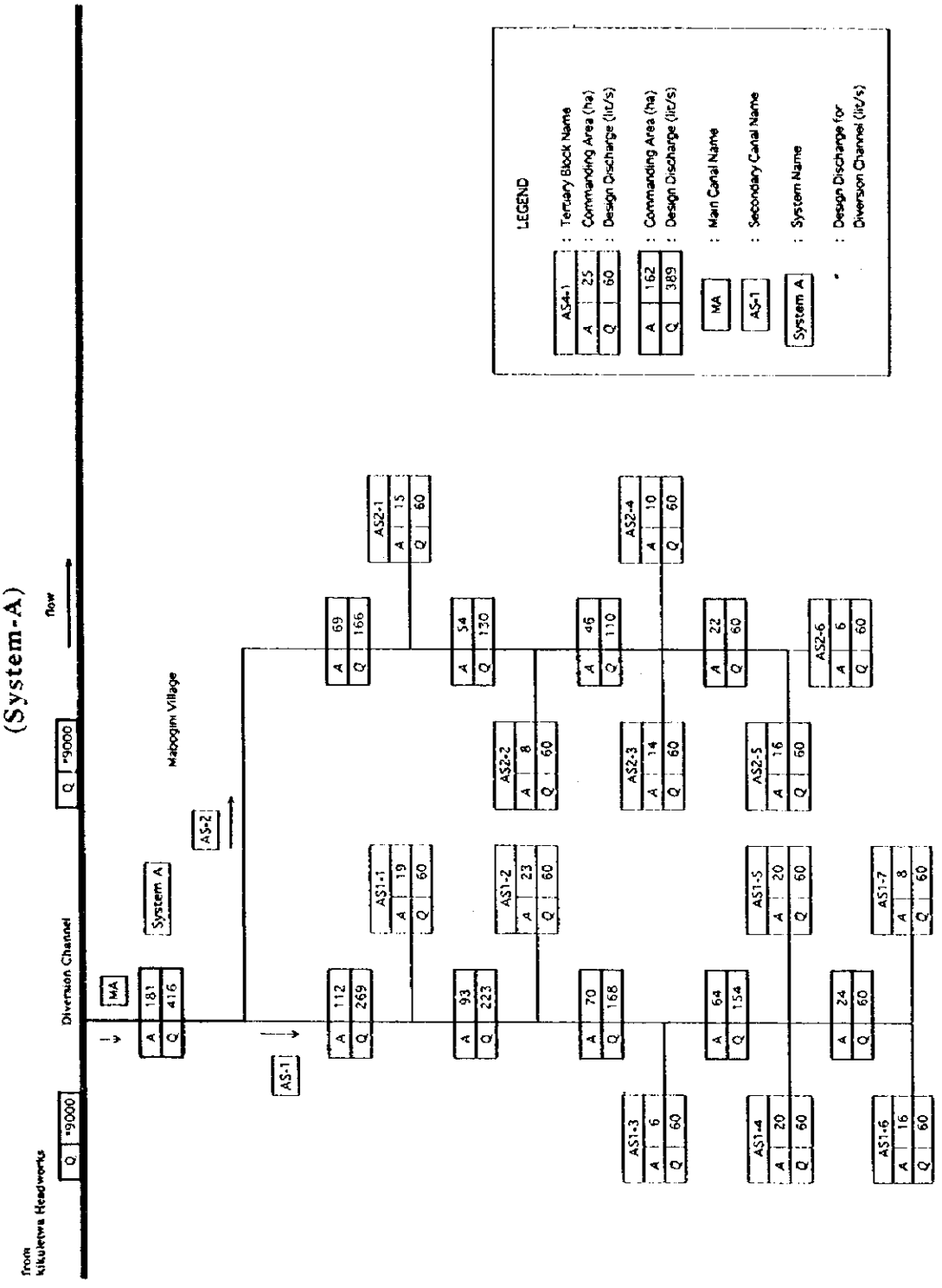


Figure K.3.2 Irrigation Water Distribution Diagram (7/13)	The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania
	Japan International Cooperation Agency

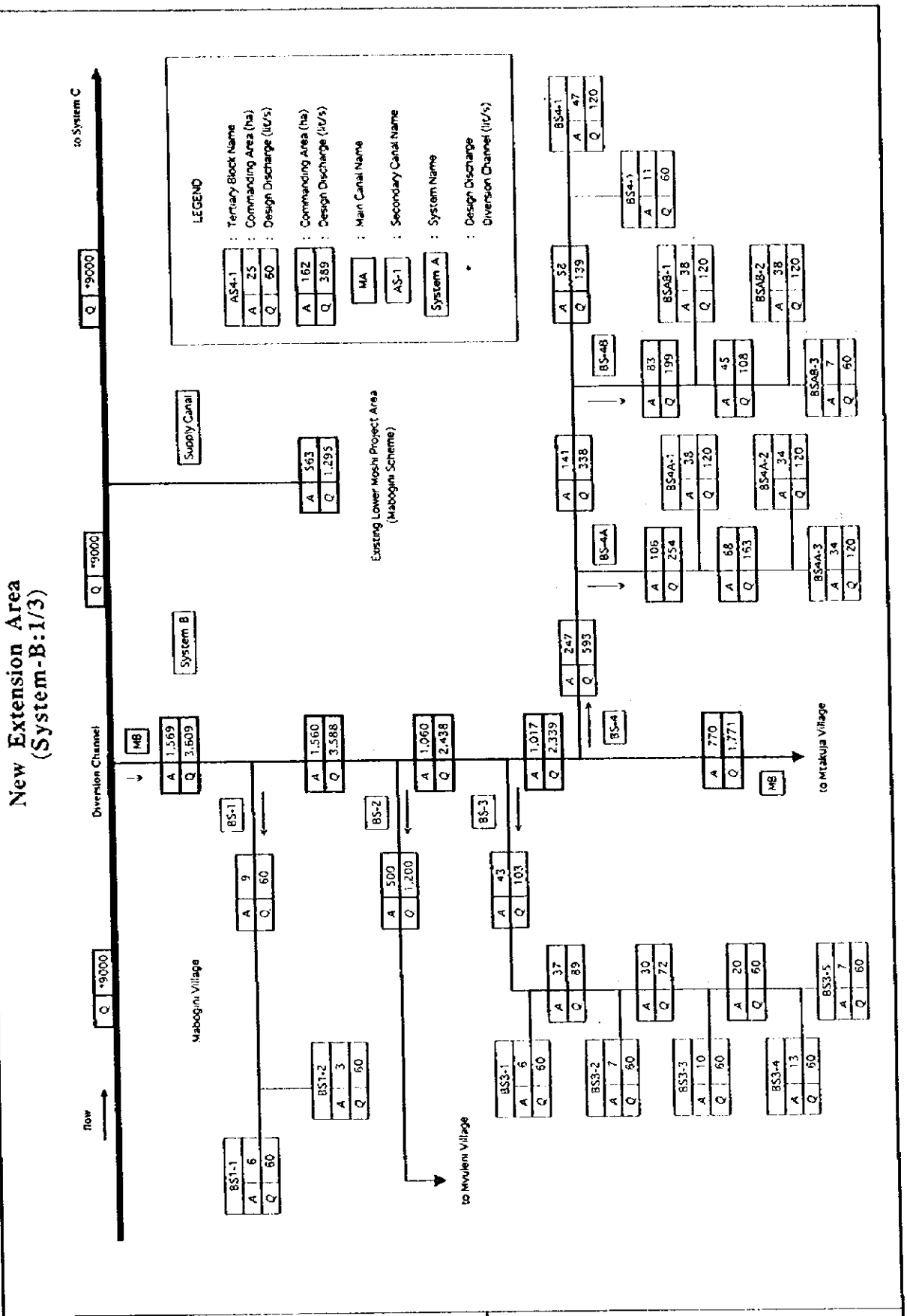


Figure K.3.2
Irrigation Water Distribution Diagram (8/13)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

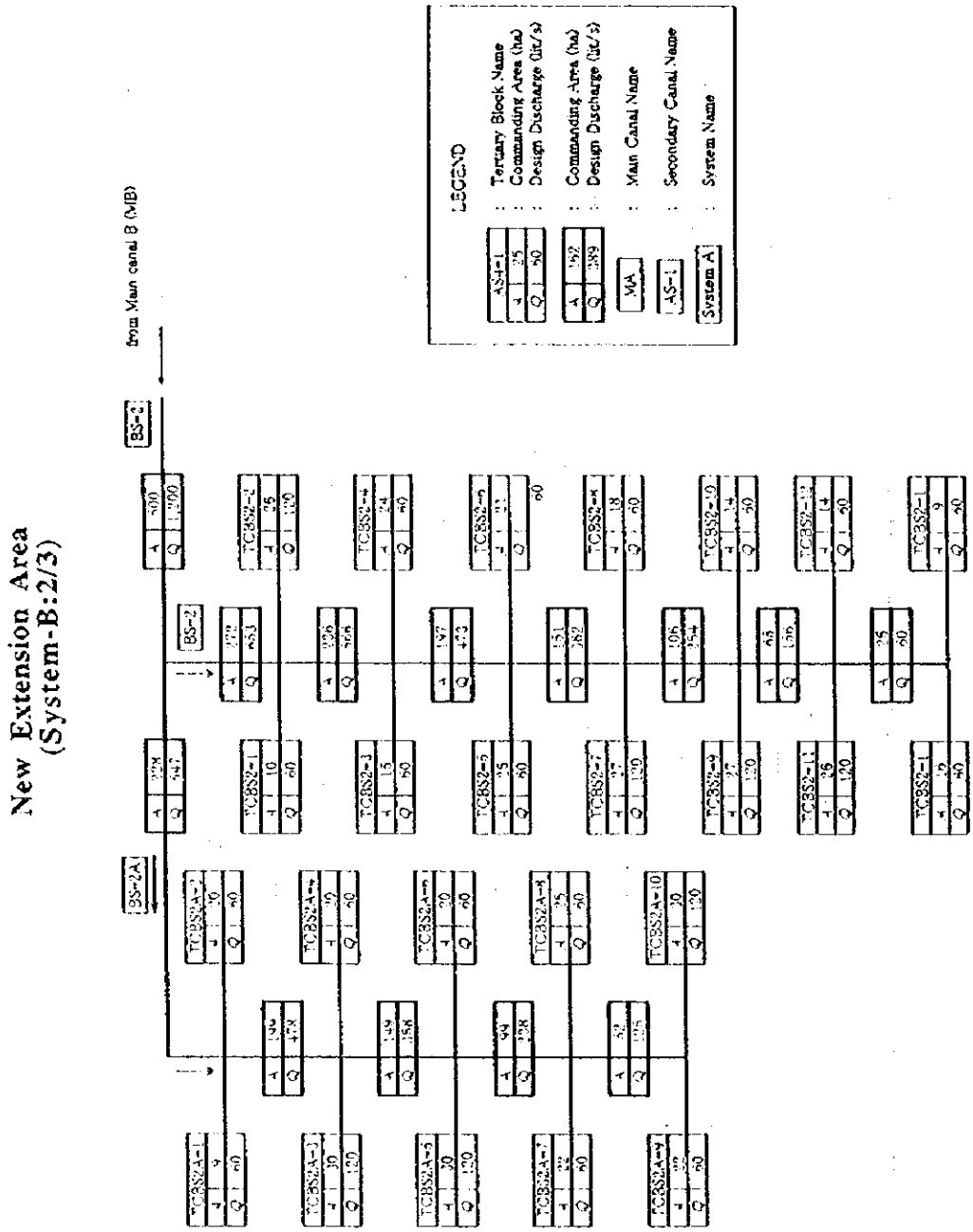


Figure K.3.2
Irrigation Water Distribution Diagram (9/13)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

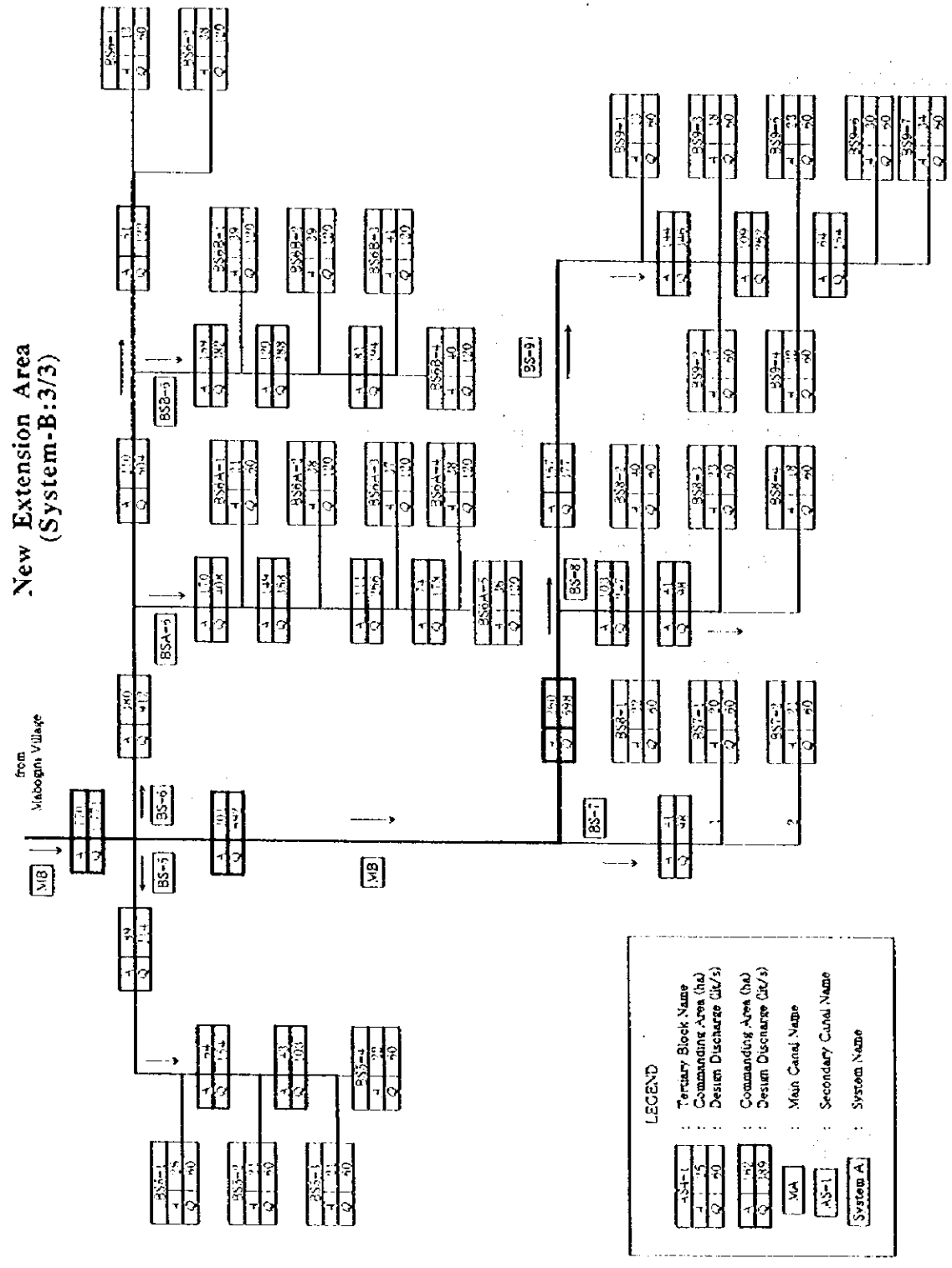


Figure K.3.2
Irrigation Water Distribution Diagram (10/13)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

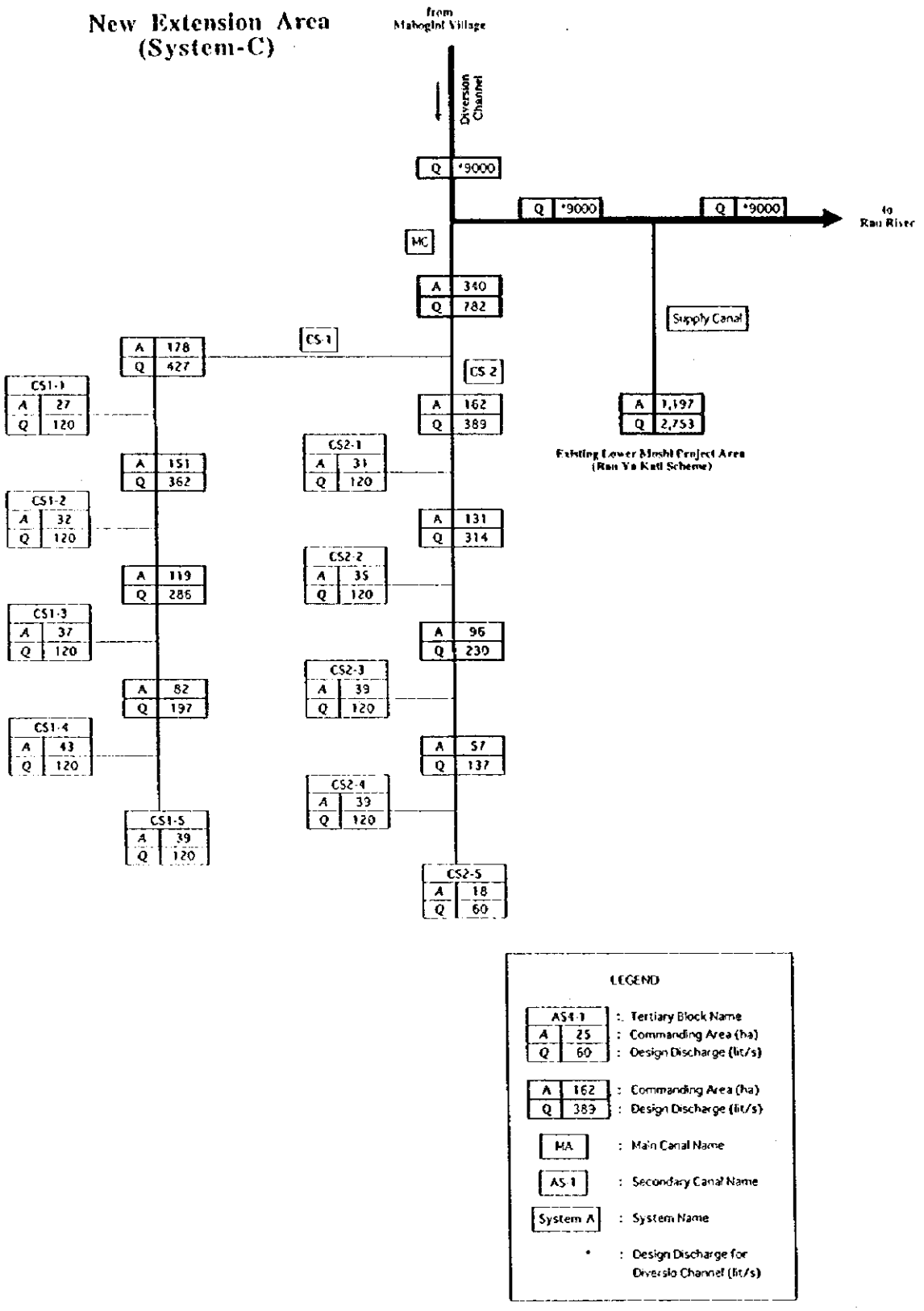


Figure K.3.2
Irrigation Water Distribution Diagram (11/13)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

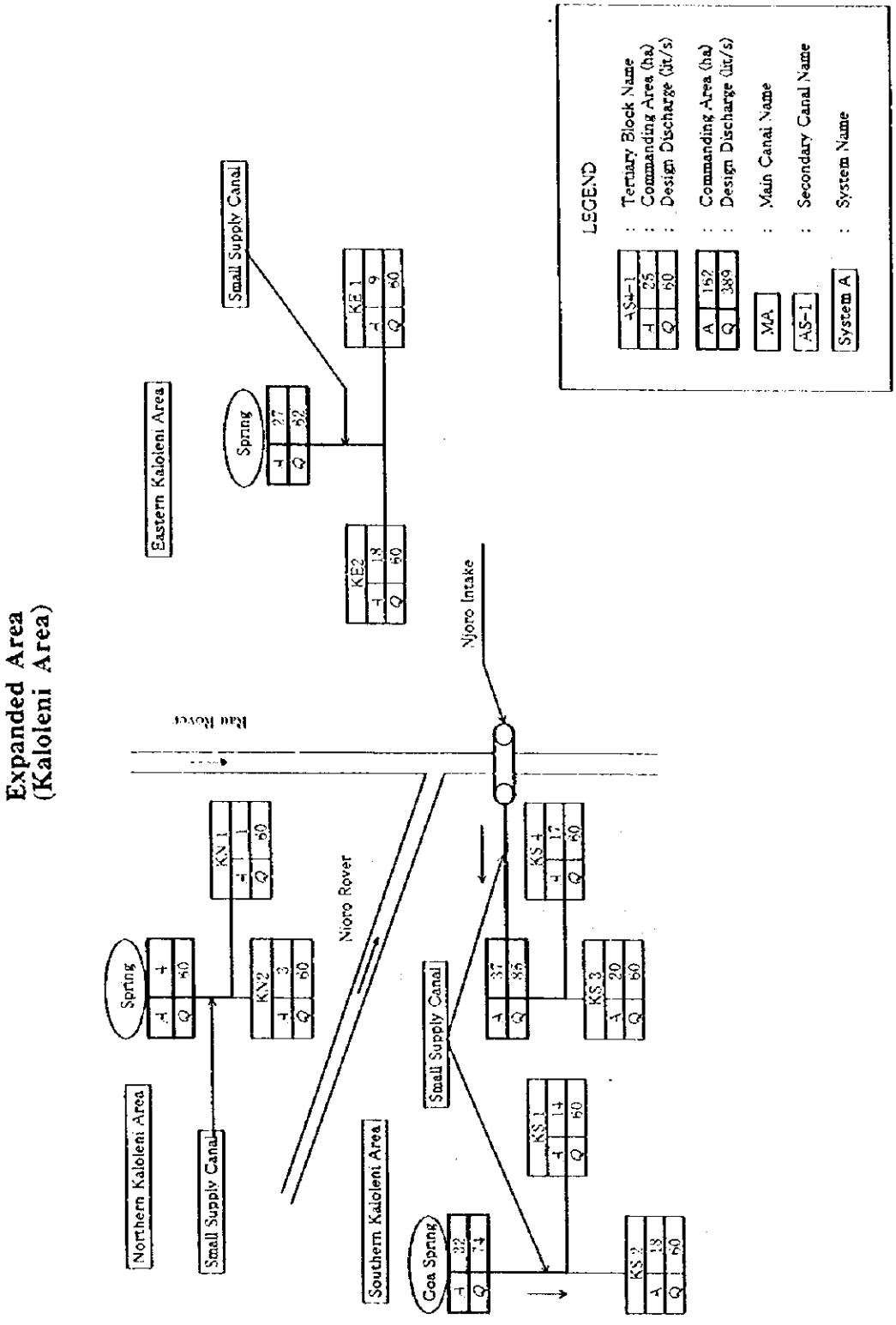


Figure K.3.2
Irrigation Water Distribution Diagram (12/13)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

Expanded Area
(Mandaka Mnono Area)

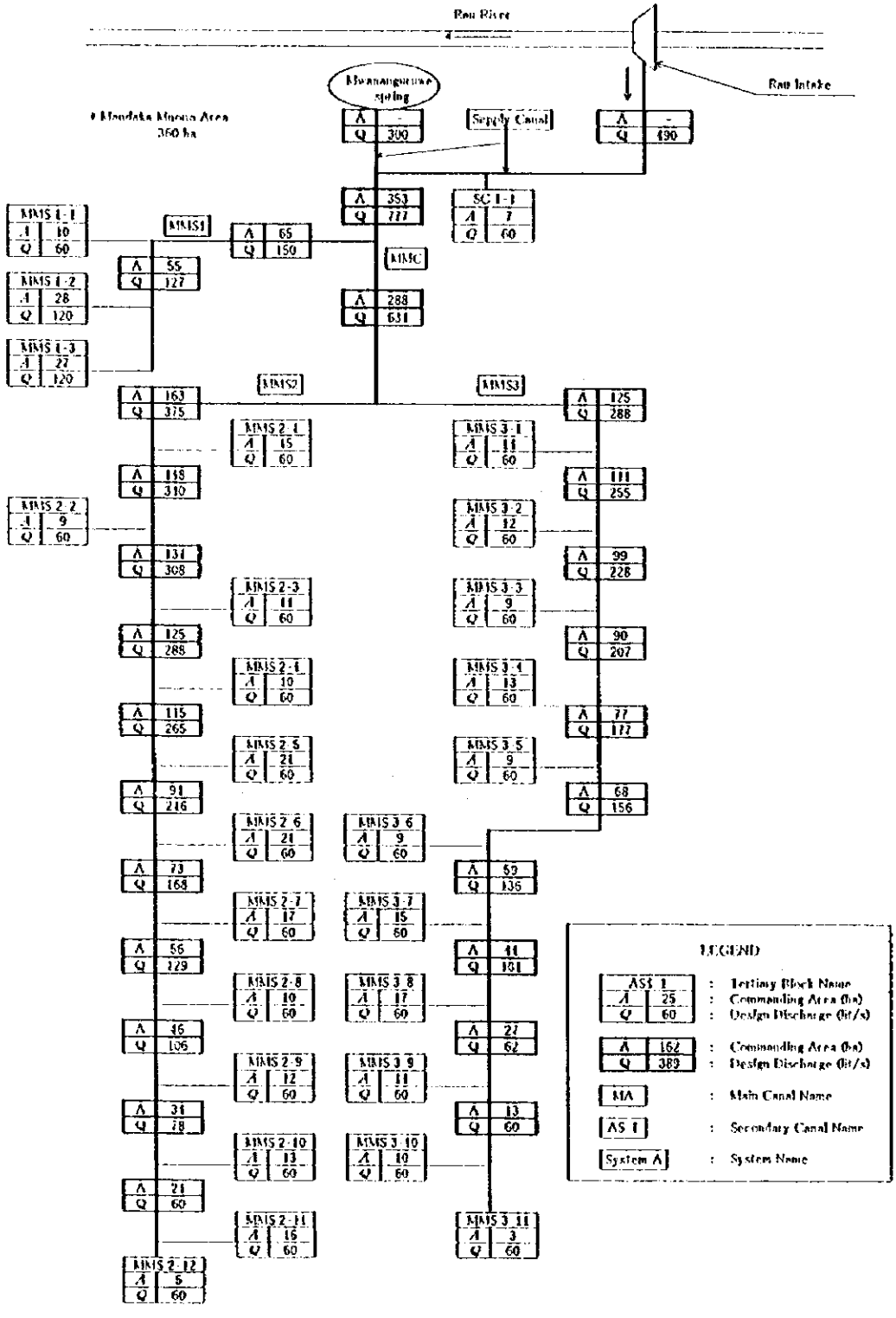


Figure K.3.2
Irrigation Water Distribution Diagram (13/13)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

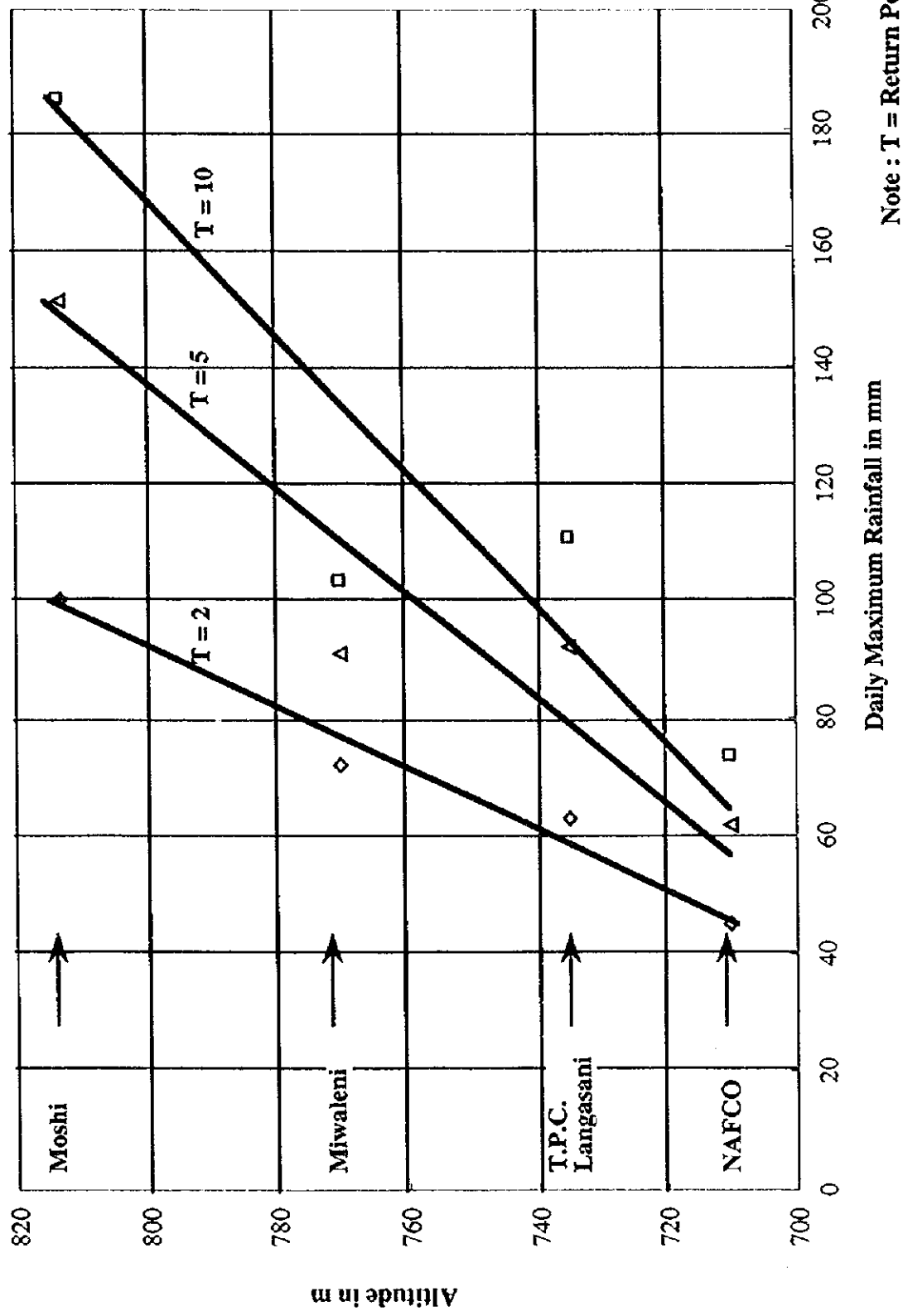


Figure K.4.1
Variation of Daily Maximum Rainfall with Altitude

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

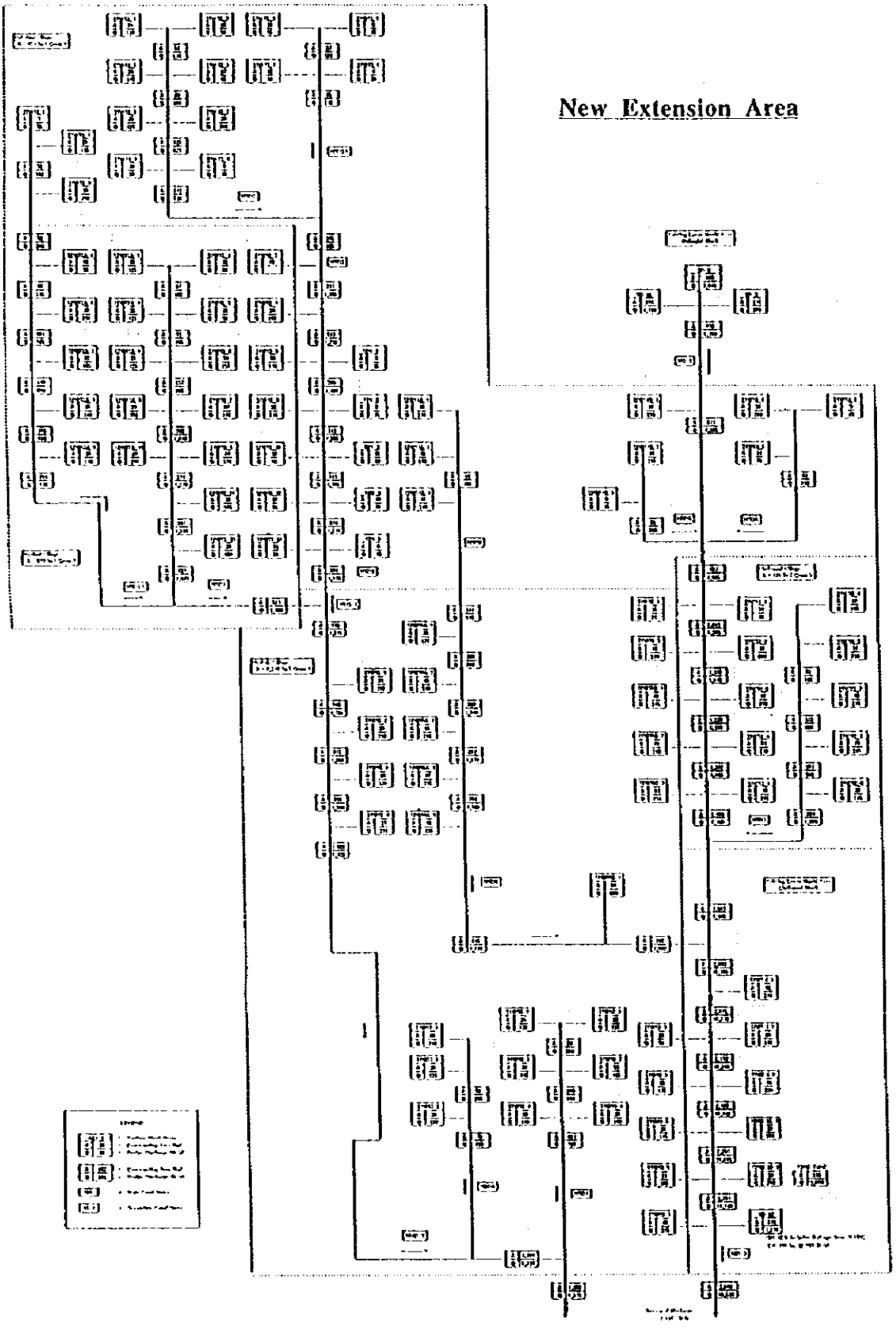


Figure K.4.2
Drainage Water Collection Diagram (1/3)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

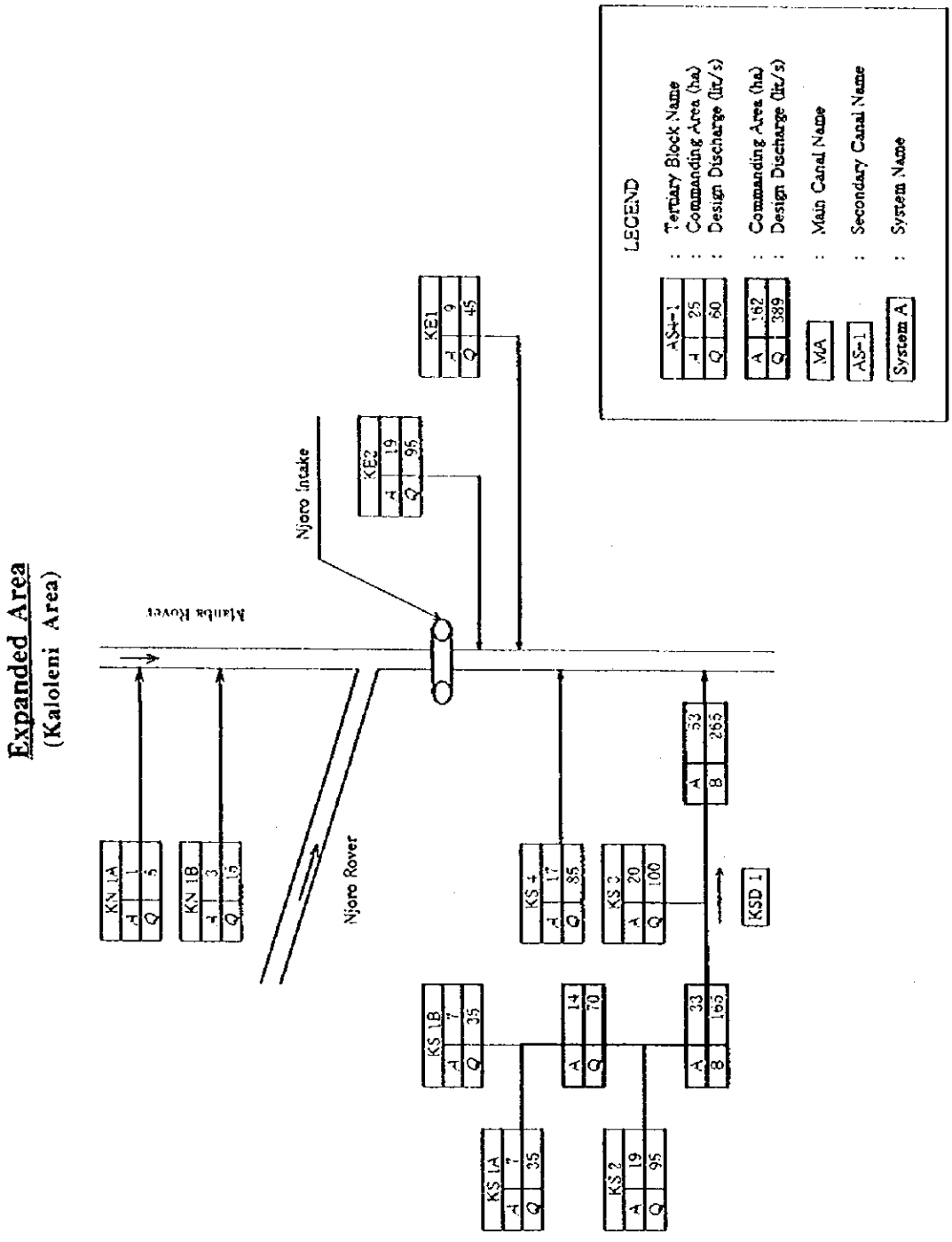


Figure K.4.2
Drainage Water Collection Diagram (2/3)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

Expanded Area
(Mandaka Mnono Area)

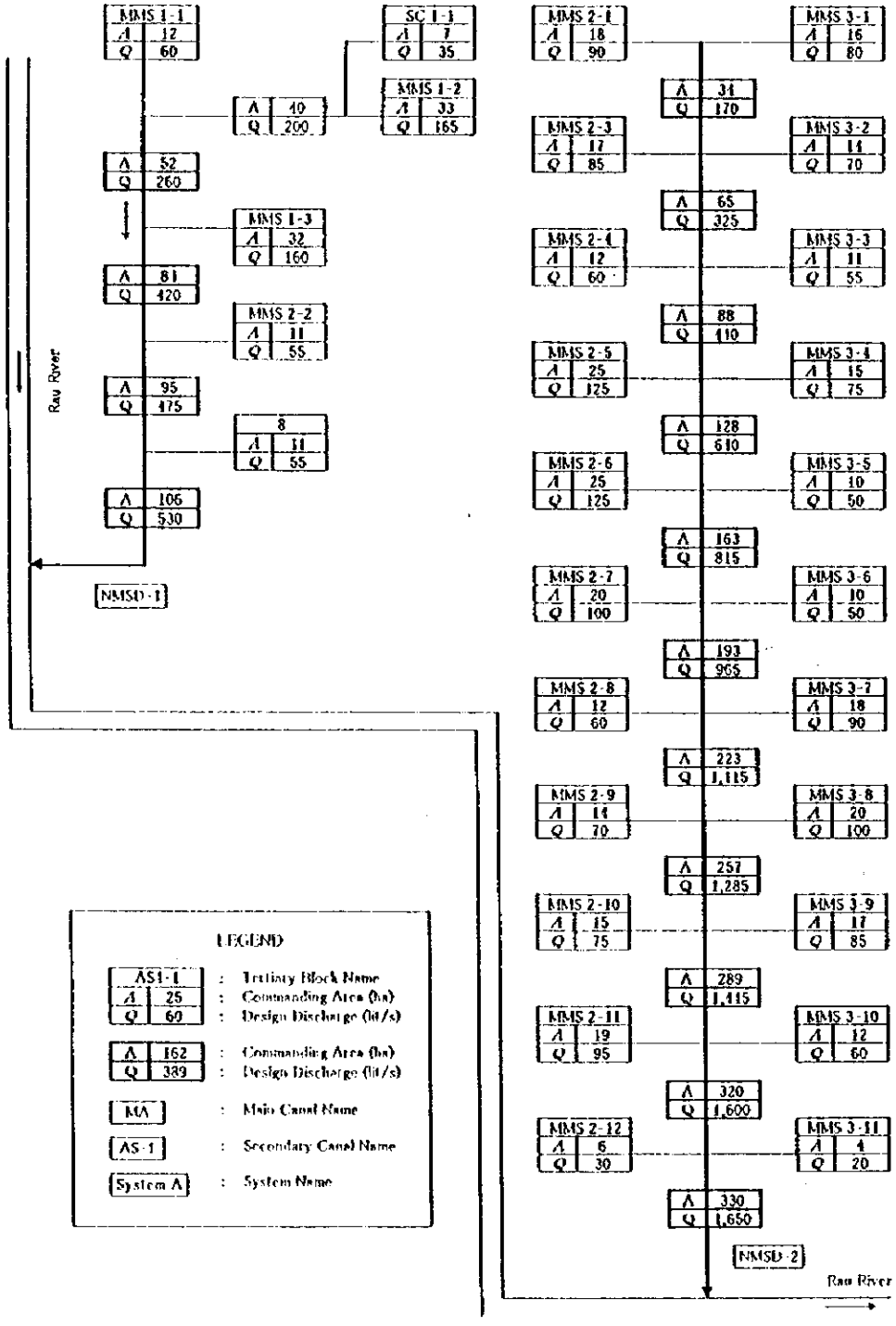
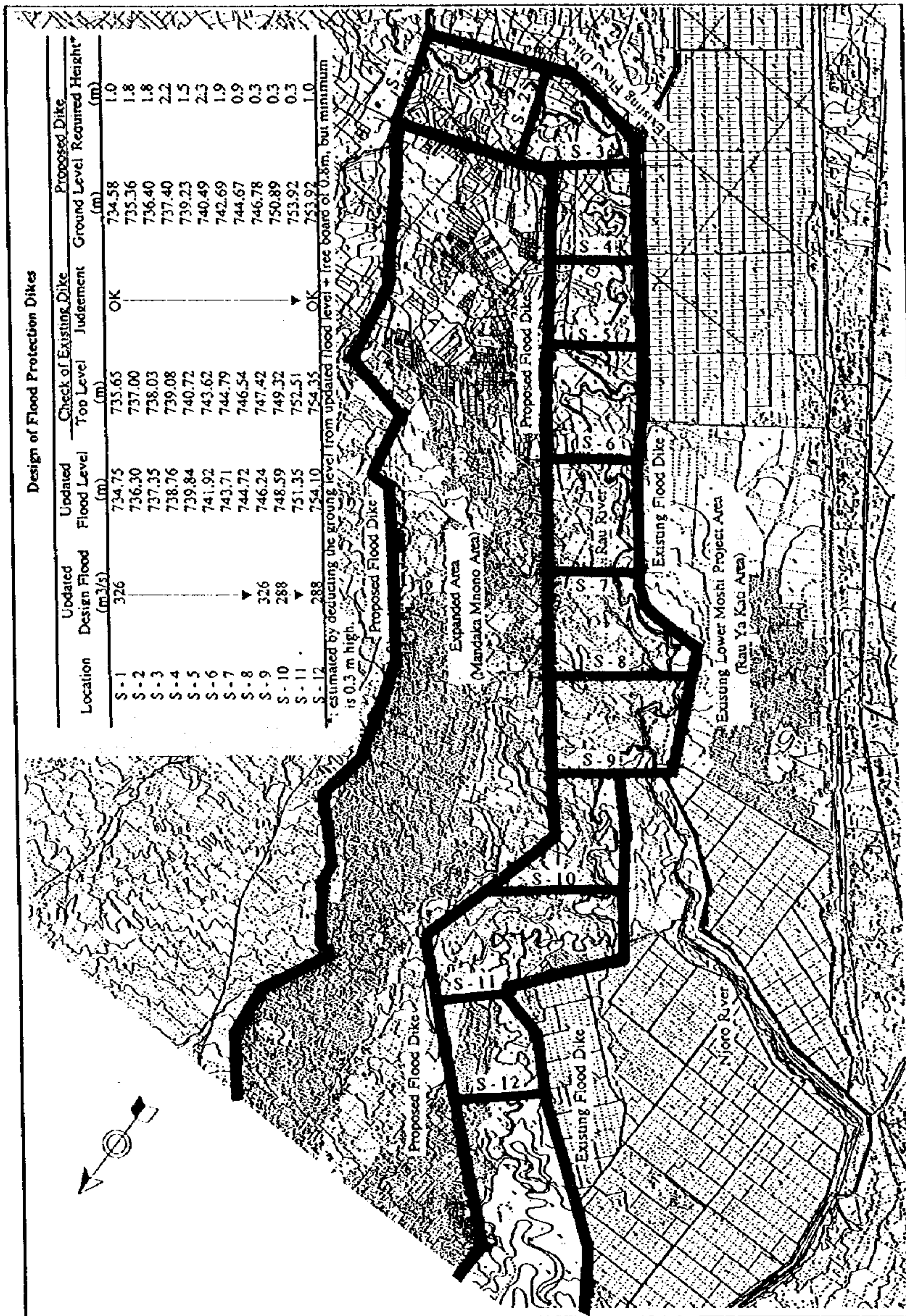


Figure K.4.2
Drainage Water Collection Diagram (3/3)

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency



Design of Flood Protection Dikes

Location	Updated Design Flood (m3/s)	Updated Flood Level (m)	Check of Existing Dike: Top Level (m)	Check of Existing Dike: Judgement	Proposed Dike: Ground Level (m)	Proposed Dike: Required Height* (m)
S - 1	326	734.75	735.65	OK	734.58	1.0
S - 2		736.30	737.00		735.36	1.8
S - 3		737.35	738.03		736.40	1.8
S - 4		738.76	739.08		737.40	2.2
S - 5		739.84	740.72		739.23	1.5
S - 6		741.92	743.62		740.49	2.3
S - 7		743.71	744.79		742.69	1.9
S - 8		744.72	746.54		744.67	0.9
S - 9	326	746.24	747.42		746.78	0.3
S - 10	288	748.59	749.32		750.89	0.3
S - 11		751.35	752.51		753.92	0.3
S - 12	288	754.10	754.35	OK	753.92	1.0

*: estimated by deducting the ground level from updated flood level + free board of 0.8m, but minimum is 0.3 m high.

Figure K.5.1
Check of Existing Flood Dike

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

ATTACHMENT-K.1

MEASUREMENT

ON

CANAL SEEPAGE LOSS

ATTACHMENT-K.1

Measurement
on
Canal Seepage Loss

1. General

Measurement of canal seepage loss was executed to grasp the present canal condition, and also to obtain the basic data for rehabilitation plan of the Projects. The results are compiled in a form of the unit of litter/sec/1,000 m2 of wetted perimeter for easy analysis and application to other canals.

2. Test Apparatus

Test apparatus for the measurement of canal seepage consists of dial gauge, float and its supports

3. Test Procedure

(1) Installation of test apparatus

(a) Install the supports with a dial gauge approximately on the mid-point of total length of the tested canal.
(b) Set the dial gauge on the support bar and place the float on the surface of the water attached to the tip of dial gauge.
(c) Check the upstream and the downstream ends of the canal completely with clay soil to create pond in the canal.

(2) Measurement procedure

(a) Start reading a dial gauge every 5 minutes to record the decrease in water level, immediately After installing the apparatus.
(b) Measure water depth and surface width with tape at several points of tested canal at 5-20 meters interval just before and after commencement of measurement.
(c) Continue the measurement until constant of gauge variation, say at least 2 hours.

4. Test Result and Analysis

Relation between time lapse and decrease of water level drawn on the section paper shows that a decrease rate in water level at the initial stage is high, and as the time has passed, it becomes lower. The decrease rate approaches to a certain constant value D_R after a few hours, which can be easily estimated from the graph.

With an assumption that the seepage loss is in proportion to the area of wetted perimeter, it is estimated using the following equation.

$$C_S = D_R \times L \times W_S \times (1{,}000/A_P) \text{ (liter/sec./1,000m}^2\text{)}$$

Where,
Cs : Canal seepage
DR : Decreasing rate of water level

L : Tested canal length (m)
Ws : Width of water surface (m)
AP : Area of wetted perimeter of tested canal (m^2)

5. Sample Calculation

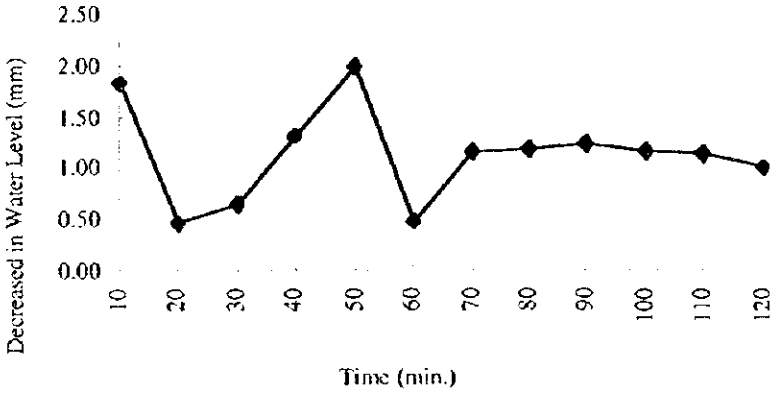
(1) General information

Measurement date	: May 26, 1997	Design water depth	: 0.26 m
Canal length	: 827 m	Side slope	: 1: 1.00
Design discharge	: 46 lit./s.	Bottom width	: 0.4 m
Canal gradient	: 1/850	Lining	: Concrete block lining

(2) Measurement on Decrease in Water Level

Length : 91.3 m

Time (mm)	Reading of dial gauge (mm)	Decrease in water level (mm)
0	24.72	
10	22.87	1.85
20	22.41	0.46
30	21.76	0.65
40	20.42	1.34
50	18.40	2.02
60	17.92	0.48
70	16.75	1.17
80	15.55	1.20
90	14.30	1.25
100	13.13	1.17
110	11.98	1.15
120	10.97	1.01



(3) Water Surface Width and Water Depth just after Finish of Measurement

Section	Width of Water Surface	Water Depth	Wetted Perimeter	Area of Wetted Perimeter
No.0 (00.0m)	0.74 m	0.305 m	1.346 m	
No.1 (20.0m)	0.75 m	0.270 m	1.247 m	25.94 m2
No.2 (40.0m)	0.74 m	0.380 m	1.558 m	28.06 m2
No.3 (60.0m)	0.93 m	0.400 m	1.615 m	31.73 m2
No.4 (80.0m)	0.96 m	0.405 m	1.629 m	32.44 m2
No.5 (91.3m)	0.99 m	0.460 m	1.785 m	19.29 m2

Average width of water surface : 0.84 m
Total area of wetted perimeter : 137.46 m2

(4) Calculation of Canal Seepage Rate

Decreasing rate in water level (Dr) approaches to a constant value of 1.1 mm/10 m., that is 0.002 mm/s. Canal seepage rate (Cs) is as follows:

Cs = 0.002 x 91.3 x 0.84 x (1,000/137.46) = 1.12 lit/s/1,000m2

(5) Calculation of Total Canal Seepage Loss at Design Discharge

Total wetted perimeter area = (0.55 + 0.08 x 2 + 0.18 x 1.414 x 2) x 827 = 1,008 m2

Total canal seepage loss = 1,008 x 1.12/1,000 = 1.1 lit/sec.

Conveyance efficiency = (46-1.1)/ 46 x 100 = 98 %

ATTACHMENT-K.2

MEASUREMENT

OF

FIELD WATER REQUIREMENT FOR PADDY

ATTACHMENT-K.2

Measurement
of
Field Water Requirement for Paddy

1. Purpose

An objective of a measurement is to grasp the water requirement of paddy, in order to estimate the proper irrigation requirement and to compare with the results calculated by the modified Penman equation.

2 Test Appratus

There are two types of test appratus in this Study: one is an automatic one and the other is a manual one. In this paper, the manual one which is locally available, is explaned hereinafter.

Two different types of tanks are arranged using the used drum cans. One is a tank with bottom and the other without bottom. One set of tanks required for measurement on field water requirement is as follows, which is given in Figure - 1:

(a) Tank-A : a bottomless tank with paddy
(b) Tank-B : a bottomless tank without paddy
(c) Tank-C : a bottom tank without paddy

These tanks are embedded in a paddy field more than one meter apart from the nearest farm ridges, leaving about one third of the tank height above the field surface.

3. Measurement

The observation shall be executed at 9:00 a.m. every day. The forms to be used for measurement are attached hereto. The observation procedure shall be as follows:

(1) Step-1: Measure the depth from the top edge of tank to water surface inside tank (RBR) and also outside the tank by a ruler.

(2) Step-2: Pour water into the tank by about 6 cm in depth if the water depth in the tank becomes less than 2 cm, and then measure the depth from the top edge to new water level (RAS) inside the tank.

(3) Step-3: Measure the rainfall at the each project office at 9:00 a.m. on the following day of the rain.

The daily field water requirements are equivalent to the water depth decreased a day and expressed in mm/day. The field water requirements can be computed as follows:

DFWR = RBR - RAR + R

where, DFWR : Daily field water requirement (mm/day)

RBR : Reading of ruler before resetting on the previous day (mm)

RAR : Reading of ruler after resetting on the previous day (mm)

R : Rainfall recorded in the last 24 hours (mm)

4. Analysis Method

The daily water balance in the tank is simply illustrated in Figure -2. The following equations can hold to explain the water movement:

Tank-A : TWS + R = E + T + P + TWR

TWS - TWR = E + T + P - R

Tank-B : TWS + R = E + P + TWR

TWS - TWR = E + P - R

Tank-C : TWS + R = E+ TWR

TWS - TWR = E - R

where, TWS : Water supply into tank (mm/day)

TWR : Water remained in tank (mm/day)

TWS - TWR : Reading of ruler after resetting on the previous day (mm)

E : Evaporation (mm/day)

T : Transpiration (mm/day)

P : Percolation (mm/day)

R : Rainfall (mm/day)

In addition, the following equations can be used for calculation of the unknown values:

$$E = (\text{Tank-C})$$

$$P = (\text{Tank-B}) - (\text{Tank-C})$$
$$= (E + P) - E$$

$$T = (\text{Tank-A}) - (\text{Tank-B})$$
$$= (ETc + P) - (E + P)$$

$$ETc = (\text{Tank-A}) - \{(\text{Tank-B}) - (\text{Tank-C})\}$$
$$= (ETc + P) - \{(E + P) - E\}$$

Where, ETc : Crop Evapotranspiration (mm/day), $ETc = E + T$

Finally, the daily observation records shall be evaluated on the following two criteria:

(1) Tank-A, Tank-B, Tank-C ≥ 0

(2) Tank-A $\geq$ Tank-B $\geq$ Tank-C ≥ 0

If the result of daily water balance will not satisfy the above criteria, such data shall be rejected during processing data.

Figure -1 TANK METHOD FOR MEASUREMENT FOR FIELD WATER REQUIREMENTS

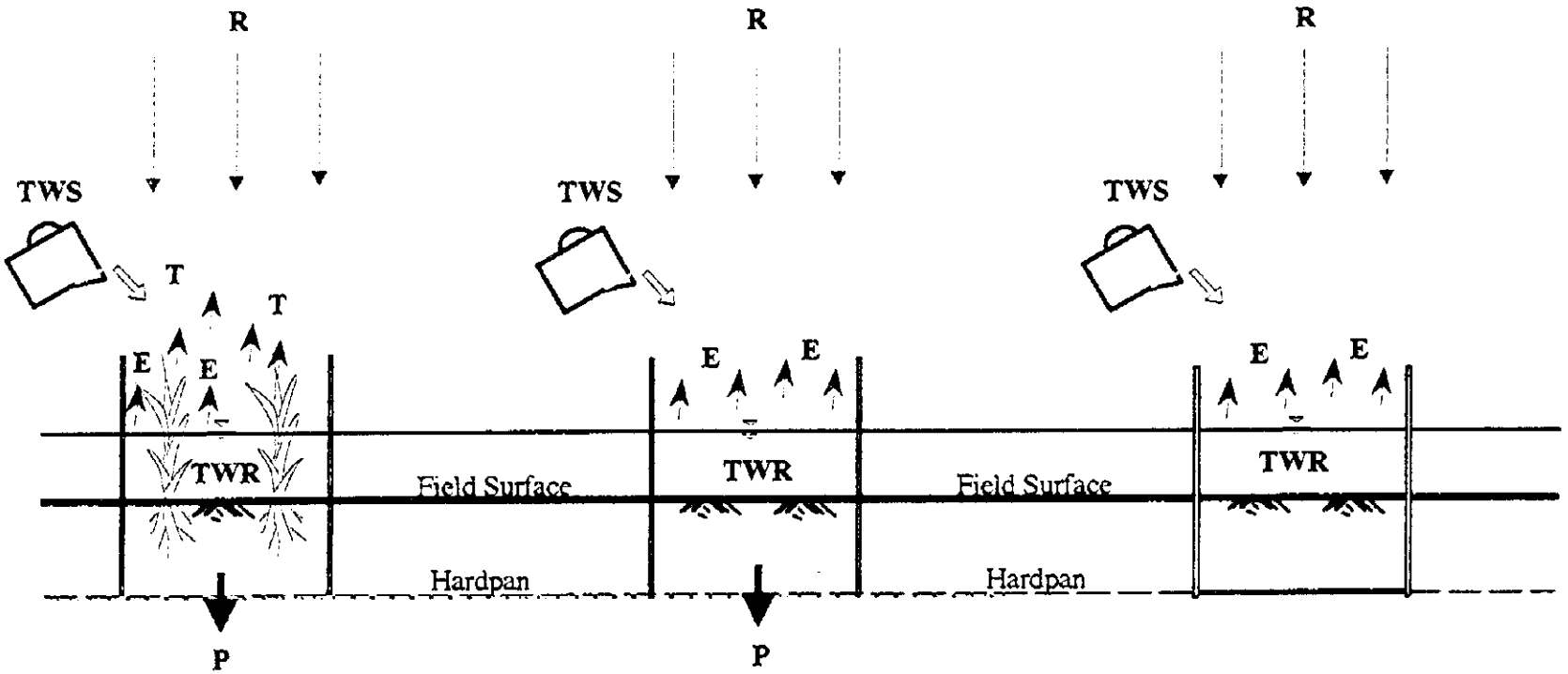
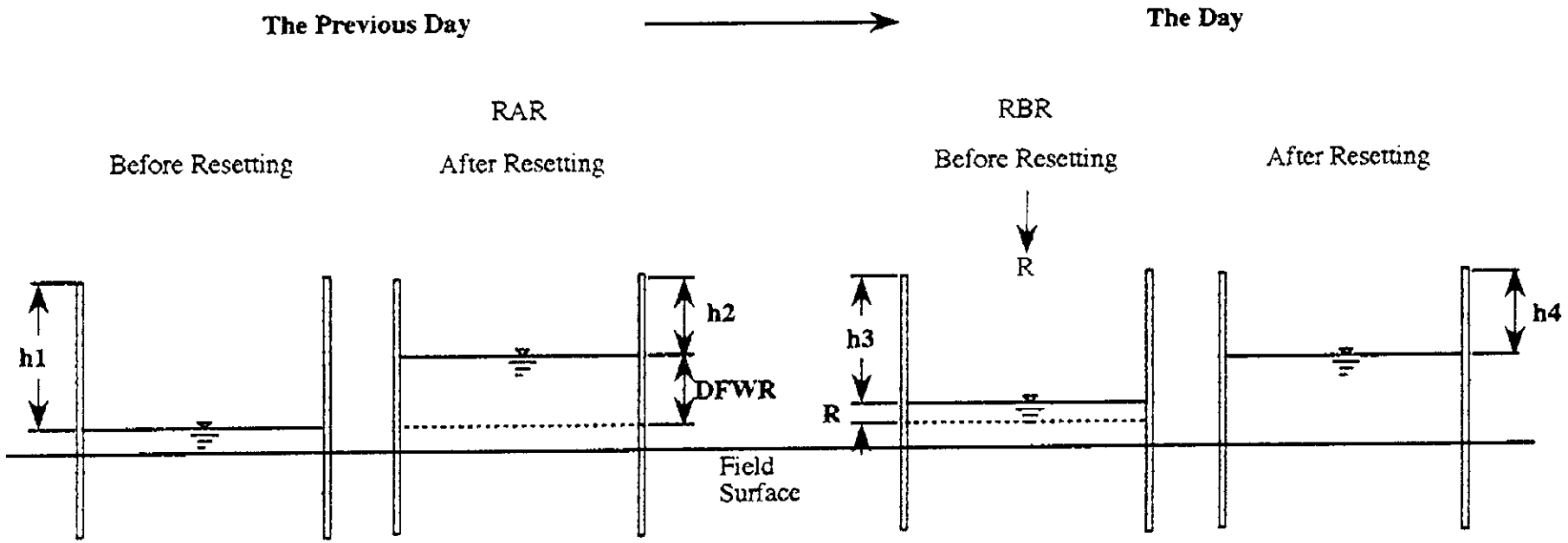


Figure -2 CALCULATION OF DAILY FIELD WATER REQUIREMENT FOR PADDY



If water depth is less than 2 cm, water shall be supplied by 6 cm in water level from field surface.

DFWR = RBR - RAR + R
= h3 - h2 + R

Where, DFWR : Daily field water requirement (mm/day)
h1 : Before resetting on the previous day (m/day)
h2 : After resetting on the previous day (mm/day)
h3 : Before resetting on the day (mm/day)
h4 : After resetting on the day (mm/day)
R : Rainfall (mm)

ANNEX-L

RURAL INFRASTRUCTURE DEVELOPMENT

ANNEX - L

RURAL INFRASTRUCTURE DEVELOPMENT

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ANNEX - L

PRURAL INFRASTRUCTURE DEVELOPMENT

1. INTRODUCTION

This Annex details the plans of rural infrastructure development and related facilities improvement for Existing Lower Moshi Project Area, New Extension Area, Expanded Area and Proposed Diversion Channel Route Area.

Chapter 2 mentions Overall Concept for Rural Infrastructure Development.

Chapter 3 presents Rural Roads improvement plan. The village linking roads are defined as roads which connect villages to the proposed inspection road along the proposed diversion channel, the trunk road and main farm roads for smooth carriage of agricultural products and inputs. In this chapter, needs and types of road are discussed, and road networks are also studied taking into consideration.

Chapter 4 relates Domestic Water Supply. The domestic water supply consists of Water facilities for domestic use and Livestock troughs.

New structures with pipe and hand pump are provided for farmers1 use in view of water quality protection and attached close to the irrigation canals. In Existing Lower Moshi Project Area, the existing washing steps are replaced to the new structures.

Livestock troughs which are planned in order to prevent canals from contamination caused by livestock such as cattle, goats, sheeps and others. Locations of the troughs are discussed and selected considering the condition of grazing and future number of livestock.

This chapter also gives estimate of population and livestock in the year 2015. The water facilities for domestic use and the livestock troughs are planed based on this estimation.

Chapter 5 describes generally other rural infrastructures such as power supply, schools and dispensaries in the Study Area.

Chapter 6 mentions relevant village development plan in the Study Area.

2. OVERALL CONCEPT FOR RURAL INFRASTURUCTURE DEVELOPMENT

The rural infrastructures planned in the Study Area are aiming to improve the social environment and stable agriculture.

It is important that the rural infrastructures are maintained directly by villagers, the prime users, who are aware that the system belongs to their community and that it is neecssary to preserve it for a sustainable and effective use.

Therefore, consideration will be given to an easily operational and maintainable system at the formulation of the rural development plan..

This rural infrastructure development plan will be formulated mainly based on the results of the field investigation, study on data and information collected from the agencies concerned, which are mentioned in section 3.1, under the following overall development concepts.

- Maximum use of the existing facility.
- Appropriate size and potential usage in the future.
- Application of the same criteria used in Existing Lower Moshi Project Area.
- Simple structures for easy operation and maintenance by villagers.
- Coincidence with respective development plans at village, district, regional and central levels if any.
- Reflection of opinions, suggestion and wishes of villagers within the framework of the agreed Scope of Works.

3. RURAL ROADS

3.1 Existing Road Network

3.1.1 General

The road which compose the existing road networks in and around the Study Area are classified into the followings:

Classification	Location	Agency in charge
National highway	Route A23 (Arusha- Moshi-Himo-Tanga)	Ministry of Works
Municipal road	Around the Study Area	Moshi D.C
District road	Around the Study Area	District(Moshi & Hai District)
Project road	In Existing Lower Moshi Project Area and TPC area	KADP, TPC
Ward road	In the Study Area	Ward
Village road	In the Study Area	Village

The structural conditions of respective roads are 1st grade asphalt pavement (Route A23), secondary level of asphalt pavement (TPC main roads), gravel pavement (KADP trunk road), laterite pavement (main and secondary farm roads), and unpaved roads (village and tertiary farm roads). Layout of the road networks are shown in Figure L.3.1.

The organization chart is given in Figure L.3.2 for Moshi district and in Figure L.3.3 for Moshi Municipal Council. District and Municipal roads are maintained by each road sections in the respective departments. The road sections are summarized as below:

Office Name	Nos. of staff	Annual Budget in year 1997	Road Length (km)
Moshi Municipal	8	11.2 million Tsh	Paved road : 60km Unpaved road : 1,500km
Moshi District	11	32.4 million Tsh	Unpaved road : 1,300 km

These departments also provides technical support for the repair of all ward and village roads as the need arises. The ward and village roads are managed by the ward and village offices, and are only repaired once or twice a year after the rainy season by the inhabitants work groups. These maintenance works consist mainly of manual banking and clearing.

3.1.2 Existing Lower Moshi Project Area

Existing Lower Moshi Project Area covers four villages such as Mabogini, Rau Ya Kati, Chekereni and Oria villages. Road networks in the Area are composed of the roads classified in the following 4 classes:

Class	Effective width (m)	Number	Length (km)	Pavement
Trunk road	9	1	16.1	Gravel
Main farm road	6	3	17.7	Laterite
Secondary farm road	5	12	38.6	Unpaved
Tertiary farm road	3	76	55.6	Unpaved

These locations are given in Figure L.3.1. The volume of traffic of the trunk road has been surveyed to grasp the existing traffic condition of the Area. An average daily volume of traffic is 150 assumed based on the survey conducted on two representative days of the week, Monday and Friday, from 6:00 to 18:00. Survey results are shown in Table L.3.1. The condition of the roads cited above has been also surveyed, and the results are summarized as follows:

(1) Trunk road:

- very rough surface with deep ruts and holes with standing water,
- zigzag traffic course,
- muddy and slipping condition after rainfall,
- poor drainage condition,
- partially gravel paved and other portions are lost or disappeared.

(2) Main and secondary farm roads:

- narrow road width due to grass growing which obstructs smooth traffic,
- rainfalls draining into irrigation canals at several places due to reverse gradient of road surface caused by less maintenance,
- others are found almost same conditions of the trunk road

(3) Tertiary farm road:

- road surface covered with many grass which brings about a difficulty in passing of vehicles and tractors,
- others are almost in the same situation with main and secondary farm roads

Especially, pipes in culverts related with secondary and tertiary canals are exposed on account of erosion of road surface by rainfalls.

The operation and maintenance works of the project roads are made by the machinery section of KADP in collaboration with the irrigation section. Equipment for maintenance such as motor grader, dump truck, wheel loader were provided in 1986 (refer to Annex - O), however, most of them are in unworkable condition due to lack of spare parts and deteriorated condition.

3.1.3 New Extension Area

There are 4 villages in New Extension Area: Mtakuja, Chekereni, Oria and Mvuleni villages. There are some village roads with total length of about 28 km in the Area. Road width is generally almost 3 m, but the width of the main village roads is more than 5m. The estimated traffic volume of each village road per day is less than 10. Road conditions are poor, and even 4 WD vehicles have difficulty to pass in the rainy season. Roads maintenance works are mostly carried out once a year after the rainy season. In Chekereni village, a motor grader from KADP is used to repair the main road. The rental charge with operator is 3,000 TSH/day. All of the cost including fuel is collected from the villagers.

3.1.4 Expanded Area

The Expanded Area includes a part of Mandaka Mnono village and Kaloleni ward. In Mandaka Mnono Area, only two village roads with 3m width are available. One road leads to Msaranga and others to Chekereni and their total length is estimated at 4.7 km. Road conditions are very poor, even in the dry season, 4 WD vehicle only are passable. Kaloleni Area is covered with only ward roads with total length of 1.7 km and average width is 3 m. Road conditions are slightly better than in Mandaka Mnono area because of their proximity to town. Roads are maintained by the inhabitants themselves once a year after the rainy season.

During harvesting time, paddy of expanded area is transported to the market of the Existing Lower Moshi Area(Chekereni village) across the Rau river by bicycle or by poor transportation method. During the survey, Most of all of farmers are urging the bridge(s) crossing the Rau river, even small scale, to transport the agriculture products and access to the market of Chekereni village and Moshi city.

3.1.5 Proposed Diversion Channel Route Area

There are TPC farm and five villages, Kawaya, Mkalama, Longoi, Kikafu Chini and Mijongweni villages, along the proposed diversion channel route. Two (2) routes access to Proposed Diversion Channel Route Area. Northern route is branched off from Route A23 on the way to Arusha, and southern route is reached from TPC crossing the Kikafu River. On the proposed diversion channel route through the TPC, village roads only are available, whose total length is about 8 km. These roads are in very rough conditions and can be passed only in the limited season due to obstruction by water stagnant on the roads, river flow crossing on the roads, etc. In Kikafu Chine and Mijongweni village, road maintenance works are done only by manpower once or twice in two weeks. In Mkalama villages, roads maintenance works are mostly carried out once a year after the rainy season as in the other villages.

Table L.3.2 presents the survey results of road conditions in the Study Area.

3.2 Problems and Constrains for Rural Road Development

Through the field investigation, study on data and information collected from the agencies concerned, the following problems and constraints have been found:

3.2.1 Existing Lower Moshi Project Area

In this area, road network is proper as the road density is enough with the existing trunk road and farm roads. But maintenance of the roads is insufficient and it makes conditions of the trunk and main farm roads bad.

However, details of the trunk and farm roads are discussed in the Irrigation and Drainage Development Plan of Annex K.

3.2.2 New Extension Area and Expanded Area

In this area, existing road network is composed of a few village roads which are in very poor condition and can be passed only for several months during dry season. Therefore, project road networks composed of new farm roads and village roads should be planned in the same criteria as the Existing Lower Moshi Project Area. Existing village roads are improved as linking roads to connect the village and the farm roads to realize smooth traffic. But some village roads are developed as farm roads according to the topographical location and flat plan.

Farm roads are also described in more detail in the Irrigation and Drainage Development Plan of Annex K.

3.2.3 Proposed Diversion Channel Route Area

From the view point of Road networks in this area, it is unsuitable for villagers that there is no village road which reaches directly to the town and/or parent roads such as trunk roads. Therefore, the inspection road proposed along the diversion channel is considered to a main road in the area, and village roads are linked to the inspection road for establishment of the road network.

Details of the inspection road is mentioned in the O&M and Water Management Plan of Annex - O.

3.3 Concept of Rural Road Development

3.3.1 Basic Concept

Rural road development is aiming at smooth carriage of agricultural products and inputs, and improvement of living circumstances of the rural habitant.

In order to attain this aim, the proposed inspection road along the diversion channel is furnished with function of rural road and is regarded as main roads for Existing Lower Moshi Project Area as same as the trunk road and the existing main farm roads. Consequently, the existing village roads which connect to these main roads are improved as village linking road and formation of road system is planned. In this project, new village roads are not constructed and developed, and only the existing village roads are improved and repaired.

3.3.2 Criteria of Selection

Proposed village linking roads are selected based on the following criteria.

- Village roads with heavy traffic for passage and transportation of agricultural product and input.
- Village roads which have bad conditions in rainy season and have potential for good access to the main roads by improvement.
- Village roads with heavy traffic which run through centers of villages and have role as main road.
- Village roads which connect to schools and hospitals and have important role for social life.

3.3.3 Design of Village Linking Roads

The existing village roads are improved as village linking roads following the basic design concepts shown below.

- Application of the same criteria used in the Existing Lower Moshi
- Maximum use of existing village roads as village linking roads.
- Plan for related structures such as drainage, cross culvert and side drain, and/or protection works such as slope protection, if needed.

3.4 Village Linking Road Plan

3.4.1 Existing Lower Moshi Project Area

Rehabilitation and improvement of roads in this Area will be executed as a part of works for Rehabilitation and Enhancement Works of Existing System, therefore, no works are considered as rural development works.

3.4.2 New Extension Area

In accordance with the development concept, total length of village roads connecting to the proposed main roads is counted about 1.0 km and their length will be rehabilitated and improved. Scope of works will be mainly reshaping of the road surface. Location and length of works are shown in Figure L.3.4 and Table L.3.3.

3.4.3 Expanded Area

As a same criteria of the above, works will be executed in this Area, and 0.7 km in Kaloreni area and 3.1 km in Mandaka area will be rehabilitated and improved. In addition, 2 numbers of simple bridges over the Rau and Njoro river will be provided to connect the Existing Lower Moshi Area and Moshi city. Location and length of works are shown in Figure L.3.4 and Table L.3.3.

3.4.4 Proposed Diversion Channel Route Area

The existing village roads crossing the proposed diversion channel route are about 30 numbers in total. In line with the development concept mentioned above, 10 village linking roads will be rehabilitated and improved as village linking roads including related structures. Range of rehabilitation and improvement will vary from 400m to 1,000m at both right and left sides of the channel. Rehabilitation and improvement of village roads connecting to the proposed diversion channel will be executed with same criteria of other area and totally 4.9km will be rehabilitated and improved. Location and length of works are shown in Figure L.3.4 and Table L.3.3.

4. DOMESTIC WATER SUPPLY

4.1 Existing Domestic Water Condition

4.1.1 General

In the Study Area, the domestic water is supplied for village people from various sources such as public water supply, canal, well, river and spring.

There are two public water supply systems in the Study Area; One is extended until Mabogini, Chekereni, Oria, Rau, Mtakuja and Mvuleni villages, the other covers Kaloleni ward. The former is under the control of the Water and Works Department of the Moshi District. The organization chart of the Department is presented in Figure L.4.1. Operation and maintenance of the facilities down to the main pipes are under the control of the District through the said Department. After the main pipes, the control of the system is made by the respective villages and households. The water source is the Coffee Curing spring (called Njoro spring in the local dialect). Water supply is made through the community taps and/or the house taps. The latter is given particular attention in the heading untitled Expanded Area.

Villages in the Study Area, which are located far from the public water supply systems and/or far from residential areas, depend on irrigation canal, well, river and spring for their water supply. Most of these water supplies are insufficient in quantity and are poor in quality. Water should be drunk after boiling in order to get rid of the impurities and pathogenic germs. Figure L.4.2 and Table L.4.1 show the existing conditions of the domestic water supply systems investigated in the Study Area by the JICA Study Team. The following explains these conditions in each Study Area.

4.1.2 Existing Domestic Water Condition

(1) Existing Lower Moshi Project Area

The number of households, which are provided with water through the pipeline network system (Mabogini - Kahe Water Supply System) in the area, is 130 out of 800 households in Mabogini, 16 out of 400 in Rau Ya Kati, 7 out of 710 in Chekereni and 10 out of 840 in Oria village. There are 47 community taps in the area, and 300 villagers share one tap on average. The water charge for the community taps is free, but a household has to pay 900 Tsh./month. Also shallow wells, KADP irrigation canals and Rau river are main sources for drinking water, however, still insufficient. Other domestic water involving that for washing, bathing and animal drinking is mostly provided by the same canals and river. In the Area, there are 9 shallow wells, however, the water level draws down and can not supply a sufficient discharge in the dry season. Recently, a tube well owned by KATC has been transferred to the Chekereni village for public use following the strong request of the villagers.

(2) New Extension Area

A public water supply system is also provided in this area. However, there are 2 private and 9 public taps for 720 households in Mtakuja village, and only 1 public tap for 550 households in Mvuleni village. Tap water discharge is insufficient because of low pressure due to the location of these villages downstream of the pipe line. Domestic water including drinking purpose have thus been obtained mainly from either canal water of the Existing Lower Moshi Project at the boundary of the eastern side, or from stream water coming in from the TPC farm. Also over 20 wells maintained by villagers and individuals exist in the area, which are used principally for washing, bathing etc. Most of these wells are shallow with less than 5m depth, and are difficult to get water from in the dry season. Villagers drink the water without boiling it, and as a result, the disease rate by bacteria and/or ameba is high. Therefore, the living standard in this area is very low. Urgent correction measures are essential. No development plan on water supply system is available in these villages.

(3) Expanded Area

Only Kaloleni ward has a public water supply system in the area. This system is under the control of the Works Department of the Moshi Municipal. The organization chart of the Department is presented in Figure L.4.3. The number of households using this water supply system is 50 out of 850 households, or a ratio of 6 %. These households pay water charge according to their use counted by a water meter. For example, a household of 10 people will pay about 4,000 Tsh/month. There is no public taps, so most village people buy water for drinking and other domestic uses from private taps at a cost of 10 Tsh/20 lit. The water source is the Msere spring located at a distance of 12km from Moshi town, which constitutes the water source for the town. And there are two springs, Goa and Dobi, which supply 30 percent of the water use in Kaloleni ward. On the other hand, Mwananguruwe spring is the main water source for Mandaka Mnono village. These 3 springs are also the main water sources of irrigation water in the Expanded Area. All these water sources are sufficient in quantity and fair in quality.

According to the investigation results, a new piped water supply in Mandaka Mnono village was requested to the District, but there is so far no response due to a lack of budget. Villagers have plans to apply some flood protection measures using their own fund in order to stop the sedimentation and the inflow of residues into the springs of Kaloleni ward.

(4) Proposed Diversion Channel Route Area

In the area, mainly all villages take domestic water directly from the closest rivers and local canals, to the exception of Kikafu Chini village where a few number of community taps are used for water distribution.. Springs constitute also water sources in all villages except Mijongweni village.

Longoi river is used in Kawaya and Longoi villages, and 3 rivers (Weruweru, Kikafu and Karanga river) are used in Mijongweni village. Some rivers are seasonal and are hence insufficient in quantity. And the rivers are sources of canal water as explained below, but the discharges of some rivers decrease in the dry season from August to February as shown in Annex - A.

Mapacha canal was constructed by the Government in 1971 and conveys water of Lundugai river to Kawaya and Mkalama villages for irrigation and domestic purpose in the dry season. The canal is managed by a main committee composed by representative members of the 2 villages. In addition, a committee established in each village is responsible for operating and maintaining the part of the canal related to their village. Maintenance works are carried out once a week by the villagers after the rainy season.

In Longoi village, there are 2 canals taking the water of Longoi river. One is the Nguzonne Pacha canal which is composed of an intake constructed by the Community Development Trust Fund and a canal with 8 km in total length made by the villagers in 1993. The other is the Mferej B Longoi canal with a local weir and an old canal. Both canals are made for agricultural purpose. The former is controlled by the Water and Works Department in Moshi District and the latter is managed by the villagers. In Mijongweni village, the canal from Weruweru river was made by the Kilimanjaro Zonal Irrigation Office, and is now maintained by villagers once a week.

There are 2 shallow wells used in Kawaya village, which had been dug by a group of interested villagers and maintained by the group. In Mkalama village, 2 shallow wells exist and are maintained by the villagers. All wells are only useful in the rainy season, therefore quantity is insufficient. The water quality is as bad as in the New Extension Area.

Mapacha spring in Kawaya village, Mkalama spring in Mkalama village and Nguzonne spring in Longoi exist in the Area. Nguzonne spring is the biggest among the three. It is located near the Longoi river at the boundary between Longoi and Kikafu Chini village.

Villagers gather along the banks of the stream flowing from this spring and use its water for drinking, washing, bathing etc. The place plays the role of a kind of community place.

The sources of domestic water supply mentioned above are generally insufficient in quantity except some rivers, and fair in quality. Urgent measures are required to address these problems.

Longoi village has a project to develop a water source for drinking. Hydrogeology survey has been already carried out by the Water and Works Department in the Moshi District, but no further works have been performed after that. There is no other development plan on water supply in these villages.

4.2 Problems and Constrains for Domestic Water Supply

4.2.1 General

As mentioned in Section 4.1, the pervasion of public water supply system has been found only in the Existing Lower Moshi Project Area, but its rate is low. All other areas are supplied with domestic water from shallow well, spring and river water. Thus, the quality oh life in these areas is still very poor and urgent measures are necessary from the viewpoints of living standard and sanitation. In spite of such poor situation, the implementation of water supply by the authority has not progressed so far mainly due to lack of budget. On the other hand, as can be found in the Existing Lower Moshi Area, the irrigation canals play a role not only providing irrigation water supply but also domestic water supply such as cooking water, bathing, washing and animal drinking. From these findings, it is deemed indispensable that water tapping facility like washing step shall be provided as an important domestic water supply facility for the New Extension Area, Expanded Area and also the Proposed Diversion Channel Route Area.

4.2.2 Water Quality of Irrigation Canal

Due to insufficient number of public water supply facilities, villagers in and around the Study Area are depending on irrigation water and river water of Rau. For the convenience of villagers, totally 12 places equipped with washing steps are provided in the Existing Lower Moshi Area. According of CHAWAMPU by-law, washing steps can only be used for drawing water, any other use being prohibited. However, villagers are using the irrigation water for washing of body, clothes, vegetables, this being done not only on the washing steps provided for that purpose but at any other places of convenience, namely near houses. In addition, cattle and other animals can drink water at any places. Due to the aforementioned reasons, irrigation water is contaminated and very high values of BOD are observed. (Test result of water quality is mentioned in Annex-A)

4.2.3 Livestock Trough

Only 2 facilities are provided as cattle troughs in the whole Study Area. Therefore, cattle, sheep, goats are directly using irrigation canal water in Lower Moshi Project Area and their excrements dropped into the canals constitute a source of contamination of the irrigation water.

4.3 Basic Development Concept

4.3.1 Basic Concept

The Development Plan, which is formulated for the purpose to improve domestic water supply and provide a multi-purpose canal with water facilities for domestic use and livestock troughs, is based on the concepts described below.

- The water facilities for domestic use and the livestock troughs will be developed

according to the number of uses and livestock in the future.
- The water facilities for domestic use and the livestock troughs will be constructed with materials located near the site to cut on cost, which are selected taking into consideration operation and maintenance in the future.
- The water facilities for domestic use and the livestock troughs will be designed based on simple structure which can be maintained by villagers themselves.
- The water facilities for domestic use and the livestock troughs in the new diversion channel are designed taking into consideration safety and convenience factors as related to channel depth.

4.3.2 Criteria of Selection

The proposed water facilities for domestic use and the livestock troughs are selected based on the following criteria.

(1) Water facility for domestic use

- The water facilities for domestic use are to be provided near the communities.
- The water facilities for domestic use are to be planned near road crossings with many pedestrians.
- The water facilities for domestic use are located near villages without other water sources.
- The water facilities for domestic use are to be located at a maximum distance of 2 km from villages. 2 km is adopted as the maximum school distance for children in some standard.

(2) Livestock trough

- The livestock troughs are to be located depending on the number of animals using the area, difficulty of access and proximity of agricultural lands.
- The livestock troughs are to be located near the communities and/or the road crossings with many pedestrians.
- The livestock troughs are to be located near places without other water source.

4.4 Development Plan of Domestic Water Supply

4.4.1 Estimate on Population and Number of Animals in Year 2015

To forecast the water demands of village people and number of livestock in the object area, estimate is made based on Water Development Plan in Moshi District and population census in 1988. On the estimate, following basic criteria is applied:

- Target year : 2015
- Growth ratio of population : 2.2 % per year

As a result of the estimates, the number of villagers using irrigation water will be 35,410, and animals will be 151,600 in the target year of 2015 and water demand depend on Tanzanian standard for those will be 1,700 m3 per day (20 l/s) for villagers and 1,300 m3 per day(15 l/s) for animals. Details of the estimates are shown in Table L.4.2. In the Table, annual growth rate is computed from the population census taken between 1979 and 1988. And the ratio of canal user in Existing Lower Moshi Project Area is determined based the hearing survey result. For the other 3 areas are estimated based on users ration of springs, rivers and other water sources.

4.4.2 Water Facility for Domestic Use

Water facilities equipped with places for domestic use will be provided along the diversion channel and irrigation canals near communities. The structure of these facilities consist of inlet, suction pit with hand pump and washing place as shown in Figure I.4.4. The number of facilities in the respective area is as follows and as shown in Figure I.3.4.

- Existing Lower Moshi Project Area		:	24
- New Extension Area		:	25
- Expanded Area	Kaloreni	:	3
	Mandaka	:	5
- Proposed Diversion Channel Route Area		:	10
Total		:	67 places

4.4.3 Livestock Troughs

Facilities equipped with livestock troughs will be provided along the diversion channel and irrigation canals depending on the number of livestock using the area, difficulty of access and proximity of agriculture land. The structure of there facilities consist of inlet, suction with hand pump and drinking manger with a length of 30 m as shown in Figure I.4.5. The number of there facilities in the respective areas is as follows and as shown in Figure I.3.4.

- Existing Lower Moshi Project Area		:	4
- New Extension Area		:	6
- Expanded Area	Kaloreni	:	3
	Mandaka	:	2
- Proposed Diversion Channel Route Area		:	5
Total		:	20 places

5. OTHER RURAL FACILITIES

5.1 Existing Electricity Power Supply Condition

The distribution lines are not provided to all villages of the Study Area. Electricity is provided by TANESCO to houses in Mabogini, Chekereni, Oria, Mijongweni village and Kaloleni ward, and factories with AC 220 V and 50 Hz. The average ratio of pervasion is lower than 10 % in the respective villages and much differences are not seen among there villages. The number of houses supplied with electricity is shown in Table L.5.1. In the house, electric lamp, iron, radio, cassette recorder, cooking heater are found as common facilities. The electricity cost 50 Tsh./kW, and household consumption cost ranges between 1000 Tsh. to 1500 Tsh. per month.

5.2 Existing Rural Facilities Related to Public Institutions

In the Study Area, there are some other rural facilities. According to the field survey, these rural facilities, which mainly relate to education and health institution, are summarized in Table L.5.1.

Mandaka Mnono has no educational facilities. This requires children living there to attend school located northward at Msaranga. Medical facilities are not found in all villages and ward. Some villages have a dispensary with beds. Both of these facilities are not sufficient for villagers needs.

These Other Rural Facilities are also described in Annex - F.

6. RELEVANT VILLAGE DEVELOPMENT PLAN

Moshi District has made the extension/rehabilitation projects for water supply systems to raise the coverage of the population supplied with clean and safe drinking water from 45% to 90%. Main and branch pipe line of Mabogini-Kahe Water Supply System will be improved depending on the projects, but there is no response from the Government after proposal. The development plans of the public water supply system for the respective villages are made or on-going by the District to improve the existing conditions, however, all plans are delayed or postponed due to financial constraint. In Oria village, there is a development plan to rehabilitate the existing well and construct a new pipeline for the domestic water supply. The said well has been already constructed and water quality has already been checked so far. Presently, the village is collecting money to purchase and install a pump. A new pipeline system is planned to run from Mwananguruwe spring in Mandaka Mnono village and connect the main pipe at Oria village to Rau Ya Kati village. An 8 inch pipe is designed and the cost is estimated at 210 million Tsh. Though the drawings have been completed, the actual works have not yet started.

Tables

Table L. 3. 1 The Result of Traffic Volume Survey(1/4)

Course 1 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	76	108	25	22	27	22	22	60	35	31	46	26	500
Bicycle	7	20	19	21	23	24	18	28	38	28	23	29	278
Motor cycle		1	1				3	1		2			8
Motorcar		1	4	2	4	3	4	2	5	1	3	1	30
Mini truck		3	3	4	9	4		1	3	2	3	3	35
Mini bus		1	1	2	1		1	2	1		2	3	14
Truck (2 - 10t)									1	1			2
-do- (over 10t)		1	1	2	3								7
Bus			1							1			2
Tractor						1					1		2
Others				31	125				43		15		217

Course 2 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	8	16	19	20	36	144	51	12	13	18	52	38	427
Bicycle	19	22	20	24	22	23	35	15	29	36	26	43	314
Motor cycle		1	1	1	1	1	1	1			2	1	10
Motorcar	2	2		3		1	2	5	1	4	8	6	34
Mini truck	1	3	2	2	1	3	2	3	7	3	5	2	34
Mini bus	3	1		1		1	1	1	1	2	2	2	15
Truck (2 - 10t)												1	1
-do- (over 10t)		1			1	1		2		2	1		8
Bus					1							1	2
Tractor									1				1
Others													0

Course 3 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	125	170	66	47	59	50	40	122	57	48	74	84	992
Bicycle	18	24	26	35	33	46	41	48	50	46	47	67	481
Motor cycle		1	2	1		1	2	1		1	1		10
Motorcar		1	3	1	4	3	4	2	5		4	2	29
Mini truck		1	4	1	7	4	2		3	1	2	3	28
Mini bus	1	1	2	2	1		1	2	1	1	2	3	17
Truck (2 - 10t)		2	1	2	3				1				9
-do- (over 10t)										1			1
Bus			1							1			2
Tractor				1								1	2
Others												48	48

Course 4 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	16	46	53	40	52	199	147	53	29	30	125	100	888
Bicycle	14	22	29	29	35	30	53	36	30	46	37	59	420
Motor cycle		1	3	1	2	1	1	2	1		1	1	14
Motorcar	2	2		2			2	4		5	7	4	28
Mini truck	1	4	2	2	1	3	4	1	5	2	2	3	30
Mini bus	3	1		1		1	1	1	2	1	2	2	15
Truck (2 - 10t)		1			1	1		2		2	2		9
-do- (over 10t)												1	1
Bus					1							1	2
Tractor		1											1
Others					43								43

Course 5 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	22	53	37	39	30	16	16	34	9	33	35	52	376
Bicycle	6	18	11	12	24	13	11	14	5	23	27	31	190
Motor cycle							1	1			1		3
Motorcar				1		1		1		1			4
Mini truck			2	2		2		1	1	2			10
Mini bus													0
Truck (2 - 10t)													0
-do- (over 10t)													0
Bus													0
Tractor			1	2	1							1	5
Others				16	57	17					26	40	156

Course 6 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	6	21	21	26	27	19	26	46	7	28	47	51	328
Bicycle	2	7	22	22	13	10	16	23	2	26	33	43	219
Motor cycle					1					1			2
Motorcar				1	1					1			3
Mini truck		1		2	2	2	1		1	1			10
Mini bus													0
Truck (2 - 10t)													0
-do- (over 10t)													0
Bus													0
Tractor													0
Others											37	51	88

Table L. 3. 1 The Result of Traffic Volume Survey(2/4)

Course 7 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	6	38	10	2	15	12	5	17	10	22	14	23	174
Bicycle	4	23	32	19	32	31	37	33	41	40	31	36	359
Motor cycle					1	1		1		1	1		5
Motorcar			5	1	3	2	1	1	1	2	1	1	18
Mini truck			2	1	4	3	1		2		2	1	16
Mini bus	1		2		2	1	1	2		2	3	3	17
Truck (2 - 10t)			6	1	4	1	1		2				15
-do- (over 10t)													0
Bus			1		1					1			3
Tractor									1	1			2
Others					8	8		20					36

Course 8 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	7	9	21	7	10	10	13	14	6	16	43	34	190
Bicycle	19	18	21	32	30	33	28	29	23	23	21	27	295
Motor cycle		1	1		1	1	1	1	1		2	1	10
Motorcar	1	1		1		1		1	1	6	6	2	20
Mini truck	1	1	1	2		2	3		5	4	1	1	21
Mini bus	1	2		1	1		1	1	2	2	2	2	15
Truck (2 - 10t)			5	1			1	1	1		2		11
-do- (over 10t)										4			4
Bus												1	1
Tractor			1										1
Others							4	16					20

Course 9 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	37	67	26	7	33	22	19	12	18	30	26	43	320
Bicycle	12	31	42	27	41	41	46	30	40	49	49	58	466
Motor cycle					1	1		2	1	1	1		7
Motorcar			4	1	3	2	1	1	1	2	1		16
Mini truck			3	1	4	2	2	1	3		3	1	20
Mini bus			2		2	2	1	2		1	2	3	15
Truck (2 - 10t)			1	1	1	1	1		2				7
-do- (over 10t)													0
Bus			1		1					1			3
Tractor													0
Others				8	48	8		4					68

Course 10 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	10	14	17	10	15	17	20	17	13	13	70	30	246
Bicycle	14	41	32	42	50	40	32	27	32	27	47	41	425
Motor cycle		1	1		1	1	1	1	1	1	1	1	10
Motorcar	1	1	3	1		2		1	1	5	6	2	21
Mini truck	1	1	2	1		2	5		4	5	2	3	26
Mini bus	1	2		1	1	1	1	1	2	3	2	2	17
Truck (2 - 10t)				1	1				1	1	1		5
-do- (over 10t)					1							1	1
Bus													0
Tractor													0
Others					8		4						12

Course 11 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	2	3	5	2	17	7	5	10	3	7	14	19	94
Bicycle	2	1	12	10	6	5	7	7	10	8	12	14	94
Motor cycle								1					1
Motorcar										1			1
Mini truck													0
Mini bus													0
Truck (2 - 10t)					1								1
-do- (over 10t)													0
Bus													0
Tractor									1				1
Others											4		4

Course 12 (30, May, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	5	20	12	4	12	8	7	8	6	8	7	18	115
Bicycle	7	13	12	7	5	4	4	7	3	6	4	12	84
Motor cycle									1				1
Motorcar										1			1
Mini truck													0
Mini bus													0
Truck (2 - 10t)							1	1					2
-do- (over 10t)													0
Bus													0
Tractor											4		4
Others													4

Table L.3.1 The Result of Traffic Volume Survey(3/4)

Course 1 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	87	93	49	43	58	43	60	40	4	23	38	41	582
Bicycle	1	16	19	24	27	21	27	32	18	31	36	43	295
Motor cycle			1	1		2	1			1	2	3	11
Motorcar			7	1		2	3	1	2	3	2	4	25
Mini truck		3		2	1	3		1	2	3	4	1	20
Mini bus	1	1	1	1	2	2	1	1	2	1	2	3	18
Truck (2 - 10t)		1	1	1			2		1	2	1		9
-do- (over 10t)			1			1							2
Bus												1	1
Tractor													0
Others			12		157	2			47		46	183	447

Course 2 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	32	39	33	34	29	41	46	41	32	16	176	54	573
Bicycle	6	18	34	26	18	27	34	25	21	22	23	39	293
Motor cycle				1		2		1		1	2	1	8
Motorcar			1		3	1	2	2		3	2	4	18
Mini truck		2	3	1	2	2	1	6			3	6	26
Mini bus	3	2			1	1	2	1		3		4	17
Truck (2 - 10t)							1	1			3	1	6
-do- (over 10t)								1				1	2
Bus			1			1		1					3
Tractor				1									1
Others													0

Course 3 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	83	151	59	49	74	82	39	65	57	80	92	212	1043
Bicycle	2	15	22	16	37	30	31	50	30	63	55	65	416
Motor cycle			1	1			1			1	1	2	7
Motorcar			8			2	2		3	2	1	3	21
Mini truck		2			2	2		1	3	2	2	1	15
Mini bus	2	1	1	1	2	1	1	1	2	2	2	3	19
Truck (2 - 10t)		1	2	1		1	1			2	1		9
-do- (over 10t)													0
Bus						1						1	2
Tractor													0
Others												45	45

Course 4 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	7	32	34	62	50	70	98	63	48	45	213	104	826
Bicycle	2	19	35	28	37	28	31	46	32	43	37	51	379
Motor cycle				1		2	1				2		6
Motorcar	1		1		3	1	2	2		4	3	3	20
Mini truck		3	3		2		1	3	1		4	3	20
Mini bus	1	2			1	2	2	1	1	3		4	17
Truck (2 - 10t)							1	2			3	2	8
-do- (over 10t)													0
Bus			1					1					2
Tractor			1										1
Others						25		1					26

Course 5 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	41	56	53	56	47	38	48	41	28	36	47	45	536
Bicycle	22	30	35	39	33	27	40	27	21	23	38	40	375
Motor cycle													0
Motorcar						1						1	2
Mini truck			1									1	2
Mini bus													0
Truck (2 - 10t)													0
-do- (over 10t)													0
Bus													0
Tractor													0
Others				22	55							37	114

Course 6 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	17	28	41	42	33	42	36	39	26	28	54	59	448
Bicycle	13	29	28	32	31	28	37	41	23	18	37	43	351
Motor cycle						1							1
Motorcar						1					1	1	3
Mini truck			1				1						2
Mini bus													0
Truck (2 - 10t)													0
-do- (over 10t)													0
Bus													0
Tractor													0
Others											23	44	67

Table L.3.1 The Result of Traffic Volume Survey(4/4)

Course 7 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	7	52	33	23	22	32	36	44	58	36	39	33	415
Bicycle	4	13	21	21	32	49	38	57	65	65	61	37	483
Motor cycle		1	1		1	3			1		2	1	10
Motorcar			4	4	1		2		3	2		2	18
Mini truck		2			1	2	3	2	2	5	3		20
Mini bus	1	1	1	1	2	2	1	2	2	1	2	3	19
Truck (2 - 10t)			1	3		1			2	2			9
-do- (over 10t)													0
Bus	1						1					1	3
Tractor						1							1
Others		1				19							20

Course 8 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	6	23	34	27	38	46	36	50	45	55	60	62	482
Bicycle	3	17	51	37	48	61	43	79	72	70	62	57	600
Motor cycle				2	2	3			2	2	2	1	14
Motorcar			1		4	1	1	2	2	4	4	1	20
Mini truck	1	2	1	1	3	2	6	3		4	3	1	27
Mini bus	1		1	1		3	1	1	1	2	3	3	17
Truck (2 - 10t)						1	1		2		4	1	9
-do- (over 10t)													0
Bus		1					1						2
Tractor													0
Others	1					19			21				41

Course 9 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	6	67	51	21	36	55	92	214	91	65	152	124	974
Bicycle	8	22	30	46	45	75	77	105	123	89	113	81	814
Motor cycle		1	2			2	1				2	1	9
Motorcar			5	2	1		2		2	3	1	1	17
Mini truck		2		1	1	3	1	2	1	3	1	1	16
Mini bus	1	1	1	1	1	1	1	1	3	1	2	2	16
Truck (2 - 10t)			2						2	1			5
-do- (over 10t)						1							1
Bus							1						1
Tractor						2				1			3
Others				9		6	4			1			20

Course 10 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	4	11	16	37	32	118	198	104	56	69	127	52	824
Bicycle	1	34	52	51	50	76	92	126	93	93	90	63	821
Motor cycle				2	1	3			3	2	2	1	14
Motorcar					2	2	2	2	1	3	2	3	17
Mini truck	1	2	3	1	3	1	6	2	1	1	2	1	24
Mini bus	1		1	1	2	3	3	1	1	3	3	3	22
Truck (2 - 10t)			1						2			1	4
-do- (over 10t)											1		1
Bus		1				1	1					1	4
Tractor						1	2				1		4
Others							43					32	89

Course 11 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	4	26	32	17	33	35	77	53	53	45	43	12	430
Bicycle	4	15	26	23	26	23	28	38	22	31	28	13	277
Motor cycle			1			1				1	2		5
Motorcar													0
Mini truck					1		1						2
Mini bus													0
Truck (2 - 10t)							1						1
-do- (over 10t)													0
Bus													0
Tractor						1							1
Others						7			17		4	7	35

Course 12 (2, June, 1997)

Time / Traffic type	6:00 - 7:00	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	Total
Walker	4	26	32	17	33	35	77	53	53	45	43	12	430
Bicycle	4	15	26	23	26	23	28	38	22	31	28	13	277
Motor cycle			1			1				1	2		5
Motorcar													0
Mini truck					1		1						2
Mini bus													0
Truck (2 - 10t)							1						1
-do- (over 10t)													0
Bus													0
Tractor						1							1
Others						7			17		4	7	35

Table L.3.2 Summary of Road Conditions in Study Area

Class of Road	Length (km)	Number (nos.)	Width (m)	Pavement	Nos. of Traffic(day)	Road Condition	Agency in charge
1. Existing Lower Moshi Project Area							KADP
1.1 Trunk road	16.1	1	9	gravel paved	< 300	Poor	
1.2 Main farm road	17.7	3	6	laterite paved	< 50	Poor	
1.3 Secondary farm road	38.6	13	5	aterite paved (partialy	< 10	Poor	
1.4 Tertiary farm road	55.6		3	unpaved	-	Poor	
2. Proposed Expansion Area							
Village road	28.4	7	3 - 5	unpaved	< 10	Poor	Village
3. Expanded Area							
3.1 Mandaka Mnono Area							
Village road	4.7	2	3	unpaved	< 10	Poor	Village
3.2 Kaloeni Area							
Ward road	1.7	1	3	unpaved	< 10	Poor	Ward
4. Proposed Diversion Channel Route Area							
Village road	7.9	5	3	unpaved	< 10	Poor	Village

Table L.3.3 Rehabilitation and Improvement Plan of Village Linking Road

Location and Mark	Name of Village	Length (m)	Road Width (m)	Pavement	Remarks
A. Diversion Channel Route					
A-1	Kawaya	500	4.0	Unpaved	
A-2	Mkalama	800	- do -	- do -	
A-3	- do -	1,000	- do -	- do -	
A-4	- do -	900	- do -	- do -	
A-5	Longoi	700	- do -	- do -	
A-6	Longoi/Kikafu Chini	600	- do -	- do -	
A-7	Kikafu Chini	400	- do -	- do -	
Sub-total		4,900			
B. Extension Area					
B-1	Chekereni/Mtkuja	1,000	4.0	Unpaved	System B
Sub-total		1,000			
C. Expanded Area					
C-1	Kaloleni	200	4	Unpaved	
C-2	- do -	300	- do -	- do -	
C-2	- do -	200	- do -	- do -	
C-3	Mandaka/Chekereni	3,100	- do -	- do -	
Sub-total		3,800			
Total		8,700			

Table L.4.1 Summary of Existing Conditions of Domestic Water Supply System(1/2)

Area	Household /population	Water source	Authority	Nos. of facility	Condition
I. Existing Lower Moshi Area					
1.1 Mabobini	800/5,000	Public	Moshi District		good/sufficient
		- house use		130	
		- community		20	
		Well	village	1	poor/insufficient
		Canal	KADP	common use	-
		River	-	domestic only	dirty/far
1.2 Rau Ya Kati	400/2,070	Public	Moshi District		poor/insufficient
		- house use		16	
		- community		6	
		Well	no well	0	-
		Canal	KADP	common use	-
		River	-	domestic only	dirty/far
1.3 Chekereni	710/3,480	Public	Moshi District		poor/insufficient
		- house use		7	
		- community		16	
		Well	village & personal	6	poor/insufficient
		Canal	KADP	common use	-
		River	no river	-	-
1.4 Oria	840/4,610	Public	Moshi District		poor/insufficient
		- house use		10	
		- community		5	
		Well	village & personal	2	poor/insufficient
		Canal	KADP/NAFCO	common use	-
		River	no river	-	-
II. Expanded Area					
2.1 Mandaka	400/1,760	Public	not provided		
		Well	no well	-	-
		Canal	village	common use	poor/insufficient
		Spring(river)	village	all purpose	dirty/far
2.2 Kaloleni	850/3,130	Public	Moshi Municipal		poor/insufficient
		- house use		50	
		- community		0	
		Well	no well	-	-
		Canal	village	common use	poor/insufficient
		Spring(river)	village	all purpose	dirty/far

(to be continued)

Table L.4.1 Summary of Existing Conditions of Domestic Water Supply System(2/2)

Area	Household /population	Water source	Authority	Nos. of facility	Condition
III. New Extension Area					
3.1 Mutakja	720/3,310	Public	Moshi District		poor/insufficient
		- house use		2	
		- community		9	
		Well	village & personal	24	poor/insufficient
		Canal	KADP/TPC	common use	dirty/far/seasonal
3.2 Mvuleni	550/2,250	Public	Moshi District		poor/insufficient
		- house use		0	
		- community		1	
		Well	village & personal	5	poor/insufficient
		Canal	TPC	common use	dirty/far/seasonal
IV. Diversion Channel Route(from upstream area)					
4.1 Kawaya	1,360/3,690	Public	not provided	-	-
		Well	village & personal	2	poor/insufficient
		Canal	village	common use	dirty/far/seasonal
		Spring	village	1/common use	poor/insufficient
		River	-	common use	dirty/far
4.2 Mkalama	370/2,580	Public	not provided	-	-
		Well	village	2	poor/insufficient
		Canal	village	common use	poor/insufficient/seasonal
		Spring	village	1/common use	poor/insufficient
		River	not provided	-	-
4.3 Longini	620/4,000	Public	not provided	-	-
		Canal	village	common use	poor/insufficient/seasonal
		Spring	village	1/common use	dirty/far
		River	-	common use	dirty/far
4.4 Kikafu Chini	560/2,800	Public	TPC		poor/insufficient
		- house use		0	
		- community		15	
		Spring	village	1/common use	dirty/far
		River	-	common use	dirty/far/seasonal
4.5 Mijongweni	850/3,000	Public	Moshi District		poor/insufficient
		- house use		0	
		- community		1	
		Canal	village	common use	poor/insufficient
		River	-	common use	dirty/far/seasonal

Table L.4.2 Estimate of Population and Livestock in 2015

Project Area/Village	Area (ha)	Basic Data 1988 Household (nos.)	Basic Data 1988 Population (nos.)	*1 Growth Rate per year (%)	Estimated 1997 Household (nos.) ①	Estimated 1997 Population (nos.)	Estimated 2015 Household (nos.)	Estimated 2015 Population (nos.) ②	*2 Ratio for Canal User (%) ③	*2 Estimate Canal User (nos.) ④=②×③	Cattle *4 Acutual 1997 (nos.)	Cattle Estimate 2015 (nos.)	Goat *5 *4 Acutual 1997 (nos.)	Goat *5 Estimate 2015 (nos.)	Sheep *5 *4 Acutual 1997 (nos.)	Sheep *5 Estimate 2015 (nos.)
1. Existing Lower Moshi Area												*3		*3		*3
Mabogini	955	432	2,741	2.2	530	3,340	790	4,940	60	2,970	827	900	1,650	1,700	284	300
Rau Ya Kati	632	327	1,695	2.2	400	2,070	600	3,070	90	2,770	670	700	1,428	1,500	724	800
Chekereni	420	316	1,571	2.2	390	1,920	570	2,840	30	860	449	500	1,356	1,400	348	400
Oria	293	694	3,783	2.2	840	4,610	1,250	6,830	70	4,700	1,880	1,900	2,802	2,900	916	1,000
sub total	2,300	1,769	9,790		2,160	11,940	3,210	17,680		11,300	3,826	4,000	7,236	7,500	2,272	2,500
2. Expanded Area												*3		*3		*3
Mandaka	360	319	1,444	2.2	400	1,760	580	2,610	90	2,350	682	700	1,104	1,200	439	500
Kaloleni	100	697	2,568	2.2	850	3,130	1,260	4,630	30	1,390	6	100	298	300	49	100
sub total	460	1,016	4,012		1,250	4,890	1,840	7,240		3,740	688	800	1,402	1,500	488	600
3. Extension Area												*3		*3		*3
Mabogini	480	215	1,364	2.2	270	1,660	390	2,460	60	1,480	412	500	821	900	142	200
Chekereni	340	258	1,280	2.2	320	1,560	470	2,320	60	1,400	365	400	1,104	1,200	284	300
Mtakuja	770	596	2,713	2.2	720	3,310	1,070	4,900	90	4,410	3,024	3,100	4,000	4,000	1,800	1,800
Mvuleni	500	448	1,845	2.2	550	2,250	820	3,340	80	2,680	350	400	500	500	200	200
sub total	2,090	1,517	7,202		1,860	8,780	2,750	13,020		9,970	4,151	4,400	6,425	6,600	2,426	2,500
Sub Total	4,850	4,302	21,004		5,270	25,610	7,800	37,940		25,010	8,665	9,200	15,063	15,600	5,186	5,600
4. Diversion Channel Route											*4		*4		*4	
Kawaya	-	-	-	2.2	1,360	3,690	2,030	5,470	20	1,100	(7,500)	11,100	(14,300)	21,200	(4,100)	6,100
Mkalama	-	-	-	2.2	370	2,580	550	3,820	60	2,300	(2,100)	3,200	(3,900)	5,800	(1,100)	1,700
Longoi	-	-	-	2.2	620	4,000	920	5,920	60	3,560	(3,500)	5,200	(6,500)	9,700	(1,900)	2,900
Kikafu Chini	-	-	-	2.2	560	2,800	830	4,150	40	1,660	(3,100)	4,600	(5,900)	8,800	(1,700)	2,600
Mijyongweni	-	-	-	2.2	850	3,000	1,270	4,440	40	1,780	(4,700)	7,000	(8,900)	13,200	(2,600)	3,900
Sub total	-	-	-		3,760	16,070	5,600	23,800		10,400	(20,900)	31,100	(56,000)	58,700	(11,400)	17,200
Total	-	-	-		9,030		13,400	61,740		35,410	29,565	40,300	71,063	74,300	16,586	22,800

Souce : Hearing Survey, 1997, JICA Study Team.

Note : 1. Growth ratio per year is applied for 2.2% which is the average from 1979 to 1988.

2. Ratio for Canal user in 2015 is applied for same ratio on data of 1997.

3. Livestock numbers of Existing Lower Moshi, Proposed Extension, Expanded Area are based on the results of discussion with RALDO.

4. Livestock number of Diversion Channel Route in 1997 is calculated by the following formula, "①:Household estimated 1997×average number of each livestock in other three areas".

Table L.5.1 Other Rural Facilities

Items	Unit	Name of Villages												
		Mabogini	Chekereni	Ray Ya Kati	Orna	Mtakja	Mvuleni	Kaloleni	Mandaka Mnono	Kawava	Longoi	Mkalama	Kikafu Chini	Mjongweni
I. Number of Electrified households	nos.	40	25	0	36	0	0	60	0	0	0	0	15	10
II. Educational Facilities														
1. Number of Schools														
a) Primary School	nos.	1	1	1	1	1	1	1	0	1	2	1	1	1
b) Secondary School	nos.	0	0	0	1	0	0	1	0	0	0	0	0	0
2. Number of Class rooms														
a) Primary School	nos.	13	12	4	9	8	4	11	0	2 [1]	4 [1]	3 [1]	2 [1]	8
b) Secondary School	nos.	0	0	0	4	0	0	5	0	0	0	0	0	0
3. Number of Students														
a) Primary School	per.	1,032	949	546	447	350	337	652	0	346	574	353	325	317
b) Secondary School	per.	0	0	0	37	0	0	50	0	0	0	0	0	0
4. Number of the teachers														
a) Primary School	per.	26	25	19	14	13	12	18	0	8	13	6	9	8
b) Secondary School	per.	0	0	0	5	0	0	4	0	0	0	0	0	0
III. Medical Facilities														
1. Number of Medical facilities														
a) Clinics	nos.	0	0	0	0	0	0	0	0	0	0	0	0	0
b) Dispensaries	nos.	1	1, 1 [2]	0	1 [2]	1	0	0	0	0	0	2, 1 [2]	0	0
c) Health Center	nos.	0	0	0	0	0	0	0	0	0	0	0	0	0
d) Hospital	nos.	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Number of :														
- Doctors	per.	0	0	0	0	0	0	0	0	0	0	0	0	0
- Medical Assistant (MA)	per.	1	1	0	0	1	0	0	0	0	0	1	0	0
-Rural Medical Assistant (RMA)	per.	1	5	0	1	3	0	0	0	0	0	2	0	2
- Nurses	per.	9		0	2	2	0	0	0	0	0	10	0	3
- Phermacists	per.	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Number of :														
- Patients	per.	15 - 20	35 - 30	0	15 - 20	15 - 20	0	0	0	0	0	30 - 35	0	20 - 25
- Inpatients	per.	3 - 7	5 - 10	0	0	1 - 2	0	0	0	0	0	2 - 5	0	0
4. Number of Beds	nos.	10	15	0	0	4	0	0	0	0	0	0	0	0
IV. Markets Facilities														
1. Number of Market facilities	nos.	0	1	0	1	0	0	0	0	0	1	0	1	0

Source : Hearing Survey, 1997, JICA Study Team

Notes :
1) : Only permanent number of class rooms.
2) : Non government dispensary.
3) : Number of the markets operated more than once a week at a open space with very few temporary tables and with no roof.

Figures

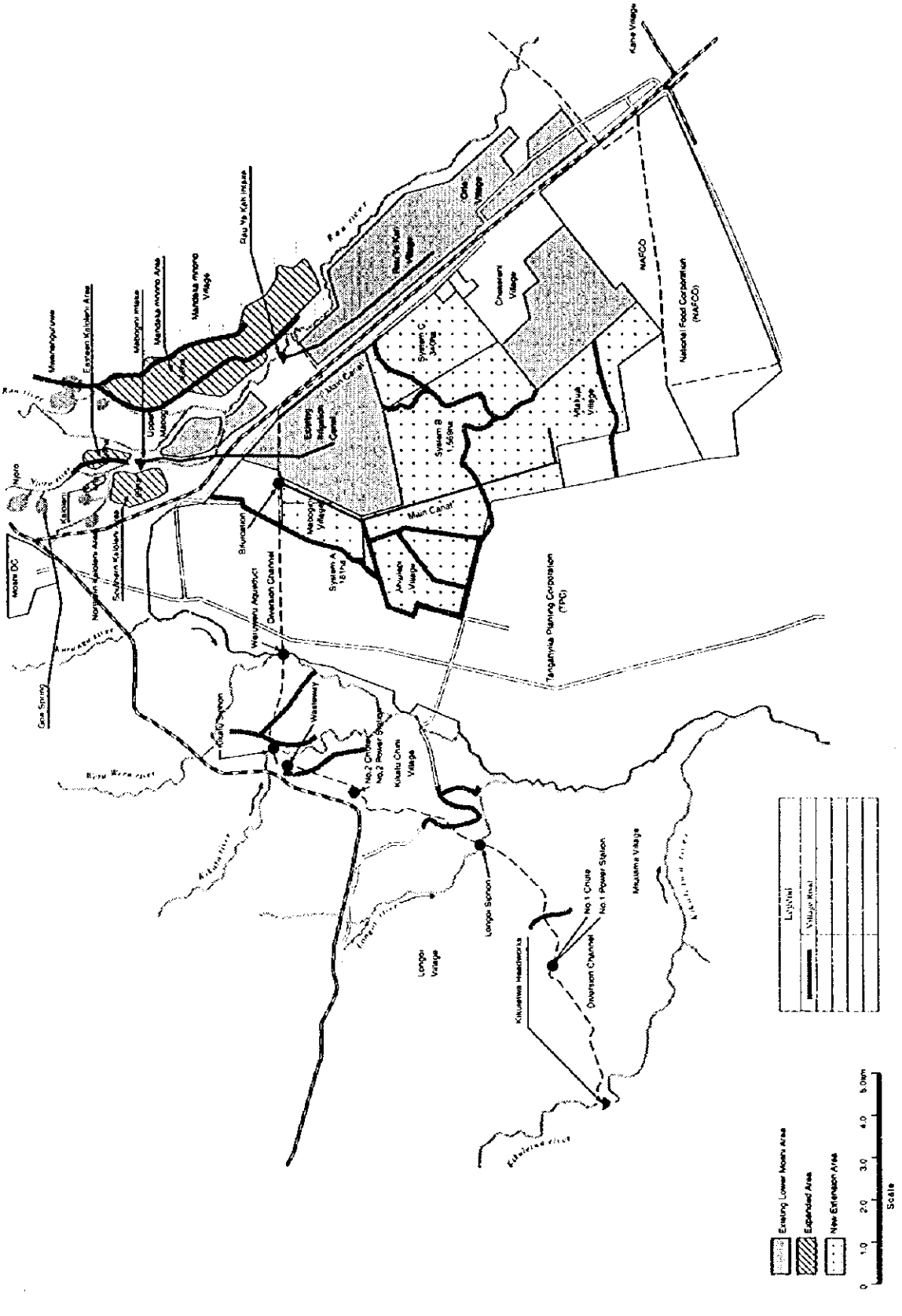
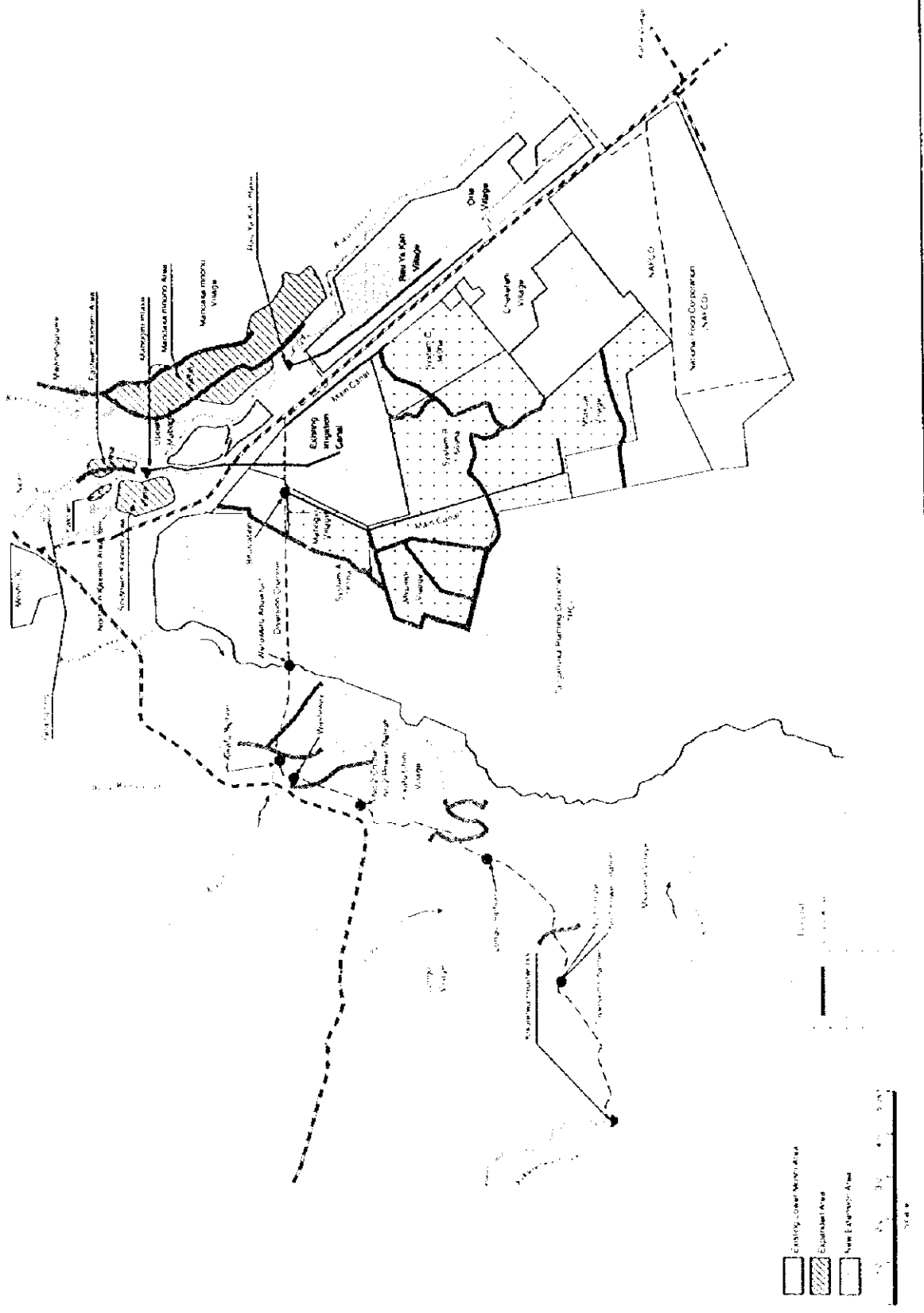


Figure L.3.1
Layout of Road Network

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency



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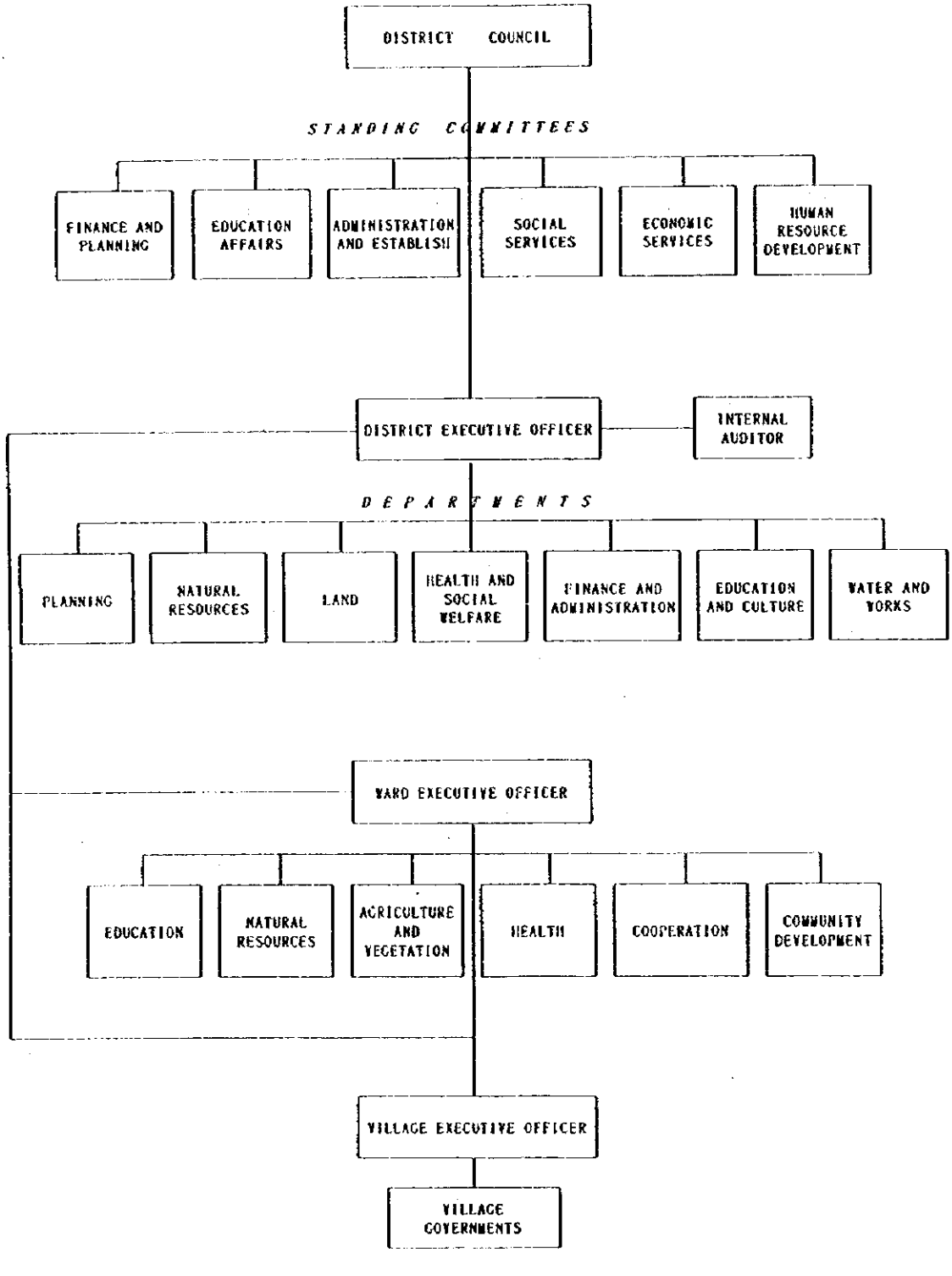


Figure L.3.2
Organization Chart of Moshi District

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

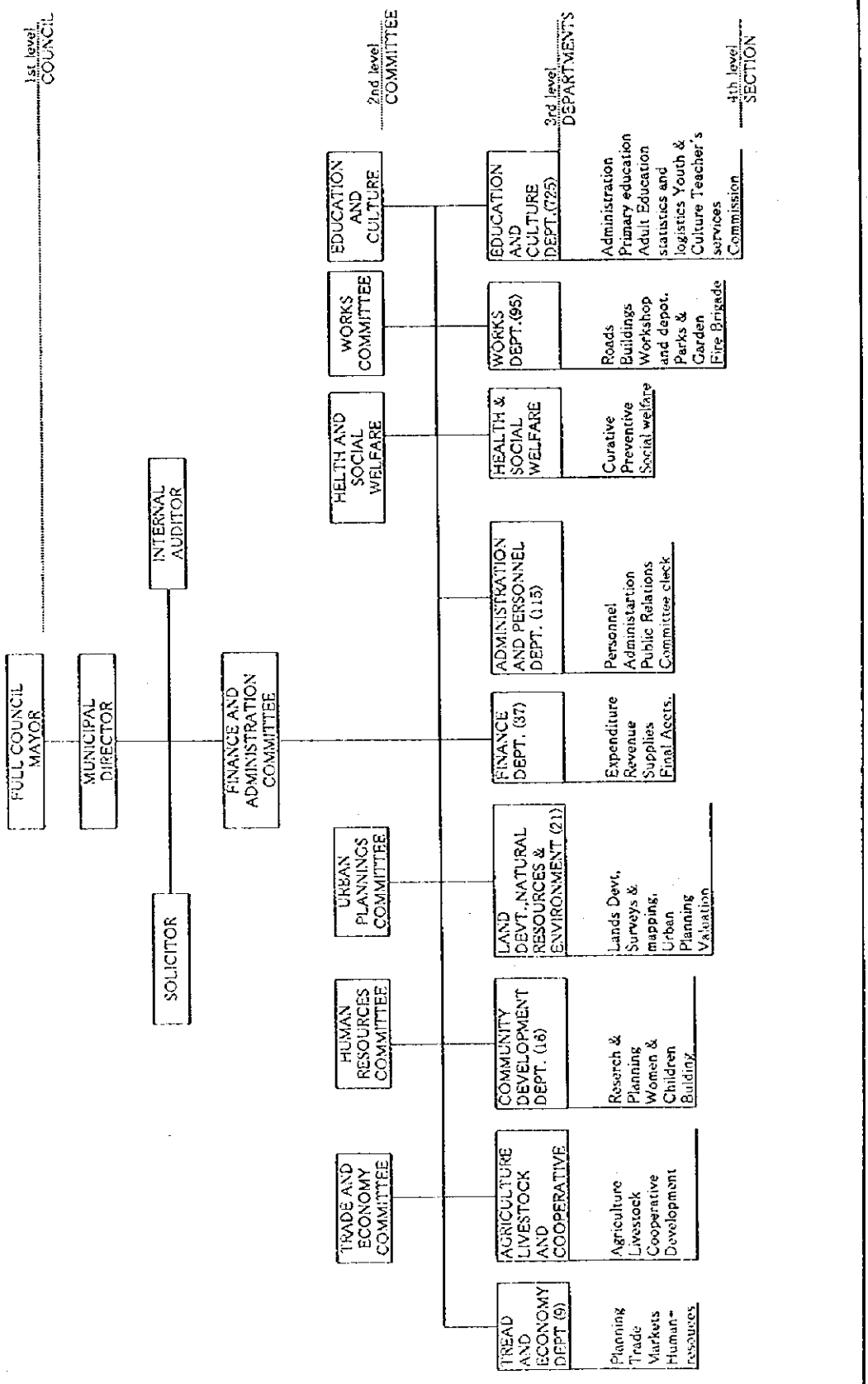


Figure L.3.3
Organization Chart of Moshi Municipal

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

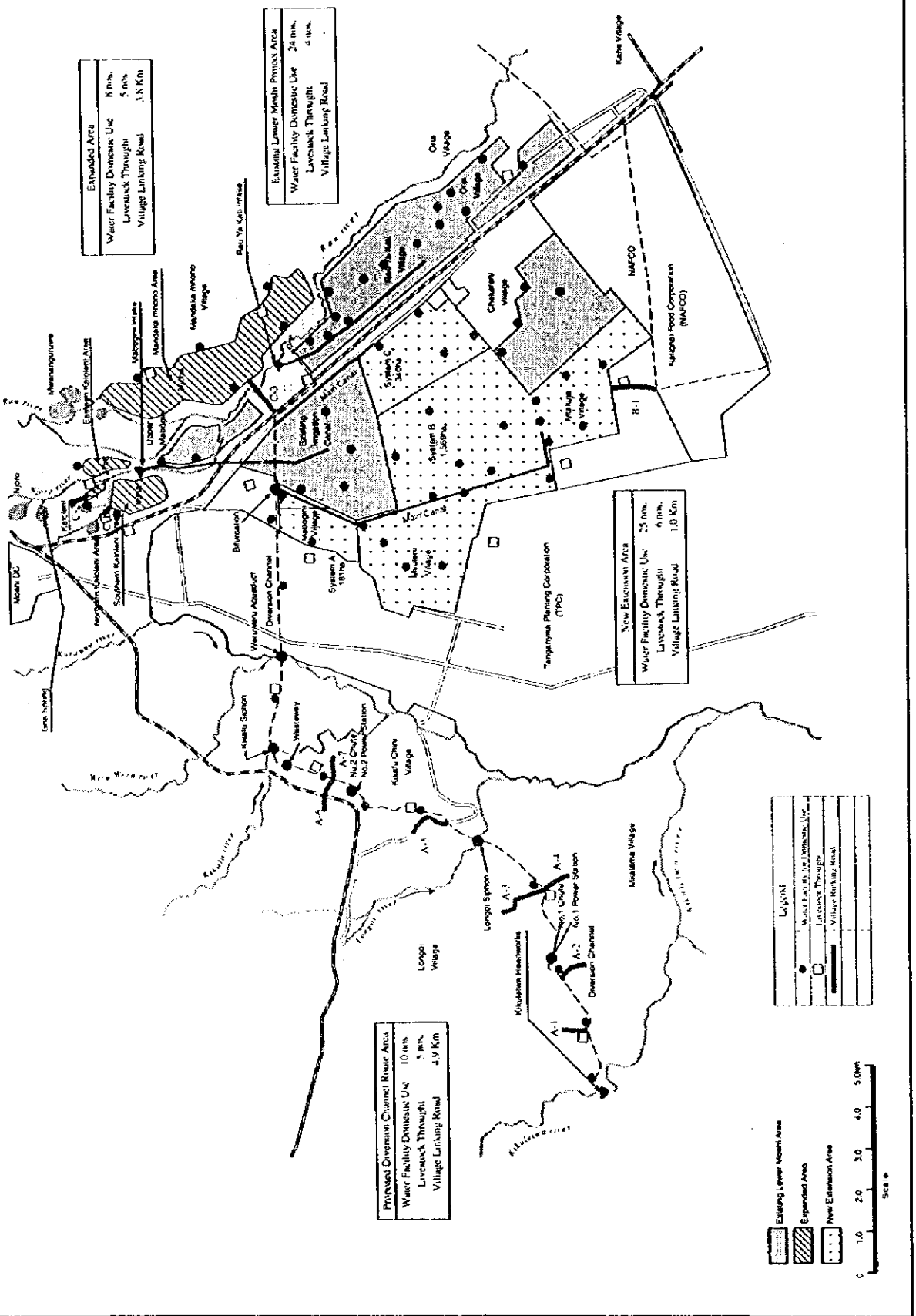
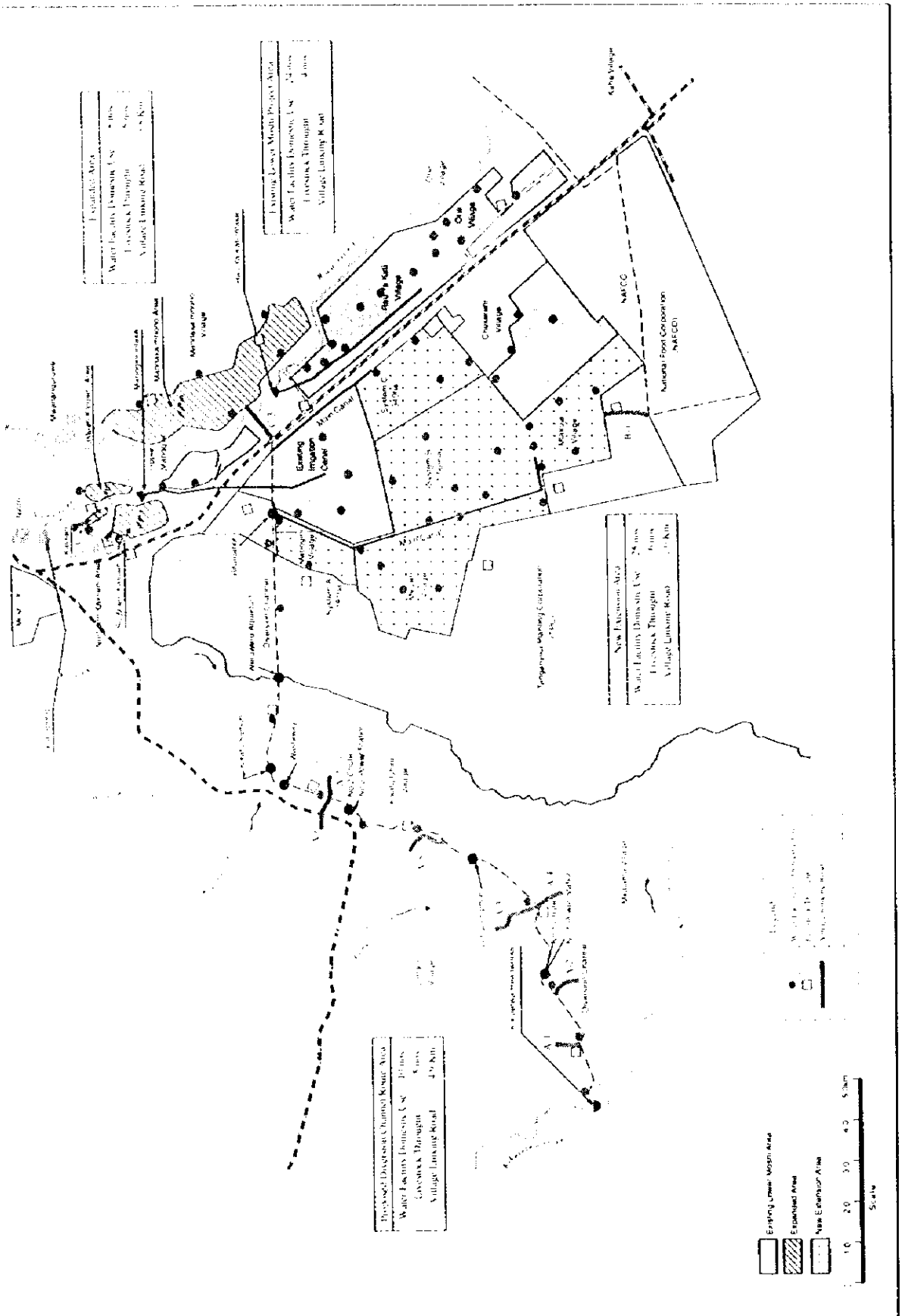


Figure L.3.4
Proposed Location of Rural Facilities

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency



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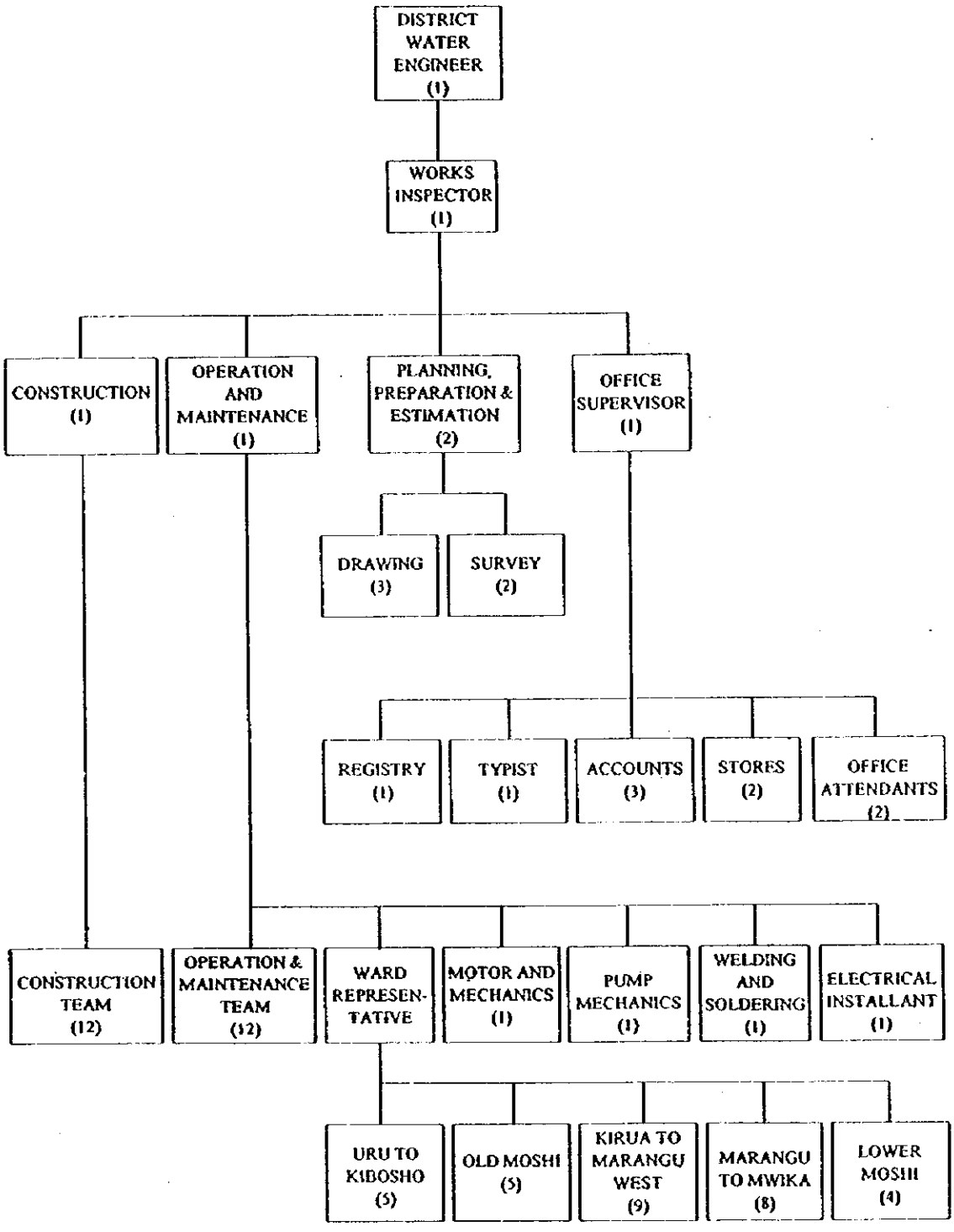

Figure L.4.1
Organization Chart of Water Department in Moshi District

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

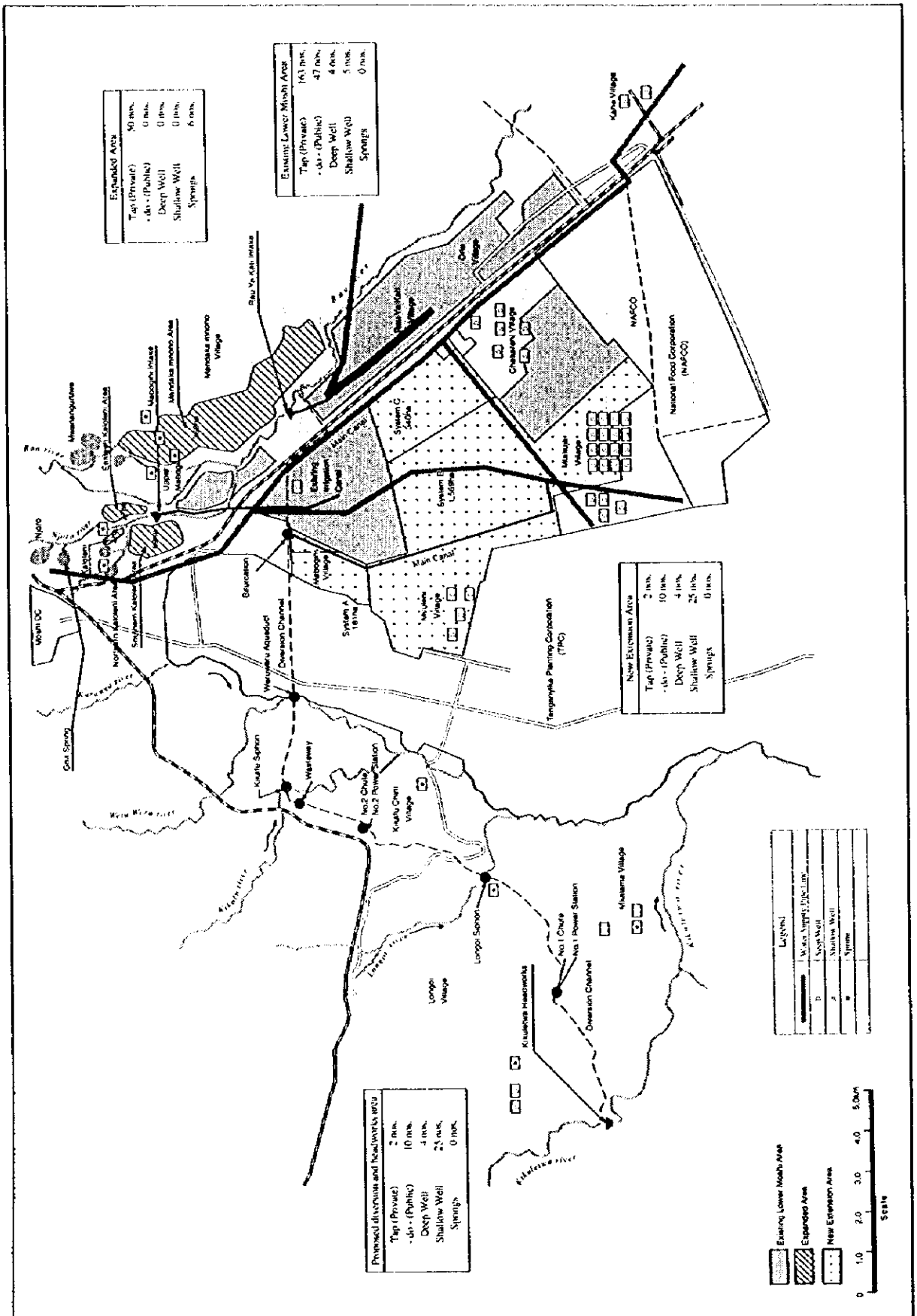

Figure L.4.2
Present Condition of Water Supply System

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

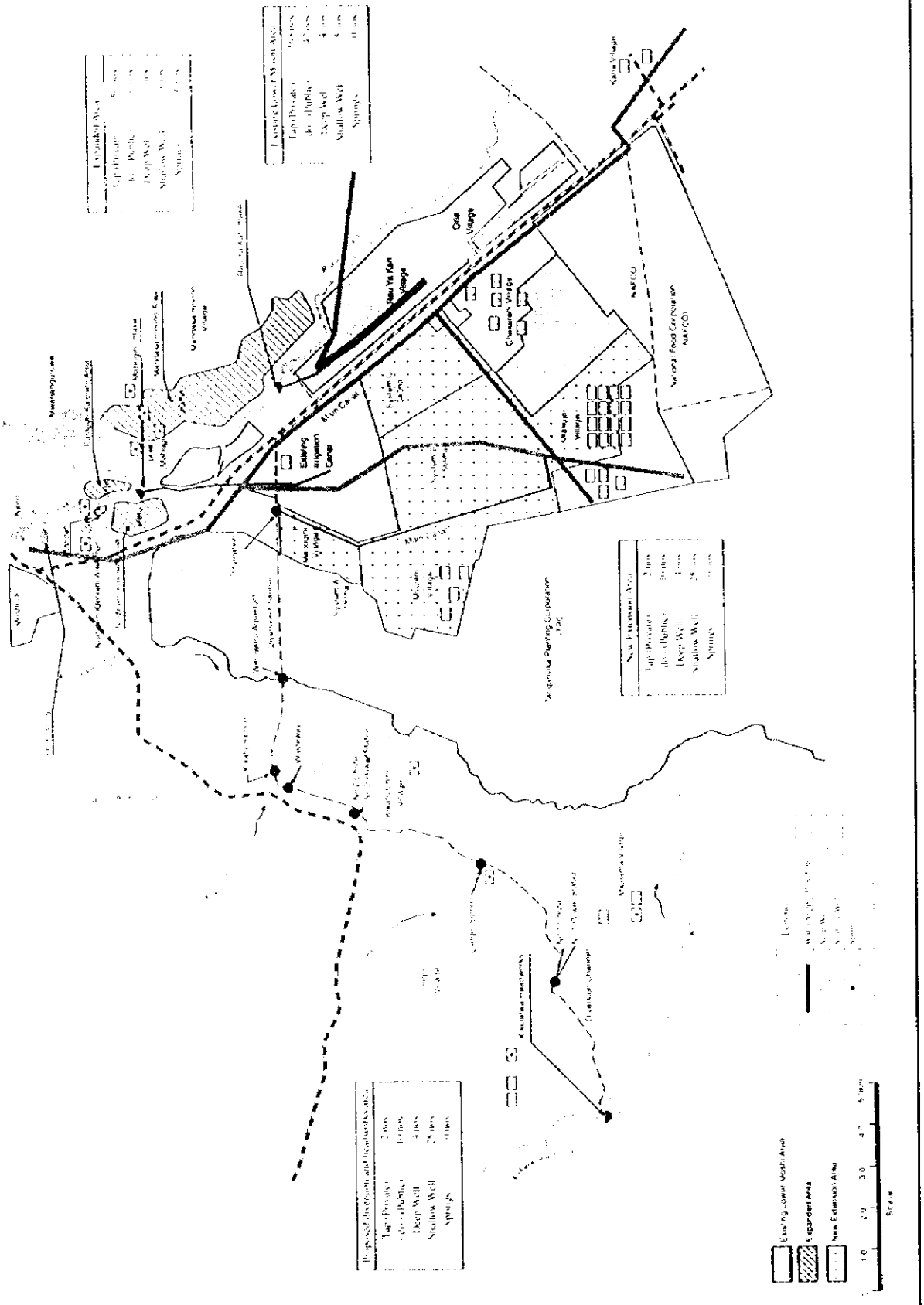

Figure L.4.2
Present Condition of Water Supply System

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

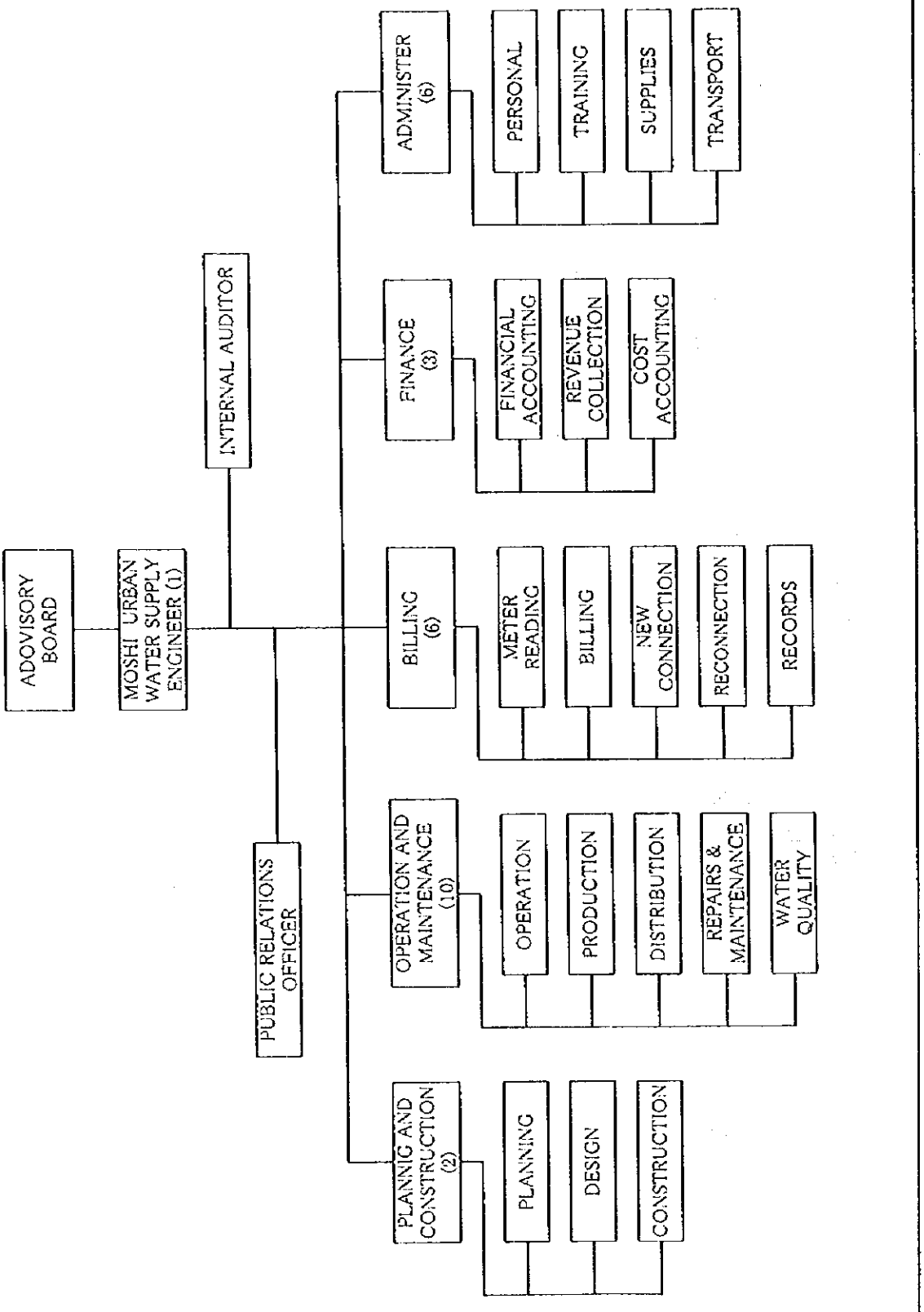

Figure L.4.3
Organization Chart of Water Department in Moshi Municipal

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

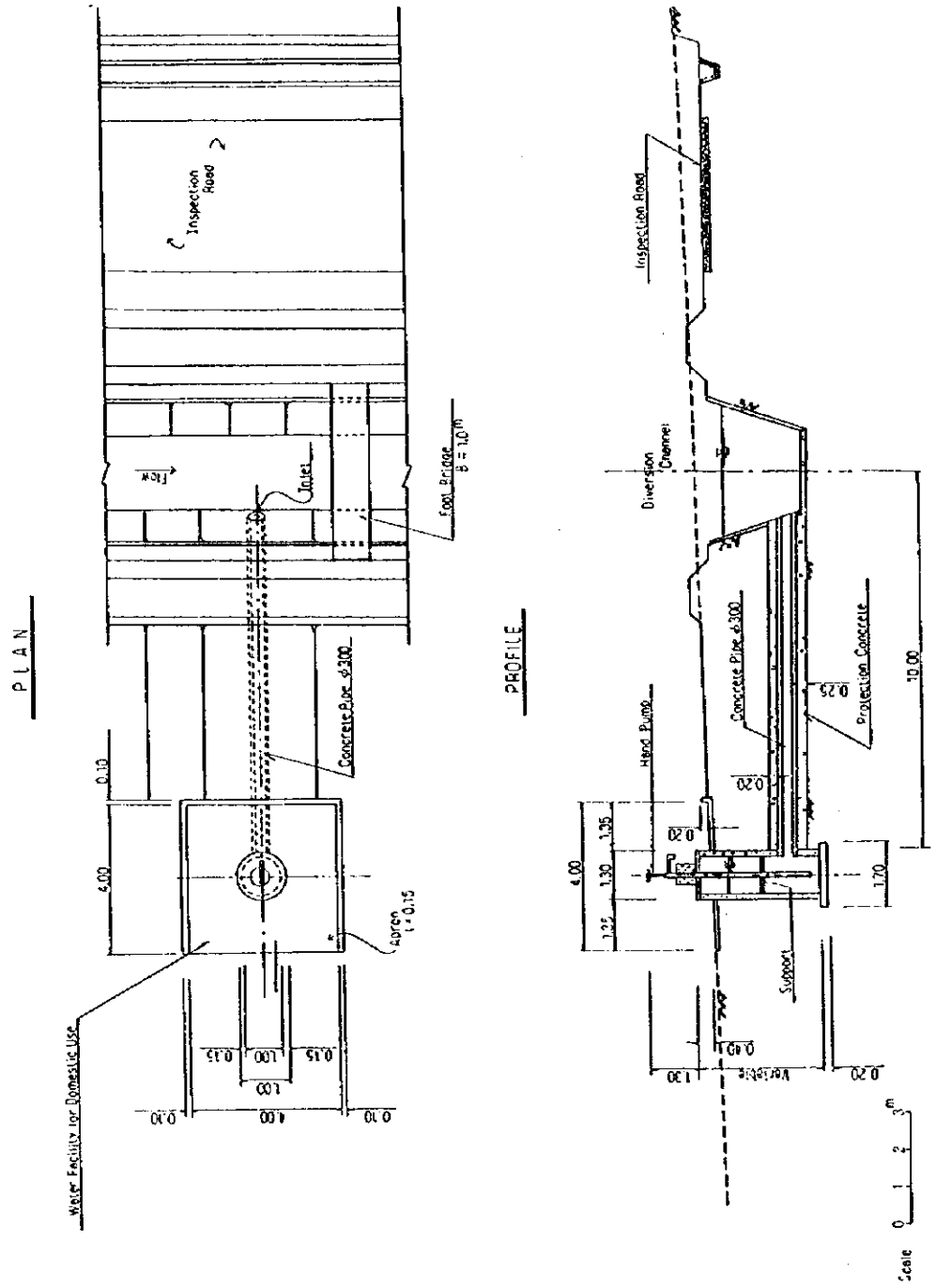

Figure L.4.4

Proposed Water Facilities for Domestic Use

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

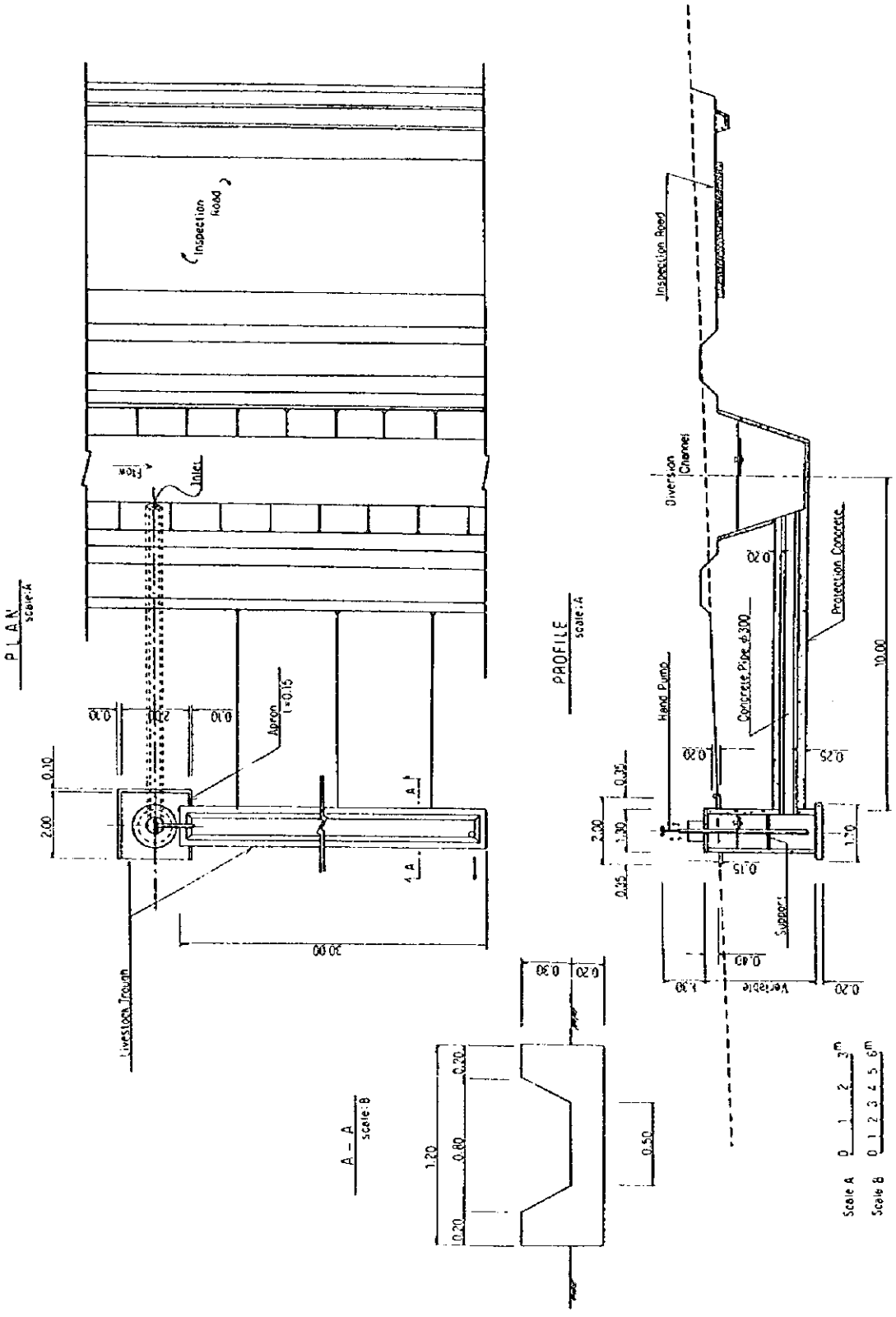

Figure L.4.5
Proposed Livestock Trough

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

ANNEX-M

SMALL-SCALE HYDROPOWER DEVELOPMENT

ANNEX - M

SMALL-SCALE HYDROPOWER DEVELOPMENT

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ANNEX-M

SMALL-SCALE HYDROPOWER DEVELOPMENT

1. INTRODUCTION

This annex deals the small-scale hydropower development plan for the utilisation of the surplus water head created by the diversion channel.

Chapter 2 describes the background, basic concept of the development plan and inquire into the reason of development.

Chapter 3 presents the selection of the No.1 and No.2 powerhouse sites taking into consideration of the topography and geology conditions and the component of power stations.

Chapter 4 and 5 present the preliminary design of both No.1 and No.2 power stations including the civil works design and electro-mechanical equipment.

Chapter 6 states the implementation plan and project cost. The required construction period was estimated at 1.5 years for No.1 power station and 2 years for No.2 power station taking into consideration the work volume. Total project cost including construction cost of hydropower station is estimated at US$ 64million.

Chapter 7 gives the results of economic and financial evalution. These project evaluation shows that the Project with small-scaled hydropower development plan is economically feasible and financially sound.

2. BACKGROUND

The irrigation water abstracted from the Kikuletwa river is carried to the irrigation command area through the diversion channel. The intake water level was set El.813.90 m at headworks and required water level at command area is estimated at El.746.0 m, and head between intaked level and required water level at the command area is 68 m after determination of more economical route of the diversion channel as described in ANNEX-J. The diversion channel has a total length with approximately 24 km, of which 12 km pass a gently sloped tableland(high land area) with ground elevation from EL.840.0 to EL.760.0 m, and then enter into the low land area. On the route of high land area, there found two steep slope portions, one is at 5.35 km point and the other is at 11.65 km point from beginning point of the diversion channel. Estimated heads are approximately 11 m at 5.35 km, and 34 m at 11.65 km points. The structure applied these portions are chute structure and about 45 m of energy head would be dissipated without any use.

On the other hand, the main portion of the electric power for the Kilimanjaro Region is supplied via long-distance transmission lines from major power stations. The Kilimanjaro region is situated at the end of the interconnected power system, so that power supply to the region frequently suffers voltage fluctuations and transmission line faults. In other words, the power supply is not enough and stable.

In order to secure a stable power supply to meet the increasing demand, it is necessary to reinforce power supply sources within the region. From this point of view that it was considered development of hydropower scheme which would utilise the surplus water head created by the diversion channel mentioned above.

The electricity generation using surplus head of the diversion channel would be created much advantages, not only to the Project but also the socio-economy of the Study Area. The generated electricity will be sent to the national grid of TANESCO. Electric charges getting from customers will be paid back to the Project. The budget getting by the electricity generation would be deposited and used for expenditure of O & M cost of the Project. In addition, this electricity generation and electrification for the habitants in the Project Area is much attractive, especially level up of living standard and public welfare.

3. SELECTION OF POWERHOUSE LOCATION

3.1 Topography and Geology of Powerhouse Sites

The power stations to be constructed on the route of diversion channel are determined through the site reconnaissance, considering the topography condition and, geological condition. The proposed station at upstream portion(5.35 km portion) is named No.1 Power Station and downstream one(11.65 km portion) is No.2 Power Station. The location of both stations is shown in Figure M.3.1.

3.2 Preliminary Estimate of Development Scale

The output of a hydropower station was determined by the available head and discharge. The head is mainly governed by the topographical features of intake and tailrace sites. As mentioned above, the effective heads are determined by the water levels of the diversion channel. The firm output for the both stations were preliminary estimated as follows:

Station No.	Effective head(m)	Firm discharge(m^3)	Firm output (kW)	Type of Turbine	Generating efficiency
1	11.0	9.0	730	S. tabular	0.75
2	33.0	9.0	2,330	Fransis	0.80

3.3 Component of Power Station

The both power stations are composed of following structures:

(1) Intake and Headrace:

Intake structure will be provided at the right side of diversion channel with control gate. After intake, headrace will be provided until head tank.

(2) Head Tank:

Head tank will be provided at inlet of penstock. At inlet mouth of penstock, control gate and trash rack will be provided.

(3) Penstock:

Penstock with diameter of 1,800 mm will be installed on the excavated rock bed ground and supported by concrete saddle or protected by the concrete.

(4) Powerhouse:

Powerhouse will be constructed on the excavated rock bed ground. Powerhouse will be of concrete structure and provided machine room, control equipment room, offices and storeroom.

(5) Generating Equipment:

A propeller type turbine will be considered for No.1 station, and a Francis turbine will be considered for No.2 station taking into account the head and firm discharge of both stations.

(6) Outdoor Switchyard

The outdoor switchyard will be constructed at a flat space close to the powerhouse. The

main transformer, switching equipment, protection devices, and other auxiliary equipment will be installed in the switchyard.

(7) Transmission Line

The 33 kV transmission line facilities will be constructed connecting to the Kiyungi Substation from both power stations.

(8) Tailrace

After the powerhouse, the tailrace will be provided to connect the diversion channel.

4 PRELIMINARY DESIGN OF NO.1 POWER STATION

4.1 Hydraulic Condition

(1) Water Level at Head Tank

Water is conducted to the head tank from the diversion channel, STA.No.5 +350 by means of headrace. Water level at head tank is set at El.808.00 m.

(2) Water Level at Tailrace

Water level at the tailrace is estimated at El. 796.55 m calculated from water level of the diversion channel.

(3) Effective Head and Firm Output

The firm output at the time of firm discharge is expressed by the following equation:

$$P=9.8 \times Q \times H \times E$$

where,

P: firm output(kW)
Q: firm discharge(m^3/s)
H: effective head(m)
E: total generating efficiency(0.75)

therefore, firm output of No.1 station is calculated as below.

$$P = 9.8 \times 9.0 \times 11.0 \times 0.75$$
$$= 728 \text{ kW}.$$

4.2 Headrace Channel and Penstock

Structure of headrace is of reinforced concrete structure with 3.5 m wide and 2 m high. Penstock is one line(inner diameter 1,800 mm, length: 10m) connecting to powerhouse. Diameter of penstock is determined considering velocity during operation(2 m/s to 5 m/s). The penstock is to be of welded steel pipe and material will be SM 400(JIS) or equivalent. Penstock is installed underground and protected by reinforced concrete. Both sides of penstock will be excavated to a slope of 1:0.50 and protected with shotcrete. At the connection of powerhouse and penstock, the pipe will be embedded in mass concrete and backfilled with earth.

4.3 Powerhouse

Semi-underground powerhouse will be constructed at the right side of the diversion channel. The location was selected apart from 30 m from the chute structure of the diversion channel to ensure sufficient distance and reduces the length of penstock. Powerhouse is of reinforced construction with approximately 8 m wide and 12 m long. The elevation of turbine center will be EL. 796.40 m, a value determined in consideration of tailrace water level(EL. 796.55 m) and the draft head. The elevation of the erection bay will be EL. 796.00 m in consideration of floor level of turbine. Space will be provided for a control room, a unit of main equipment, an erection bay and overhead travelling crane, 11 kV switching equipment and auxiliary equipment.

4.4 Electro-mechanical Equipment

(1) Number of Main Equipment

Taking into consideration of discharge characteristics between the rainy season and dry

season, and a small part of TANESCO's overall electric power system in the Kilimanjaro region, a single turbine of 730 kW rated capacity was chosen as a main equipment.

(2) Selection of Main Equipment

The specific speed of a turbine is expressed by the following equation:

$$ns = n \times P^{1/2} / H^{5/4}$$

where,
ns : specific speed(m-kW)
H : effective head(m): 11.0m
n : rotating speed(rpm)
p : maximum output(kW) at effective head H (m): 728 kW

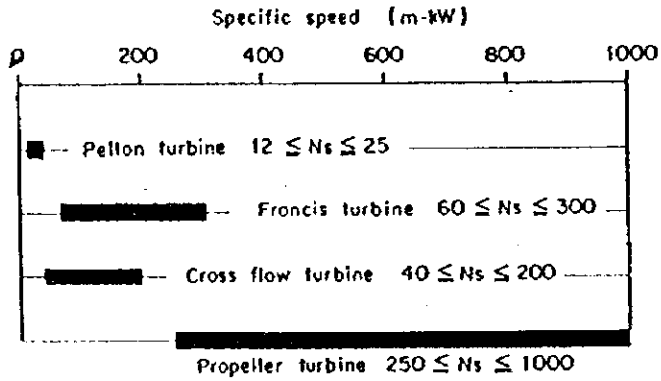
The applicable maximum specific speed of a turbine is:
Ns max $\leqq$ 20,000 / (H+20) + 30 = 675(m-kw)
The rotating speed of the turbine is:
$ns = (Ns\ max \times H^{5/4}) / P^{1/2} = 501.2$ rpm.

The turbine rotating speed should therefore not exceed 501.2 rpm.

The synchronises rotating speed of the generator directly coupled to turbine is 600 rpm, the standard applicable rotating speed at 50 Hz. The specific speed(Ns) of the turbine under such conditions will be as follows:

$$Ns = N \times P^{1/2} / H^{5/4} = 802 \text{ (m-kW)}$$

As below chart indicates, a propeller type best compiles with this specific speed. Therefore, a propeller-type turbine is most suited to satisfying the basic specifications described above. Such turbine may be classified into tubular turbine or Kaplan turbines. For reason of economy and easy operation and maintenance, a horizontal-shaft S-type tubular with fixed-blade runners was selected.



The specifications of main electro-mechanical equipment for the No.1 station are as follows:

1) Turbine

Type	: Horizontal-shaft , S-type tubular turbine
Number of unit	: 1 unit
Effective head	: 11.0 m
Firm discharge	: 9.0m^3/s
Rated capacity	: 720 kW

2) Generator

Type	: 3-phase, AC, synchronises generator
Number of unit	: 1 unit
Capacity	: 850 kVA
Frequency	: 50 Hz

3) Main transformer

Type	: Out-door, 3-phase, self-cooled
Number of unit	: 1 unit
Rated capacity	: 850 kVA
Rated voltage	: 11/33 kV

4.5 Main Circuit

A low-voltage synchronised system for parallel-in of the generator is to be adopted to ensure apply of station service power. The main transformer will be of an outdoor type and will be installed in the outdoor switchyard near powerhouse. The powerhouse and switchyard are to be connected by a circuit of 11 kV overhead line.

4.6 Outdoor Switchyard

The outdoor switchyard is to be constructed at a flat space close to the powerhouse. The main transformer, 33 kV switching equipment, protection devices, and instrument transformers are to be installed in the switchyard. Operation and monitoring of the switchyard will be executed at the control board in the powerhouse.

4.7 Transmission Line

The 33 kV transmission line facility to be newly constructed are outlined below:

Line voltage	: 33 kv
Electrical system	: 3-phase, 3 wire
Frequency	: 50 Hz
Conductor	: Wolf
Insulator	: 33 kV pin type insulator
Line length	: 8 km to Kiyungi sub-station
Support	: Wooden pole

The general layout of the No.1 Power Station is shown in Figure M.4.1 and layout of transmission line is shown in Figure M.4.2.

5 PRELIMINARY DESIGN OF NO.2 POWER STATION

5.1 Hydraulic Condition

(1) Water Level at Head Tank

Water is conducted to the head tank from the diversion channel, STA.No.12+650 by means of headrace. Water level at head tank was estimated at EL.789.3 m.

(2) Water Level at Tailrace

Water level at the tailrace was estimated at EL. 755.5 m calculated from water level of the diversion channel.

(3) Effective Head and Firm Output was calculated in the same manner with No.1 station.

P= 9.8 x 9.0 x 33.0 x0.80
=2,328 kW.

5.2 Headrace Channel and Penstock

Structure of headrace is of reinforced concrete structure with 3.5 m wide and 2 m high. Penstock is one line(inner diameter 1,800 mm, length: 65m) connecting to powerhouse. Diameter of penstock is determined considering velocity during operation. The penstock is to be of welded steel pipe and material will be SM 400(JIS) or equivalent. Penstock is installed on the excavated rock and concrete anchor blocks are to be provided at the bend point of penstock. Both sides of penstock will be excavated to a slope of 1:0.50 and protected with shotcrete. At the connection of powerhouse and penstock, the pipe will be embedded in mass concrete and backfilled with earth.

5.3 Powerhouse

Semi-underground powerhouse will be constructed at the right side of the diversion channel. The location was selected apart from 30 m from the chute structure of the diversion channel to ensure sufficient distance and reduces the length of penstock. Powerhouse is of reinforced construction with approximately 13 m wide and 20 m long. The elevation of turbine center will be EL. 755.5 m, a value determined in consideration of tailrace water level(EL. 755.5 m) and the draft head. The elevation of the erection bay will be EL. 754.2 m in consideration of floor level of turbine. Space will be provided for a control room, a unit of main equipment, an erection bay and overhead travelling crane, 11 kV switching equipment and auxiliary equipment as well as No.1 station.

5.4 Electro-mechanical Equipment

(1) Number of Main Equipment

Taking into consideration discharge characteristics between the rainy season and dry season, and a small part of TANESCO's overall electric power system in the Kilimanjaro region, a single turbine of 2,300 kW rated capacity was chosen as a main equipment.

(2) Selection of Main Equipment

The specific speed of a turbine is expressed by the following equation:

$$ns = n \times p^{1/2} / H^{5/4}$$

where,
ns : specific speed(m-kW)
H : effective head(m): 33.0m
n : rotating speed(rpm)
p : maximum output(kW) at effective head H (m): 2,328 kW

The applicable maximum specific speed of a turbine is:

$Ns\ max \leq 20,000/(H+20) + 30 = 397$ (m-kW)

The rotating speed of the turbine is:

$ns = (Ns\ max \times H^{5/4}) / p^{1/2} = 650.8$ rpm.

The turbine rotating speed should therefore not exceed 650.8 rpm.

The synchronises rotating speed of the generator directly coupled to turbine is 600 rpm, the standard applicable rotating speed at 50 Hz. The specific speed(Ns) of the turbine under such conditions will be as follows:

$$Ns = N \times p^{1/2} / H^{5/4} = 366 \text{ (m-kW)}$$

As shown in chart in 4.4, chart indicates a Francis type best compiles with this specific speed. Therefore, a propeller-type horizontal shaft Francis turbine is to be selected.

The specifications of main electro-mechanical equipment for the No.2 station are as follows:

1) Turbine

Type	: Horizontal-shaft Francis
Number of unit	: 1 unit
Effective head	: 33.0 m
Firm discharge	: 9.0m^3/s
Rated capacity	: 2,300 kW

2) Generator

Type	: 3-phase, AC, synchronises generator
Number of unit	: 1 unit
Capacity	: 2,700 kVA
Frequency	: 50 Hz

3) Main transformer

Type	: Out-door, 3-phase, self-cooled
Number of unit	:1 unit
Rated capacity	: 2,700 kVA
Rated voltage	: 11/33 kV

5.5 Main Circuit

A low-voltage synchronised system for parallel-in of the generator is to be adopted to ensure supply of station service power. The main transformer will be of an outdoor type and will be installed in the outdoor switchyard near powerhouse. The powerhouse and switchyard are to be connected by a circuit of 11 kV overhead line.

5.6 Outdoor Switchyard

The outdoor switchyard is to be constructed at a flat space close to the powerhouse. The Main transformer, 33 kV switching equipment, protection devices, and instrument transformers are to be installed in the switchyard. Operation and monitoring of the switchyard will be executed at the control board in the powerhouse.

5.7 Transmission Line

The 33 kV transmission line facility to be newly constructed are outlined below:

Line voltage	: 33 kv
Electrical system	: 3-phase, 3 wire
Frequency	: 50 Hz
Conductor	: Wolf
Insulator	: 33 kV pin type insulator
Line length	: 3 km to Kiyungi sub-station
Support	: Wooden pole

The general features of No.1 and No.2 power stations are summarised as follows:

Description	No.1 Power Station	No.2 Power Station
1. Hydraulic condition		
-1. Firm discharge(m^3/s)	9.0	9.0
-2. WL. at head tank(m)	808.00	789.30
-3. WL. at tailrace(m)	796.55	755.5
-4. Effective head(m)	11.0	33.0
2. Penstock		
-1. Diameter(mm)	1,800	1,800
-2. Length	10.0	65.0
3. Firm output(kW)	728	2,328
4. Electro-mechanical Equipment		
-1. Turbine		
Type	S-type tubular	Francis
Unit	1	1
Rated capacity(kW)	720	2,300
-2. Generator		
Type	3-p, synchronise	3-p, synchronise
Unit	1	1
Capacity(kVA)	850	2,700
-3. Main transformer		
Type	Outdoor, 3P	Self-could
Unit	1	1
Capacity (KVA)	850	2700
Rated voltage	11 / 33KV	11 / 33KV
-4. Transmission line		
Voltage	11/33 kV	11/33 kV
Length to Kiyungi sub-station	8 km	3 km

6 IMPLEMENTATION PLAN AND CONSTRUCTION COST

6.1 Implementation Plan

The implementation plan of No.1 and No.2 hydropower stations will be prepared considering the effects to regional economy and benefit occurrence in early stage of the project implementation. It is thus proposed that No.1 power station be constructed in the Phase-II stage and No.2 power station in the Phase-I.

The required construction period is estimated at 1.5 years for No.1 power station and 2 years for No.2 power station as shown in Figure M.6.1.

6.2 Construction Cost

Construction cost is estimated under the same condition of other facilities as described in Annex-O. Construction cost of No.1 power station is 2.8 million US$ and No.2 power station is 4.6 million US$. Breakdown of the construction cost for No.1 power station and No.2 power station are given in Table M.6.1 and M.6.2, respectively.

6.3 Total Project Cost

Total project cost including construction cost of hydropower station is estimated at 64million US$ as shown in below table.

Total Project Cost

Work Description	Foreign Currency (1,000US$)	Local Currency (million Tsh.)	Total (1,000 US$)
(1) Phase-I			
-Headworks	2,597	429	3,289
-Diversion channel	8,454	1,485	10,850
-No.2 hydropower station	3,975	369	4,570
-Existing Lower Moshi Area	3,434	892	4,874
Phase-I Total	18,460	3,175	23,583
(2) Phase-II			
-Extension & Expanded Area	11,388	2,616	15,606
-No.1 hydropower station	2,436	201	2,760
Phase-II Total	13,824	2,817	18,366
(3) O&M equipment	1,000	-	1,000
(4) Project administration cost	-	632	1,020
(5) Engineering services cost	4,400	682	5,500
Sub-total (1) to (5)	37,684	7,306	49,469
(6) Physical Contingency	3,768	731	4,947
(7) Price Contingency	3,149	4,197	9,920
(8) Total Project Cost	44,602	12,234	64,336

The disbursement schedule of the project cost is also prepared as shown below.

Disbursement Schedule

Item	Physical Year					
	1998	1999	2000	2001	2002	2003
(1) Construction Cost	0	12,340	11,243	8,371	5,938	4,057
(2) O&M Equipment	0	0	500	0	0	500
(3) Project administration cost	170	170	170	170	170	170
(4) Engineering Service Cost	734	1,393	1,393	660	660	660
(5) Physical Contingency	90	1,390	1,331		677	539
(6) Price Contingency	0	939	1,873	2,251	2,384	2,473
Total	994	16,232	16,510	12,372	9,829	8,399

6.4 Project O&M Cost

O&M cost in each stage of project implementation and respective organizations are estimated as follows:

O&M Cost

Item	1st Stage		2nd Stage	
	KADP	Farmers Organization	KADP	Farmers Organization
Salary for project staff	40.7	-	11.3	12.1
Operation cost of office	22.3	-	11.1	3.7
O&M equipment	29.0	-	2.9	26.1
Labor wage	2.9	4.1	0.2	5.0
Material cost	1.4	1.5	0.4	1.9
Operation cost of power	30.80	-	30.80	-
Total	128.8	5.6	56.7	48.8
Total in each stage	134.4	(US$216,800)=US$46/ha	105.5	(US$117,200)=US$36/ha

6.5 Replacement Cost

Items of replacement cost for hydropower station are hydro-mechanical equipment such as turbine, generator and penstock. Tabulated below are the useful life and its replacement cost.

Replacement Cost and Useful Life

Equipment	Useful Life (year)	Replacement Cost (1,000US$)
(1) Penstock, turbine, generator for No.1 Power Station	50	2,045
(2) Penstock, turbine, generator for No.2 Power Station	50	3,400

6.6 Water Charge

The O&M cost and replacement cost of O&M equipment and electro-mechanical equipment will be collected from the beneficial farmers as a water charge, which will be used for operation, maintenance and management of the Project. The replacement cost of O&M equipment is estimated at US$ 54 /ha. Thus, the water charge comes to US$ 100 /ha at the 1st stage and US$ 90 /ha at the 2nd stage.