社会開発協力部報告書

LOCAL WATER UTILITIES ADMINISTRATION

MASTER PLAN AND FEASIBILITY STUDY OF THE LOCAL WATER SUPPLY PROJECTS IN THE REPUBLIC OF THE PHILIPPINES

ILOCOS NORTE WATER SUPPLY SYSTEM

JUNE 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

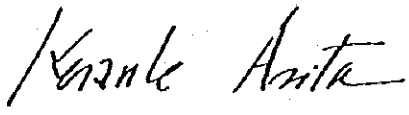
In response to the request of the Government of the Republic of the Philippines, the Japanese Government decided to cooperate in formulating a master plan and making a feasibility study on the Local Water Supply Project and entrusted the work to the Japan International Cooperation Agency (JICA).

The JICA sent to the Philippines a survey team from 28 June 1981 to 27 December 1981. The team exchanged views with the officials concerned of the Government of the Philippines and conducted field surveys in the Ilocos Norte Province (Laoag City, Bacarra Municipality, Pasquin Municipality, Vintar Municipality and Paoay Municipality), the Albay Province (Legaspi City and Daraga Municipality) and the Bohol Province (Tagbilaran City). After the team returned to Japan, further studies were made and the present report has been prepared.

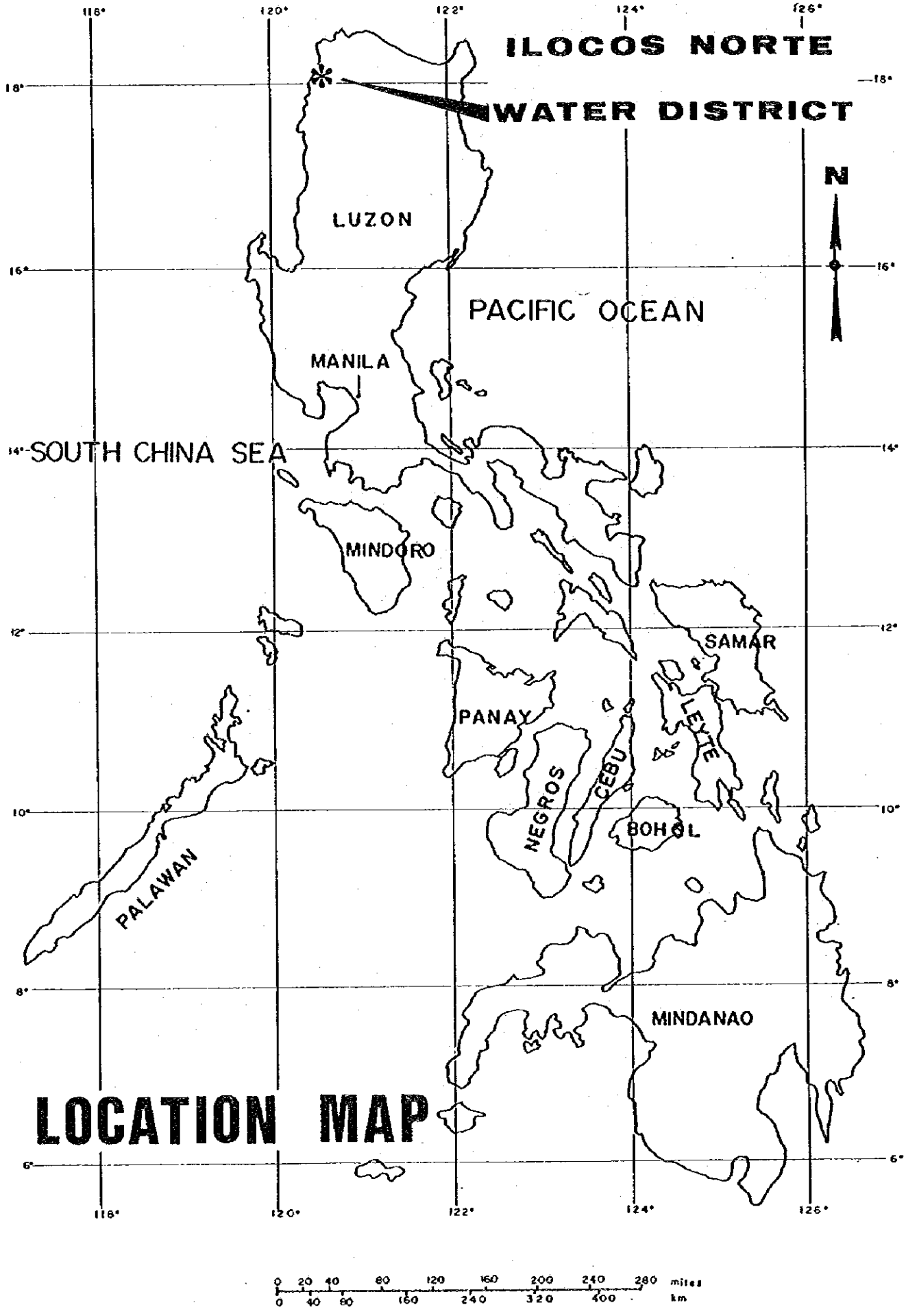
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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

June, 1982



Keisuke Arita
President
Japan International
Cooperation Agency


ILOCOS NORTE
WATER DISTRICT
N
LUZON
PACIFIC OCEAN
MANILA
SOUTH CHINA SEA
MINDORO
SAMAR
PANAY
LEYTE
NEGROS
CEBU
BOHOL
PALAWAN
MINDANAO
LOCATION MAP
118°
120°
122°
124°
126°
18°
16°
14°
12°
10°
8°
6°
0 20 40 80 120 160 200 240 280 miles
0 40 80 160 240 320 400 km

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ABBREVIATIONS

GOP	- the Government of the Republic of the Philippines
GOJ	- the Government of Japan
JICA	- the Japan International Cooperation Agency
LWUA	- the Local Water Utilities Administration
WD	- Water District
WTC	- willingness-to-connect
BPWS	- the Bohol Provincial Waterworks System
APWS	- the Albay Provincial Waterworks System
INMW	- the Ilocos Norte Metropolitan Waterworks
NEDA	- National Economic Development Authority
NCSO	- National Census and Statistics Office
BCGS	- Bureau of Coast and Geodetic Survey
NIA	- National Irrigation Administration
PAGASA	- Philippine Atmospheric, Geophysical and Astronomical Services Administration
NWRC	- National Water Resources Council
DPWTC	- Department of Public Works, Transportation and Communications
MPW	- Ministry of Public Works
mm	- millimeters
cm	- centimeters
m	- meters
km	- kilometers
cm^2, sq cm	- square centimeters
m^2, sq m	- square meters
km^2, sq km	- square kilometers
m^3, cu m	- cubic meters
cm/sec	- centimeters per second
m/sec	- meters per second
m^3/sec	- cubic meters per second
m^3/min, cu m/min	- cubic meters per minute

m^3/h, cu m/h	- cubic meter per hour
m^3/day, cu m/day	- cubic meters per day
l/sec	- liters per second
l/min	- liters per minute
l/c/d	- liters per capita per day
kg/cm^2, kg/sq cm	- kilograms per square centimeter
ha	- hectare
%	- percents
°C	- degrees centigrade
mg/l	- miligrams per liter
FTU	- function turbidity unit
pH	- potential of Hydrogen
ppm	- parts per million
mm/year	- millimeters per year
hp	- horse - power
rpm	- revolutions per minute
V	- volt
A	- ampere
kWh	- kilowatt-hour
kVA	- kilovolt-ampere
MVA	- mega volt-ampere
kW	- kilowatt
PVC	- polyvinyl chloride pipe
ACP	- asbestos cement pipe
CIP	- cast iron pipe
DIP	- ductile iron pipe
GSP	- galvanized steel pipe
SP	- steel pipe
Fig	- Figure

Currency Equivalent

US$1.00 = ₱7.80 (Philippine Peso)

Fiscal Year Period

from Jan. 1 to Dec. 31

SUMMARY

I. General

1.1 Physical and Socioeconomic Conditions

The Project Area includes one city, Laoag, and four municipalities, Pasuquin, Bacarra, Vintar and Paoay. Poblacions of these municipalities are widely scattered generally in the alluvial plains formed by rivers. The area is dotted with low hills and bounded with the sea on the west and high mountains on the north and east. The plains extend beyond the southern boundary of the area. Main features of the Area are as follows.

(1)	Location:	North-western tip of Luzon Island in the Philippines
(2)	Topography:	Consisting of alluvium, hills 30 to 60 m high, mountains, and dunes
(3)	Climate:	Rainfall = 2,100 mm/year (May to October in wet season)
(4)	Population:	151,210 in 1980, with 1.23% of annual growth rate
(5)	Socio-Economic Conditions:	Identified as an agricultural area Dialect: Ilocano (99%) Road Condition: Better than other provinces Public Water Supply: Existing, however supply conditions poor Sewerage System: Not existing Electricity: 71% in electrification Transportation: Accessible to various points in the island by roads

1.2 Existing Water Supply

Most outstanding is overall deterioration of the existing facilities due to long-term use for the past fifty years, resulting in leaks and low water pressure. Although some facilities have been added to strengthen the supply capacity, the present supply conditions are far from satisfactory. There are some wells and an infiltration gallery constructed recently, but they have not been put in use yet, because pumps and power supply facilities are not installed. Meters are very insufficient and so no accurate records of production and consumption are available. Major features of the existing water supply are summed up as below.

(1)	System:	Started in 1930's with springs. Currently owned and operated by the Ilocos Notre Metropolitan Waterworks.
(2)	Water Source:	Springs, riverbed water and groundwater
(3)	Distribution System:	Storage facilities and distribution networks: Transmission pipelines (24,500 m in length and 300-200 mm in diameter) and distribution pipelines (32,700 m in length and 250-75 mm in diameter)
(4)	Present Water Use:	Maximum amount of supply = 5,180 cu m/day Served Population = 25,000 Service Connections = Total 3,166
(5)	Water Rate:	Peso 20.0 per month for domestic use in Laoag and Peso 15.0 per month in Bacarra and Pasuquin (Minimum change for the first 10 cu m)

II. Master Plan

For master planning the water supply system, a period from the present up to the year 2010 was taken for the design period. Served population was assumed to gradually rise from the present 25,000 (17% of total population) to 127,600 (62%) at the end of the design period. Based on the served population, future water demand was projected.

All potential water sources to meet the projected water demand were investigated in the project area, including springs, groundwater and riverbed water. As for the use of water sources, all water sources were arranged in the design so that the distance between the source and the served area is as close as possible.

The whole design period was divided into Phases I, II and III. Phase I intends to utilize fully the existing water sources, with some improvement and addition of facilities to alleviate the chronic water shortage within a rather short period up to the year 1987. Phase II intends to expand the water supply system in the middle term future up to the year 1993, for which plan more reliable design factors, to be gained by the Phase I project, will be used. The remaining period of the design period is termed Phase III.

Major figures and items of work are tabulated below.

(1) Target Year:

Phase I = 1987
Phase II = 1993
Phase III = 2010

(2) Service Area:

Present	:	1,280 ha
1987	:	2,701 ha
1993	:	4,906 ha
2010	:	10,531 ha

(3) Population Projection:

Present	:	151,210
1987	:	166,410
1993	:	178,090
2010	:	204,870

(4) Served Population:

Present	:	25,000 (17%)
1987	:	44,130 (27%)
1993	:	72,980 (41%)
2010	:	127,660 (62%)

(5) Water Demand:

Present	:	6,060 cu m/day
1987	:	10,230 cu m/day
1993	:	14,980 cu m/day
2010	:	27,530 cu m/day

(6) Water Sources:

See page 5.

(7) Facilities to be Constructed:

See page 6.

(8) Project Cost:

	Phase I	Phase II	Phase III
Foreign	$2.95 M	$4.23 M	$7.90 M
Local	$2.03 M	$2.55 M	$4.62 M
Total	$4.98 M	$6.78 M	$12.52 M

(Costs as of July 1981: Not including price escalation)

Water Sources for Master Plan

Phase	Laoag	Pasuquin	Bacarra	Vintar	Paoay	Total
Existing Water Sources 1/ and Production	E-I/G-680 W-I/G-1,080 B-I/G-1,600 D-1,820	Dilumot	Dilumot	None	None	5,180
Phase I Water Demand 2/ Water Sources and Production	6,300 E-I/G-860 W-I/G-2,000 B-I/G-1,280 Deep Well-2,160	950 Dilumot -950	1,610 Dilumot-870 Bacarra I/G- 740	800 Vintar I/G- 800	580 (Nangalisan I/G-580) 3/	10,240 10,240
Phase II Water Demand Water Sources and Production	8,920 Existing-6,920 (San Mateo I/G -1,450 (Nangalisan I/G-550)	1,580 Dilumot -1,580	2,430 Dilumot-240 (Bacarra I/G II-2,190)	1,180 Vintar I/G- 1,180	870 Nangalisan I/G-870	14,980 14,980
Phase III Water Demand Water Sources	15,630 Existing-6,880 (San Mateo I/G -5,944) (Nangalisan I/G-2,806)	2,490 Dilumot-1,820 (Bacarra I/G II-670)	4,410 (Bacarra I/G II-4,410)	2,690 (Vintar I/G -2,200) (Bacarra I/G II-490)	2,320 (Nangalisan I/G-2,320)	27,540 27,540

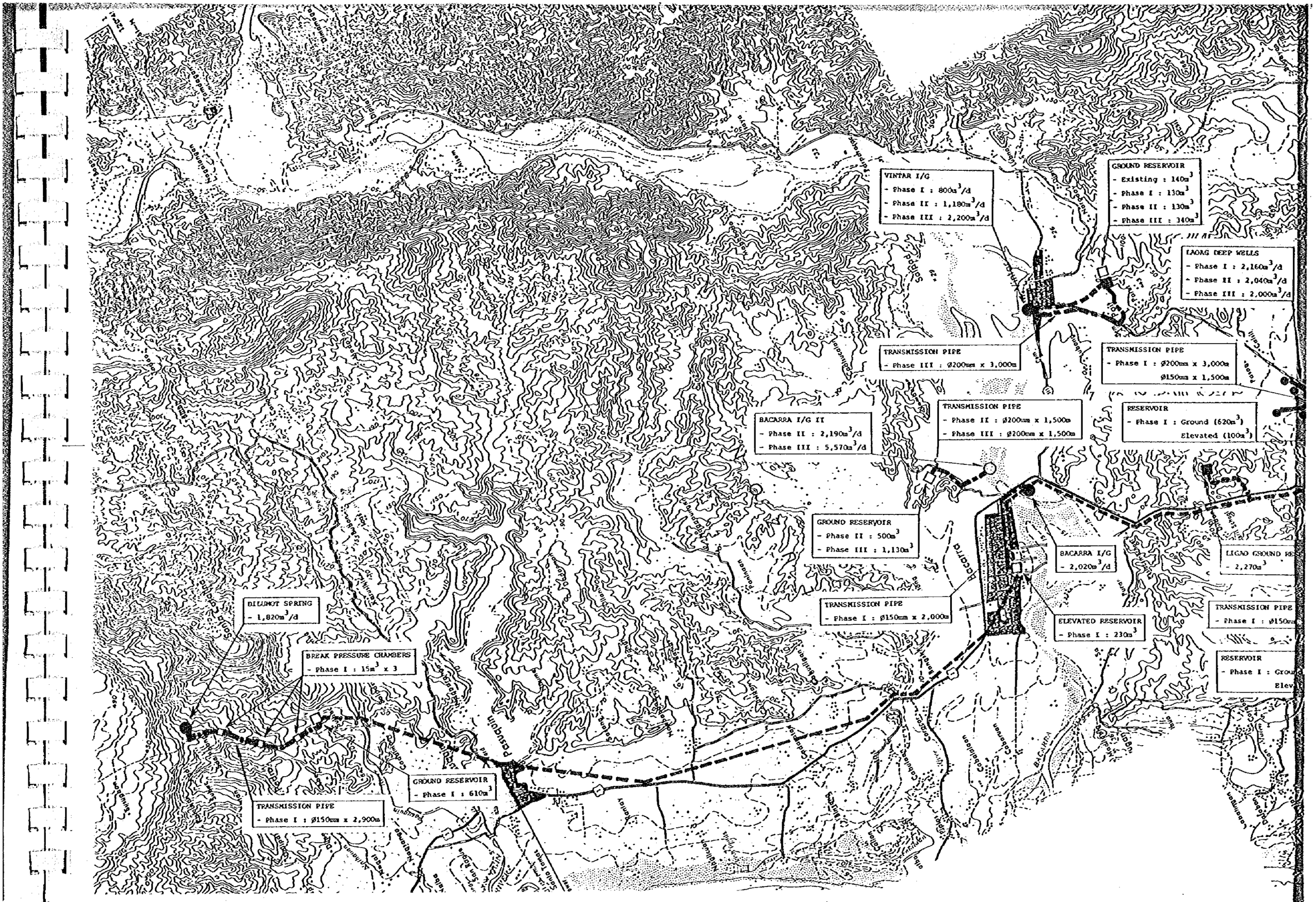
1/ Production (cu m/d)
E-I/G: Ermita Infiltration Gallery
W-I/G: West Riverside Infiltration Gallery
B-I/G: Bacarra Infiltration Gallery

2/ Maximum Day Demand

3/ ( ) Water Sources to be Developed

Facilities to be Constructed

Phase I	Phase II	Phase III
A. Dilumot Spring a) Transmission Pipe b) Break Pressure Chamber c) Ground Reservoir B. Bacarra I/G a) Intake Pump Station b) Transmission Pipe c) Elevated Reservoir d) Roofing of Ligao Reservoir C. West Riverside I/G a) Intake Pump b) Transmission Pipe c) Ground Reservoir d) Distribution Pump Station e) Elevated Reservoir D. Vintar I/G a) Intake Pump b) Ground Reservoir E. Laoag Deep Wells a) Pump Station b) Transmission Pipe c) Ground Reservoir d) Distribution Pump Station e) Elevated Reservoir F. Nangalisan I/G a) Infiltration Gallery b) Intake Pump Station c) Transmission Pipe d) Ground Reservoir G. Distribution Pipe H. Valve I. Fire Hydrant J. Bulk Meter K. Chlorinator L. Service Meter M. Stored Material N. Vehicle	A. San Mateo I/G a) Infiltration Gallery b) Intake Pump Station c) Transmission Pipe d) Ground Reservoir e) Distribution Pump B. Bacarra I/G II a) Infiltration Gallery b) Intake Pump Station c) Transmission Pipe d) Ground Reservoir C. Vintar I/G Ground Reservoir D. Bacarra I/G Intake Pump Station E. Nangalisan I/G a) Infiltration Gallery b) Intake Pump Station c) Transmission Pipe d) Elevated Reservoir e) Ground Reservoir F. Distribution Pipe G. Valve H. Fire Hydrant I. Bulk Meter J. Chlorinator K. Service Meter L. Stored Material M. Administrative Building N. Operational Center O. Vehicle	A. Bacarra I/G II a) Infiltration Gallery b) Intake Pump c) Transmission Pipe d) Ground Reservoir B. Vintar I/G a) Infiltration Gallery b) Intake Pump c) Transmission Pipe d) Ground Reservoir C. San Mateo I/G a) Infiltration Gallery b) Intake Pump c) Transmission Pipe d) Ground Reservoir e) Distribution Pump D. Nangalisan I/G a) Infiltration Gallery b) Intake Pump c) Transmission Pipe d) Ground Reservoir e) Ground Reservoir f) Distribution Pump g) Elevated Reservoir E. Distribution Pipe F. Valve G. Fire Hydrant H. Bulk Meter I. Service Meter J. Stored Material K. Vehicle


VINTAR I/G
- Phase I : 800m³/d
- Phase II : 1,180m³/d
- Phase III : 2,200m³/d
GROUND RESERVOIR
- Existing : 140m³
- Phase I : 130m³
- Phase II : 130m³
- Phase III : 340m³
LAOAG DEEP WELLS
- Phase I : 2,160m³/d
- Phase II : 2,040m³/d
- Phase III : 2,000m³/d
TRANSMISSION PIPE
- Phase III : Ø200mm x 3,000m
TRANSMISSION PIPE
- Phase I : Ø200mm x 3,000m
Ø150mm x 1,500m
BACARRA I/G II
- Phase II : 2,190m³/d
- Phase III : 5,570m³/d
TRANSMISSION PIPE
- Phase II : Ø200mm x 1,500m
- Phase III : Ø200mm x 1,500m
RESERVOIR
- Phase I : Ground (620m³)
Elevated (100m³)
GROUND RESERVOIR
- Phase II : 500m³
- Phase III : 1,130m³
BACARRA I/G
- 2,020m³/d
LIGAO GROUND RE
- 2,270m³
TRANSMISSION PIPE
- Phase I : Ø150mm x 2,000m
ELEVATED RESERVOIR
- Phase I : 230m³
TRANSMISSION PIPE
- Phase I : Ø150mm
RESERVOIR
- Phase I : Grou
Elev
DILUMOT SPRING
- 1,820m³/d
BREAK PRESSURE CHAMBERS
- Phase I : 15m³ x 3
GROUND RESERVOIR
- Phase I : 610m³
TRANSMISSION PIPE
- Phase I : Ø150mm x 2,900m
Pasuquin
Bacarra
Laoag

SAN MATEO I/G
- Phase II : 1,450m^3/d
- Phase III : 5,944m^3/d

TRANSMISSION PIPE
- Phase II : Ø200mm x 4,500m
- Phase III : Ø300mm x 4,500m

VINTAR I/G
- Phase I : 800m^3/d
- Phase II : 1,180m^3/d
- Phase III : 2,200m^3/d

GROUND RESERVOIR
- Existing : 140m^3
- Phase I : 130m^3
- Phase II : 130m^3
- Phase III : 340m^3

LAOAG DEEP WELLS
- Phase I : 2,160m^3/d
- Phase II : 2,040m^3/d
- Phase III : 2,000m^3/d

GROUND RESERVOIR
- Phase II : 490m^3
- Phase III : 1,500m^3

ELEVATED RESERVOIR
- 380m^3

ERMITA I/G
- 860m^3/d

NANGALISAN I/G
- Phase I : 772m^3/d
- Phase II : 1,564m^3/d
- Phase III : 5,126m^3/d

TRANSMISSION PIPE
- Phase III : Ø200mm x 3,000m

TRANSMISSION PIPE
- Phase I : Ø200mm x 3,000m
  Ø150mm x 1,500m

TRANSMISSION PIPE
- Phase II : Ø200mm x 1,500m
- Phase III : Ø200mm x 1,500m

RESERVOIR
- Phase I : Ground (620m^3)
  Elevated (100m^3)

TRANSMISSION PIPE
- Phase II : Ø150mm x 1,000m

RESERVOIR
- Phase II : Elevated (190m^3)
- Phase III : Ground (160m^3)

RESERVOIR
- Phase III : Ground (490m^3)
  Elevated (100m^3)

BACARRA I/G
- 2,020m^3/d

LIGAO GROUND RESERVOIR
- 2,270m^3

ELEVATED RESERVOIR
- Phase I : 230m^3

TRANSMISSION PIPE
- Phase I : Ø150mm x 1,000m

WEST RIVERSIDE I/G
- 2,000m^3/d

RESERVOIR
- Phase I : Ground (570m^3)
  Elevated (100m^3)

TRANSMISSION PIPE
- Phase I : Ø200mm x 8,000m
- Phase III : Ø300mm x 8,000m

TRANSMISSION PIPE
- Phase I : Ø200mm x 5,100m
- Phase III : Ø200mm x 5,100m

Ilocos

SAN MATEO I/G
- Phase II : 1,450m³/d
- Phase III : 5,944m³/d

TRANSMISSION PIPE
- Phase II : ø200mm x 4,500m
- Phase III : ø300mm x 4,500m

GROUND RESERVOIR
- Phase II : 490m³
- Phase III : 1,500m³

ELEVATED RESERVOIR
- 380m³

ERMITA I/G
- 860m³/d

NANGALISAN I/G
- Phase I : 772m³/d
- Phase II : 1,564m³/d
- Phase III : 5,126m³/d

TRANSMISSION PIPE
- Phase II : ø150mm x 1,000m

RESERVOIR
- Phase II : Elevated (190m³)
- Phase III : Ground (160m³)

RESERVOIR
- Phase III : Ground (490m³)
  Elevated (100m³)

WEST RIVERSIDE I/G
- 2,000m³/d

TRANSMISSION PIPE
- Phase I : ø200mm x 8,000m
- Phase III : ø300mm x 8,000m

TRANSMISSION PIPE
- Phase I : ø200mm x 5,100m
- Phase III : ø200mm x 5,100m

ELEVATED RESERVOIR
- 40m³

GROUND RESERVOIR
- Phase III : 270m³

GROUND RESERVOIR
- Phase I : 160m³
- Phase II : 90m³
- Phase III : 260m³

TRANSMISSION/DISTRIBUTION PIPE
- Phase I : ø200mm x 7,400m
- Phase III : ø300mm x 7,400m

Remarks

Existing Water Source :
Proposed Water Source :
Existing Facility :
Proposed Facility :
Existing Pipeline :
Proposed Pipeline :

WATER SUPPLY SCHEME FOR MASTER PLAN

S = 1 : 50,000

III. Feasibility Study

Feasibility study was carried out for two cases: Case 1 study was made on the initial project, namely, Phase I, as is generally made in the feasibility study of a project, and Case 2 study was made on the combined project of Phases I and II, as this is deemed more beneficial for the development of the municipalities concerned.

The results of both Case studies indicate that the two cases are feasible. The only difference is that the Case 2 project is to given a government subsidy of 25% of the total investment cost.

(1) Implementation Schedule:

Phase I	:	1982 - 1987
Phase I + II	:	1982 - 1988

(2) Project Costs:

	Phase I	Phase I + II
Foreign	$4.82 M	$10.40 M
Local	$3.43 M	$ 6.22 M
Total	$8.25 M	$16.62 M

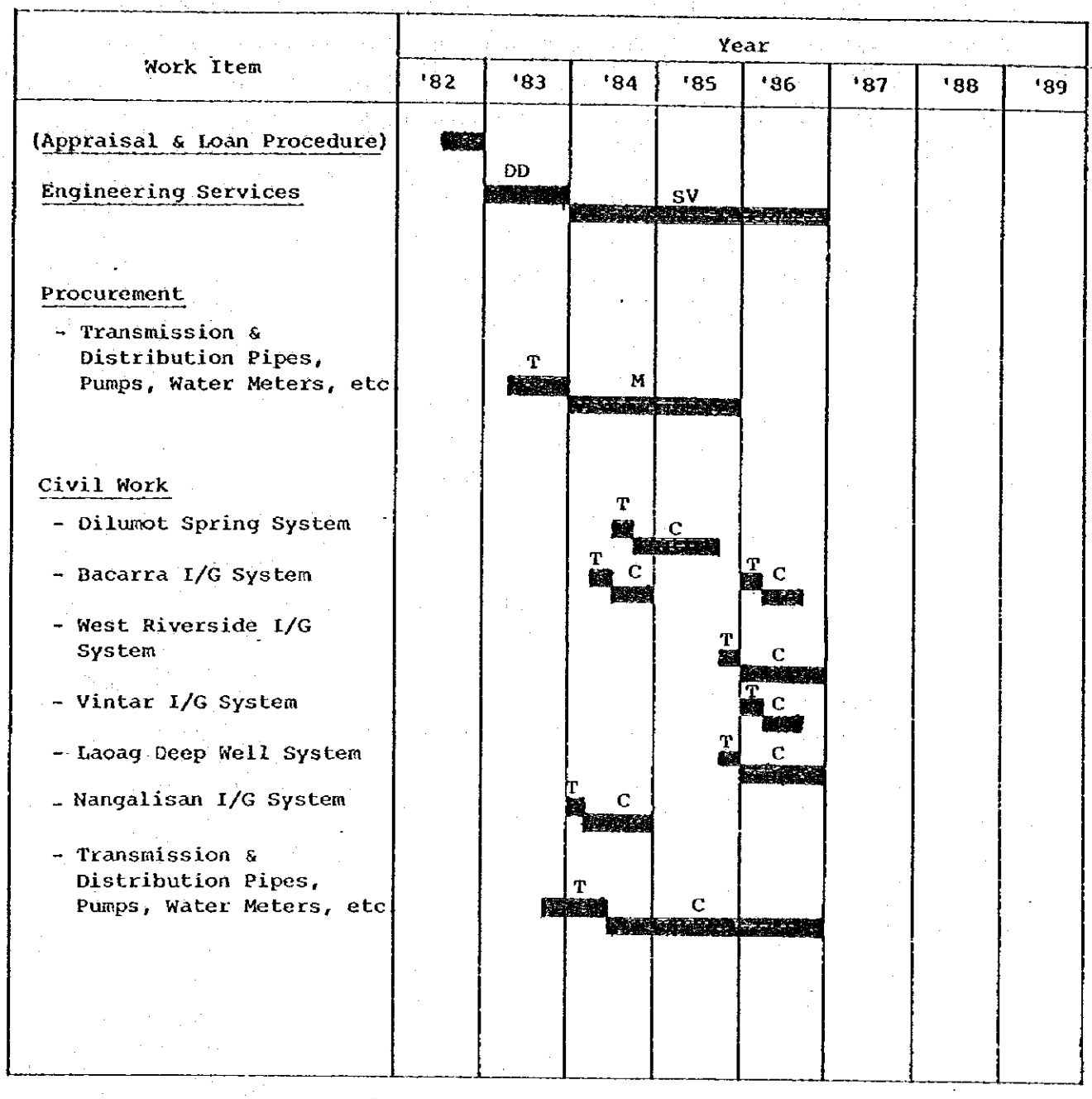
(Costs including price escalation according to implementation schedule)

(3) Financial Feasibility:

Phase I	:	Feasible
Phase I + II	:	Feasible with government subsidy of 25% of total investment cost

Construction Schedule for Phase I

(Target Year: 1987)



Note: DD = Detailed Design
SV = Supervision of Construction
T = Tendering Procedure (Advertisement/Tendering/Evaluation/Award)
M = Manufacturing & Shipping
C = Construction/Installation

Project Cost for Phase I (Target Year: 1987)

Note: - Unit = One Thousand Pesos = '000 Pesos
- Prices as of 1st July 1981
- Foreign Exchange Rate: US $ 1.00 = Peso 7.80

Work Items	Cost		
	Total Cost	Foreign Currency Component	Local Currency Component
A. Dilumot Spring System	2,258	1,069	1,189
B. Bacarra I/G System	2,520	1,159	1,361
C. West Riverside I/G System	2,388	1,064	1,324
D. Vintar I/G System	502	252	250
E. Laoag Deep Wells System	5,389	2,882	2,507
F. Nangalisan I/G System	8,950	5,737	3,213
G. Distribution Pipe	4,693	3,145	1,548
H. Valve	386	282	104
I. Fire Hydrant	858	566	292
J. Bulk Meter	185	148	37
K. Chlorinator	120	108	12
L. Service Meter	2,080	1,602	478
M. Stored Material	305	238	67
N. Vehicle	140	70	70
Sub Total	30,774	18,322	12,452
Detailed Design Cost (10.5%)	3,231	1,939	1,292
Supervision Cost (3.5 %)	1,077	646	431
Land Cost	200	-	200
Total	35,282	20,907	14,375
Physical Contingency (10 %)	3,529	2,091	1,438
Total	38,811	22,998	15,813
Price Contingency	25,541	14,603	10,938
Grand Total (Project Cost)	64,352 (Equivalent to US$8.25 M)	37,601 (Equivalent to US$4.82 M)	26,751 (Equivalent to US$3.43 M)

Water Rate Schedule

(Phase I)

DOMESTIC AND GOVERNMENTAL SERVICE CONNECTIONS, 1/2"

Year	First 10 m^3 1/	Charge for Each Added m^3 2/			Charge 3/ per Revenue Unit
		11-20	21-45	over 45	
1981	20.00	0.96	1.12	1.36	0.80
1982	20.00	0.96	1.12	1.36	0.80
1983	30.00	1.44	1.68	2.04	1.20
1984	47.50	2.28	2.66	3.23	1.90
1985	52.50	2.52	2.74	3.57	2.10
1986	60.00	2.88	3.36	4.08	2.40
1987	62.50	3.00	3.50	4.25	2.50
1988	70.00	3.36	3.92	4.76	2.80
1989	77.50	3.72	4.34	5.27	3.10
1990	86.25	4.14	4.83	5.87	3.45
1991	95.00	4.56	5.32	6.46	3.80
1992	104.50	5.02	5.85	7.11	4.18
1993	115.00	5.52	6.44	7.82	4.60

Note: 1/ To obtain charge per m^3 for the first 10 m^3 classified by connection size, multiply R.U. charge shown in 3/ above by the following connection size factors.

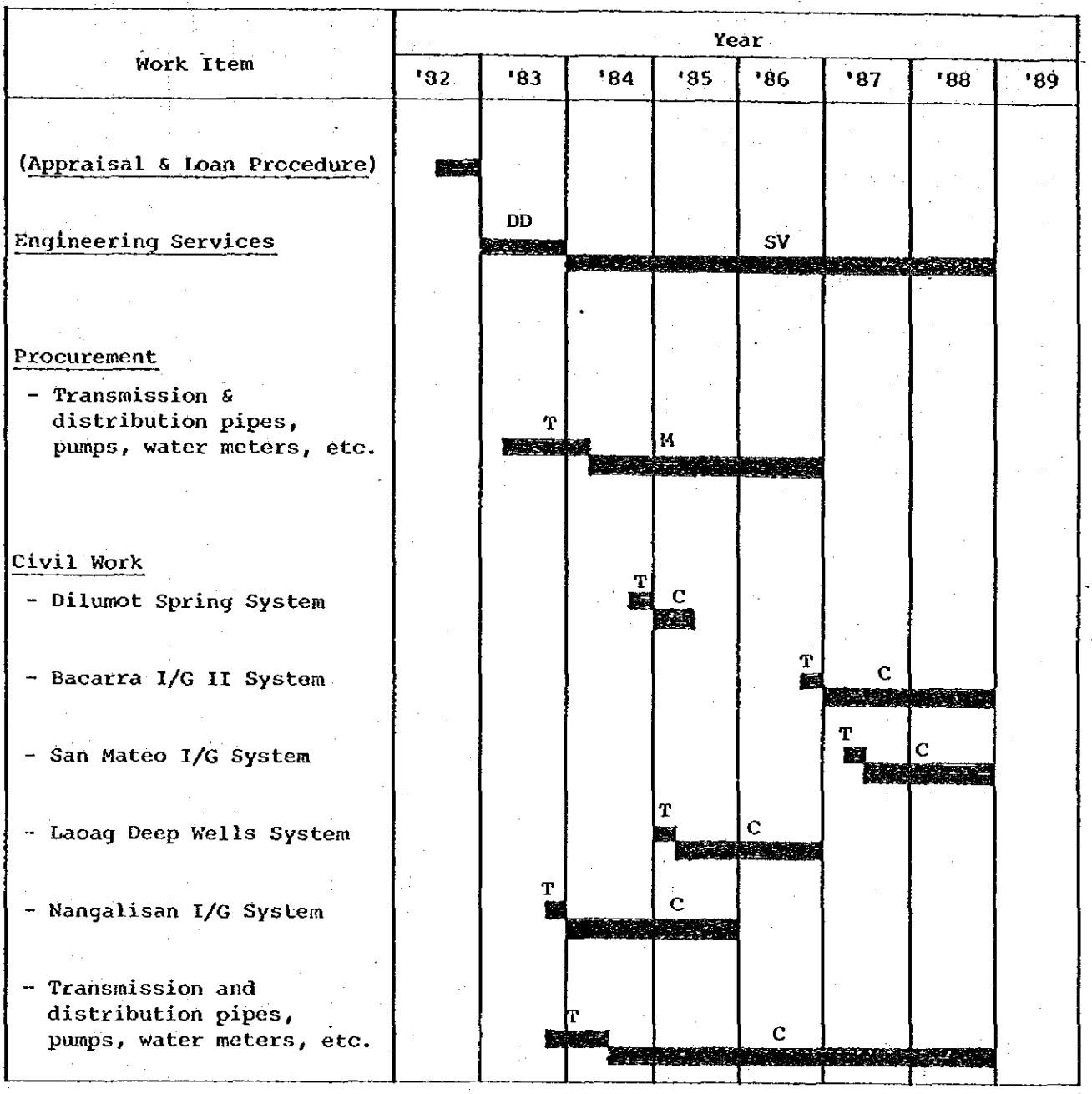
Domestic : 1.0 for 3/8"; 2.5 for 1/2"; 4.0 for 3/4"; 8 for 1"
Commerical: 5.0 for 1/2"; 8.0 for 3/4"; 16.0 for 1"; 40.0 for 1 1/2"

2/ To obtain charge for each added m^3, multiply R.U. charges shown in 3/ by the following block factors.

Domestic : 1.2 for 11-20 m^3; 1.4 for 21-45 m^3; 1.7 for over 45 m^3
Commercial: 2.4 for 21-45 m^3; 2.8 for 45-100 m^3; 2.4 for over 100 m^3

Construction Schedule for Phase I + II

(Target Year: 1993)



Note: OD = Detailed Design
SV = Supervision of Construction
T = Tendering Procedure (Advertisement/Tendering/Evaluation/Award)
M = Manufacturing & Shipping
C = Construction/Installation

Ilocos

Project Cost for Phase I + II

(Target Year: 1993)

Note: - Unit = One Thousand Pesos = '000 Pesos
- Prices as of 1st July 1981
- Foreign Exchange Rate: US $ 1.00 = Peso 7.80

Work Items	Cost		
	Total Cost	Foreign Currency Component	Local Currency Component
A. Dilumot Spring System	826	207	619
B. West Riverside I/G System	243	219	24
C. Vintar I/G System	194	175	19
D. Bacarra I/G II System	2,844	1,290	1,554
E. San Mateo I/G System	3,422	2,125	1,297
F. Laoag Deep Wells System	5,949	3,088	2,861
G. Nangalisan I/G System	10,154	6,080	4,074
H. Distribution Pipe	24,844	16,645	8,199
I. Valve	1,666	1,215	451
J. Fire Hydrant	2,801	1,849	952
K. Bulk Meter	173	138	35
L. Chlorinator	130	117	13
M. Service Meter	7,771	5,984	1,787
N. Vehicle	210	105	105
Sub Total	61,227	39,237	21,990
Detailed Design Cost (10.5%)	6,429	3,857	2,572
Supervision Cost (3.5 %)	2,143	1,286	857
Land Cost	200	-	200
Total	69,999	44,380	25,619
Physical Contingency (10 %)	7,000	4,438	2,562
Total	76,999	48,818	28,181
Price Contingency	52,610	32,251	20,359
Grand Total (Project Cost)	129,609 (Equivalent to US$16.62 M)	81,069 (Equivalent to US$10.40 M)	48,540 (Equivalent to US$6.22 M)

RECOMMENDATIONS

1. Implementation of the Project

The water supply Master Plan proposed a long term development program up to the year of 2010, and recommended its implementation by stages, namely, Phase I up to 1987, Phase II up to 1993, and Phase III up to the final target year 2010.

In accordance with the above recommendation, the present feasibility study was made with regard to two cases, i.e., Case 1 for Phase I project, of which the major intention is to maximize use of the existing facilities, together with urgent improvements and reinforcement works, and Case 2 for a combined project to Phase I and II, which includes, in addition to the Phase I works, development of a new water source/s and pipeline extension works.

The results of the study of the two cases indicate that both cases are technically and financially feasible, meeting satisfactorily the basic requirements concerning loan ceiling, water rate and consumers' paying ability. Case 2, however, is based on the given conditions that a national subsidy equivalent to 25% of the total project cost will be provided to the project.

As regards implementing the water supply development project, it is desirable to consider the Case 2 project, because it can meet the water requirement over a medium term future, contributing to the unimpeded social development of the community concerned. Decision of the implementation must be made solely depending on the national policy. If case 1 should be selected for implementation, the Phase II project should, needless to say, follow immediately the Phase I project.

2. Technical Recommendations

1) Periodic Review of Master Plan

In preparing and drawing out the present water supply master plan and feasibility study some assumptions were inevitably made owing to insufficiency of necessary data, and furthermore, the projected development of the area, together with water consumption, may possibly differ from the actual future development. Therefore, review and revision of the present report is recommended from time to time as required, at least once every five years after the commencement of the operation of Phase I or before implementation of the subsequent phases.

2) Measures to be Immediately Taken

Reduction of leakage and wastage is the most effective measure to substantially increase water supply. As water shortage in the served area is presently very acute, it is recommended, that the newly formed water district should concentrate its effort on reduction of leakage and wastage even before the proposed project is started. Water thus saved can alleviate the suffering of the customers from water shortage, and may in addition be supplied to new customers. Besides, the financial position of the water district will accordingly be improved.

At present, leakage and wastage from the plumbing systems account for more than half that of the whole water supply system. Therefore, to maximize the results of the leakage abatement activities, all existing service systems should be inspected, and all leaks thereof be repaired. Further, to discourage wasteful use of water, all the connections should be metered. If required, fund necessary for metering should be borrowed on a short term basis, though the cost for meter procurement and installation is provided in the present project cost.

3) Population and Water Demand

Population growth may be influenced by changes in the social conditions and industrial development in the area, and water demand will be affected accordingly. Therefore, population, both total and served, and water demand should be continuously reviewed, and in addition the categorized water demand should be calculated. It is advisable to revise the projected figures in the master plan according to the above review.

4) Water Loss and Metering

Loss of water from the water supply system means inefficient operation and maintenance of resources and loss of revenue to the district. To maintain sound management and self-sustaining water district, loss of water must be prevented by all means. Loss of water can be known by the metering of water production and comsumption, and, by analyzing the results of metering, causes and remedies for such loss can be established. Installation and maintenance of meters, on account of this, is essential for production facilities and all consumers' connections.

5) Water Rate Schedule

The current water rate schedule is composed of basic and surcharge rates. The surcharge rate is about half of the basic rate. This system is applicable to the cases the supply capacity is larger than the water demand, and there is a need to induce the consumers to use more water. However, in the case of a water supply system with no surplus capacity, it is a normal practice to make the surcharge rate higher than the basic rate, to compel the consumers to save water. As the water district has a rather limited supply capacity, the latter rate schedule together with 100 % metering is considered absolutely necessary.

6) Training of Staff in Operation

During the field survey of the existing water supply systems, various inefficiencies in operation were noticed. Such inefficiencies originate from lack of skill and knowledge in operation and insufficiency of fund for maintenance. To remedy this situation, a thorough training of the staff concerned is considered indispensable. LWUA is providing such training. It is, therefore, strongly recommended that staff concerned be given an opportunity to participate in the training course and improve their capability in their assignments.

7) Preparation for Phase II Project

Emphasis of Phase I is placed on restoration of the originally designed capacity of the system by rehabilitating all defects of the existing facilities. This measure will provide a sound basis for future expansion of the water supply system. On account of this basic purpose of the project, the supply capacity will soon be overtaken by the growth of water demand. Therefore, the preparation for Phase II has to be started as early as possible. Furthermore, all factors to be used for the design of Phase II works should be gathered from the actual development of the water supply conditions as results of Phase I project.

8) Observation of Salinity of Groundwater

According to the past experience, in the Paoay area salinity of groundwater, both shallow wells and deep wells, is supposed to change with progress of time. As reported in Appendix 5. Study on Water Sources, salinity in deep ground water is slightly higher than that of shallow groundwater. When groundwater is withdrawn from the well, the movement of groundwater causes change in salinity. This change must be regularly observed so as to enable to take remedial steps in time.

9) Water Quality of Infiltration Gallery Water

The present test results show that water from the two infiltration galleries is polluted by domestic waste water in the Laoag area. As such polluted water has adverse effects on human health, the quality of the gallery water should regularly be monitored, and necessary actions be taken. As far as this condition continues, or even worsens in the future, water taken from the gallery system must be treated so as to ensure its potability, or the existing two infiltration galleries should be replaced by new ones so designed as to take only riverbed water.

10) Water Right

Intake of water for water supply from water sources, such as springs, riverbed water and groundwater, and construction of facilities for such water intake should be authorized/approved by authorities in charge in compliance with relevant laws and regulations. It is, therefore, recommended that formal procedures for such authorization/approval be taken before the implementation of the present project.

PART ONE: GENERAL

1. Introduction

1.1 Authorization

The present report on water supply master plan and feasibility study is prepared in accordance with the terms of reference of the Contract for the Engineering Services (the work) made between the Japan International Cooperation Agency (JICA) and Nihon Suido Consultants, Co., Ltd. (the Consultant) on June 22, 1981. The work was earlier requested by the Government of the Philippines to the Government of Japan, and the latter decided to undertake the work through JICA within the frame of the international cooperation program. With regard to execution of the present work, the leading agency of the Government of the Philippines is the Local Water Utilities Administration (LWUA).

The work consists of two parts, namely, preparation of the master plan for the water supply of the Ilocos Norte Water District to be formed and preparation of the feasibility study of the initial portion of the project envisaged in the said master plan.

1.2 Objective and Scope

The objective of the work is to establish a comprehensive water supply plan for the Ilocos Norte Water District covering Laoag, Pasuquin, Bacarra, Vintar, and Paoay (the study area) for a long term period up to the year of 2010, including preparation of a project having a highest priority, will be studied with regard to its feasibility in the aspects both technical and financial in PART THREE.

The scope of the master plan covers:

1) Data collection and analysis,
2) Establishment of the target year for planning,
3) Definition of served area for planning,
4) Estimation of population,

5) Estimation of water demand,
6) Study of present status of waterworks,
7) Study of water source,
8) Planning of water supply system,
9) Rough estimation of costs for construction, operation and maintenance,
10) Preparation of implementation schedule,
11) Study of Interim Program,
12) Socio-economic study, and
13) Studies of organization, operation and management plan.

The scope of the feasibility study covers:

1) Definition of the target year,
2) Definition of project area,
3) Estimation of population to be served,
4) Estimation of the water demand,
5) Study of improvement of existing facilities,
6) Study of water source,
7) Study of required facilities and layout of facilities,
8) Study of design criteria,
9) Preliminary design,
10) Preparation of construction schedule,
11) Study of construction materials and labour force and study of construction ability of local contractors,
12) Preparation of construction method and procurement method of materials and equipments,
13) Estimation of costs for construction, operation and maintenance,
14) Estimation of benefits,
15) Financial analysis,
16) Studies of organization, operation and management plan, and
17) Preparation of Implementation program.

1.3 Terminology

The following words and terms in the present report mean as set forth below:

(a) Water District - local water district formed pursuant to the Provincial Water Utilities Act.
(b) Rural Waterworks Association - a rural waterworks association organized pursuant to the Executive Order No. 577.
(c) Level I system - developed point source, such as artesian well or protected spring, generally suited for clusters of around 15 households for a shallow well and 50 households for a deep well.
(d) Level II system - Level I plus a system of communal faucets, generally suited for more dense clusters of around 100 households.
(e) Level III system - system of individual house connections.
(f) Point Source - generally a protected well or a spring with no distribution system, which has a distance to the farthest user of no more than 250 m.
(g) Poblacion - an urbanized area in a city/town
(h) Barangay - a political unit or community in a city/town, however "Barangay" in this Report refers to that which is located outside of a poblacion.

1.4 Compilation of the Report

As of March 1982, the formation of a single water district including all of the city and four municipalities has not been finalized, and another alternative plan is under consideration by LWUA and the local governments concerned, namely, to form 1) one water district for Laoag, and 2) one water district for the remaining municipalities. Under the circumstances, the master plan and feasibility study for water supply of the said city and municipalities, all inclusive as one district, is considered not necessarily sufficient. To facilitate, therefore, the use of this master plan and feasibility study for such a split case, Sections of Part Three concerning construction costs and financial projections will separately be studies and provided for the above alternative plan of the water district formation.

2. Present Conditions of the Study Area

The study area of the Ilocos Norte Water District to be formed covers one city and four municipalities, that is, Laoag, Pasuquin, Bacarra, Vintar and Paoay. This chapter describes major natural and socio-economic features of the study area.

2.1 Natural Conditions

2.1.1 Location

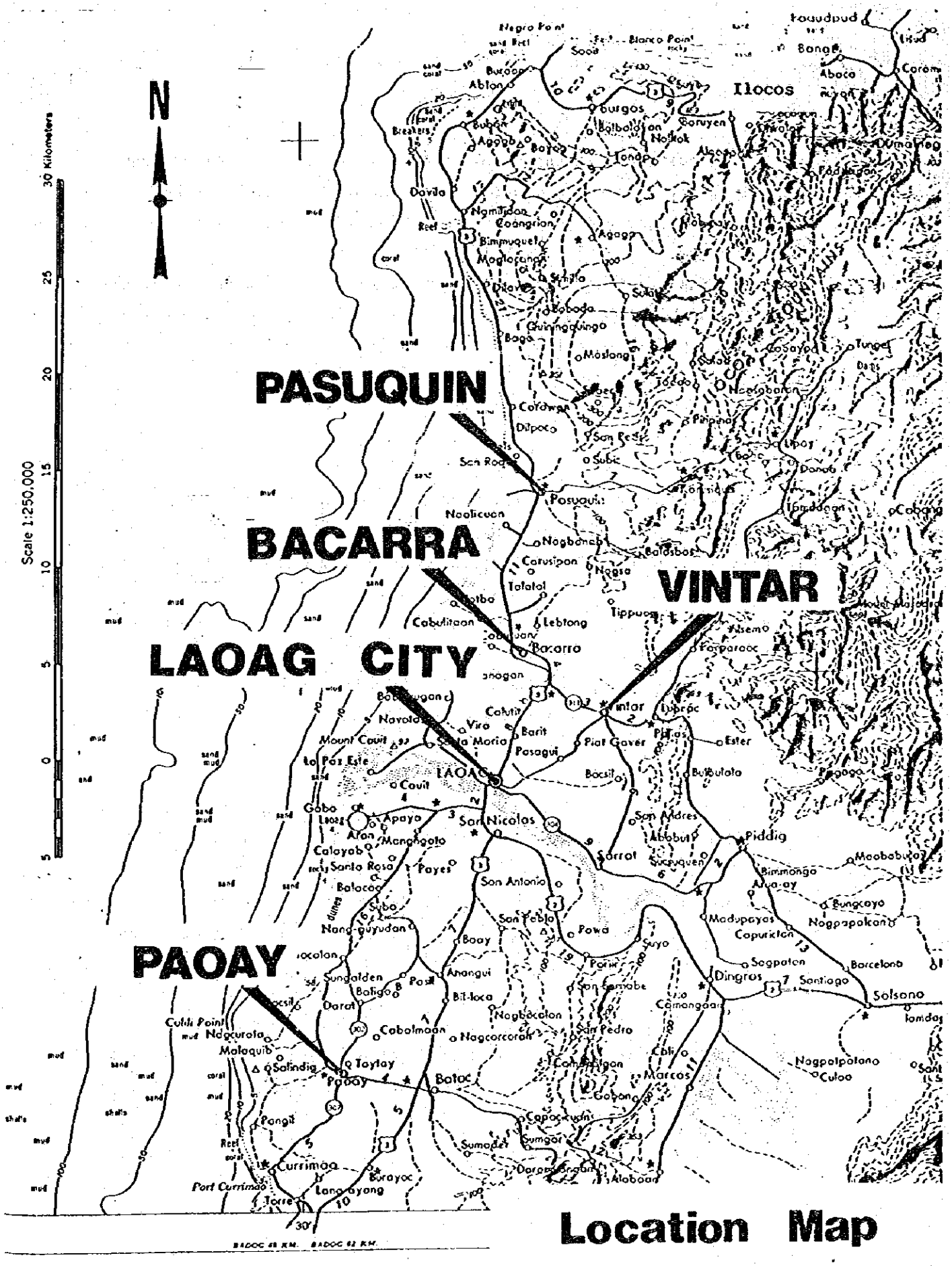
The Province of Ilocos Norte is located on the north-western tip of Luzon Island, and the study area consisting of the city of Laoag and other four municipalities is in the middle of the Province. The distance from the capital Manila to the study area is about 480 km by the highway, and the capital and the study area are linked by the bus transportation system or by cars, taking about eight to ten hours. There is, in addition, the airway system connecting the city of Laoag with the capital Manila, which takes about two hours.

2.1.2 Topography

The topography of the study area has four distinct types, that is, dunes, alluvium, hills 30 to 60 m high, and mountains of which the highest is 560 m.

The dunes are found in a wide area along the seacoast, especially stretching in the direction of Bacarra to Paoay. The dunes have two types: one, of recent sediments and the other, of rather old origin. The latter form hills of 30 to 80 m in elevation and extend like a narrow belt along the sea shore.

The alluvium extends over a vast area in Paoay, Bacarra and Laoag. The alluvial plain has a very gentle inclination toward the sea.



Location Map of the Project Area

Hills, scattered in the study area, have many small valleys and generally their slopes are gentle. This shows that the hills have easily been eroded, and so the contour lines are irregular.

Mountains are in the northern part of Pasuquin. Their elevations are high and the slopes steeper. In the mountainous area, there are many small streams and a few springs.

2.1.3 Geology

Dunes, which are dominantly located in Paoay are mainly composed of medium sand. The formation is permeable and contains water, and at some places, shallow wells dug in the dune produce good quality water.

Hills, scattered in the area east of Paoay lake, consist of Pliocene-Pleistocene formation. Due to erosion, countless small valleys have developed in the hills. Alluvial sediments cover the valleys. The Pliocene-Pleistocene formations are composed of clay, silt, sandstone and gravel.

Alluvium which extends in Paoay and Laoag areas is composed mainly of silt, sand and gravel. The alluvial plain in and around Paoay contains plentiful groundwater and many shallow and deep wells have been sunk, widely scattered in the area. Both shallow and deep well waters in Paoay have some salinity. The alluvial plain in Laoag has potable groundwater.

Mountains located in the north of Pasuquin are formed of cretaceous-Paleogene igneous rocks. The formations have fissures, which serve as good passage for groundwater. A few springs with abundant yields are found in the mountainous area.

2.1.4 Climate

The study area belongs to the zone with two pronounced seasons: dry and wet, according to the meteorological classification of the country. The period of October to April is dry and the rest is wet.

The area has an annual average rainfall of 2,098.5 mm (normal 1951 - 70) with an extremely low average 25.9 mm per month from October through April and a very high average 383.5 mm per month from May to September. The annual precipitations in the area are not much varied every year.

Table 1.2.1 Climate Record, Laoag City

(Period: 1951 - 1970, Normal)
Source of Data: Annual Climatological Review, 1974 (PAGASA, March 1980)

Month	Rainfall (mm)	Rainy Days	Relative Humidity (%)
Jan	6.3	2	73
Feb	2.0	1	72
Mar	6.2	2	72
Apr	24.7	2	71
May	122.1	8	75
Jun	436.0	16	82
Jul	404.2	19	84
Aug	565.7	21	86
Sep	389.5	18	86
Oct	65.5	7	78
Nov	59.5	6	75
Dec	16.8	2	74
Annual	2,098.5	105	77

2.2 Population

The population of the whole study area is 151,213 according to the census made in May, 1980. The population of Laoag totals 69,659, and the population of the other municipalities of Pasuquin, Bacarra, Vintar and Paoay is 81,554. The population in each municipality is tabulated below:

	May 1980 Population
Laoag	69,659
Pasuquin	17,813
Bacarra	23,369
Vintar	23,356
Paoay	17,016
T O T A L	151,213

The above population is distributed among the 221 barangays in which 34 percent or 51,941 of the total population is concentrated in the urban area while 66 percent or 99,272 is considered living in the rural area.

The population increase for a period of past 10 years, in terms of average annual growth rate, was 1.2% in Laoag, 1.9% in Pasuquin, 1.2% in Bacarra, 1.8% in Vintar and 1.1% in Paoay. It is observed from the above that population increase in the study area is stagnant and only Pasuquin and Vintar are still exceeding the average rate of 1.7% in Ilocos Norte.

Table 1.2.2 (1) Past Population Trend: Laoag City
(1970 - 1980)

Barangay	Population			Average Annual Growth Rates (%)		
	1970	1975	1980	1970-75	1975-80	1970-80
1. Apaya	712	726	712	0.4	-0.4	0
2. Araniw	502	676	585	6.1	2.9	1.5
3. Bacsil North	622	726	762	3.1	1.0	2.1
4. Bacsil South	572	664	796	3.0	3.7	3.4
5. Balacad	783	756	796	-0.7	1.0	0.2
6. Balatong	908	1,049	1,017	2.9	-0.6	1.7
7. Barit Vira-Pandan	706	815	1,000	2.9	4.2	3.5
8. Bengcag	854	895	1,040	0.9	3.0	2.0
9. Buttong	1,029	1,205	1,279	3.2	1.2	2.2
10. Caaoacan	803	968	1,098	3.8	2.6	3.2
11. Cabungaan North	803	866	900	1.5	0.8	1.1
12. Cabungaan South	611	666	684	1.7	0.5	1.1
13. Calayab	1,044	1,072	1,194	0.5	2.2	1.4
14. Camangan	401	472	488	3.3	0.7	2.0
15. Casili	480	545	577	2.6	1.1	1.9
16. Cataban	458	472	531	0.6	2.4	1.5
17. Cavit	543	639	694	3.3	1.7	2.5
18. Caraycay	583	654	680	2.3	0.8	1.6
19. Cibua North	592	494	545	-3.7	2.0	-0.8
20. Cibua South	607	624	655	0.6	1.0	0.8
21. Gabu North East	455	464	475	0.4	0.5	0.4
22. Gabu North West	778	925	865	3.5	-1.4	1.1
23. Gabu Sur	878	883	1,099	0.1	4.5	2.3
24. La Paz East	562	618	699	1.9	2.5	2.2
25. La Paz East	807	875	963	1.6	1.9	1.8
26. La Paz Proper	420	451	415	1.4	-1.7	-0.1
27. La Paz Proper	558	647	610	3.0	-1.2	0.9
28. La Paz West	489	517	564	1.1	1.8	1.4
29. Lagui Sail	896	979	1,051	1.8	1.4	1.6

- to be continued -

Table 1.2.2 (2) Past Population Trend: Laoag City
(1970 - 1980)

Barangay	Population			Average Annual Growth Rates (%)		
	1970	1975	1980	1970-75	1975-80	1970-80
30. Lataag	541	591	607	1.8	0.5	1.2
31. Maciladig	684	759	828	2.1	1.8	1.9
32. Mangato East	484	536	483	2.1	-2.1	0
33. Mangato West	543	592	638	1.7	1.5	1.6
34. Nabutas North	592	587	611	-0.2	0.8	0.3
35. Nabutas South	522	635	596	4.0	-1.3	1.3
36. Nalbo	664	805	937	3.9	3.1	3.5
37. Nangalisan East	668	755	838	2.5	2.1	2.3
38. Nangalisan West	481	517	546	1.5	1.1	1.3
39. Pila	854	917	991	1.4	1.6	1.5
40. Poblacion(u)	30,203	31,336	32,365	0.7	0.6	0.7
41. Raraburan	420	531	802	4.8	2.5	3.7
42. Rioeng	785	886	898	2.5	0.3	1.4
43. Salit Bulangan Passagui	544	787	891	7.7	2.5	5.1
44. San Mateo	439	477	447	1.7	-1.3	0.2
45. Santa Maria	661	718	811	1.7	2.5	2.1
46. Santa Rosa	402	487	444	3.9	-1.9	1.0
47. Suyo	427	490	563	2.8	2.8	2.8
48. Talingaan	666	687	759	0.6	2.0	1.3
49. Tangid	583	613	675	1.0	1.9	1.5
50. Vira	446	541	626	3.9	3.0	3.4
51. Zamboanga	662	669	729	0.2	1.7	1.0
T O T A L	61,727	66,259	69,659	1.4	1.0	1.22

Note: (u) - Urban

Table 1.2.3 Past Population Trend: Pasuquin Municipality
(1970 - 1980)

Barangay	Population			Average Annual Growth Rates (%)		
	1970	1975	1980	1970-75	1975-80	1970-80
1. Batuli	139	197	174	7.2	-2.5	2.3
2. Binsang	284	527	539	13.1	0.5	6.6
3. Cababaan-Nalvo	267	232	288	-2.9	4.4	0.8
4. Caruan	390	377	519	0.7	6.6	2.9
5. Carusikis	249	386	473	9.2	4.1	6.6
6. Carusipan	273	280	345	0.5	4.3	2.4
7. Dadaeman	234	284	315	3.9	2.1	3.0
8. Darupidip	261	279	282	1.3	0.2	0.8
9. Davila	1,605	1,799	2,084	2.3	3.0	2.6
10. Dilanis	346	322	372	-1.4	2.9	0.7
11. Dilavo	209	230	268	1.9	3.1	2.5
12. Estancia	387	480	565	4.4	3.3	3.9
13. Naglicuan	504	611	686	3.9	2.3	3.1
14. Nagsanga	419	430	530	0.5	4.3	2.1
15. Ngabangab	401	444	483	2.1	1.7	1.9
16. Pangil	205	203	210	0	0.7	0.2
17. Poblacion(u)	4,561	4,748	4,837	0.8	0.4	0.6
18. Pragati-Bungro	288	309	343	1.4	2.1	1.8
19. Puyupuyan	351	435	459	4.4	1.1	2.7
20. Solongan	116	175	226	8.6	5.2	6.9
21. Salpad	537	219	255	-	3.1	-
22. San Juan	637	682	817	1.4	3.7	2.5
23. Santa Catalina	520	557	631	1.4	2.5	2.0
24. Santa Matilde	258	296	312	2.8	1.1	1.9
25. Sapat	-	390	307	-	4.9	-
26. Sulbec	285	265	303	1.5	2.7	0.6
27. Sarong	246	250	247	0.3	-0.2	0
28. Susugaon	472	559	633	3.4	2.5	3.0
29. Tabungao	162	156	160	-0.80	0.5	-0.1
30. Tadao	169	132	150	-5.1	2.6	-1.2
T O T A L	14,775	16,258	17,813	1.9	1.8	1.9

Note: (u) - Urban

Table 1.2.4 Past Population Trend: Bacarra Municipality (1970 - 1980)

Barangay	Population			Average Annual Growth Rates (%)		
	1970	1975	1980	1970-75	1975-80	1970-80
1. Bani	418	427	500	0.4	3.2	1.8
2. Buyon	666	686	801	0.6	3.1	1.9
3. Cabaruan	834	933	965	2.3	0.7	1.5
4. Cabulalaan	578	607	651	1.0	1.4	1.2
5. Cabusligan	619	645	716	0.8	2.1	1.5
6. Cadanatan	907	991	1,078	1.8	1.7	1.7
7. Calioit-Libong	523	568	626	1.7	2.0	1.8
8. Casilian	233	334	425	7.5	4.9	6.2
9. Corocor	401	441	486	1.9	2.0	1.9
10. Duripes	564	556	662	-0.3	3.6	1.6
11. Ganagan	453	500	548	2.0	1.9	1.9
12. Libtong-Apaleng	816	896	1,013	1.9	2.5	2.2
13. Nacupit	355	370	422	0.8	2.7	1.7
14. Nambaran	525	661	631	4.7	-0.9	1.9
15. Natba	413	433	450	1.0	0.8	0.9
16. Paninaan	352	335	346	-1.0	0.6	-0.2
17. Pasiocan	591	634	636	1.4	-	0.7
18. Pasugal	419	435	425	0.8	-0.5	0.1
19. Pipias	751	838	910	2.2	1.7	1.9
20. Pulangi	525	562	643	1.4	2.7	2.0
21. Punto	368	387	429	1.0	2.1	1.5
22. Pablacion(u)	7,715	7,967	8,001	0.6	0.1	0.4
23. Sangil	578	619	712	1.4	2.8	2.1
24. Tambidao	174	197	213	2.5	1.6	2.0
25. Teppang	411	442	475	1.5	1.5	1.5
26. Tubburan	546	614	605	2.4	-0.3	1.0
T O T A L	20,736	22,118	23,369	1.3	1.1	1.2

Note: (u) - Urban

Table 1.2.5 Past Population Trend: Vintar Municipality
(1970 - 1980)

Barangay	Population			Average Annual Growth Rates (%)		
	1970	1975	1980	1970-75	1975-80	1970-80
1. Abkir	687	759	824	2.0	1.7	1.8
2. Alsem	381	435	466	2.7	1.4	2.0
3. Bago	350	312	384	-2.3	4.2	0.9
4. Bulbulala	893	969	991	2.1	0.5	1.3
5. Cabangaran	571	661	702	3.0	1.2	2.1
6. Cabayo	618	649	666	1.0	0.5	0.8
7. Cabisocolan	819	501	596	-	3.5	-
8. Canaan	528	534	644	0.2	3.8	2.0
9. Colombia[1/]	-	395	434	-	1.9	-
10. Bagupan	440	422	469	-0.80	2.1	0.6
11. Daiton	683	708	766	0.7	1.6	1.2
12. Dipitat	653	730	810	2.3	2.1	2.2
13. Esperanza	364	331	274	-1.9	-3.8	-2.9
14. Ester	849	924	1,031	1.7	2.2	2.0
15. Isic isic	902	980	1,047	1.7	1.3	1.5
16. Lubnac	873	993	1,152	2.6	3.0	2.8
17. Nabanbanag	386	420	467	1.7	2.1	1.9
18. Malasig Alejo	381	603	670	-	2.1	-
19. Manarang	521	597	582	2.8	-0.5	1.1
20. Mangaay	344	509	527	-	0.7	-
21. Mamoroc	545	599	608	1.9	0.3	1.1
22. Malampa	432	492	508	2.6	0.6	1.6
23. Parparoroc	543	627	766	2.9	4.1	3.5
24. Parut	585	744	769	4.9	0.7	2.8
25. Salsalamagui	604	693	747	2.8	1.5	2.1
26. San Jose	615	357	346	-	-0.6	-
27. Santo Tomas[2/]	-	322	364	-	2.5	-
28. Tamdagan	624	714	794	2.7	2.1	2.4
29. Visaya	588	640	733	1.7	2.8	2.3
30. Poblacion(u)	3,696	4,035	4,217	1.8	0.9	1.3
T O T A L	19,455	21,655	23,356	2.2	1.5	1.8

Note: (u) - Urban

Table 1.2.6 Past Population Trend: Paoay Municipality
(1970 - 1980)

Barangay	Population			Average Annual Growth Rates (%)		
	1970	1975	1980	1970-75	1975-80	1970-80
1. Baesil	426	452	436	1.2	-0.7	0.2
2. Cabagoan	232	234	252	-	1.5	0.8
3. Cabangaran	288	318	334	2.0	1.0	1.5
4. Callaguip	1,273	1,404	1,458	2.0	0.8	1.4
5. Cayobog	271	255	304	-1.2	3.6	1.2
6. Dolores (u)	-	473	493	-	0.8	-
7. Laoa	236	235	221	0	-1.2	0.4
8. Masintoc	503	529	525	1.0	-0.2	0.4
9. Monte	332	354	352	1.3	-0.1	0.6
10. Mumulaan	395	438	473	2.1	1.5	1.8
11. Nagbacalan	1,494	1,723	1,877	2.9	1.7	2.3
12. Nalasin	853	889	932	0.8	0.9	0.9
13. Nanguyudan	341	395	470	3.0	3.5	3.3
14. Daig-Abulay Upay	313	323	376	0.6	3.1	1.9
15. Pambaran	344	291	288	-3.4	-0.2	-1.8
16. Panatong	-	802	847	-	1.1	-
17. Pasil	594	634	621	1.3	-0.4	0.4
18. San Juan	287	254	233	-2.5	-1.7	-2.1
19. San Pedro	258	350	430	6.3	4.2	5.2
20. Sideg	175	323	302	13.0	-1.4	5.6
21. Suba	653	706	932	1.6	5.7	3.6
22. Sungadan	678	717	793	1.1	2.0	1.6
23. Surgiu	678	629	657	-1.5	0.9	-0.3
24. Veronica (u)	-	228	226	-	-0.2	-
25. Poblacion (u)	4,027	2,460	2,521	-	0.5	-
26. San Agustin	567	578	663	0.4	2.8	1.6
T O T A L	15,218	15,994	17,016	1.0	1.2	1.1

Note: (u) - Urban

2.3 Socio-Economic Conditions

The study area including Laoag City, Pasuquin, Bacarra, Vintar and Paoay is basically agricultural. Even Laoag City which is most highly urbanized among other municipalities is agricultural as indicated by the fact that 81% of its total land area is considered agricultural or rural.

Most of manufacturing industries in the area are of the cottage type. Commercial establishments are limited to small-scaled ones such as drugstores, groceries and other daily goods dealers with the exception of the distribution center of agricultural products in Laoag City.

The census conducted in May 1980 registered 151,213 as the total population of the area, a gain of 8,929 or 6.28% from May 1975. This increase in terms of annual growth is only 1.23% which is far below the national average rate of 2.64%. This is attributable to an excess of out-migrants over in-migrants.

Ilocano is now the major dialect of the Ilocos Norte Province and is reportedly used as the mother tongue by 99.2% of all the population of the province, with Tagalog by 0.25% and others by 0.55%.

The educational attainment level of the study area is among the highest of the Ilocos Norte province.

Speaking of the conditions of infrastructures, the area is bestowed with better highways and roads compared with other provinces.

The mode of transportation in the area depends upon that of motorcycles and jeepneys, with the small percentage of the population owing cars.

Water supply service is being provided by a provincial system, the service of which is, however, poor as described in Chapter 3.

The area does not have sewerage systems. Some residents utilize septic tanks, but because of their prohibitive cost, most cannot afford.

The study area employs both the communal and canal irrigation systems maintained by different Zanfera associations and the National Irrigation Administration, and irrigation systems in the area are considered to be more advanced than the national level.

Electric power service is given by the Ilocos Norte Electric Cooperative which has at present 19,297 consumers, 70.8% of the potential households in the area.

Gastro-Enteritis, typical water-borne disease, ranks high among the ten leading causes of morbidity in the study area; second in Laoag and Paoay; first in Bacarra and Pasuquin; and fourth in Vintar.

For details, please refer to Appendix 6.

3. Existing Water Supply

3.1 General

Existing water supply systems in the study area range from complete water supply systems of Level III to simple point sources of Level I. Densely populated areas of Laoag, Pasuquin and Bacarra are served by the Ilocos Norte Metropolitan Waterworks, a Level III system. A new water supply system now under construction will serve the densely populated area of Vintar with completion target within 1981, and another water supply system is also under construction for Paoay. The former of the above systems is undertaken by the Province and the latter by the Ministry of Public Works. There are Level I and II systems in many of barangays of the city and municipalities of the study area.

The following sections present an overall picture of the technical, operational and managerial aspects of all the above-mentioned water supply systems, which is to serve as a basis for the planning of immediate and long-term water supply improvement and expansion.

3.2 Water Sources

The water sources which are presently used for water supply in the study area are the following, as detailed in Appendix 5.

1) Springs
2) Riverbed water
3) Deep wells
4) Shallow wells

Major features of the above water sources are as follows:

(1) Spring

All springs in use in the study area are presented in Table 1.3.1. They are all located in the mountainous area of Pasuquin. Their characteristics are that 1) they are at rather high elevations, more than 200 m above sea level, 2) they are all outcrops of groundwater from fissures in the lava of Quartzite, 3) their yields vary with seasons, more precisely with precipitation, and 4) Bararing spring water would sometimes have high turbidity during heavy rains.

With regard to the yeild of the springs, the Ilocos Norte Metropolitan Waterworks Office indicated that the three springs shown in Table 1.3.1 have a minimum yield of 1,820 cu m/day in total. In July 1981, which falls in the middle of the rainy season, the yield of the springs was observed in the field. The yield thereof was so large as to produce overflows at each spring.

Apart from the above observation, transmission quantity was estimated based on the pipe diameter and the flow gradient, and it was found to be about 2,200 cu m/day, as described in Appendix 3.

Table 1.3.1 Spring Yield

Spring	Minimum Yield 1/
Dilumot	700 m^3/d
Bararing	580
Dinalsuan	540
Total	1,820

1/ By Ilocos Norte Metropolitan Waterworks

(2) Riverbed Water

Riverbed water is tapped by way of the infiltration gallery. Presently there are three infiltration galleries in the study area, as shown in Table 1.3.2.

The infiltration gallery built at the left bank of the Bacarra River has good quality water, but the other two galleries installed at the right bank of the Laoag River produce poor quality water. Of the latter two, the Erimita gallery appears to be directly taking in the river water, as evidenced by the fact that when the river water gets turbid, the gallery water also becomes turbid. In addition, the two galleries are taking polluted groundwater from the poblacion area, which is densely populated and where domestic waste water infiltrates into the ground. The correlation of the groundwater, the river water and the gallery water is discussed in detail in Appendixes 1 and 2.

Table 1.3.2 Existing Infiltration Galleries

Gallery	Year Constructed	Operation Hour (hr.)	Discharge (m^3/min.)	Production (m^3/day)	Pump
Ermita	1959	19	0.60	680	Turbine pump with electric motor
West Riverside	1969	19	0.95	1,080	- do -
Bacarra	1979	19	1.4	1,600	- do -
Total				3,360	

(3) Deep Wells

In the Paoay municipal area, there are several deep wells sunken as point sources for Level I or Level II water supply systems. In the area almost all deep wells have fairly high saline water, excluding the wells north of the Paoay lake located in the sand dune.

In Laoag, a number of deep wells have been sunk by MPW but are not operated yet. Well water is potable.

(4) Shallow Wells

In Laoag, the shallow wells have generally high conductivity due to pollution by domestic waste water, and are not necessarily suitable for drinking, though widely in use for domestic purpose in the area.

In Paoay, the shallow well water has generally high salinity, only except the water taken from the sand dunes. Besides, such salinity water is very limited in quantity.

3.3 Distribution System

Of all the water sources stated in the foregoing section, the water sources that are presently used by the Ilocos Norte Metropolitan Waterworks are the three springs of Dinalsuan, Bararing and Dilumot, and the three infiltration galleries of Bacarra, West Riverside and Ermita. The springs are located in the northern mountainous area of Pasuquin and the infiltration galleries in the served areas of Bacarra and Laoag as shown in Fig. 1.3.1 and Fig. 1.3.2.

The transmission line, 200/250/300 mm in diameter and 24.5 km in total length, of the spring water starts at the Dilumot spring, collecting Dinalsuan and Bararing spring water, and ends at the beginning of the distribution networks of Laoag. The two poblacions in Pasuquin and Bacarra are served through distribution networks that are connected directly with the transmission line. On the way, barangays in Pasuquin and Bacarra take water from the transmission line.

The Bacarra infiltration gallery, which was intended to increase the supply capacity, pumps water into the Ligao reservoirs located in Laoag via the Barit booster pumping station. The reservoirs have a capacity 1,980 cu m and 380 cu m each. The West Riverside gallery strengthens the water supply in the Laoag poblacion area by pumping water directly into the distribution main. The Ermita gallery pump lifts water into an elevated tank with a capacity 380 cu m constructed nearby, and the water is distributed by gravity in the served area of Laoag.

Distribution pipelines in Laoag, Pasuquin and Bacarra were installed in 1930's and they are presently still used. In case of Paoay, they were laid in 1960's together with construction of a deep well which was abandoned in 1975 due to saline water intrusion. Though being out of service now, they are serviceable on completion of a new water source by this project. Distribution pipelines in Vintar were recently installed by MPW and are ready for use. Almost of all the pipelines are of cast iron or gaivanized steel pipes.

Fire hydrants are placed at main corners in poblacions of Laoag, Pasuquin, Bacarra and Paoay to some extent. Regarding public faucets, in Pasuquin, some fire hydrants has a function of public faucets though they are out of service presently. In other poblacions, there are no public faucets.

There is a visible leakage on a transmission pipeline linking Dilumot Spring and Laoag City, at a river crossing point over Bacarra River.

Details of the existing pipelines are presented in Table 1.3.3.

Table 1.3.3 Existing Pipelines in the Study Area

Pipelines	Diameter (mm)	Length (m)	Material	Year Installed
Transmission Pipelines	300	3,000	C I P	1931, 1959, 1969 and 1979
	250	3,100	C I P	
	200	18,400	C I P	
Total		24,500 m		
Distribution Pipelines	250	1,000	C I P	Around 1930
	200	1,200	C I P	
	125	1,900	G S P	
	100	9,800	G S P	
	75	18,800	G S P	
Total		32,700 m		

As regards water pressure of the spring water system, the transmission line is subjected to an excessively high pressure, because there are no break pressure chambers. Nevertheless, the portion beyond the Bacarra bridge the water pressure is too low that almost no water reaches the reservoirs at Liago.

Due to the high pressure, coupled with insufficient maintenance, there are fairly large leaks on the transmission line. As no bulk water meters are provided on the start point of the transmission line and strategic points of the distribution mains, no reliable transmission or distribution quantities can be obtained. Estimation of the present leakage, therefore, has to be made by measurement of transmission quantity and estimation of consumption based on the number of connections or served population, instead of calculation of leakage by records. In this regard, details will be treated in 3.4 Present Water Use and Appendix 3.

On the other hand, the infiltration gallery systems are not equipped with bulk water meters, production quantities are not recorded. The present production, therefore, was measured during the field survey, the results of which are shown in Table 1.3.2.

As for water pressure in the served area, it is generally very low, as described in Appendix 4. In wider areas of the Laoag poblacion, where a field survey was undertaken, water is only available intermittently, with some places with no water throughout the whole day. It is noticed that the consumers' peculiar way of water use, namely, to store water at their households with taps left open, has some connections with the extremely low water pressure.

Although efforts to distribute water as uniformly through the day and area as possible are being made, no tangible results are obtained yet, mainly due to insufficiency in production and storage.

As regards leakage, visible leaks on the ground surface are very rare, but this fact leads to suspicion that invisible underground leaks may exist. To ascertain actual conditions of the existing pipelines, some representative spots were dug to inspect the soil and the conditions of pipe corrosion. Major findings of the investigation were that pH of the soil was generally higher than 7, sulfate concentrations ranged from 62 ppm to 199 ppm, and chloride contents were in a range of 2 ppm to 11 ppm. Exterior surface of the laid pipe had encrustations, but pittings of the pip wall were not detected.

From the above conditions, as well as the results of water analysis, leaks may, it is concluded, be attributable to the aging of the pipelines and the poor maintenance of all the facilities; it may not be caused by soil corrosiveness.

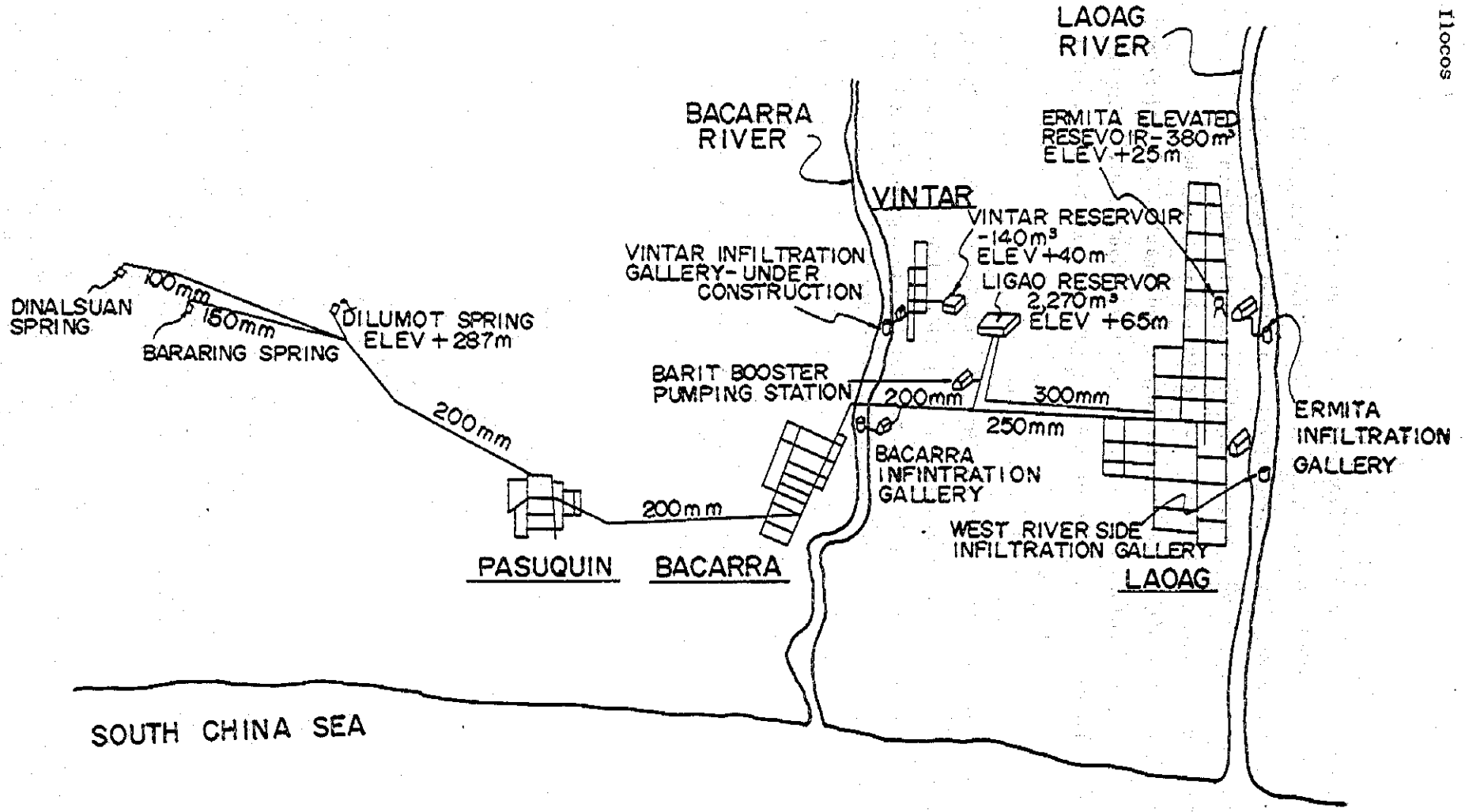


Fig. 1.3.1 Existing Water Supply System

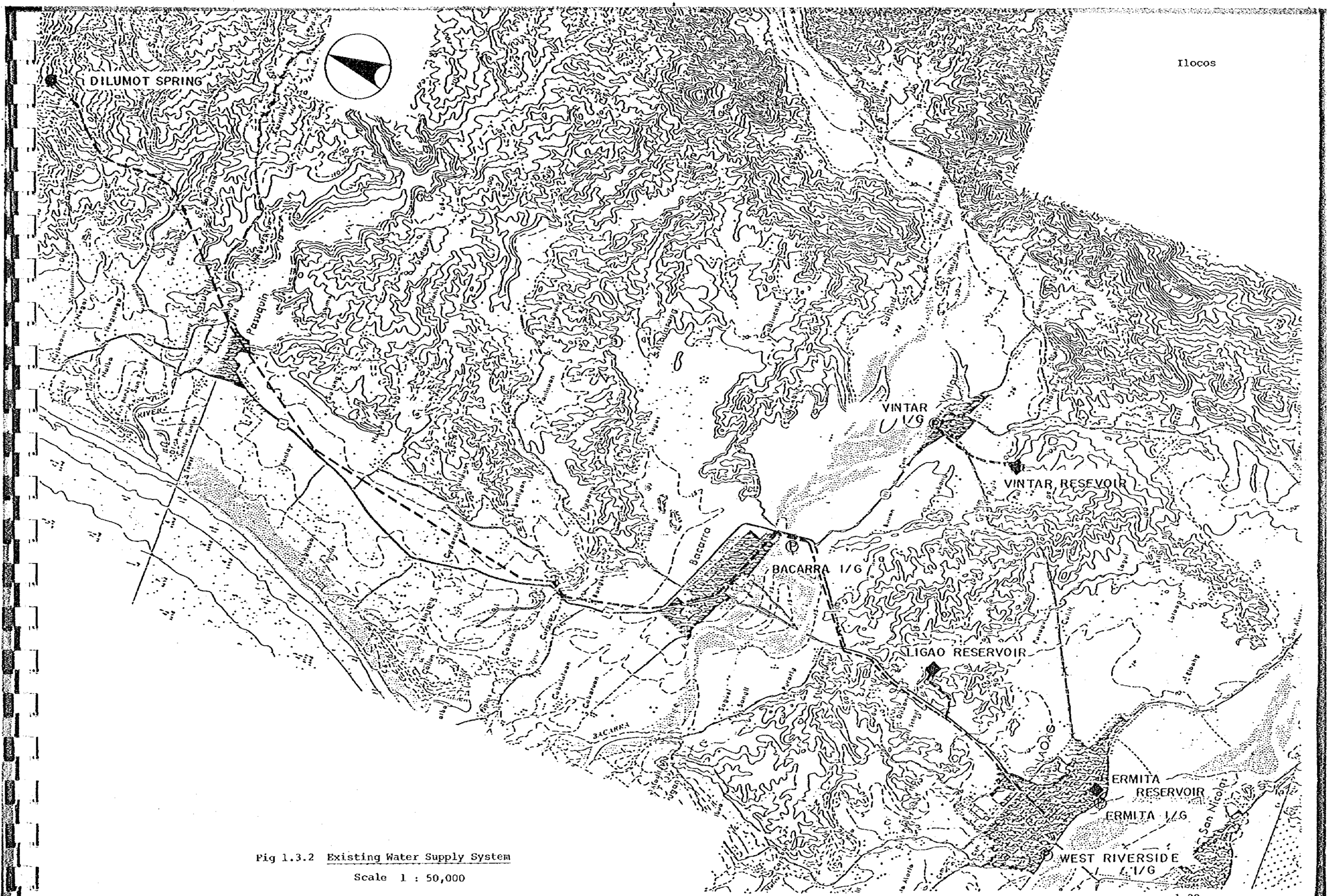


Fig 1.3.2 Existing Water Supply System

Scale 1 : 50,000

3.4 Present Water Use

Present water use in the Ilocos Norte Metropolitan Waterworks (INMW) cannot be obtained from the records of service meter reading since only less than 20 percent of the total service connections are equipped with service meters and actual total consumption has never been measured. Therefore, present water use is assumed using the present water supply amount from the existing sources. The total production, equivalent to the maximum supply amount, is estimated 5,180 cu m/d in 1981 as described in 3.2 Water Sources.

The above production accounts for overall average consumption of 207 liter per capita per day for an approximate served population of 25,000. While, the overall average consumption per service connection is estimated as 1.64 cu m/d.

The present service connections are 3,166 in total, of which only 544 connections or 17 percent of the total are metered. Out of 544 metered service connections, 500 connections are found in Laoag and 44 connectios are in Bacarra, while no metered connection is in Pasuquin. The break down of service area is shown in the Table below.

Table 1.3.4 Present Service Connections

Use Category	Laoag	Pasuquin	Bacarra	Total
Domestic	1,238	740	942	2,920
Commercial	185	20	38	243
Industrial	3	-	-	3
Institutional	-	-	-	-
Total	1,426	760	980	3,166

As for system loss and leakage or unaccounted-for-water, the actual amount cannot be measured from the balance of supply and consumption since no consumption records are available as mentioned previously. However, a trial estimation of the system loss and leakage can be done as in the following. The average water use per service connection in INMW is 1.64 cu m/d, 49.2 cu m/month, which includes system

loss and leakage. While, the average metered water consumption in the other water districts in the Philippines, ref. Appendix 8, is 32.4 cu m/month per connection as experienced in 1978. Assuming that the above average metered water consumption can by adopted as the potential water consumption in INMW the system loss and leakage will be the balance of the said two amounts, that is 16.8 cu m/month per service connection. Thus, the system loss and leakage will be counted as 34 percent of the total supply in the INMW.

3.5 Present Water Rates

3.5.1 Procedure for Determining Water Rates

The original establishment of water rates and their changes are recommended by the Waterworks Superintendent through the Provincial Treasurer to the Provincial Governor. Based upon the initiative of the Provincial Governor, the Sangguniang Panlalawigan (Provincial Board) deliberates upon and approves the recommended water rates. A public hearing is sometime conducted by the Sangguniang Panlalawigan for this purpose.

3.5.2 Present Schedule of Water Rates

The present water rates came into effect in 1980. As shown in Table 1.3.5, the water rates differ according to service areas, the reason being that the production cost of water is not same in the three different areas, as they depend upon different types of water sources.

3.5.3 Discounts

In view of a very limited number of hours of water supply a day, particularly in specified areas during the dry season, the Waterworks often discount the prevailing water charges for those consumers who submit their complaints of poor services if and when their compliants are verified.

3.5.4 Billing and Disconnections

No bills are sent to flat rate consumers who are required to pay water charges every three months. To the metered consumers, water bills are rendered by meter readers every three months. When a consumer fails to pay the water charges within 15 days after the bill becomes due, disconnection is ordered for the delinquent consumer.

Table 1.3.5 Present Schedule of Water Rates

1. Flat Rate

Domestic	
Laoag:	₱20.00 per month
Bacarra and Pasuquin:	₱15.00 per month
Commercial	₱30.00 per month
Industrial	₱40.00 per month for small-size industries
	₱50.00 per month medium and large-sized industries

2. Meter Rate*

Laoag:	₱20.00 per month minimum charge for the first 10 cu m
	₱ 1.00 per cu m for additional consumption
Bacarra and Pasuquin:	₱15.00 per month minimum charge for the first 10 cu m
	₱ 0.75 per cu m for additional consumption

Note: * Same rates apply to Domestic, Commercial and Industrial Consumption.

Source of Data: Ilocos Norte Metropolitan Waterworks.

3.6 Present Institutional Water Supply Practice

3.6.1 Responsible Agency

The Ilocos Norte Metropolitan Waterworks is owned and operated by the Provincial Government of Ilocos Norte. Its Superintendent and other staff members are all Provincial Government officials and employees.

3.6.2 Policy-making Function

The policy-making function relating the water supply and the implementation of those policies are carried out by the Provincial Governor subject to the resolutions or approval of the Sangguniang Panalalawigan (Provincial Board).

3.6.3 Direct Responsibility

The direct responsibility for important matters such as the preparation and execution of annual budgets for the Waterworks and the recommendation of changes in water rates is placed in the Provincial Treasurer. In these important matters, the role of the Waterworks Superintendent is indirect and limited to the presentation of necessary reference data to the Provincial Treasurer.

3.6.4 Accounting

The accounting of the Waterworks is not separated from that of the Provincial Government, and the income and expenditures of the Waterworks are accounted by the Provincial Treasurer's Office as part of the Provincial Government's income and expenditures. The expenditures of the Waterworks consist of personnel expenses and maintenance expenses which are further sub-divided into 16 items. Table 1.3.6 shows the income and expenditures of the Waterworks for the year 1977 to 1980,

and its budget for 1981 of the Waterworks is not carried over to the following fiscal term but is incorporated into the surplus or deficit of the Provincial Government accounts.

3.6.5 Relationship with Consumers

The relationship of the Waterworks with the consumers is governed by the Provincial Tax Code and the Contract on Water Services which is made between the Provincial Government and each consumer.

3.6.6 Organization

The staff of the Waterworks is organized as shown in Fig. 1.3.3, and consists of the superintendent, and other 23 staff members who are grouped into three sections, i.e., "Maintenance & Operation Section", "Administrative Section" and "Credit Collection Section". The superintendent belongs to the Provincial Engineering Division and is also assigned to supervise the Telephone and Telegram System being operated by the Provincial Government.

3.6.7 Office Procedure

The description of the assignments to each staff member is given by the Provincial Governor, but the functional relationship among the staff members is not clear enough to show the definite chains of command. Delegation of authority and inter-section communication are being made at the discretion of each staff member in charge. The Waterworks has no written office procecures and no manuals for the maintenance and operation of water supply facilities.

3.6.8 Personnel Management

The Waterworks has no established system of recruitment, and no programs for personnel training. New-comers are usually trained by senior staff members on the job.

Table 1.3.6 Income and Expenditures

Ilocos Norte Metropolitan Waterworks System
(1977 - 1981)

Report of the Actual Collections and the Estimates of Income and the Actual and Estimates of Expenditures of the Ilocos Norte Waterwork System for the Calendar Years 1977-1980

	Year	Actual	Estimates
Income:			
	1977-	196,796.40	220,000.00
	1978-	209,881.30	220,000.00
	1979-	166,874.20	200,000.00
	1980-	245,790.30	200,000.00
Total - - - - - - - - - - -		819,342.20	840,000.00
Expenditures:			
	1977-		
Personal Service- -		88,994.82	147,098.07
Maintenance & Other Operating Expenses-		32,937.56	70,000.00
Total- - - - -		121,932.38	217,098.07
	1978		
Personal Service-		96,479.84	140,803.15
Maintenance & Other Operating Expenses-		60,946.41	70,000.00
Total- - - - - - -		157,426.25	210,803.15
	1979		
Personal Service-		79,698.23	143,267.15
Maintenance & Other Operating Expenses-		32,299.50	63,000.00
Capital Outlay-		1,249,952.26	2,500,121.16
Total- - - - - - -		1,361,950.09	2,711,388.31
	1980		
Personal Service-		95,222.02	172,824.31
Maintenance & Other Operating Expenses-		93,118.97	93,568.00
Capital Outlay-		908,133.04	1,265,168.90
Total- - - - -		1,096,474.03	1,531,561.21

CERTIFIED CORRECT:

PAULA A. PASTOR
Asst. Prov. Treasurer & OIC

Table 1.3.7 Budget of Ilocos Norte Metropolitan Waterworks for 1980

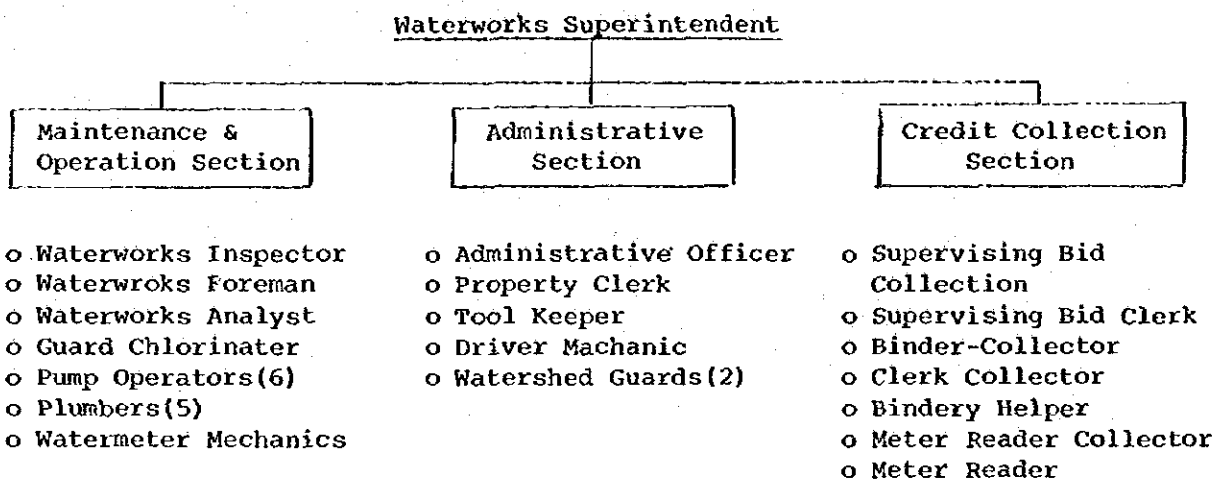
PROGRAM APPROPRIATIONS AND OBLIGATIONS BY OBJECTS

Program: Public Service — Province of Ilocos Norte
Office/Department I.N. Waterworks — Page 17

APPROPRIATION LANGUAGE

Object of Expenditures	Past Year 1979 (Actual)	Current Year 1980 (Estimate)	Budget Year 1981 (Estimate)
I. Current Operating Expenditures			
1. Personal Services			
Salaries		119,772.00	149,915.06
Life Insurance Premiums		3,887.52	4,887.45
Retirement Premiums		7,383.28	9,244.47
Medicare Premiums		2,370.00	2,370.00
State Insurance Premiums		2,133.73	1,499.13
Living Allowance		19,800.00	19,800.00
Total Personal Services	79,698.87	145,267.13	188,426.13
II. Maint. & Other Operating Expenses			
Travel Expenses		4,000.00	4,000.00
Communication Services		500.00	500.00
Repair & Maint. of Fact. & Bldg.		15,000.00	15,000.00
Other Services		8,000.00	8,000.00
Supplies and Materials		15,000.00	15,000.00
Gasoline & Oil		10,000.00	10,000.00
Illumination & Power Service		12,000.00	52,000.00
Repair of Equipments		500.00	1,500.00
	32,899.60	65,000.00	104,000.
II. Capital Outlays		15,000.00	-
Totals	111,697.53	225,267.13	292,426.13

Fig. 1.3.3 Organization Chart
of
Ilocos Norte Metropolitan Waterworks



PART TWO: MASTER PLAN

1. General
2. Target Year and Served Area
3. Projection of Population and Water Demand
4. Water Sources
5. Proposed Water Supply System
6. Cost Estimate
7. Implementation Schedule
8. Organization and Management

1. General

This Part discusses and proposes a water supply master plan for the Ilocos Norte Water District to be newly formed taking over the existing water supply system owned and operated by the Ilocos Norte Metropolitan Waterworks and, in addition, the water supply facilities at Vintar and Paoay which are not operational yet. The master plan will treat Level III systems as a mainstay of water supply in the District.

The master plan will project the needs for water supply over a long range future and present a water supply system to meet the growing water demand. For a short range future, in particular, full utilization of the existing deteriorated and not-yet-working facilities will be studied in detail, so as to obtain most cost-effective solutions for the water supply system to be constructed. Based thereon, the feasibility study, technical and financial, of a project necessary for the short term future water demand will be conducted in the following Part Three.

2. Target Year and Served Area

2.1 Target Year

(a) Phase I

Basically the purpose of this Phase project is to satisfy the present water requirement which has not been met in recent years due to deterioration of the water supply facilities, by rehabilitation, improvement and some additional works, within as short a period as possible.

Taking into account the work volume, financial constraints and the required time for foreign financing, six years time is considered optimal. As illustrated in Fig 2.7.1, the Phase I project will require at least five years from the commencement of the master planning and feasibility study until completion of the construction works, that is, the completion is in the end of 1986. Therefore, the target year, which is defined as the year when the designed supply capacity equals to the water demand, must be at least a few years ahead of 1986. And during the period between the completion of the work and the target year, preparation for the succeeding Phase II project must be made. As is known from the barchart in the figure, one year for this period is a most realistic solution, not making the construction cost of Phase I unbearably high. After all considered as above, the target year of Phase I is proposed as 1987.

(b) Phase II

Major purpose of this Phase project is to provide water for all consumers of the served area which is realized in the previous Phase and for additional population in the thereafter extended built-up area, and to upgrade the level of consumption in accordance with the improvement of the whole national living standard.

For this Phase, six years time is also considered appropriate from the same standpoint as Phase I. Therefore, the target year is proposed as 1993.

(c) Phase III

Long range planning of public facilities in the Philippines is currently being made with the year of 2010 as the target year. As water supply is one of the public utilities, the said year is employed as the target year of the present master planning.

2.2 Served Area

The Local Water District Law stipulates that a water district, when formed, covers all the municipal or city area, but on the other hand the Executive Order 577 (an order concerning formation of RWA's) allows that Level I and II systems be constructed and maintained in the area of the water district in consideration of economy and early realization of water supply services.

Served area, for which water supply is being planned by the present master plan is, in accordance with the intention of the above Law and Executive Order, delineated to confine such an area to the existing built-up area for the short term plan, and to the anticipated built-up area as the final served area for the long range plan.

General topography, natural barriers, and zoning plans are also concidered in determining served area limits by each phase. Based on technical, topographic, and socio-economic conciderations, the served area boundaries for different phases of program implementation are determined as follows, and shown in Fig 2.2.1 through Fig 2.2.5.

1. Present Served Area- the area presently served by existing system, 1,280 ha approximatly.
2. Phase I Served Area- the reinforcement and the extention of present served area, where minimum investment is required but maximum number of persons can be served to create a high impact/effectiveness on the consumers in the W.D. The Phase I served area is extended approximately by 1,421 ha totaling to 2,701 ha.
3. Phase II Served Area- further extension of served area into 4,906 ha, taking into account the extent of development within the design year of 1993 in the WD.
4. Master Plan Served Area- the total area within the WD jurisdiction where service can be provided technically and financially. In this study, the main objective is to

provide water service to the maximum number of persons within the area in the Master Plan period. The expanded served area is 10,531 ha in total in the year 2010.

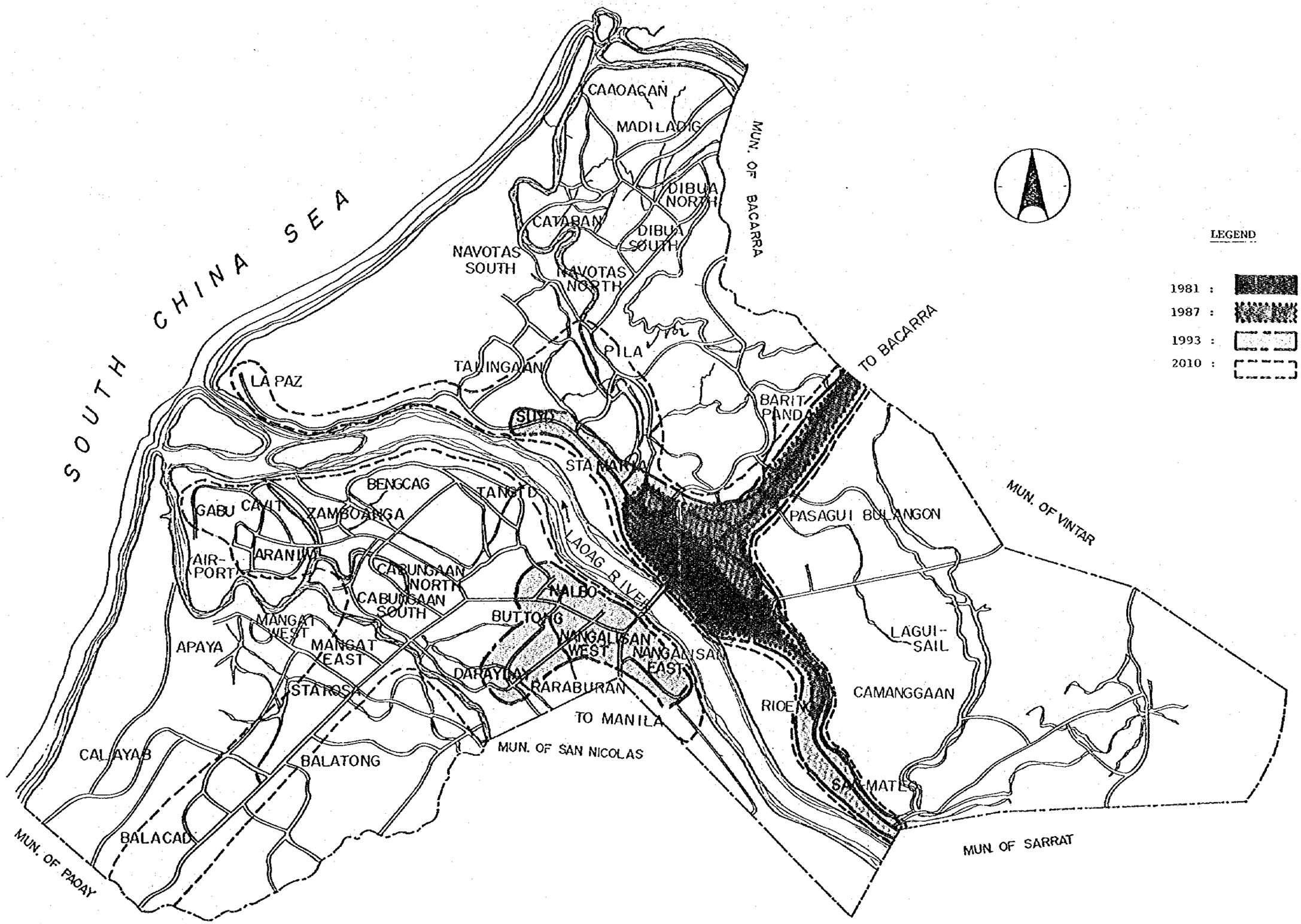


Fig 2.2.1 Served Area in Laoag

S = 1 : 50,000

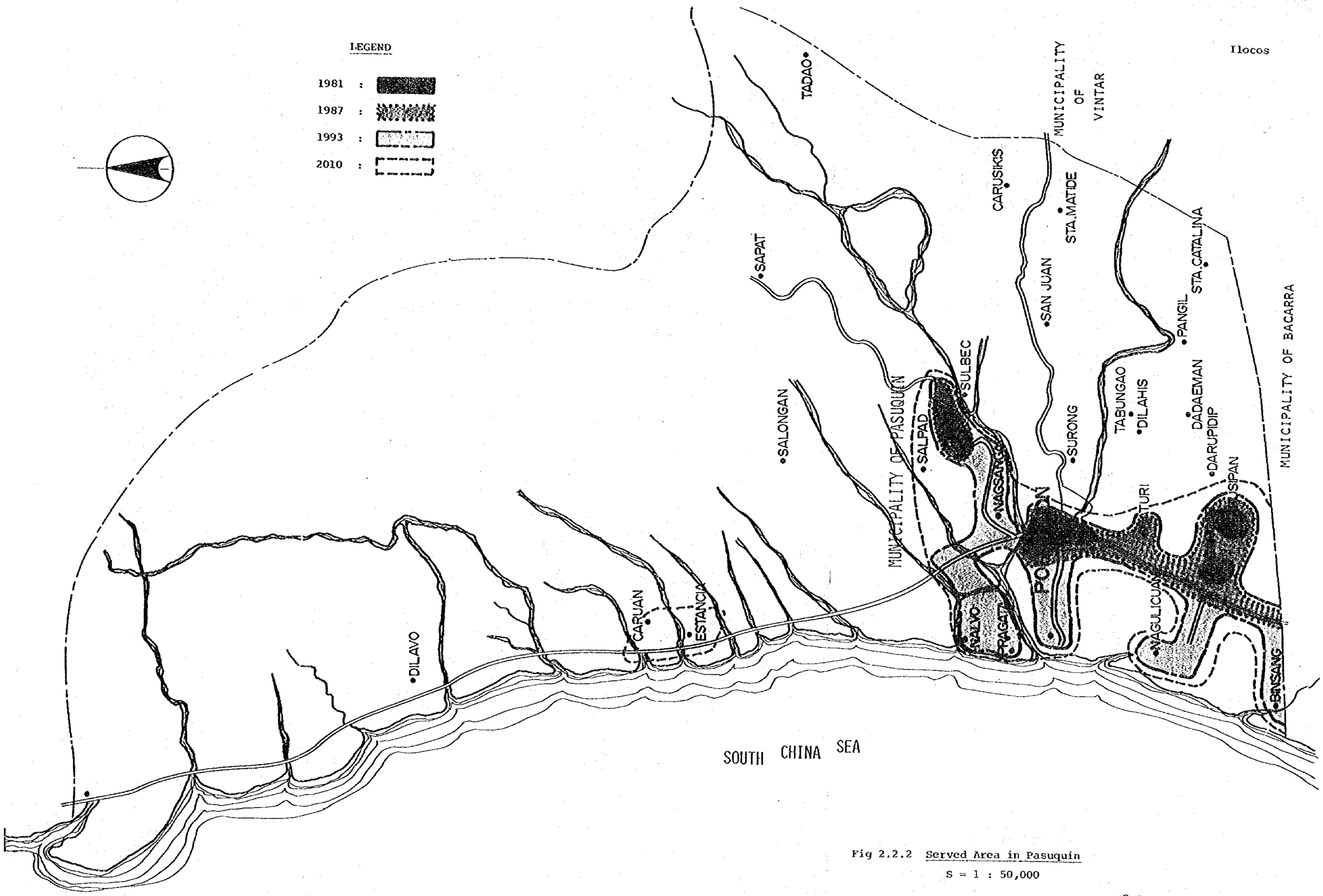


Fig 2.2.2 Served Area in Pasuquin

S = 1 : 50,000

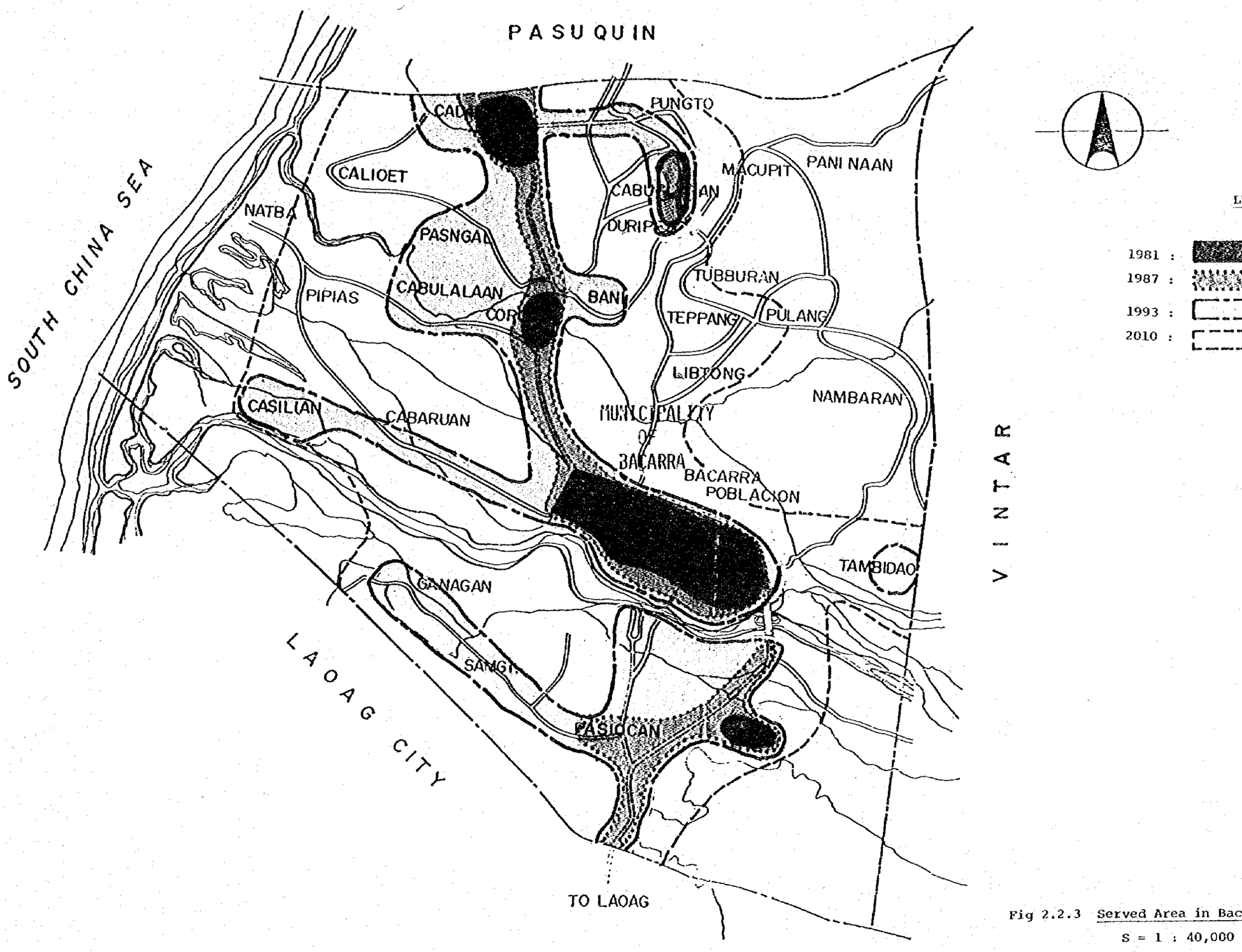


Fig 2.2.3 Served Area in Bacarra

S = 1 : 40,000

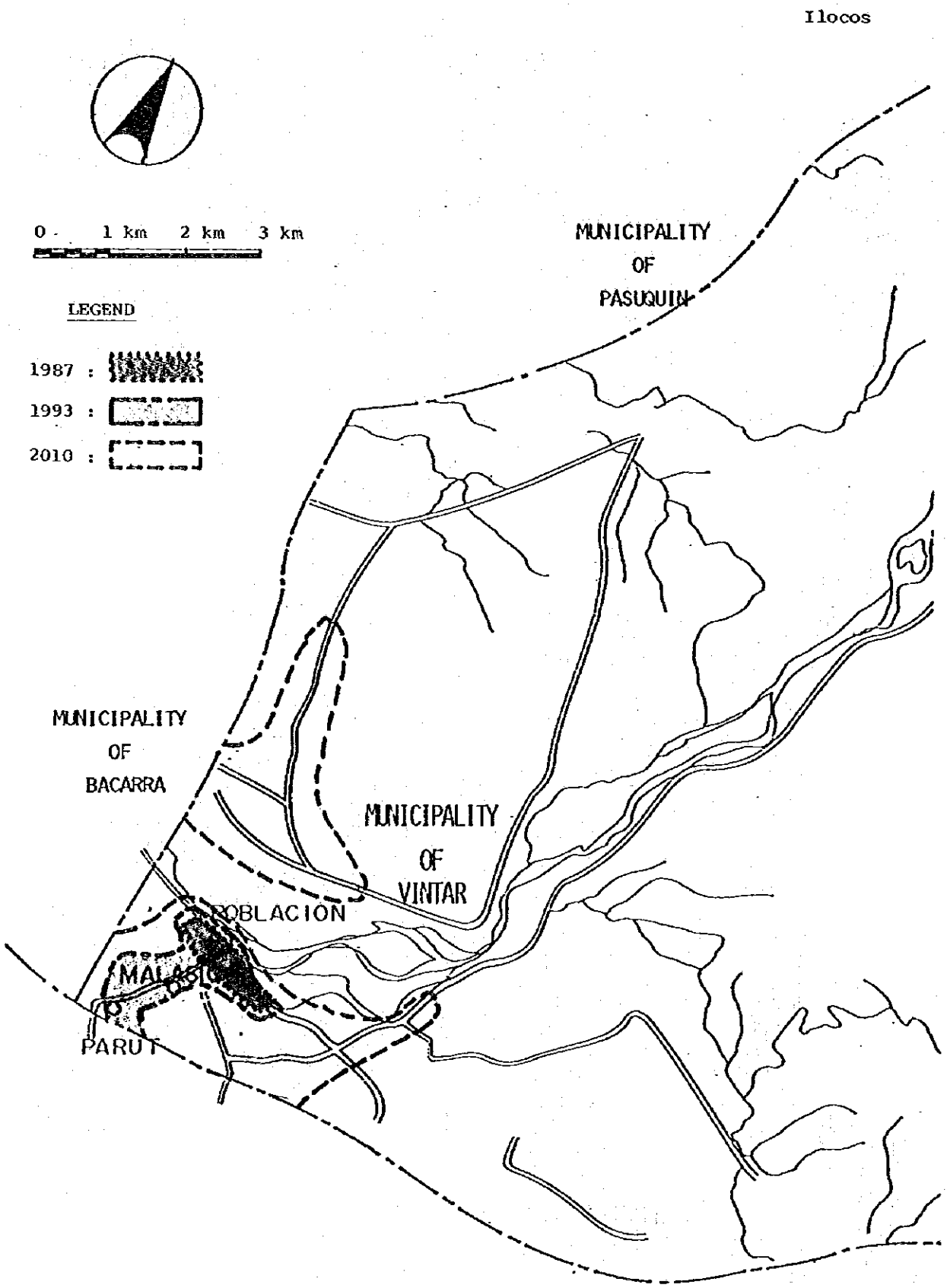


Fig 2.2.4 Served Area in Vintar

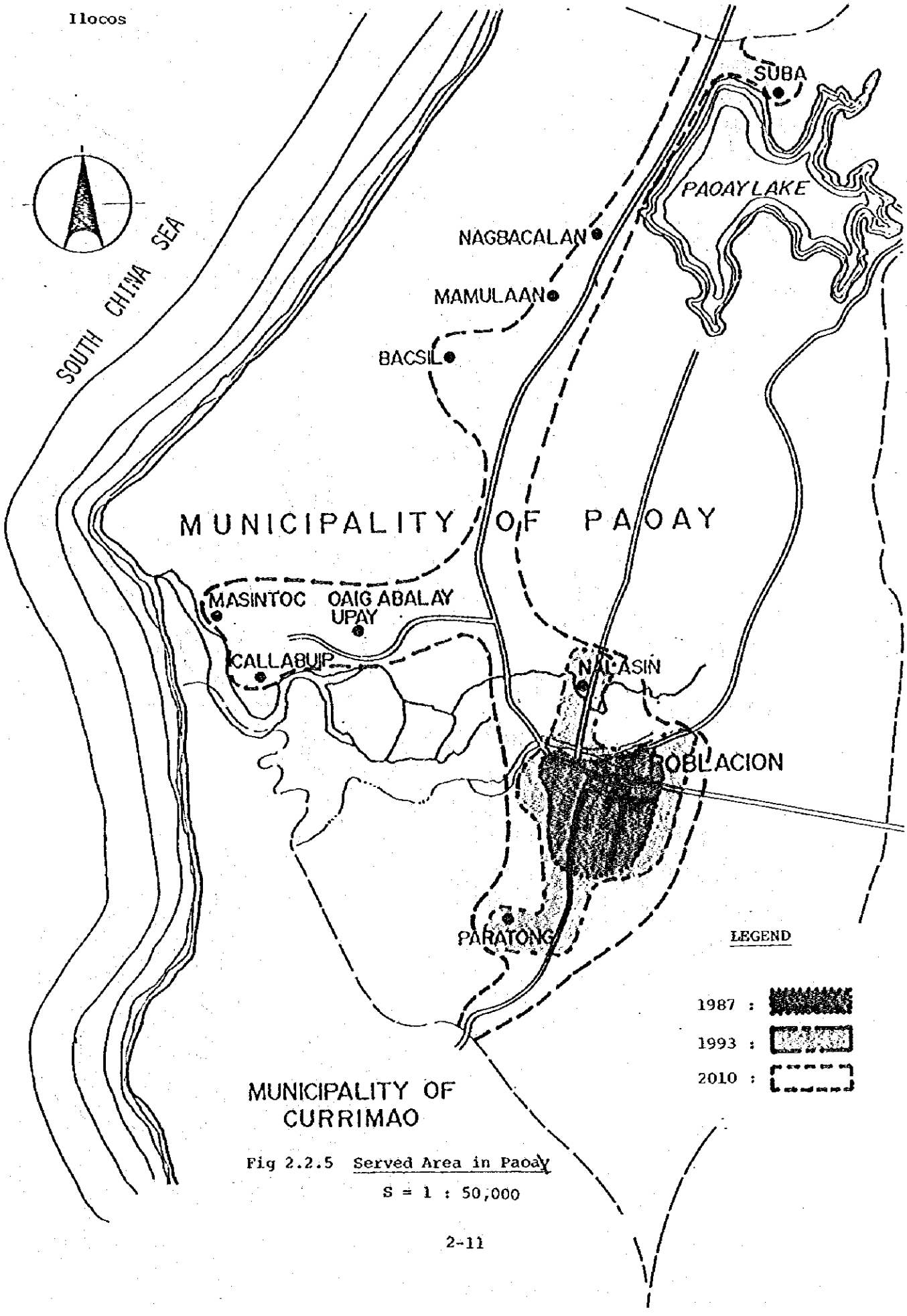


Fig 2.2.5 Served Area in Paoay

S = 1 : 50,000