THE REPUBLIC OF THE PHILIPPINES

NATIONAL IRRIGATION ADMINISTRATION

FEASIBILITY STUDY REPORT ON THE IMPROVEMENT PROJECT OF THE OPERATION AND MAINTENANCE OF NATIONAL IRRIGATION SYSTEMS (AMRIS)

(MAIN REPORT)

VOLUME I

FEBRUARY 1984

JAPAN INTERNATIONAL COOPERATION AGECY

No.

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PREFACE

In response to the request of the Government of the Republic of the Philippines, the Japanese Government decided to conduct a feasibility study on the Improvement Project of the Operation and Maintenance of National Irrigation Systems and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA dispatched to the Philippines a study team headed by Mr. Satoshi KADOWAKI from September 1982 to January 1983 and from June to September 1983. The team exchanged views with the officials concerned of the Government of the Philippines and conducted a survey in the Angat and Maasim areas, Bulacan and Pampanga Provinces. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the improvement of the Angat and Maasim River Irrigation System (AMRIS) and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the team.

February 1984

Keisuke Arita

Keisuke ARITA
President
Japan International Cooperation Agency

Mr. Keisuke Arita
President
Japan International Cooperation Agency (JICA)
Tokyo, Japan

LETTER OF TRANSMITTAL

Dear Sir:

We are very pleased to submit herewith the Feasibility Study Report on the Improvement Project of the Operation and Maintenance of National Irrigation Systems (AMRIS) in the Republic of the Philippines. The field survey and study has been conducted in two stages; the field survey, investigation and study were carried out for about four months from September 22, 1982 to January 31, 1983 and about three months from June 7 to September 4, 1983, and study and report compilation as home office works were made from February 11 to March 20, 1983 and from September 8 to October 28, 1983, respectively. In the course of survey and study in the Philippines, we held a series of discussion meetings with the officials concerned of the Government of Philippines and counterpart persennel for the Project formulation.

The proposed Project Area of this feasibility study covers about 35,000 hectares in net, being located some 40 km northeast of Greater Manila in the Province of Bulacan and Pampanga of Central Luzon.

The Project envisions increase in cropping intensity, upgrading of system management inclusive of irrigation efficiency, rehabilitation of existing facilities, expansion of irrigation service area with appropriate irrigation and drainage facilities, uplevelling of collection efficiency of irrigation fee, and partial turnover of operation and maintenance works to viable irrigator's associations.

The Feasibility Report consists of the following three volumes;

Volume I	Main Report
Volume II	Appendix A
Volume III	Appendix B and C

We are confident that the Project will sharply increase the farm production through the stabilized irrigation water supply, improvement of the structures of operation and maintenance providing related appropriate facilities and establishing viable irrigator's associations, and furthermore, we earnestly hope that implementation of the Project will greatly contribute to the rural development.

We wish to express our sincere gratitude to the System Management Department, Project Development Department and Management Service Department in NIA, Regional Irrigation Office III and AMRIS Operation and Maintenance Office, National Power Corporation, Manila Water Supply System, National Water Resources Council, and other Philippine Governmental organizations and agencies and the Japanese Embassy in the Philippines, Ministry of Foreign Affairs, Ministry of Agriculture, Forestry and Fisheries of the Government of Japan, and Japan International Cooperation Agency, the Advisory Committee for their closest cooperation and worthwhile advise given to us.

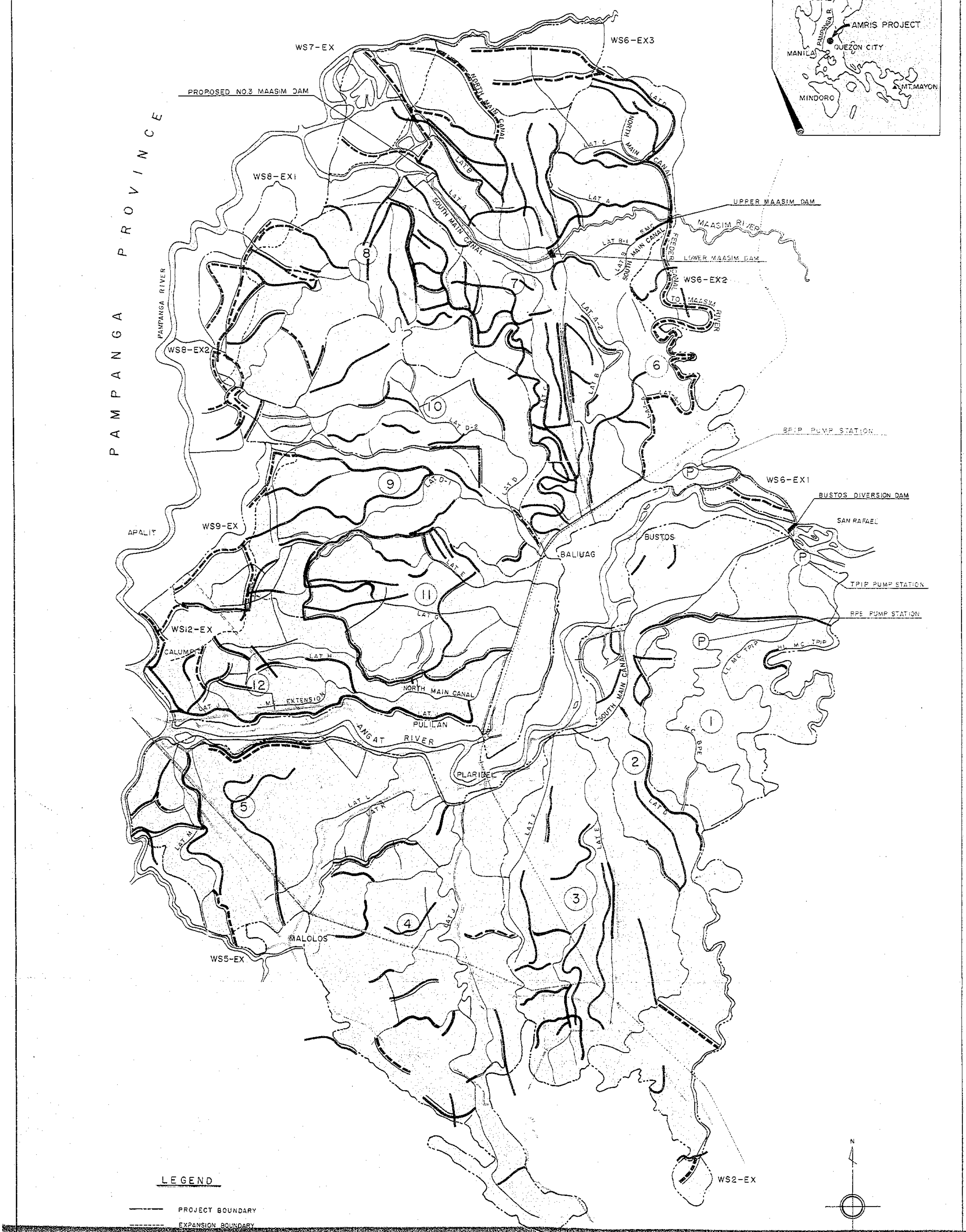
February, 1984

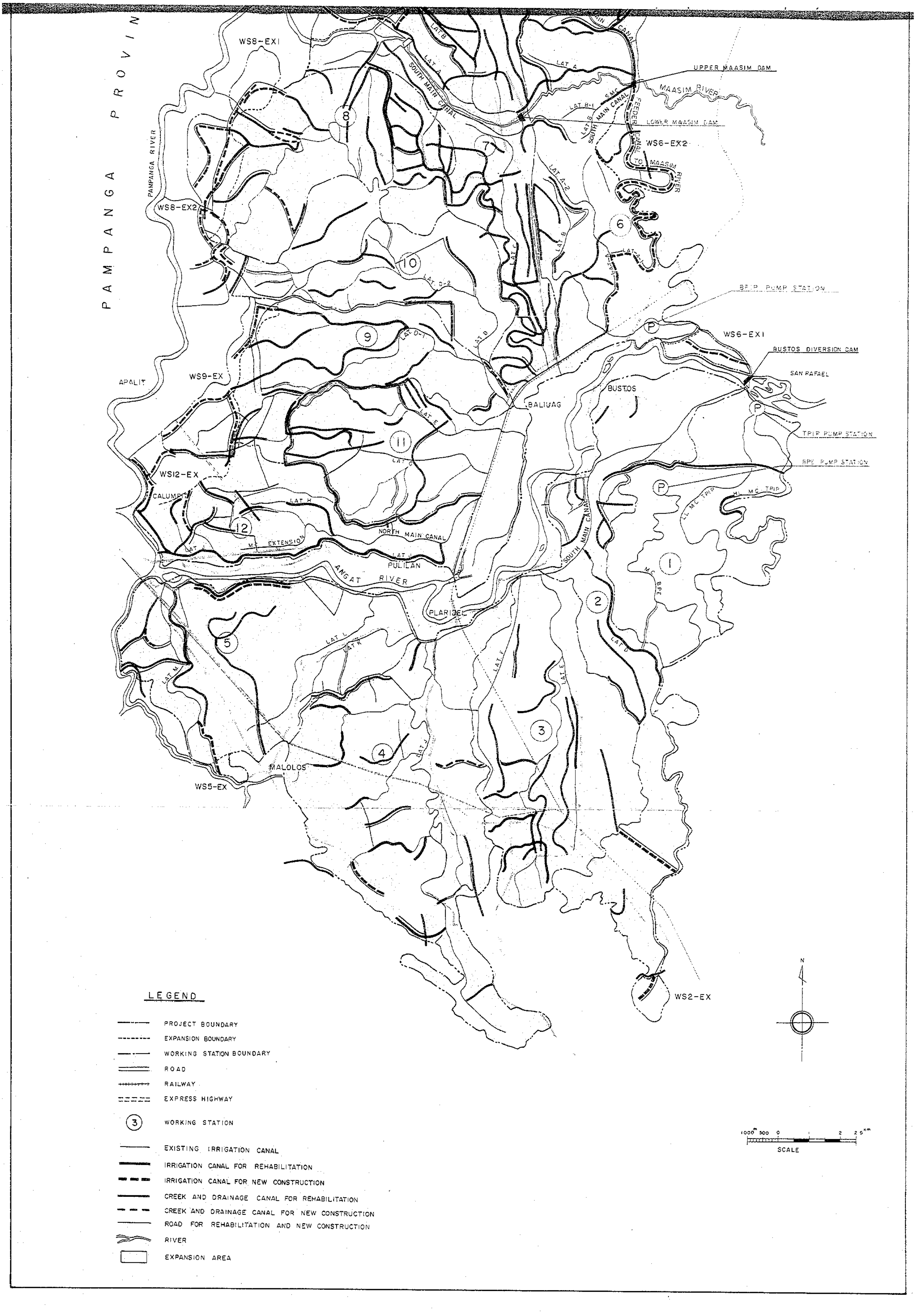
Sincerely Yours,

S. Kadowaki

Satoshi Kadowaki
Team Leader of Feasibility Study
Team for the AMRIS

GENERAL MAP OF AMRIS IRRIGATION PROJECT

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PAMPANGA RIVER
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WS8-EX2
WS9-EX
WS12-EX
WS6-EX1
WS6-EX2
WS5-EX
WS2-EX
APALIT
CALUMPIT
BALIUAG
BUSTOS
SAN RAFAEL
PULILAN
PLARIDEL
MALOLOS
ANGAT RIVER
MAASIM RIVER
UPPER MAASIM DAM
LOWER MAASIM DAM
FEEDER CANAL TO MAASIM RIVER
SOUTH MAIN CANAL
NORTH MAIN CANAL
M.C. EXTENSION
BUSTOS DIVERSION DAM
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TPIP PUMP STATION
BPE PUMP STATION
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EXPANSION BOUNDARY
WORKING STATION BOUNDARY
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WORKING STATION
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IRRIGATION CANAL FOR REHABILITATION
IRRIGATION CANAL FOR NEW CONSTRUCTION
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ABBREVIATIONS AND GLOSSARY

ABBREVIATIONS

ACA : Agricultural Credit Administration
ADB : Asian Development Bank
AMC : Area Marketing Cooperatives
AMIADP : Angat Magat Integrated Agricultural Development Project
AMRIS : Angat Maasim River Irrigation Systems
BAI : Bureau of Animal Industry
BAEcon : Bureau of Agricultural Economics
BAEx : Bureau of Agricultural Extension
BCOD : Bureau of Cooperative Development
BPE : Bustos Pandi Extension
BPI : Bureau of Plant Industry
BPIS : Bustos Pump Irrigation System
BPW : Bureau of Public Works
BS : Bureau of Soils
CIS : Communal Irrigation Systems
CRB : Cooperative Rural Bank
DT : Ditch Tender
EC : Electric Conductivity
EIRR : Economic Internal Rate of Return
FAD : Farmers Assistance Department
FAO : Food and Agriculture Organization
FIA : Federation of Irrigators' Association
FIO : Farmer Irrigators' Organizer
FIOP : Farmer Irrigator Organizer Project
GDP : Gross National Product
GK : Gate Keeper
GNP : Gross National Product
HYV : High Yielding Variety
IA : Irrigators' Association
IBRD : International Bank for Reconstruction and Development
ICO : Irrigation Community Organizer

ICOP : Irrigation Community Organization Program
IDD : Institutional Development Division
IOS : Irrigator's Organization Specialist
IRRI : International Rice Research Institute
IS : Irrigation Superintendent
JICA : Japan International Cooperation Agency
KKK : Kilusang Kabuhayan at Kaunlaran (National Livelihood Program)
LB : Land Bank
LTG : Leader of Terminal Group
MA : Ministry of Agriculture
MC : Memorandum Circular
MLGCD : Ministry of Local Government and Community Development
MSD : Management Services Department
MWSS : Metropolitan Waterworks and Sewerage System
NFA : National Food Authority
NFAC : National Food and Agriculture Council
NIA : National Irrigation Administration
NCC : National Computer Center
NPC : National Power Corporation
MFD : Main Farm Ditch
NWRC : National Water Resources Council
PAGASA : Philippine Atmospheric Geophysical and Astronomical Service Administration
PCARRD : Philippine Council for Agriculture and Resources Research Development
PCB : Philippine Central Bank
PD : Presidential Decree
PIO : Provincial Irrigation Office
PMT : Project Management Team
PNB : Philippine National Bank
PO : Pump Operator
RB : Rural Bank
RID : Regional Irrigation Director
RIO : Regional Irrigation Office

SFD : Supplemental Farm Ditch
SFIO : Supervisor of the Farmers Irrigators' Organizers
SMD : System Management Department
SWMT : Supervising Water Management Technologist
TPIS : Tibagan Pump Irrigation System
TTC : Transportation Training Center
UNDP : United Nations Development Program
UNESCO : United Nations Educational, Scientific and Culture Organizations
UPLB : College of Agriculture, University of the Philippines, Los Banos
UPRIIS : Upper Pampanga River Integrated Irrigation System
USAID : United States Agency for International Development
USBR : United States Department of Interior, Bureau of Reclamation
USDA : United States Department of Agriculture
WCCS : Water Control Coordinating Section
WMT : Water Management Technologist

GLOSSARY

Unit of Measurement

Length

mm : millimeter
cm : centimeter
m : meter
km : kilometer

Area

sq.cm., cm^2 : square centimeter
sq.m., m^2 : square meter
sq.km., km^2 : square kilometer
ha : hectare

Volume

l, lit. : liter
cu.m., m^3 : cubic meter
MCM, $10^6 m^3$: million cubic meter

Weight

g : gram
kg : kilogram
ton, m.t. : metric ton

Others

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
lit./sec.	: liter per second
cu.m/sec., cms	: cubic meter per second
m/sec	: meter per second
PPM	: part per million
cavan	: 50 kg of palay
%	: percent
No.	: number
°C	: degree centigrade
°F	: degree fahrenheit
Cl	: chlorine
HP	: horse power
ET	: evapotranspiration
N	: nitrogen
P	: phosphorous
K	: potassium

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

A. Present Conditions and Problem Areas of the Project

A.01. Location and Service Area

The AMRIS Project provides one of the largest irrigation systems in the Philippines. The Project Area is located some 40 km northeast of Greater Manila in the provinces of Bulacan and Pampanga of Central Luzon.

The existing service areas of 31,485 ha are irrigated by the Bustos, Upper and Lower Maasim diversion dams and the Tibagan pumping station. In addition, a proposed expansion area is amounts to approximately 3,480 ha, of which about 3,100 ha is now unused during the wet season because the area is deeply submerged for four to five months annually.

A.02. Climate

The annual mean temperature observed at Ulingao Research Center for the last ten years is approximately 26.4°C. The monthly temperature shows little seasonal fluctuation. The annual mean relative humidity is 87 percent. The annual evaporation measured by means of A-pan averages at about 5.1 mm/day or 1,850 mm annually, which corresponds to approximately the annual mean rainfall. Seasonal variation ranges 4.2 mm/day in December to 6.8 mm/day in April. The average annual rainfall in the Area is estimated to be about 1,810 mm. The consecutive seven-day probable rainfall is also estimated at 551 mm for a return period of five years.

A.03. Soil and Water Salinity

The soils prevailing in the Project Area are clayey with moderately well developed structures because of alluvial sedimentation of the fine particles derived by river flooding under annually wet and dry condition, this giving different solid profile characteristics.

A.04. Land Use and Cropping Intensity

Double cropping land dominates on the middle and higher sides of the Area where irrigation water is available for two seasons. While along the marginal areas, single crop land only in the dry season is most common. Majority of the expansion area is being used as paddy lands only in the dry season due to being deeply submerged in the wet season.

Cropping intensity in the existing area reaches about 74 percent in the wet season and 91 percent in the dry season respectively, while the intensity in the expansion area is about 69 percent for the Area to be developed.

The present land use is estimated as follows:

Classification	Present Service Area (ha)	Expansion Area (ha)	Total
Rice field	31,485	2,401	33,886
Upland crop field	630	-	630
Forest (mainly fruit tree land)	1,580	-	1,580
Waste Land/Swamp	2,200	1,510	3,710
Right of Way	2,080	84	2,164
Residence/Industrial Area	4,725	5	4,730
Total	42,700	4,000*	46,700

* Irrigable area is estimated to 3,480 ha out of this.

A.05. Present Status of Irrigation Water Supply

The presently irrigated areas in the AMRIS are summarized by seasons based on the Harvest Report of the past three years, as follows:

Present Irrigated Area in Hectares

Year	Wet Rice	Dry Rice
1980	22,880	28,741
1981	23,845	28,144
1982	23,375	28,905
Mean	23,366	28,627

The diversion water requirements are summarized as below:

Present Diversion Water Requirement (MCM)

Item	Upper Massim	Lower Massim	Tibagan P.I.S.	Angat North	M.C. South	Total
Maximum	13.2	15.4	23.6	241.5	196.5	489.9
Minimum	5.3	9.7	16.1	158.7	133.6	325.3
Mean	7.9	13.6	20.0	208.8	167.8	418.1

Note: durations of computation are 11 years from 1972 to 1982.

Major water sources of the AMRIS are the Angat and Maasim rivers. The Angat River, supported by the storage function of the Angat Reservoir, allows irrigation water for diversion almost adequate to meet the needs in the AMRIS area at the point of the Bustos Diversion Dam. The Maasim River, on the contrary, does not contribut much to the purpose of irrigation water supply because of inadequate distribution of runoff during the dry season. Some areas are irrigated by use of return flow from the upstream irrigated area, and others are served by Pampanga water by use of pumping facilities.

A.06. Water Resources Availability

Results of a water balance study under present conditions show that shortage in irrigation water occurred twice during the wet seasons in October 1977 and September 1979. On the other hand during the dry season, the Area suffered from shortage in irrigation water for diversion as frequent as eight times in the past 11 years.

Judging from the results of the study, as well as the inflow into the reservoir, storage capacity and demands reported by MWSS and NPC for water supply and power generation respectively, it could be expected that the presently irrigated area in the AMRIS would not lack irrigation water supply, even during drought, even once in five years, this is even if the operation rule curve of the Angat Reservoir is slightly modified just to meet the actual demand for irrigation.

A.07. Irrigation Facilities

Major irrigation facilities in the Project Area consist of four diversion dams, three pumping stations and conveyance canals including appurtenant structures.

The Bustos dam is equipped with six sector gates 79 m long and 2.5 m high. Automatic gate operation, however, was successfull for only two years after installation of operational mechanisms. These mechanisms and rubber gate sealers should be replaced in order to operate the gate stably and prevent sedimentation in the gate chambers.

The Upper Maasim Dam which was constructed in 1949 is of removable type equipped with eight gates. Because of flood damage operation of the gates became impossible and the flood way gates were fixed by concrete in 1963. At the same time, the upper portions of intermediate piers were demolished for the purpose of making smooth flood flush-out possible. These inoperable gate systems should be reconstructed in order to decrease flood damages in adjacent river areas.

The Lower Maasim Dam is no remarkable improvement except flood and scouring sluiceway.

Major constraints of the conveyance canal are siltation, erosion of canal sideslopes and vegetation control. Carrying capacity of the canals in several parts is decreased due to heavy siltation, erosion and insufficient maintenance. Therefore, several of the canals should be desilted, widened, and heightened and additional canals should be built. The existing related structures are functioning comparatively well except for some structures. Major problems are improvement and rehabilitation of gate mechanics due to lack of rust prevention, damage and missing spare parts, and large number of inoperable and illegal turnouts.

A.08. Present Status of the Drainage

There are two problems where drainage systems are concerned. Surrounded by the Pampanga, Angat, Maasim and other rivers, the large scale submerged area lies in the lower reaches of the service area which used to suffer from frequent inundations. On the other hand, many local areas of relatively high elevation are located along drainage creeks receiving local inundations mainly due to insufficient drainage facilities.

The north side service area suffers from inundation two to nine times a year for a total duration of 27 to 128 days. The maximum water level of inundation varies depending on the flood involved from 2.73 to 6.81 m above mean sea level, resulting in inundated areas of 4,100 to 13,000 ha, of which 1,500 to 9,000 ha lie within the service area. The statistical evaluation for the computed result of inundation is summarized as follows:

Probable Dimension of Flood (Angat North)

Return Period (Year)	Maximum Water Stage Pampanga (m)	Maximum Water Stage N.Candaba (m)	Maximum Water Stage The Area (m)	Inundated Area (ha)	Maximum Duration (days)	Total Duration (days)
2	5.12	6.07	4.29	8,790	41	81
5	5.86	6.93	5.25	11,000	65	116
10	6.34	7.48	5.88	12,250	82	140
20	6.82	8.03	6.47	13,330	89	163

On the other hand, the south side service area has been inundated more frequently seven to 16 times annually for a total duration of 27 to 114 days. The maximum water level of inundation varies from 1.09 to 2.10 m above mean sea level with an inundated area of 850 to 2,050 ha. The probable dimensions of flood obtained by the statistical evaluation are summarized as follows:

Probable Dimension of Flood (Angat South)

Return Period (Year)	Maximum Level Labanga (m)	Maximum Level The Area (m)	Inundated Area (ha)	Maximum Duration (days)	Total Duration (days)
2	2.83	1.40	1,250	24	87
5	3.40	1.97	1,970	30	98
10	3.75	2.02	1,990	34	106
20	4.11	2.13	2,030	40	117

A.09. Drainage Facilities

There exists 136 drainage creeks with a total length of about 450 km within the boundary of the service area. All the canals and creeks are earth canals and rather small in carrying capacity due to poor maintenance and many water lilies. In total 11 drainage outlets, consisting of one to three rows of culvert with flap or sluice gates, are provided at the end of drainage creeks along the Pampanga, Maasim and Labangan Rivers. The majority of the control gates do not function well.

A.10. On-farm Facilities

The density of turnout is sufficient to fulfill the NIA's standard of 30 to 50 hectare per unit. In many places, however, the gates installed in the existing turnouts are deformed and do not function well for proper water management.

Farm ditches are comprised of main and supplementary ditch with an averaged density of some 43 m per hectare. At present, the total length of farm ditches has been decreased due to failure in getting farmers' consensus in the proper location of the ditches.

The existing farm drains account for about 13 m per hectare. This too is lower than the density of NIA's standard.

The service and access roads constructed along the canals and creeks are about 570 km long, which corresponds to 55 hectares per km. Part of the road is passable for 4.W.D.V. though other parts are very rough and narrow.

A.11. Present Organization and Staffing of AMRIS

The AMRIS office, headed by Irrigation Superintendent V, has six sections; those for Administrative, Bill and collection, Operation and Maintenance, Water Control Coordination, Equipment and Agricultural Coordinating Sections. The Irrigation Superintendent III, as the chief of O & M section, supervises twelve working stations which is in control of three to five Divisions of 500 to 750 ha each.

The assigned personnel of the AMRIS is 441 in total as of the end of August 1983. According to the results of the personnel audit of the AMRIS conducted by the Management Service Department (MSD) in NIA Central, the total number of staff was reduced to 382 persons from existing 441. Major reason for this difference is non-fulfillment of MC No.2, 1982 which prescribes the works standards for Watermasters, Water Management Technicians and Ditch Tenders.

A.12. Operation and Maintenance

System operations from diversion dams to turnout level are being carried out by the staffs of O & M section and water control coordination section and working stations. Operations of on-farm level, on the other hand, are executed by the beneficiary farmers.

The sector gates of the Bustos diversion dam are not operated automatically because the mechanical system of the gates has not functioned well since 1959. Irrigation canals inclusive of appurtenant structure are functioning except for some gate systems of the headgate and turnouts. Each pumping system is operated and maintained nicely and gets many farmers' appreciation.

Preparation and submission of the report at the system level, however, seems to need tough work and much time. This reporting should be simplified and computerized as well, in order to reduce work volumes and execute it more effectively and efficiently.

Present maintenance work in the Project is being performed by the staff of O & M and equipment sections and working stations. In many irrigation and drainage canals, there are sedimentation problems arising from bank erosion and sloughing. Desiltation is unsatisfactory because of the negligible budget allocated for this. Heavy growth of aquatic vegetation and siltation have significantly reduced canal carrying capacity. Cleaning of vegetation from drainage and creeks has not been practiced as a maintenance activity.

Service roads along main canals and some laterals are being kept in good condition as compared to those along laterals or sub-laterals. Overtopping of the canal bank and road has frequently occurred. Besides, some road embankments along the canals are so low that they have become saturated and unstable from lateral over-checking. For keeping passable condition of roads throughout the year, gravel pavement is required as much as possible.

A.13. Farmers Organization and Activities

The number of Compact Farm Association (CFA), one of the irrigators associations, totaled 1041 as of 1978.

Purpose and criteria of the CFA. formation are, (1) to maintain and clean the farm ditches, (2) to schedule and handle water distribution of members, (3) to campaign and collect irrigation service fee from the members, (4) to resolve conflict on the water distribution and maintenance of farm ditches among members, and (5) to negotiate and coordinate their problems with NIA and other government agencies concerned.

Overall evaluations of their activities and functions through field survey and discussions with official concerned are as following.

- The associations were hurriedly established during the construction period and farmers were not given adequate orientation as to the proposed role and function of the associations.

- The associations were not organized on a formal basis and there were no written rules and regulations to bind the members of the associations.

- Majority of the beneficiary farmers practiced traditional farming without complete irrigation facilities at on-farm level.

- The associations were not given adequate incentive and continuous support from government agencies concerned, since they have also farmers associations of their own, which the composition is different from the compact farm associations.

- Efforts were made by the water management technician and other O.M staff concerned but it is still not enough for the acceleration of farmer supports.

A.14. Status of Irrigation Fee Collection

Irrigation fees are set by cavans of palay or cash equivalent at the prevailing government support price at the time of payment. The status of collection during last six years are summarized as follows:

Unit: Thousand Pesos

Fiscal Year	Collectable	Collection		Total
		Current	Back Account	
1977	6,541	2,890 (44)	636 (10)	3,526 (54)
1978	6,281	2,640 (42)	1,017 (16)	3,657 (58)
1979	7,940	3,446 (43)	1,021 (13)	4,467 (56)
1980	8,835	3,543 (40)	1,055 (12)	4,598 (52)
1981	10,046	4,953 (49)	1,383 (14)	6,336 (63)
1982	10,837	5,302 (49)	1,345 (12)	6,647 (61)

* Figures in parenthesis indicate collection efficiency.

A.15. Expenditure on Operation and Maintenance

NEDA Resolution No.20 (Series of 1978) states that irrigation fees are to be established at the levels that will provide for total coverage of working expenses incurred in the operation and maintenance of irrigation systems. The balance between revenue and expenditure of the O & M during last four years is summarized below:

Unit: Thousand Pesos

Fiscal year	Revenue	Expenditure	Balance	Deficit Ratio
1979	4,445	5,274	(-) 829	15.7%
1980	4,612	7,485	(-) 2,873	38.4
1981	6,352	8,725	(-) 2,373	27.2
1982	7,032	9,355	(-) 2,323	24.8
Mean	5,610	7,710	(-) 2,100	27.2

Remarkably big share in the annual expenditures has been taken by personnel service of 71 percent and power for pumping stations of 17 percent respectively.

A.16. Present Agriculture

Present cropping pattern in the existing area can be classified into three categories. Pattern A is mostly followed in fairly well drained areas wherein late maturing rice varieties can be grown twice a year. Pattern B is common to poorly drained low lying areas where only dry season rice can be grown using late maturing varieties due to submergence in the wet season. Pattern C covers a small area where double cropping with rice has been tried at a low intensity using early maturing varieties because of the insufficiency of irrigation water. Summary of the planted area is tabulated below:

Unit: Hectare

Pattern	Service Area	Planted Area: Wet Season	Planted Area: Dry Season
A	22,082	21,255	20,732
B	7,292	0	7,292
C	2,111	2,111	603
Total	31,485	23,366	28,627
Intensity (%)		(74.2)	(90.9)

Average rice yields in AMRIS area were reached about 4.3 ton per ha in wet season and 4.6 ton per ha in dry season in 1982, respectively.

B. Project

B.01. Project Components

The Project envisions increase in cropping intensity, upgrading of system management inclusive of irrigation efficiency, rehabilitation of the existing facilities, expansion of irrigation service area with appropriate irrigation and drainage facilities, uplevelling of collection efficiency of irrigation fees, and partial turnover of operation and maintenance works to capable irrigators' associations. Furthermore, the Project will promote the extension of crop diversification through agricultural supporting services in the Area.

In order to fulfill these objectives, the Project Area of about 35,000 ha including some 3,500 ha of new expansion areas involves the following components:

- Rehabilitation and upgrading of existing irrigation and drainage facilities including some expansion of these facilities in the existing service area of about 31,500 ha;

- Construction of irrigation and drainage facilities for new expansion area of about 3,500 ha with the same level of upgrading standard;

- Rehabilitation of existing roads and construction of additional service and access roads;

- Consolidation of on-farm facilities in the new expansion areas as well as in part of the existing service area;

- Strengthening of NIA operation and maintenance structures through joint operation between NIA and capable irrigators' associations;

- Establishment of capable irrigators' associations and gradual turnover of operation and maintenance works of the systems below sub-lateral canals level to the IAs taking development stage and capability of the IAs into consideration;

- Establishment of demonstration farm for the crop diversification program and promotion of scheme extension and;

- Procurement of equipment and vehicles both for construction of on-farm facilities and O & M works, and instrument for operation and maintenance works.

B.02. Proposed Land Use and Cropping Pattern

Proposed land use is slightly different from present one providing adequate irrigation and drainage systems and proper water management for the Area. The proposed land use is summarized as follows:

Classification	Existing Area (ha)	Expansion Area (ha)	Total (ha)
Rice field	31,485	3,480	34,965
Upland field	630	-	630
Forest or orchard	1,580	-	1,580
Waste land, swamp	2,200	415	2,615
Right of way	2,080	100	2,180
Residence, others	4,725	5	4,730
Total	42,700	4,000	46,700

The cropping pattern depends on the topographical features, soil characteristics of farm land, availability of irrigation water and necessary repairing period. Accordingly, five patterns including diversified cropping are proposed for both the wet and dry seasons. The proposed cropping patterns and acreages are presented as belows:

Pattern	Wet season (ha)	Dry season (ha)	Total (ha)
A	20,212	20,212	40,424
B	2,111	2,111	4,222
C	2,250	4,500	6,750
D	2,000	2,000	4,000
E	0	8,392	8,392
Total	26,573	37,215	63,788
Crop Intensity(%)	(76.0)	(106.4)	(182.4)

B.03. Irrigation Plan

In connection with the proposed irrigation scheme of the Area, detailed water balance studies were made, including the Angat Reservoir operation. Various operation rule curves were prepared and inputted in the study to simulate the optimal solution of the Reservoir operation which meets water demands by MWSS for water supply, by NIA for irrigation and by NPC for additional power generation.

Proposed cropping area which needs irrigation water supply is 26,579 ha and 34,965 ha for the wet and the dry seasons respectively.

Irrigation water requirement was estimated at 450.9 MCM, in terms of annual diversion water requirement based on the proposed schedule of irrigation supported by hydrological data.

In addition an overall irrigation efficiency of 60 percent was adopted in the study.

With regard to MWSS water demand, seasonal requirements were put into calculation as scheduled by MWSS. Actual requirements for water were computed as 22 cu.m/sec in discharge on 695.4 MCM in volume. On the other hand, NPC has no specified rule to measure water requirements for power generation. Actual achievement of production of power generation in terms of both annual amount and seasonal pattern, was therefore fully considered in order to supervise the computation.

Consequently through simulation studies of water balance, the operation rule of the Angat Reservoir was proposed by two curves presenting the upper and lower limits of the reservoir water level by time. With application of this rule, no shortage of MWSS water supply is expected. Estimate on possible production of power generation was examined to follow the actual results. Irrigation water requirements for the AMRIS are not expected to encounter shortage in water even during a critical dry period of once every ten years.

A conference entitled "On the Operation Rule Curve for the Angat Reservoir in Connection with the Proposed Cropping Schedule in the AMRIS" was held on August 15, 1983, attended by NWRC, MWSS, NPC and NIA.

NIA summarized the major achievements of the study including a proposal for adoption of the proposed rule curves, which were almost an accepted by all authorities who attended.

Accordingly, the proposed areas of 34,965 ha can be irrigated following respective crop calendars of of both the wet and dry season crops.

B.04. Drainage Scheme

To avoid adverse flow from the Pampanga and the Maasim Rivers as well as from the North Candaba Swamp, and to reduce flood water level and flood duration in the Area, two alternative plans of flood protection dikes and four cases of improvement of drainage facilities in the Area were put into the flood simulation model.

Simulated results of every combination of plans and cases were evaluated in terms of acreage and water level of inundation, flood duration as well as cost and benefit ratio. Construction of protection dike contributes to prevention of adverse flows from the rivers. Runoff caused by rainfall in the Area is, however, forced to stagnate as long as the external water level in the rivers exceeds the external level of pre-construction of dikes, and the Area still remains inundated with a great degree of damage to crops when it is planted with rice. In addition B/C ratios were calculated much lower than is economically acceptable. These plans are therefore not recommended as far as costs and benefits are concerned.

From the study made on duration, period of occurrence and frequency of inundation, cropping pattern D was proposed as the one acceptable practically in the higher portion of the inundated area for wet season rice. With adoption of pattern D cropping calendar and without any plan of protection dike, the Project would conservatively expect benefits from the existing inundated area of 2,000 ha elevated between 3.5 m and 4.5 m above mean sea level by slightly shifting cropping calendar.

B.05. Improvement and Construction of Facilities

The following facilities will be improved and constructed based on irrigation and drainage plans.

	Facilities	Improvement	Construction	Total
1.	Diversion Dam	3.0 units	1.0 units	4.0 units
2.	Irrigation Canal	161.1 km	110.2 km	271.3 km
3.	Structures for Canal	2,866.0 pls.	166.0 pls.	3,032.0 pls.
4.	Drainage, creeks	188.5 km	13.8 pls.	202.3 km
5.	Structures for drainage	16.0 pls.	38.0 pls.	54.0 pls.
6.	Service and Access Road	263.3 km	22.5 km	285.8 km
7.	On-farm Facility	29,374.0 ha	5,591.0 ha	34,965.0 ha

B.06. Agricultural Production

The tentative target yields with project for the rice and diversified crops can be expected to increase considerably in the future by applying the proper fertilizers and plant pesticides, provided the improved water management can be realized. Target yield of the crops is especialed in the following table.

Crops	Future with Project
Wet Season Rice	4.5 (ton/ha)
Dry Season Rice	5.2
Watermelon	8.0
Green Corn	2.7
Yellow Corn	4.0
Pole Sitao	7.5

The expected incremental production can be estimated from the unit yield and proposed land use.

	Item	Wet Season	Dry Season	Total
1.	Future Without Project	95,400 ton	144,100 ton	239,500 ton
2.	Future With Project			
	Paddy	122,700	177,000	299,700
	Green Corn	-	4,300	4,300
	Water Melon	-	5,400	5,400
	Yellow Corn	-	6,300	6,300
	Pole Sitao	-	5,100	5,100
3.	Incremental Production			
	Paddy	27,300	32,900	60,200
	Green Corn	-	4,300	4,300
	Water Melon	-	5,400	5,400
	Yellow Corn	-	6,300	6,300
	Pole Sitao	-	5,100	5,100

B.07. Pilot Demonstration Farm of Upland Crops

Pilot demonstration farm should be operated under the cooperative administration of NIA and BAEx taking the former experience of promotion on the upland crop diversification into account. The pilot farms would be ten farms with one hectare each in the respective proposed blocks.

B.08. Project Implementation

The Project shall be implemented in parallel with the following three aspects such as ordinary operation and maintenance work, construction work and promotion of the establishment of irrigators' associations. These works and activities have a close relationship with each other so that organizational structures shall be incorporated to one executive body under the Irrigation Superintendent cum Project Manager. The period of project implementation is tentatively assumed to be seven years including one year of preparatory term taking work volumes of construction, time schedule of IAs establishment and so forth into consideration. Construction manners will be adopted on the contract basis for major work such as diversion dams, canal systems, service roads and appurtenant structures, and force account basis for on-farm facilities expansion and other minor works. The programs which consist of the establishment of several IAs, training to beneficiary farmers, and turnover of O & M work to IAs, will be implemented according to the timetable within the period of project implementation. During the period, attention should be paid how to give farmers opportunity of participating in the Project activities especially for establishment of IAs and design and construction of on-farm facilities development.

B.09. Strategy of Upgrating O & M Structures

The strategy of upgrading O & M structure of the Project is summarized from view points of physical, organizational, and financial aspects and agricultural development.

Physical Improvement Aspect

For the better water management, necessary irrigation water must be allocated up to the terminal facilities in proper quantity as well as at the proper time; excess water shall be drained out adequately. Upgrading the irrigation efficiency is of much importance for effective use of the limited water resources and expansion of the service area. For this purpose to be realized, the first necessity is to keep satisfactory conditions of the facilities in the Area so as to enable the proper water management. AMRIS is not an exception where the present O & M status seems not so satisfactory, being affected by continuous financial deficits, similar to other projects. It will be important to intensify the facility maintenance work by reasonable re-allotment of the limited annual budget. The better water management would be thus realized, gaining the confidence of farmers in the Project. Aside from this, there may be another way of balancing the budget for maintenance of the roads by requesting their authorization as public barangay roads under the current road law system.

Organizational Aspect

Present AMRIS office organization and staffing seems slightly excessive compared to the NIA working standard. Solution of the major constraints which have been affecting the NIA's operation and maintenance structures is to reduce personnel service costs within reasonable working capability. In order to realize the said purpose, partial turnover to the irrigators' association of the present O & M work conducted by NIA will result in decrease of financial O & M expenditures currently borne by NIA.

First of all in realizing the long term prospect, the farmers shall be instructed to organize irrigators' associations step by step by themselves. In this connection, a useful reference is the Farmer Irrigators Organizer Program (FIOP) which has been conducted in the AMRIS Area. The first step shall be taken to form irrigator organizations during the project implementation, in which joint operation of the facilities with farmers be smoothly carried out. With the Irrigators' Associations (IAs) established, the partial turnover of the facilities' O & M shall be made possible as the second step which might also give some favorable changes in the organization of the NIA office. For instance, ordinary tasks will be simplified and computerized in order to upgrade management efficiency.

Financial Support Aspect

Overall expenditures for operation and maintenance of the facilities under the NIA irrigation system are to be balanced with the irrigation fees collected from the beneficiary farmers. The irrigation fees shall be paid from the benefit obtained by the farmers through the irrigation water supply.

From the viewpoint of public utility of these roads serving many unspecified people, it should be urgently investigated how to request them authorized as barangay roads and to obtain the government financial support. Since the minimum width requirements of the barangay road is defined to be seven meters, some alleviation of the existing road law is necessary.

In order to decrease O & M costs, the inevitable budget for the repair work of facilities when damaged by natural disasters such as typhoon and heavy flood shall be requested also to be specially accounted as the government's responsibility.

Agricultural Development Aspect

By means of the improvement of existing irrigation facilities in the Project Area, great strides in agricultural production shall be anticipated as a result of stabilized allocation of irrigation water and the development of expansion areas as well. Increased cropping intensity derived from efficient use of facilities and water source will contribute to overall increase. The farmers will be favored with the higher income sufficient to pay irrigation fees. Incremental collectable amount of irrigation fees is expected to be about 3.5 million pesos by the increased cropping intensity and production from the proposed expansion area.

B.10. Operation and Maintenance Cost

The prospected annual O & M costs based on the staffing plans for before and after partial turnover to the IAs are described as follows:

(Unit: ₱1,000)

Description	Before Turnover	After Turnover NIA	After Turnover IAs	After Turnover Total
1. Personnel services	6,468	4,900	1,822	6,722
2. Power illumination	1,738	1,800	-	1,800
3. Other expenses	1,374	1,530	3,040	4,570
Total	9,580	8,230	4,862	13,092
Service area	34,965 ha	34,965 ha	34,965 ha	34,965 ha
O & M cost per ha	0.274	0.235	0.139	0.374

B.11. Irrigation Fee Collection

The percentage of collected fees to collectable fees and collected fees to actual expenditures for the last five years from 1978 to 1982 are about 58 percent and 72 percent on the average, respectively.

Incremental collectable irrigation fees are estimated at about 3.51 million pesos as the surplus between without project amount of 12.57 million pesos and with project amount of 16.08 million pesos. The collection efficiencies of irrigation fees are estimated as follows:

(Unit: ₱1,000)

Item	Before Turnover	After Turnover
Collectable fees (A)	16,079	16,079
Required O & M cost (B)	9,580	13,092
Ratio (C) = (B)/(A)x100	60	81

The current collection efficiencies of irrigation fees including back account are about 60 percent. From the above table, the target collection efficiency should be increased to about 80 percent in future.

B.12. Plan for Association Establishment

Establishment of IAs shall be commenced in the manner that the associations belonging to the same canal system shall be formed preferably in the same year as the construction schedule. The first priority shall be given to those associations in the proposed expansion area. The details are shown below.

Years	North Area	South Area	Total	No. of T.G.
First Year	31	32	63	332
Second Year	48	32	80	421
Third Year	68	29	97	474
Total	147	93	240	1,227

B. 13. Project Cost

The project cost consists of that of survey and design, civil works, procurement of equipment for on-farm facilities construction works and post project operation and maintenance of the systems, land acquisition, institutional development activities, project facilities, consulting services, administration as well as physical and price contingencies.

The total investment cost, including the price escalation but excluding the interest during the construction period, was estimated at 511 million pesos (equivalent to US$46.45 million), of which about 250 million pesos will be foreign currency component and about 261 million pesos local currency component, respectively.

The summary of the project cost and disbursement schedule is presented as below:

SUMMARY OF THE PROJECT COST

(Unit: ₱'000)

Description	Foreign Currency	Local Currency	Total
1. Survey design	-	4,000	4,000
2. Civil works	111,519	84,989	196,508
3. Procurement	33,430	1,070	34,500
4. Land acquisition	-	2,255	2,255
5. Project facilities	372	1,130	1,502
6. Institutional development	308	15,486	15,794
7. Consulting services	24,882	5,278	30,160
8. Administration	-	28,472	28,472
9. Physical contingency	25,489	21,320	46,809
Sub-total	196,000	164,000	360,000
(%)	(54.4)	(45.6)	(100.0)
10. Price escalation	54,000	97,000	151,000
Total	250,000	261,000	511,000
(%)	(48.9)	(51.1)	(100.0)

SUMMARY OF THE DISBURSEMENT SCHEDULE

(Unit: ₱'000)

Project Year	Foreign Currency	Local Currency	Total	Proportion (%)
1st	13,652	9,279	22,931	6.4
2nd	58,746	28,669	87,415	24.3
3rd	23,863	25,756	49,619	13.8
4th	34,897	40,307	75,204	20.9
5th	26,184	25,710	51,895	14.4
6th	23,981	23,975	47,956	13.3
7th	14,676	10,304	24,980	6.9
Total	196,000	164,000	360,000	100.0

Note: The price escalation is excluded from the above figures.

B.14. Project Benefit and Evaluation

Incremental agricultural benefit, which is about 75,667,000 pesos, is difference between the with project production value of 377,623,000 pesos and the without project production value of 301,956,000 pesos. Economic initial cost of project estimated is about 332,652,000 pesos. The replacement cost has also been estimated for pumps and gates and other O & M equipments that require replacement during the project life. The incremental economic O & M cost after completion of the Project is estimated at 2,771,000 pesos per year.

The streams of economic cost and benefit over the project life of 50 years have been converted into the present worth using various discount rates. The economic internal rate of return thus calculated is 17.53 percent.

B.15. Sensitivity Analysis

The sensitivity analysis has been attempted for the following cases with respective EIRR's.

(1) Ten percent increase in project cost 16.15%
(2) Twenty percent increase in project cost 14.98%
(3) Ten percent reduction in target yield 13.84%
(4) Two years delay in attaining full benefit... 15.72%
(5) Combination of case (1) and (3) 12.73%
(6) Combination of cases (2) and (3) 11.77%
(7) Combination of cases (1) and (4) 14.57%
(8) Combination of cases (2) and (4) 13.58%

B.16. Farm Budget Analysis and Cost Recovery

Farm budget analysis has been also conducted to measure the project benefit accruing to the representative beneficiary farmers of averaged farm size of 1.4 hectares. As a result of analysis, with project farm family surplus increases by about ₱1,900 and ₱1,600, respectively, for owner operator and lessee.

Cost recovery required under the study is established that provides for total reimbursement without interest of public investment on this project within the project life of 50 years as well as for total O & M cost. The sum of 206 pesos per hectare per year for investment and 374 pesos per hectare per year for O & M cost is multiplied by farm size of representative farm household of 1.4 ha to arrive at the level of 812 pesos. Since this level is less than 50 percent of the difference in farm family surplus both for owner operator and lessee, it is safely assumed to be within the farmers' ability to pay.

B.17. Prospected Socio Economic Impact

Aside from the direct project benefit derived from the incremental production of agricultural products, the Project is anticipated to give rise to the following socio economic impact.

- Expansion of employment opportunities
- Expansion of agricultural production
- Increase in disposable income among farm households
- Improvement in transportation network

C.01. Conclusion

Consideration of all these discussion previously along with EIRR of 17.53 percent leads to the conclusion that the project implementation is technically sound and economically feasible.

CHAPTER I. INTRODUCTION

CHAPTER I. INTRODUCTION

1.1. General Background of the Project

1.1.1. General

The Report was prepared in accordance with the Implementing Arrangement for the technical cooperation on the Angat and Maasim River Irrigation Systems (AMRIS) Project between the Republic of the Philippines and Government of Japan.

In compliance with the request of the Government of the Republic of the Philippines, the Government of Japan dispatched a survey team through the Japan International Cooperation Agency (JICA), the executing agency for overseas technical cooperation programs under the Government of Japan, and let the team conduct the field survey, investigation and study for the AMRIS Project in the Republic of the Philippines based on the preliminary survey conducted in February 1982. The survey team completed a feasibility study for the Project that involved preparation of the comprehensive agricultural development plan for the total service area of about 35,000 ha.

The feasibility report, consisting of the Main Report and Appendices with major drawings, has been compiled based on the results of the surveys and studies conducted in the field as well as discussions held among the Philippines Governmental officials, the Supervisory Committee's Members and the Team.

1.1.2. Historical Background of the Project

The Angat-Maasim Rivers Irrigation Systems is one of the oldest and largest irrigation systems in the Philippines. It is located some 40 km northeast of Manila in the provinces of

Bulacan and Pampanga in Central Luzon. The system with a diversion dam located in the Angat river in San Rafael, Bulacan and another in the Maasim river in Candaba, Pampanga, was built in 1957. It covers a total service area of about 26,400 ha.

Before implementing the Angat Magat Integrated Agricultural Development Project (AMIADP) which had been financed by the ADB, the existing irrigation facilities consisted of two main canals and 13 laterals, having a total length of about 400 km. Of the total service area of 26,400 ha, only 13,400 ha are actually irrigated for year round cultivation. The remaining area of some 5,900 ha are not irrigated during the dry season, while some 7,100 ha are submerged during the wet season.

In order to overcome major constraints in the Project Area, the National Irrigation Administration (NIA) requested technical assistance from the Asian Development Bank (ADB) for implementation of irrigation water management at the farm level in 1968. The Angat and Magat Irrigation Systems were recommended by the ADB as the pioneer models for the system wide extension of the water management project, being the largest and most advanced irrigation systems of NIA at that time. The AMIADP for which the ADB financed about US$10.00 millions was commenced in 1973.

The main objective is to expand and increase the irrigation service area to its potential hectarage both in the wet and dry seasons, through improvement measures on the existing irrigation facilities and water management, integrated agri-technological and institutional supports.

Consequently, the total service area after the Project covers about 30,200 ha inclusive of the new expansion area of some 3,800 ha. There are obvious improvement and progress prevailing in the Project service area both in engineering and agricultural aspects. The necessity has been stressed by the people within the Project Area of undertaking additional works for the Area not included in the Project Area and repair or rehabilitation works in the existing Project Area.

1.2. Scope of Works and Assignment Accomplished

1.2.1. Scope of the Study

The major scope of works for feasibility study on AMRIS project is summarized, based on the Implementation Arrangement, as follows:

- The feasibility study will be undertaken by two study teams in consideration of the limited study period of two years from 1982 to 1984; one study team for UPRIIS and the other for AMRIS and technical assistance for the study of 18 national irrigation systems.

- A new water resources development plan will be formulated for the irrigation systems short of irrigation water, however, full-scaled river training for the inundated areas due to floods will not be included in the study.

- On-farm development in the study will be confined to the level of farm ditches and farm drains, and improvement works of ditches and drains functioning reasonably well will not be considered in the study.

- Road development will be, in principle, limited to the service roads for the O & M of irrigation and drainage facilities, however, the effective utilization of the other roads will be taken into consideration for farming operation.

- The study team for AMRIS will undertake a careful and detailed study of farmers' organization and institutions.

- If the necessity of mapping arises in the study, NIA will be responsible for such mapping.

- A JICA advisory team, with the assistance of NIA, will coordinate the activities of two feasibility study teams with respect to the engineering standard in O & M and others.

1.2.2. Assignment Accomplished and Counterparts Personnel

Listed herein are the supervisory committee members, team members and counterpart personnel of NIA assigned to the Project. The study was conducted in two stages, the first stage from September 1982 to February 1983 and the second stage from June 1, 1983 to December 1983.

<u>Supervisory Committee Members assigned to the Project</u>

1. Mr. Teizo Takahashi	Chairman of the Committee
2. Mr. Masaru Kimura	Advisor on Irrigation and Drainage
3. Mr. Terumoto Aoki	Advisor on Agro-Economy
4. Mr. Shozo Kitta	Ditto
5. Mr. Norio Matsuda	Coordinator

<u>Team Members assigned to the Project</u>

<u>A. First Stage</u>

1. Mr. Satoshi Kadowaki (Team Leader)	Sep. 22 - Nov. 21, 1982 Dec. 11 - Jan. 31, 1983

2.	Mr. Ichiro Sato (Hydrology)	Sep. 22 - Dec. 22, 1982
3.	Mr. Shigeo Ohtani (Irrigation and On-farm)	Sep. 22 - Dec. 5, 1982
4.	Mr. Masahiro Iida (Drainage)	Sep. 22, 1982 - Jan. 31, 1983
5.	Mr. Suenori Isayama (Design & Cost Estimate)	Oct. 21 - Dec. 28, 1982
6.	Mr. Hideo Hiratsuka (O & M Expert)	Sep. 22, 1982 - Jan. 31, 1983
7.	Dr. Yasuo Takijima (Agriculture & Soil)	Sep. 22, 1982 - Dec. 22, 1982
8.	Mr. Kensuke Iriya (Agro-Economy)	Oct. 21 - Dec. 28, 1982

B. <u>Second Stage</u>

1.	Mr. Satoshi Kadowaki (Team Leader)	Jun. 7 - Sep. 4, 1983
2.	Mr. Tsunesuke Hiwatashi (Irrigation & On-Farm)	Jun. 7 - Aug. 24, 1983
3.	Mr. Yoshiaki Kimura (Drainage)	Jul. 1 - Sep. 4, 1983
4.	Dr. Yasuo Takijima (Agriculture & Soil)	Jul. 1 - Sep. 4, 1983
5.	Mr. Seiji Tanabe (Design & Cost Estimate)	Jul. 1 - Aug. 24, 1983
6.	Mr. Hideo Hiratsuka (O & M)	Jun. 7 - Aug. 24, 1983
7.	Mr. Kensuke Iriya (Agro-Economy)	Jul. 1 - Sep. 4, 1983

NIA Counterpart Personnel assigned to the Project

1.	Mr. Benjamin U. Bagadion	Assistant Administrator for Operations
2.	Mr. Jose B. del Rosario, Jr.	Assistant Administrator for Project Development and Implementation
3.	Mr. Sebastian I. Julian	Department Director Systems Management Department
4.	Mr. Ediberto B. Payawal	Division Manager (SMD) Project Coordinator
5.	Mr. Leonardo S. Gonzales	Irrigation Superintendent V AMRIS (Chief Counterpart)
6.	Mr. Marcelino S. Santos	Irrigation Superintendent III AMRIS
7.	Mr. Felix N. Regalado	Irrigation and Drainage Engineer
8.	Mr. Armando I. Marcelo	Hydrologist, AMRIS
9.	Mr. Aurelio M. Punzalan	Institutional Specialist AMRIS
10.	Mr. Felix C. Jose	Agronomist, AMRIS
11.	Mr. Enrique R. Reyes	Drainage (North Zone Engineer) AMRIS
12.	Mr. Emmanuel R. Mendoza	Agro-Economist (WMT) AMRIS
13.	Mr. Leodegario S. Dalisay	Design Engineer, AMRIS
14.	Mr. Ambrosio I. Ignacio	Drainage Engineer
15.	Mr. Ernesto S. Ventura	Design Engineer
16.	Mr. Virgilio E. Flores	Soil Specialist

1.3. National Economy

1.3.1. General

(1) National Land

The Philippines, with a total area of about 300,000 sq.km, is composed of more than 7,100 islands and 11 main islands account for almost 95 percent of the total area.

(2) Population

The population was about 49.2 million in 1981 and the population density then was estimated at 164 persons/sq.km. Since 1970, annual growth rate of the population has been about 2.7 percent. An average family is composed of 5.6 persons.

According to the statistics in 1978, the labor force of people 15 years of age and over was 27.2 million persons, of whom the actually employed was about 16.7 million persons or 61.3 percent of the labor force.

Of the total employed persons, 52.2 percent was in agriculture, forestry and fisheries, 12.1 percent in manufacturing, 35.3 percent in service, and 0.3 percent in others.

Some changes in the types of employment are observable within a sector but the sectoral composition among the above four classifications has remained almost the same since 1976. The number of employed persons in the agriculture, forestry and fisheries sector increased by 13.6 percent.

(3) Administrative Regions

The Philippines has 12 administrative regions in 72 provinces. The provinces are divided into 1,505 Municipalities and the Barangay is the administrative unit of the Municipalities.

(4) General Economy

The gross national product (GNP) of the nation increased from 92.93 billion pesos in 1980 to 97.44 billion pesos in 1981 at 1982 constant prices and the annual growth rate was 4.9 percent. Annual growth rate in the last five years has been declining; 7.0 percent in 1976-77, 6.8 percent in 1977-78, 6.1 percent in 1978-79, 5.4 percent in 1979-80, and 4.9 percent in 1980-81.

Meanwhile, the gross domestic product in 1981 was 97.25 billion pesos at 1972 constant prices and the sectoral composition was 25.4 percent for agriculture, forestry and fisheries, 36.6 percent for manufacturing, and 38.0 percent for service.

The annual growth rate of the agricultural sector since 1977 declined by 1.5 percent point, whereas that of manufacturing sector increased by 1.3 percent and the growth rate of service sector remained almost the same.

The national income per capita at 1972 constant prices was 1,481 pesos in 1979 and its annual growth rate between 1975 and 1979 was 3.3 percent.

The consumer price index in the country had been rather stable between 106.8 and 107.3 from 1974 to 1978 at 1972 constant prices but it increased sharply to 116.5 in 1978-79 and 117.6 in 1979-80 and 112.3 in 1980-81. The price increase of petro-chemical goods is considered to have had an important effect on the consumer price index.

The national economy of 1981 had a total revenue of 45.37 billion pesos, of which 90 percent was earned from tax, while expenditure was 54.95 billion pesos. The major items of expenditure were economic development 46.4 percent, social development 19.9 percent, defence 9.7 percent, and general public utilities 24.0 percent.

The balance of international trade in the Philippines has been in the deficit every year. The total value of exports and imports in 1981 was 4.36 billion pesos and 6.06 billion pesos, respectively, resulting in a deficit of 1.7 billion pesos.

Agricultural products account for approximately 40 percent of exports, and in particular, coconut oil and sugar products are the main commodities. But the amount of exports of these two products has declined by 16 percent in 1981 as compared with that in 1977. In 1980, the paddy export of 230,625 tons earned 64.48 million US dollars. As for the imports in 1981, consumer goods accounted for 18.4 percent, capital goods 25.7 percent, and raw materials 55.9 percent.

1.3.2. National Development Plan

The current national development plan is based on the five-year plan between 1983 and 1987 issued in May, 1982 and the long-term Philippine development plan up to the year 2000.

The five-year plan is expected to achieve a target of annual average economic growth rate of 6.5 percent in the said period and gross national product per capita of 13,199 pesos by 1987.

The rate of inflation is expected to be cut to nine percent and the GNP to be 749 billion pesos. In these development plans, KKK (Kilusang Kabuhayan at Kaunlaran-National Livelihood Program) has been conceived earnestly in order to increase employment opportunity and to reduce the rate of unemployment to four percent.

In the agricultural sector the emphasis has been placed on the increased agricultural production in order to cope with the population increase, improve the nutritional level, and increase the income of farm households as well as to earn more foreign exchange.

Besides, the need to correct regional differences, conserve oil, develop new energy sources, consolidate irrigation system, develop agricultural roads and communication system by telephones, and construction of schools, etc. has been keenly felo.

The population is forecasted at 52 million in 1983 and 56.8 million in 1987 and its annual growth rate between 1983 and 1987 is expected to be 2.2 percent.

1.3.3. Agricultural Sector

The total value of agricultural production in 1980 was 37.55 billion pesos, of which coconut accounts for 9.26 billion pesos (25%), paddy 8.03 billion pesos (21%), and sugarcane 4.22 billion pesos (11%). These three crcps account for 57 percent of the total value.

In 1980, the paddy was planted on 29 percent (3.5 million ha) of the total harvested area (12 million ha) and the harvested area in the last five years has been constant. The consolidation of irrigation facilities, diffusion of the high yielding varieties, and improved cropping management all contributed to the average yield increase from 1.72 tons in 1976 to 2.14 tons per hectare in 1980.

As stated in the five-year plan, the status of agriculture in the Philippines is highly significant in terms of earning foreign exchange and supplying nutrients to the estimated population of 56.8 million in 1987.

1.4. Regional Economy

1.4.1. Area and Population

(1) The Bulacan Province

The Project Area extends over the Bulacan Province and the Pampanga Province and more than 80 percent of the Project Area lies in the Bulacan Province.

The Bulacan Province with a total area of 2,637.7 sq.km consists of 24 municipalities which are divided into 514 Barangays. The provincial capital is Malolos. The population of the Province was 1,096,363 persons in 1980 and the ratio of male and female was 1:1. Malolos has the largest population of 95,426 persons.

The population density in the Province is 416 persons per sq.km. The number of households was 190,934 in 1980 and the average family size was 5.6 persons, which is the same as the national average.

According to the 1975 statistics, the population of 10 years of age and over was 742,146 persons of whom approximately 44 percent (328,274 persons) were employed. The sectoral ratios to the total employed persons recorded in 1975 were 28 percent in the primary industry, 32 percent in the secondary industry, and 40 percent in the tertiary industry. About 82 percent of the employed in the primary industry were engaged in agricultural production.

The consumer price index in the Province between 1976 and 1980 was 136 per year, which was a little higher than the national average of 128.

(2) The Pampanga Province

The Pampanga Province is composed of 21 municipalities and one city and is divided into 526 Barangays. Total area of the Province is 2,180.7 sq.km and its east side is bordered on the Bulacan Province. The capital of the Province is San Fernando. The population in 1980 was, 1,181,590 persons and its annual growth rate in the last five years has been 2.5 percent, which was less than the national average of 2.7 percent. The population density was estimated at 542 persons per sq.km, which was 3.4 times higher than the national equivalent of 160 persons per sq.km.

The number of households was 190,934 and average family size was 6.2 persons, which is higher than that of Bulacan Province.

According to the statistics of 1975, the population 10 years of age and over was 710,598 persons and of whom 266,576 persons (37.5 percent) were employed. The sectoral ratios to the total employed persons were 32 percent in the primary industry, 24 percent in the secondary industry, and 44 percent in the tertiary industry. About 88 percent of the employed persons in the primary industry were engaged in agriculture.

1.4.2. Agricultural Sector

(1) The Bulacan Province

The main industry in the Bulacan Province is agriculture on the fertile soil and farmers also engage in fishery, animal husbandry, and cottage industry such as wooden crafts, sewing, and etc.

According to the census of 1975, 73,621 persons were engaged in agriculture.

Total paddy planted area in 1980 was 102,736 ha, of which 72,180 ha is irrigated. The total palay production in the Province from April 1978 to April 1979 was 432,627 tons. The provincial agriculture is highly dependent on palay production.

The secondary crop is corn. In 1980, 2,191 tons of corn was harvested in an area of 413 ha. Upland crops are grown in the municipalities like San Miguel and San Ildefonso located at a higher elevation.

Vegetables like sitao, tomatoes, pechay eggplants, ampalaya, squash, potato, cucumber, etc. are planted at Bustos, Pulilan, Sta. Maria, and so on. Total planted area of vegetables was 1,789 ha and their production was 16,898 tons in 1980. Vegetables produced are mostly consumed in the Province but part of them are transported to the Metropolitan Manila Area from nearby municipalities.

Other crops like cassava, root crops, fruits, and watermelon are also grown. The number of carabaos in 1979 was 19,825 heads, which is a decline of 12,563 heads as compared with that of 1975. The sharp decline in such a short time is attributed to the Foot and Mouth Disease, that took place in 1976 and the diffusion of hand tractor of 12 p.s. which retail at about 8,000 pesos. The carabao has, however, recently been replacing the hand tractor because of the higher production cost caused by an increase in oil price.

The number of cattle has also been reduced by 11 percent in 1980 as compared with 13,300 heads in 1975, but recently the number has been increasing. Meat production from cattle increased from 429,744 ton in 1977 to 665,528 tons in 1979 due to the increased number of cattles. The number of other livestock raised such as hogs, goats, chickens, and ducks is 206,254, 19,604, 2,531,553, and 459,990 respectively. These are kept both for domestic consumption and as a secondary source of income.

(2) The Pampanga Province

Agriculture is also the main industry in Pampanga and the province is known as the granary and sugar belt of Central Luzon. According to the census of 1971, about 90,115 ha or 41 percent of the total area of the province is classified as agricultural lands, of which 87,236 ha (97 percent) are planted mainly with sugarcane and paddy. The number of people employed in agriculture was 74,910 according to the census of 1975.

The above two crops account for almost 90 percent of the present land used. Palay planted area in 1980 was 64,559 ha, of which 46,131 ha was irrigated and 15,896 ha was rainfed. Total palay production was 393,442 tons and average yield per hectare was 3.67 tons. Sugarcane is also a main crop in the Province, and is planted in an area of 24,611 ha, equivalent to 17 percent of the total planted area with production of 85,929 tons. Other crops planted are corn, citrus, fruits, vegetables, beans, and root crops, etc.

According to the survey conducted by Bureau of Animal Industry, the number of livestock and poultry in 1979 was 69,050 heads of carabao, 1,090 heads of cattle, 139,640 heads of hog, 1,351,952 of chicken, and 476,030 of duck. The number of livestock farms in the Province is 3 for cattle, 2 for carabao, 96 for hog, 184 for chicken, and 26 for duck. Artificial insemination is practiced for carabao and cattle.

1.4.3. Other Related Industries

Southern part of the Bulacan Province borders on the Metropolitan Manila Area and is reached by a one hour car journey using the highway from Manila to Malolos. Taking advantage of these geographical conditions, various kinds of industry sprung up such as cement, ceramic plant, chemical industry, textile mill, food processing plant, footwear factory, and metal industry, etc. In some municipalities facing the Manila Bay, inland fisheries are also common in an area of 19,000 ha and 29,934 tons of fish were caught in 1980. Cultured fish are Tilapia and Carp, but recently this industry has been plagued with problems like water pollution, lack of flood control, and high production cost, etc.

The Bulacan Province is rich in mineral resources. In the east area of the Province, iron, clay, feldspar, limestone, marble, quartz, silica, and etc. are deposited. The value of production of these mineral resources amounted to about 300 million pesos in 1978, particularly the cement industry generated 269 million pesos. The Bulacan Province produces almost 93.6 percent of non-metalic resources in Central Luzon.

The Pampanga Province is not blessed with mineral resources except for pumicite and pumica. There are many wooden craft industries and 18,760 small food shops.

CHAPTER II. THE PROJECT AREA

CHAPTER II. THE PROJECT AREA

2.1. Location

The AMRIS project is one of the largest irrigation systems in the Philippines. The Project Area is located some 40 km northeast of Greater Manila in the provinces of Bulacan and Pampanga of Central Luzon. The system was completed in 1927 with a diversion dam located on the Angat River in San Rafael, Bulacan and another dam located on the Maasim River in Candaba, Pampanga. It covers a total service area of 31,485 ha.

The service area is bounded by the meandering Pampanga and Maasim Rivers along its western and northern limits and by the Malolos, Matimbo and Mambog Rivers on its southern borders.

2.2. Social Environment

2.2.1. Population

The population survey is conducted every four years and based on the population in 1975 of 470,165 persons, the population of 1982 in the Project Area is estimated at 543,160 persons. The 1980 census shows the proportion of female and male was 50 percent each. There are no recent data available on the number of population by age, but according to the population census of 1975, the population is composed of 29 percent of those below 10 years of age, 24.3 percent of 10 - 19 years, 17.3 percent of 20 - 29 years, 18.5 percent of 30 - 49 years and 11 percent of 50 years and over. Considering those of 15 years to 60 years of age as the labor force, they account for about 65 percent of the total population.

2.2.2. Socio-Economic Conditions

The Project Area covers the Bulacan Province and the Pampanga Province but more than 80 percent of the Area lies in the former Province. The number of municipalities in the Area is 15 in the Bulacan Province and four in the Pampanga Province.

There are 24,560 farm households in the Area and the average farm size is 1.4 ha per farm household. Since most of the farm households lack capital for increased agricultural production, agricultural management has been facing difficulties due to the rise in price of agricultural input materials. In order to improve such circumstances and increase agricultural income, introduction of the upland crops after the second harvesting of palay was planned in the dry season of 1981. This program has been already instituted in part of the Project Area but actual planted area for upland crops was much smaller than expected. KKK Project aiming at increased farm income covers a wide range of activities like wooden crafts, animal husbandry, inland fisheries, and so on.

2.2.3. Transportation and Communication

As for transportation, AMRIS area mainly depends on roads and partly on railway. The existing roads are classified into National, Provincial and Rural roads. About 95 percent of road surface is paved either by concrete, asphalt or gravel. The summary of the existing roads is shown in the following Table.

Roads Within AMRIS Area (Unit: km)

	Type of Surface			Total
Type of Road	Concrete	Asphalt	Gravel	Length
National Road	81.9	109.1	55.7 (5.6)	246.7
Provincial Road	58.0	67.5	57.8 (25.9)	183.3
Rural Road	61.1		92.0	153.1
Total	201.0	176.6	205.5	583.1

Note: Figures in parenthesis show the length of unpaved road.

The national roads and two (2) provincial roads, i.e., the Manila North Road (McArthur Highway) and the Manila North Diversion Road (Marcelo H. del Pilar Expressway) connect Manila and the AMRIS area. The Manila North Road leads to the Cagayan Valley Road and runs in South North direction in the center of the AMRIS area.

In the AMRIS area, there used to be two railroads. However, one which ran in the center of AMRIS was abolished in 1967 due to the shortage of freight cars, the other runs in the Southern part of the Area, connecting Metro Manila and San Fernando. In AMRIS area, there is one railway station at Malolos. Generally, the level of utilization of railway is very low. It is estimated that only about two hundred passengers get on and off at Malolos station daily.

As for the communication facilities, telephone, mail service and telegram are available, but the facilities are not widely used due to the inconvenience.

2.3. Physical Features

2.3.1. Topography

The Project Area lies in the southernmost part of the vast plain of Central Luzon extending from Manila Bay north to the Gulf of Lingayen. It is bounded by the Candaba Swamp to the north, predominant areas of the low mountain ranges to the east, coastal marsh areas to the south, and Pampanga River to the west.

The greater part of the Area is flat and has a low elevation of several meters above the mean sea level. Even the highest portion is less than 15 m at the Bustos Dam Site. The land slopes down toward the west and south extending to Manila Bay. It is largely divided by the Angat River into the northern and southern portions, the former of which is channeled by Maasim River. Both rivers irrigate almost all the rice fields of the Area, emptying into the Pampanga River.

Frequent big floods of the Pampanga River, however, have formed various physical features by braided streams throughout the Area. Not only the Candaba Swamp but also many creeks and marshes still remain and hamper the agricultural development. Some enclosed depressions along the Pampanga River are situated only one meter or so above the mean sea level. In this connection, a slight tidal influence may be observed particularly in the vicinities of coastal zone in the south. Another topographical hazard, though not serious is the rolling terrain at the southeast corner of the Area where the gradient of surface slope ranges from one to five percent.

Figure 2.3-1 gives the contour line of the Project Area expressed in meters. An alluvial fan topography is clearly identified from east to west. The low alluvial lands below five meters cover about one third of the total area.

2.3.2. Climate

The climate of the Philippines is influenced to a great extent by the location and intensity of nearby semipermanent cyclones and anticyclones which produce air streams and ocean currents greatly affecting the climate throughout the country. Among climatic elements, the most important ones which affect hydrology are temperature, humidity and rainfall.

The AMRIS area, situated in the Central Luzon under tropical conditions with warm air current flowing over the Area, generally has a high temperature. The mean annual temperature observed at Ulingao Research Center is about 26.4°C. The hottest months are April and May with maximum temperatures of 33.5°C and 32.5°C, respectively, and the coldest months are January and February with minimum temperatures of 19.9° and 19.7°C. The average annual range in temperature is reported at 5.0°C.

Throughout the year, the humidity is relatively high mainly resulting from extensive evaporation, rich vegetation, moist air stream and rainfall. The average annual humidity in the Area is about 87 percent ranging from 79 percent in March to 90 percent in December.

Rainfall in the Area is influenced by the tropical monsoon type of climate. The southwest monsoon is predominant during the months from May to September causing heavy rainfalls in the Area. Almost 95 percent of annual rainfall is concentrated during the period from May to November, and the heaviest rainfall is usually associated with the typhoon. The northern or northeastern monsoon is predominant from December to April providing less rainfall in the Area.

The average annual rainfall in the Area is about 1,710 mm. August has the highest average of about 390 mm. February, on the other hand, has the lowest average of only 4 mm. May to November is generally considered to be the wet season and December to April the dry season.

Regarding the evaporation, the annual observed value is reported to be about 5.1 mm/day on average or 1,850 mm in total, corresponding approximately to the average annual rainfall.

2.3.3. Geology and Soil

(1) Geology

The land is entirely composed of recent alluvium. Materials are derived to a great extent from the eastern flank of the Cordillera which contains iron and limestone deposits, forming gently sloping alluvial terrace lands on both sides of the Angat River.

The western section of the Area is a delta plain with level alluvial deposits of tuffaceous materials. This portion lies at a very low elevation of one to four meters. These basic materials reflect the slightly alkaline property of the soils. An outline of the geological feature covering Region III is shown in Figure 2.3-2.

Most of the lands are clayey in textures although those of the river bank are rather sandy. Some portions in the fan area consist of gravel subsoils containing debris of tuffaceous materials or laterite concretions. Such evidence is used as leading factors for determining soil classification in the Area.

(2) Soil

1) Soil Series and Types

The soil survey was concentrated in the expansion areas scattering at several locations just outside the AMRIS service area. Soil profiles were examined for a total of 14 pits and 28 bores, together with the water samples. These were analysed with respect to pH and EC.

Based on the examination and the existing soil surveys, a new AMRIS soil map has been developed as shown in Figure 2.3-3. The Area consists of seven soil series and thirteen soil types.

Table 2.3-1 presents for AMRIS gross and expansion area the extent of each soil series and type. Among the soil series, the Quingua Soil Series predominate, followed by Bigaa and Candaba.

These soil series cover almost 80 percent of the total service area. The Calumpit Series which is further divided into two Soil Types (Sandy Loam-17 and Silty Clay Loam-18) has been described for the first time; these account for only nine percent of the whole area, and are found along river levees and poorly drained lowlands.

2) Soil Fertility and Salinity

No serious problem has been noted in the soil fertility because of the overall clayey texture under alluvial sedimentation, except of course the frequent flood which causes damages to the lowland areas with poor drainage conditions. With the objective of producing higher yield, however, nitrogen and phosphorous are needed in almost all the AMRIS areas. Subsoils are often too hard for the roots of crops to penetrate into the solum, making it necessary to deep plow the field at intervals.

According to the analytical data, high salinity in the subsoils has been found in the expansion areas of Candaba and Malolos, slightly exceeding four mmhos. In order to grow crops on this kind of soil with high salt content, continuous irrigation of sufficient amount and planting of crop varieties resistant to salinity are required.

Soils of the Candaba Swamp may have some indications of zinc deficiency considering their high base saturation and alkalinity, although no apparent symptom has yet been observed.

All of the irrigation water samples analysed gave low EC values of less than 0.3 mmhos, denoting safe use for irrigation purposes. Re-use of the drain water would not cause any damage to crops. The average values of each water source are as follows:

		EC (mmhos at 25°C)
1. River	Angat	0.154
	Maasim	0.261
	Pampanga	0.240
2. Canal/Lateral	Angat RIS	0.168
	Maasim RIS	0.283

		EC (mmhos at 25°C)
3.	Creek	0.280
4.	Drain (Angat RIS)	0.269
5.	Fish pond (Candaba)	0.642
6.	Groundwater (Pit and Bore)	1.551
7.	Well (San Rafael)	0.419

Water of the Pampanga River may not be recommended as a source of irrigation because of its high EC value during the dry season.

(3) Land Classes

The land has been analyzed with respect to its soil properties, qualities of topographic, and drainage features. Figure 2.3-4 is the land class map made by AMIADP Land Classification Upgrading (1978). In comparison with the soil map, each of the soil units have two or three classes and/or subclasses as summarized in Table 2.3-2.

The various topographic conditions affect flooding, drainage and soil deficiency and this is an important factor in classifying the land. Most of the irrigated rice land which is about 80 percent of the service area is ranked highest class (1R); of this, about 4,200 ha have been evaluated as Class 1-2R (2d) which is potentially good both for rice and diversified crops production. The expansion areas are one class lower than the other areas.

2.3.4. River and Hydrology

There exist three rivers relative to the irrigation systems in the Area. The Pampanga River flow southward on the western border of the Area. The Maasim River runs westward near the northern border of the Area dividing the Candaba swamp into North and South, and joins the Pampanga River at 10 km upstream of San Luis.

Intersecting the central part of the Area, the Angat river flows westward dividing the Area into two zones, namely, the North and South service areas.

The Pampanga River, having a drainage area of 7,715 sq.km at the confluence of the Angat river, is under the influence of tidal motion even in the AMRIS area. Five gaging stations are situated in and around the AMRIS area and are controlled by the National Water Resources Council (NWRC), and most of the stations keep only gage height records for the observation period of 17 to 18 years since 1960. All observations were, however, suspended at the end of 1978. River discharge records are available only at station No.51, Pasig, Candaba, where no sea water intrusion is observed. According to NWRC, discharge records are fair but affected by bank overflows upstream from the station during the wet season.

During the wet season, the Pampanga River often overflows its left bank toward the service area of the AMRIS. The carrying capacity of river channel is estimated at about 1,800 cms.

Along the Maasim River, there exist two hydrological gaging stations managed by NWRC. One is located at about 500 m downstream from the Lower Maasim Dam and, therefore, discharges are affected by irrigation diversion, and the other about 3.8 km upstream from the Upper Maasim Dam. The latter has a drainage area of 150 sq.km and the observation period was 15 years from 1960 to 1975 except for 1972. Since the hydrological analysis is to be made based on the long-term reliable records of recent years, runoff synthesis of the Maasim River is one of the objectives included in the study.

The estimated annual mean runoff at the gaging station is 175 MCM in volume or 5.6 cms in discharge. Almost 93 percent of the annual runoff is concentrated in the wet season from June to November. In addition, the carrying capacity of the river channel is estimated to be about 100 cms at the downstream section of the Lower Maasim Dam.

Along the Angat River, there exist three dams, namely, the Angat Reservoir, Ipo and Bustos Diversion Dams. The drainage area of the river is 568 sq.km at the Angat Reservoir site and 920 sq.km at the confluence of the Pampanga River. The Angat Reservoir, which has an effective capacity of 850 MCM, is being operated by the National Power Corporation (NPC) based on the established operation rule curve, and is being utilized for domestic and industrial water supply to Metro Manila by the Metro Manila Waterworks and Sewerage Services (MWSS), NIA being in charge of irrigation and NPC hydroelectric power generation. In addition the Reservoir also controls the flood of the river.

The inflow into the Angat Reservoir is estimated by NPC based on the actual measurement of the reservoir water surface elevation, released water as well as spillage, and reported to be an annual average of about 2,080 MCM.

With regard to the water quality, salinity of water was measured by use of the electric conductivity meter at five selected sample sites in the rivers bordering the AMRIS area. The measurement and sampling were conducted in February, 1983, the period of spring tide in the dry season. The analysed values of conductivity vary from 800 to 2,800 micromhos/cm. According to the classification prepared by the United States Department of Agriculture (USDA) and the United States Department of Interior, Bureau of Reclamation (USBR), all of the selected samples are classified into the grades C3 and C4 which indicate high salinity water and very high salinity water, respectively.

In general these kinds of water are not suitable for irrigation under normal conditions. The Pampanga River during the dry season provides river water to several small scale irrigation systems with pumping facilities in the upstream portions of the water sample sites, and in fact, no adverse effects have been noted during the past years of using the river water for irrigation.

TABLE 2.3-1 CLASSIFIED SOILS AND AREA OF DISTRIBUTION IN AMRIS PROJECT

Soil Series	Soil Type	Type No.	Distribution in Gross Area (ha) Existing Area	Expansion Area	Total	Distribution Ratio (%)
I. Soils of the Lowlands						
1. Obando	Fine Sandy Loam	2	1,725	-	1,725	3.7
2. Bigaa	Clay Loam	3	11,995	885	12,880	27.5
	Silty Clay Loam	546	175	-	175	0.4
3. Quingua	Fine Sandy Loam	4	810	358	1,168	2.5
	Silt Loam	5	9,015	304	9,319	19.9
	Silty Clay Loam	285	3,950	-	3,950	8.4
	Silty Clay	899	1,150	-	1,150	2.5
4. Calumpit*	Sandy Loam*	17	1,435	63	1,498	3.2
	Silty Clay Loam*	18	2,530	103	2,633	5.6
5. Candaba	Silt Loam	69	1,280	69	1,349	2.9
	Clay Loam	70	3,405	1,918	5,323	11.4
II. Soils of the Uplands and Hills						
6. Prensa	Silty Clay Loam	66	2,780	-	2,780	6.0
7. Buenavista	Silt Loam	9	2,485	300	2,785	6.0
Total		(13)	42,735	4,000	46,735	100.0

Note: Service area of AMRIS comprises the existing gross area of 31,485 ha and the estimated expansion area of 3,480 ha.

* Newly established by the present soil survey.

TABLE 2.3-2 LAND CLASSES OF THE SOILS IN AMRIS PROJECT AREA

Soil Series and Types		Symbol No.	Present Service Area	Expansion Area
1. Obando	Fine Sandy Loam	2	2Raf, 3Rdf	-
2. Bigaa	Clay Loam	3	1R, 1R (2do), 2Rdf	2Rdf 2-3
3. Bigaa	Silty Clay Loam	546	1R (2do), 2Rdf	-
4. Quingua	Fine Sandy Loam	4	2Rst, 3Rst, 3df	2s, 2Rst, 3Rsdf2
5. Quingua	Silt Loam	5	1R, 1R (2d/A)	2Rdf 1-3
6. Quingua	Silty Clay Loam	285	1R, 1R (2d/A)	-
7. Quingua	Silty Clay	899	1R, 2Rdf	-
8. Calumpit	Sandy Loam	17	1R, 2Rdf, 2Rs	2Rdf 2
9. Calumpit	Silty Clay Loam	18	1R, 1R (2do)	2Rdf 2
10. Candaba	Silt Loam	69	1R, 1R (2do), 2-3 Rdf	-
11. Candaba	Clay Loam	70	2Rdf, 3Rdf	2Rdf 3
12. Prensa	Silty Clay Loam	66	1R, 2Rtj, 3Rtj	-
13. Buenavista	Silt Loam	9	1R, 2Rd	-

Note : Classes are denoted following AMIADP Land Classification Upgrading (1978).

Class Symbols : Irrigated diversified cropland - 1 to 3
Irrigated rice land - 1R to 3R
Irrigated dual class land - 1R(2) - 2R(2)

Subclass Symbols :
s - Soil deficiency
t - Topography deficiency
d - Drainage deficiency, construction required
A - Low irrigation water requirement
j - irregular topography
o - subsurface drainage
f - subject to flooding

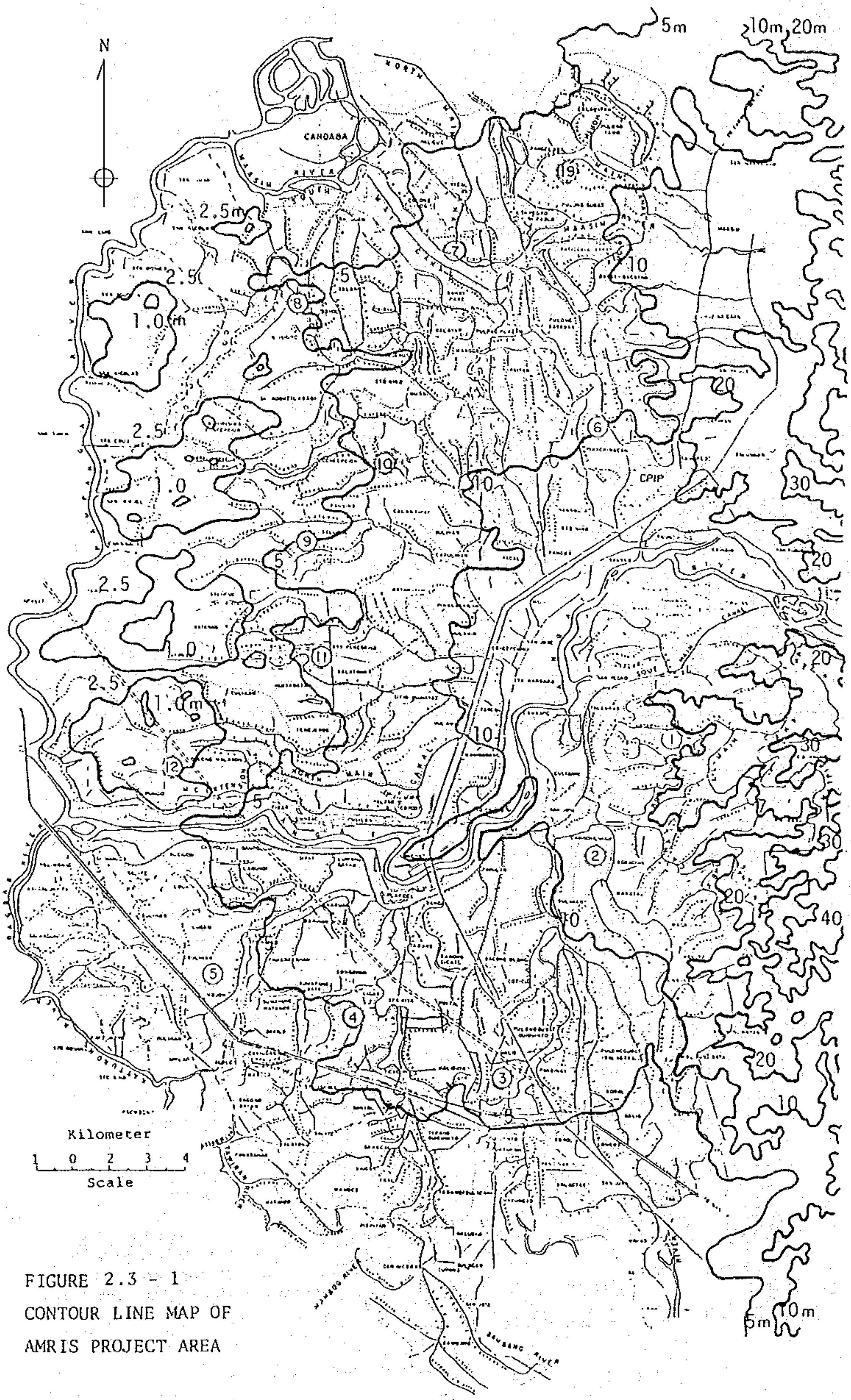
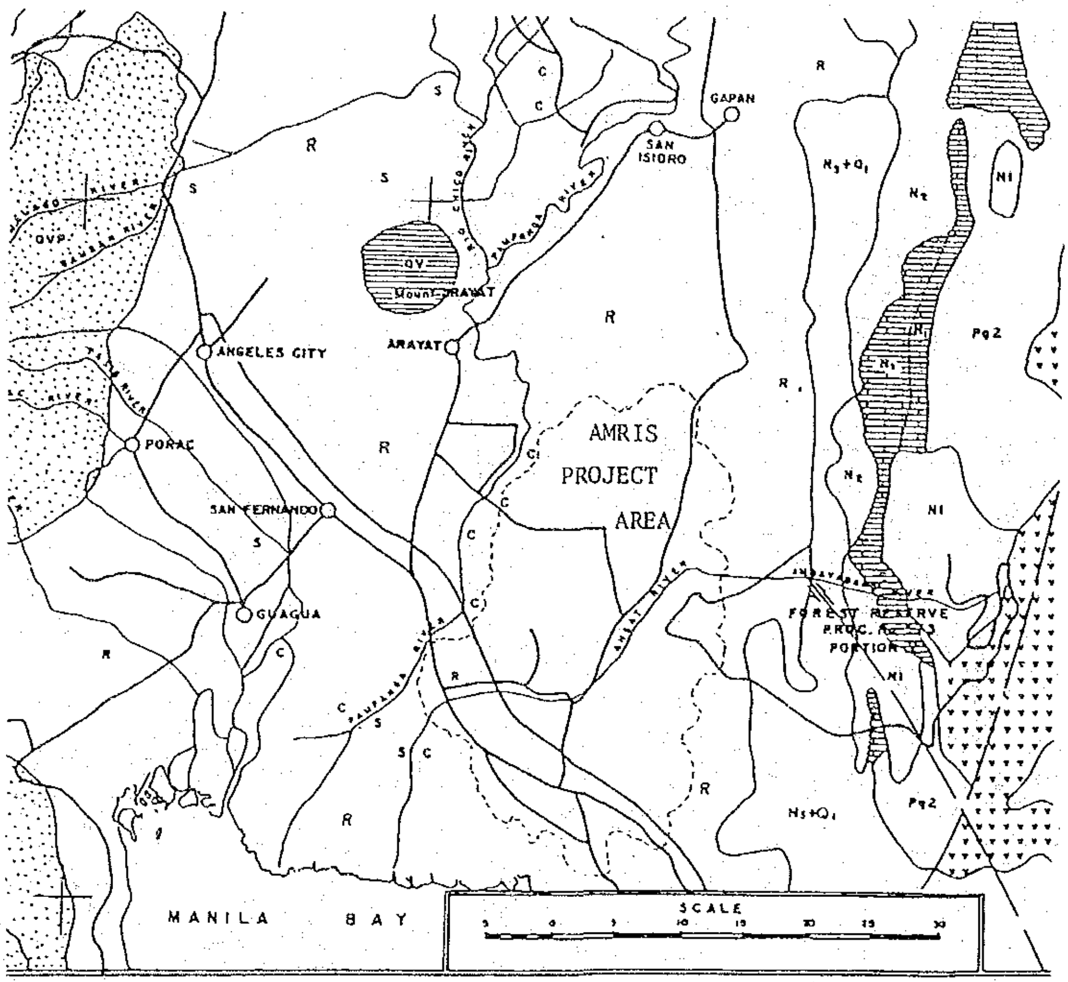


FIGURE 2.3 - 1
CONTOUR LINE MAP OF
AMRIS PROJECT AREA



SEDIMENTARY AND METAMORPHIC ROCKS

R	RECENT
N_3+Q_1	PLIOCENE-PLEISTOCENE
N_2	UPPER MIOCENE-PLIOCENE
N_1	OLIGOCENE-MIOCENE
Pg_2	OLIGOCENE
Pg_1	PALEOCENE-EOCENE
KPg	UNDIFFERENTIATED
BC	BASEMENT COMPLEX (PRE-JURASSIC)

LEGEND

IGNEOUS ROCK

NI	NEOGENE
UC	CRETACEOUS-PALEOGENE
QVP	PLIOCENE-QUATERNARY
QV	PLIOCENE-QUATERNARY
UV	UNDIFFERENTIATED
K	CRETACEOUS-PALEOCENE

This pattern assigned to various sedimentary rock units indicates major limestone bodies of the same age.

Source: Bureau of Mines Phil. (1963)

FIGURE 2.3-2 GEOLOGICAL MAP AROUND AMRIS AREA

For symbol number of soil series and types, refer to Table

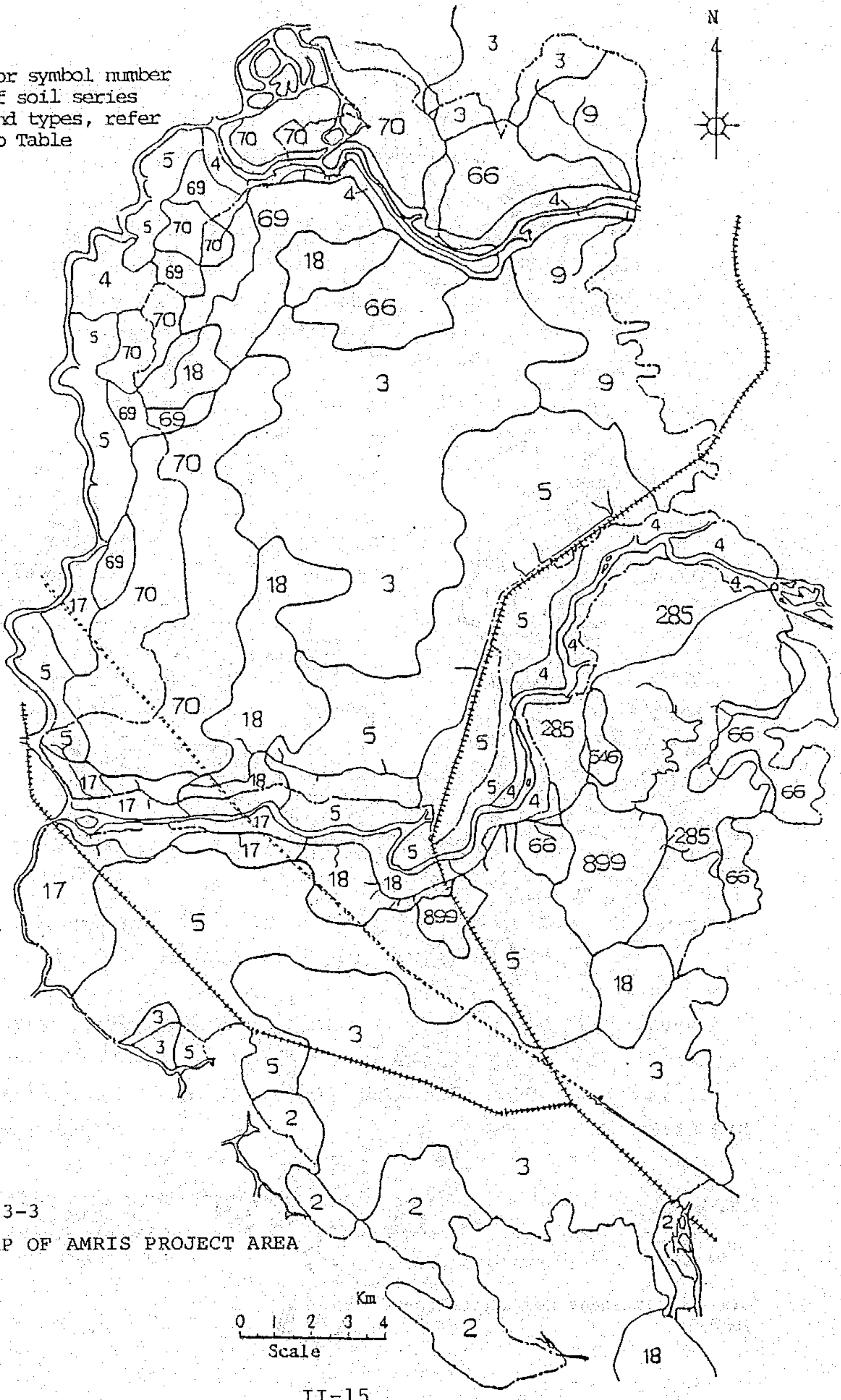
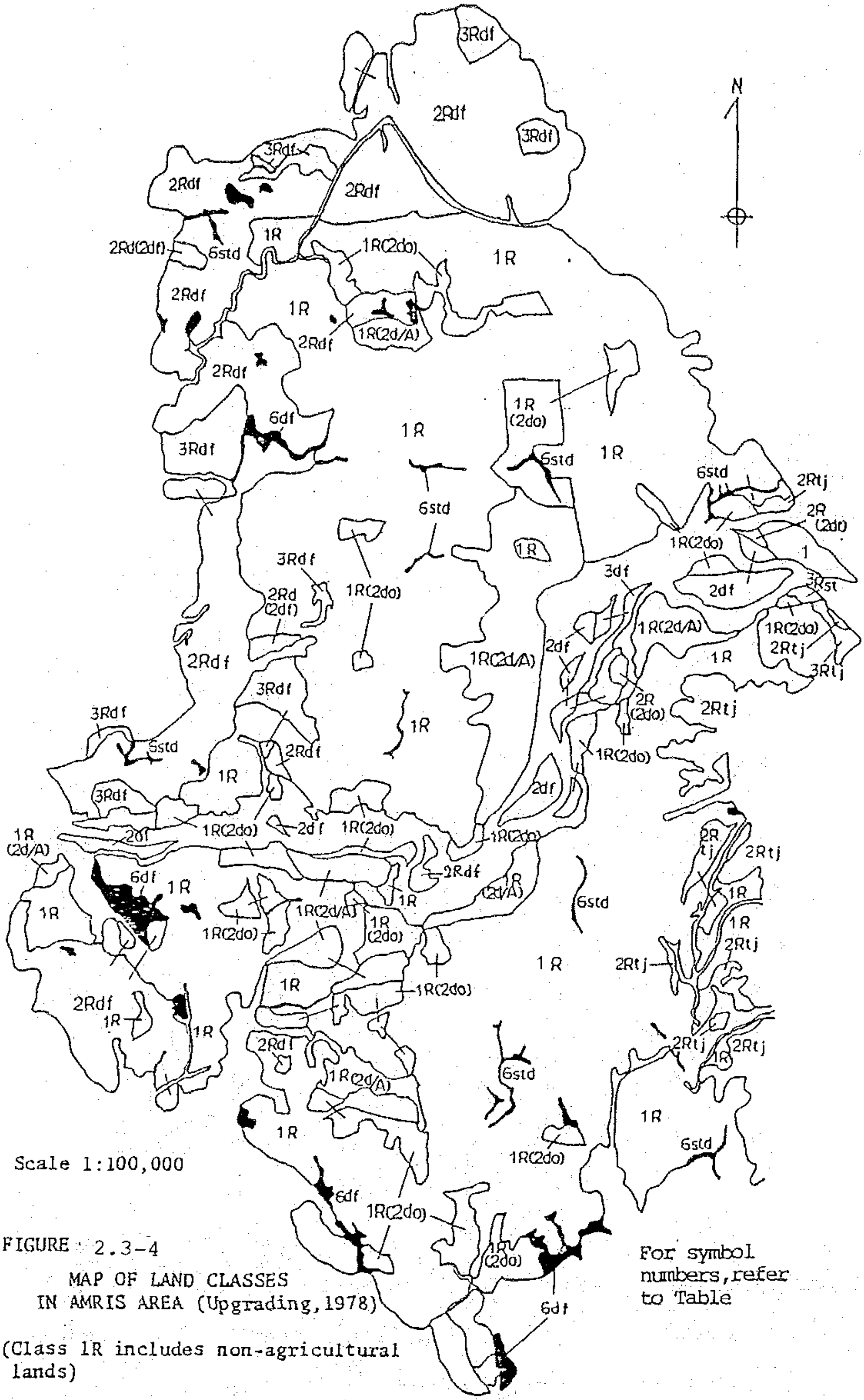


FIGURE 2.3-3
SOIL MAP OF AMRIS PROJECT AREA



Scale 1:100,000

FIGURE 2.3-4

MAP OF LAND CLASSES
IN AMRIS AREA (Upgrading,1978)

(Class 1R includes non-agricultural lands)

For symbol numbers, refer to Table