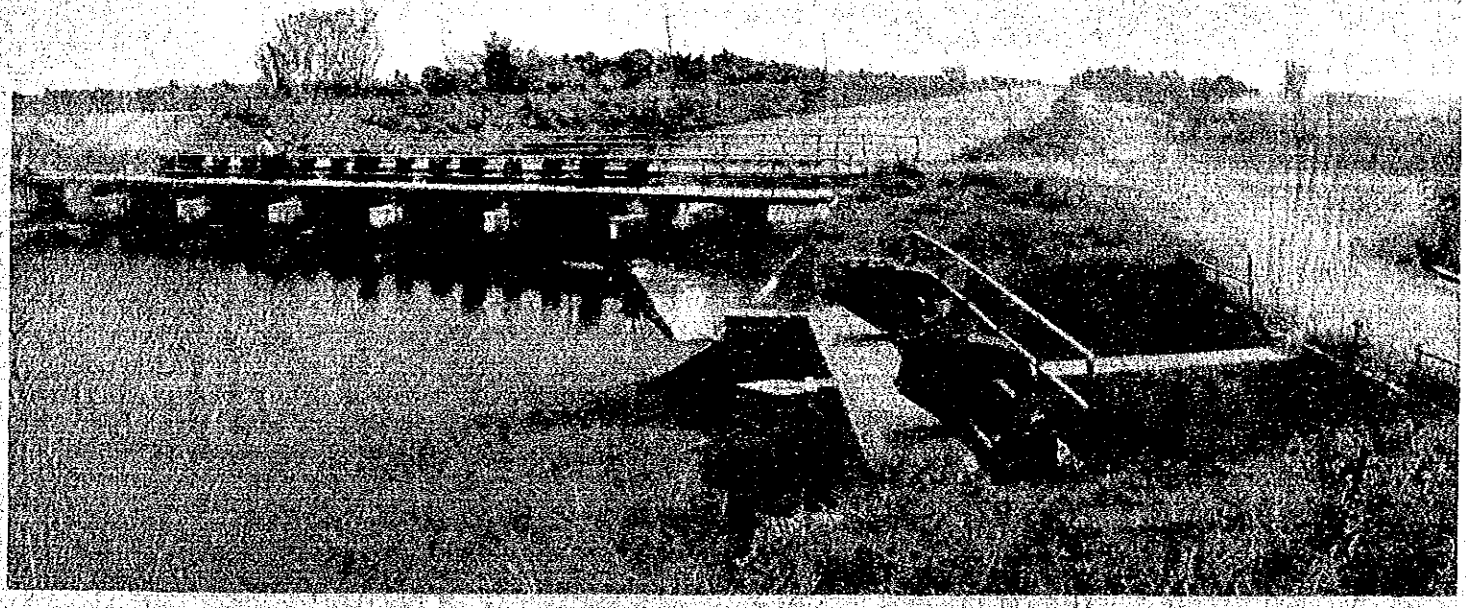
MASTER PLAN STUDY
ON

THE IMPROVEMENT PROJECT OF THE O & M
OF
MAGAT RIVER INTEGRATED IRRIGATION SYSTEM
IN THE
REPUBLIC OF THE PHILIPPINES

O & M MANUAL



JULY, 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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OPERATION AND MAINTENANCE MANUAL FOR THE MAGAT RIVER INTEGRATED IRRIGATION SYSTEM

MAGAT RIVER INTEGRATED IRRIGATION SYSTEM

Cauayan, Isabela

PREFACE

This is the revised edition of the manual which was established on June 1985 as "OPERATION AND MAINTENANCE MANUAL FOR THE MAGAT RIVER INTEGRATED IRRIGATION SYSTEM". The revise was specially made on Chapter III, IV and V for the practical purpose basing on the result of the master plan study on the Improvement Project of the O & M of Magat River Integrated Irrigation System by JICA.

The Magat River Integrated Irrigation System (MRIIS) is composed of the Magat reservoir, three diversion dams, a large number of irrigation canals and three pumping station to supply irrigation water for an area of about 97,400 ha. It also includes hydro-electric power plants with the out put of 360 MW at Magat, 6,000 KW at Baligatan and 2,500 KW at Maris main canal. These facilities had been developed as a project in stage-wise way by NIA since 1960's and was completed in 1983 with total investment of about US$500 million. It is one of the largest irrigation system in the Philippines, and a valuable national property.

This manual introduces the way to maintain the system facilities in the area, to manage irrigation water efficiently and to enhance rice productivity in the Magat area. It presents the organization and management of the irrigation system, the plan and implementation strategies for operation and maintenance, the project's unique approaches in institutional development and the training programs for both the farmers and irrigation personnel.

We look forward this manual will be further improved and availed to the farmers needs not only of the Magat River Integrated Irrigation System, but also of other irrigation system in the country.

July 1987

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ABBREVIATIONS AND GLOSSARY

Abbreviations

ADCC	Agricultural Development Coordinating Council
AMC	Area Marketing Cooperative
ADD	Agricultural Development Division
AE	Area Engineer
AWMT	Assistant Water Management Technicians
BA	Barangay Association
BAEx	Bureau of Agricultural Extension
BAI	Bureau of Animal Industry
BAEcon	Bureau of Agricultural Economics
BCOD	Bureau of Cooperative Development
BFAR	Bureau of Fisheries and Aquatic Resources
BPI	Bureau of Plant Industry
BS	Bureau of Soil
CIADP	Cagayan Integrated Agricultural Development Project
DFIA	District Federation of Irrigators' Association
DT	Ditch Tender
EOD	Engineering and Operation Division
FACOMA	Farm Cooperative Marketing Association
FIG	Farmers Irrigators' Group
GK	Gate Keeper
HEP	Hydroelectric Plant
IA	Irrigators' Association
IDD	Institutional Development Division
IRRI	International Rice Research Institute
ISELCO-I	Isabela - I Electric Cooperative, Inc.
ISELCO-II	Isabela - II Electric Cooperative, Inc.
ISU	Isabela State University
JICA	Japan International Cooperation Agency
KKK	Kilusang Kabuhayan at Kaunlaran
MAF	Ministry of Agriculture and Food
MAR	Ministry of Agrarian Reform
MARIS	Magat River Irrigation System
MFD	Main Farm Ditch
MHS	Ministry of Human Settlement
MRIIS	Magat River Integrated Irrigation System
MRMP	Magat River Multi-purpose Project
MPWH	Ministry of Public Works and Highways
NAPHIRE	National Post Harvest Institute for Research and Extension
NCSO	National Census and Statistics Office
NEA	National Electrification Administration
NEDA	National Economic and Development Authority
NFA	National Food Authority
NIA	National Irrigation Administration

NIS	National Irrigation System
NPC	National Power Corporation
NPGC	Northern Philippines Grains Complex
NWRC	National Water Resources Council
O/M	Operation and Maintenance
PLDT	Philippines Long Distance Telecommunication
PNB	Philippines National Bank
SIFFURIS	Siffu River Irrigation Section
WCCS	Water Control Coordination System
USAID	United State Agency for International Development
USBR	United State Department of the Interior, Bureau of Reclamation
WM	Water Master

Units of Measurement

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer
sq.cm	:	square centimeter
sq.m	:	square meter
sq.km	:	square kilometer
MSM	:	million square meter
l, lit.	:	liter
cu.m	:	cubic meter
MCM	:	million cubic meter
lit/sec	:	liter per second
m/s	:	meter per second
PPM	:	part per million
g	:	gram
kg	:	kilogram
ton, m.t.	:	metric ton
cavan	:	50 kg
EL	:	elevation above mean sea level
MSL	:	mean sea level
FWL	:	full water level
HWL	:	high water level
LWL	:	low water level
sec.	:	second
minu.	:	minute
hr.	:	hour
min.	:	minimum
max.	:	maximum

%	:	percent
No.	:	number
°C	:	degree centigrade
°F	:	degree fahrenheit
Cl	:	chlorine
HP	:	horse power
ET	:	evapotranspiration
N	:	nitrogen
P	:	phosphorous
K	:	potassium
HYV	:	high yielding variety
O & M	:	operation and maintenance
KWh	:	Kilowatt hour
EIRR	:	economic internal rate of return
B/C	:	benefit cost ratio
FY	:	fiscal year
₱	:	Pesos, ₱ = approx. US$ 0.05
$	:	Dollar, US$ = approx. ₱20.5

Conversion Factors

Unit		Comparison	English Equivalent
Unit of Length:			
Millimeter	(mm)	0.001 meter	0.0394 inch
Centimeter	(cm)	0.01 meter	0.3937 inch
Meter	(m)		3.2800 inch
Kilometer	(km)	1,000 meter	0.6213 mile
Unit of Area:			
Square centimeter	(sq.cm)	0.0001 sq.m	0.155 square inch
square meter	(sq.m)		10.764 square feet
Hectare	(ha)	10,000 sq.m	2.471 acres
Square kilometer	(sq.km)	1,000,000 sq.m	0.386 square mile
Unit of Volume:			
Cubic centimeter	(cu.m)		0.061 cubic inch
Liter	(1,000 cu.cm)	0.001 cu.m	1.0567 quarts (liquid)
Cubic meter	(cu.m)	1,000 liters	35.3145 cubic feet
Unit of Weight:			
Gram	(g)		0.0353 ounce
Kilogram	(kg)	1,000 grams	2.2046 pounds
Metric Ton	(mt)	1,000 kg	2,204.6 pounds

Miscellaneous

1 cu.m per second	=	1,000 liters per second (1/s)
	=	35.3145 cu.ft per second (cfs)
	=	15,850 gallons per minute (gpm)
1 liter per second for 1 day	=	8.64 mm depth over one hectare
10 mm depth over 1 hectare	=	1.157 liters per second for 1 day
	=	3,532 cu.ft

Terminology

Project Area	:	Area of 164,800 ha corresponding to the objective area for Magat River Integrated Irrigation System
Service Area	:	Area of 97,400 ha to be benefited by the project
service area	:	Indivitual irrigation area in District, Division IA, FIG and etc.
Province	:	A political subdivision of a country comprising several towns
Barangay	:	A political subdivision of town
Poblacion	:	Political center of town
Monsoon	:	Periodic wind that blows from the sea to the continent and oppositely in winter
Typhoon	:	A storm or system of winds occurring in the Philippines and China Sea regions, known as hurricane in the West India and South Pacific, cyclone in the Indian Ocean
Palay	:	The rice plant which bears a staple cereal, or the cereal itself unhulled. Sometimes called rough rice.
IR58, IR60, IR62:		High yielding rice varieties from the IRRI, Los Baños, Laguna, Philippines
Ganta	:	A common unit of volume for rice equivalent to 2.24 kilograms of milled rice
Bamboo	:	A woody grass with a big hollow in the center of the internodes, growing in groves or clumps reaching a height of 25 meters or more
Nipa	:	Heavy-leafed type of reed used in thatching huts
Share Tenancy	:	A practice where operators rent the land they work and pay as rent a share of the cash or crops grown

Terminology

Carabao	:	The animal that most farmers used for plowing and other farm work. It is about the size of an ox and is similar to the water buffalo in other Asian countries
Fiesta	:	Spanish term for feast, celebrated pompously once a year to honor the patron saint

CHAPTER I. INTRODUCTION

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1.1. Irrigation Development in the Country

Prior to the construction of irrigation systems in the country, most farmers were raising only one rice crop a year. They timed this during the rainy season to utilize available rainfall to irrigate their crops. For the rest of the year, most farms were left idle.

From 1937 to 1964, gravity as well as pump irrigation systems were constructed all over the country. It was during this time that changes occurred in the irrigation scene. Most farmers were able to raise two rice crops a year. Also, the areas placed under irrigation were greatly increased.

In 1957, the Magat River Irrigation System (MARIS) in Isabela was completed to serve about 22,860 ha. For various reasons, however, only about 20,000 ha and 14,056 ha were irrigated during the wet and dry seasons, respectively, for a cropping intensity of 149 percent.

The SIFFU River Irrigation System (SIFRIS) also in Isabela on the other hand, was completed in 1960 and served about 8,365 ha during the wet season and 4,682 ha during the dry season out of its 9,690 ha irrigable area. The cropping intensity therefore was a low 135 percent.

There were other irrigation systems constructed in other parts of the country but their actual irrigated areas is always lesser than their irrigable area. This situation was brought about by the low water supply in the system's main supply rivers during the dry months. The problem of water inadequacy is further aggravated by inadequate distribution and control devices and the absence of

strong farmers associations to manage the distribution and application of irrigation water to the farms. Furthermore, these constructed irrigation systems deteriorated with time significantly decreasing their irrigation capabilities. Meanwhile, the country's population has been increasing at a rate faster than the increase in food production which necessitates the implementation of an extensive irrigation development program.

The year 1967 marked the start of intensive irrigation development in the country. The National Irrigation Administration (NIA) embarked on a crash program of improving the existing irrigation systems and constructing new ones. It rehabilitated the MARIS expanding its irrigable area to 39,610 ha and developed the country's surface water resources.

In 1969, eight (8) water Management Improvement Pilot projects were established and operated in selected irrigation systems in the country. Alternative types of on-farm improvements were developed, tested and recommended. Insights relating to concepts of water control and measurement and intensity of farm level facilities and structures where obtained. With the assistance of foreign lending institutions, multi-purpose irrigation projects were later constructed.

In 1973, the Angat-Magat Integrated Agricultural Development Project (AMIADP) was implemented. The project involved the rehabilitation of the MARIS and the Angat River Irrigation System (ARIS) consisting of 39,610 and 34,000 ha, respectively. In the same year, the NIA, with the technical assistance of the United States Bureau of Reclamation (USBR) and the United States Agency for International Development (USAID) completed the feasibility study of the Magat River Multi-Purpose Project (MRMP). On May 7, 1975, MRMP was created by virtue of P.D. 693.

After this more than twenty (20) foreign - assisted irrigation projects were implemented in the country.

In Region II alone, three big foreign-assisted projects are presently being implemented, namely, MRMP with an irrigable area of 97,400 ha, CHICO River Irrigation Project (CRIP) with a service area of 49,000 ha, and Cagayan Integrated Agricultural Development Project (CIADP) with a potential area of 13,200 ha for a combined service area of 159,600 ha. There are likewise twelve (12) small irrigation systems in Cagayan and Isabela now irrigating 14,231 ha out of their combined irrigable area of 27,767 ha. In addition, several communal and pump irrigation systems in the region irrigates about 58,351 ha out of their almost 84,518 ha potential service area.

All efforts are presently geared toward the improvement and expansion of these existing irrigation systems to cover their entire irrigable area.

With this accelerated irrigation program, the NIA is now faced with the demanding challenge of not only efficiently operating its national, communal and pump irrigation systems serving about 1.6 million hectares but also of carrying out its plan to irrigate 3.0 million hectares by the year 2000 which would mean that by then all the identified potential rice lands in the country shall have been fully irrigated.

1.2. MRMP

The main purpose of the MRMP project is to provide dependable year-round irrigation for about 97,400 ha of rice lands in the provinces of Isabela, Quirino and Ifugao and to generate cheap hydro-electric power.

Its main features are:

1. Dam

Height	:	114 m
Crest length	:	4,160 m
Volume of fill	:	18 MCM of rock and earth

2. Spillway

Width	:	164 m
Length	:	500 m
Discharge capacity	:	30,600 cu.m/sec

3. Reservoir

Store Capacity	:	1.25 BCM
Full supply level elevation (FSL)	:	193 m
Area at FSL	:	45 km^2
Min. supply level elevation (MSL)	:	160 m
Live storage (Elev. 193 - 160 m)	:	820 MCM

4. Power Facilities

Installed capacity	:	360 MW
Additional capacity	:	180 MW
Total capacity	:	540 MW

5. Diversion Tunnels

Number	:	2
Diameter	:	12 m

6. Irrigation Service Area : 97,400 ha

7. Provision for domestic and industrial water supply, flood control, recreation and fish conservation.

Due to its complexity, MRMP was implemented by stages:

a. Stage I - involves the rehabilitation and upgrading of the Magat and Siffu River Irrigation System, with a combined area of 52,000 ha and the generation of an additional 23,000 ha for a total irrigable area of 75,000 ha.

Stage I is further subdivided into two stages:

Stage Ia which involves the rehabilitation and upgrading of the AMIADP-MPO service area of 40,000 ha and Stage Ib which involves the modification of the MARIS and SIFRIS dams, the upgrading of 12,000 ha in the two systems and the generation of 23,000 ha.

b. Stage II - the construction of the Magat Storage Dam, the Baligatan Diversion Dam and the power plant.

c. Magat III - involves the construction of irrigation facilities and structures for an additional 22,000 ha, 8,000 ha of which is served by pumps.

At full development of the project, rice production would reach 897,599 tons/annum. This increased farm activity would generate additional 8.5 million man-days of farm labor annually. On the other hand, the estimated rice import net savings would amount to US$ 27M per year.

About 67,444 farm families and 21,304 non-farm families with an estimated total population of 425,085 will be directly and indirectly benefited after objectives are met.

Heavy internal migration into the project area together with the full implementation of the Agrarian Reform Program resulted to the fragmentation of land. Average farm size in 1983 as 2.10 ha compared to 2.90 ha in 1976 and 3.19 ha in 1972. The average farm size is estimated to be further reduced to 1.86 at full development.

The Ilocanos dominate the area (64%), Ranked second are the Tagalogs (14%) followed by the Ibanags, Yogads, Pangasinanses, Ifugaos and Pampangueños. Crop production practices are expected to improve due to the transfer of farming technology from one ethnic group to another.

Illiteracy rate in the service area is generally low (8%). Farmers who have not undergone any formal education composed mainly of the aged farmers.

1.3. MRIIS

By the time the project will be completed in 1985, the shift in management's priority will be from construction to operation and maintenance. This aspect is considered complex because it will involve the operation and maintenance of two big National Irrigation Systems, three pump irrigation systems, small check dams, the Baligatan Diversion dam, the Magat High Dam and its reservoir. All operation and maintenance activities will then be closely coordinated and periodically evaluated to minimize problems in the post project operation. It is therefore necessary to integrate all these activities under one management hence the MRMP will be known as the Magat River Integrated Irrigation System (MRIIS) after project completion to be under the supervision of an Operation Manager.

1.4. Objectives

The general objective in putting up this O & M Manual is to provide irrigation personnel of MRIIS with easy reference and/or guide in carrying out their varied duties and responsibilities.

Its specific objectives are:

1. To present the management scheme of the system for possible adoption nationwide especially in irrigation systems with similar situation/features as that of MRIIS.
2. To develop an ideal cropping pattern for MRIIS .
3. To familiarize WM, AEs and other O & M Personnel with basic water management variables and the methods and techniques of estimating the irrigation diversion requirement of an area.

4. To present the methods and techniques of discharge measurement and evaluation of systems performance.

5. To develop an Operation Rule Curve for the Magat Reservoir

6. To present the systems program on institutional development and the approaches being implemented.

7. To provide management with ready training syllabus on the different aspects of O & M.

8. To appraise field personnel of the basic requirement for canal maintenance as contained in NIA's existing guidelines/circulars.

9. To present the different methods of water distribution and application to improve system's irrigation efficiency.

10. To provide WMs with practical guide in measuring areas of field lots for billing purposes.

1.5. Purpose and Scope

1.5.1. Purpose

Primarily, this O & M Manual was prepared to serve as reference and/or guide for MRIIS Personnel in carrying out their duties and responsibilities relative to the Operation and Maintenance of the System.

Secondly, it aims to present the management scheme and operation strategies of the project for possible adoption nation-wide especially in irrigation systems with similar situation/features.

In the course of its utilization, valid suggestions and comments shall be adopted for inclusion in the periodic revisions to make it more responsive to the goals/objectives of the integrated system.

1.5.2. Scope

This manual discusses in detail the organization and management of the Magat River Integrated Irrigation System and its operation plan and implementation strategies.

Chapter I presents the development of irrigation in the country, the construction of the MRMP and the benefits that is expected to be derived from the project at full development.

Chapter II presents the organizational structure of MRIIS, the scheme of management to be adopted, the functions of offices and the responsibilities of personnel.

Chapter III tackles the operation plan and implementation strategies. Detailed guidelines in the preparation of cropping pattern/calendar and in the allocation/distribution/measurement and control of irrigation water are discussed. Likewise, reservoir regulation techniques as well as reservoir analysis were included. The topic on Billing and Collection was not extensively discussed because there is already a manual prepared by the NIA Central Office being adopted nationwide. Only a brief discussion on strategies of improving efficiency of collection are therefore presented. Reports, reporting system and monitoring and evaluation with emphasis to the "M" curve is also included in this chapter.

Chapter IV covers the maintenance and repair activities. The types and kinds of activities and the frequency of implementation was discussed including the strategies of reducing cost by way of transferring some O & M responsibilities specifically canal clearing to strong farmers organizations.

Chapter V set centers on the institutional development of water beneficiaries for it is recognized that the water users play a vital role in the effective and efficient utilization of irrigation water and irrigation facilities.

Chapter VI covers the manpower development program to improve performance of irrigation personnel and farmer-clienteles. Complete training designs for selected levels of participants were prepared and presented in this chapter.

CHAPTER II. ORGANIZATION AND MANAGEMENT

CHAPTER II. ORGANIZATION AND MANAGEMENT

2.1. Name of System

The name of system is the Magat River Integrated Irrigation System (MRIIS) and has its principal office at Minante, Cauayan, Isabela. The MRIIS integrates the Operation and Maintenance of the Magat River Irrigation System, the Siffu River Irrigation System, the three pump stations and the Magat Dam and Reservoir.

2.2. Location and Area Coverage of District

The integrated system is divided into districts to decentaralize the implementation of its activities. District I covers the southern portion and has a service area of about 24,054 ha. Its principal office is at Batal, Santiago, Isabela, which is the former office of Division I, District II covers the western portion of about 24,468 ha and occupies the present NIA Office at San Mateo, Isabela. District III is based at San Manuel, Isabela and covers the northern portion of about 24,793 ha. The eastern portion of the service area with about 24,087 ha is covered by District IV, which is based at Cauayan, Isabela.

For an efficient operation and maintenance of the Dam and Reservoir, a Dam and Reservoir District is established. Its main responsibility is the safe operation and the maintenance of the Magat Dam and all its appurtenant structures and facilities. The District has its office at Ambatali, Ramon, Isabela.

2.3. Staffing Pattern and Management Scheme

The integrated system is headed by an Operation Manager who receives instructions and orders directly from the Assistant Administrator for Operations. The system functions as an organization independent from the NIA Regional Office.

The Operations Manager is supported by four (4) Staff Divisions who undertake the planning, programming, monitoring and evaluation of the systems activities and the care and maintenance of NIA properties. These are the Engineering and Operations Division, the Equipment Division, the Administrative Division which are all based at Cauayan and the Institutional Development Division which is based at Echaque, Isabela.

The implementation of all system's operation and maintenance activities are the responsibility of the four districts which are each headed by District Manager.

2.4. Agricultural Development Coordinating Council (ADCC)

The important roles played by other government and private agencies in the agricultural development of the area has been recognized since the inception of the AMIADP. The Agricultural Division of AMIADP worked for the organization of a council whose members are heads of agricultural agencies/companies as early as 1973. In 1974, the Agricultural Development Coordinating Council (ADCC) was formally organized with the objective of coordinating and synchronizing agricultural activities in the project area. The Provincial Governor of Isabela was named permanent honorary chairman while the Assistant Project Manager of AMIADP acted as the Chairman.

When MRMP was implemented, the same ADCC was maintained, revitalized and expanded with the Project Manager of MRMP as the Chairman. After project completion, the Council will be further strengthened by encouraging other agencies to participate to make it more responsive in meeting the complex problems of the integrated irrigation system. The Operations Manager of MRIIS now acts as the Chairman.

2.5. Functions and Responsibilities of the Different Offices

The main functions of MRIIS is the operation of the Magat Dam and Reservoir, MARIS Dam and Siffu Dam and the three pump stations in order to provide year-round irrigation to about 97,400 ha and attain the maximum level of production in the area.

2.5.1. Office of the Operation Manager

The Operation Manager is charged with the responsibility of planning, directing and supervising the implementation of all activities involved in the operation and maintenance of the integrated system as well as in the supervision, direction and control of personnel, preparation of budgets and all other functions pertaining to the efficient administration of the system.

He shall likewise have general supervision over the preparation, implementation and revision, if necessary, of irrigation and cropping schedules as well as the billing and collection of irrigation fees, proper utilization and maintenance of vehicles, agricultural, pump and hydrologic equipment and other office facilities.

He shall, as the Chairman of the ADCC, also conducts regular as well as special meetings of the Council.

It shall also be his responsibility to study, prepare and implement short and long range development/improvement plans for the system to accelerate the attainment of the desired benefits.

2.5.2. Engineering and Operations Division

The Engineering and Operations Division shall consist of three sections, namely, Operation Section, Engineering Section and Water Control Coordinating Section.

The Division shall assist the Operations Manager on the following activities:

a. Planning, programming and scheduling of water deliveries, areas to be irrigated and periodic irrigation diversions in all supply canals.

b. Monitoring and evaluation of daily discharges, local flows, rainfall, weekly progress of farming activities and allocation of weekly irrigation requirements to all service canals.

c. Reservoir operation analysis and regulation.

d. Supervision of the operation of the MARIS and Baligatan Diversion Dams for the efficient allocation of irrigation water to the Districts.

e. Planning, programming, scheduling and implementation of major and minor repairs and rehabilitation works and the routine maintenance in the system.

f. Evaluation of operation and maintenance as well as construction activities undertaken by the District offices.

g. Preparation and submission of all periodic and routine Operation and Maintenance report required by the Central Office.

h. Coordination with the Institutional Development Division on matters pertaining to agri-institutional activities.

i. Other activities that may be required for the efficient operation and maintenance of the integrated irrigation system.

2.5.3. Institutional Development Division

The functions of the Institutional Development Division are the following:

a. To undertake the organization and development of farmers into Irrigators Associations (IAs), assist the IAs in the management of their projects and periodically evaluate their progress of development.

b. To assist in the preparation of cropping pattern and irrigation calendar and in the implementation of operation and maintenance activities of the system.

c. To plan, schedule and supervise the conduct of trainings for farmers.

d. To undertake the monitoring and evaluation of all agricultural information needed in the planning and programming of agricultural development in the system.

e. To plan and coordinate the implementation of agricultural programs with other agencies.

f. To conduct regular and special meetings of the ADCC.

g. To perform other related activities that may be assigned by the Operation Manager.

2.5.4. Administrative Division

The Administrative Division provides administrative services for the system related to personnel, records and property management, accounting, procurement, cashiering and related services. It shall prepare guidelines/procedures for the implementation of administrative rules and regulations.

It likewise directs the study and implementation of personnel program such as recruitment, selection and placement, promotion plans, incentive awards, and performance rating.

The Division also undertakes records management for the system and liaisoning works with the GSIS, CSC, etc. pertaining to administrative matters.

It is also responsible for the safekeeping of personnel records, equipment, supplies and other government properties owned by the system.

2.5.5. Equipment Division

The Equipment Division is responsible for the planning and programming of the proper utilization of all NIA vehicles and equipment. It undertakes the systematic transfer and movement of equipment and vehicles to the Districts as may be needed as well as the scheduling of repair and maintenance of the system.

2.5.6. Functions of the District Office

The territorial boundaries of the system is divided into four districts, namely, District I, District II, District III and District IV. Each of these Districts is headed by a District Manager who is responsible on the following activities.

a. Preparation of derivative irrigation plans based on the system's plan for implementation in the District.

b. Implementation of plans and programs on the efficient operation and maintenance of the districts like:

   - the equitable distribution of irrigation water to all laterals/sub-laterals

   - the proper maintenance of all irrigation facilities, structures and discharge measuring devices.

   - the timely distribution of irrigation bills and the collection of irrigation fees

   - the strengthening of organized IAs

   - the repair and rehabilitation of damaged facilities and structures.

c. Submission of reports on rehabilitation, repairs, calamity damages and other construction works undertaken in the district that may be required from time to time.

d. General supervision of all other activities in the District that may be required from time to time.

For purposes of decentralizing the implementation of planned operation, maintenance and institutional development activities, the District is further sub-divided into area. Each area covers from 8,000 to 12,000 ha and is headed by an Area Engineer. The Area Engineer is supported by Water Master (WM) who manage an area of not less than 750 ha, and Gate Keepers and Ditchtenders who undertake the routine adjustment of gates and maintenance of the canals, respectively.

The Dam and Reservoir District is responsible for the safe operation of the Magat Dam and the maintenance of all its appurtenant structures and facilities. It is responsible for the immediate release of periodic irrigation diversion requirements as well as the reduction of supply as may be required. The detailed function of this district is contained in the Operations Manual prepared specifically for the Dam by the Central Office.

2.6. Responsibilities of Personnel in the District

2.6.1. Responsibilities of the Area Engineer

As head of the Area, the Area Engineer supervises the implementation of planned operation and maintenance as well as the institutional activities in his coverage. He performs the following activities:

a. Prepares and submits irrigation and crop schedules

b. Coordinates with all concerned system personnel regarding the timely releases of irrigation water based on approved cropping pattern and irrigation schedules.

c. Prepares, analyzes and consolidates daily reports for his routine use and submits regular and special reports to through District Manager.

d. Coordinates with the IA Advisors regarding the organization and development of Irrigators Association in his area coverage.

e. Settles farmers disputes elevated to him by the WM on matters pertaining to water use.

f. Coordinates with the Technicians of various government and private agencies regarding promotion and development of agricultural activities in his area.

g. Plans and undertakes the efficient utilization of Area facilities assigned to him.

h. Prepares annual maintenance programs and request for budget and equipment for his area.

i. Studies and plans the improvement works within his area.

j. Performs other related activities that may be assigned to him by the District Manager.

2.6.2. Responsibilities of the Hydrologist

The Hydrologist is responsible for the conduct of the following activities:

a. Installation of discharge measuring devices in all major inflow and outflow points in the District.

b. Calibration of discharge at the headgates of canals and major drains.

c. Preparation of discharge rating tables.

d. Periodic checking of discharge and updating of discharge rating tables.

e. Routine checking and monitoring of discharge in canals for efficient water allocation and distribution.

f. Maintenance of all discharge measuring devices, hydrologic equipment and hydro-meteological stations in the District.

g. Computation and analysis of hydro-meteorological data.

2.6.3. Responsibilities of Water Master (WM)

a. Supervises the proper utilization and maintenance of canals and structures in his area coverage.

b. Undertakes bill distribution and collection of irrigation fees.

c. Assists IAs/FIGs in the implementation of on-farm irrigation water management. Specifically, he will:

- Coordinate with the IA/FIG leaders regarding the implementation of cropping pattern and irrigation calendar.

- Prepare and supervise the implementation of water management and maintenance program in the IA/FIG.

- Mediate farmers' disputes concerning water allocation and distribution.

- Schedule and conduct regular IA/FIG/Barangay meetings to discuss operation maintenance and agri-institutional activities in his area.

- Coordinate with the IA/FIG leaders regarding the repair and/or rehabilitation of damaged irrigation structures or canals.

d. Submits the following reports to the Area Engineer:

- Weekly progress of farming activities.

- Irrigated, planted and benefited lots, harvest reports, crop damages, recommended lots for exemption, periodic collection performance and other reports required.

e. Assesses the progress of implementation of agri-institutional activities in his area.

f. Performs other duties that may be assigned by the Area Engineer.

2.6.4. Responsibilities of the Gate Keepers (GK)

Under the direction of the Area Engineer/WM, he performs the following tasks:

a. Operates headgates, turnouts gates and checks gate within, his area of jurisdiction.

b. Patrol canals, observes and records discharges in laterals, sub-laterals and turnout.

c. Prepares and submits reports to Area Engineer.

d. Cleans and removes debris in canals, turnouts and measuring devices.

e. Distributes irrigation bills, campaigns for the collection of and collects irrigation fee.

f. Performs other related duties that may be assigned by the Area Engineer.

2.6.5. Responsibilities of the Ditchtender (DT)

Under the direction of the Area Engineer/WM, he undertakes the following activities:

a. Maintains canal in accordance with the provision of MC 70 s.72.

b. Patrols canals and submits reports on damages and repair/maintenance works undertaken.

c. Distributes irrigation fee bills, campaigns for the collection of and collects irrigation fees.

d. Performs other related duties that may be assigned to him by the Area Engineer/WM.

2.7. Qualifications of Personnel

2.7.1. Area Engineer (AE)

The Area Engineer must be either a graduate of Bachelor of Science in Civil or, Agricultural Engineering with experience in operation and maintenance works.

2.7.2. Assistant Water Management Technician (AWMT)

The AWMT must be a college graduate, preferably in Agriculture, from a recognized college or university and must have experience in operation and maintenance works.

2.7.3. Water Master (WM)

Must be high school graduate and have combination of training and experience in the operation and maintenance of irrigation systems.

2.7.4. Gate Keeper (GK)

A high school graduate shall be the qualification of a gate keeper. He must at least have passed an oral and written examination to be given by the District Manager for the purpose. He must preferably by residing in the barangay nearest his area of assignment.

2.7.5. Ditchtender (DT)

The Ditchtender must at least be a high school graduate and must be a resident of the barangay covering his area of assignment.

CHAPTER III. OPERATION PLAN AND IMPLEMENT STRATEGIES

CHAPTER III. OPERATION PLAN AND IMPLEMENT STRATEGIES

3.1. Cropping Pattern and Calendar

3.1.1. Present Cropping Pattern

The total projected Service Area in MRIIS is 97,400 ha, but actual irrigation area in 1985 is about 71,000 ha, and paddy is the major crops for both wet and dry seasons. Figure 3-1 presents the actual cropping calendar prevailing in the Service Area, while standard cropping pattern proposed in the existing O/M Manual is illustrated in Figure 3-2. As is seen in Figure 3-1, however, there exists a log time of farming activities ranging about four months between up and downstream area, due to several integrated factors such as water allocation, available labor force, farmers' financial reasons, NFA's warehouse capacity, etc.

As a result, cropping calendar seems to take year-round which brings such problems as; i) increased pest infection due to the availability of host plants of rice pests throughout year, ii) decreased soil bearing capacity which make inefficient the farm operation, iii) poor paddy quality of delayed harvest in wet season, and iv) waste of irrigation water by the prolonged irrigation period of land preparation from land soaking to final harrowing.

MRIIS O/M Office intends to improve gradually this present cropping calendar to the standard one by means of a proper and stable water supply from the Magat reservoir. However, the comprehensive improvement of operation and maintenance in MRIIS is indispensable to attain the amendment of the present cropping calendar.

FIGURE 3–1. PROJECTED AND ACTUAL CROPPING CALENDAR (C/Y 1984 – 1985)

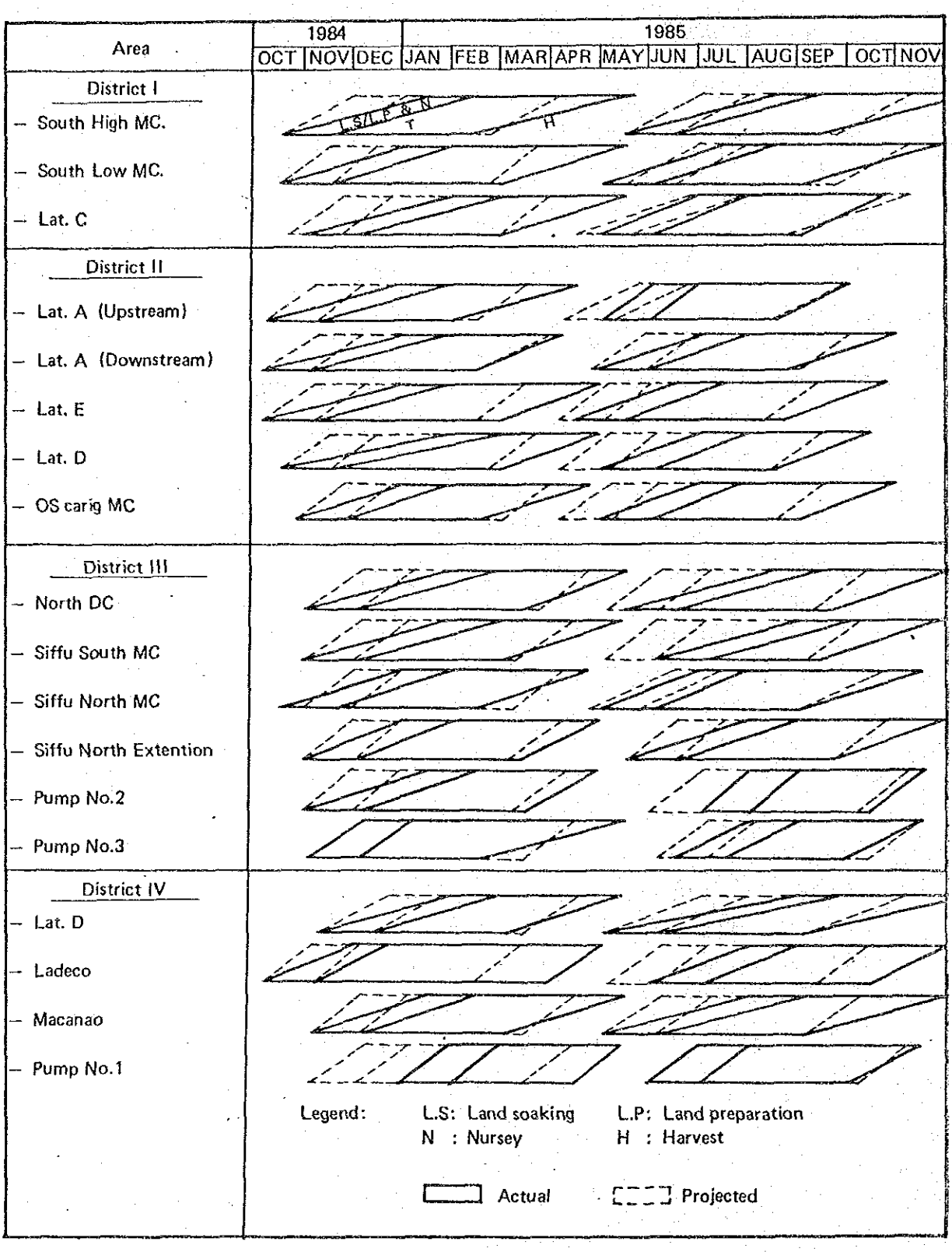
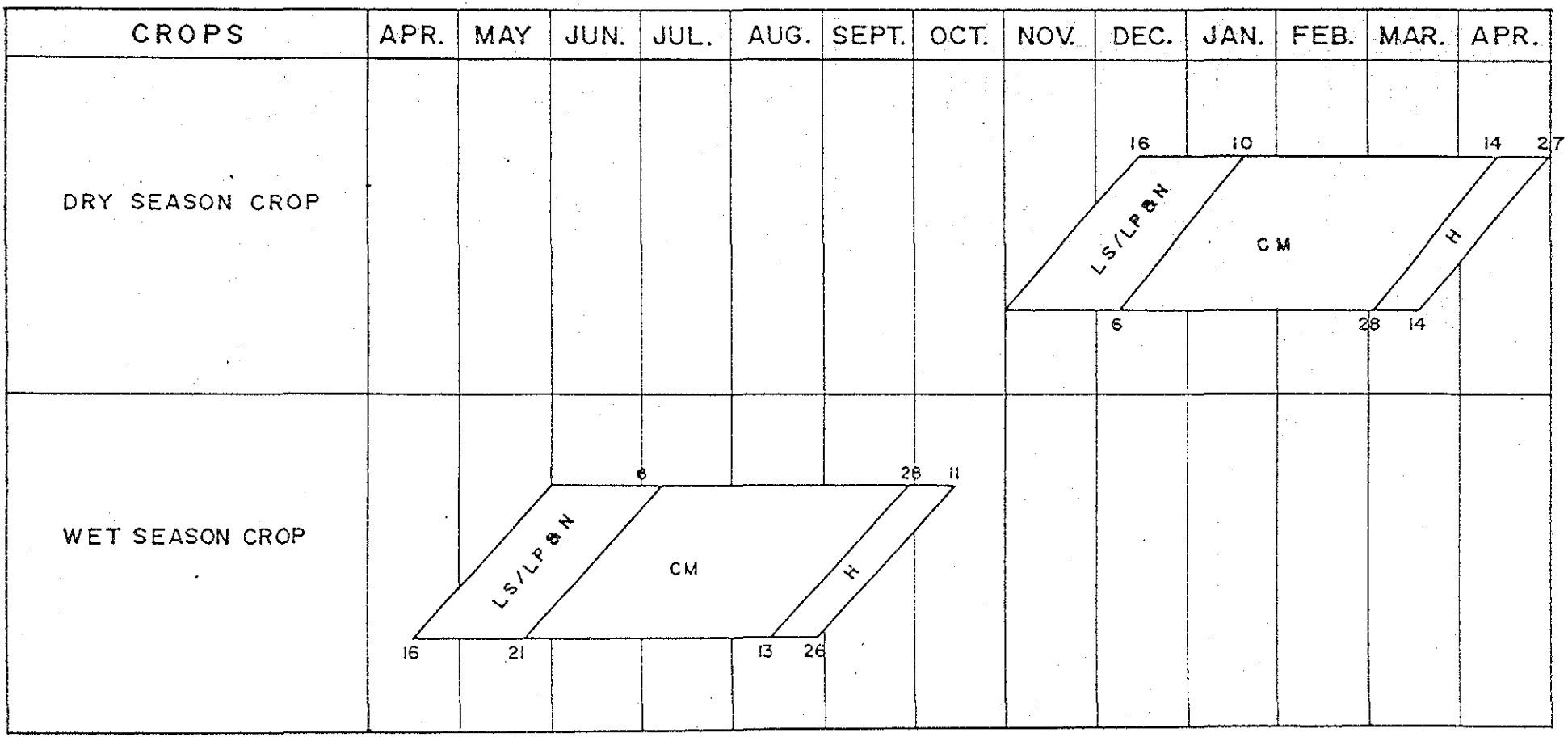


FIGURE 3–2. PROPOSED CROPPING PATTERN AND CALENDAR



LS — LAND SOAKING
LP — LAND PREPARATION
N — NURSERY
CM — CROP MAINTENANCE
TD — TERMINAL DRAINAGE
H — HARVESTING

SOURCE: OPERATION AND MAINTENANCE MANUAL FOR THE MAGAT RIVER INTEGRATED IRRIGATION SYSTEM

3.1.2. Proposed Cropping Pattern and Schedule

According to the collected data on the suitable rice varieties from BPI research institutions, the growing period of recommendable varieties is 100 to 125 days from sowing works to harvesting for the transplanted paddy. Therefore, same durations of land soaking/preparation, crop maintenance to those in the existing MRIIS O/M Manual, that is, 35 days and 84 days respectively, are taken to prepare the standard proposed cropping pattern.

An appropriate combination of cropping schedules in time and space anywhere in the Service Area was examined to obtain the most suitable distribution of reservoir water, so as to expect the optimal use of storaged water for the dual purposes of irrigation and power generation.

Starting from the prototype cropping schedule given in the existing MRIIS O/M Manual, and making a comparison between seasonal water requirement for power generation projected by NPC and irrigation demand, a combination of cropping patterns were proposed in consideration of the following;

- To expect efficient utilization of the Siffu river runoff especially in wet season, cropping schedule for the Siffu service area for both the wet and dry crops should be shifted about 30 to 40 days afterward.

- Cropping schedule for the service area of the Baligatan diversion dam should also be recommendable to be shifted afterwards in order to expect higher yield of generator outputs by use of irrigation release while the reservoir keeps relatively elevated water levels, and to reduce the burden for the reservoir by means of utilizing wet season discharge as much as possible.

- The North Diversion main canal service area, involving the Siffu East Extension area, should also be the subject for shifting its cropping schedule. Especially for service areas of the Siffu East Extension where irrigation water is supplied by pumping up, it may inevitably be advantageous to be planted during such period that much effective rainfalls are expected on the field and that electric charge are relatively cheap.

Figure 3-3 presents the prototype standard cropping pattern and the proposed cropping schedule thus obtained is given in Figure 3-4.

FIGURE 3-3. PROTOTYPE AND ALTERNATIVE CROPPING SCHEDULE

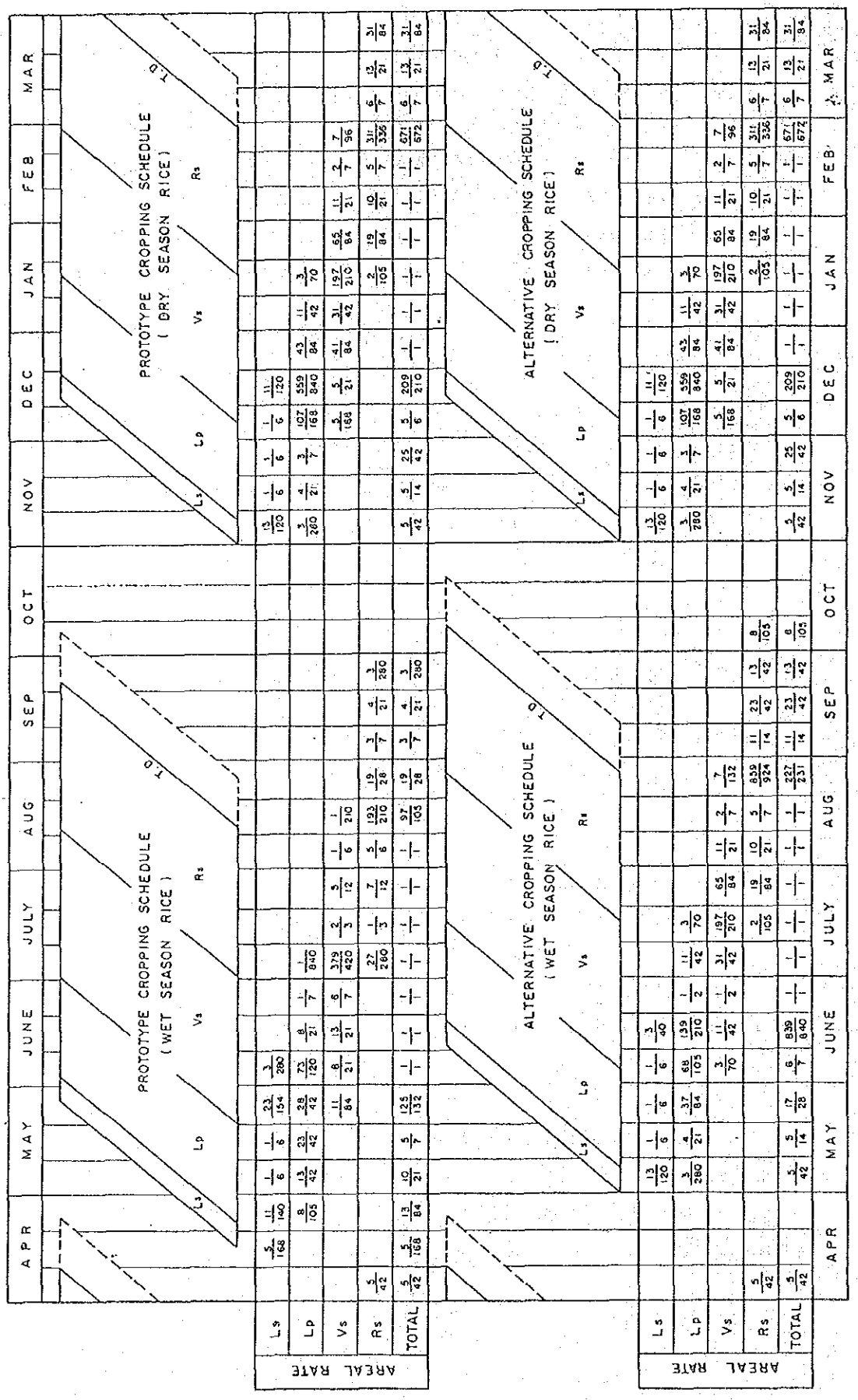
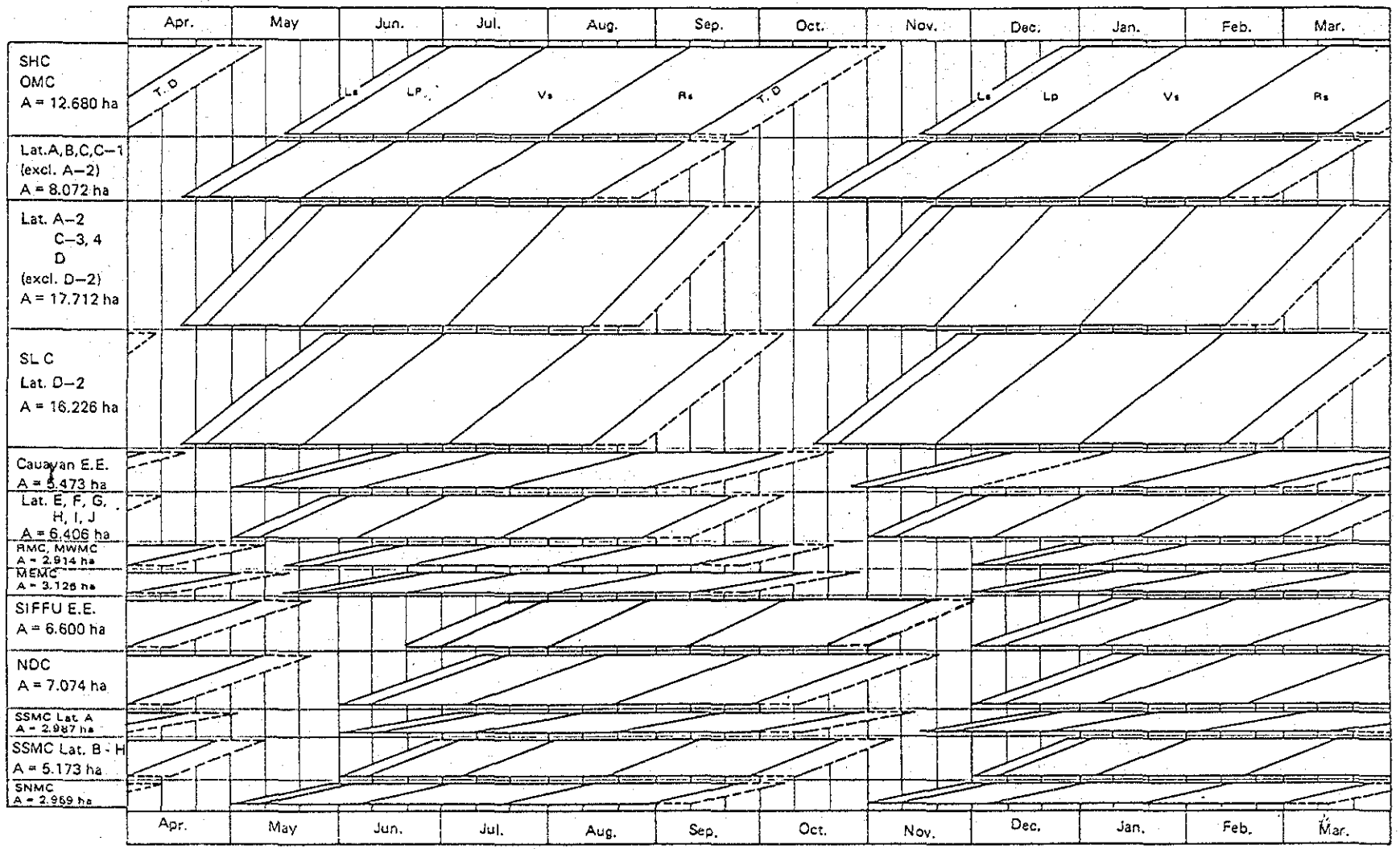


FIGURE 3–4. PROPOSED CROPPING SCHEDULE



3.2. Estimation of Irrigation Service Area

3.2.1. Determination of Service Area

Determination of irrigation service area for each cropping season prior to start the water supply is the most basic works to estimate the required irrigation water requirement in the lateral base. Such works should be made about two months before the commencement of paddy cultivation.

The areas classified into four growing stages as shown in Form 3-1 and 3-2 would be estimated at the basis of Irrigation Block as illustrated by O/M Drawing No.23 to No.26, "Irrigation Flow Diagram", by the Water Master (WM) with the cooperation of member of Irrigators' Association. These estimated irrigation areas would be summed up on the basis of lateral canals by District Offices and transferred to the MRIIS O/M Head Office to estimate weekly total irrigation areas at each diversion dam sites.

3.2.2. Preparation of Irrigation Block

From the results of above estimation, irrigation flow diagram by each Irrigation Block indicating proposed maximum irrigation area and related discharge would be prepared by MRIIS O/M Head Office at each cropping season.

FORM 3–1. PROPOSED WEEKLY CROPPING AREA FOR WET SEASON PADDY (19)

District:

Lateral: (unit: ha)

Irrigation Block	Growing Stage	APR.				MAY				JUN.				JULY			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
(ha)	LS																
	LP																
	VS																
	RS																
	FL																
	Total																
	Accum. Area																

Irrigation Block	Growing Stage	AUG.				SEPT.				OCT.				NOV.			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
(ha)	LS																
	LP																
	VS																
	RS																
	FL																
	Total																
	Accum. Area																

LS: Land Soaking

LP: Land Preparation

VS: Vegetative Stage

RS: Reproductive Stage

FL: Fallow Land

FORM 3-2. PROPOSED WEEKLY CROPPING AREA FOR DRY SEASON PADDY (19)

District:

Lateral :

(unit: ha)

Irrigation Block	Growing Stage	OCT.				NOV.				DEC.				JAN.			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
(ha)	LS																
	LP																
	VS																
	RS																
	FL																
	Total																
	Accum. Area																

Irrigation Block	Growing Stage	FEB.				MAR.				APR.				MAY			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
(ha)	LS																
	LP																
	VS																
	RS																
	FL																
	Total																
	Accum. Area																

LS: Land Soaking
LP: Land Preparation
VS: Vegetative Stage
RS: Reproductive Stage
FL: Fallow Land

3.3. Hydrological Data and Its Utilization

3.3.1. Hydrological Data

Hydrological and meteorological data to be collected are as follows;

1) Daily rainfall at various stations in the service area and in the drainage basin of the Magat and Siffu rivers.

2) Operation record of the Magat reservoir, diversion dams and weirs

   - Magat reservoir
     Reservoir water stage, inflow into and outflow from the reservoir through the Magat and Baligatan Power Plant

   - Diversion dams and weirs
     Water level, intake discharge to main canals and spillages

3) Other meteorological data at representative stations, inclusive of:

   - Daily mean, maximum and minimum air temperature
   - Daily mean, maximum and minimum relative humidity
   - Daily pan-evaporation
   - Daily wind speed and direction
   - Daily sunshine hours or cloudiness
   - Hourly record of reservoir and diversion dam operation during typhoon/heavy storm

Above data are to be observed and collected in the form of attached Farmat sheets, Form 3-3 to 3-12 by a hydrologist in the District, and submitted to WCCS, MRIIS Head Office through District Manager.

3.3.2. Utilization of Data

Hydro-meteorological data thus concentrated into WCCS are inputted into and compiled by the computer systems to expect computer application involving the following subjects;

1) Data management system for hydro-meteorological data storage, processing and retrieval.

2) Publishing monthly, semiannual and annual meteorological and hydrological reports.

3) Analytical study on irrigation and drainage problems.

4) Periodical revision of the existing (proposed) reservoir operating system aiming at updating operation rules during floods and droughts.

5) Optimization of irrigation schedule taking into account the combined effects of soil type, land availability, water resources, cropping schedule and others.

FIGURE 3-5. HISTORICAL RAIN AND METEOROLOGICAL RECORD

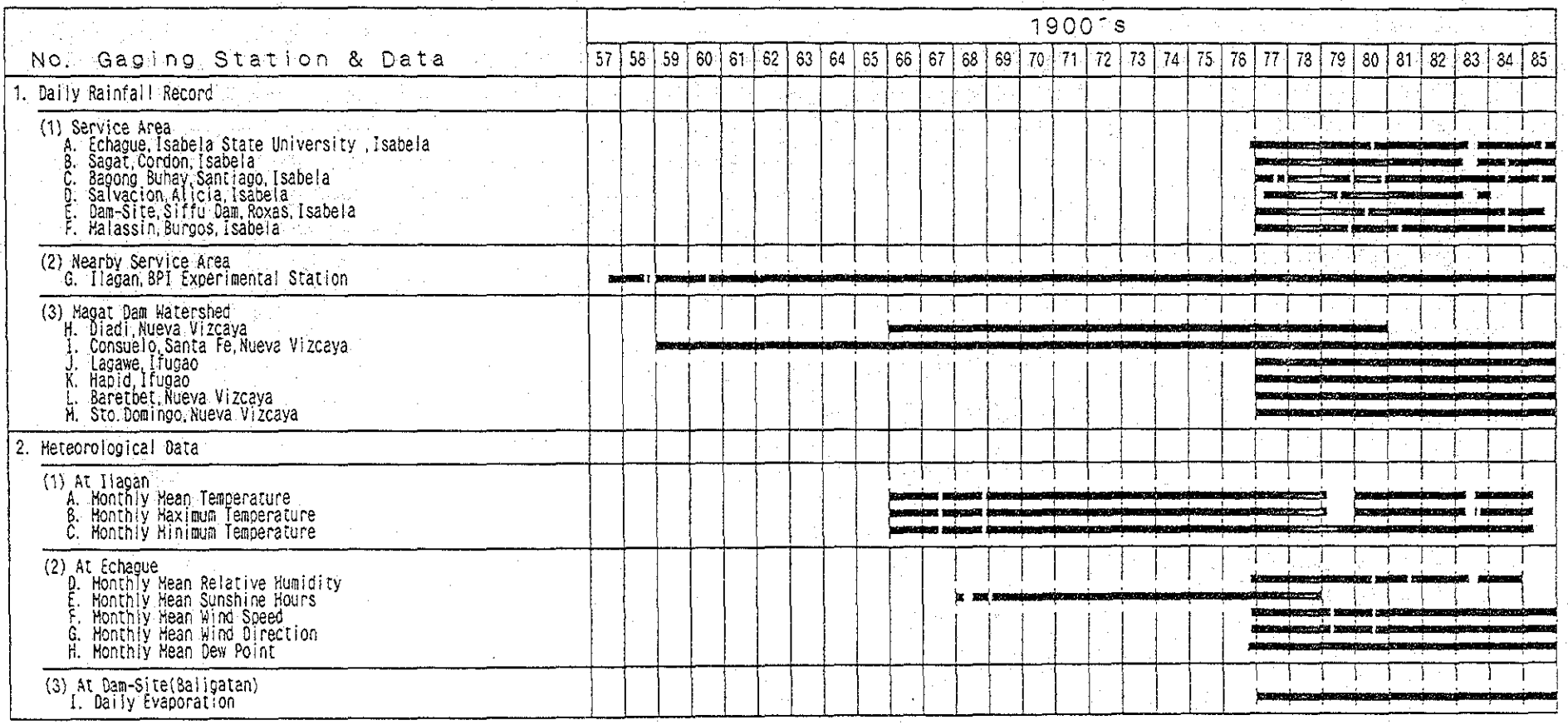


FIGURE 3-6. HISTORICAL STREAMFLOW RECORD

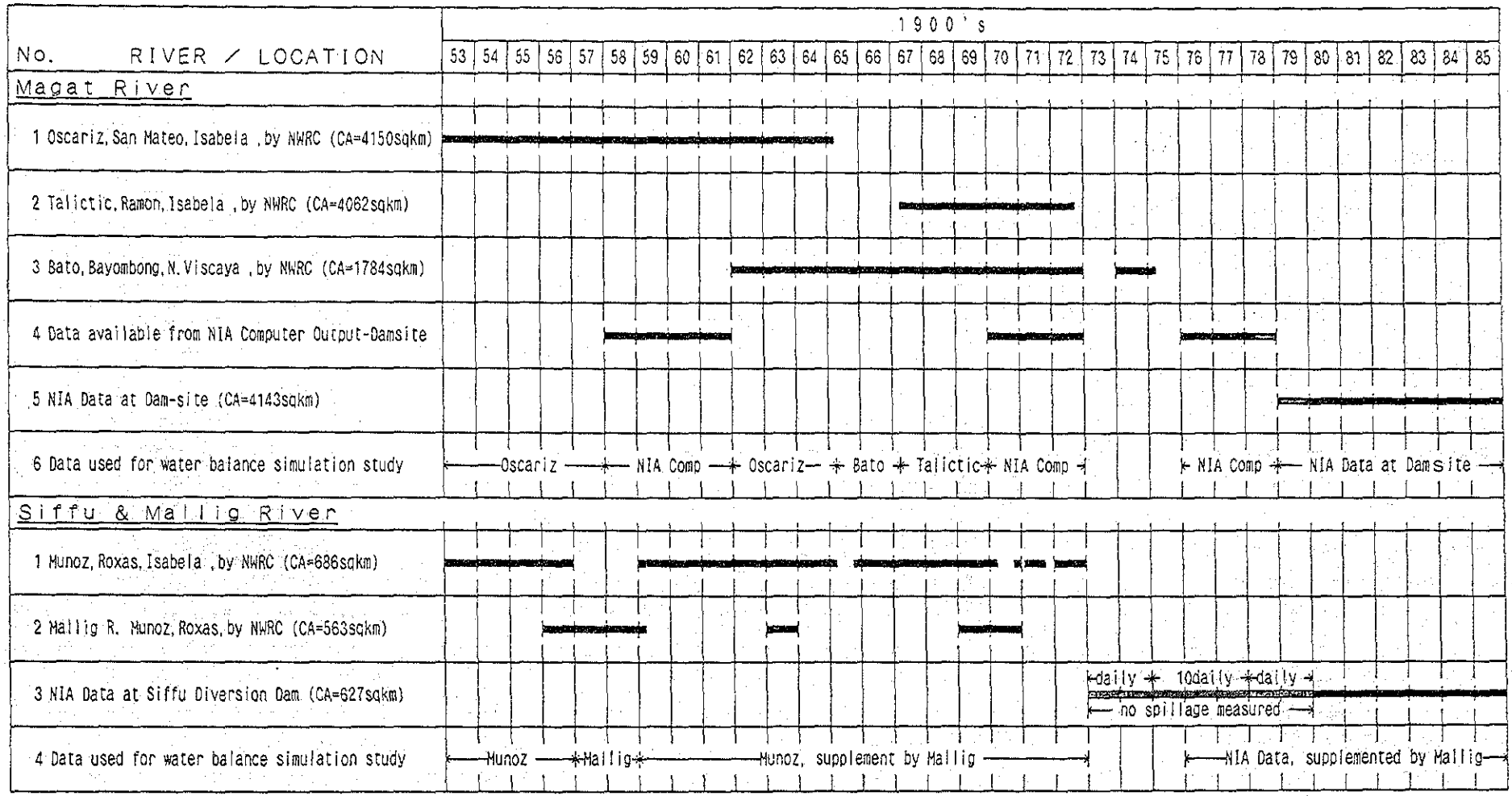


TABLE 3-1. MONTHLY RAINFALL OBSERVED AT ILAGAN

* STATION --- ILAGAN

(UNIT : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1957	-	-	-	-	-	-	-	208.2	227.7	226.6	267.5	84.3	-
1958	37.5	41.9	44.6	24.9	119.4	106.7	121.4	106.2	-	848.5	-	-	-
1959	61.0	29.8	39.5	16.6	47.3	89.5	292.2	735.1	242.1	179.2	308.4	222.9	2263.6
1960	52.5	156.9	46.7	25.7	16.8	32.3	-	91.5	183.2	426.8	52.5	120.1	-
1961	62.2	21.3	77.4	19.0	45.3	115.3	336.2	219.2	244.0	372.1	412.8	54.1	1978.9
1962	64.9	61.7	53.4	46.9	52.1	196.2	173.4	232.1	148.5	468.8	393.9	174.0	2065.9
1963	55.8	46.8	8.9	17.2	27.9	271.0	88.0	69.9	153.9	83.9	78.2	262.2	1163.7
1964	262.2	23.3	69.3	11.2	84.1	109.8	131.5	180.4	268.6	341.5	931.7	154.3	2567.9
1965	69.9	21.6	24.1	29.2	67.6	121.3	290.1	210.8	161.2	75.0	133.9	108.4	1313.1
1966	2.8	99.1	35.0	55.8	284.6	171.3	213.6	70.0	54.6	181.1	785.6	222.0	2175.5
1967	55.9	42.9	25.8	116.3	67.2	31.1	132.6	238.7	454.5	150.0	156.3	26.0	1497.3
1968	34.0	1.5	2.3	125.1	120.2	210.2	163.0	256.9	121.2	52.3	16.8	12.3	1115.8
1969	17.4	2.8	4.6	49.3	99.2	120.8	235.7	50.2	156.8	164.5	158.2	64.7	1124.2
1970	84.7	7.9	28.2	27.4	267.7	135.1	158.7	292.7	132.7	283.7	301.9	180.2	1900.9
1971	81.3	55.9	193.2	0.0	187.8	373.1	326.4	284.4	242.2	685.1	772.1	508.5	3710.0
1972	149.8	15.2	20.3	218.4	349.8	137.2	131.9	116.9	104.7	58.3	205.7	43.2	1551.4
1973	15.2	7.6	22.8	0.0	81.2	341.0	154.8	228.5	121.8	418.7	740.7	147.4	2279.7
1974	47.0	22.8	0.0	17.8	143.1	213.3	99.0	124.4	180.3	922.0	437.0	347.8	2554.5
1975	78.6	5.0	5.0	35.6	154.9	149.8	135.2	86.1	119.3	294.4	58.4	337.8	1460.1
1976	99.0	22.8	43.2	88.9	281.9	241.3	106.7	218.5	193.0	185.2	578.9	228.5	2287.9
1977	91.4	27.9	7.6	20.4	182.7	40.6	88.8	109.2	256.4	40.6	231.0	40.6	1137.2
1978	2.5	7.5	0.0	12.7	152.3	30.5	69.8	286.9	299.6	279.3	238.6	138.1	1517.8
1979	49.8	0.8	23.9	67.3	144.6	137.7	191.8	183.1	184.9	174.2	325.9	56.6	1540.6
1980	42.2	23.2	48.3	53.4	186.0	8.8	167.2	37.8	115.4	306.6	306.8	183.2	1478.9
1981	44.0	10.2	3.4	19.8	81.8	250.7	191.6	214.0	174.0	242.2	449.5	63.8	1745.0
1982	21.4	10.8	21.0	79.6	79.4	261.6	31.9	288.6	235.2	125.4	156.2	182.5	1493.6
1983	115.6	14.8	13.2	49.4	145.0	71.0	51.2	116.0	127.0	229.2	109.3	30.8	1072.5
1984	43.0	15.6	124.8	157.0	293.6	218.6	266.8	215.2	35.8	479.2	17.6	129.0	1996.2
1985	15.0	17.3	84.0	154.8	43.9	315.9	132.1	207.6	347.7	334.2	204.0	83.8	1940.3
AVERAGE	62.7	29.1	38.2	55.0	136.0	160.8	166.0	195.8	188.8	297.5	315.3	150.3	1805.1

TABLE 3-2. MAGAT RIVER MONTHLY RUNOFF AT DAM

*** MAGAT RIVER MONTHLY RUNOFF AT DAM ***

UNIT - MCM/MON.

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT	OCT.	NOV.	DEC.	ANNUAL
1953	326.4	222.2	141.8	253.4	572.5	1241.1	907.0	1150.4	933.4	845.5	721.4	1059.5	8374.6
1954	342.4	135.2	195.3	199.1	107.0	134.5	270.2	401.3	584.3	497.6	861.0	286.3	4014.2
1955	500.4	183.6	115.0	108.6	227.4	191.4	318.4	449.4	705.9	714.4	1013.6	457.5	4985.6
1956	227.4	137.9	155.1	930.8	497.6	201.7	572.5	484.3	393.6	615.4	1507.4	992.6	6716.3
1957	305.0	147.4	505.6	354.2	125.8	367.2	334.4	508.3	1303.2	912.4	677.4	227.4	5768.3
1958	157.8	84.6	117.7	142.2	173.9	362.0	222.0	896.3	1280.0	1142.4	493.9	240.8	5313.6
1959	131.1	111.1	1006.0	188.8	286.3	142.2	128.4	243.5	377.5	350.5	692.9	272.9	3931.2
1960	214.0	694.0	267.5	243.1	200.7	343.9	441.4	800.0	998.0	941.8	254.7	206.1	5565.2
1961	123.1	70.1	149.8	147.4	240.8	359.4	963.2	874.9	809.3	762.5	375.0	131.1	5006.6
1962	203.4	205.4	291.6	250.8	203.4	385.2	1046.1	872.2	773.1	618.1	840.4	436.1	6125.8
1963	251.5	415.5	203.4	124.0	96.3	530.1	864.1	1546.4	928.2	382.6	284.4	489.6	6116.1
1964	235.4	215.5	179.3	93.0	256.9	317.5	917.6	1305.6	967.1	1685.5	1639.3	882.9	8755.6
1965	321.1	372.1	187.3	462.8	385.2	411.1	639.4	610.0	830.0	607.4	475.8	334.4	5636.6
1966	283.6	159.4	272.9	263.0	1359.1	532.6	465.5	452.1	545.6	420.1	806.7	757.1	6317.7
1967	398.6	171.5	37.4	188.8	216.7	385.2	711.7	1166.5	1993.5	1741.7	1303.2	524.4	8839.2
1968	444.1	278.1	232.8	227.5	347.8	605.1	642.1	1348.4	1437.6	717.0	279.2	224.7	6784.4
1969	184.6	111.1	72.3	116.4	152.5	287.0	698.3	695.6	558.4	893.6	426.7	417.4	4613.9
1970	532.4	224.6	165.9	196.5	294.3	659.3	334.4	778.6	1272.1	2279.5	2546.9	1003.3	10287.8
1971	500.4	425.2	481.6	268.9	543.1	708.5	1570.5	746.4	1473.8	2785.2	1494.6	1530.4	12528.6
1972	1032.7	456.5	323.8	493.9	781.3	560.0	2071.0	1367.0	991.0	281.0	346.0	104.0	8808.2
1976	519.1	215.1	240.6	126.8	2222.0	1311.9	1248.7	802.2	1095.1	957.5	286.4	340.4	9365.8
1977	348.4	205.8	135.8	110.8	284.0	345.2	597.9	684.5	949.9	521.9	621.8	294.4	5100.4
1978	108.7	62.6	50.6	119.2	181.9	284.1	501.4	1300.6	1709.0	2280.0	1068.3	739.5	8405.9
1979	207.7	106.5	81.5	85.7	217.4	530.0	586.2	506.7	710.6	1034.9	511.3	351.3	4929.8
1980	201.7	129.8	143.2	106.3	226.2	186.1	930.6	647.9	816.1	946.3	2313.6	592.3	7240.1
1981	228.7	199.8	95.6	128.0	228.7	418.9	1586.4	696.5	456.2	811.3	1316.1	487.5	6653.7
1982	204.2	142.2	74.1	294.2	353.8	491.3	399.4	506.5	660.7	378.6	136.2	394.8	4036.0
1983	412.2	215.8	127.0	41.8	63.5	67.9	149.7	380.1	330.0	928.1	397.6	163.4	3277.1
1984	157.5	105.5	250.9	381.3	896.9	453.2	610.8	945.6	637.2	1022.5	700.6	296.2	6458.1
1985	118.9	62.8	99.6	312.4	298.5	497.3	628.4	640.5	1347.4	1303.6	709.5	387.8	6401.7
TOTAL	9222.5	6226.9	6395.9	6959.6	12041.5	13370.8	21357.6	23808.2	27867.7	29378.8	25101.8	14626.1	196358.1
MEAN	307.4	207.6	213.2	232.0	401.4	445.7	711.9	793.6	928.9	979.3	836.7	487.5	6545.3

TABLE 3-3. SIFFU RIVER MONTHLY RUNOFF AT DAM

*** SIFFU RIVER MONTHLY RUNOFF AT DAM ***

UNIT - MCM/MON.

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT	OCT.	NOV.	DEC.	ANNUAL
1953	49.2	32.3	28.8	44.8	115.3	112.9	44.0	156.1	189.0	166.1	96.8	196.8	1232.1
1954	44.5	22.2	30.4	30.9	10.5	20.9	54.6	57.7	120.5	131.1	102.5	54.5	680.3
1955	64.4	20.7	15.0	16.2	14.2	27.8	66.7	101.1	93.8	79.1	228.3	80.4	807.6
1956	21.6	18.2	28.3	64.4	41.0	24.5	111.2	127.8	159.8	121.2	92.3	61.2	871.3
1957	48.6	20.1	33.7	19.4	13.8	51.8	43.4	55.8	137.1	124.7	136.1	31.4	715.9
1958	33.5	19.9	20.9	10.1	31.1	90.3	52.0	178.0	229.8	58.9	68.9	24.1	817.5
1959	16.4	19.0	52.9	18.3	59.1	36.1	46.5	95.1	163.6	84.2	171.8	159.4	922.4
1960	76.0	153.9	40.9	39.8	24.6	35.0	38.6	64.0	183.2	150.3	33.6	28.2	868.0
1961	23.7	22.6	35.1	38.3	71.9	39.1	112.3	155.0	86.9	122.9	125.4	13.5	846.8
1962	22.6	21.7	27.0	28.3	30.3	121.6	75.8	153.2	67.3	74.2	77.5	72.2	771.6
1963	27.8	52.5	23.7	23.8	24.5	91.1	121.1	136.7	190.0	25.1	23.4	65.7	805.4
1964	21.4	21.4	21.9	29.5	125.4	139.8	136.7	218.8	170.5	166.1	271.9	137.2	1460.6
1965	46.0	37.6	27.2	63.5	37.4	95.5	117.9	104.1	149.8	56.2	40.9	36.5	812.4
1966	26.6	23.2	22.6	31.5	136.1	92.2	98.1	154.5	59.3	35.5	209.8	131.8	1021.1
1967	64.7	23.5	27.8	27.5	19.8	83.1	95.9	155.1	183.4	145.2	109.9	41.2	977.2
1968	25.1	21.9	21.3	26.7	32.5	133.5	66.2	119.6	103.7	50.0	31.2	22.8	654.5
1969	22.6	12.4	22.1	31.0	38.9	73.4	137.3	30.6	73.0	95.3	72.5	72.7	681.7
1970	77.5	27.8	20.0	24.1	39.2	100.0	44.2	121.0	212.0	418.0	485.3	165.5	1734.7
1971	72.5	60.0	69.2	34.0	79.0	107.5	270.0	114.0	251.4	520.5	256.3	265.0	2099.3
1972	165.9	65.5	43.0	70.0	119.8	82.5	372.0	230.0	158.0	37.0	47.7	22.5	1413.9
1976	63.6	26.4	29.5	15.5	272.4	160.8	153.1	98.3	134.2	117.4	35.1	41.7	1148.1
1977	43.8	25.9	17.1	13.9	35.7	43.4	75.1	86.0	119.3	65.6	78.1	37.0	640.7
1978	13.3	7.7	6.2	14.6	22.3	34.8	61.5	159.4	209.5	279.5	131.0	90.7	1030.4
1979	29.5	15.2	11.6	12.2	30.9	75.4	83.4	72.1	101.1	147.2	72.7	50.0	701.3
1980	41.4	20.8	11.6	5.3	16.0	11.9	96.6	62.7	66.6	53.1	43.4	36.2	465.6
1981	24.8	16.8	8.9	5.6	17.9	103.8	99.8	146.3	104.8	118.4	131.3	72.1	850.5
1982	28.1	15.0	9.7	15.8	53.6	45.2	39.3	45.2	42.6	29.5	46.0	56.6	426.6
1983	48.9	19.5	10.4	8.8	8.1	9.2	13.0	40.0	23.0	43.4	38.5	26.2	289.1
1984	17.7	11.1	17.6	8.0	26.1	42.3	54.2	64.5	35.8	41.7	36.2	43.0	398.3
1985	16.1	8.2	7.4	12.4	26.5	43.5	44.5	51.0	44.1	54.9	52.5	39.8	400.9
TOTAL	1277.8	863.0	741.5	784.4	1573.8	2128.8	2825.1	3353.6	3863.2	3612.2	3346.8	2175.9	26545.8
MEAN	42.6	28.8	24.7	26.1	52.5	71.0	94.2	111.8	128.8	120.4	111.6	72.5	884.9

FORM 3-3.

Republic of the Philippines
NATIONAL IRRIGATION ADMINISTRATION
MAGAT RIVER MULTI-PURPOSE PROJECT

MONTHLY RECORD OF DAILY RAINFALL

STATION CODE NO. (1–4)
PROCESSING TYPE (6)
YEAR 19 (8)
MONTH (10)

STATION NAME	
DISTRICT	
TOWNSHIP	
PROVINCE	
UNIT	MM/DAY

1st DECADE			2nd DECADE			3rd DECADE		
NO	Rainfall	Remark	No	Rainfall	Remark	No	Rainfall	Remark
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		
						31		

REMARKS:

NOTES:

(1) Rainfall is observed in mm/day, down to one decimal place, at 8:00AM of the following day.

(2) Mark "—" for no rainfall, while 0.0 if rainfall is less than 0.1mm.

		Date
OBSERVED BY		19 / /
PREPARED BY		19 / /
CHECKED BY		19 / /
SUBMITTED BY		19 / /
REVISED BY COMPUTER SECTION		19 / /
ADDITION FROM CODING STAFF		19 / /
DATA ENTRY BY		19 / /

FORM 3-4.

Republic of the Philippines
NATIONAL IRRIGATION ADMINISTRATION
MAGAT RIVER MULTI-PURPOSE PROJECT

MONTHLY RECORD OF MAGAT RESERVOIR OPERATION

BASIN CODE NO. (1)
STATION CODE NO. (4)
PROCESSING TYPE (5)
YEAR 19 (8)
MONTH (10)

	1st DECADE				2nd DECADE				3rd DECADE				
NO	W-Level	Q-Magat	Q-Bali	Q-Spill	No	W-Level	Q-Magat	Q-Bali	Q-Spill	No	W-Level	Q-Magat	Q-Bali	Q-Spill
1					11					21				
2					12					22				
3					13					23				
4					14					24				
5					15					25				
6					16					26				
7					17					27				
8					18					28				
9					19					29				
10					20					30				
										31				

STATION NAME	MAGAT RESERVOIR
DISTRICT	DAM & RESERVOIR
TOWNSHIP	RAMON
PROVINCE	ISABELA
UNIT	CUM/SEC & El.m

NOTES:

(1) W-Level stands for Magat Reservoir water surface elevation.
(2) Q-Magat stands for outflow discharge through Magat Power Plant(QM).
(3) Q-Bali stands for outflow discharge through Baligatan Power Plant(QB).
(4) Q-Spill stands for outflow discharge through spillway.
(5) Reservoir inflow=[QM+QB+QS+{V(H)-V(H0)}]/24Hours

REMARKS:

		Date
OBSERVED BY		19 / /
PREPARED BY		19 / /
CHECKED BY		19 / /
SUBMITTED BY		19 / /
REVISED BY COMPUTER SECTION		19 / /
ADDITION FROM CODING STAFF		19 / /
DATA ENTRY BY		19 / /

FORM 3-5.

Republic of the Philippines
NATIONAL IRRIGATION ADMINISTRATION
MAGAT RIVER MULTI-PURPOSE PROJECT

BASIN CODE NO. [ ] (1)
STATION CODE NO. [ ] (4)
PROCESSING TYPE [ ] (6)
YEAR 19[ ] (8)
MONTH [ ] (10)

MONTHLY RECORD OF SIFFURIS DAM OPERATION

1st DECADE				2nd DECADE				3rd DECADE			
NO	Intake-A	Intake-B	Spillage	No	Intake-A	Intake-B	Spillage	No	Intake-A	Intake-B	Spillage
1				11				21			
2				12				22			
3				13				23			
4				14				24			
5				15				25			
6				16				26			
7				17				27			
8				18				28			
9				19				29			
10				20				30			
								31			

STATION NAME	SIFFURIS DAM
DISTRICT	III
TOWNSHIP	ROXAS
PROVINCE	ISABELA
UNIT	CUM/SEC

NOTES:
(1) Intake-A stands for intake discharge to Siffu North Main Canal
(2) Intake-B stands for intake discharge to Siffu South Main Canal
(3) Spill stands for waste flow overtopping dam crest

REMARKS:

		Date
OBSERVED BY		19 / /
PREPARED BY		19 / /
CHECKED BY		19 / /
SUBMITTED BY		19 / /
REVISED BY COMPUTER SECTION		19 / /
ADDITION FROM CODING STAFF		19 / /
DATA ENTRY BY		19 / /

FORM 3-6.

Republic of the Philippines
NATIONAL IRRIGATION ADMINISTRATION
MAGAT RIVER MULTI-PURPOSE PROJECT

MONTHLY RECORD OF [14] TEMPERATURE — MEAN or MAX. or MIN.

STATION CODE NO. [1–4]
PROCESSING TYPE [6]
YEAR 19 [8]
MONTH [10]

STATION NAME	
DISTRICT	
TOWNSHIP	
PROVINCE	
UNIT	° C

1st DECADE			2nd DECADE			3rd DECADE		
NO	Data	Remark	No	Data	Remark	No	Data	Remark
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		
						31		

REMARKS:

NOTES:

(1) Mean, maximum or minimum temperature is observed in ° C down to one decimal place, at 8:00AM of the following day

		Date
OBSERVED BY		19 / /
PREPARED BY		19 / /
CHECKED BY		19 / /
SUBMITTED BY		19 / /
REVISED BY COMPUTER SECTION		19 / /
ADDITION FROM CODING STAFF		19 / /
DATA ENTRY BY		19 / /

FORM 3-7.

Republic of the Philippines
NATIONAL IRRIGATION ADMINISTRATION
MAGAT RIVER MULTI-PURPOSE PROJECT

MONTHLY RECORD OF [ ] (14) RELATIVE HUMIDITY — MEAN or MAX. or MIN.

STATION CODE NO. [ ] (1–4)
PROCESSING TYPE [ ] (6)
YEAR 19 [ ] (8)
MONTH [ ] (10)

STATION NAME	
DISTRICT	
TOWNSHIP	
PROVINCE	
UNIT	%

1st DECADE			2nd DECADE			3rd DECADE		
NO	Data	Remark	No	Data	Remark	No	Data	Remark
1 (18)			11 (18)			21 (18)		
2 (22)			12 (22)			22 (22)		
3 (26)			13 (26)			23 (26)		
4 (30)			14 (30)			24 (30)		
5 (34)			15 (34)			25 (34)		
6 (38)			16 (38)			26 (38)		
7 (42)			17 (42)			27 (42)		
8 (46)			18 (46)			28 (46)		
9 (50)			19 (50)			29 (50)		
10 (54)			20 (54)			30 (54)		
						31 (58)		

NOTES:

(1) Mean, maximum or minimum relative humidity is observed in % down to one decimal place, at 8:00AM of the following day

REMARKS:

		Date
OBSERVED BY		19 / /
PREPARED BY		19 / /
CHECKED BY		19 / /
SUBMITTED BY		19 / /
REVISED BY COMPUTER SECTION		19 / /
ADDITION FROM CODING STAFF		19 / /
DATA ENTRY BY		19 / /

FORM 3-8.

Republic of the Philippines
NATIONAL IRRIGATION ADMINISTRATION
MAGAT RIVER MULTI-PURPOSE PROJECT

MONTHLY RECORD OF PAN-EVAPORATION

STATION CODE NO. (1–4)
PROCESSING TYPE (6)
YEAR 19 (8)
MONTH (10)

STATION NAME	
DISTRICT	
TOWNSHIP	
PROVINCE	
UNIT	MM/DAY

1st DECADE			2nd DECADE			3rd DECADE		
NO	Data	Remark	No	Data	Remark	No	Data	Remark
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		
						31		

NOTES:

(1) Evaporation is observed from a fixed reference point, in mm/day down to one decimal place, at 8:00AM of the following day

REMARKS:

		Date
OBSERVED BY		19 / /
PREPARED BY		19 / /
CHECKED BY		19 / /
SUBMITTED BY		19 / /
REVISED BY COMPUTER SECTION		19 / /
ADDITION FROM CODING STAFF		19 / /
DATA ENTRY BY		19 / /

FORM 3-9.

Republic of the Philippines
NATIONAL IRRIGATION ADMINISTRATION
MAGAT RIVER MULTI-PURPOSE PROJECT

MONTHLY RECORD OF WIND SPEED

STATION CODE NO. (1–4)

PROCESSING TYPE (6)

YEAR 19 (8)

MONTH (10)

STATION NAME	
DISTRICT	
TOWNSHIP	
PROVINCE	
UNIT	KNOT

1st DECADE			2nd DECADE			3rd DECADE		
NO	Data	Remark	No	Data	Remark	No	Data	Remark
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		
						31		

(Data: 14, 18, 22, 26, 30, 34, 38, 42, 46, 50; Remark: 54)

REMARKS:

NOTES:

(1) Wind Speed is observed at 10m height as a mean value during 10 minutes just before noon

		Date
OBSERVED BY		19 / /
PREPARED BY		19 / /
CHECKED BY		19 / /
SUBMITTED BY		19 / /
REVISED BY COMPUTER SECTION		19 / /
ADDITION FROM CODING STAFF		19 / /
DATA ENTRY BY		19 / /

FORM 3-10.

Republic of the Philippines
NATIONAL IRRIGATION ADMINISTRATION
MAGAT RIVER MULTI-PURPOSE PROJECT

MONTHLY RECORD OF WIND DIRECTION

1st DECADE			2nd DECADE			3rd DECADE		
NO	Data	Remark	No	Data	Remark	No	Data	Remark
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		
						31		

REMARKS:

STATION CODE NO. (1–4)
PROCESSING TYPE (6)
YEAR 19 (8)
MONTH (10)

STATION NAME	
DISTRICT	
TOWNSHIP	
PROVINCE	
UNIT	—

NOTES:

(1) Wind Direction is observed at 10m height as a mean direction of wind during 10 minutes just before noon

		Date
OBSERVED BY		19 / /
PREPARED BY		19 / /
CHECKED BY		19 / /
SUBMITTED BY		19 / /
REVISED BY COMPUTER SECTION		19 / /
ADDITION FROM CODING STAFF		19 / /
DATA ENTRY BY		19 / /

FORM 3-11.

Republic of the Philippines
NATIONAL IRRIGATION ADMINISTRATION
MAGAT RIVER MULTI-PURPOSE PROJECT

MONTHLY RECORD OF SUNSHINE HOURS

STATION CODE NO. (1–4)
PROCESSING TYPE (6)
YEAR 19 (8)
MONTH (10)

STATION NAME	
DISTRICT	
TOWNSHIP	
PROVINCE	
UNIT	HOURS

1st DECADE			2nd DECADE			3rd DECADE		
NO	Data	Remark	No	Data	Remark	No	Data	Remark
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		
						31		

REMARKS:

NOTES:

(1) Sunshine is accumulated a day from sunrise to sunset in hours down to one decimal place

(2) Mark '-' for no sunshine, while 0.0 if less than 0.1 hours

		Date
OBSERVED BY		19 / /
PREPARED BY		19 / /
CHECKED BY		19 / /
SUBMITTED BY		19 / /
REVISED BY COMPUTER SECTION		19 / /
ADDITION FROM CODING STAFF		19 / /
DATA ENTRY BY		19 / /

FORM 3-12.

Republic of the Philippines
NATIONAL IRRIGATION ADMINISTRATION
MAGAT RIVER MULTI-PURPOSE PROJECT

MONTHLY RECORD OF CLOUDINESS

STATION CODE NO.	(1–4)
PROCESSING TYPE	(6)
YEAR	19 (8)
MONTH	(10)

STATION NAME	
DISTRICT	
TOWNSHIP	
PROVINCE	

1st DECADE			2nd DECADE			3rd DECADE		
NO	Data	Remark	No	Data	Remark	No	Data	Remark
1			11			21		
2			12			22		
3			13			23		
4			14			24		
5			15			25		
6			16			26		
7			17			27		
8			18			28		
9			19			29		
10			20			30		
						31		

UNIT (15) OKTAS or TENTH

NOTES:

(1) Cloudiness is observed in Oktas or Tenths system

REMARKS:

		Date
OBSERVED BY		19 / /
PREPARED BY		19 / /
CHECKED BY		19 / /
SUBMITTED BY		19 / /
REVISED BY COMPUTER SECTION		19 / /
ADDITION FROM CODING STAFF		19 / /
DATA ENTRY BY		19 / /

3.4. Water Requirement and Allocation Plan

3.4.1. Unit Water Requirement

(1) Unit Irrigation Requirement at On-Farm Level

Unit irrigation requirement at on-farm level so called farm water requirement (crop water requirement) refers to the amount of water to be supplied to the farm to satisfy the percolation, field evaporation and evapotranspiration, since these are the basis of distributing irrigation water on the area.

The values of farm water requirement at different stages of crop growing are presently computed based on the researches[1/] conducted by MRIIS O/M Office within the Service Area. The formula used in estimating these values is presented as follows;

$$LSWR = \frac{Sn + F}{7} + Ef + P$$

$$LPWR = Ef + P$$
$$VSWR = Et + P$$
$$RSWR = Et + P$$

where;

LSWR = Land Soaking Water Requirement
LPWR = Land Preparation Water Requirement
VSWR = Vegetative Stage Water Requirement
RSWR = Reproductive Stage Water Requirement
Sn = Saturation Requirement
Ef = Field Evaporation
P = Percolation
Et = Evapotranspiration
F = Flooding (65 mm)

1/ Source: "Operation and Maintenance Manual for the Magat River Integrated Irrigation System" Prepared by MRIIS Office in June, 1985.

Saturation Requirement

Soil saturation is the amount of water used to fill pore spaces in the soil after a considerable length of the fallow period. Saturation requirement was computed by using the established rate of moisture depletion for every soil type and were tabulated into simplified form readily available for irrigation personnel in estimating their land soaking irrigation requirement.

Accordingly, saturation requirement has been computed by using the following equation;

$$Sn = \frac{(Sc - Mc) \times As \times Ds}{100}$$

Where;

Sn = Saturation requirement
Sc = Saturation capacity
  36% for rice class land
  49% for dual class land
Mc = Moisture content
As = Apparent specific gravity
  1.7 for rice class land
  1.35 for dual class land
Ds = Depth of root zone of rice (30 cm)

Saturation requirement(Sn) of the different laterals within the Service Area is tabulated as shown below based on the above equation:

Saturation Requirement of Laterals

(unit: mm)

Month	Lat. A	Lat. B	South Zone 2/	East Zone 3/	Division III
Jan.	50	77	48	37	37
Feb.	113	97	61	58	58
Mar.	128	97	68	68	68
Apr.	130	93	75	71	71
May	80	89	58	54	20
Jun.	69	77	31	34	26
Jul.	60	65	17	20	30
Aug.	46	61	14	14	32
Sep.	39	35	33	5	5
Oct.	0 1/	0	0	0	0
Nov.	0	0	0	0	0
Dec.	0	0	0	0	0

Note: 1/: Saturated
2/: South Zone - South area of Maris main canal, (SLC, C, C-Extra, E, E-Extra, F, G, H, I-Extra, J-Extra)
3/: East Zone - North-East area of Maris main canal (Lat. D, H-Extra, I,J)

Field Evaporation and Evapotranspiration

According to the study on the relationship between panevaporation (Ep) and field evaporation (Ef), evapotranspiration (Et), which has been conducted by MRIIS Office, the values of Ef and Et can be estimated as shown below by using the model equation expressing Ef and Et as a function of Ep.

Field Evaporation and Evapotranspiration based on Evaporation

(unit: mm/day)

Month	Ep	Ef	Et	
			Vegetative Stage	Reproductive Stage
Jan.	3.6	2.6	4.0	4.2
Feb.	4.4	3.2	4.6	5.0
Mar.	5.3	3.8	5.4	5.8
Apr.	6.3	4.5	6.2	6.8
May	6.1	4.4	6.0	6.6
Jun.	5.8	4.2	5.8	6.3
Jul.	5.8	4.2	5.8	6.3
Aug.	5.5	4.0	5.6	6.0
Sep.	4.4	3.2	4.6	5.0
Oct.	4.7	3.4	4.9	5.3
Nov.	4.0	2.9	4.3	4.6
Dec.	3.3	2.4	3.7	4.9

Note: Model equations are expressed as follows:
Ef = 0.72 Ep - 0.004
Et = 0.83 Ep + 0.99 (during vegetative stage)
Et = 0.94 Ep + 0.85 (during reproductive stage)

Percolation Rate

In the determination of irrigation water, one of the most important parameters is percolation rate of the soil - downward movement of water into soil profile which varies greatly with soil type, groundwater depth and drainability of the area.

The percolation rates of the different areas to be served with irrigation water within the Service Area have been quantified by the MRIIS O/M Office as shown below;

Percolation Rate

(unit: mm/day)

Laterals/Sub-Laterals	Percolation Rate	Laterals/Sub-Laterals	Percolation Rate
Division-I			
C	2.0	B	10.1
C-1	2.6	B-1	10.1
C-2	2.6	D, H-Extra, I and J	2.6
C-3		CEE	2.2
C-4	1.8	RMC	2.2
	1.8	Mac. East	2.6
E series, F, G and H	2.6	Mac. West	10.1
SLC	2.1		
SHC	2.2		
Division-II		Division-III	
A	11.2	NMC	5.2
A-1	12.0	SMC	2.5
A-2	9.0	A	6.4
A-3	16.0	A-1, A-Extra	6.0
A-4	9.0	B	6.0
A-5	7.0	C, D, E, F, G & H	2.5
A-5 Extra	29.0	NDC	2.7
A-6	4.0		
A-7	7.0		

As shown in the above table, percolation rates in the Laterals "A" and "B" which belong to dual class land are comparatively large, so that the Study Team installed the measuring devices of percolation rate at four sites in those areas to check the rates for the periods of three months from June 1986 to August 1986 during the wet season. As the results, it was proved that an average percolation rate in the dual class land varies in the ranges of 11 mm/day to 15 mm/day, although further long term observation will be needed.

Unit irrigation water requirement at on-farm level thus estimated by the above mentioned procedures is tabulated in Table 3-4 to 3-7. As is seen in the tables, only one unit irrigation requirement is applied to the large service area commanded by such main and

TABLE 3-4. UNIT WATER REQUIREMENT AT ON-FARM LEVEL IN EACH GROWING STAGE (1)

(unit : mm/day)

Main/Lateral Canal	Service Area (ha)	Farming Stage	Month											
			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Lat C.	1,420	LS	20.7	23.2	24.8	26.5	24.0	19.9	17.9	17.3	15.9	14.7	14.2	13.7
		LP	4.6	5.2	5.8	6.5	6.4	6.2	6.2	6.0	5.2	5.4	4.9	4.4
		VS	6.0	6.6	7.5	8.2	8.0	7.8	7.8	7.6	6.6	6.9	6.3	5.7
		RS	6.2	7.0	7.8	8.8	8.6	8.3	8.3	8.0	7.0	7.3	6.6	6.0
Lat. C-1 & C-2	1,385	LS	21.3	23.8	25.4	27.1	24.6	20.5	18.5	17.9	16.5	15.3	14.8	14.3
		LP	5.2	5.8	6.4	7.1	7.0	6.8	6.8	6.6	5.8	6.0	5.5	5.0
		VS	6.6	7.2	8.0	8.8	8.6	8.4	8.4	8.2	7.2	7.5	6.9	6.3
		RS	6.8	7.6	8.4	9.2	9.2	8.9	8.9	8.6	7.6	7.9	7.2	6.6
Lat. C-3 & C-4	4,344	LS	20.5	20.8	24.6	26.3	23.8	19.7	17.7	17.1	15.7	14.5	14.0	13.5
		LP	4.4	5.0	5.6	6.3	6.2	6.0	6.0	5.8	5.0	5.2	4.7	4.2
		VS	5.8	6.4	7.2	8.0	7.8	7.6	7.6	7.4	6.4	6.7	6.1	5.5
		RS	6.0	6.8	7.6	8.4	8.4	8.1	8.1	7.8	6.8	7.1	6.4	5.8
Lat. E.F.G.H.	3,536	LS	21.3	23.8	25.4	27.1	24.6	20.5	18.5	17.9	16.5	15.3	14.8	14.3
		LF	5.2	5.8	6.4	7.1	7.0	6.8	6.8	6.6	5.8	6.0	5.5	5.5
		VS	6.6	7.2	8.0	8.8	8.6	8.4	8.4	8.2	7.2	7.5	6.9	6.3
		RS	6.8	7.6	8.4	9.2	9.2	8.9	8.9	8.6	7.6	7.9	7.2	6.6
South Low Canal (SLC)	7,920	LS	20.8	23.3	24.9	26.6	24.1	20.0	18.0	17.4	16.0	14.8	14.3	13.8
		LP	4.7	5.3	5.9	6.6	6.5	6.3	6.3	6.1	5.3	5.5	5.0	4.5
		VS	6.1	6.7	7.6	8.3	8.1	7.9	7.9	7.7	6.7	7.0	6.4	5.8
		RS	6.3	7.1	7.9	8.9	8.7	8.4	8.4	8.1	7.1	7.4	6.7	6.1
South High Canal (SHC) & Oscariz	12,680	LS	20.9	23.4	25.0	26.7	24.2	20.1	18.1	17.5	16.1	14.9	14.4	13.9
		LP	4.8	5.4	6.0	6.7	6.6	6.4	6.4	6.2	5.4	6.5	5.1	4.6
		VS	6.2	6.8	7.7	8.4	8.2	8.0	8.0	7.8	6.8	7.1	6.5	5.9
		RS	6.4	7.2	8.0	9.0	8.8	8.5	8.5	8.2	7.2	7.5	6.8	6.2

TABLE 3-5. UNIT WATER REQUIREMENT AT ON-FARM LEVEL IN EACH GROWING STAGE (2)

(unit : mm/day)

Main/Lateral Canal	Service Area (ha)	Farming Stage	Month											
			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Lat. A.	1,558	LS	30.2	39.8	42.6	43.6	36.3	34.5	33.2	31.1	29.7	23.9	23.4	22.9
		LP	13.8	14.4	15.0	15.7	15.6	15.4	15.4	15.2	14.4	14.6	14.1	13.6
		VS	15.2	15.8	16.6	17.4	17.2	17.0	17.0	16.8	15.8	16.1	15.5	14.0
		RS	15.4	16.2	17.0	18.0	17.8	17.5	17.5	17.2	16.2	16.5	15.8	15.2
A-1	279	LS	31.0	40.6	43.4	44.4	37.1	35.3	34.1	31.8	30.5	24.7	24.2	23.7
		LP	14.6	15.2	15.8	16.5	16.4	16.2	16.2	16.0	15.2	15.4	14.9	14.4
		VS	16.0	16.6	17.4	18.2	18.0	17.8	17.6	17.6	16.6	16.9	16.3	15.7
		RS	16.2	17.0	17.8	18.8	18.6	18.3	18.3	18.0	17.0	17.3	16.6	16.0
A-2 & A-4	4,077	LS	28.0	37.6	40.4	41.4	34.1	32.3	31.0	28.8	27.5	21.7	21.2	20.7
		LP	11.6	12.2	12.8	13.5	13.4	13.2	13.2	13.0	12.2	12.4	11.9	11.4
		VS	13.0	13.6	14.4	15.2	15.0	14.8	14.8	14.6	13.6	13.9	13.3	12.7
		RS	13.2	14.0	14.8	15.8	15.6	15.3	15.3	15.0	14.0	14.3	13.6	13.0
A-3	673	LS	35.0	44.6	47.4	48.4	41.1	39.3	38.0	35.8	34.5	28.7	28.2	27.7
		LP	18.0	19.2	19.8	20.5	20.4	20.2	20.2	20.0	19.2	19.4	19.4	18.4
		VS	20.0	20.6	21.4	22.2	22.0	21.8	21.8	21.6	20.6	20.9	20.3	19.7
		RS	20.2	21.0	21.8	22.8	22.6	22.3	22.3	22.0	21.0	21.3	20.6	20.0
A-5 & A-7	666	LS	26.0	35.6	38.4	39.4	32.1	30.3	29.0	26.9	25.5	19.7	19.2	18.7
		LP	9.6	10.2	10.8	11.5	11.4	11.2	11.2	11.0	10.2	10.4	9.9	9.4
		VS	11.0	11.6	12.4	13.2	13.0	12.8	12.8	12.6	11.6	11.9	11.3	10.7
		RS	11.2	12.0	12.8	13.8	13.6	13.3	13.3	13.0	12.0	12.3	11.6	11.0
A-5 Extra	92	LS	48.0	57.6	60.4	61.4	54.1	52.3	51.0	48.9	47.5	41.7	41.2	40.7
		LP	31.6	32.2	32.8	33.5	33.4	33.2	33.2	33.0	32.2	32.4	31.9	31.4
		VS	33.0	33.6	34.4	35.2	35.0	34.8	34.8	34.6	33.6	33.9	33.3	32.7
		RS	33.2	34.0	34.8	35.8	35.6	35.3	35.3	35.0	34.0	34.3	33.6	33.0
A-6	202	LS	23.0	32.6	35.4	36.4	29.1	27.3	26.0	23.9	22.5	16.7	16.2	15.0
		LP	6.6	7.2	7.8	8.5	8.4	8.2	8.2	8.0	7.2	7.4	6.9	6.4
		VS	8.0	8.6	9.4	10.2	10.0	9.8	9.8	9.6	8.6	8.9	8.3	7.7
		RS	8.2	9.0	9.8	10.8	10.6	10.3	10.3	10.0	9.0	9.3	8.6	8.0

TABLE 3-6. UNIT WATER REQUIREMENT AT ON-FARM LEVEL IN EACH GROWING STAGE (3)

(unit : mm/day)

Main/Lateral Canal	Service Area (ha)	Farming Stage	Month											
			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Lat. B.	1,713	LS	33.0	36.4	37.0	37.2	36.5	34.6	32.9	32.1	27.6	22.8	22.3	21.8
		LP	12.7	13.3	13.9	14.6	14.5	14.3	14.3	14.1	13.3	13.5	13.0	12.5
		VS	14.1	14.7	15.5	16.3	16.1	15.9	15.9	15.7	14.7	15.0	14.4	13.8
		RS	14.3	15.1	15.9	16.9	16.7	16.4	16.4	16.1	15.1	15.4	14.7	14.1
Lat. D. H-Extra I and J	20,280	LS	19.8	23.4	25.4	26.5	24.0	20.9	18.9	17.9	15.8	15.3	14.8	14.3
		LP	5.2	5.8	6.4	7.1	7.0	6.8	6.8	6.6	5.8	6.0	5.5	5.0
		VS	6.6	7.2	8.0	8.8	8.6	8.4	8.4	8.2	7.2	7.5	6.9	6.3
		RS	6.8	7.6	8.4	9.2	9.2	8.9	8.9	8.6	7.6	7.9	7.2	6.6
Lat. I-Extra, J-Extra	271	LS	21.3	23.8	25.4	27.1	24.6	20.5	18.5	17.9	16.5	15.3	14.8	14.3
		LF	5.2	5.8	6.4	7.1	7.0	6.8	6.8	6.6	5.8	6.0	5.5	5.5
		VS	6.6	7.2	8.0	8.8	8.6	8.4	8.4	8.6	7.6	7.9	7.2	6.6
		RS	6.8	7.6	8.4	9.2	9.2	8.9	8.9	8.6	7.6	7.9	7.2	6.6
CEE & RMC	7,249	LS	19.4	23.0	25.0	26.1	23.6	20.5	18.5	17.5	15.4	14.9	14.4	13.9
		LP	4.8	5.4	6.0	6.7	6.6	6.4	6.4	6.2	5.4	5.6	5.1	4.6
		VS	6.2	6.8	7.7	8.4	8.2	8.0	8.0	7.8	6.8	7.1	6.5	5.9
		RS	6.4	7.2	8.0	9.0	8.8	8.5	8.2	7.2	7.2	7.5	6.8	6.2
Mac. East	3,126	LS	19.8	23.4	25.4	26.5	24.0	20.9	18.9	17.9	15.8	15.3	14.8	14.3
		LF	5.2	5.8	6.4	7.1	7.0	6.8	6.8	6.6	5.8	6.0	5.5	5.0
		VS	6.6	7.2	8.0	8.8	8.6	8.4	8.4	8.2	7.2	7.5	6.9	6.3
		RS	6.8	7.6	8.4	9.2	9.2	8.9	8.9	8.6	7.6	7.9	7.2	6.6
Mac. West Ladeco	1,138	LS	33.0	36.4	37.0	37.2	36.5	34.6	32.9	32.1	27.6	22.8	22.3	21.8
		LP	12.7	13.3	13.9	14.6	14.5	14.3	14.3	14.1	13.3	13.5	13.0	12.5
		VS	14.1	14.7	15.5	16.3	16.1	15.9	15.9	15.7	14.7	15.0	14.4	13.8
		RS	14.3	15.1	15.9	16.9	16.7	16.4	16.4	16.1	15.1	15.4	14.7	14.1

TABLE 3-7. UNIT WATER REQUIREMENT AT ON-FARM LEVEL IN EACH GROWING STAGE (4)

(unit : mm/day)

Main/Lateral Canal	Service Area (ha)	Farming Stage	Month											
			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Siffu-South Lat. A.	2,987	LS	23.6	27.2	29.2	30.3	22.9	23.6	24.2	24.3	19.6	19.1	18.6	18.1
		LP	9.0	9.6	10.2	10.9	10.8	10.6	10.6	10.4	9.6	9.8	9.3	8.6
		VS	10.4	11.0	11.9	12.6	12.4	12.2	12.2	12.0	11.0	11.3	10.7	10.1
		RS	10.6	11.4	12.2	13.2	13.0	12.7	12.7	12.4	11.4	11.7	11.0	10.4
Lat. B.	1,723	LS	23.2	26.8	28.8	29.9	22.5	23.2	23.8	23.9	19.2	18.7	18.2	17.7
		LP	8.6	9.2	9.8	10.5	10.4	10.2	10.2	10.0	9.2	9.4	8.9	8.4
		VS	10.0	10.6	11.5	12.2	12.0	11.8	11.8	11.6	10.6	10.9	10.3	9.7
		RS	10.2	11.0	11.8	12.8	12.6	12.3	12.3	12.0	11.0	11.3	10.6	10.0
Lat. C.D.E. F.G.H.	3,450	LS	19.7	23.3	25.3	26.4	19.0	19.7	20.3	20.4	15.7	15.2	14.7	14.2
		LP	5.1	5.7	6.3	7.0	6.9	6.7	6.7	6.5	5.7	5.9	5.4	4.9
		VS	6.5	7.1	7.9	8.7	8.5	8.3	8.3	8.1	7.1	7.4	6.8	6.2
		RS	6.7	7.5	8.3	9.1	8.1	8.8	8.8	8.5	7.5	7.8	7.1	6.5
Siffu-North NMC	2,959	LS	19.7	23.3	25.3	26.4	19.0	19.7	20.3	20.4	15.7	15.2	14.7	14.2
		LP	5.1	5.7	6.3	7.0	6.9	6.7	6.7	6.5	5.7	5.9	5.4	4.9
		VS	6.5	7.1	7.9	8.7	8.5	8.3	8.3	8.1	7.1	7.4	6.8	6.2
		RS	6.7	7.5	8.3	9.1	9.1	8.8	8.8	8.5	7.5	7.8	7.1	6.5
NDC	13,674	LS	19.9	23.5	25.5	26.2	19.2	19.9	20.5	20.6	15.9	15.4	14.9	14.4
		LP	5.3	5.9	6.5	7.2	7.1	6.9	6.9	6.7	5.9	6.1	5.6	5.1
		VS	6.7	7.3	8.1	8.9	8.7	8.5	8.5	8.3	7.3	7.6	7.0	6.4
		RS	6.9	7.7	8.5	9.3	9.3	9.0	9.0	8.7	7.7	8.0	7.3	6.7

lateral canals of South Low, South High, Cauayan East Extension and North Diversion canals. Since it could be considered that the soil characteristics and permeability are a little different between the upstream and downstream areas along the above mentioned canals, the irrigation requirement for each area should be reviewed by the classification of soil permeability (percolation rate) and actual irrigation result under proper water management.

The detail descriptions of measurement of field water requirement consisting of evapotranspiration and percolation rate are given in attached data sheet of Form 3-13.

(2) Unit Diversion Water Requirement on Main and Lateral Canal Basis

Diversion water requirement can be calculated by taking into account the effective rainfall and water losses in addition to the farm water requirement.

Effective Rainfall

The following describes the proposed criteria for estimating an effective rainfall.

i) Effective rainfall for paddy cultivation will be estimated on the daily basis in paddy fields which is considered as a small storage taking into account rainfall, evapotranspiration, percolation, water depth on paddy field and irrigation water supply.

ii) Estimation of effective rainfall will be made on the basis of the following conditions:

- Ilagan observation record (1961 - 1985) are selected as representative rainfall.

- Effective rainfall will be counted throughout the crop growing periods for both wet and dry seasons.

- Initial water depth on paddy field is assumed to be 50 mm.

- Daily water balance in field will be made in considering evapotranspiration, rainfall and percolation, and when water depth at paddy field drops to less than 20 mm, irrigation water is to be supplied up to the depth of 50 mm.

- In case much rainfall will be obtained in the paddy field, such rainfall will be stored in the field at the maximum depth of 80 mm, and rain water more than 80 mm will be drained to the lower plot or terminal drainage canal with no effective use for crops.

iii) Based on the above-mentioned criteria, the calculation of effective rainfall was made for a period of 25 years for two groups of different percolation rates, that is, those for rice class land and dual class land, and their average values are estimated at 2.7 mm/day for rice land and 10.1 mm/day for the dual class land.

The design effective rainfall with a return period of about six years with an extremely dry year is determined. The following table indicates an estimated effective rainfall for two group areas.

Estimated Effective Rainfall

(unit: mm)

Farming	Rice Class Land	Dual Class Land
Dry Season Paddy (Nov. - Apr.)	122.7	268.6
Wet Season Paddy (May - Oct.)	456.7	559.5
Total	579.4	828.1

Note: Details are shown in Table 3-8.

Irrigation Efficiency

Overall irrigation efficiency (1 - loss) is usually divided into two parts: the efficiency of water use below the farm turnout and the efficiency of water use in the conveyance system between the source of water supply and the farm turnout. Furthermore, from the aspects of water losses encountered in the operation of irrigation system, the water losses are subdivided into three stages: i) farm waste at on-farm level, ii) conveyance losses in lateral and sub-lateral canals, and iii) system operation losses in main and lateral canals.

The proposed overall irrigation efficiency adopted in the Project is 54 percent for the dry season paddy and 48 percent for the wet season paddy on an average, as shown below;

Irrigation Efficiency	Dry Season Paddy (%)	Wet Season Paddy (%)
Farm Irrigation Efficiency	80	70
Conveyance Efficiency (average)	80	80
System Operation Efficiency	85	85
Overall Efficiency	54.4	47.6

Conveyance efficiency for each lateral applied to the Project has been decided by MRIIS O/M Office as shown below, based on the actual discharge observation, and these efficiencies are considered to be appropriate at the prevailing farming practices, water management and physical conditions of canals.

TABLE 3-8. ESTIMATED EFFECTIVE RAINFALL

(unit: mm)

Month	Rainfall	Effective Rainfall	
		Dual Class Land	Class Land
Jan.	62.7	27.9	27.9
Feb.	29.1	13.3	13.6
Mar.	38.2	2.8	6.7
Apr.	55.0	2.7	1.0
May	136.0	66.0	23.4
Jun.	160.8	195.1	89.1
Jul.	166.0	77.9	73.1
Aug.	195.8	173.3	169.0
Sep.	188.8	31.4	77.7
Oct.	297.5	15.8	24.4
Nov.	315.3	167.8	41.2
Dec.	150.3	54.1	32.3
Total	1,795.5	828.1	579.4