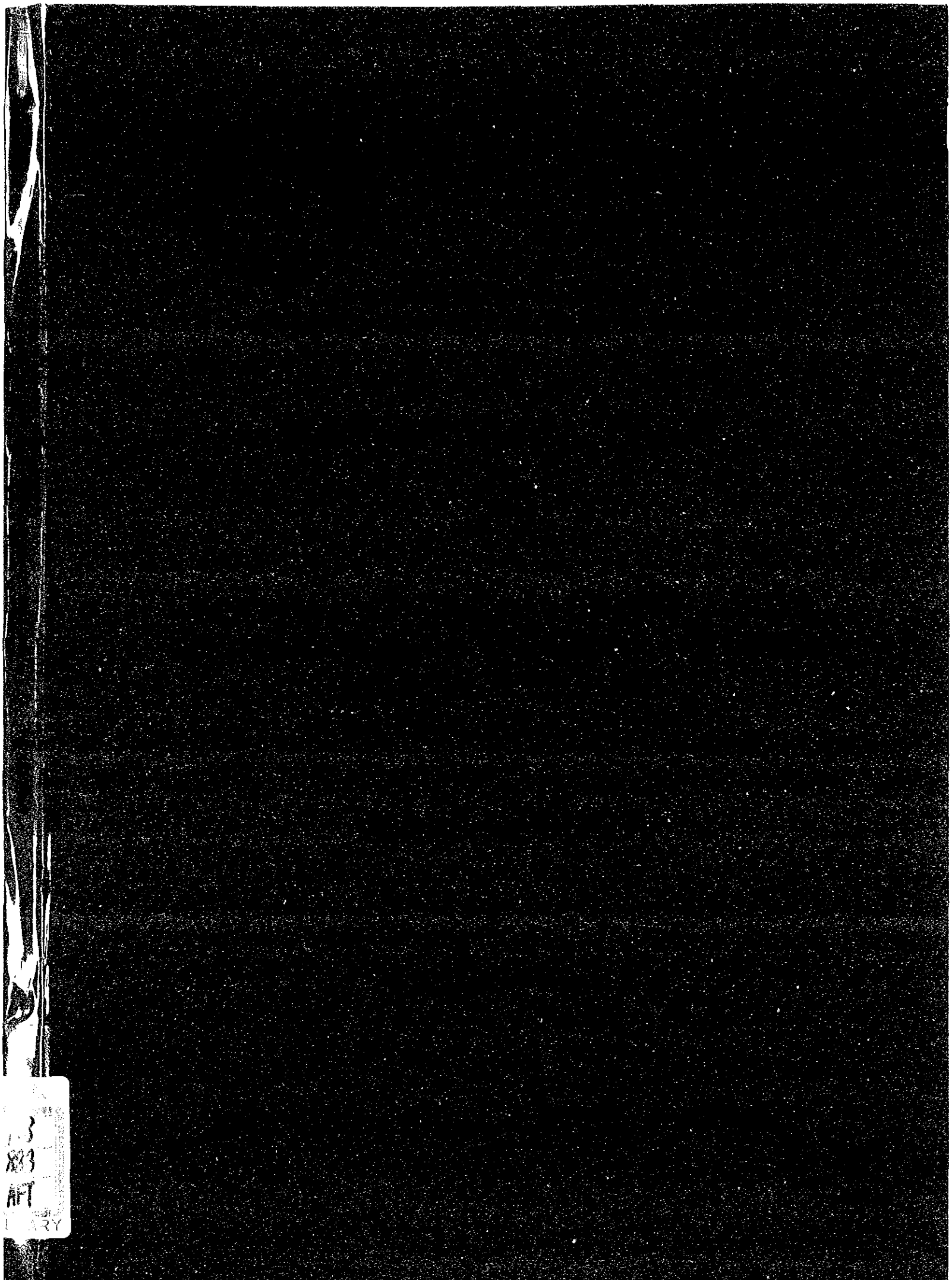


REPUBLIC OF THE PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION

MASTER PLAN STUDY

ON

IMPROVEMENT OF COMMUNAL IRRIGATION SYSTEMS THROUGH PHYSICAL AND INSTITUTIONAL DEVELOPMENT AND RURAL DEVELOPMENT IN SOUTHERN TARLAC PROVINCE

MAIN REPORT

OCTOBER 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Japanese Government decided to conduct a master plan study on the Improvement of Communal Irrigation Systems through Physical and Institutional Development and Rural Development in Southern Tarlac Province and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Mr. Yoshio Arai, Sanyu Consultants Inc., two times between August 1989 and March 1990.

The team held discussions with the officials concerned of the Government of the Philippines and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

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

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

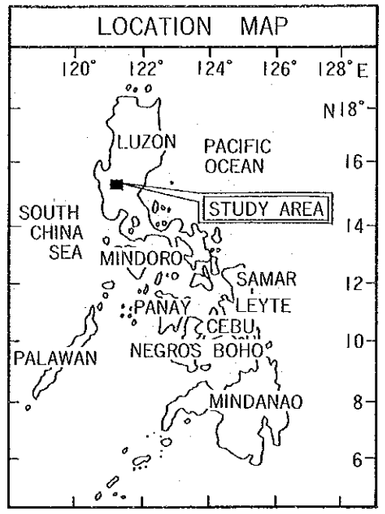
October, 1990

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

GENERAL MAP

IMPROVEMENT OF COMMUNAL IRRIGATION SYSTEMS
THROUGH PHYSICAL AND INSTITUTIONAL DEVELOPMENT AND
RURAL DEVELOPMENT IN SOUTHERN TARLAC PROVINCE



LEGEND :

- NATIONAL OR PROVINCIAL ROAD
- BOUNDARY OF CIS
- BOUNDARY OF NIS
- BARANGAY ROAD
- RIVER OR CREEK
- EXISTING. DIVERSION DAM
- BRUSH OR DIVERSION DAM TO BE IMPROVED
- EXISTING CANAL
- CANAL TO BE IMPROVED OR CONSTRUCTED
- PROPOSED GROUNDWATER COLLECTING CONDUIT
- PROPOSED LINK CANAL OF B.B.M.P
- SEED MULTIPLICATION STATION (SMS)

MAJOR DEVELOPMENT COMPONENTS

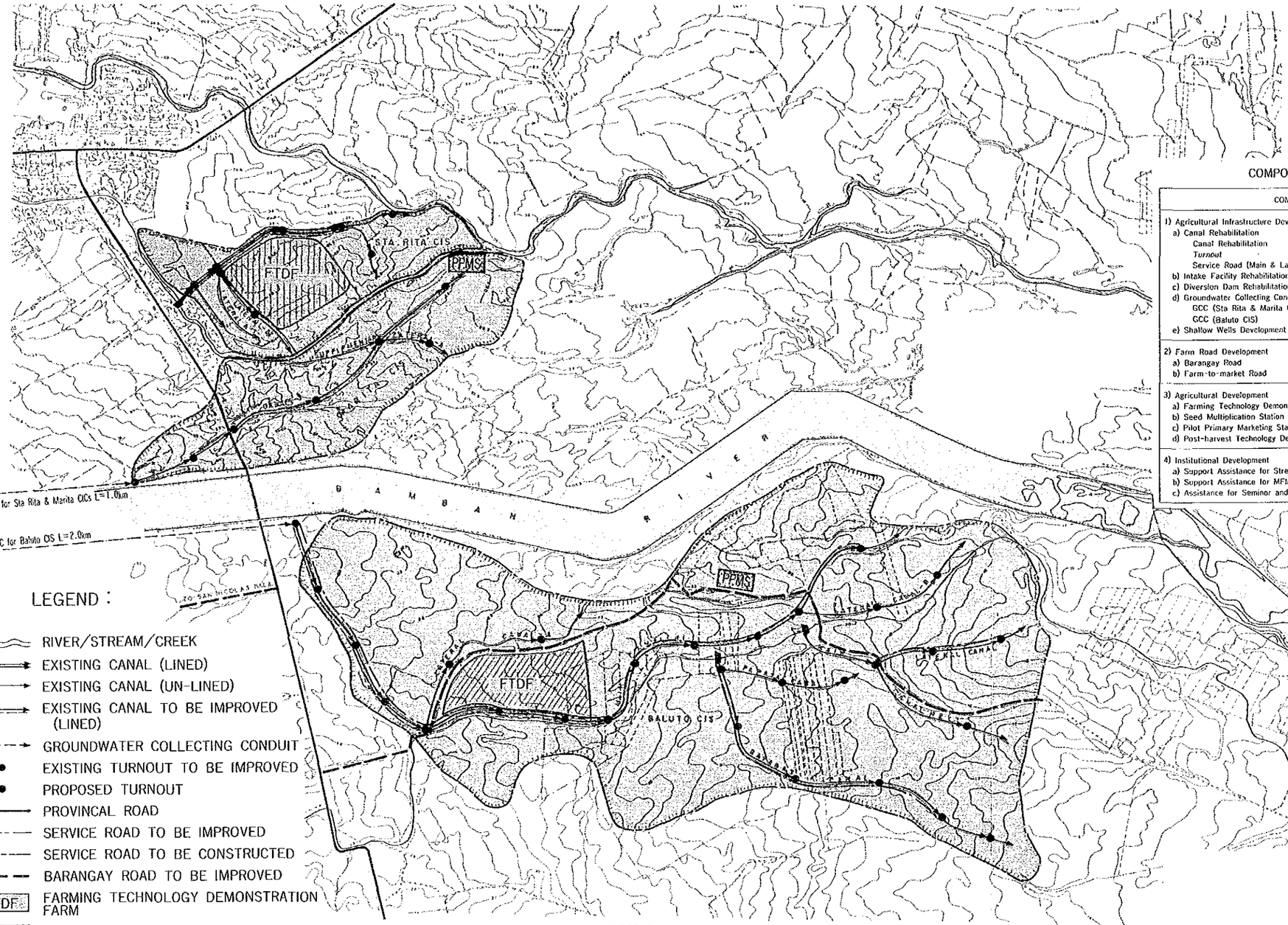
Development Components	Unit	Total	Phase-I (Pilot)	Phase-II
1) Agricultural Infrastructure Development				
a) Irrigation Facilities Development				
Canals	Km	37	1	36
Canal Structures	Unit	95	44	251
Service Road	Km	73	10	63
Intake Facilities	Unit	7	1	6
b) Diversion Dams Improvement				2
Replacement by Rubber Dams	Unit	4	2	2
Rehabilitation	Unit	6	–	6
c) Groundwater Collecting Conduit	Unit	4	2	2
b) Shallow Wells	Unit	271	12	259
e) Drainage Development	Km	4	–	4
2) Farm Road Development				
Barangay Road	Km	53	8	45
Farm-to-market Road	Km	58	1	57
3) Agricultural Development				
Farming Technology Demonstration Farm	Farm	11	2	9
Seed Multiplication Station	Sta.	1	1	–
Pilot Primary Marketing Station	Sta.	2	2	–
Primary Marketing Station	Sta.	3	–	3
Post-harvest Technology Demonstration Farm	Farm	5	2	3
Duck Raising	Pla.	5	–	5
Fishery Pond	Pla.	5	–	5
4) Institutional Development				
Support Assistance for Strengthening IAs		L.S.	L.S.	L.S.
Support Assistance MFIA		L.S.	L.S.	L.S.
Support Assistance for Strengthening FIAs		L.S.	–	L.S.
Support Assistance for Strengthening CIAs		L.S.	–	L.S.
Support Assistance for Stregthening ASS		L.S.	–	L.S.
Support Assistance for Seminar & Training		L.S.	L.S.	L.S.

COMMUNAL IRRIGATION SYSTEMS UNDER THE PROJECT

Name of CIS	Area(Ha)	Name of CIS	Area(Ha)	Name of CIS	Area(Ha)
1. Bamban	1,054	8. Marita	100	15. Magao	620
2. San Pedro	120	9. San Martin	280	16. Tinang	850
3. Malonzo	240	10. Baluto	740	17. Sto Rosario	200
4. Bangcu	700	11. Lilibangan	240	18. Sta Monica	740
5. Susuba Cutcut	40	12. San Bartolome	375	19. Caluluan	80
6. Telebance	389	13. San Isidro	635		
7. Sta Rita	135	14. Lucong	2,250	Total Area	9,785

LAYOUT

PILOT COMMUNAL IRRIGATION SYSTEMS DEVELOPMENT
(Pilot CISD)



LEGEND :

- RIVER/STREAM/CREEK
- EXISTING CANAL (LINED)
- EXISTING CANAL (UN-LINED)
- EXISTING CANAL TO BE IMPROVED (LINED)
- GROUNDWATER COLLECTING CONDUIT
- EXISTING TURNOUT TO BE IMPROVED
- PROPOSED TURNOUT
- PROVINCAL ROAD
- SERVICE ROAD TO BE IMPROVED
- SERVICE ROAD TO BE CONSTRUCTED
- BARANGAY ROAD TO BE IMPROVED
- FTDF — FARMING TECHNOLOGY DEMONSTRATION FARM
- PPMS — PILOT PRIMARY MARKETING STATION
- IRRIGABLE AREA LIMIT

COMPONENTS OF PILOT CISD

COMPONENTS	QUANTITY
1) Agricultural Infrastructure Development	
a) Canal Rehabilitation	
Canal Rehabilitation	3,400 m
Turnout	38 units
Service Road (Main & Lateral Canals)	6,600 m
b) Intake Facility Rehabilitation	1 unit
c) Diversion Dam Rehabilitation (Tinang & Lucong CISs)	2 units
d) Groundwater Collecting Conduit (GCC)	
GCC (Sta Rita & Marita CISs)	1.0 km
GCC (Baluto CIS)	2.0 km
e) Shallow Wells Development (Equipment & Wells)	12 wells
2) Farm Road Development	
a) Barangay Road	9,200 m
b) Farm-to-market Road	500 m
3) Agricultural Development	
a) Farming Technology Demonstration Farm (FTDF)	2 farms
b) Seed Multiplication Station (SMS)	1 station
c) Pilot Primary Marketing Station (PPMS)	2 stations
d) Post-harvest Technology Demonstration Farm (PTDF)	2 farms
4) Institutional Development	
a) Support Assistance for Strengthening of IAs	L.S.
b) Support Assistance for MFIA	L.S.
c) Assistance for Seminor and Training	L.S.

LIST OF CISs IN PILOT CISD

NAME OF CIS	POTENTIAL AREA
Sta Rita CIS	135 Ha.
Marita CIS	100
Baluto CIS	740
TOTAL	975

CONTENTS

ABBREVIATIONS
AGENCIES, INSTITUTIONS AND ORGANIZATIONS

ABBREVIATIONS
AGENCIES, INSTITUTIONS AND ORGANIZATIONS

BAPA	Barangay Power Association
BAS	Bureau of Agricultural Statistics
BCGS	Bureau of Coast and Geodetic Survey
BFD	Bureau of Forest Development
BFT	Bureau of Foreign Trade
BIR	Bureau of Internal Revenue
BL	Bureau of Lands
BOI	Board of Investment
BSWM	Bureau of Soils and Water Management
BUTEL	Bureau of Telecommunications
CB/CBP	Central Bank of the Philippines
DA	Department of Agriculture
DAR	Department of Agrarian Reform
DBM	Department of Budget and Management
DECS	Department of Education,Culture and Sports
DFA	Department of Foreign Affairs
DLG	Department of Local Government
DOF	Department of Finance
DOH	Department of Health
DOLE	Department of Labor and Employment
DOTC	Department of Transportation and Communication
DPWH	Department of Public Works and Highways
DSWD	Department of Social Welfare Development
DTI	Department of Trade and Industry
ELCO	Electric Cooperative
EOJ	Embassy of Japan
FDC	Forestry Development Center
FNRI	Food and Nutrition Research Institute
FPOP	Family Planning Organization of the Philippines
FSDC	Farm System Development Corporation
GSIS	Government Service Insurance System
IBRD	International Bank for Reconstruction and Development
IRRI	International Rice Research Institute
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
JSPS	Japan Society for the Promotion of Science
LBP	Land Bank of the Philippines
LWUA	Local Water Utilization Administration
MWSS	Metropolitan Waterworks and Sewerage System
NCSO	National Census and Statistics Office
NEA	National Electrification Administration
NEDA	National Economic and Development Authority
NEPC	National Environmental Protection Council
NFA	National Food Authority
NIA	National Irrigation Administration
NIST	National Institute of Science and Technology
NLUC	National Land Use Committee
NMYC	National Manpower and Youth Council
NNC	National Nutrition Council
NPC	National Power Corporation
NPCC	National Pollution Control Commission

NWRB	National Water Resources Board
OEA	Office of Energy Affairs
OECF	Overseas Economic Cooperation Fund
PAGASA	Philippine Atmospheric Geophysical and Astronomical Services Administration
PCA	Philippine Coconut Authority
PCARRD	Philippine Council for Agricultural Resources Research and Development
PCCI	Philippines Chamber of Commerce and Industry
PCIERD	Philippine Council for Industry and Energy Research and Development
PCGG	Presidential Commission on Good Government
PCGR	Presidential Commission on Government Reorganization
PNB	Philippine National Bank
RDC	Regional Development Council
RWDC	Rural Waterworks Development Corporation
SSS	Social Security System
TBAC	Technical Board for Agricultural Credit
UN	United Nations
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultura Organization
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UP	University of the Philippines

OTHER TERMS

A & D	Alienable and Disposable
BHS	Barangay Health Station
CAL	Certificate of Agricultural Leasehold
CARP	Comprehensive Agrarian Reform Program
CBR	Crude Birth Rate
CDR	Crude Death Rate
CLT	Certificate of Land Transfer
CPI	Consumer Price Index
FB	Farmer Beneficiary
FIES	Family Income and Expenditure Survey
GDP	Gross Domestic Product
GNP	Gross National Product
GOJ	Government of Japan
GOP	Government of the Philippines
GRDP	Gross Regional Domestic Product
IMR	Infant Mortality Rate
LHO	Leasehold Operation
LIT	Land Investment Trust
NGO	Non-Government Organization
OECF	Overseas Economic Cooperation Fund
PD	Presidential Decree
RHU	Rural Health Unit

CONVERSION FACTORS, MEASUREMENT AND GLOSSARY

CONVERSION FACTORS, MEASUREMENT AND GLOSSARY

CONVERSION FACTORS

Unit		Comparison	English Equivalent
Unit of Length			
Millimeter	(mm)	0.001 m	0.0394 inch
Centimeter	(cm)	0.01 m	0.3937 inch
Meter	(m)		3.2809 feet
Kilometer	(km)	1,000 m	0.6214 mile
Unit of Area			
Square centimeter	(cm^2)	0.0001 m^2	0.155 square inch
Square meter	(m^2)		10.764 square feet
Hectare	(ha)	10,000 m^2	2.471 acres
Square kilometer	(km^2)	1,000,000 m^2	0.3861 square mile
Unit of Volume			
Cubic centimeter	(cm^3)		0.061 cubic inch
Liter	(lit)	1,000 cm^3	0.264 US gallon (0.21997 gallon)
Cubic meter	(m^3)	1,000 lit	35.3247 cubic feet
Unit of Weight			
Gram	(g)		0.0353 ounce
Kilogram	(kg)	1,000 g	2.2046 pounds
Metric ton	(ton or mt)	1,000 kg	2,204.6pounds

UNIT OF MEASUREMENT

mm	:	millimeter(s)
cm	:	centimeter(s)
m	:	meter(s)
km	:	kilometer(s)
cm^2	:	square centimeter(s)
m^2	:	square meter(s)
km^2	:	square kilometer(s)
lit	:	liter(s)
m^3	:	cubic meter(s)
MCM or 10^6	:	million cubic meter(s)
lit/sec	:	liter per second
m/sec	:	meter(s) per second
PPM or ppm	:	part(s) per million
g	:	gram(s)
kg	:	kilogram(s)
ton	:	ton(s)
cavan	:	50 kg
m3/sec	:	1,000 lit/sec = 35.3145 cubic feet per second = 15,850 US gallons per minute

knot(s)	:	1.86 = km/hr = 0.515 m/sec
lit/sec/day	:	8.64 mm depth over one hectare
10 mm deoth over one (1) hectare	=	1.157 lit/sec/day
	=	3,532 cubic feet
sec	:	second(s)
min	:	minute(s)
hr	:	hour(s)
Max. or max.	:	maximum
Min. or min.	:	minimum
%	:	percent(s)
°C	:	degree centigrade
°F	:	degree fahrenheit
Cl	:	chlorine
HP	:	horse power
W	:	watt(s)
KW	:	kilowatt(s)
MW	:	megawatt(s)
WH	:	watt(s)hour
KWH	:	kilowatt(s)hour = 1,000 WH
MWH	:	megawatt(s)hour = 1,000 KWH
EL	:	elevation above MSL
MSL	:	mean sea level
FWL	:	full water level
HWL	;	high water level
LWL	:	low water level
ET	:	evapotranspiration
ETcrop	:	evapotranspiration of crop
N	:	nitrogen
P	:	phosphorus
K	:	potassium
LV	:	local variety
LIV	:	local improved variety
HYV	:	high yielding variety
O & M	:	operation and maintenance
EIRR	:	economic internal rate of return
FIRR	:	financial internal rate of return
B/C	:	benefit cost ratio
BY	:	fiscal year (1st of January to 31st of December in the Philippines)
P	:	one peso = US$ 0.0444
$	:	one dollar = pesos 22.50

GLOSSARY

Study Area	:	Area of km^2 covered by the Study
province	:	A political subdivision of a country comprising several municipality

municipality	:	A political subdivision of a province comprising several barangays
Barangay	:	A political subdivision of a municipality comprising about 50 to 100 households
poblacion	:	A political center of a town
Monsoon	:	Periodic wind that blows from the sea to the continent and oppositely in rainy season
Trade wind	:	One of three Philippines air currents, comprising from a generally easterly direction reaching the island during the period from February to April.
Tropical cyclone	:	PAGASA classifies the tropical cyclone by the wind speed as follows;

- Tropical Depression ; up to 17.1 m/sec (33 knots)
- Tropical Storm ; 17.2m/sec(34 knots) to 32.6 m/sec (34 knots) to 32.6 m/sec (34 knots)
- Typhoon ; over 32.7 m/sec (64 knots)

Paddy (Oryza sativa)	:	The rice plant which bears a staple cereal, or the cereal itself unhulled.
IR 62 or 64	:	High yielding varieties from IRRI, Los Banos,Philippines
Cogon (Imperita cyclindrica)	:	A coarse grass which usually covers idle lands or abandoned clearing.
Ganta	:	A common unit of volume for rice equivalent to 2.24 kg of milled rice.
Bamboo	:	A woody grass with a big hollow in the center of the (Banbusa Spinosa) internodes, growing in groves or clums reaching a height of about 25 m or more.
Nipa (Nypa fructicans)	:	Heave-leafed type of palm 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.
Carabao	:	The animal that most farmers used for plowing and other farm work. It is about the size of an ox and its similar to the water buffalo in other countries.
Fiesta	:	Spanish term for feast, celebrated pompously once a year to honor the patron saint.
Payatak	:	Traditional land preparation method, by trampling by using more than two carabaos without any other instruments.
Kaingin	:	Deforestation by shifting cultivation with slashing and burning forest/brush.
Banca	:	small boat
Survival rate	:	The number who graduate/ the number who enroll
Intra-regional	:	Within a region
Inter-regional	:	Between regions

SUMMARY,

CONCLUSION AND RECOMMENDATION

SUMMARY

(Introduction)

1.01 In accordance with the Implementing Arrangement of the Technical Cooperation (I/A) between Japan International Cooperation Agency (JICA) and National Irrigation Administration (NIA) for the Master Plan Study on the Improvement of Communal Irrigation Systems through Physical and Institutional Development and Rural Development in Southern Tarlac Province concluded on February 21, 1989, JICA dispatched the Study Team to the Philippines for the first field survey from August 8 to November 2, 1989 and the second field survey from January 11 to March 16,1990.

1.02 The objective of the Study is to formulate a master plan for improvement of communal irrigation systems through physical and institutional development and rural development in southern Tarlac province. The Study Area covers about 40,000 hectares in southern Tarlac province.

1.03 This Report consists of Main Report, Appendix I and Appendix II, incorporating the findings and observations of the field survey conducted in the Philippines by the Study Team in cooperation with NIA. Appendix I compiles the supporting data for the Master Plan Study while Appendix II compiles the study of the priority components.

(Background)

2.01 The Philippine economy grew up gradually during the decade of 1970's through implementation of large-scale development projects in agriculture, industry, energy and transportation sectors accompanied with bilateral and multilateral cooperation. However, the Philippines faced with the problems on the serious economic stagnation. GNP as the major economic indicators of statistics was recorded at negative growth after 1983. The Government redirected its policies after the so-called People's Power Revolution in February 1986 and formulated the Medium-Term Philippine Development Plan (1987-1992), which aims the eradication of poverty and attainment of a better life for each and every Pilipino in an equitable and just society.

2.02 Agriculture is one of major industries in the Philippines sharing about half the total household population employed. Attainment of self-sufficiency in rice production is primary approach for the development and recovery in the Philippines and this approach will be attained by providing, among other things, irrigation and drainage facilities.

2.03 Out of the total paddy lands of 3.17 million hectares, 1.488 million hectares are irrigated by the various irrigation systems/projects under the administration of NIA. In the irrigated paddy lands, 147 national irrigation systems (NISs) serve in about 0.627 million hectares, about 6,200 communal irrigation systems (CISs) cover over about 0.709 million hectares, and the rest of 0.152 million hectares are irrigated by pump irrigation systems

(PISs). Operation and maintenance of NISs are responsible by NIA, while that of CISs and PISs are handled by beneficiary-farmers under the assistance of NIA.

2.04 Improvement of CISs is accorded high priority by NIA to attain self-sufficiency in rice production in line with the goals of the Medium-Term Philippine Development Plan which emphasized on achievement in the improvement of rural living standards particularly for low-income farmers.

2.05 Tarlac province has a total land area of 3,053.4 Km^2 and located northwest Manila in Region III, Central Luzon. The total farm area and arable land in Tarlac province are about 97,100 and 83,200 hectares, respectively. In the province, there are two NISs serving about 25,200 hectares and 52 CISs covering a total paddy land of about 16,600 hectares, while the Study Area served by 19 CISs are located in southern Tarlac province and its facilities are required to be improved for proper water management as well as augment of productivity.

(Location and Geographic Conditions)

3.01 The Study Area is located in the southern part of Tarlac province about 120 kilometers northwest Manila, lying in the western portion of the sedimentary basin (Central Luzon Basin) with its long axis trending north-south. The area comprises lowland and moderately a sloping area with a gentle relief. The main drainage systems crossing the area are Bamban, Lucong, and Tinang rivers, all draining eastwards Chico river. The area abound in numerous large and small tributaries.

(Geology and Hydrogeology)

3.02 The geological structures covering the area is simple having three structures such as Tarlac and Capas anticlines and Capas syncline. The Tarlac anticline is gently folded in the Tarlac Formation with the axis trending north-south. The sediments forming a synclinal basin have the thickness increasing progressively towards the center of the plain. The thickness of the Quaternary sediments is around 20 meters at the western boundary of the Study Area increasing considerably toward the east with approximate thickness of more than 250 meters.

3.03 Groundwater in the Study Area occur in the interstices of loosely to fairly compacted alluvium, alluvial fan, and terrace gravel deposits; which are Quaternary age, and in fairly consolidated sedimentary rocks which range in age from Upper Miocene to Pleistocene. The Miocene and Pliocene aquifers are usually semi-confined, while the Quaternary ones are unconfined or semi-confined. Aquifer transmissivities in the Study Area may range from 500 m^3 /day/m to more than 1,000 m^3/day/m, and exploitable well yield may range from five to 100 l/sec.

(Meteorology and Hydrology)

3.04 Climate in the Study Area is classified into the first type climate of the Corona's classification system. There exist clearly

distinct two seasons; wet season from May to October and dry season from November to April, and an annual rainfall about 1,900 mm in the area. The annual mean temperature is 27.1℃ on an average with 32.9℃ in maximum and 21.3℃ in minimum. The monthly mean temperature is the highest in May and the lowest in January.

3.05 The Study Area consists of three river basins; Parua (Bamban), Cut-cut (Lucong) and Tinang river basins, catchment area of which are 298 Km^2, 225 Km^2 and 104 Km^2 , respectively. Discharge records within the Study Area are available at Parua river (148.0 Km^2 site). Based on this records, hydrology for the study is analysed by applying Tank Model Method.

(Soils and Land Use)

3.06 The Study Area is almost flat alluvial plain formed by the enormous deposits from the rivers of Bamban, Chico, Lucong, Tinang, etc. In general, the sandy soils are dominant in southern part of the area, while clayey soils are often occurred in northern area. Soils in the Study Area are mainly divided into 10 Soil Series such as Luisita, Pawing, Banga, La Paz, Angeles, Zaragoza, Baran, Cabetican, Tarlac and San Manuel. According to the land classification made by USBR method, the arable land in the Study Area are classified to Riceland, Dual Class Land and Diversified Cropland.

3.07 Most of the Study Area is located in a flat alluvial plain, being cultivated as agricultural lands with 25,900 hectares. About 18,944 hectares of agricultural lands, which is 73 percent of the total agricultural lands are used as paddy fields, and more than 70 percent of the paddy field are irrigated mainly by surface water. In addition to this, there are large scale of sugarcane fields with a total area of 3,990 hectares in the northern and western parts of the Study Area. As for 19 CISs concerned, the total arable land is 9,785 hectares, of which 8,175 hectares for paddy fields and 900 hectares for sugarcane fields.

(Present Irrigation and Drainage)

3.08 Out of 39,400 hectares of the Study Area, 25,900 hectares is used as agricultural lands. In the area, only 4,300 hectares is served by SMORIS and 7,800 hectares is irrigated by 19 CISs. There exist 27 units of diversion works, 31 units of intakes, 95.4 kilometers of main canals and 48.2 kilometers of lateral canals in 19 CISs area. During the wet season, almost all agricultural lands is irrigated by river water except those in the upland area of 680 hectares and some area inundated with water of Chico river, while in the dry season, the upper reaches of Tinang, Lucong and Bamban rivers are irrigated by CISs, however, in those at the lower reaches, private pumps irrigation are widely prevailed.

3.09 Tinang, Lucong and Bamban rivers and Caluluan and Sapang Balen creeks, these are major drainage systems in the Study Area and flow eastward down to Chico river in almost parallel. Lucong and Bamban rivers are considered medium scale in which the catchment area varies from 145 to 150 square kilometers, while the other three

drainages are just considered small scale in which the catchment area is varying from 30 to 70 square kilometers. Due to absence of watershed management and erosion control project at the upstream reaches of Bamban river, sediment loads moved down freely which caused the rising of river bed yearly. Flood control dikes along Bamban river was constructed in 1985 and made up of groins and sandy soils, so, there is a continuity of scouring of the toe by floods.

3.10 General features of CISs is mostly depended on the available water source of irrigation. Five major sources in the area are served for 19 CISs; Bamban river covers more than a half of the CISs which are 10 CISs of Bamban, San Pedro, Malonzo, Bangcu, Telabanca, Sta Rita, Marita, San Martin, Baluto, and Lilibangan; Lucong river serves three CISs of Susuba-Cutcut, Lucong and Magao; Tinang river irrigates three CISs of Tinang, Sto Rosario and Sta Monica; Sapang Belen creek covers two CISs of San Bartolome and San Isidro; and Caluluan creek serves for Caluluan CIS area only.

3.11 The irrigation facilities of the CISs are composed of diversion dams, intakes, and main and lateral canals. The diversion dams are classified into 14 places of brushdams located all in Bamban river and 13 units of the Ogee-type diversion dams situated in Lucong and Tinang rivers and creeks. Intake structures located along Bamban river were sometimes buried by sediment loads due to low elevation of the intake sill resulting difficult to take irrigation water. Since these intake structures have no gate, it is quite difficult to control the discharge especially during big floods. About 10 percent of the total main canals of 95.4 kilometers or 10.1 kilometers is concrete lined and/or concrete bench-flume while on the lateral canals, about 7 percent of the total or 3.3 kilometers is lined. In general, canal bed slope is gentle, without proper maintenance, hence, canal capacity is further decreased by the presence of weeds.

3.12 The average irrigation rate of the proposed BBMP is 91 percent during wet season, and 71 percent during dry season. Since the Study Area is located in the lower reaches of southern Bamban district, the irrigation water from the BBMP to 12 CISs is less than 79 percent during wet season and 47 percent during dry season. Basic concept for irrigation on improvement of CISs is that the existing water sources in the Study Area would be used to their fullest and water from BBMP will be augmented the irrigation rate of CISs in the area. On the other hand, irrigation facilities would be rehabilitated or improved in order to carry out proper water management and to improve the irrigation efficiency in cooperation with farmers' association.

(Present Agriculture)

3.13 The principal agricultural occupation in the Study Area is rice culture and the most predominant cropping pattern is rice - rice. In wet season, 7,522 hectares or around 77 percent of the 19 CISs area of 9,785 hectares are planted to rice; 900 hectares or about nine percent are planted to sugarcane and the remaining about seven

percent are flooded. In dry season, 6,144 hectares or around 63 percent including flooded paddy field are planted to rice, 900 hectares or about nine percent are sugarcane, and 1,088 hectares or about 11 percent are the diversified crops. 710 hectares or around seven percent is under fallow.

3.14 Rice cultivation is carried out in labor extensive form from the stage of seeding to harvesting. High yielding varieties of rice have been widely grown. The prevailing varieties are IR 32, IR 36, IR 60, IR 66, IR 72 and IR 74 which are more than 110 days' maturing high yielding varieties. The diversified crops are mongo, corn, peanuts, cowpea, sweet potato, eggplant, etc. Mongo and corn are cultivated under rainfed condition, and planted just after harvest of wet season rice to take advantage of the soil which is still moist.

3.15 The present yield of paddy ranges from 2.00 metric tons (40 cavans) to 4.75 metric tons (95 cavans) per hectare in wet season, while in dry season it is 2.50 metric tons (50 cavans) to 5.50 metric tons (110 cavans) per hectare. Some have stepped up their productivity recently, but others still remain low.

(Post Harvest and Marketing)

3.16 According to the survey with the several agencies, the total post-harvest losses of rice in quantity is 23.5 percent on an average in the entire Philippines which ranges from 10 to 37 percent, while that in the Study Area is 22.5 percent. Concerning the losses in quality, which consist mainly of whiteness, brokens, shape and chalkiness strongly affecting to sale price. Especially inability to dry high moisture paddy in period of unfavorable weather condition for sun drying, which leads to poor quality grains and consequently low returns for farmers.

3.17 Most farmers, IAs and agricultural cooperatives suffer seriously how to dry paddy especially in wet season and to keep them until price coming high due to shortage of post-harvest facilities. Together with improvement of post-harvest facilities and enhancement of training, effective credit system and national support program are required so that farmers do not suffer how to get living or next production expenses without selling paddy immediately after harvest. According to the rice distribution structure in the Study Area, 85 percent of paddy produced were sold to middlemen and eight percent to paddy buying stations in or near Barangay, three percent to the NFA especially in wet season and the remained four percent preserved for their self-consumption and seed for next production.

(Rural Infrastructure)

3.18 The first class national highway runs northward in the western edge of the Study Area linking Tarlac provincial capital in the north and Manila metropolis in the south. Provincial road, a core road of the Study Area, runs eastward linking the national road of Capas, to La Paz and to the Concepcion municipal proper. This road plays a crucial role in commuting people and transporting

commodities or other agricultural products to the nearby markets. On the other hand, Barangay - Barangay road, Barangay- farm road and Barangay-market road still remain bumpy or muddy especially in the wet season. This is one among the inconvenient factors in their daily activities.

3.19 Domestic water supply system is categolized into three levels; Level I (point source), Level II (communal faucet) and Level III (house connection). Level II and III water supply systems are served only in the Concepcion municipal proper by the water district formed in 1987. Level I water supply system is a common case in Barangays. There exists 30 wells in Capas, 24 wells in Bamban and 60 wells in Concepcion constructed by DPWH for public use.

3.20 Medical and health care are provided with a health station located in each Barangay. A midwife is either stationed or makes her round to the Barangay regularly or twice a week. Moreover, medical check services are also provided by a doctor and a nurse who make their round to the Barangay once or twice a month. There is only one hospital called as Concepcion district hospital in the municipal proper.

3.21 No telephone equipment is facilitated in all Barangays. Telephone services is only provided by the PLOT to the municipal proper area. Postal delivery services is available but the service is so time consuming that it takes one week to one month to receive letters from Manila. Sending service is only available in the post office of the municipal proper area.

3.22 Electricity is exclusively provided by TARELCO II (Tarlac Electric Cooperative II) in the Study Area. Power source is provided by the NPC substation located at Sta Rosa which is adjacent to VOA (Voice of America) relay station. At least 94 percent of the whole Barangays in Capas, 80 percent of those in Bamban and 86 percent of those in Concepcion are actually energized. For consumership, 73 percent of the whole households in Capas, 85 percent in Bamban and 69 percent in Concepcion have individual house connection.

3.23 For public elementary, there are two school districts with 26 schools in Capas, one with 14 schools in Bamban and four with 55 schools in Concepcion. Nine secondary schools are established in the three municipal proper areas. School buildings are not well-equiped since some have no toilet in the school yard or do not have enough classrooms to educate all the pupils at their regular school hours. In such schools, a shift education is adopted.

3.24 Housing can be categorized into three by the type of construction materials used; concrete block, wooden and bamboo built. Barangay people with high income built the more houses with concrete blocks. In general, Barangay houses have two or three bedrooms, one kitchen and one living room which can afford to house six to ten people.

(Farm-Economy)

3.25 Agricultural input materials such as fertilizers and pesticides and output products are mostly handled by private sector dealers and are available in the town proper which gives farmers inconvenience of hard accessibility and one of the constraints. Insufficient supply of qualified seeds due to a few seeds growers in the area is caused for low productivity. Inaccessibility of short-term credit for annual crop materials and unavailability of medium-term and long-term credit for perennial crop materials obstruct the expansion of cultivation and products and make an another constraint for the agricultural development in the area.

3.26 Out of 39.4 thousand hectares of the total land area, 25.9 thousand hectares are classified as agricultural lands including 18.9 thousand hectares of paddy field. Out of 18.9 thousand, 8.2 thousand hectares is covered by 19 CISs. The average farm size of 2.3 hectares are mostly cultivated with paddy. Among four tenurial status, the amortizing owners have the predominant share of 50 percent with the biggest aggregate area of 14 thousand hectares while owner-cultivator, leaseholder and share-tenant are occupied at 30 percent, 15 percent and 5 percent, respectively. The progress of CARP is rather smooth in Program-A but confronting so many problems in Program B to D.

3.27 Farm economy survey was conducted in 20 Barangays with 100 farmers' respondents in the area. The survey sought to grasp the farmer's living status as well as to determine the prevailing problems and constraints in the area. Significant information such as family size, farming capacity and practice, tenure status of full owner, part owner and tenant, living conditions, banking and creditting, etc. were collected.

3.28 Out of 19 CISs in the Study Area, 15 were already formed IAs under the concentrated efforts of NIA's PIO and ICOs, and the remaining unformed CISs are being made institutional training or propagandizing by PIO. IAs is organized for mainly operation and maintenance of the irrigation facilities. On the other hand, a total of 28 agricultural cooperatives were organized in the area and have a total membership of 4,947 which is about 13 percent of the farmers. Some cooperatives are actively functioning as agricultural cooperative in handling the input and output materials, however, most of cooperatives were just organized still unactive.

(Felt Needs Survey)

3.29 To grasp the inhabitants' needs toward the future development, inquiry survey was conducted with the target respondents of 45 Barangay captains in Concepcion municipality. Felt needs items prioritized by 40 Barangay captains indicats that farm-to-market road is ranked at the top followed by irrigation and drainage facilities and health care. During farm economy survey, felt need survey also conducted with 100 samples and the results show that irrigation and drainage facilities placed at the top and followed

by drying facilities for products, farm-to-market road and school building in order.

(Development Problems and Constraints)

3.30 Physical problems and constraints in the Study Area are mostly caused by natural features in topography and climate. Bamban and Lucong rivers are major source of surface water and have no watershed management and erosion control project. A great deal of sand and silt is effluxed from the denuded watershed area and made most brushdams difficult to maintain for irrigation. Moreover, discharge of the said rivers are seasonally fluctuated and river course is often changed in resulting more difficult operation and maintenance of irrigation facilities of CISs.

3.31 Drainage system in the Study Area is quite complicated in system and structure by existence of many creeks and streams providing several separated groups of agricultural lands. Major rivers of Bamban and Lucong are joined with Chico river, one of the biggest tributaries of Pampanga river discharged into Manila bay, and the backwater of Pampanga river is influenced to inundation in the eastern most flat area along Chico river and the some areas along Bamban river.

3.32 An analysis of formal credit in the Study Area reveals that there are adequate short-term funds available but borrowers, especially low-income farmers have difficulty to gain it due to; i) inconvenient accessibility to the banks, ii) requirement of strict eligibility and limited amount to be extended, and iii) complicated procedures to offer.

3.33 Major farmers' organizations such as irrigator's associations and agricultural cooperatives have just established recently. Primary problems on these organizations are; i) lack of good planner and organizer, ii) indiscriminated size of organizations, and iii) insufficiency of government's support.

3.34 There is a high degree of exmigration from the area due to lack of sufficient jobs and as a consequence, there is a shortage of skilled labor. Under the prevailing Rural Industrization Can Happen program (RICH) bringing-up of skilled labors and absorption of rural unemployment and underemployment are highly expected.

(Development Target and Strategy)

4.01 The Master Plan on improvement of communal irrigation systems through physical and institutional development and rural development in southern Tarlac province aims at uplifting the rural economy by solving the basic problems of the people such as persistence of poverty and income inequality reducing high unemployment and underemployment ratio by creating employment opportunity and rectifying urban/rural and regional disparities in line with the national development goals under the Medium-Term Philippine Development Plan (1987-92).

4.02 Improvement of communal irrigation systems are being handled by NIA under the administration and engineering support of the Regional/Provincial Irrigation Offices with the active participation of beneficial farmers and farmers'/irrigators' associations. Participatory irrigation development recently becomes a significant role of the NIA for successful implementation of the projects and efficient operation and maintenance of the irrigation facilities.

4.03 The improvement of communal irrigation systems in southern Tarlac province would serve as a model project by active participation of farmers and farmers' associations in terms of methodology of planning and development among the thousands of communal irrigation systems/projects in the Philippines.

4.04 Target of the master plan is expected to attain the desirable annual income for low-income and healthy and worthy living environment in the Study Area. The target will be realized through provision of the complete irrigation water distribution system, development/equipment of the agricultural productive, processing and marketing facilities and establishment/strengthening of the farmers' association and agricultural supporting services.

4.05 Development components of the Master Plan is composed of physical development and institutional development. The physical development component involves irrigation facilities, farming facilities, post-harvest including processing facilities, marketing and so on, while the institutional development deals with establishment/strengthening of farmers' associations, seminar/ training program, etc.

(Projected Population and Labor Force)

4.06 The population by Barangay of the Study Area up to CY 2030 is projected based on the actual population in 1988 and population growth rate prepared by the Provincial Planning and Development Office. According to the population projection, the present population of 178 thousand persons in 1989 will increase to the projected population of 242 thousand in 2010. The average annual growth rate of population is adopted at 2.37 percent in 1985 to 1990 and slowed down to 1.63 percent in 1990 to 2020.

4.07 Labor force projection is made based on the prevailing ratio obtainable on provincial and regional bases. According to the employment classification performed by NCSO in April 1989, about 33 percent of the economically active persons (age group between 15 and 65 years old) are engaged in agriculture, while it was 46 percent in April 1980. It is obviously noted that a huge number of new employment has been created in the second and third sectors of the industries during the period from 1985 to 1989 and a considerable number of farm workers have been moved to non-farm workers. Unemployment and underemployment are estimated at six and 40 percent, respectively. In the Study Area, a total of 114 thousand is estimated as the economically active persons and out of

which, 52 thousand person is regarded as unemployment and underemployment.

(Physical Development Plan)

4.08 In physical development plan of the master plan, alternative physical development schemes are comparatively studied. The study is concentrated on how to mitigate physical constraints prevailing in the Study Area, especially enormous sediment occurred and rising up of river bed in front of the intake structures for and also unstable irrigation water resources for CISs. Unless otherwise implementation of the watershed management and flood control project and construction of a reservoir at the upper reaches of the rivers concerned, it is difficult at present to solve completely both these constraints on the sediment and water source. From the technical soundness and economical point of view, permanent structures such as an unified diversion dam and intake structures are not recommended to introduce to the master plan so far due to the master plan is intended to be quick return project.

4.09 The proposed physical development of the master plan basically consists of rehabilitation of the existing irrigation facilities, provision of agricultural farming facilities and installation of post-harvest equipment and marketing facilities.

(Institutional Development Plan)

4.10 Institutional development aims at establishing/strengthening farmers' association for active participation to the project, so-called participatory approach, in the stages of planning, implementation and operation of the Project for successful implementation and proper operation of the facilities. The participatory approach was originated by NIA and is recently considered as a significant role of NIA for successful implementation of irrigation development. Under this approach, NIA made great efforts to establish the farmers' association in every CIS and tried to grade up the collection rate of irrigation fee or amortization.

4.11 Proposed institutional development aims at strengthening irrigator's association (IA) and expanding its function of sole operation and maintenance of the irrigation facilities to multi-functions with cooperative activities. Multi-functional IA encourages member farmers with some incentive to participate in the activities of the IA. Proceeding of institutional development takes some steps according to the present situation of the systems and farmers organization. The first step expects strengthening of farmers association in order to implant more cooperative spirit in member farmers' mind through public communication and training and seminar. The second step in the institutional development is a stage for expanding its scale and activating functions as cooperatives.

(Proposed Land Use)

5.01 Soils in the area is generally suitable for double cropping of paddy rice as available as irrigation water. In case that

irrigation water is insufficient for double cropping of paddy rice, diversified crops are introduced in dry season. Of a total study area of 39,400 hectares, proposed paddy land is 8,450 hectares while sugarcane and idle land are 900 hectares and 435 hectares, respectively. In the paddy land of 8,450 hectares, the proposed paddy rice is planted in 7,858 hectares in wet season and 6,894 hectares in dry season. In addition in dry season, the diversified crops are to be planted in 670 hectares of paddy land.

(Water Resources Development Plan)

5.02 Through probability analysis on rainfall and discharge, the design year to be applied for the master plan study is decided to be the year 1982 as drought year with an equivalent of 1/5 probability. Surface water balance study for the Project is conducted by applying the tank model method and available water is estimated at about 250 MCM in wet season and about 81 MCM in dry season. This result shows that the surface water is not surplus under the present land use and cropping pattern.

5.03 Groundwater resources is abundant and rather high water table in the Study Area. On the assumption of available drawdown, the exploitable groundwater is estimated at approximately 24 to 35 MCM per annum in the area. Well yield may range from 5 to 100 liters per second.

(Agricultural Development)

5.04 The purpose of agricultural development is to realize stable and high productivity through the development of irrigation systems and proper operation and maintenance of the facilities. The agricultural development particularly emphasizes on increase of production by expanding farming area, improvement of productivity by diffusing modern techniques and enhancement of quality of products through the improvement of farming facilities.

5.05 The cropping pattern of paddy rice as main crop in the area is proposed to be improved the transplanting duration of about three-month period to two-month period, however, the cropping intensity is nearly kept with the present one due to availability of water resources for the area. For introduction of the modern farming techniques and materialization of the objectives of the agricultural development, establishment of Farming Technology Demonstration Farm (FTDF) with 20 hectares are recommended.

(Post-harvest Equipment and Facilities Development)

5.06 Pre harvest mechanization is a mean to take proper timing in planting and harvesting of crops to reduce harmful effects of weather disturbances in the form of a tropical depression,storm or typhoon. On the other hand, post-harvest equipment and facilities is required for more efficient and timely operation to reduce grain loss and consequently increases post harvest yields by as much as six percent from the present losses of 22.5 percent on an average and to improve the quality and quantity of milled rice. In the future development stage, another two percent of post-harvest

losses can be expected to improve by development of secondary marketing station which deals with mostly milling rice.

5.07 To reduce post-harvest losses, to improve quality of products and to provide farmers with better market access, it is proposed to establish pilot primary marketing station (PPMS), primary marketing station (PMS) and post-harvest technology demonstration farm (PTDF) in the area. The proposed PPMS and PMS are provided with a yard of about 8,000 square meters and equipment such as thresher, multi-pavement of about 3,000 square meters, mechanical solar dryer, warehouse of about 1,440 square meters, small size rice milling unit, cargo truck, etc. at each station. The proposed PTDF with about four hectares of paddy field is located at adjacent PPMS or PMS and prepare some agricultural machinery for training of farmers.

(Irrigation Plan)

5.08 Water resources for irrigation in the area are utilized mainly surface water and supplemented by groundwater especially in dry season. Proposed irrigation plan emphasizes effective utilization of the existing water resources by proper water management with improved farming practice because development of new water resources is hardly expected in the master plan. Instead of scanty surface water, abundant groundwater is used for gravity irrigation by providing a new system of groundwater collecting conduit (GCC) in five CISs areas.

5.09 For improvement of farming practice, transplanting duration of two-month period is recommended instead of generally prevailing three-month transplanting period. Crop water requirement is estimated by applying Modified Penman Method and irrigation efficiency of 46.8 percent in wet season and 54 percent in dry season and maximum water requirement per hectare of 2.11 liters per second.

(Irrigation Facilities)

5.10 Since the existing canal density seems to be sufficient for water management, improvement of the irrigation facilities is concentrated in canal lining at the portion with soft soils like sandy or sandy loam, expansion of canal section to keep sufficient flow capacity and improvement of canal structures such as turnout and check structures for proper water management. Aside from the canal improvement, the proposed development plan emphasizes the rehabilitation or improvement of the diversion dams and intake structures, particularly on the brush dams.

5.11 For improvement of brush dams, three alternative methods such as low weir method with stop-log, low weir method with triangular gate and low weir method with gabions are comparatively studied and the low weir method with stop-log is proposed in the master plan. All of those structures are semi-permanent structure due to the unavoidable river conditions. For improvement of diversion dams, it is proposed that the present wooden flap gate is replaced with rubber dam for prevention of water leakage and easy operation of

dam during flood. In addition, rehabilitation is made also on the damaged dam bodys and appurtenant structures of the diversion dams.

5.12 Supplemental irrigation by private owned pumps is commonly prevailing in dry season in the eastern part of the area where groundwater is abundant and groundwater table is quite shallow. As development of new technique on utilization of groundwater resources, it is recommended groundwater collecting conduit (GCC) to be placed at some sites where geographycal and hydrogeological conditions and irrigable areas by gravity are suitable for the purpose. The GCC consists of collecting conduit with 600 to 1,000 milimeters in diameter and one kilometer in length, and open feeder channel to be connected to the existing canals in Sta Rita, San Martin, Lilibangan and Baluto CISs.

5.13 Drainage on the farm lands in the Study Area is made through creeks and density of drainage canals seems to be enough for the drainage of the on-farm, therefore, drainage development is considered in development of insufficient drainage capacity in Susuba Cutcut and Caluluan CISs.

(Rural Road Development)

5.14 Rural road development in the master plan consists of Barangay road and farm-to-market road development. Barangay road is defined as any road connecting a Barangay with another Barangay which play a vital role on living activities, communication and agricultural productive activities. Earth or gravel Barangay road to be muddy or bumpy in wet season is planned to be concreted for improvement. Farm-to-market road is defined as any road connecting farm to Barangay road which is utilized for transporting agricultural inputs and also ease the carrying convenience. The farm-to-market road is gravelled for improvement.

(Institutional Development)

5.15 Institutional development of the master plan is proposed based on NIA's participatory approach with certain revision and development of the approach. The basic concept on the participatory approach is considered maximizing participation of farmers-beneficialies to the activities of CISs from planning and design stage to operation and maintenance stage of the completed project facilities. The proposed institutional development consists of strengthening/ establishment and expansion of IAs, development of training program, improvement and reinforcement of finance and crop insurance systems and establishment of coordinating body among the government agencies and IAs for implementation and operation of the project.

5.16 Establishment of IAs in CISs which has no organization is primary action on the Study Area and in parallel with the above, strengthening of the existing IAs is forwarded by rearrangement of the IA's organization to practically functional one through activities of assigned ICO/IOW, supplemented and revised IA's by-low, establishment of financial stability and cooperative activities on water management and O/M of the facilities. After

strengthening of IAs, establishment of model federation of irrigator's association (MFIA) to show a recommendable procedures for establishment of a federation of irrigator's association as a model. Following the MFIA, federation of irrigator's associations (FIAs) is established in combined with several IAs. In the future,likewise the FIAs are developed to a confederation of irrigator's association (CIA).

5.17 Development of training program is made by supplementing curricula of training and provision of training instrument like audio-visual facilities in order to enhance various training program. Concerning the improvement and reinforcement of finance and crop insurance systems, several ways are recommended; changing the collecting method from "case-to-case" to "in-advance", minimizing illegal cultivation, changing the registration in SEC from "no profit" to "with profit", providing authority to BODs especially Treasurer, establishing the research and treatment on the damage of Tungro and establishing the booking system with introduction of computerized system. In addition, a particular suggestion is emphasized on introduction of production loan program like two step loan and setup of the crop insurance system in MFIA and FIAs to provide some fund out of the benefits expected from the cooperative activities with the association.

5.18 For successful implementation of the Project and effective operation and maintenance of the facilities, it is recommended to establish a coordinating body among the government agencies and IAs. The activities of MFIA and FIAs are very widely concerned with several agencies and groups due to its multi-functional organization, and the coordination becomes a significant role.

(Project Cost and Annual O/M Cost)

5.19 The total project cost at current price is estimated at 720 million Pesos, of which 221 million Pesos is for the Phase-I development and 499 million Pesos is for the Phase-II development. On the other hand, the annual operation and maintenance cost is amounted at 5.42 million Pesos for the Phase-I and 12.13 million Pesos for the Phase-II.

(Project Implementation Plan)

5.20 Considering the jurisdiction of irrigation and the past outstanding performance of NIA, implementing agency shall be NIA with active participation of IAs, MFIA and FIAs to be organized under the Project and also other government agencies concerned. Under the administration of NIA Head Office and Regional Irrigation Office, Project Office headed by Implementation Manager (IM) shall be established directory under the Provincial Irrigation Engineer of NIA. The IM shall manage the office and supervise the implementation of the Project.

5.21 Implementation of the Project is programmed in taking two phases. The Phase-I development is expected to carry out for the initial two years period by special funding sources, while the Phase-II development is to be carried out for another four years period.

After completion of the Project construction, all facilities constructed/provided and equipment by the Project shall be turned over to the farmers' association of MFIA or FIAs. The farmers' association shall be responsible for the operation and maintenance of the said facilities and equipment.

(Project Evaluation)

5.22 Economic evaluation is carried out from the standpoints of national economy and financial analysis is also made from the standpoints of farmers to be benefited. For the purpose, economic cost is estimated based on local and foreign currency portion and annual disbursement schedule by applying opportunity cost of 0.39 for wages of unskilled construction labor in local currency portion and standard conversion factor of 0.78 for the rest of local currency portion. As a result, the economic project cost is evaluated at 624 million Pesos for the project cost of 720 million Pesos. Likewise, economic annual operation and maintenance cost is evaluated at 10.355 million Pesos for the annual operation and maintenance cost of 17.550 million Pesos. On the other hand, the project benefits are quantified based on the benefits of agricultural production, Barangay road benefits, farm-to-market road and O/M cost saving.

5.23 As a result, the internal rate of return (IRR) is computed at 18 percent indicating higher value than the opportunity cost of capital of 15 percent in the Philippines. As for financial analysis, farm budget analysis on typical farm household model is carried out on small farm with 1.45 hectares farm size and middle farm with 2.30 hectares farm size. In without project situation, monthly average net farm income for small farm and middle farm are estimated at about 1,300 Pesos and about 1,800 Pesos,respectively which are below the average poverty threshold of 2,491 Pesos in Region III. In with project situation, monthly average net farm income for small farm and middle farm are expected to increase to about 2,500 Pesos and about 3,700 Pesos. As for annual disposal income, it is expected to increase by about 13,500 Pesos for small farm and about 22,600 Pesos for middle farm.

(Environmental Impact Assessment)

5.24 The construction of civil works, no matter how small, is always accompanied by a change in the surrounding environment. In improvement of communal irrigation systems, such changes, whether beneficial or adverse, will be very slight. The environmental impacts resulting from the implementation of the Project would be very minimal.

(Development of Priority Project)

6.01 The Project would serve as a model project for improvement and development of thousands of communal irrigation systems/projects in the Philippines. Therefore, the Project is expected to implement immediately. However, considering the magnitude of the project components and availability of the funding source in addition to the required term for the institutional arrangement on the farmers' association, a pilot project should be formulated among the

development components of the master plan and implemented at the early stage of the project.

6.02 The criteria for selection of the priority components are provided based on certain assumptions that the components should be pilot structures, as for a model project, the components should be concerned with viable IAs as a leading body and the components should be located at the accessible place by the project members as well as visitors from outside.

6.03 The Pilot Communal Irrigation Systems Development (Pilot CISD) is proposed to formulate a project among high priority components selected based on the criteria and aims at providing a sample on improvement of communal irrigation systems in physical and institutional development and implementing the proposed components as a pilot project through active participation of farmers' association. Three CISs of Sta Rita, Marita and Baluto for the Pilot CISD are selected based on the consideration of maturity of IA organization, fee collection records, financial status, and others.

6.04 The components of the Pilot CISD consists of agricultural infrastructure development including rehabilitation of canals, intake facilities and diversion dams, construction of GCC and shallow well development, farm road development, agricultural development such as FTDF, SMS, PPMS and PTDF, and various programs of institutional development.

6.05 The Pilot CISD is expected to be implemented by NIA at the early stage of the project for a period of two-year for Phase-I as a pilot of the improvement of communal irrigation systems by receiving financial support from certain foreign country /international agency for the implementation of the Pilot CISD.

CONCLUSION

1. The eradication of poverty and improvement of living standards are primary aims of the Philippine government stressed in the Medium-Term Philippine Development Plan (1987-1992). Agriculture in the Philippines occupied more than a half the household population employed in the industries and played a very important role in attaining self-sufficiency in rice production as well as in uplifting the income and living standards of the low-income farmers. Purpose of the agricultural development will be attained by providing, among other things, irrigation facilities.

2. Irrigation in the Philippines handled by irrigation systems are classified into (1) national irrigation systems (NIAs), (2) communal irrigation systems (CISs) and (3) pump communal irrigation systems (PISs) under the administration of NIA covering an irrigated paddy lands of about 1.5 million hectares out of the total paddy lands of about 3.2 million hectares in the country. Among the irrigated paddy lands, about 0.7 million hectares or about 48 percent are served by more than 6,200 CISs and operated and maintained uneffectively or hardly by farmers or farmers' associations. Improvement of these CISs becomes urgent government policy from the viewpoints of easy and quick materialization of the development aims for the agriculture. For smooth execution of the improvement of CISs, it is proposed that improvement of the CISs through physical and institutional development and rural development in southern Tarlac province as a model project should be immediately implemented.

3. For the successful implementation of the improvement of CISs, active participation to the Project in all stages from planning and design stage through the implementation stage up to operation and maintenance stage will be required by beneficial-farmers or farmers' associations to be established or strengthened. Considering the magnitude of the project development components as well as the time and funds in the implementation of the Project, it is proposed that implementation be carried out in two phases : Phase-I development should be carried out as a pilot of the Project for initial period of two years by special funding source, while Phase-II development should be carried out for a period of four years thereafter by another funding source.

4. Proposed scope of the improvement on communal irrigation systems through physical and institutional development and rural development in southern Tarlac province is, as a conclusion of the Master Plan Study, delineated as follows :

Communal Irrigation Systems (CISs) under the Project

1. Bamban CIS	2. San Pedro CIS	3. Malonzo CIS
4. Bangcu CIS	5. Susuba Cutcut CIS	6. Telabanca CIS
7. Sta.Rita CIS	8. Marita CIS	9. San Martin CIS
10. Baluto CIS	11. Lilibangan CIS	12. San Bartolome CIS
13. San Isidro CIS	14. Lucong CIS	15. Magao CIS
16. Tinang CIS	17. Sto.Rosario CIS	18. Sta.Monica CIS
19. Caluluan CIS		

Major Development Components

Description	Unit	Total	Phase-I Pilot CISD	Phase-II
(1) Agricultural Infrastructure Development				
a) Irrigation Facilities Developmnet				
Canals	km	37	1	36
Canal Structures	Unit	295	44	251
Service Road	km	73	10	63
Intake Structures	Unit	7	1	6
b) Diversion Dams Improvement				
Replacement by Rubber Dams	Unit	4	2	2
Rehabilitation	Unit	6	-	6
c) Groundwater Collecting Conduit	Unit	4	2	2
d) Shallow Wells	Unit	271	12	259
e) Drainage Development	Unit	4	-	4
(2) Farm Road DEvelopment				
Barangay Road	km	53	8	45
Farm-to-market Road	km	58	1	57
(3) Agricultural Development				
Farming Technology Demonstration Farm	Farm	11	2	9
Seed Multiplication Station	Station	L.S.	L.S.	-
Pilot Primary Marketing Station	Station	2	2	-
Primary Marketing Station	Station	3	-	3
Post-harvest Technology Demonstration Farm	Farm	5	2	3
Duck Raising	Place	5	-	5
Fishery Pond	Place	5	-	5
(4) Institutionla Development				
Support Assistance for Strengthening IAs		L.S.	L.S.	L.S.
Support Assistance for MFIA		L.S.	L.S.	L.S.
Support Assistance for FIAs		L.S.	-	L.S.
Support Assistance for CIAs		L.S.	-	L.S.
Support Assistance for ASS		L.S.	-	L.S.
Support Assistance for Seminar & Training		L.S.	L.S.	L.S.

Project Cost (Financial)

(Unit: Thousand Pesos)

	Total Cost	Foreign Currency	Local Currency
Phase-I Development	221,000	152,400	68,600
Phase-II Development	449,000	284,600	214,400
Total	720,000	437,000	283,000

Project Economics

Internal Rate of Return
Overall Project 18 %

Improvement of Farm Budget

	Small Farm		Medium Farm	
Description	W/o Project	W/ Project	W/o Project	W/ Project
Farm Size (ha)	1.45	1.45	2.30	2.30
Net Farm Income (Peso)	15,600	29,900	21,200	44,600
Disposable Income (Peso)	0	13,500	200	22,800

RECOMMENDATION

1. In the early stage of the project implementation, activities on the institutional development especially strengthening of IAs and plan of the Project will be informed to farmers concerned to develop cooperative spirit among farmers on the operation and maintenance of the irrigation facilities and expansion of the farmers' association to multi-functional association.

2. CISs are operated and maintained by farmers or farmers' association. Improvement or construction of the facilities are carried out by farmers under technical assistance of NIA and the farmers/farmers' association pay such cost of construction by amortization. Most farmers in CISs belong to small scale farming with low-income, thus, they hardly pay back the cost by amortization basis. For effective implementation of the government policy on expansion of the irrigated lands for the purpose of increasing of rice production, it is recommended that the project cost of CISs will be subsidized by the government while the operation and maintenance of the facilities will be made by the farmers in the same manner as the national irrigation systems.

3. For carrying out the final design of the Project , the following additional topographical survey and geological investigation including soil laboratory test will be required in order to obtain sufficient information before proceeding with the design work.

   (1) Rehabilitation of diversion dams
   Intake water level required to serve the irrigation area and also backwater level at the upstream reach of the diversion dam to prevent the area along the river from damages of inundation will be confirmed for the design of replacement of flush board by rubber dam.

   (2) Groundwater Collecting Conduit
   Geologic and hydrogeological investigation including soil laboratory test as well as topographical survey on the proposed site of groundwater collecting conduit will be conducted and confirmed.

   (3) Location of Canal Structures
   Location of the proposed canal structures particularly turnout will be decided through confirmation of irrigation water distribution at on-farm level and coordination meetings with farmers and farmers' association concerned.

4. To develop completely the agricultural infrastructures and the related matters, watershed management and flood control project of Bamban and Lucong rivers should be early implemented. Flood control project on Chico river should not be neglected for development.

5. Strong earthquake ravaged the Central Luzon on July 16, 1990 and left heavy casualities and damages in various sectors, particularly social

infrastructure including irrigation facilities in the Study Area. However, this master plan does not include countermeasures on restoration of the said earthquake damages, because the master plan study had been completed before the earthquake. Therefore, it is recommended that reconstruction for restoration of the said damages would be included in the implementation of the proposed development in the master plan. Major damages were as follows;

Irrigation Facilities	
Canals in Lucong and Sta Monica CISs	about 3.1 km
Service Road	about 4.0 km
Intake Facilities including Brushdams	about 9 units
Farm Road	
Barangay Road	about 3.0 km
Farm-to-market Road	about 1.0 km
Bridges, Drainage Crossing and Others	L.S.

CHAPTER 1. INTRODUCTION

In response to the request of the Government of the Republic of the Philippines, the Government of Japan through the Japan International Cooperation Agency (JICA) dispatched a Preliminary Study Team to the Philippines from February 13 to February 22,1989 and concluded the Implementing Arrangement of the Technical Cooperation (I/A) between JICA and National Irrigation Administration (NIA) for the Master Plan Study on the Improvement of Communal Irrigation Systems through Physical and Institutional Development and Rural Development in Southern Tarlac Province in the Republic of the Philippine on February 21,1989.

In accordance with the I/A, JICA dispatched the Study Team consisting of ten members to the Philippines for the first field survey from August 8 to November 2, 1989 and the second field survey from January 11 to March 16, 1990.

The objective of the Study is to formulate a master plan for the improvement of communal irrigation systems through physical and institutional development and rural development in southern Tarlac province. The Study area covers about 40 thousand hectares in southern Tarlac province.

This Report consists of Main Report, Appendix I and Appendix II, incorporating the findings and observations of the field survey conducted in the Philippines by the Study Team in cooperation with NIA. Appendix I compiles the supporting data for the Master Plan Study while Appendix II compiles the priority components of the Study.

CHAPTER 2. BACKGROUND

2.1 National Economy

The Philippine economy grew up gradually during the decade of 1970's through promotion of large-scale development projects especially in agriculture, industry, energy and transportation sectors accompanied with bilateral and multilateral cooperation. Industrial production in the electronics, electric appliances, textile and garments, equipment and machinery,etc. were remarkably expanded. Social infrastructure such as road, electric power generation, and irrigation and drainage facilities were fully developed and constructed during the past decade. GNP was marked with an average annual growth rate of 6.4 percent from 1970 to 1980 and thereafter slowed down until 1983 (refer to Tables B.1.1& B.1.2 in Appendix B).

Major industry of the Philippines is agriculture sharing about half the total household population employed. On the other hand, labor force in the primary, secondary and tertiary industries were recorded at 31.5 percent, 25.0 percent and 43.6 percent, respectively in 1970 and 25.6 percent, 36.2 percent and 38.2 percent, respectively in 1980 (refer to Table B.1.10 in Appendix B). Although the primary industry was relatively decreased during 1970's due to rapid increase of the secondary industry and also population growth of more than 2.8 percent, development and construction of the large-scale agricultural productive infrastructures were performed successfully through attaining self-sufficiency in rice production at the end of 1970's.

After 1983, however, due to the world wide economic recession, the Philippines faced with the problem on the serious economic stagnation. GNP as the major economic indicators of statistics showed the negative growth at -7.1 percent in 1984 and -4.2 percent in 1985, abnormal rise of consumer price index, increase of external debts as well as the devaluation of the peso.

The Government redirected its policies after the so-called People's Power Revolution in February 1986 and established the development policy under the Medium-Term Philippine Development Plan (1987-92). The ultimate aim of this Plan is the eradication of poverty and attainment of a better life for each and every Pilipino in an equitable and just society. This development plan outlines such major goals as alleviation of poverty and income inequality, generation of more productive employment, and improvement of urban/rural and regional disparities.

Attainment of self-sufficiency in rice production is primary approach for the development and economic recovery in the Philippines and this approach will be attained by providing, among other things, irrigation and drainage facilities. Recently, 1,488 thousand hectares of paddy field, out of the total paddy field of 3, 170 thousand hectares in the Philippines are irrigated by the various irrigation systems/projects under the administration of NIA. In the irrigated paddy field of 1,488 thousand hectares, the national irrigation systems/projects serve in about 627 thousand hectares (42%), the communal irrigation systems/projects serve in

about 709 thousand hectares (48%), and the remaining 152 thousand hectares (10%) is irrigated by pump irrigation systems/projects.

The national irrigation systems/projects which are mostly large-scale in size and constructed by NIA are being well-operated and maintained directly by NIA and being produced comparatively high yield. However, the communal irrigation systems/projects, which are generally small scale in size and constructed by the group of beneficiary-farmers under the assistance of NIA, mostly have serious problems on operation and maintenance of the said system due to inadequate facilities and lack of water resources. Consequently, the yield remains at a low level and small farmers concerned earned low income.

To attain self-sufficiency in rice production in the country, to achieve the goals of the Medium-Term Philippine Development Plan and to improve the living standards of small farmers, NIA accords high priority for implementation in the improvement of communal irrigation systems/projects. Beneficiary-farmers' participation with the project implementation and their organizational set-up shall also be considered in the formulation of development plan.

2.2 Regional Economy

Tarlac province is one of the six provinces in Central Luzon (Region III) and is located on the western part of the Central Luzon plain (about 120 kilometers northwest Manila). Social and economic conditions of Region III shows nearly average compared to the whole Philippines.

Average annual population growth rates of Region III in 1985 and 1986 are 2.51 percent and 2.42 percent, respectively against that in the whole Philippines are 2.47 percent and 2.44 percent, respectively (refer to Table B.1.5 in Appendix B). Employment rate in 1986 for Region III and the whole Philippines are 88.8 and 88.9 percent, respectively, while underemployment rate of Region III in 1986 is 26.5 percent which is much lower than the whole Philippines of 36.0 percent (refer to Tables B.1.6 & B.1.7 in Appendix B). This indicator shows favorable social situation in Region III, located in the neighboring National Capital Region.

Growth rates of Gross Regional Domestic Product (GRDP) in 1986 for Region III and the whole Philippines are reported to be 0.86 percent and 1.08 percent, respectively (refer to Table B.1.8 in Appendix B). With respect to the poverty threshold by region and urban-rural in 1986, the total, urban and rural of Region III are accounted for 2,491 Pesos, 3,055 Pesos and 2,053 Pesos, respectively, while that of the whole Philippines are 2,372 Pesos, 3,071 Pesos and 2,001 Pesos, respectively (refer to Table B.1.9 in Appendix B).

Land area of Region III is 18,230.8 km^2 out of the Philippines' land area of 300,000 km^2 and Tarlac province occupied in 3,053.4 km^2 (refer to Table B.2.1 in Appendix B). The total farm area and arable land are 97,108 hectares and 83,176 hectares, respectively. There are two national irrigation systems serving 25,175 hectares and 52 communal irrigation systems serving 16,632 hectares of paddy field in Tarlac province (refer to Tables B.2.2 & B.2.3 in Appendix B). These national irrigation systems are being operated and well maintained by NIA and farmers in the area are able to produce stable and relatively high yield of palay. However, most communal irrigation systems are not well operated and maintained by farmers themselves or irrigator's association, and production in the area is at rather low level due to poor water management and lack of facilities.

Many communal irrigation systems are located in southern Tarlac province and its facilities required rehabilitation/improvement of water management as well as production. Effective planning and implementation for improvement of communal irrigation systems will be carried out through farmers' participation which shall require strengthening or establishment of farmers' organizations. Through participation of such organizations, successful implementation of the said improvement can be expected.

CHAPTER 3. PRESENT CONDITION OF THE STUDY AREA

3.1 Natural Conditions

3.1.1 Location and Geographic Conditions

The study area is located in the southern part of Tarlac province, lying in the western portion of the sedimentary basin (Central Luzon Basin) with its long axis trending north-south. This basin is bounded at the east by the Sierra Madre Mountains, at the north by the Caraballo and Cordillera Central, and at the west by the Zambales Range.

The Mount Arayat, in the south central part, is the extincted volcano which rises about 984 meters above the sea level.

The study area comprises lowlands and moderately a sloping area with a gentle relief. The main drainage systems crossing the area are Bamban, Lucong, and Tinang rivers, all draining eastward towards the Chico river. Numerous large and small tributaries abound the area.

3.1.2 Geological Conditions

(1) Stratigraphy

The locks within the study area and its proximities consist of seven different types (refer to Appendix D). The stratigraphic column in the said table shows in order of increasing age.

(2) Structures

The geological structures of the area are simple. Three structures are known in the study area and its proximity, namely the Tarlac and Capas anticlines, and the Capas syncline. The Tarlac Anticline is gently folded in the Tarlac Formation with the axis trending north-south. The locks which underlie the Tarlac Anticline are exposed in the hills west of Tarlac.

The sediments filling a syncline basin have a thickness which increases progressively towards the center of the basin. The thickness of the Quarternary sediments is around 20 meters at the western boundary of the study area increasing considerably towards the east with an approximate thickness of more than 250 meters.

3.1.3 Hydrogeology and Water Quality

(1) Groundwater Occurrence

The groundwater in the study area and its proximity occur in the interstices of loosely to fairly compacted alluvium, alluvial fan, and terrace gravel deposits, of Quarternary age, and in fairly consolidated sedimentary rocks which range in age from Upper Miocene to Pleistocene.

The Miocene and Pliocene aquifers are usually semi-confined, while the Quarternary ones are unconfined.

The basement complex and the volcanic rocks are essentially poor in groundwater because of their dense, mAssive, and impervious character. The distribution of the favorable and poor water-bearing formation in the area, as well as the piezometric contours of the groundwater level, is shown in Appendix D.

(2) Configuration of the Water Table

The configuration of the unconfined groundwater table under the study area during the dry season (April 1976) and during the wet season (September 1976) are shown in Figures 3-1-1 and 3-1-2, respectively.

These figures indicate that the unconfined groundwater beneath the plain flows in different directions. The groundwater originating from the foothills of the Zambales range, at the western margin of the study area, generally moves eastward of southern Tarlac, while groundwater originating from the foothills of the southern Caraballo and Sierra Madre Mountain ranges, at the eastern margin of the study area, generally moves southwestward. The unconfined groundwater from the east and west finally converge almost at the course of the Chico river, flowing to the south.

The depth to the potentiometric surface of the unconfined groundwater during the dry season (April 1976), is indicating that the unconfined groundwater level in the study area is less than five meters below the ground surface (refer to Appendix D).

Under considering about a variation of the groundwater level from the dry season (April 1976) to the end of the rainy season (September 1976), it is shown that a valley-like depression zone of the groundwater traverse the central part of the study area from west to east, and that the groundwater tends to gathercinto the valley and move towards the east. The seasonal variation of the groundwater level is minimal in the central part of the study area at the vicinity of Concepcion with a value of less than 0.5 meters, increases towards the marginal area, to attain more than two meters at the north-western margin of the study area (refer to Appendix D).

There may be a local discoincidence with the value ranging from one to two meters due to an annual fluctuation of the well yields and precipitation. The drawdown of the groundwater level during the dry season may not exceed more than five meters. Hydrographs show sin-wave-like fluctuations with an annual period (refer to Appendix.D). The groundwater level becomes lowest between April and July (May in average), and attains its highest level between August and December (October in average). For each well, these extreme values are not always reached at the same month. The confined groundwater observed in the study area has an artesian potentiometric water level about ten centimeters above the groundsurface, yielding almost a constant volume of water throughout the year.

(3) Groundwater Availability

The location of the existing wells in the study area and its vicinity are shown in Figure 3-1-3. The depth of wells exploited in the study area ranges from four meters to more than 250 meters. The total number of wells supplying drinking water in the study area is 114 ; 23 shallow wells with a depth of less than 20 meters, 84 deep wells with a depth of more than or equal to 20 meters, and seven wells with an unknown depth. In addition to these wells, some tens of wells are exploited for the purpose of irrigation.

Adequate groundwater for the large scale development of the study area is thought to be available to supply irrigation water, even during a dry season.Aquifer transmissivities in the study area may range from 500 m^3/day/m to more than 1,000 m^3/day/m , and exploitable well yields may range from five l/sec to 100 l/sec.

Almost all the soils of the study area are permeable or semi-permeable so that almost everywhere the infiltration and deep percolation of the surface water towards the aquifer is comparatively easy. Therefore the recharge of the aquifer system by direct infiltration seems to be adequate.

The apparent recharge of the groundwater,viz.actual groundwater recharge-groundwater run off, in the study area is estimated on the basis of the drawdown (refer to Appendix D), to be approximately 24 and 35 MCM/year assuming that the effective porosity of the aquifer is 10 percent and 15 percent, respectively. As the total amount of well yields should be controlled less than the above-estimated recharge, the value estimated can be considered to be the maximum exploitable groundwater amount in the study area.

(4) Water Quality

Water quality analyses were carried out on selected sites at the mainstreams and the tributaries, and at shallow and deep wells in the Study Area (refer to Appendix D).

It is remarkable that the water from the wells has relatively higher conductivities than those of the river water. A slight sulphuric smell is observed in the water flowing freely from the deep well at Santa Cruz. The sulphuric concentration is probably due to the depositional environment which is very near to an extincted volcano, the Mount Arayat.

3.1.4 Climate

(1) General Condition

The Study Area is located in the lower central part of the Central Luzon. This area is bounded by the Zambales Mountains on the west, the Caraballo Mountains on the northeast and the Sciera Madre Mountains on the east. And this area generally slopes down from west to east direction.

Based on the records of the meteorological and rainfall stations located inside or near the Study area, the climate falls under the First Type of the Coronas' classification system. It is characterized by two clearly distinct seasons:

- Wet season, from May to October, during the southwest monsoon
- Dry season, from November through April

(2) Rainfall

Annual rainfall observed at four rainfall-stations, Cabanatuan, Hacienda Luisita, Clark Air Base and O'Donnell RIS are averaged as follows:

Station	Annual Rainfall	Duration
Cabanatuan	1883 mm	1949-1984 (36Years)
Hacienda Luisita	1878 mm	1968-1988 (21Years)
Clark Air Base	1926 mm	1946-1988 (42Years)
O'Donnell RIS	1964 mm	1948-1967 (19Years)

In those four rainfall stations, Hacienda Luisita and Clark Air Base are located neighboring on the Study Area and these records are considered applicable for the study. But it is impossible to get the daily rainfall records from 1975 to 1988 at Clark Air Base due to military aggairs. Therefore the rainfall at Hacienda Luisita would be adopted as the representative rainfall in the Study Area.

Annual rainfall at Hacienda Luisita is recorded at 1878 mm on an average for 21 years form 1968 through 1988. The rainfall is effected by the monsoons, and recorded at 3.5mm minimum monthly mean reinfall in February and at 399.5mm maximum in August, respectively. the period from November to April has brought a comparatively small rain in the year.

(3) Temperature and Humidity

The annual temperature is 27.1°C on an average with 32.9°C in maximum and 21.3°C in minimum. The monthly mean temperature is the highest in May and the lowest in January.

The annual mean relative humidity is 80.6 percent, while the minimum and maximum are 71.0 percent in April and 90.5 percent in August respectively.

(4) Wind Direction and Velocity

The mean wind velocity is 2.25m/s (8.1km/hr.)at San Miguel, Tarlac. The wind direction varies seasonally due to the monsoon. During the period from June to September the prevailing winds blow in association with the southwest monsoon. During the rest of the year, the prevailing winds blow from the northeast or east, in association with the northeast monsoon or the North Pacific Trades.

(5) Sunshine and Evaporation

Sunshine and evaporation records are available in Hacienda Luisita. The annual mean sunshine hour is 6.8 hours/day; 4.3 hours/day at minimum in August and 9.3 hours/day at maximum in April.

The annual mean evaporation by Class A-Pan is 1730mm; 209 mm/month in May at maximum and 101.2mm/month in June at minimum.

3.1.5 Hydrology

(1) River Basins

The Study Area consists of three river basins, Parua (Bamban) river basin, Cut-Cut (Lucong) river basin and Tinang river basin .

Furthermore Parua (Bamban)river basin is divided into two river sub-basins, namely Parua river basin and Balen creek basin. Also Tinang river basin is divided into the river sub-basins ; Tinang river basin and Caluluan river basin.

- Bamban river 298 sq.km
- Lucong river 225 sq.km
- Tinang river 104 sq.km

(2) Parua River Flow Analysis

The discharge records within Study Area are available at Parua (Bamban) river (148.0sq.km). According to these records, some phenomena on the discharge are found as follows:

- The discharge records tend to increase year by year.
- Runoff percentage is very high.
- Artificial influences are found in the discharge pattern.

Therefore the discharge of Parua river would be analyzed in this study by applying Tank Model Method. In order to determine each coefficient of the tank model, the rainfall records at O'Donnell should be used. Because the rainfall station of O'Donnell is located close to the catchment area of the river and the rainfall records of Hacienda Luisita are available only from 1968. By this analysis, the annual mean runoff of Parua river is estimated at 3.365 cum/sec (148sq.km).

(3) Runoff by River Basin

The Study Area is divided into two basins considering runoff form. One is the runoff of mountain and the other is the runoff of flat ground.

Bamban river basin consists of mostly mountain basin. However, Lucong river basin consists of mountain and flat ground basin. Further Balen creek basin, Tinang river basin and Caluluan river basin belong to the flat ground basin.

The runoff discharge in Lucong river's mountain basin is estimated at about 70 percent of Bamban river's specific discharge by judging from observed discharge.

The runoff discharge in the flat ground basin should be estimated on the basis of certain assumed conditions and discharge measurement.

By applying the Tank Model Method, runoff discharge was represented from 1968 to 1988. Judging from these calculated discharge, the annual mean runoff in the flat ground basin is estimated at 0.024 cum/sec/1.0 sq.km.

3.1.6 Soils

(1) Soil Classification

The soil map scaled 1:100,000 covering the Tarlac province has been used as the standard map published by Bureau of Soils for the concerned areas. However, it is slightly small in scale to use as the base map for this master plan study, and some parts of the soil classification on this map do not necessarily correspond to field observation. New more detailed soil map scaled 1:50,000 described in USDA system is now being compiled by Bureau of Soils. Though it is still in draft, the soil classification was made based on the informations from this draft, and the field survey was conducted mainly in CIS command areas so as to check the said informations (dozens of stick boring and some test pits), and finally the soil map in Figure 3-1-4 was drawn up.

The Study Area is almost flat alluvial plain formed by the enormous deposits from the rivers of Bamban, Chico, Lucong, Tinang, etc. In general the sandy soils are dominant in southern part of the area, while clayey soils are often occurred in northern area.

Soils in the Study Area are mainly divided into 10 Soil Series excluding some soil series covered small acreage in the area, that is summed up as follows.

a) Luisita Series: Recent Alluvial Deposits

The color of surface soil varies from dark gray, gray, light gray to brownish gray. It is loose and structureless sandy loam with 30 to 50 centimeters in depth. Subsoil is grayish brown, coarse to fine sand. Lower subsoil contains tuffaceous concretions and gravel with 80 to 90 centimeters in depth from the surface. Relief is nearly level and drainage conditions are good. This soil series occurs broadly at the western part and northeastern part in the Study Area and cultivated to paddy rice, sugarcane etc..

b) Pawing Series: Recent Alluvial Deposits

Surface soil is dark brown to reddish brown, structureless and very loose fine sandy loam, and fairly rich in organic matter. Boundary to substratum is clear and abrupt with 15 to 20 centimeters in depth.

Substratum is gray structureless and very loose sand. Relief is level to nearly level, and drainage is a little poor temporarily during wet season due to high water table and cultivated to rice. This soil series are distributed in the southern and middle parts of the Study Area.

c) Banga Series: Recent Alluvial Deposits

Surface soil is dark brown, structureless, slightly compact sandy loam and fair in organic matter content. Boundary to lower layer is diffused and smooth with 5 to 10 centimeters in depth. Subsoils are brown to medium brown, loose and structureless sand with 115 to 120 centimeters in depth. Substratum is grayish brown or gray and very loose coarse sand with gravel. Relief is level to nearly level and drainage is good. Cultivated crops are rice and corn. This soil series mainly occupied the southeastern part in the area, of which considerable lands are often flooded.

d) Lapaz Series: Recent Alluvial Deposits

Surface with 25 to 30 centimeters is gray to very dark grayish brown fine sandy loam. Subsoil is very dark grayish fine sandy loam with a depth to 50 centimeters, dark grayish brown to light brownish loamy sand with a depth to 60 centimeters, and very weak subangular blocky structure. Soils with a depth from 60 to 75 centimeters is light brownish loamy sand with weak fine crumb or loose structure, and lower horizons are all sand. Relief is level to nearly level and drainage is good to excessive. A small area of this soil are scattered in the study area.

e) Angeles Series: Recent Alluvial Deposits

The soil is a member of the coarse loamy deep and well drained soils. Surface soil ranges from 10 to 30 centimeters grayish brown loamy fine sand. Subsoil is gray to light gray sand down to 100 to 110 centimeters in depth. Substratum is stratified light gray sand. Relief is level to nearly level. Thisseries appears only in small parts of the Study Area.

f) Zaragoza Series: Recent Alluvial Deposits

It is used mainly for paddy rice. Surface soil with 15 to 20 centimeters in depth is gray to grayish brown, and clay loam to clay with puddled structure. Subsoils are grayish brown weakly stratified clay loam, sandy clay loam and clay with moderate medium subangular blocky structure. Substratum is gray or grayish stratified fine sandy clay loam, sandy loam, and clay or loamy fine sand, and internal drainage is a little poor. Relief is nearly level and cultivated to paddy rice, sugarcane, etc. It is the largest distributed soils especially in northern part of the Study Area.

g) Baran Series: Recent Alluvial Deposits

Surface soil is brownish gray silt loam with a depth of 15 to 20 centimeters. Subsoil is brownish to gray silty clay to sandy clay loam with many brown mottes and nutty to subangular blocky structure. Drainage

is fair to good and cultivated to rice, sugarcane, etc. This series is located mainly in the deposit area of Bamban river in the Study Area.

h) Cabetican Series: Recent Alluvial Deposits

Surface soil is grayish yellow brown silt loam with a depth of around 15 centimeters. Subsoil is gray, sandy loam to sandy clay loam and drainage is fair. Relief is level to nearly level, and cultivated to rice, sugarcane. The area of this soil series lies along Bamban river.

i) Tarlac Series: Residual Soil Derived Tuffaceous Sandstone

Surface soil is nearly black or dark gray sandy clay loam to clay loam. Subsoil is grayish brown, dark gray to nearly black columnar clay loam. Substratum is brownish gray to grayish brown chalky tuff or tuffaceous sandstones. Relief is slightly sloping to gently undulating. Internal drainage is poor and cultivated to sugarcane, upland crops, etc. This soil series lies in the western part of the Study Area.

j) San Manuel Series: Recent Alluvial Deposits

Surface soil is grayish brown to pale brown loose and friable silt loam with a depth of 25 to 40 centimeters. Subsoil is brownish gray to light brown and friable and fine granular silt loam. Substratum is yellowish brown to light reddish brown fine sandy loam to fine to medium sand. Relief is nearly level. Drainage is fair to somewhat poor and cultivated to rice, sugarcane, corn, root-crops, etc. This series appears in the northwest of the Study Area. Hectarage tabulation of Soil Series in the Study Area and concerning CISs are shown in Table 3-1-1.

Zaragoza Series is the largest soil series that occupies 30 percent of the study area, followed by Banga Series of 16 percent and Luisita Series of 14 percent (refer to Table 3-1-1).

Roughly speaking, sandy soil group of Lt Pw Ba Lp and An and silty or clayey soil group of Zg Br Cb Tc and Sm are fifty-fifty in the study area, and nine soil series are related to the command areas of 19 CISs. And these soils themselves do not have any fatal defects for cropping except frequent flooded zone along Chico river.

(2) Land Classification

Land classification map was drawn up using the USBR method adjusted to suit local conditions. According to this method the arable lands in the study area are classified to Riceland, Dual classlands and Diversified cropland as described below.

a) Riceland

Riceland classes are characterized by moderately deep to deep solum, fine to medium texture, and restricted to poor drainability with shallow water table. These are suitable for the production of paddy rice and classified to 1R, 2R, and 3R by topography soil texture and drainage (flooding and internal).

b) Dual Classland

These lands have multiple suitability for the production of lowland rice and diversified crops and classified to 1R-1, 1R-2, 2R-2, 2R-3, 3R-2, 3R-3 by topography, soil texture and drainage.

c) Diversified Cropland

As the soils are predominantly light texture allowing excess soil water to drain out readily, this classes are favorable and suitable for the production of diversified crops. These have three classes according to limiting factors as same as the previous classes.

Table 3-1-2 presents the hectarage of land classes in the Study Area and Figure 3-1-5 is the Land Classification Map.

Most of the lands in the Study Area are classified to Dual Classland and Riceland. Especially, all of the CISs command areas except to Susuba-cutcut CIS fall into the former class which is suitable for rice in wet season, while suitable for diversified crops in dry season. Actually, some diversified crops like beans, corn, vesetables, etc. are grown in a lot of CIS in dry season, but in case that sufficient water is available, the paddy rice is predominant even if in dry season.

3.1.7 Present Land Use

Most of the Study Area is located in a flat alluvial plain, being cultivated as agricultural lands with 25,900 hectares in the area. About 18,944 hectares of agricultural lands, which is 73 percent of the total agricultural lands in the Study Area are used as paddy fields and more than 70 percent of the paddy fields are irrigated mainly by surface water. In addition to this, there are large scale of sugarcane fields with a total area of 3,990 hectares in the northern and western parts of the Study Area.

In general, most of the flat area where sufficient water is available for rice cropping have been fully cultivated as paddy fields. As the paddy fields, however, are not well improved by farm consolidation, each field lot is very small in scale, and no farm road is observed in the fields except a number of thin ridges.

Although the cropping pattern of paddy can be divided broadly into wet season paddy and dry season paddy, they are actually cropped continuously throughout a year so that many cropping stages are complicatedly observed in the Study Area. As a result of this, it is difficult to perform a timely water management for each paddy field in different growing stage. Non-arable lands are the built-up area of the municipalities of Concepcion, Capas, and Bamban, river floodplain of Bamban and Chico rivers, flooded area of the low land along Chico river, several classes of roads, residential area of Barangays and the site of VOA.

As for the 19 CISs concerned, total arable lands are 9,785 hectares, of which 8,175 hectares is for paddy fields and 900 hectares for sugarcane fields and the rest 710 hectares for idle land. The details of CISs are described below:

(1) Bamban CIS

The agricultural land is 1,051 hectares in the area, comprising of paddy fields of 751 hectares and sugarcane fields of 300 hectares. About 200 hectares of paddy fields located at the downstream area cannot be cropped in dry season due to insufficient irrigation water resources.

(2) San Pedro CIS

The agricultural lands are 120 hectares in the area, where paddy is cropped in all seasons.

(3) Malonzo CIS

The agricultural lands of 240 hectares in the area are almost double cropping of paddy, expecting 61 hectares of the area where irrigation water is not available in wet season.

(4) Bangcu CIS

Among the total agricultural lands of 700 hectares in the area, 500 hectares of the area is double cropping area of paddy, and 200 hectares of the area at the downstream is not cropped in dry season due to the lack of water.

(5) Susuba-cutcut CIS

Most of the paddy fields are cropped only in wet season due to the lack of irrigation water.

(6) Telebanca CIS

Double paddy cropping is performed at more 90 percent of the paddy fields with area of 389 hectares. At the rest of the paddy fields are used as diversified croplands. And there are 20 hectares of idle land resulted from the defective irrigation facilities.

(7) Sta.Rita CIS

A 80 hectares out of 115 hectares of paddy fields are double cropping area. At the rest of the paddy fields are used for diversified croplands.

(8) Marita CIS

Among the total agricultural lands of 100 hectares in the area, 65 hectares is planted with double cropping paddy, 20 hectares of the paddy field is used as diversified croplands, and 15 hectares of the area is idle in dry season due to the lack of water.

(9) San Martin CIS

Paddy fields with total area of 240 hectares is comprised of 80 hectares of double cropping area, another 80 hectares of diversified croplands in dry season, and 80 hectares of non-cropped area in dry season due to lack of irrigation water. Additionally there are 40 hectares of idle land coming from inadequate irrigation facilities.

(10) Baluto CIS

Among 600 hectares of paddy fields, 320 hectares of fields are used as double cropping area. At the rest of the fields, regumes and vegetables are cropped in dry season. Aside from the above paddy fields, 140 hectares of the potential area have been left as idle land due to inadequate irrigation facilities.

(11) Lilibangan CIS

Out of 240 hectares of the paddy fields, 200 hectares are planted paddy with double cropping and 40 hectares of the rest is used as diversified crops in dry season.

(12) San Bartolome CIS

Paddy fields with total area of 350 hectares is composed of double cropping area with 260 hectares in the area and diversified croplands with 90 hectares in dry season. There is an idle land with 25 hectares in the area.

(13) San Isidoro CIS

Paddy fields with total area of 450 hectares comprises 330 hectares of double cropping area in the area and 120 hectares of diversified croplands in dry season. A 185 hectares of the area is idle land due to inundation of Chico river.

(14) Lucong CIS

Lucong CIS is the largest system among the 19 CISs in the study area having 2,000 hectares of paddy fields. Out of which 1,390 hectares is double cropping. Diversified cropping is practiced in dry season in the paddy fields at the vicinity of each Barangay. Non-cropped area in dry season is estimated to be 400 hectares, of which considerable parts may be irrigated by using private pumps, while most of 250 hectares are idle lands due to flooded zone of Chico river.

(15) Magao CIS

Among total paddy fields of 620 hectares in the area, 468 hectares is under the double cropping of paddy rice. The area in the vicinity of Chico river cannot be cropped in wet season due to flood water from the river, while they are widely cropped in dry season.

(16) Tinang CIS

Sugarcane cropping with the area of 600 hectares is dominant in this CIS area under the influence of the sugarcane plantation (Hacienda) neighbouring at the north. The total area of paddy fields is 250 hectares. The area cropped in dry season is only 100 hectares.

(17) Sta Rosario CIS

All of the paddy fields with 150 hectares in the area are double cropping. However, there are idle land with 50 hectares because of inadequate irrigation facilities.

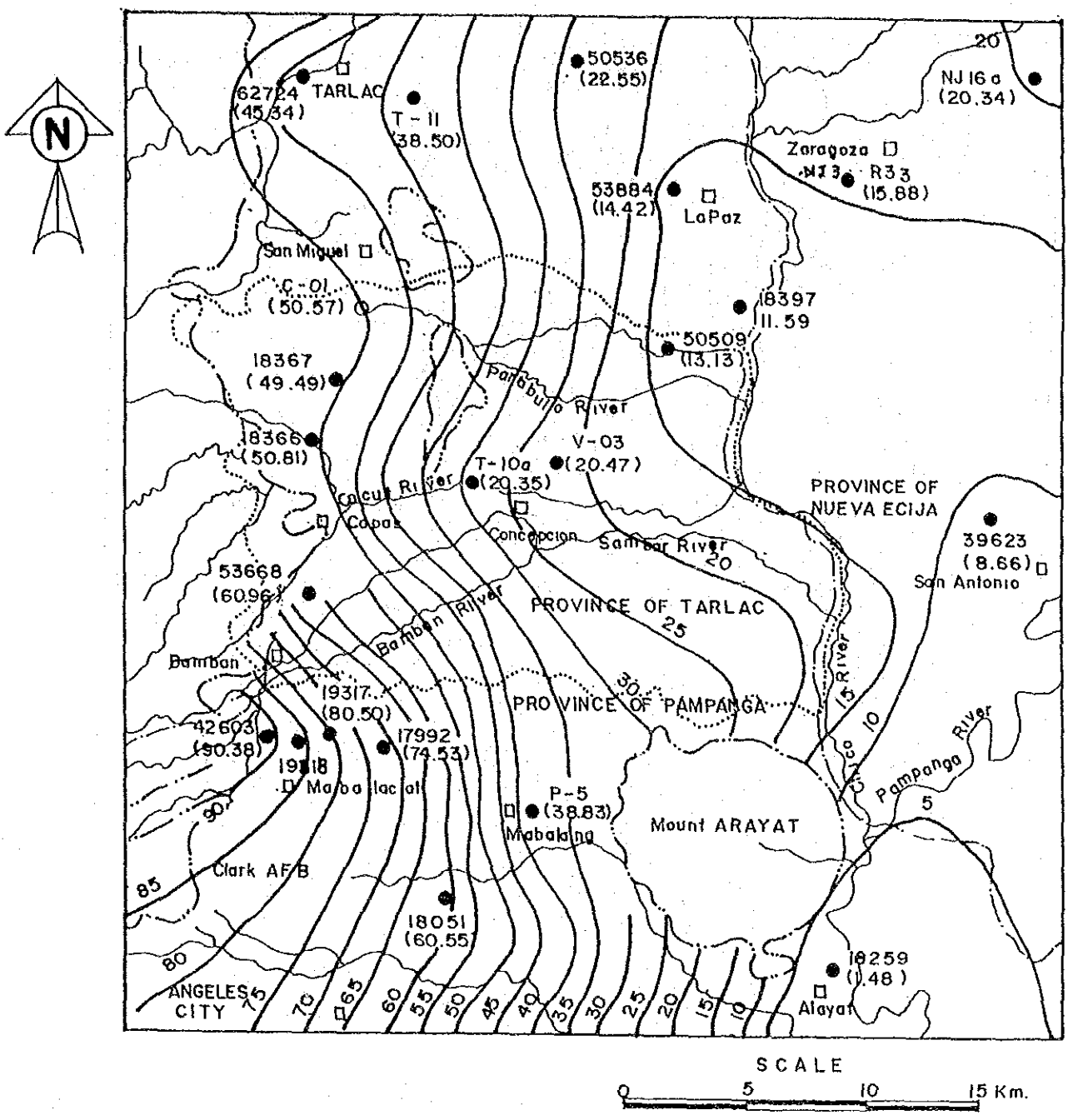
(18) Sta Monica CIS

Among the total paddy fields with 740 hectares in the area, 440 hectares of fields located in the downstream area are often submerged by the flood water in wet season. The paddy cropping in wet season is practiced at the 300 hectares of the fields, while all of the fields are cropped in dry season.

(19) Caluluan CIS

Among the total paddy fields with 80 hectares in the area, 45 hectares of the area are double cropping, and the rest 35 hectares are used as diversified croplands in dry season.

Those above-mentioned are summarized on Table 3-1-3 and Figures 3-1-6 and 3-1-7.



L E G E N D

17394 ● NWSA WELLS ○ NJ-17 BPW WELLS

(11.83) PHREATIC WATER ELEVATION RELATIVE TO MEAN SEA LEVEL IN METERS

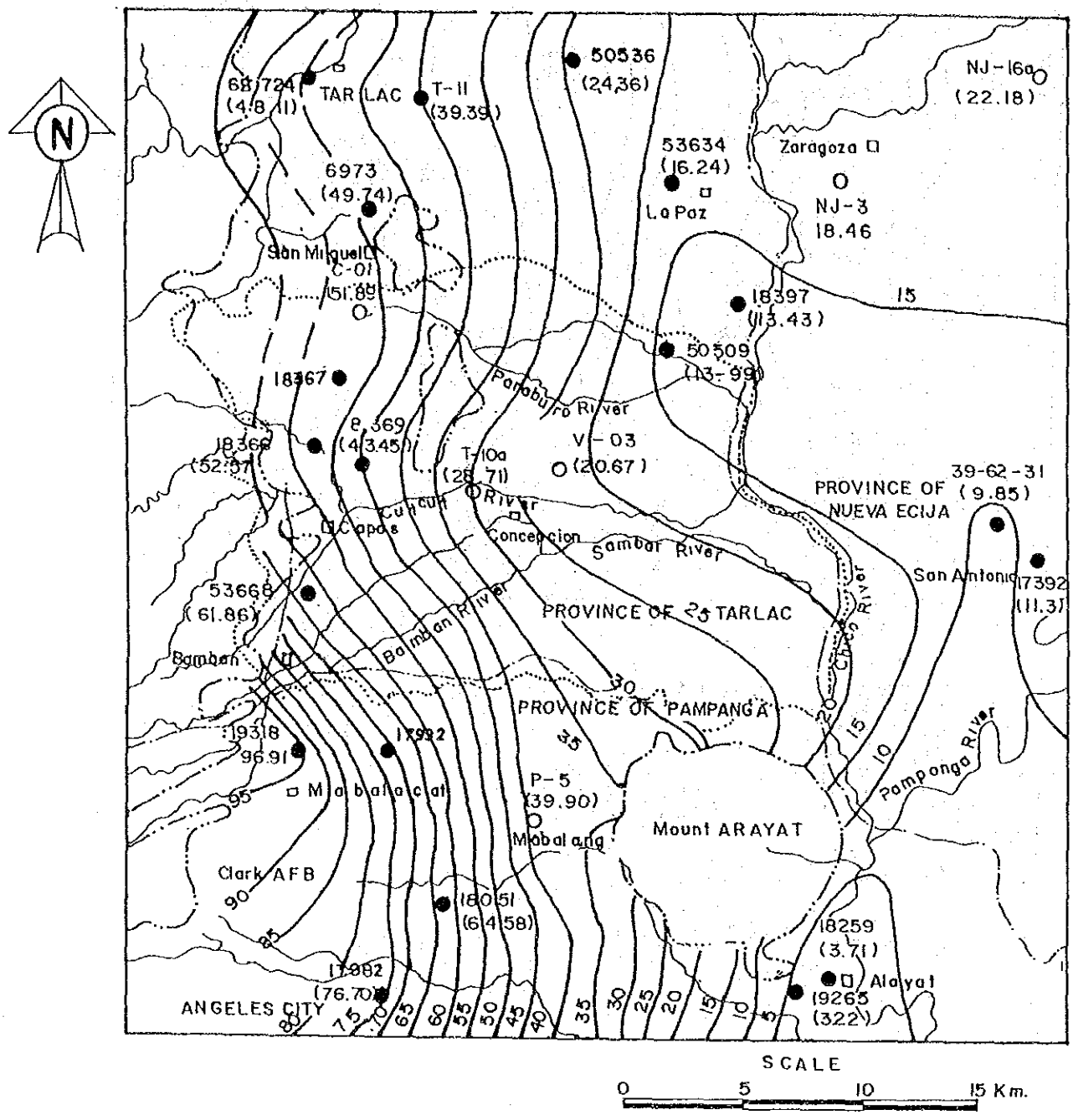
——— EQUIPOTENTIAL LINE

ROAD

BOUNDARY OF ALLUVIUM

BOUNDARY OF PROVINCE

Figure 3-1-1 Water Level Contour Map in April (Shallow Wells)



LEGEND

19394 ● NWSA WELLS

NJ-16 ○ BPW WELLS

(16.68) PHREATIC WATER ELEVATION RELATIVE TO MEAN SEA LEVEL IN METER

EQUIPOTENTIAL LINE

ROAD

BOUNDARY OF ALLUVIUM

BOUNDARY OF PROVINCE

EQUIPOTENTIAL LINE INFERRED

Figure 3-1-2 Water Level Contour Map in September (Shallow Wells)

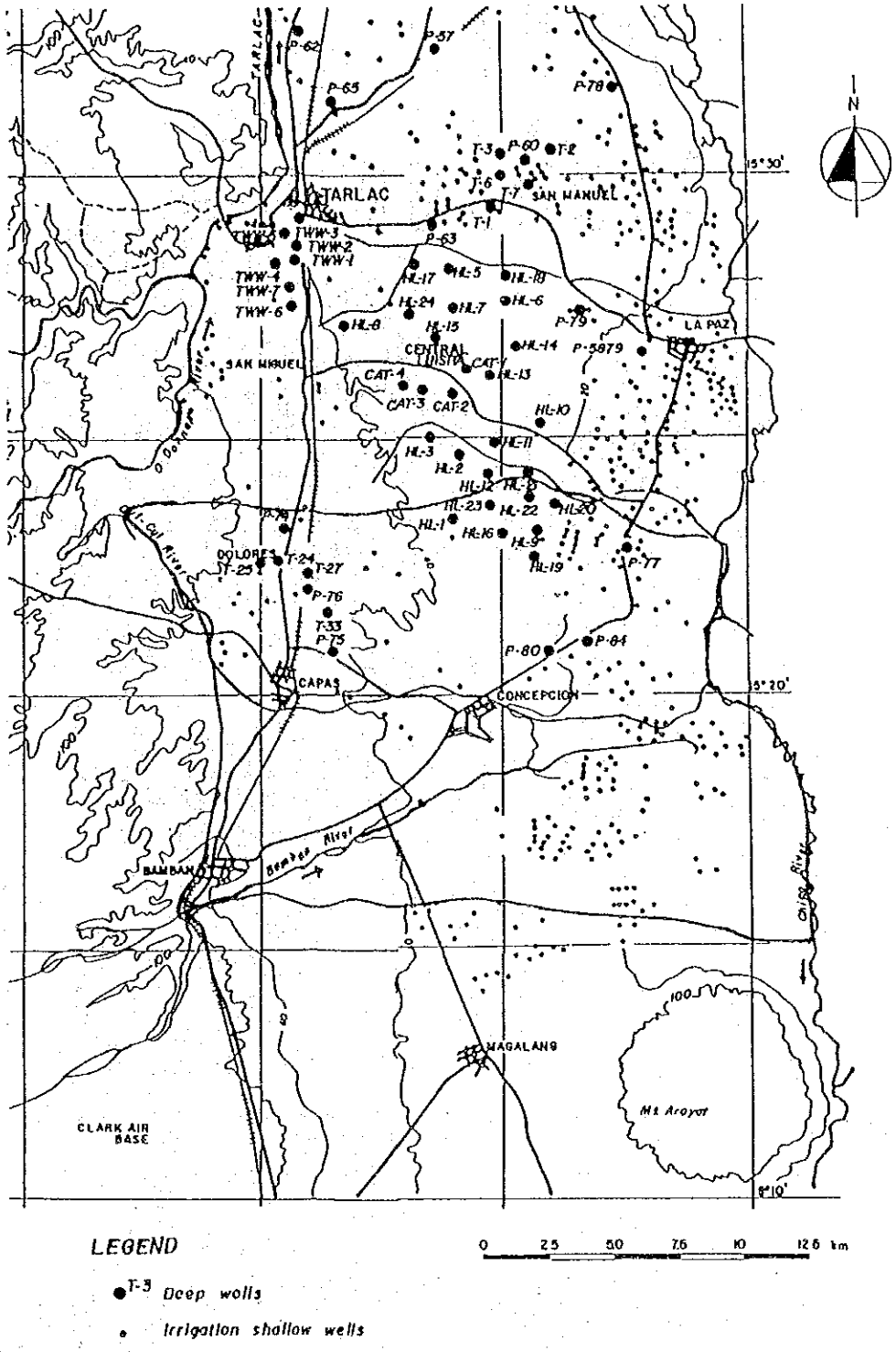


Figure 3-1-3 Location Map of The Existing Wells

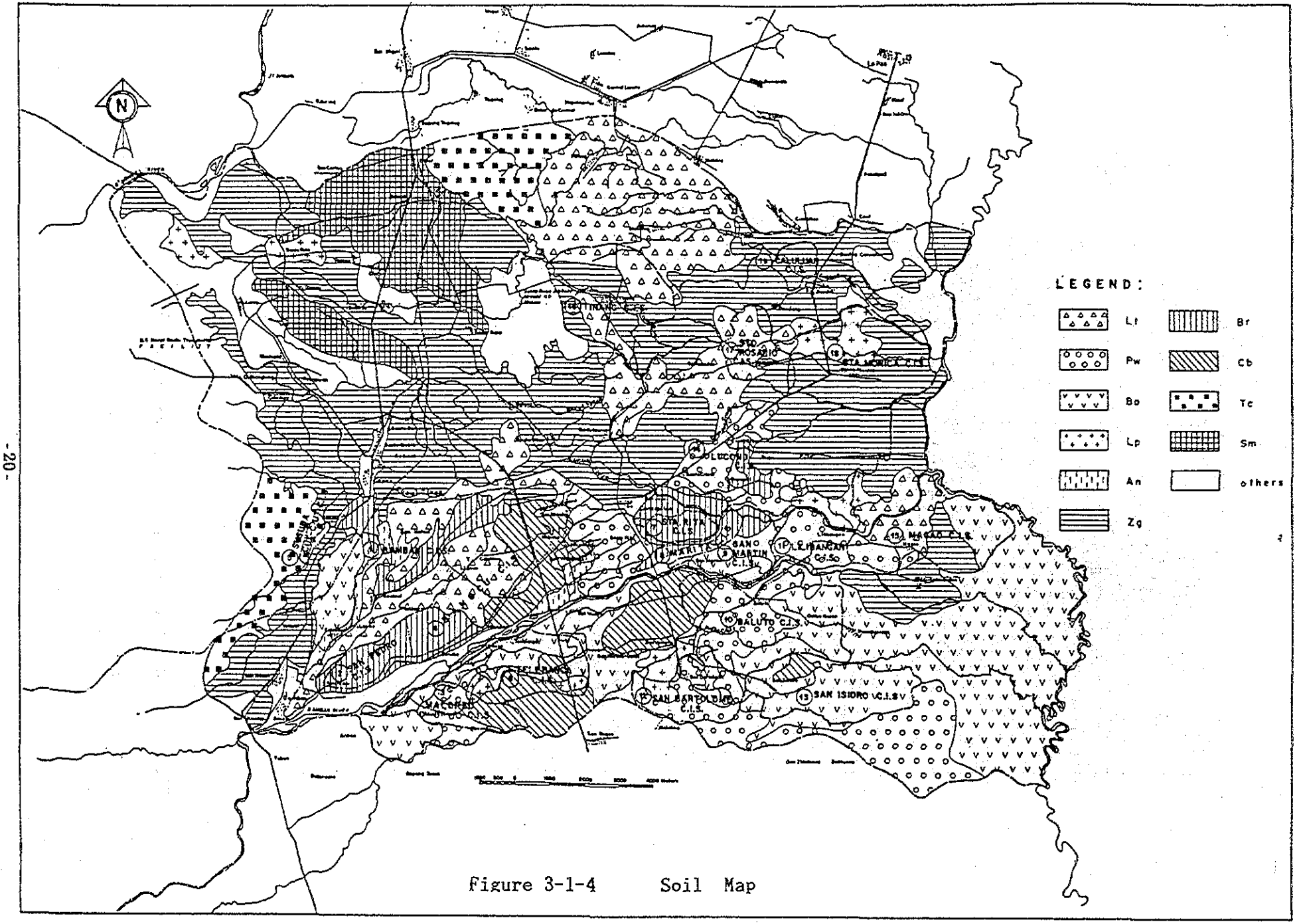


Figure 3-1-4 Soil Map

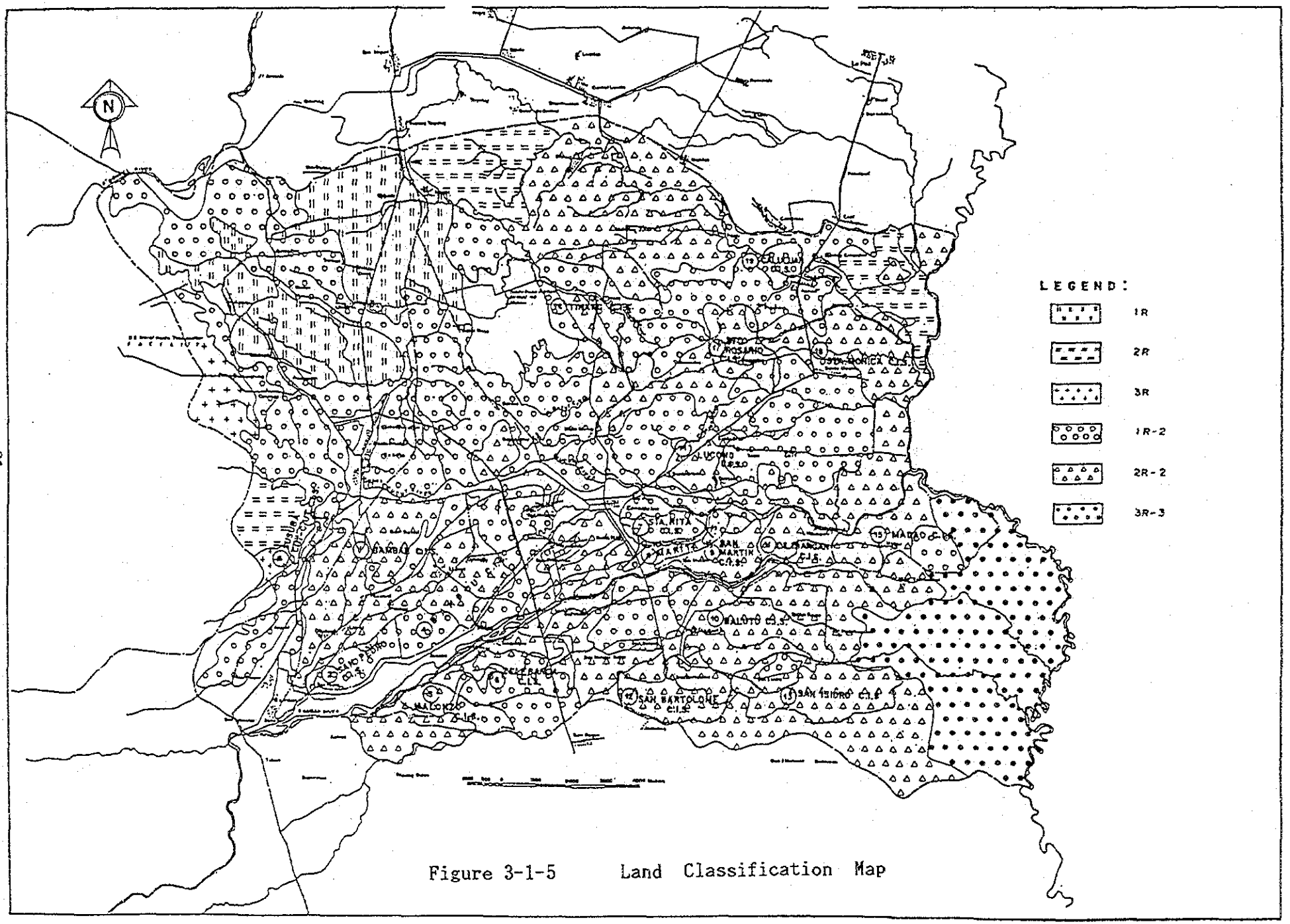


Figure 3-1-5 Land Classification Map

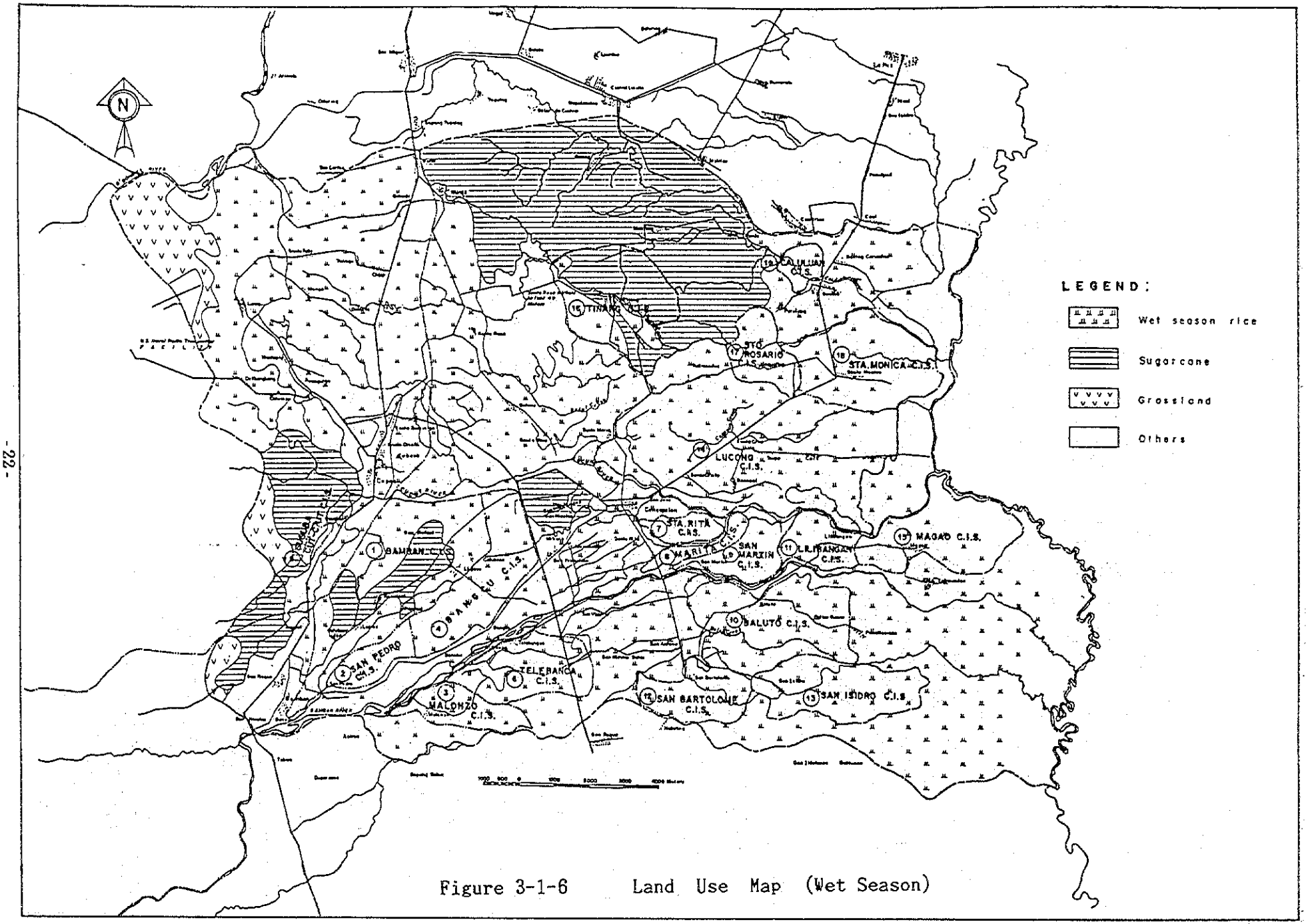


Figure 3-1-6 Land Use Map (Wet Season)

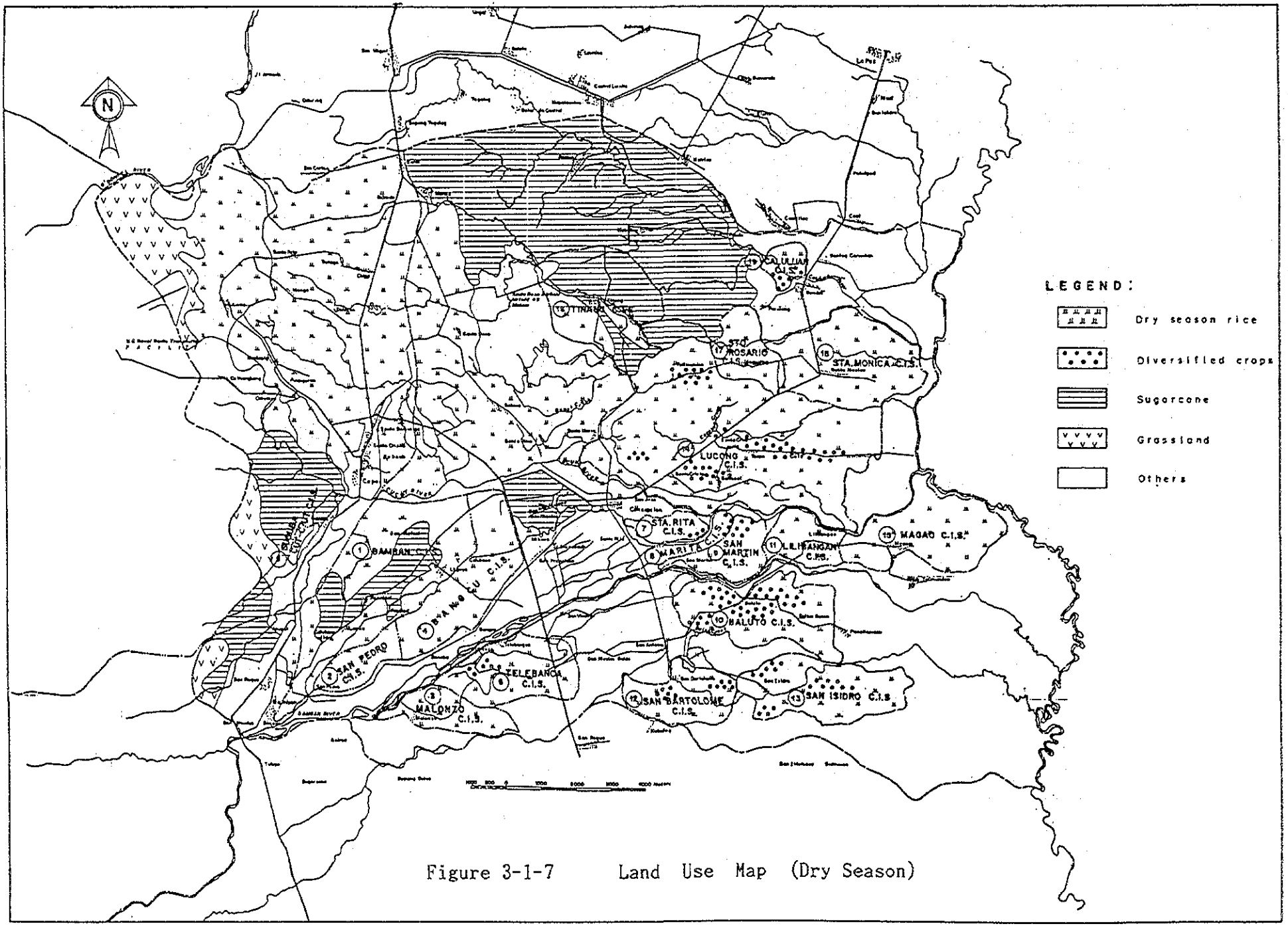


Figure 3-1-7 Land Use Map (Dry Season)

Table 3-1-1 Soil Classification

Unit : Hectare

	Name of CIS	Total Area	Soil Series										
			Lt	Pw	Ba	Lp	An	Zg	Br	Cb	Tc	Sm	Others
1.	Bamban	1,490	810	-	205	-	180	50	245	-	-	-	-
2.	San Pedro	238	18	-	-	-	-	-	220	-	-	-	-
3.	Malonzo	315	-	120	65	5	-	-	-	125	-	-	-
4.	Bangcu	728	380	-	-	-	-	5	215	128	-	-	-
5.	Susuba-cutcut	57	-	-	-	-	-	-	-	-	57	-	-
6.	Telebanca	600	-	20	317	95	-	-	-	168	-	-	-
7.	Sta. Rita	150	-	20	-	-	-	-	130	-	-	-	-
8.	Marita	132	-	40	-	-	-	-	92	-	-	-	-
9.	San Martin	317	-	160	127	-	-	-	30	-	-	-	-
10.	Baluto	780	-	370	315	-	-	-	-	95	-	-	-
11.	Lilibangan	281	-	281	-	-	-	-	-	-	-	-	-
12.	San Bartolome	447	-	285	115	47	-	-	-	-	-	-	-
13.	San Isidro	667	-	-	614	-	-	-	-	53	-	-	-
14.	Lucong	2,832	465	522	-	195	-	1,463	187	-	-	-	-
15.	Magao	730	255	100	200	-	-	175	-	-	-	-	-
16.	Tinang	905	327	-	-	-	-	578	-	-	-	-	-
17.	Sta Rosario	323	200	-	-	-	-	123	-	-	-	-	-
18.	Sta.Monica	889	-	-	-	200	-	489	-	-	-	-	-
19.	Caluluan	123	-	-	-	-	-	123	-	-	-	-	-
	Subtotal	12,004	2,455	1,918	1,958	542	180	3,206	1,119	569	57	-	-
	Others	27,396	3,050	1,857	4,292	433	180	8,484	456	1,126	1,448	2,035	4,035
	Total	30,400	5,505	3,775	6,250	975	360	11,690	1,575	1,695	1,505	2,035	4,035

Name of Soil Series : Lt : Luisita, Pw : Pawing, Ba : Bagan, Lp : Lapaz, An : Angeles, Zg : Zaragosa, Br : Baran, Cb : Cabetican

Table 3-1-2 Land Classification

Unit : Hectare

Name of CIS	Arable Land	Land Classification						Non Arable Land
		Riceland			Dual Classland			
		1-R	2-R	3-R	1R-2	2R-2	3R-3	
1. Bamban	1,051	-	-	-	210	841	-	
2. San Pedro	120	-	-	-	111	9	-	
3. Malonzo	240	-	-	-	101	139	-	
4. Bangcu	700	-	-	-	339	361	-	
5. Susuba Cutcut	40	-	40	-	-	-	-	
6. Telebanca	389	-	-	-	109	280	-	
7. Sta. Rita	135	-	-	-	117	18	-	
8. Marita	100	-	-	-	70	30	-	
9. San Martin	280	-	-	-	-	280	-	
10. Baluto	740	-	-	-	92	648	-	
11. Lilibangan	240	-	-	-	-	240	-	
12. San Bartolome	375	-	-	-	39	336	-	
13. San Isidro	635	-	-	-	52	583	-	
14. Lucong	2,250	-	-	-	1,475	775	-	
15. Magao	620	-	-	-	120	328	172	
16. Tinang	850	-	-	-	543	307	-	
17. Sta Rosario	200	-	-	-	75	125	-	
18. Sta. onica	740	-	-	-	296	444	-	
19. Caluluan	80	-	-	-	80	-	-	
Subtotal	9,785	-	40	-	3,829	5,744	172	2,219
Others	16,115	2,066	1,366	588	5,807	4,442	1,846	11,281
Total	25,900	2,066	1,406	588	9,636	10,186	2,018	13,500

Table 3-1-3 Present Land Use

Unit : Hectare

Name of CIS	Total Area	Arable Lands						Rivers Roads Others
		Rice		Dry Crops	Sugarcane	Idles etc.	Total	
		Wet	Dry					
1. Bamban	1,490	751	532	-	300	-	1,051	439
2. San Pedro	238	120	120	-	-	-	120	118
3. Malonzo	315	179	240	-	-	-	240	75
4. Bangcu	728	700	500	-	-	-	700	28
5. Susuba Cutcut	57	40	8	-	-	-	40	17
6. Telebanca	600	389	364	25	-	-	389	211
7. Sta. Rita	150	115	80	35	-	20	135	15
8. Marita	132	100	65	20	-	-	100	32
9. San Martin	317	240	80	80	-	40	280	37
10. Baluto	780	600	320	280	-	140	740	40
11. Lilibangan	281	240	200	40	-	-	240	41
12. San Bartolome	447	350	260	90	-	25	375	72
13. San Isidro	667	450	330	120	-	185	635	32
14. Lucong	2,832	2,000	1,390	400	-	250	2,250	582
15. Magao	730	468	620	-	-	-	620	110
16. Tinang	905	250	100	-	600	-	850	55
17. Sta. Rosario	323	150	150	-	-	50	200	123
18. Sta. Monica	889	300	740	-	-	-	740	149
19. Caluluan	123	80	45	35	-	-	80	43
Subtotal Gross		7,522	6,144	1,125				
Net	12,004	8,175			900	710	8,785	2,219
Others	27,396	10,769		1,088	3,090	2,256	16,115	11,281
Total	39,400	18,944		2,213	3,990	2,966	25,900	13,500
Irrigated		13,423						
Rainfed		5,521						