

The Republic of the Philippines

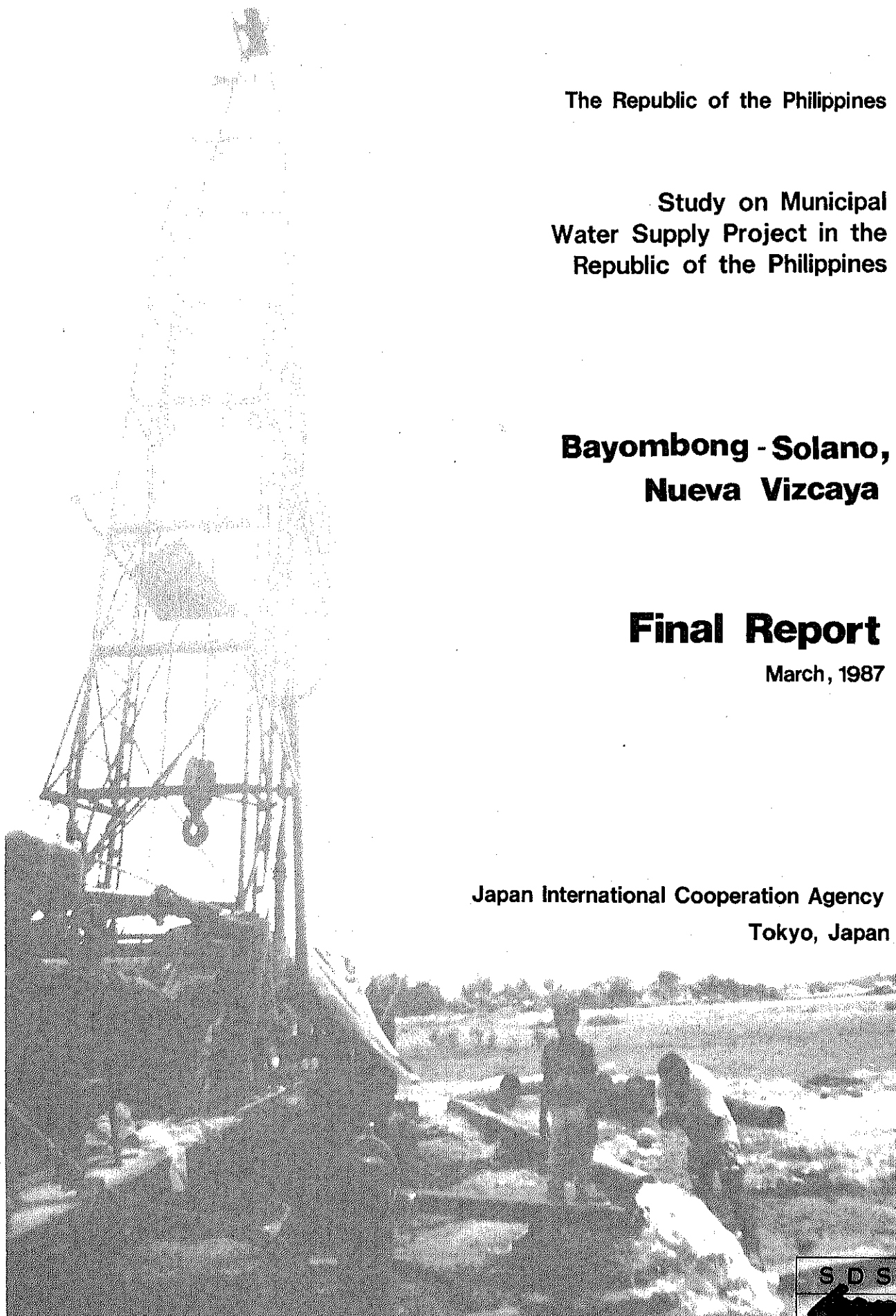
Study on Municipal
Water Supply Project in the
Republic of the Philippines

Bayombong - Solano,
Nueva Vizcaya

Final Report

March, 1987

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THE REPUBLIC OF THE PHILIPPINES

**STUDY
ON
MUNICIPAL WATER SUPPLY PROJECT
IN
THE REPUBLIC OF THE PHILIPPINES**

**BAYOMBONG-SOLANO,
NUEVA VIZCAYA**

FINAL REPORT

MARCH, 1987

**JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN**

国際協力事業団		
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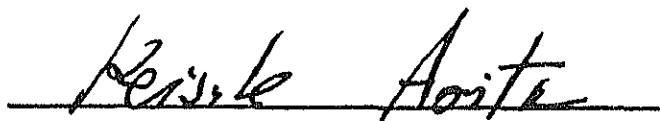
PREFACE

In response to the request of the Government of the Republic of the Philippines, the Japanese Government has decided to conduct a Master Plan and a Feasibility Study on Municipal Water Supply Project and entrusted the Study to the Japan International Cooperation Agency (JICA). JICA organized a study team headed by Mr. Toru Hayashi, Director, Nippon Jogesuido Sekkei Co., Ltd. to conduct the said study, from February 1986 to March 1987.

The team had discussions with the officials concerned of the Government of the Philippines and conducted a field survey in the Study Area and Metropolitan Manila. 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 Philippines for their close cooperation extended to the team.

March, 1987

A handwritten signature in dark ink, reading "Keisuke Arita", is written over a horizontal line.

Keisuke ARITA

President

Japan International Cooperation Agency

Dagupan City
Pangasinan Province

LUZON

Bayombong-Solano
Nueva Vizcaya Province



Angeles City
Pampanga Province

Cabuyao-Sta. Rosa-Biñan
Laguna Province

MANILA

PACIFIC OCEAN

MINDORO

SOUTH CHINA SEA

SAMAR

PANAY

NEGROS

CEBU

BOHOL

LEYTE

PALAWAN

MINDANAO

LWUA-JICA

STUDY ON MUNICIPAL WATER SUPPLY PROJECT

STUDY AREA

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LIST OF ACRONYMS AND ABBREVIATIONS

ACRONYMS

AC	-	Asbestos Cement
BPW	-	Bureau of Public Works (now MPWH)
Brgy.	-	Barangay
BSWS	-	Bayombong-Solano Waterworks System
BWP	-	Barangay Water Program
CI	-	Cast Iron
EIRR	-	Economic Internal Rate of Return
FIRR	-	Financial Internal Rate of Return
GI	-	Galvanized Iron
GIP	-	Galvanized Iron Pipe
GOJ	-	Government of Japan
GOP	-	Government of the Republic of the Philippines
HH	-	Household
I.D.	-	Inner Diameter
JICA	-	Japan International Cooperation Agency
LWUA	-	Local Water Utilities Administration
MERALCO	-	Manila Electric Company
MPWH	-	Ministry of Public Works and Highways
MSL	-	Mean Sea Level
MWSS	-	Metropolitan Waterworks and Sewerage System
NCSO	-	National Census and Statistics Office
NEDA	-	National Economic and Development Authority
NIA	-	National Irrigation Administration
NPC	-	National Power Corporation
NUVELCO	-	Nueva Vizcaya Electric Cooperative Incorporated
PE	-	Polyethylene
PLDT	-	Philippine Long Distance Telephone Company
Pob.	-	Poblacion
POPCOM	-	Population Commission
PT&T	-	Philippine Telegraph and Telephone Corporation
PVC	-	Polyvinyl Chloride
RCPI	-	Radio Communication of the Philippines, Incorporated
RWDC	-	Rural Waterworks Development Corporation

ABBREVIATIONS

Units

cm	-centimeter
cm/sec	-centimeter per second
cu.m	-cubic meter
cu.m/conn.day	-cubic meter per connection per day
cu.m/day	-cubic meter per day
cu.m/day/km	-cubic meter per day per kilometer
cu.m/day/m	-cubic meter per day per meter
cu.m/hr	-cubic meter per hour
cu.m/month	-cubic meter per month
cu.m/sec	-cubic meter per second
FTU	-formazin turbidity unit
ha	-hectare
HP	-horse power
hr	-hour
kg/day	-kilogram per day
kg/sq.cm	-kilogram per square centimeter
km	-kilometer
KVA	-kilo volt ampere
kw	-kilo watt
KWH	-kilo watt hour
l/day	-liter per day
l/min	-liter per minute
l/min/m	-liter per minute per meter
l/sec	-liter per second
lpcd	-liter per capita per day
lps	-liter per second
lps/m	-liter per second per meter
mbgs	-meter below ground surface
mD	-meter in Depth
mH	-meter in Height
micro-S/cm or micro-Siemens/cm	-micro Siemens per centimeter
mm/day	-millimeter per day
m/km	-meter per kilometer

ABBREVIATIONS (CONTINUED)

Units

mm	-millimeter
MM	-man month
m	-meter
m/sec	-meter per second
MWH	-mega watt hour
mm/year	-millimeter per year
ohm-m	-ohm meter
pc or pcs	-piece(s)
pc/ha	-piece per hectare
p/ha	-person per hectare
P/annum	-peso per annum
P/month	-peso per month
sq.cm/sec	-square centimeter per second
sq.km	-square kilometer
sq.m	-square meter
sq.m/day	-square meter per day

CHAPTER 1

SUMMARY AND RECOMMENDATION

CHAPTER 1 SUMMARY AND RECOMMENDATION

1.1 GENERAL

This Chapter presents a summary of the results and analyses of the field surveys conducted in Bayombong and Solano for the Project. The Short Term Development Plan and Long Term Development Plan with special emphasis on the water resources are also incorporated.

In the course of study, planning stages are considered as Phase I from 1986 to 1995 for the Short Term Development and Phase II from 1996 to 2010 for the Long Term Development period, respectively. The Phase I project period is further divided into two stages; Stage 1 from 1986 to 1990 and Stage 2 from 1991 to 1995, considering the practical implementation period for the required facilities.

With regard to the criteria and approach of technical and financial studies, the Methodology Manual being established and adopted by the Local Water Utilities Administration (hereinafter referred to as LWUA) was employed through the thorough review with data and information collected during the field surveys. Some deviations to the Methodology Manual, such as system pressure during the Phase I period, were made by cost considerations. Also adopted at the request of the LWUA was the terms and conditions for financial analysis of the Project. Those which referred to the Methodology Manual are contained in APPENDIX of this report.

The fundamentals used for planning and the study results are shown in TABLE 1.1.1

1.2 FINDINGS AND PROJECTIONS

1.2.1 Study Area

The study area covers two adjacent municipalities; Bayombong and Solano, which are 5 km apart. Bayombong, the capital town of the Province of Nueva Vizcaya, is about 265 km from Manila. Solano is considered the commercial center of the Province and has a higher population though a smaller land area than Bayombong.

TABLE 1.1.1 SUMMARY OF PROPOSED PROJECT (Bayombong-Solano)

Description	Present (1986)	Phase I		Phase II (2010)
		Stage 1 (1990)	Stage 2 (1995)	
A. Population				
1. Total Population	76,757	82,520	89,720	111,330
2. Pop. in Service Area	51,149	56,280	62,240	80,780
% of Total Pop.	67	68	69	73
3. Served Population	10,414	14,460	36,020	62,910
% of Pop. in Service Area	20	26	58	78
% of Total Pop.	14	18	40	57
B. Served Area (ha)	322	322	497	560
C. Water Demand (cu.m/day)				
1. Domestic (Daily Ave.)	1,326	1,590	4,320	8,500
2. Commercial (Daily Ave.)	17	210	600	2,140
3. Institutional (Daily Ave.)	75	50	100	240
4. Others (Daily Ave.)	153	-	-	-
5. Total Water Demand				
a) Daily Ave.	1,571	3,080	7,170	13,600
b) Daily Max.	-	4,000	8,970	17,000
c) Peak Hour	-	7,400	15,500	28,200
D. Number of Connection				
1. Domestic (Individual)	1,299	2,834	7,171	13,323
2. Domestic (Public Faucet)	7	-	-	-
3. Commercial	10	160	431	1,070
4. Institutional	29	9	19	32
5. Industrial	-	-	-	-
6. Total	1,345	3,003	7,621	14,425
E. Water Sources and Treatment				
1. Existing Facility	Spring	Expansion	-	-
(capacity: cu.m/day)	(4,770)	(6,100 in dry & 11,000cu.m/d in rainy season)		
2. New Facility	-	-	Radial well	Radial well
(capacity: cu.m/day)			(Max. 12,900)	(Max. 12,900)
F. Transmission Facility	ø200 4,300m	ø250 4,300m	-	-
G. Distribution Facility				
1. Reservoir (cu.m)	1,900	-	-	-
2. Main Pipeline	ø200 - ø300 11,650m	ø100 - ø400 8,710m	ø150 - ø600 7,310m	ø150 - ø350 2,750m
3. Internal Network	ø100 9,100m	ø75/ø100 20,350m	ø75/ø100 12,550m	ø75/ø100 7,550m
H. Number of Workers	11	43	49	58
I. Project Cost (Peso)				
1. Construction Cost				
a) Foreign Exchange	-	14,204,000	11,614,000	22,440,000
b) Local Currency	-	12,269,000	7,865,000	10,414,000
c) Total	-	26,473,000	19,479,000	32,854,000
2. O & M Cost (₱/annum)	159,616 ^{1/}	1,107,000	2,073,000	3,756,000
J. Ave. Family Income of Low Income Group (₱/month)	628	1,080	2,080	-
K. Water Rate(₱/cu.m; 0-10 cu.m)				
1. Domestic	5-10 ₱/month	5.0	8.5	-
2. Commercial	53 ₱/month	10.0	17.0	-
3. Institutional	-	5.0	8.5	-

^{1/} : 1984

Bayombong has an aggregate area of 16,165 ha and is composed of 25 barangays of which 9 are urban and the rest, rural. Solano, with a total land area of 9,077 ha, has 19 barangays of which 6 form the poblacion area. The terrain of both municipalities is characterized as plain and moderately rolling.

In terms of use, the lands are classified into residential, commercial, institutional, open spaces, parks and vacant lands. The built-up area in Bayombong is 541 ha or about 3.3% of the total municipal area. In Solano, about 240 ha or 2.6% of the total municipal area belongs to urban land use.

The population of Bayombong and Solano increased from 31,566 and 36,710 in 1980 to 36,290 and 40,470 in 1986, respectively.

The revenues and expenditures of the two Municipalities are derived from real property taxes, business taxes, licence fees and receipts. In 1985, Bayombong and Solano had their respective revenues amounting to ₱1,785,660 and ₱2,963,108 and expenditures of ₱1,721,617 and ₱2,845,082.

The commercial and industrial activities in the two municipalities are primarily engaged in retail and small scale home industries.

The means of transportation in the area are jeepneys, buses and tricycles. Telecommunication services are rendered by the RCPI, PT&T, Phil-Phone and the Bureau of Telecommunications.

The power supply for Bayombong and Solano is being provided by the Nueva Vizcaya Electric Cooperative Incorporated (hereinafter referred to as NUVELCO).

1.2.2 Existing Water Supply and Sanitation Conditions

The Nueva Vizcaya Provincial Waterworks, otherwise known as the Bayombong-Solano Waterworks System, was established in 1947 to supply drinking water in the poblacion area of Bayombong and Solano Municipalities. The present Bayombong-Solano Waterworks System (hereinafter referred to as BSWS) has been formed in 1960. The served population at present is

about 5,840 in Bayombong and about 4,580 in Solano. The population coverage is about 21% in Bayombong and about 20% in Solano.

Aside from the above-mentioned Level III system, there only exist Level I systems in both municipalities. Shallow wells are dominant due to hydrogeological conditions in the subject area. It is reported that there are 21 public wells (2 deep and 19 shallow wells) in Bayombong and 28 (9 deep and 19 shallow wells) in Solano, in addition to a number of privately-owned shallow wells in the subject area. Owing to the small coverage of the BSWS, most of the population, even within the poblacion area depend on such wells.

The water source of the BSWS is the Borobob Spring at an elevation of 403 m. The spring yield measured during the field survey showed a seasonal fluctuation from about 11,000 cu.m/day in April to about 6,100 cu.m/day in July. The present intake amount for water supply is constant through the year at about 4,770 cu.m/day. The excess amount of spring discharge overflows and leaks from the spring box to the nearby stream. This excess amount of spring discharge and stream flow are utilized for irrigation purposes. The spring water is conveyed to a reservoir via a $\phi 200$ mm pipeline for a distance of about 4,300 m. This conveyance main is mostly laid on the ground along the river bed from the spring down to the mountain foot.

An open concrete reservoir with a capacity of 1,900 cu.m sits on the summit of small mountain with an elevation of 322 m. The water supply to the two municipalities is controlled by means of gate valve operation at the reservoir outlet for a 17 hours a day (from 4:00 A.M. to 9:00 P.M.) service. In other words, the water from the spring is being stored in the reservoir during night time and transmitted to the service area the following morning to meet the peak-hour demand. This has been practiced for more than 10 years by the Provincial Waterworks Office due to insufficient intake amount from the spring.

Two transmission lines are connecting the reservoir to the two municipalities: one from the reservoir to Bayombong by $\phi 300$ mm for 1,200 m length; the other from Bayombong to Solano by a $\phi 250$ mm for 6,000 m length.

The distribution lines in Bayombong has a total length of 6,200 m with diameters of ϕ 100 mm and ϕ 200 mm, while in Solano, there are 7,400 m of ϕ 100 mm and ϕ 200 mm pipelines.

A total of 1,345 service connections (797 in Bayombong and 548 in Solano) are supplied by the existing waterworks system. No water meter exists throughout the service area and water charges are therefore all at flat rate. The present water consumption is estimated at 1,570 cu.m/day which is equivalent to about 40% of the total distributed amount. The unaccounted-for water is thus considered to be about 60%.

As to the operation and maintenance, only two out of a total of 9 personnel of the Provincial Waterworks Office are assigned to this task. Due to lack of budget as a result of cheap water rate (P10.0/month/domestic connection), the said Office does not have the appropriate equipment, tools and spare parts for inspection and repair. Major operation and maintenance activities are valve operations for distribution, cleaning of reservoir, minor repair and inspection of service pipes and connections.

With regard to drainage and sewage disposal, there is no systematic facilities. Sanitary sewage is disposed at privately-owned septic tanks or pit privies. The surface run-off flows into the nearby channels and into the Magat River.

The collection of garbage and street cleaning are performed by each Municipality and the collected garbage is dumped at the municipal dumping sites near the Magat River.

1.2.3 Population and Water Demand Projection

(1) Population Projection

The population projection was made using the breakdown method. The provincial population was projected and compared with the National Economic and Development Authority (hereinafter referred to as NEDA) projections. The projected provincial population was then broken down into Municipalities using the "sharing method." These projections were further broken down into urban and rural barangays of each Municipality using the same method.

The 1980 municipal population of 31,566 in Bayombong and 36,710 in Solano are predicted to increase to 53,530 and 57,800 in 2010, respectively. TABLE 1.1.1 shows the projected population by design years.

(2) Population and Area to be Served

The potential service area to be covered by the water supply system in the future was established considering the existing water supply system, future development, result of market survey and special conditions in the locality.

The service area for the long and short term development is identified to cover a total of 15 barangays of two municipalities with a size of 560 ha in 2010 and 497 ha in 1995, respectively.

The served population percentage by barangay for the years 1995 and 2010 are recommended to be 60% and 80%, respectively. The served populations for the target years are 36,020 (19,150 in Bayombong and 16,870 in Solano) in 1995 and 62,910 (33,330 and 29,580, respectively) in 2010.

(3) Water Demand Projection

The future water consumption in the proposed service area was projected for the years 1986, 1990, 1995 and 2010.

The unit water consumption for each design year was estimated by type of water consumer based on the analysis of the present water consumption. The increase rate for future figures are based on the LWUA Methodology Manual. The unit water consumption employed for projection purposes is given below:

Consumer Type	Design Year			
	1986	1990	1995	2010
Domestic (lpcd)	100	110	120	135
Commercial (cu.m/conn.day)	1.1	1.3	1.4	2.0
Institutional (cu.m/conn.day)	3.8	4.5	5.2	7.5

The total water consumption on the daily average basis is summarized below for each design year:

Item	Design Year		
	1990	1995	2010
No. of connections	3,003	7,621	14,425
Water consumption (cu.m/day)	1,840	5,020	10,880

The percentages of unaccounted-for water were assumed to be 40%, 30%, and 20% in 1990, 1995, and 2010, respectively based on the present figure obtained from the field investigation. The demand variations by design years are calculated based on the LWUA Methodology Manual and are summarized below:

Water Demand (cu.m/day)	1990	1995	2010
Daily Average	3,080	7,170	13,600
Daily Maximum	4,000	8,970	17,000
Peak Hour	7,400	15,500	28,200

1.2.4 Water Resources

The potential water sources were identified and evaluated based on the results of field investigations and the water demand projections for the long and short term developments of the water supply system. Among others, the maximum utilization of the existing Borobbob Spring in a cost-effective manner was studied in the course of the water source evaluation.

Hydrological constraints of the study area limited a choice of potential water sources for water supply purpose in relation to the necessary amount to be developed. The utilization of the Magat River in the form of river bed water was suggested for additional water source. The hydraulic characteristics of the river bed at the proposed construction site of water source facility were further evaluated and considered to be favorable to the required intake amount. The method of water intake was recommended to be radial well through technical and cost comparison with infiltration gallery.

As a whole, the existing Borobbob Spring shall be fully utilized in principle at about 11,000 cu.m/day or more particularly in the rainy season. The presumable minimum discharge through the year is 6,100 cu.m/day. The water demand in excess of the spring discharge shall be obtained from the Magat River at about 11,000 cu.m/day in the year 2010.

1.2.5 Analysis and Evaluation of Alternative

The evaluation of alternative takes into account the recommended water sources, water demand, locations and other conditions. The water supply system may be determined based on the source capacity and its location.

The improvement and expansion of the existing intake box at the Borobbob Spring is firstly recommended for the maximum utilization of existing water sources in a cost-effective manner. However, the total discharge of the Borobbob Spring fluctuates by season through the year. The utilization of the river bed water at the Magat River by means of radial well is recommended to cope with the said seasonal fluctuation and to augment the total water production of the water supply system.

The alternative water supply systems covering the two municipalities were studied using the result of the study made on water source alternatives. Recommendations on each system are based on the recommended water sources.

Economic cost comparison on distribution alternatives was made considering a 12% per annum of the discount rate as instructed in the LWUA Methodology Manual.

1.2.6. Recommended Plan

(1) Scope of Recommend Project

The short term development plan was studied with the selected long term development plan. The bases for planning the major facilities through the Phase II is as follows:

Source:

- Phase I - Improvement and expansion of the Borobob Spring and construction of a radial well at the Magat River.
- Phase II - Construction of additional radial well.

Treatment:

- Phase I - Replacement of existing chlorine dispensing box with a constant flow chlorinator at the existing reservoir and provision of the same chlorinator at the transmission line from the radial well.

Transmission:

- Phase I - Installation of additional line from the spring to the existing reservoir and new line from the radial well to Bayombong town proper.

Distribution:

- Phase I - Extension of main line from the existing reservoir to Masoc/La Torre area and to Bonfal area via Bayombong town proper.
- Phase II - Extension of main line from Bonfal area to Solano town proper.

Electricity:

- Phase II - Power substation with a capacity of 150 KVA for pumping facilities at the Magat River.

(2) Project Cost

The cost of construction, operation and maintenance by phase is estimated in accordance with the implementation plan. The following is the summary of the cost in thousand pesos as of 1986 price level:

Construction Cost

Phase I	Stage 1	:	26,473
	Stage 2	:	19,479
Phase II		:	32,854

Operation and Maintenance Cost (Per Annum)

Phase I	Stage 1	:	1,107
	Stage 2	:	2,073
Phase II		:	3,756

1.3 FINANCIAL ASPECTS

1.3.1 Financial Feasibility

The financial feasibility of the project was analyzed using the LWUA's guideline.

The balance sheet (revenue vs. expenditure) shows substantial deficits in 1984 and 1986 when the repayment to the national government's loan was not even made because of high operation and maintenance expenses. The water charge is the major source of the revenue for the water supply system. A flat rate is presently charged since the system is unmetered. The charge ranges from ₱5.00 to ₱10.0 per month for domestic use.

The market survey results show that the majority of the respondents are willing to connect to the municipal water supply system.

The capital cost of the project is estimated to be ₱86.06 million taking into account a 15% per annum of the escalation rate as instructed in the LWUA Methodology Manual; 50% is presumed to be financed from the LWUA's regular loan, 45% from the LWUA's soft loan and remaining 5% is the water district's equity participation. The future water tariff structure was developed with assumptions as shown below.

- (1) The minimum charge for the first 10 cu.m/month consumption must not exceed 5% of the monthly average family income of the low income group, and

- (2) The increase of the minimum charge is limited not to be more than 60% of that in the previous year's rate.

WATER TARIFF IN THE FUTURE

<u>Period</u>	<u>Rate/ Unit</u>	<u>Consumption (cu.m)</u>			
		<u>First 10</u>	<u>11-20</u>	<u>21-35</u>	<u>Above 35</u>
1988	₱1.0	₱25.0	₱ 3.3	₱ 4.5	₱ 6.0
1989	1.5	37.5	4.9	6.8	9.0
1990	2.0	50.0	6.5	9.0	12.0
1991	2.4	60.0	7.8	10.8	14.4
1992	2.6	65.0	8.5	11.7	15.6
1993	3.2	80.0	10.4	14.4	19.2
1994	3.4	85.0	11.1	15.3	20.4
1995	3.4	85.0	11.1	15.3	20.4
1996	4.2	105.0	13.7	18.9	25.2
1997	4.8	120.0	15.6	21.6	28.8

Although the increases of the water rate will be inevitable due to the low rates at present, the estimated Financial Internal Rate of Return (hereinafter referred to as FIRR) is 13.5%. The recommended project for the Short Term Development Plan then is seen to be financially feasible.

1.3.2 Economic Feasibility

The proposed water supply improvement is expected to bring social and economic benefits to the municipality as a whole.

The economic analyses presented in CHAPTER 10 evaluate the effectiveness of the project in terms of socio-economic factors. The method adopted to give a measure of effectiveness is the Economic Internal Rate of Return (hereinafter referred to as EIRR). The benefit considered is the economic value of water. Results of the findings show that the EIRR is 4.3%.

1.4 ORGANIZATION AND MANAGEMENT

1.4.1 Existing Management System

The main root of problems regarding organization is institutional weakness. It is the shortcoming of human resources that gives rise to inadequate physical system and deficient water service.

For the BSWS, good management and organization are wanting. On the area of personnel management, there is a lack of a consistent policy on hiring, personnel performance evaluation, reward system or promotion, personnel/functional schedules, commercial and technical operations system as well as the facilities.

1.4.2 Proposed Organization Structure

It is recommended that the BSWS be formed into a water district. From the experience of 13 years, the water district concept has been proven to be the best organization structure instrumental to manage water utility operations.

Using the LWUA Methodology Manual, the number of personnel needed for the BSWS is 72 for the year 1975 and 175 for the year 2010.

Although the formula presented in the LWUA Methodology Manual is based on statistical data, no evaluation has been made whether the figures derived from the formula are appropriate or not.

The Japan International Cooperation Agency (hereinafter referred to as JICA) Study Team is proposing a new staffing guideline regarding the number of personnel based on the appropriate performance of individual work. This is intended to help management carry policy into effect efficiently within the limits assigned in order to attain maximum performance at minimum cost. In other words, all resources, particularly human resources, should be optimally utilized to realize the objectives of the water district.

Based on this guideline the number of personnel needed to man the Bayombong-Solano Water District, when formed, is 49 for 1995 and 58 for 2010.

Organization-wise, the JICA Study Team also proposes to divide the water district organization into two main branches or divisions: the administrative and commercial division and the engineering and technical division.

1.4.3 Other Recommendations

It is believed that the promotion of the water district concept should be more aggressively undertaken by the LWUA. Many municipalities are interested in forming its water system into a water district only if the LWUA's package of assistance is explained to them. Therefore, the LWUA should address itself to effective public relations to promote water district formation through grass-roots and media based information campaigns. The LWUA's assistance in all aspects of water district operations, that is, technical, financial, institutional, training and public information, will greatly enhance the water system's capability to provide adequate and efficient water service to its consuming public.

Another recommendation is in the area of water resources. Some areas in the Philippines have difficulties in finding adequate water sources, quality or quantity-wise. In the near future, it may be necessary to amend further the Presidential Decree No. 198 (hereinafter referred to as PD 198) to enable the LWUA to implement without much difficulty the "bulk water supply" concept. For areas close to Metro Manila, a "mutual interdependence" between the Metropolitan Waterworks and Sewerage System and a water district having difficulties in water-resource may be made to solve such problems.

It also may be worth noting for the effective management of two or more water districts that PD 198 provides for a "consolidation and joint operation" of these districts. It is believed that a merger or consolidation of the facilities or operations of two or more water districts can lower the cost of operating the system. This will lead to lowering the water rates charged to the consumers. If not, then subsidy may be granted

to water districts whose construction costs may be too high for such districts can afford.

Subsidy is recommended especially if the resulting water rates would be impractically high. For example, a guideline to subsidize for the development of water resources that would double the quantity of the existing water source or for systems where the raw conduit or transmission pipeline length exceeds 20 km would be instructive.

1.5 CONCLUSIONS

The Short Term and Long Term Development Plans were established to improve and expand the existing municipal water supply system as presented herein. The proposed project, in line with the Short Term Plan was verified to be technically and financially feasible. This project should be urgently implemented, however serious consideration must be given to the following matters for its effective implementation.

Spring water should be utilized as much as possible because it will reduce the electric charge as compared when river water is used.

Full metering of the system should be given a priority to increase revenue and encourage the conservation of water. The cooperation of the residents is needed especially in the installation of individual house connections. The water district may attract residents to be willing to connect to the system by making it easier for them to connect by giving financial assistance at low interest or by giving discounts.

In relation to the full metering program, the leakage detection survey on all the existing service connections shall be carried out simultaneously. Through these activities, it is believed that the BSWS will eventually regain the reasonable level of the unaccounted-for water.

The preventive maintenance program, especially periodical check up of water meters, is also prerequisite for sound operation of the BSWS.

CHAPTER 2

GENERAL BACKGROUND

CHAPTER 2 GENERAL BACKGROUND

2.1 AUTHORIZATION

In response to the request of the Government of the Republic of the Philippines (hereinafter referred to as GOP), the Government of Japan (hereinafter referred to as GOJ) decided on the conduct of a study on the Municipal Water Supply Project in the Philippines.

The JICA is the official agency responsible for the implementation of the technical cooperation programs of the GOJ and the LWUA is the official agency responsible for the municipal water supply in the GOP. Both agreed on an Implementing Arrangement for Technical Cooperation for the Study on 23 October 1985. The Study was started in mid February 1986 and was completed on March 1987.

2.2 BACKGROUND OF THE PROJECT

Many of the water supply facilities of the local cities and municipalities in the Philippines do not meet the needs of the people due to rapid increase of population and deterioration of such facilities.

The LWUA is responsible to promote countryside waterworks development in cities and municipalities with a population of 20,000 or more except the Metropolitan Manila area. Its aim is to improve public health and sanitation, and raise the standard of living.

This study is made on four areas of local cities and municipalities, among which are the Bayombong and Solano Municipalities in Nueva Vizcaya Province. Despite the large scope of the municipalities, the conditions of the water supply therein are extremely unsatisfactory. The GOP, therefore, with high priorities requested the GOJ to cooperate in conducting a study on the improvement and development of the water supply systems for the municipalities.

2.3 OBJECTIVE AND SCOPE OF WORK

The basic objective of this study is to assist the implementing agency (LWUA) in the preparation of the Long Term Development Plan and the Short Term Development Plan for the water supply project for Bayombong and Solano Municipalities in Nueva Vizcaya.

The Scope of Work includes the following major elements:

A. General

1. Review and evaluate all the data and previous studies directly relevant to the Study and conduct field investigations.
2. Conduct analysis mainly on general background, study area, existing system facilities, population, water demand projection and water resources.
3. Examine and evaluate scheme to seek the most favorable plan for feasibility analysis.

B. Specific

1. Data collection, review and field investigations. Collect and review the existing data and information including those on topography, hydrogeology, meteorology, population, existing land use and municipal development planning, socio-economy, water supply statistics and existing water supply facilities.
2. Conduct the following field investigations;
 - field reconnaissance and demand survey,
 - discharge rate measurement of existing spring,
 - existing system hydraulic survey,
 - present unaccounted-for-water survey, and
 - water quality survey.
3. Preparation of Long Term Development Plan (up to the year 2010)
4. Preparation of Short Term Development Plan
5. Financial and Economic Study
6. Organizational and Managerial Study

CHAPTER 3

DESCRIPTION OF THE STUDY AREA

CHAPTER 3 DESCRIPTION OF THE STUDY AREA

3.1 GEOGRAPHIC LOCATION

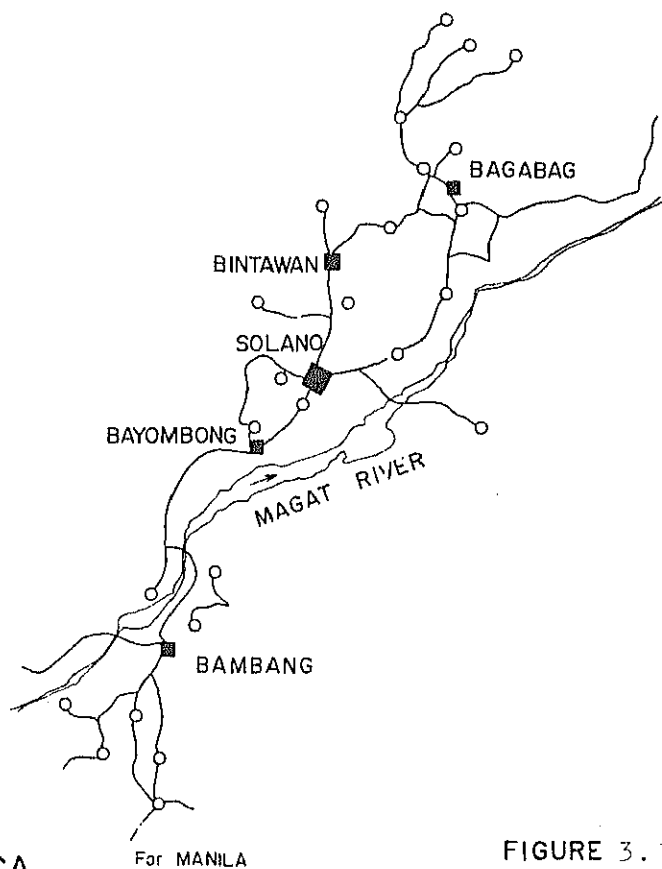
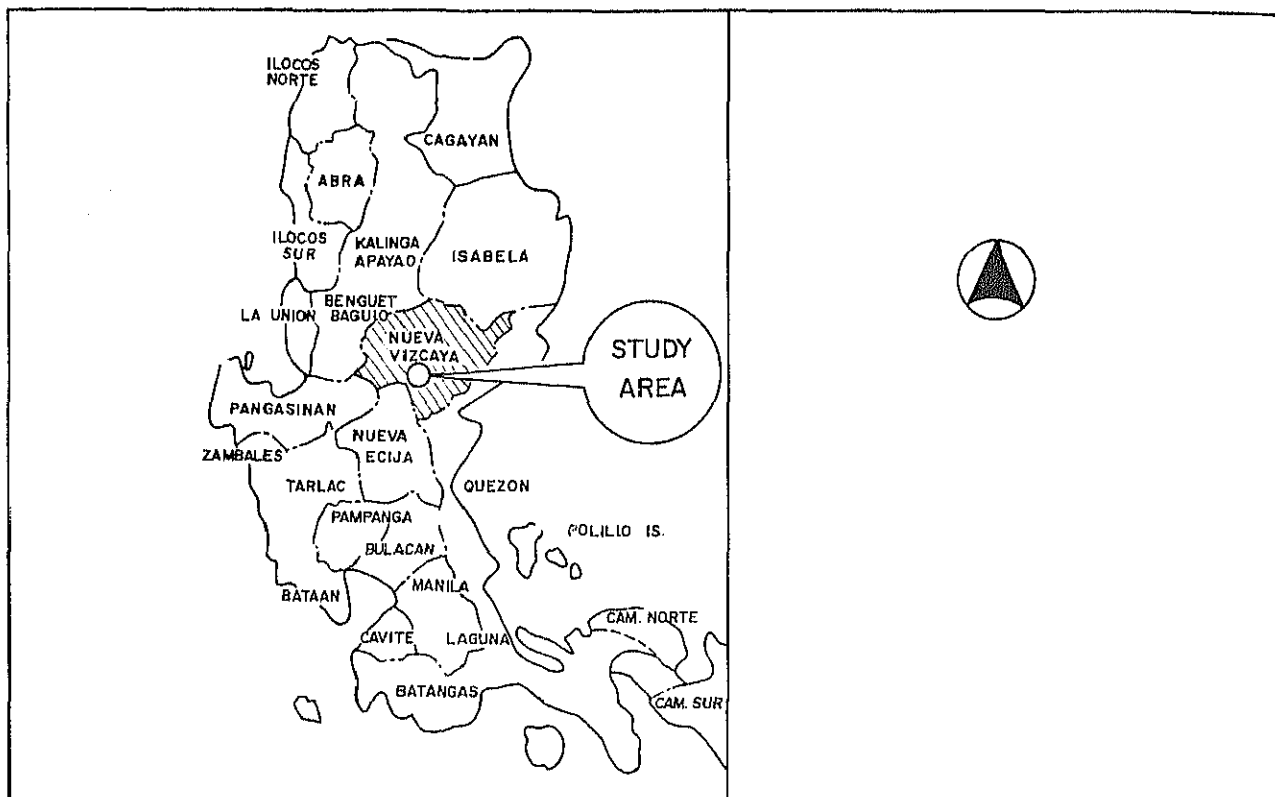
Bayombong, the provincial capital and its neighboring municipality, Solano are located in the central portion of the Province of Nueva Vizcaya. Bayombong is bounded on the north by the Municipalities of Solano and Villaverde, on the south by the Municipality of Bambang, on the west by the Municipality of Ambaguio and on the east, by the Municipality of Quezon and the Sierra Madre Mountains. As for Solano; on the east are the towns of Quezon and Diadi, and on the north are the Municipalities of Bagabag and Villaverde. Bayombong is approximately 265 km from Manila and Solano is 5 km north of Bayombong. Geographically, the study area is located at coordinates $16^{\circ}2'$ latitude and $121^{\circ}6'$ longitude.

FIGURE 3.1.1 presents the geographic location of the study area.

3.2 PHYSICAL FEATURES

The terrain in some parts of Bayombong can be described as rolling area. This characteristic is found on the northwestern portion of the Caraballo Mountain and on the outskirts of the Poblacion, the Vista Hill, the Dynamite Hill and the Bangan Hill. The Magat River, which bisects the Municipality, causes serious problems each year, such as flooding and erosion.

There are several bodies of water within the Municipality of Solano. One is the Magat River, which flows from south to north and is located in the eastern sector. The Lanog River traverses the western part of the Municipality. The Bauan River passes through the town proper and joins the Lanog River downstream. The Polloc Lake is the proposed demonstration fish farm and hatchery of the Bureau of Fishery.



LWUA-JICA

STUDY ON MUNICIPAL WATER SUPPLY PROJECT

FIGURE 3.1.1
LOCATION MAP

BAYOMBONG-SOLANO, NUEVA VIZCAYA

3.3 ADMINISTRATIVE COMPOSITION AND LAND USE

(1) Bayombong

Bayombong is where the government offices and other institutions are located. The progress of the town is fast, due to the presence of provincial offices and schools within the Municipality.

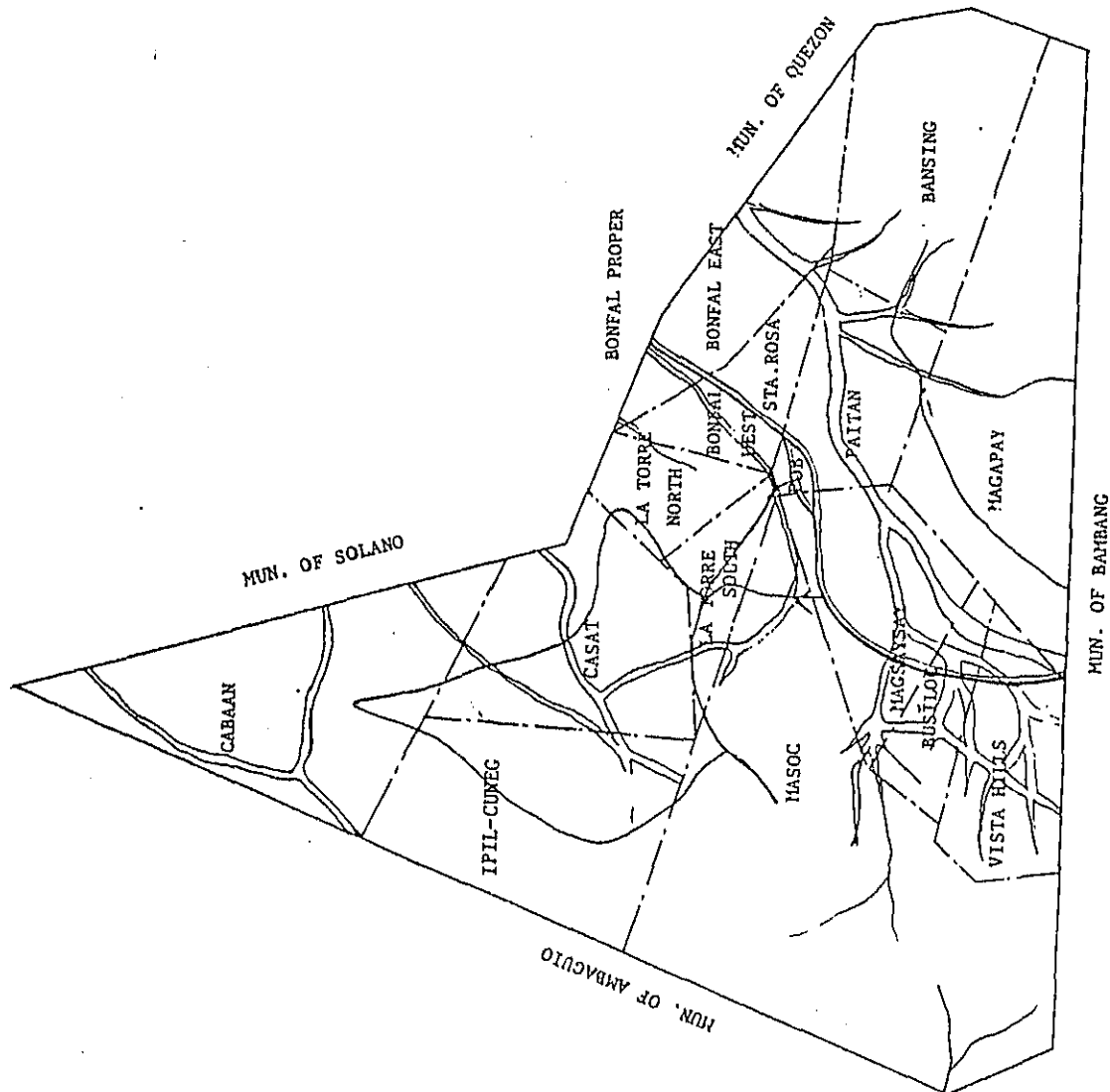
The Municipality covers 25 barangays, composed of 9 urban and 16 rural barangays. Urban barangays include District No. 1, District No. 2, District No. 3, District No. 4, Banca-Baringin, Luyang, Mariano Marcos, Salvacion and St. Nicholas. The rural barangays include Barsing, Bonfal East, Bonfal Proper, Bonfal West, Busilac, Casat, La Torre North, La Torre South, Magapuy, Magsaysay, Masoc, Paitan, Vista Hill, Ipil-Cuneg, Cabaan and Sta. Rosa. See FIGURE 3.3.1 for the barangay map.

The town has a total area of 16,165 ha with different land uses that are developed in response to population and economic growth. Built-up areas follow a circumferential pattern of development. A sprawling site of residential, commercial and other uses is generally located within an area of 940.5 ha. The Poblacion, being the nucleus of the Municipality, is where the major needs of the people are served.

TABLE 3.3.1 shows present land use in Bayombong and Solano. The land use in poblacion is also shown in TABLE 3.3.2.

TABLE 3.3.1 GENERAL LAND USE, BAYOMBONG AND SOLANO

Land Use Classification	Bayombong		Solano	
	Area (ha)	% To Total Area	Area (ha)	% To Total Area
Urbanized	880.70	5.45	2,110.00	23.25
Forest	6,105.31	37.77	980.00	10.80
Agricultural	5,303.60	32.81	4,475.00	49.30
Open Grass land	3,232.08	19.99	1,142.00	12.58
Roads	70.78	0.44	240.00	2.64
Rivers & Creeks	572.53	3.54	130.00	1.43
T O T A L	16,165.00	100.00	9,077.00	100.00



LEGEND :

ROAD

CREEK

MUNICIPAL BOUNDARY

BARANGAY BOUNDARY

FIGURE 3.3.1
MUNICIPALITY OF BAYOMBONG

LWUA - JICA
STUDY ON MUNICIPAL WATER SUPPLY PROJECT

TABLE 3.3.2 URBAN LAND USE, BAYOMBONG AND SOLANO

Land Use Classification	Bayombong		Solano	
	Area (ha)	% To Total Area	Area (ha)	% To Total Area
Residential	54.34	10.04	127.05	52.99
Commercial	7.47	1.38	15.82	6.60
Institutional	28.91	5.34	8.58	3.58
Industrial	0.11	0.02	2.79	1.16
Agricultural	240.99	44.52	-	-
Utilities	4.80	0.89	-	-
Roads	37.79	6.98	57.98	24.18
Vacant Lot	16.74	3.09	17.20	7.17
Parks and Open Spaces	145.94	26.96	6.63	2.77
Rivers and Creeks	4.21	0.78	3.72	1.55
T O T A L	541.30	100.00	239.77	100.00

Source: Comprehensive Development Plan, 1985 - 1989, Bayombong and Solano

(2) Solano

Solano is composed of 19 barangays, namely; Quezon, Osmena, Roxas, Quirino, Poblacion North, Poblacion South, Aggub, Bangar, Bangaan, Bascaran, Curifang, Lactawan, Dadap, San Juan, San Luis, Tucal, Uddiawan, Wacal, and Concepcion. Poblacion North and South are in the center of the Municipality surrounded by the 4 barangays, namely; Quirino, Quezon, Roxas, and Osmena. FIGURE 3.3.2 shows the barangays and their boundaries.

The Municipality has a total area of 9,077 ha, of which 4,475 ha are arable. Almost 50 percent of the total land area is planted to rice, corn and root crops. The rest of the areas are residential, forest and hill land.

The urban core covers an area of 239.77 ha allocated to various land uses, including residential, commercial, industrial, institutional, open spaces, park and vacant lands. Land use in Solano is shown in TABLES 3.3.1 and 3.3.2.

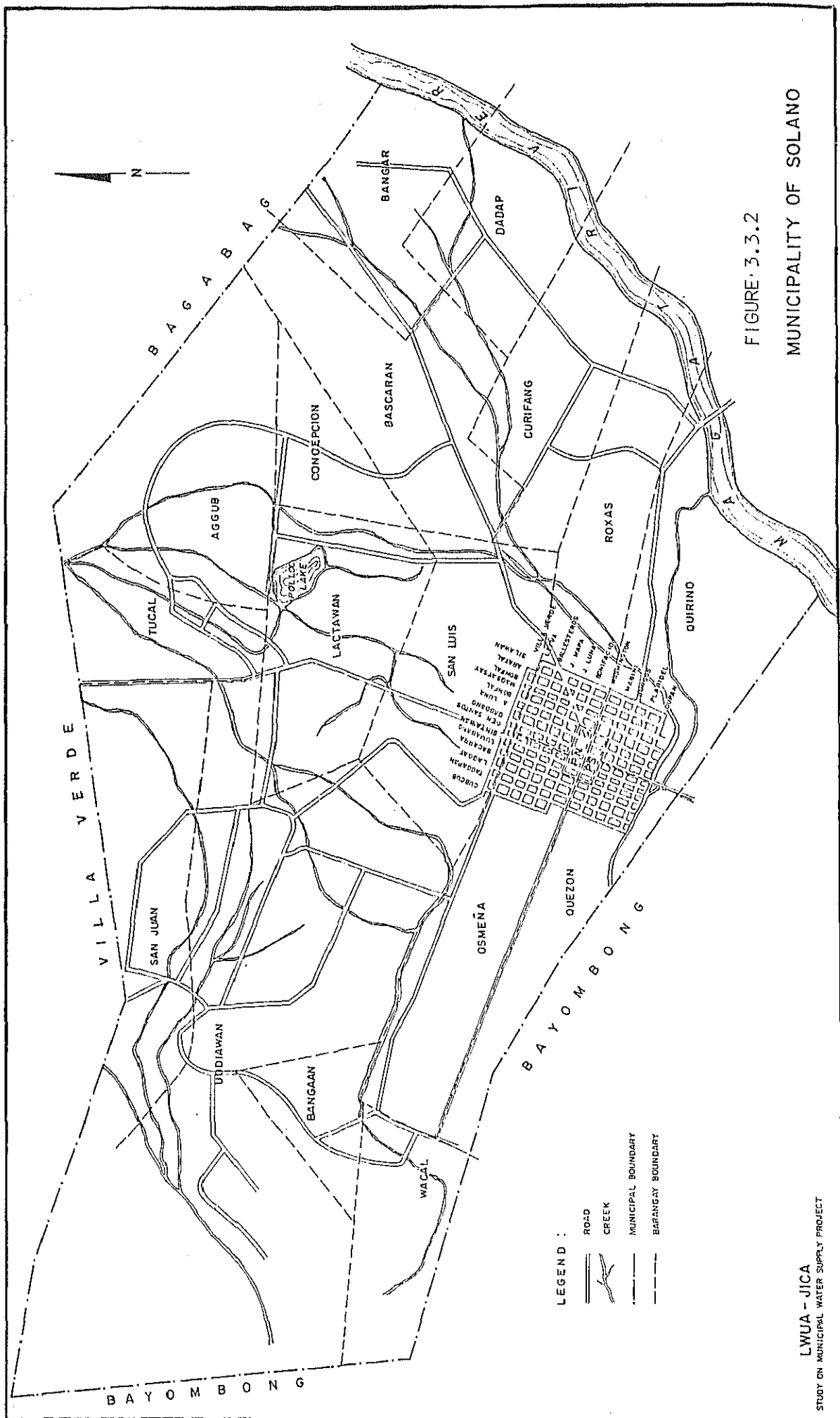


FIGURE 3.3.2
MUNICIPALITY OF SOLANO

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3.4 POPULATION AND LIVING CONDITIONS

(1) Bayombong

The total municipal population for the year 1986 was estimated at 36,286 using annual growth rate of 2.35% from 1980 to 1986 (Refer to CHAPTER 5 - Population Projection).

The 1980 population of the Poblacion was 17,745, with a density of 72 persons/ha; while the rural barangays had a population of 18,997, with a density of 2 persons/ha. This shows that the Municipality was within the low density bracket. The most populated barangay was District No.1.

The physical indicators of the living standard of the Municipality are listed in TABLE 3.4.1. These indicators include type of dwelling units, water facilities, lighting facilities, and toilet facilities.

TABLE 3.4.1 CLASSIFICATION OF HOUSEHOLDS BY TYPE OF FACILITIES, BAYOMBONG

<u>Classification</u>	<u>Number of Household</u>
Water Facilities	
Pipe water	834
Pump well, jetmatics, etc.	5,370
Lighting Facilities	
Electricity	4,159
Electric generators, lamps, etc.	2,045
Type of Dwelling Units	
Single	5,855
Duplex	46
Apartments	60
Improvised Barong-barong	192
Agricultural/commercial/industrial	45
Toilet Facilities	
Water sealed/flush toilet	4,547
Pit privy	1,657

Source: Comprehensive Development Plan, 1985 - 1989, Bayombong

(2) Solano

The 1986 projected population for Solano is 40,474 (annual growth rate from 1980 to 1986; 1.64) distributed among 19 barangays. (Refer to CHAPTER 5 - Population Projection). The population density is 2.36 persons/ha.

There is only one hospital, the privately-owned Nueva Vizcaya Doctor's Hospital. Other health facilities include health centers and 5 clinics. The municipal health centers are distributed among 5 barangays, namely; Lactawan, Bascaran, Curifang, Uddiawan and Quirino.

Common diseases that have a high rate of incidence in the Municipality include the following:

1. Acute upper respiratory infection
2. Parasitism
3. Malaria
4. Gastroenteritis
5. Influenza
6. Pulmonary Tuberculosis
7. Bronchitis
8. Hypersensitivity Reaction
9. Nutritional Anemia
10. Dermatosi

3.5 SOCIO-ECONOMIC CONDITIONS

3.5.1 Provincial and Municipal Revenue

(1) Nueva Vizcaya Province

The province derives its revenue mostly from the real property tax, BIR allotment and specific tax allotment from the national government; and other sources, such as fees, bank interest and revenues generated from the operation of the public utilities.

From 1981 to 1984, the revenues of the Province and its expenditures are shown in the TABLE 3.5.1.

A review of provincial revenue shows that it has been increasing yearly; in 1982 by 22% over 1981, in 1983 by 2% over 1982, in 1984 by 6% over 1983 and in 1985 by 29% over 1984. Between 1981 and 1985, the total increase was ₱5,563,113 or 71%.

TABLE 3.5.1 PROVINCIAL REVENUE AND EXPENDITURE

<u>Year</u>	<u>Revenue</u>	<u>Expenditure</u>	<u>Net Revenue (Deficit)</u>
1981	₱ 7,833,706	₱ 7,364,184	₱ 469,522
1982	9,558,608	11,008,717	(1,450,109)
1983	9,770,151	11,399,716	(1,629,565)
1984	10,404,664*	10,894,344	(489,680)
1985	13,396,819	13,242,871	153,948

* Estimate

Source: Comprehensive Development Plan, Bayombong and Solano

In view of the high expenditures, the Province has been showing a net deficit on its operations from 1982 till 1984.

(2) Bayombong and Solano Municipalities

The sources of revenue of the municipalities come from the real property tax, business taxes, licenses and fees, and receipts from operations. TABLE 3.5.2 shows the revenues and expenditures of the Municipalities from 1980 to 1985.

TABLE 3.5.2 MUNICIPAL REVENUE AND EXPENDITURE

<u>Bayombong</u>				<u>Solano</u>		
<u>Year</u>	<u>Revenue</u>	<u>Expenditure</u>	<u>Net Revenue (Deficit)</u>	<u>Revenue</u>	<u>Expenditure</u>	<u>Net Revenue (Deficit)</u>
1980	₱ 759,362	₱ 773,198	(₱ 13,836)	₱ 1,698,776	₱ 1,521,393	₱ 177,383
1981	830,112	800,855	29,257	1,939,681	1,572,628	367,053
1982	950,475	977,157	(26,682)	2,193,520	1,706,029	487,491
1983	1,062,331	1,051,890	10,441	2,464,788	2,001,142	463,646
1984	1,177,292	1,155,345	21,937	2,805,395	2,095,853	709,542
1985	1,785,660	1,721,617	64,043	2,963,108	2,845,002	118,106

Source: Comprehensive Development Plan, Bayombong and Solano

The revenue and expenditure of the Municipalities shows yearly increase. In Bayombong, the revenue increased by ₱1,026,298 from 1980 to 1985 or 135%, whereas expenditure increased by ₱948,419 or 123% for the same period. While Solano, the revenue increased by ₱1,264,332 or 74% and the expenditure increased by ₱1,323,609 or 87% for the same period.

3.5.2 Family Income

The average monthly family income in Bayombong was ₱1,770 based on income in Bayombong as of the date the market survey conducted on June, 1986. Employment status in 1985, which has relation with income level, is given below. The total labor force in the Municipality was 22,388, of which 85% was employed.

TABLE 3.5.3 PERCENTAGE DISTRIBUTION OF WORKERS BY INDUSTRY OF BAYOMBONG

<u>Kind of Industry</u>	<u>%</u>
Farming	52
Workers in Business Establishment	24
Own Business	14
Livestock	6
Fishing	3
Others	1
<u>Total</u>	<u>100</u>

Agriculture is the major labor absorption sector in Solano, comprising about 53% of the labor force; and the next largest is commerce and trade, at 27%. The average monthly income of family heads in Solano is shown in TABLE 3.5.4.

TABLE 3.5.4 MONTHLY INCOME LEVEL OF SOLANO

<u>Income Level</u>	<u>Number</u>	<u>%</u>
₱ 300 - below	3,536	46.5
300 - 400	1,250	16.4
400 - 500	811	10.6
500 - 600	722	9.5
600 - above	865	11.5
No income	418	5.5
<u>Total</u>	<u>7,602</u>	<u>100.0</u>

Based on the above table, 46.5% of the family heads have per capita income of ₱300 and below a month, 48% have a per capita income of more than ₱300/month, while 5.5% have no income at all.

3.5.3 Agriculture, Livestock Farming and Fisheries

In Bayombong, agriculture being a primary source of livelihood for the people, has an aggregate area of 4,358 ha or 26.96% of the total area. Crops being planted are rice, (the major crop), and corn, vegetables and root crops. In 1981, the Municipality reported that a total of only 2,498 ha of cropland devoted to rice production. Of this rice cropland, 77% is irrigated while 23% represents non-irrigated area. It is projected that the irrigated area will be 5,030 ha when the San Vicente Dam comes into use.

In 1984, there were estimated 3,627 carabaos, 4,163 cows, and 6,568 hogs in Bayombong. Currently, there are commercial piggeries and poultry raisers in the area. Also, a number of households within the locality maintain backyard poultry farms and piggeries for their own consumption. Furthermore, there are also beneficiaries of governmental cattle fattening and breeding projects in Bayombong.

Fishing production is limited to the Magat River and its creeks, where fish species include mudfish, catfish, gouramy, shells, tilapia and others. However, there is no estimation of the current fish yield. Fish from the Magat River provides a high percentage of protein in the diet of the people inhabiting the surrounding areas. At present, no major fishpond is operated in Bayombong.

The total area of agricultural land in Solano is 4,475 ha, of which 84.72% is irrigated while 15.28% is non-irrigated. This is cultivated for rice, corn and root crops.

As of 1976, the estimated meat production of cara-beef, pork and poultry meat was 86 tons. Based on the consumption pattern of the Municipality, the supply of these commodities is deficient.

Fish production in Solano is insufficient, but there is potential for expansion in the northern part of Solano. A 10 ha wide body of water is available for the development of fish culture. Also, the Municipality has donated 5 ha of the Polloc Lake to the Bureau of Fisheries to serve as a demonstration farm for the development of fish pond which will ultimately increase the fish supply in Solano.

3.5.4 Commerce and Industry

Bayombong has 110 establishments currently engaged in the commerce and trading business, which are classified as follows:

- a. Services
- b. Banking and Financing
- c. Insurances
- d. Wholesale Trade
- e. Retail Trade
- f. Factory

Existing industries are limited to small-scale and home industries, such as furniture and hollow-block making, which are generally found in the poblacion. Three (3) rice mills are also found in Bayombong, which serve the milling needs of the area.

In 1983, there were 920 commercial establishments in Solano ranging from retail activities to small scale manufacturing. The Municipality has the largest public market in the Province and has a livestock trading association which deals with the food terminal market in Metro Manila.

3.5.5 Transportation and Communication

In Bayombong, the means of transportation within the Municipality are jeepneys, tricycles and buses.

Serving the telegraph needs of the residents are the Bureau of Telecommunication, RCPI and PT&T. As for telephone service, the Bureau of Telecommunication serves for only local calls, while the RCPI may be used for both local and long-distance calls.

As for the postal service, the Municipality has 3 post offices which efficiently serve the people.

Being an inland town, the Municipality of Solano utilizes road transportation in the movement of goods and people. Passenger jeepneys and tricycles are the most common type of vehicles available in the Municipality.

Solano has one telegraph sub-station, 4 telephone stations of which one is government-owned, and a post office for mail service. It also has one radio station serving the Province.

3.5.6 Power Supply

Electricity is being supplied by the NUVELCO. Out of 6,204 households, 4,160 are being served by this cooperative in Bayombong. The rest are using other forms of lighting, such as kerosene lamps, generators and others. Almost all of the barangays of Solano area are already energized, except for Barangay Bongan. The on-going construction of the Uddinon Mini-Hydro Power Plant will augment the current power needs of Solano in the future.

The electric charges per classification of consumers are shown in APPENDIX 3.5.6.

3.6 MUNICIPAL DEVELOPMENT PLAN

Both Bayombong and Solano issued the Comprehensive Development Plan for the years from 1980 to 1989. Major concern of their development plan is to overcome poverty and unemployment as well as to improve basic infrastructures both in urban and rural areas, such as;

- Extension of power supply to remote barangays and reduction of the present high power charges,
- Improvement of water supply conditions and expansion to unserved areas in the poblacion and its adjacent barangays,
- Provision of adequate irrigation system to all arable lands, and
- Conversion of vacant space for residential and commercial land use to trigger further economic growth of the Municipality.

The urban development program contained in the above-mentioned comprehensive plan is mainly focused on the poblacion area in both municipalities. However, the budget for land development, for example, is not considered in the said plan.

CHAPTER 4

EXISTING WATER SUPPLY AND SANITATION CONDITIONS

CHAPTER 4 EXISTING WATER SUPPLY AND SANITATION CONDITIONS

4.1 PRESENT WATER SUPPLY IN THE MUNICIPALITIES

In the Municipalities of Bayombong and Solano, there are 2 types of water supply systems, or Level I and III systems.

Level I systems, of which water sources are dominantly shallow wells due to hydrogeological conditions, are dispersed in the whole area of the municipalities including that covered with a Level III system as mentioned below.

The Bayombong and Solano Municipalities have an existing combined Level III water supply system, the Nueva Vizcaya Provincial Waterworks established in 1947. This waterworks, otherwise known as the Bayombong-Solano Waterworks System, is utilizing the Borobbob Spring as its sole water source to supply drinking water to the town proper of these Municipalities via an open concrete reservoir.

The total number of service connections at present is 1,345 and the served population is assumed to be 10,400 persons, which is 21% of the total population of the present served area. Owing to the absence of water meters, a flat charge has been employed for water bill collections.

4.2 WATER SUPPLY FACILITY BY DIFFERENT LEVEL OF SERVICES

4.2.1 Level I System

Level I system are composed of 2 deep and 19 shallow wells in Bayombong and 1 deep and 27 shallow wells in Solano as presented in TABLE 4.2.1. These represent only the publicly-constructed facilities. Other barangays besides those listed and/or covered by a Level III system as mentioned below are not provided with a public source of drinking water, however, when hydrogeological conditions are taken into account, potable water from a shallow aquifer is easily obtained and it was learned during the field survey that people residing in such areas are commonly utilizing privately-owned shallow wells.

TABLE 4.2.1 EXISTING LEVEL I WATER SUPPLY FACILITIES

Municipality/Barangay	Shallow Well	Deep Well
Bayombong		
Poblacion	1	1
Bgy. Busilac	2	
Bgy. Bonfal	2	
Bgy. La Torre	1	
Bgy. Salvacion	8	1
Bgy. Casat	1	
Bgy. Vista Alegre*	1	
Bgy. Luyang	2	
Bgy. Latuyot*	1	
Total	19	2
Solano		
Poblacion	8	
Bgy. Lactawan	2	
Bgy. Uddiawan	3	
Bgy. Wacal	2	
Bgy. Bascaran	1	1
Bgy. Dapdap	2	
Bgy. Sinafal*	1	
Bgy. San Juan	2	
Bgy. Curifang	3	
Bgy. Concepcion	3	
Total	27	1

Note: Source; Nueva Vizcaya District Engineer's Office, MPWH

*; These barangays have changed their names and the exact locations of wells are not available now.

4.2.2 Level III System

(1) Water Source and Treatment

The Borobob Spring is located in the midportion of the mountain side at an elevation of 402 m. The open concrete box with an outlet pipe ($\phi 200$ mm) and two (2) drain pipes is constructed to collect spring water. Details of the spring box are shown in FIGURE 4.2.1.

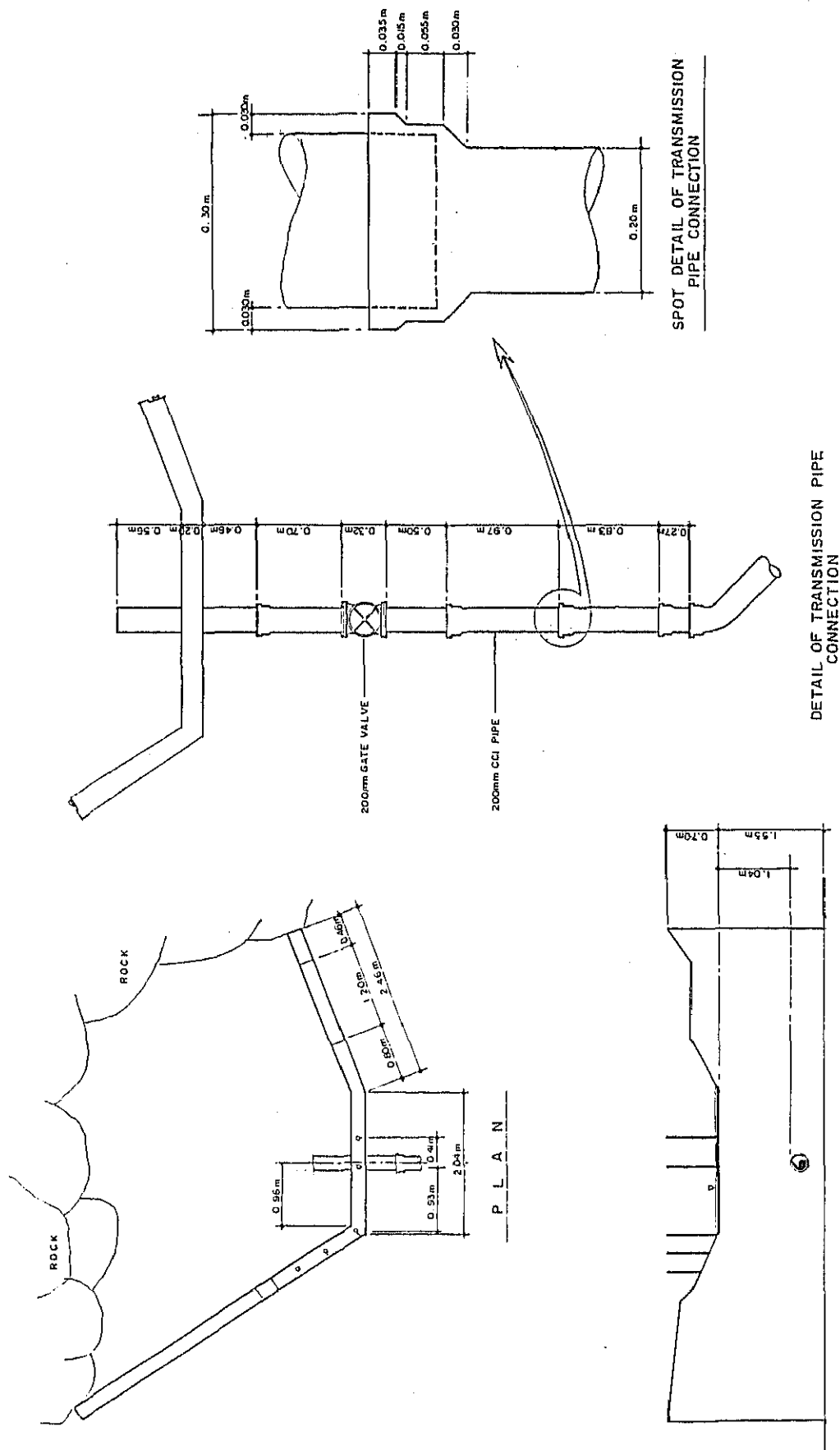


FIGURE 4.2.J
BOROBBOB SPRING INTAKE
BAYOMBONG - SOLANO WATER SUPPLY SYSTEM

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(2) Transmission

Two transmission lines are presently in operation; one being a $\phi 300$ mm CCI pipeline spanning a distance of 1,200 m from the reservoir to the poblacion area of Bayombong; and the other being a $\phi 250$ mm CCI pipeline spanning a distance of 6,000 m from Bayombong to the poblacion area of Solano. None of the pipes used in these lines have been replaced since their installation. The thickness of the pipes is greater than that of the presently manufactured ones. All pipes of transmission lines are joined by metal calking.

Although the original purpose of these pipes was water transmission, some barangays along the pipeline route are receiving water directly from their respective transmission lines.

The "C" value of the transmission line was estimated to be 125 based on the field measurement in a section from the spring box for a distance of 1,404 m. The estimated figure implies favorable conditions of the pipes, though the pipes have been about 25 years in use. This survey result may be supported by the result of water quality examination. Although the spring water is in a slight alkaline condition owing to the presence of limestone in the water shed area, the pipes usually last longer under this condition than acidic condition. Details of "C" value survey is given in APPENDIX 4.2.1.

The survey result may be applied to the other transmission lines since all these pipes are made of same materials and in the straight alignment without accessories.

From the reservoir to Bayombong area, the transmission line is installed underground. In Bayombong town proper, the transmission line branches water for Bayombong and Solano provided with 2 gate valves for each line. A balance of the distribution amount between two towns is being controlled by the operation of these gate valves. Aside from these valves, it was found out that 2 more gate valves are installed in Bayombong and Solano. These valves are, however, not used since they have been buried without valve boxes or similar protection devices. Considering these situations, appropriate locations and installation of gate valves should be taken up for the future expansion of water supply and maintenance works.

From Bayombong to Solano, the transmission line runs along the national road under the road shoulder. Although there are several river crossing points, no air release valve has been installed. Since the existing system is supplying water only 17 hours a day by gravity distribution, such valves are indeed necessary. It was also found out that throughout the transmission line, there is no drain valve for maintenance. The drain valves and air release valves should be located at strategic points.

(3) Distribution

a) Reservoir

The reservoir as shown in FIGURE 4.2.2 sits on the summit of a small mountain at an elevation of 325 m. A chlorination facility has been installed at the outlet of the reservoir, but has not been in use recently for continuous disinfection due to lack of fund.

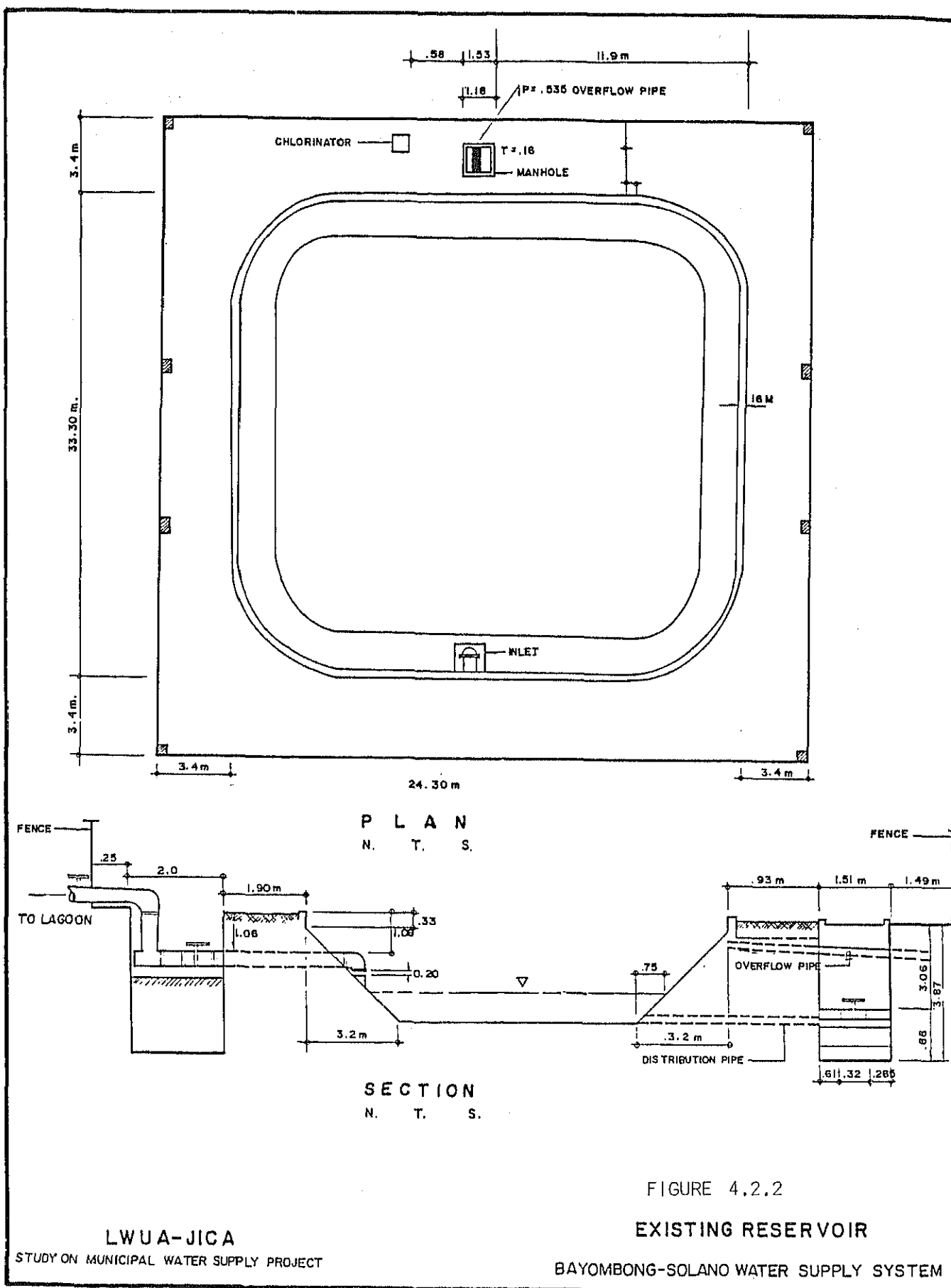
The existing reservoir was often repaired to stop water leakages. Several cracks were observed at the reservoir. Although actual leakage amount could not be detected in the field survey, immediate measures for leakage protection is necessary.

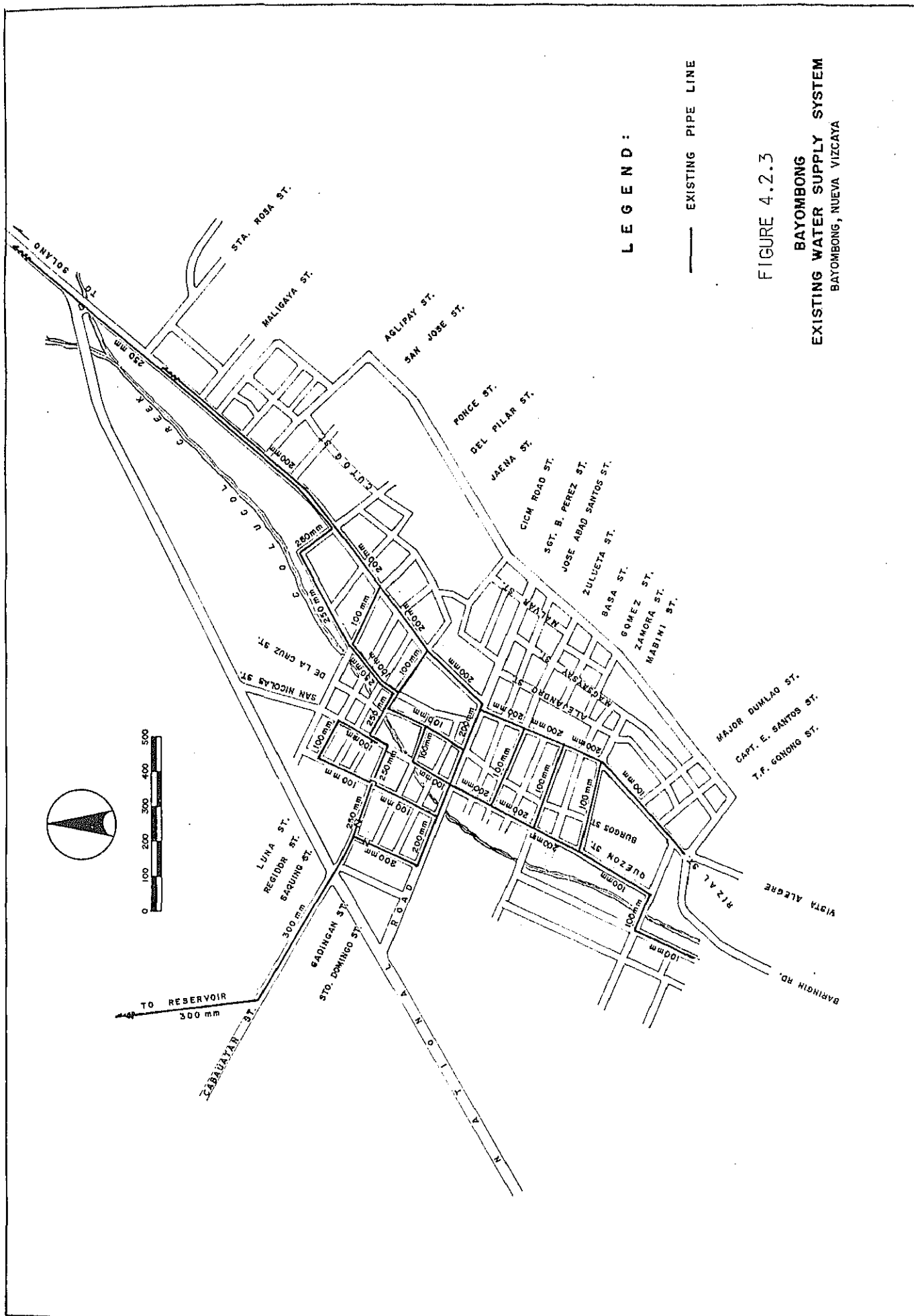
b) Distribution Line

A distribution network has been formed in the poblacion areas of both Bayombong and Solano. Major distribution pipelines with diameters of 100 mm and over are composed of CCI pipes. The configuration of the distribution line is presented in TABLE 4.2.2 and its network is shown in FIGURES 4.2.3 and 4.2.4.

TABLE 4.2.2 CONFIGURATION OF DISTRIBUTION LINE

Size (mm)	Type	Length (m)		
		Bayombong	Solano	Total
ø 200	CCI	2,800	1,700	4,500
ø 100	CCI	3,400	5,700	9,100
TOTAL		6,200	7,400	13,600





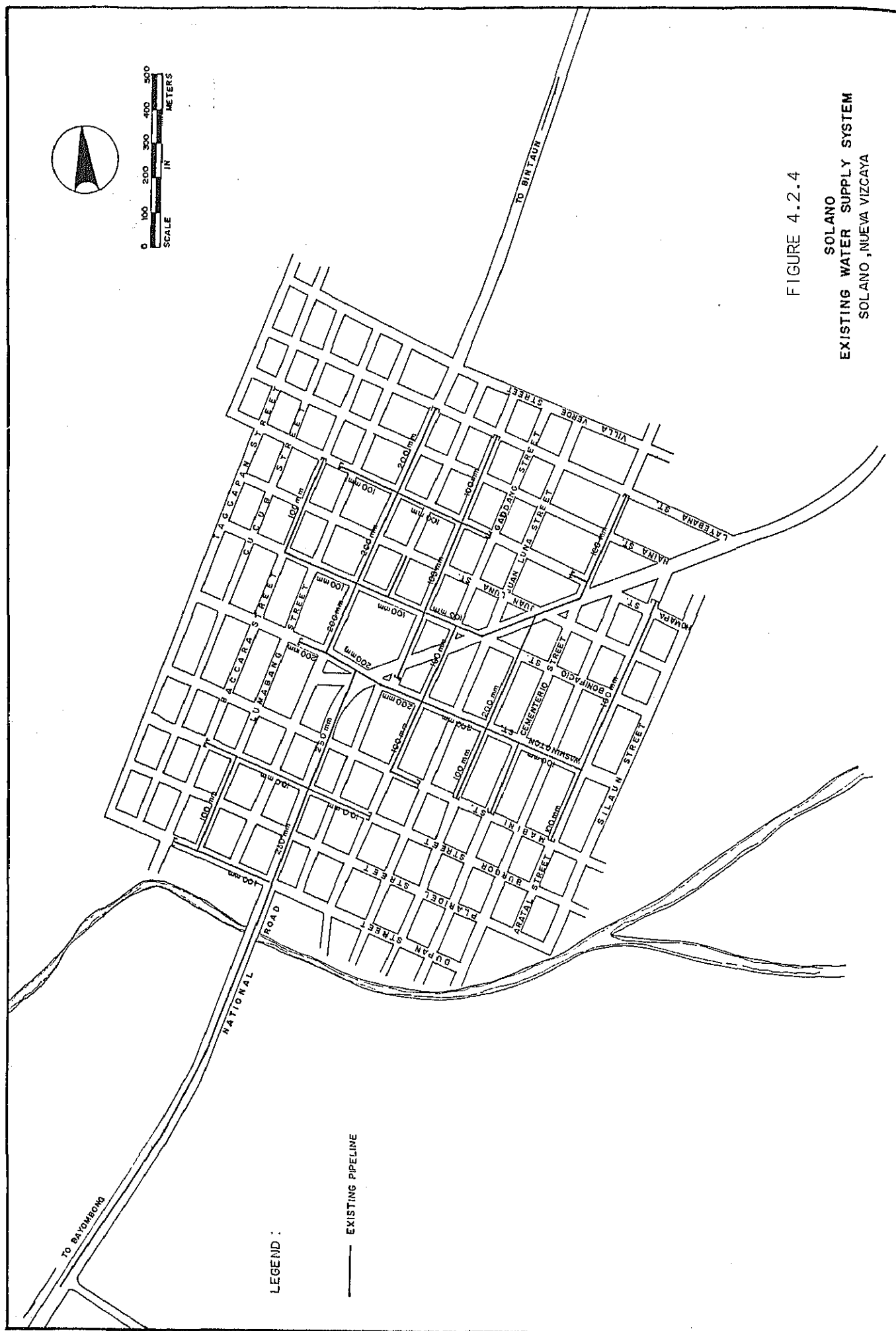


FIGURE 4.2.4
SOLANO
EXISTING WATER SUPPLY SYSTEM
SOLANO, NUEVA VIZCAYA

According to the Supervisor of the Provincial Waterworks, distribution lines and service connections in both Bayombong and Solano have remained unchanged for last several years, and no new applicant has been accepted. This is due to lack of water pressure within the existing water supply system. In fact, water service to these two municipalities has been limited to only 17 hours a day, from 4:00 A.M. to 9:00 P.M., since 1975. The water stored in the reservoir during the nighttime is used to cope with the peak hour demand in the following morning.

In addition, the repair of leakages and extension of service connections, as well as the installation of water meters have been suspended for more than ten years, due to lack of fund resulting from imposing flat water charges.

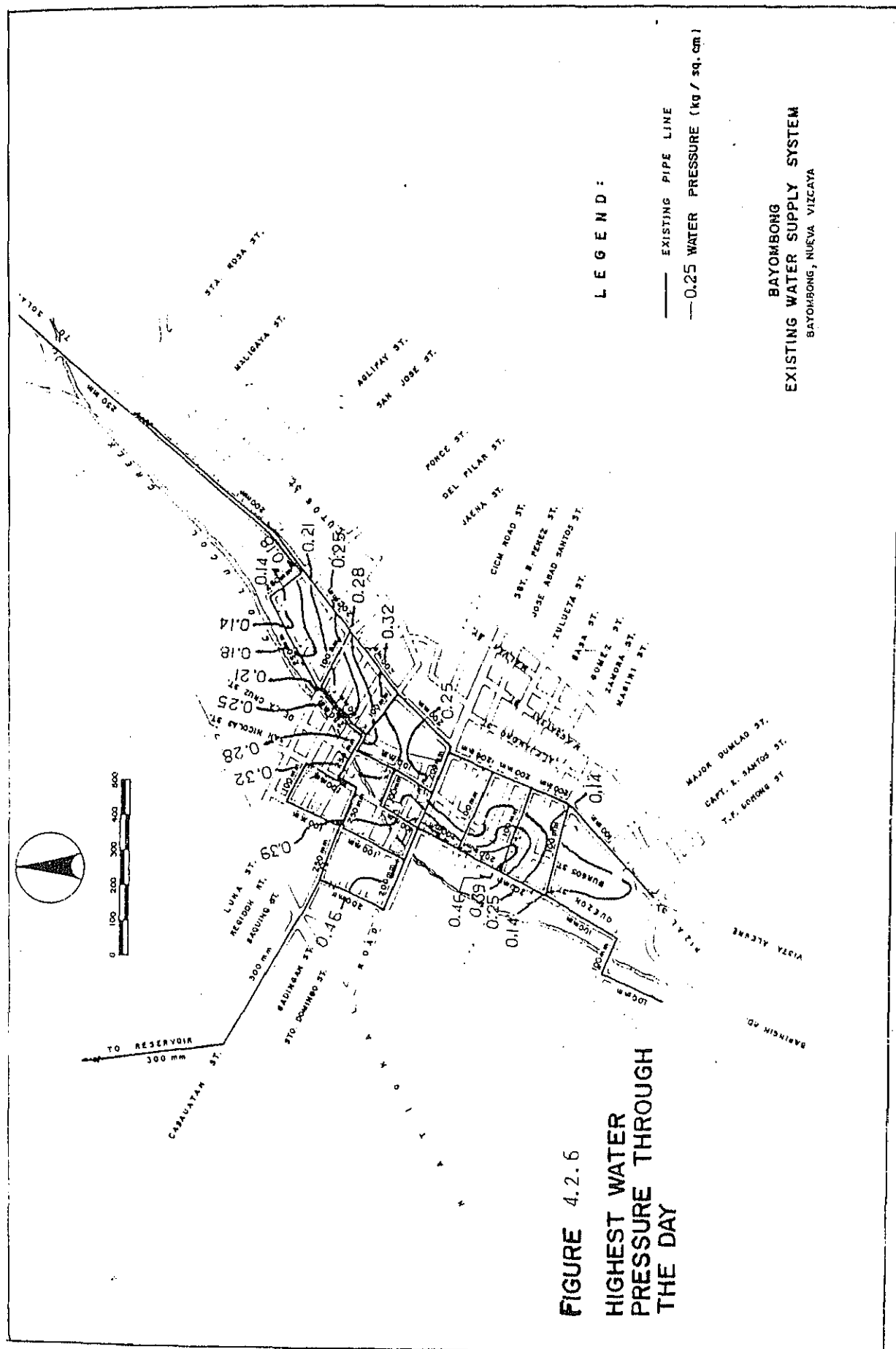
Water pressure in the distribution system covering Bayombong and Solano were surveyed. FIGURES 4.2.5 to 4.2.8 present contour line of the highest and lowest water pressures through the day.

In Bayombong, the highest water pressure zone is found along the distribution main with the largest diameter in the system. Also in Solano, comparatively higher pressure zone is limited along the main distribution line. Some parts of deadend points in Solano show high water pressure owing to their lower ground elevation.

Although the above discussions can be made on relative comparison, it must be noted that the existing water supply system has not been providing consumers with sufficient water pressure throughout the day. Details of the survey are given in APPENDIX 4.2.2.

c) Service Connections

As of July 1986, the total number of service connections is 1,345, consisting of 797 connections in Bayombong and 548 connections in Solano. TABLE 4.2.3 shows the break down of the existing service connections by barangay by municipality together with the served population.



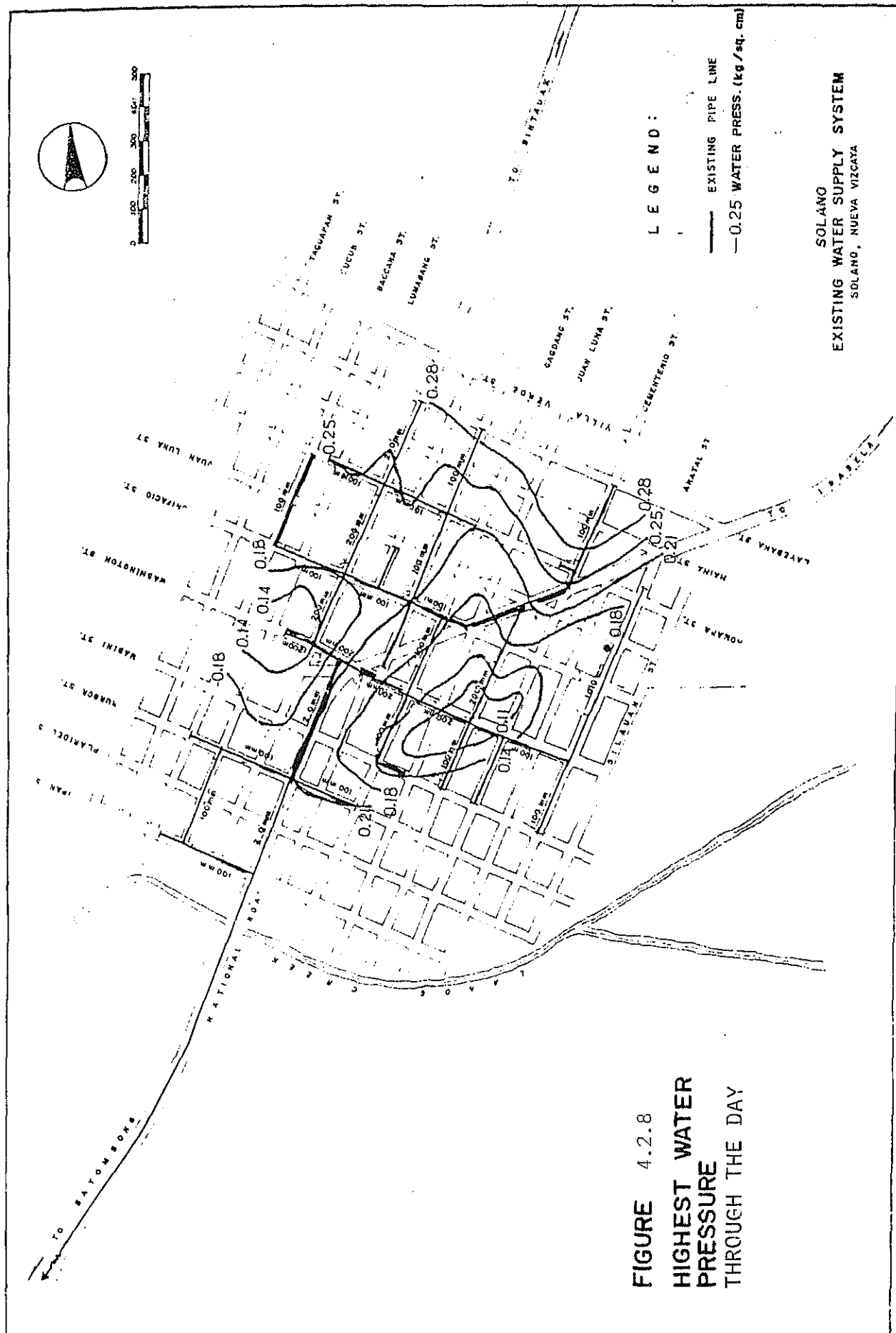


TABLE 4.2.3 SERVED POPULATION AND NUMBER OF CONNECTIONS

Service Area Barangay	Pre- sent Popu- lation	Served Population				Number of Connections				
		Primary User	Bor- rower	Public Faucet	Total	Dom- estic	Public Faucet	Ins- titu- tional	Com- mer- tional cial	Total
<u>MASOC/LA TORRE</u>										
Masoc	1,492	400	240	25	665	79	1	1	-	81
La Torre	2,222	258	155	26	439	51	1	1	-	53
Sub-Total	3,714	658	395	51	1,104	130	2	2	-	134
<u>BAYOMBONG</u>										
District I	7,002	706	318	-	1,024	140	-	4	-	144
" II	3,274	111	50	-	161	22	-	2	-	24
" III	3,686	1,134	510	45	1,689	225	4	1	-	230
" IV	3,482	923	415	-	1,338	183	-	11	-	194
Sub-Total	17,444	2,874	1,293	45	4,212	570	4	18	-	592
<u>BAYOMBONG TO SOLANO</u>										
Bonfal Area	5,142	359	162	-	521	71	-	-	-	71
<u>SOLANO</u>										
Quirino	6,285	313	188	22	523	58	1	6	1	66
Quezon	3,737	490	294	-	784	91	-	1	3	95
Roxas	5,263	507	304	-	811	94	-	1	-	95
Osmena	3,800	658	395	-	1,053	122	-	1	2	125
Pob. North	1,868	442	265	-	707	82	-	-	1	83
Pob. South	2,274	437	262	-	699	81	-	-	3	84
Sub-Total	23,227	2,847	1,708	22	4,577	528	1	9	10	548
TOTAL	49,527	6,738	3,558	118	10,414	1,299	7	29	10	1,345

Although service connections are registered under the individual names of household heads and private/public organizations, it was learned that many unregistered households are dependent on the registered connections. This kind of water use occurs as a result of the flat rate water charge and an insufficient number of service connections.

d) Fire Hydrants

A total of 18 fire hydrants are connected to the distribution pipelines, 8 in Bayombong and 10 in Solano. All of these are of $\phi 3$ " GI stand pipe with valve and outlet, and are functioning.

4.2.3 Operation and Maintenance

A total of 9 personnel are presently working at the BSWS, of which 2 of them are assigned to the operation and maintenance of the system. Since the existing system does not have any water treatment facility except for chlorination, activities are mainly focused on gate valve operation at the reservoir outlet, cleaning of the reservoir, and minor repairs of water leakage.

One of these two personnel is residing in the reservoir guard house with his family and has been assigned the said valve operation and reservoir cleaning duties, simultaneously taking charge of water bill collection. The reservoir is cleaned up once a week. The surrounding area of the reservoir is regularly maintained and is also cleaned.

As for the distribution lines, only minor repair, i.e., leakage repair of the service connection pipes, has been taken up, due to a lack of fund and absence of equipment and materials.

4.2.4 Deficiencies of the Existing System

(1) Level I System

Generally, the use of shallow wells requires more attention than that of deep wells, in terms of water source protection, especially from the seepage of contaminated surface water.

(2) Level III System

a) Source and Treatment

The spring is observed to be functioning in good condition. Two units of drain pipes with blind caps are installed, but are not equipped with a valve. Large amounts of water leak from these drain pipes. The spring box has no cover on top. This situation may necessitate certain improvements when an increase of the intake amount is required for water supply in the future.

The conveyance main from the spring to the reservoir seems to leak at points along its 4,300 m length. Most of this pipeline from the spring down to the mountain foot is laid on the ground along the river bed. Formerly, part of this pipeline just downstream from the spring was destroyed and disconnected by strong stormwater run-off and was relocated to the present location. Pipe joints are all of metal calking. Although it is only a spot measurement of water flow, a considerable amount of water is observed to be lost on the way to the reservoir. In this regard, an immediate check-up of pipelines and repair of leakages, if detected, shall be undertaken.

At the reservoir, a lot of floating materials, most of which are scums with algae, have been observed. Although regular cleaning is performed, such materials are stuck and accumulated on the surface of the wired screen of the reservoir outlet at low water level. Under such conditions, these materials may enter into the transmission line. Furthermore, it may lead to clogging of small size distribution line and will deteriorate the quality of supplied water. To prevent this kind of possible trouble, the installation of a floating fence around the reservoir outlet is one of countermeasures.

To assure good water quality, it is necessary to maintain continuous chlorination at the reservoir outlet. Considering the present supply conditions of 17 hours a day, sufficient concentration of residual chlorine shall be maintained until the following morning.

b) Transmission

There are two different transmission lines; 1,200 m from the reservoir to Bayombong, and 6,000 m from Bayombong to Solano.

Just like the conveyance main, the above mentioned 1,200 m transmission line was also destroyed at the river crossing near the reservoir. This point was repaired by replacing the pipes with those of a smaller diameter, since the original size was not available.

It has been learned that all of the pipe joints of these pipelines are of metal calking and most of them are buried underground along the national road. Since the installation of these pipes, no intensive check-up of leakage has been taken up. A leakage detection and repair program will have to be undertaken immediately.

c) Distribution

The distribution lines has been basically unchanged since the inauguration of the present system. The experimental measurement of water flow revealed that about 4,080 cu.m/day of water is supplied to 1,200 service connections in the poblacion areas of Bayombong and Solano. This means that one service connection consumes approximately 3,400 liters of water per day, or approximately 600 lpcd. Although it is understood that water is shared with neighboring households, the leakages and improper use of water shall also be considered. Prior to an increase in the number of service connections, leakage detection and repair works shall be implemented along with the installation of water meters.

4.3 WATER PRODUCTION

Due to the absence of flow measuring devices throughout the existing water supply system, accurate figures on water production and distribution were not kept in the official records.

Through the field measurement done in the Phase I and Phase II study periods, the potential water production at the Borobbob Spring was determined. The total discharge measured in April, 1986 was 11,000 cu.m/day, while that in July, 1986 was only 6,100 cu.m/day due to the delayed start of the rainy season. Thus, the 6,100 cu.m/day discharge is being considered the minimum discharge at the end of the dry season and 11,000 cu.m/day or more is available during the rainy season and most of the dry season.

On the other hand, the intake amount from the spring box for the transmission line is stable through the year at about 4,770 cu.m/day. The rest of spring discharge is leaked/overflowed from the spring box to the nearby stream. The survey result is given in APPENDIX 4.3.1.

4.4 WATER CONSUMPTION

4.4.1 General

The water consumption of the existing water supply system was studied based mainly on the results of field measurements and interviews due to absence of water meters throughout the system. The field survey on the unit water consumption was therefore included in a part of the survey for estimation of unaccounted-for water/not utilized water.

The existing water supply system was divided into four (4) service areas considering the geographical and water supply conditions.

a) Masoc/La Torre Area

This area is being served on a continuous 24-hour basis with high water pressure (3.8 kg/sq.cm to 4.3 kg/sq.cm). The service pipes are directly connected to the transmission line between the span of the Borobbob Spring and the reservoir.

- b) Town Proper of Bayombong
- c) Bonfal Area along the transmission line, and
- d) Town Proper of Solano

The above three (3) areas are supplied from the reservoir through its respective transmission line for 14 hours a day (4:00 A.M. to 9:00 P.M.).

The major information taken up in the estimation of water consumption are as follows:

- No. of registered concessionaires by consumer type.
- No. of primary users/borrowers per registered concessionaires (based on field interviews), and
- Unit water consumption by consumer type (based on field measurement).

4.4.2 Unit Water Consumption

Based on the field measurement of the water consumption per connection, the following unit water consumption by consumer type was obtained.

(1) Domestic consumption

The average consumption per capita/connection for the house connection and public faucet is shown in TABLE 4.4.1.

The number of borrowers is estimated based on the field survey result. The average percentages of the number of borrowers to that of primary users are 60% in Masoc/La Torre and Solano areas, while 45% in Bayombong and Bonfal areas. (Refer to APPENDIX 4.5.1)

TABLE 4.4.1 AVERAGE DOMESTIC UNIT WATER CONSUMPTION

Service Area	House Connection		Public Faucet	
	cu.m/conn.day	lpcd	cu.m/conn.day	lpcd
Masoc/La Torre	3.21	350	1.52	60
Bayombong (including Bonfal)	0.76	105	1.65	90
Solano	0.78	90	1.58	70

(2) Commercial Consumption

There are only 10 registered commercial connections comprising restaurants, gas station and food/grocery shops. Three connections were selected for the measurement of water consumption. The measurement result is given in TABLE 4.4.2. The average consumption per connection is 1.53 cu.m/day.

TABLE 4.4.2 UNIT WATER CONSUMPTION (COMMERCIAL USE)

Service Area/ Location	Type of Business	Consumption (cu.m/day)	Water Charge (₱/month)
<u>Solano</u>	Brgy. Quezon	Restaurant	1.24
		Gas Station	1.85
	Pob. South	Restaurant	1.49

(3) Institutional Consumption

Of 31 institutional connections, four connections were selected for the measurement. TABLE 4.4.3 gives the information on the four connections.

TABLE 4.4.3 INSTITUTIONAL WATER CONSUMPTION

Area	User	Consumption (cu.m/day)
Masoc/La Torre	Masoc Elementary School	26.39
Bayombong	Bank	0.85
	Government Office	1.03
Solano	Government Office	0.54

The Masoc Elementary School is regarded as a large consumer and the average consumption by majority of the consumers maybe the same as that of the other three consumers in the above TABLE (0.81 cu.m/day).

(4) Miscellaneous Consumption

It was found that a part of the distributed water in Masoc and La Torre area is used for filling fish pond and soaking carabaos. A total of 7 fishpond concessionaires were confirmed to be involved. Of these connections, two were selected and the measurement of water consumption was then carried out. The average consumption of the two connections was found to be 25.13 cu.m/day (26.55 and 23.70 cu.m/day).

The average consumption for the miscellaneous use was calculated at 21.92 cu.m/day, excluding the water consumption for domestic use (25.13 cu.m/day - 3.21 cu.m/day).

4.4.3 Total Water Consumption

The total water consumption was estimated based on the study on the served population and the unit water consumption by consumer type. The following are the calculation bases and TABLE 4.4.4 shows the total water consumption.

- (1) Domestic consumption: The average consumption per connection by area and number of connections for house connections, and average per capita consumption and served population for public faucet.
- (2) Commercial consumption: Average consumption per connection and number of connections.
- (3) Institutional consumption: Measured figure for the Masoc Elementary School and average per connection consumption and number of connections for remaining connections.
- (4) Miscellaneous consumption: Average consumption per connection and number of connections.

TABLE 4.4.4 TOTAL WATER CONSUMPTION

Service Area Barangay	Served Population				Water Consumption (cu.m/day)						
	Pre- sent Popu- lation	Primary User	Bor- rower	Public Faucet	Domestic			Com- mer- cial	Ins- titu- tional	Misc- cella- neous	
					Service Conn.	Public Faucet	Total				
<u>MASOC/LA TORRE</u>											
Masoc	1,492	400	240	25	254	2	256	-	26	153	435
La Torre	2,222	258	155	26	164	2	166	-	26	-	192
Sub-Total	3,714	658	295	51	418	4	422	-	52	153	627
<u>BAYOMBONG</u>											
District I	7,002	706	318	-	106	-	106	-	3	-	109
District II	3,274	111	50	-	17	-	17	-	2	-	19
District III	3,686	1,134	510	45	171	4	175	-	1	-	176
District IV	3,482	923	415	-	139	-	139	-	9	-	148
Sub-Total	17,444	2,874	1,293	45	433	4	437	-	15	-	452
<u>BAYOMBONG TO SOLANO</u>											
Bonfal Area	5,142	359	162	-	54	-	54	-	-	-	54
<u>SOLANO</u>											
Quirino	6,285	313	188	22	45	2	47	2	5	-	54
Quezon	3,737	490	294	-	71	-	71	5	1	-	77
Roxas	5,263	507	304	-	73	-	73	-	1	-	74
Osmeña	3,800	658	395	-	95	-	95	3	1	-	99
Pob. North	1,868	442	265	-	64	-	64	2	-	-	66
Pob. South	2,274	437	262	-	63	-	63	5	-	-	68
Sub-Total	23,227	2,847	1,708	22	411	2	413	17	8	-	438
TOTAL	49,527	6,738	3,558	118	1,316	10	1,326	17	75	153	1,571

4.5 ANALYSIS ON WATER SUPPLY AND CONSUMPTION

4.5.1 Comparative Study on Production Amount and Consumption

The total discharge of the Borobob Spring and the intake amount for water supply were determined in the previous section. The distribution amount to respective service areas was also computed based on the result of field measurements at eight (8) strategic points of the transmission line.

A balance of distributed water and accounted-for water/utilized water is summarized in TABLE 4.5.1.

TABLE 4.5.1 BALANCE OF DISTRIBUTED WATER AND ACCOUNTED-FOR WATER

Service Area	Distributed Water	Accounted-for Water/Utilized Water	Unit: cu.m/day
			Unaccounted-for Water/Not utilized Water
Masoc/La Torre	940	627	313
Bayombong	1,200	452	748
Bonfal Area	360	54	306
Solano	1,790	438	1,352
TOTAL	4,290	1,571	2,719

Of the total distributed amount of 4,290 cu.m/day, only about 1,570 cu.m/day or about 40% is estimated to be accounted-for water or utilized water. (Refer to survey result in APPENDIX 4.5.1)

4.5.2 Unaccounted-for Water

Through the evaluation of the distributed amount and water consumption, about 60% of the total distributed amount is considered to be unaccounted-for water/not utilized water.

The high ratio of unaccounted-for water/not utilized water is attributed to the following:

- presence of hidden illegal connections.
- abuse of supplied water, i.e., watering to fish ponds, piggeries,
- leakage from pipelines and in the reservoir,
- application of booster pump at in-house connection to draw larger amount of water (one of this case was observed in Solano),
- unknown large consumption by domestic, commercial and/or institutional users.

4.6 EXISTING SANITATION CONDITIONS

4.6.1 Drainage and Sewage Disposal

Rivers and creeks form the natural drainage of Bayombong. During rainy days, Barangays of Busilac, Paitan, Magsaysay, Salvacion, Don Mariano Marcos, and District IV, where the ground elevation is not high enough from the Magat River, flooding occurs.

The flood area however, has been minimized by the construction of flood control structures in recent years. In Solano, no reported serious problems on drainage condition occur.

There are no sewerage system at present for both Bayombong and Solano. Human waste is generally disposed in water sealed toilets or latrines. In rural barangays, human waste is disposed in conventional cess pits.

4.6.2 Solid Waste Disposal

Solid wastes are generally disposed by open dumping or burning at vacant lots. In the poblacion area, garbages is collected regularly as a public service by the Municipality and thrown into the Magat River dumping site.

CHAPTER 5

POPULATION AND WATER DEMAND PROJECTIONS

CHAPTER 5 POPULATION AND WATER DEMAND PROJECTIONS

5.1 GENERAL

A future water supply plan for the Municipalities of Bayombong and Solano was studied, based on collected data and discussions with the officials concerned. The target year for this long term development is 2010. The potential service area for this plan was identified on the basis of technical and economic considerations.

The target year settled upon for the short term development is 1995. In addition, the period for the short term development plan has been divided into two stages, with 1990 and 1995 serving as design years. The Adoption of this staged plan owes to the time constraints and magnitude of improvement and expansion of the existing BSWs.

The water demand projection including consumption and unaccounted-for water was performed for the design years.

5.2 POPULATION PROJECTION

5.2.1 General

Several factors were considered in the population projection of the study area, which are as follows:

- a. possible migration within the municipality and past population trends,
- b. physical limits to geographical development of the area,
- c. population density and overall economic development, and
- d. proximity to other municipalities.

The figures obtained in the projections were further modified on the basis of field investigation and comparison with the NEDA-POPCOM projections.

The population figures of Bayombong and Solano were projected by the method of least squares, using population data for the years 1960, 1970, 1975 and 1980. Provincial figures were also projected in the same way that the municipal population figures were predicted.

The projected municipal population data were broken down and distributed among the urban and rural areas, using the sharing method. The population by barangay in the urban and rural areas was finally projected based on historical data.

5.2.2 Population Projection of the Province and Municipalities

The historical populations of Bayombong and Solano are the primary bases for population projections on the study areas. The latest historical population data available were compared with the three categories of the NEDA-POPCOM. The nearest assumption of the NEDA with the latest historical population is taken up as the basis of all future projections until 2000. The historical populations of Bayombong and Solano and the province of Nueva Vizcaya for the years 1903 to 1980 are shown in TABLE 5.2.1.

The percentages of the municipal population to the provincial population are projected as follows:

<u>Year</u>	<u>Bayombong (%)</u>	<u>Solano (%)</u>	<u>Remarks</u>
1960	15.37	19.79	
1960	14.64	16.08	
1975	13.14	15.50	
1980	14.70	15.19	
1985	(12.48)	(13.33)	Projected
1990	(11.89)	(12.15)	Projected
1995	(11.29)	(10.98)	Projected
2000	(10.70)	(9.81)	Projected
2010	(9.52)	(7.47)	Projected

TABLE 5.2.1 HISTORICAL POPULATION BY MUNICIPALITY

Municipality/ Province	Item	1903	1918	1939	1948	1960	1970	1975	1980
Bayombong	Population	4,039	5,661	12,146	14,078	17,499	25,202	28,017	31,566
	Growth Rate	-	2.28	3.70	1.65	1.83	3.72	2.14	2.41
	% to Total	25.20	15.80	16.23	17.55	15.37	14.64	13.14	14.70
Solano	Population	5,624	7,563	17,878	19,840	22,523	27,692	33,036	36,710
	Growth Rate	-	1.99	4.18	1.16	1.06	2.09	3.59	2.13
	% to Total	35.09	21.10	23.89	24.74	19.79	16.08	15.50	15.19
Nueva Vizcaya	Population	16,026	35,838	74,838	80,190	113,824	172,198	213,151	214,690
	Growth Rate	-	5.51	3.57	0.77	2.96	4.23	4.36	2.54
	% to Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: Growth Rate : Between Census Years
Percent to Total : Municipal Population/Nueva Vizcaya Provincial Population
Source : National Censuses

Although the historical shares to the provincial population were slightly decreasing, the future shares projected were too low. Thus, the population projections for Bayombong and Solano were projected by the method of least squares. TABLE 5.2.2 and FIGURES 5.2.1 and 5.2.2 show the projected population from 1980 to 2010.

5.2.3 Population Projection by Barangay

The projections for barangays of Bayombong and Solano are based on the historical trend of population share from 1970 to 1980 as shown in TABLE 5.2.3. The ratio of each barangay is further multiplied by the projected municipal population to obtain the barangay population in the years desired. Barangays with no past record were dealt with making reference to the original barangay, where they were linked, and the future populations for the new barangays are obtained by extrapolation or by ratio and proportion. In addition, the recent reformation of barangays is considered to maintain the consistency of various studies in this project. The followings are the barangays merged with neighboring barangays:

- Poblacion District I includes Salvacion and Banca Baringin,
- Poblacion District II includes Luyang and St. Nicolas,
- Poblacion District IV includes Mariano Marcos and Sta. Rosa,
- Casat includes Cabaan and Ipil-Cuneg,
- Paitan includes Bansing, and
- Lactawan includes Concepcion.

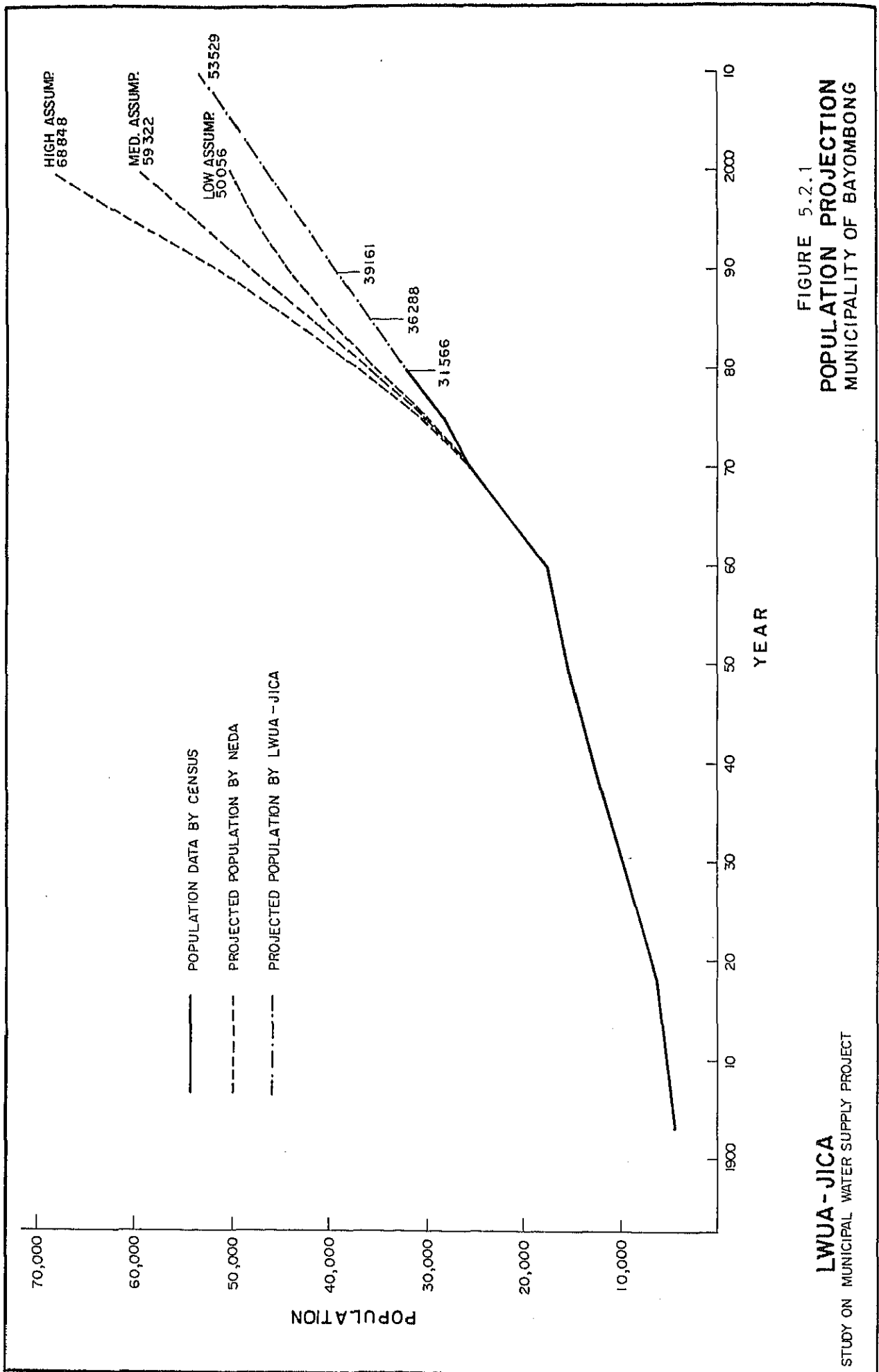
TABLE 5.2.4 shows the population projection data by barangay of Bayombong and Solano from 1986 to 2010.

5.2.4 Projection of Number of Households

The average numbers of persons per household in Bayombong and Solano as of 1980 are 5.09 and 5.35, respectively. The number of persons per household is projected to decrease, due to the influence of the family planning program of the government and foreseeable economic constraints. The projection was done by ratio and proportion or the straight-line method. TABLE 5.2.5 shows the projected population and number of households for Bayombong and Solano from 1980 to 2010.

TABLE 5.2.2 POPULATION PROJECTION BY MUNICIPALITY

Municipality/ Province	Item	1980	1986	1990	1995	2000	2010
Bayombong	Population	31,566	36,286	39,161	42,752	46,345	53,529
	Growth Rate	2.41	2.35	1.92	1.77	1.63	1.45
	% to Total	14.70	12.92	12.76	12.60	12.47	12.26
Solano	Population	36,710	40,474	43,362	46,971	50,581	57,800
	Growth Rate	2.13	1.64	1.74	1.61	1.49	1.34
	% to Total	15.19	14.41	14.13	13.05	13.61	13.24
Nueva Vizcaya	Population	241,690	280,852	306,787	339,207	371,626	436,464
	Growth Rate	2.54	2.53	2.23	2.03	1.84	1.62
	% to Total	100.00	100.00	100.00	100.00	100.00	100.00



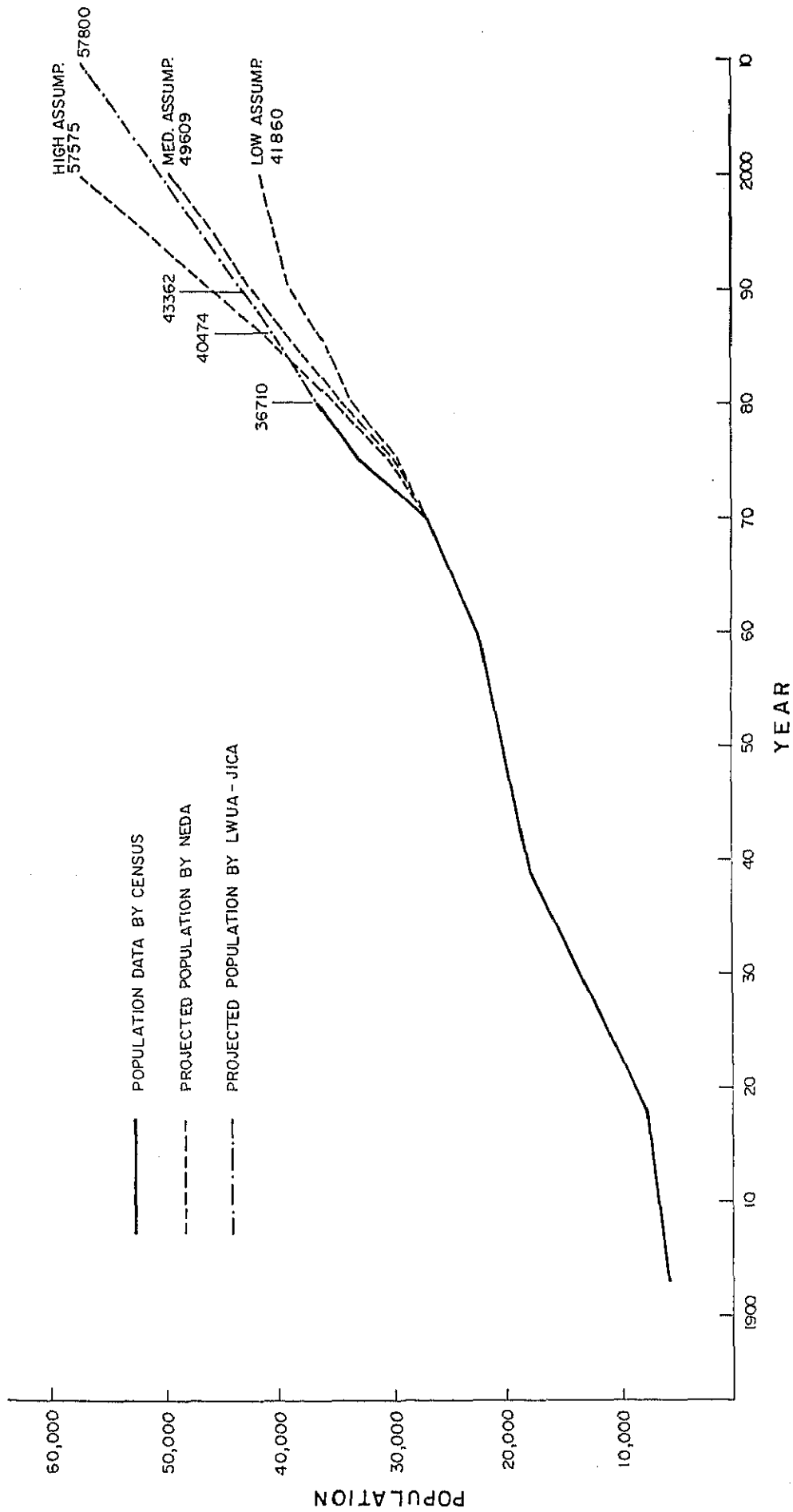


FIGURE 5.2.2
POPULATION PROJECTION
MUNICIPALITY OF SOLANO

LWUA - JICA
STUDY ON MUNICIPAL WATER SUPPLY PROJECT

TABLE 5.2.3 HISTOPICAL POPULATION BY BARANGAY

NAME OF MUNICIPAL. AREA	NAME OF BARANGAY	1970				1975				1980			
		POP'N	SHARE	H.H.	POP'N	SHARE	H.H.	POP'N	SHARE	H.H.	POP'N	SHARE	H.H.
BAYOMBONG	URBAN												
	POB.DIST.#1	4947	41.45	811	4860	37.53	830	6393	42.84	1227			
	POB.DIST.#2	2174	18.21	356	2576	19.89	423	2308	15.47	573			
	POB.DIST.#3	2483	20.80	407	2823	21.80	507	3208	21.50	614			
	POB.DIST.#4	2332	19.54	383	2692	20.79	466	3014	20.20	563			
	URBAN SUB TOTAL	11936	100	1957	12951	100	2226	14923	100	2977			
	RURAL												
	BONFAL EAST	1509	11.38	280	1544	10.25	289	1614	9.70	267			
	BONFAL PROPER	2244	16.92	416	2525	16.76	467	2641	15.87	527			
	BONFAL WEST	1522	11.47	293	1690	11.22	296	1968	11.83	365			
	BUSILAC	842	6.35	156	1015	6.74	150	1098	6.60	195			
	CASAT	1020	7.69	189	1314	8.72	252	1528	9.18	289			
	LA TORRE	1785	13.46	331	2008	13.33	434	2051	12.32	469			
	MAGAPUY	398	3.00	74	385	2.56	69	418	2.51	83			
	MAGAYSAY	1015	7.65	188	1651	10.96	298	1468	8.82	304			
	MASOC	677	5.10	126	957	6.35	197	1135	6.82	231			
	PAITAN	701	5.28	130	949	6.30	173	1583	9.51	292			
	VISTA HILLS	1553	11.71	290	1028	6.82	171	1139	6.84	205			
	URBAN SUB TOTAL	13266	100	2473	15066	100	2796	16643	100	3227			
	TOTAL	25202		4430	28017		5022	31566		6204			
SOLANO	URBAN												
	OSMENA	2276	15.02	381	2854	15.71	512	3284	16.16	605			
	POB.NORTE	1803	11.90	201	1512	8.30	233	1648	8.11	302			
	POB.SOUTH	1635	10.79	274	2056	11.28	342	2082	10.25	366			
	QUEZON	2245	14.82	376	2824	15.49	477	3232	15.91	617			
	QUIRINO	4012	26.48	672	5045	27.68	858	5538	27.25	1033			
	ROXAS	3182	21.00	833	3926	21.54	648	4536	22.32	780			
	URBAN SUB TOTAL	15153	100	2737	18227	100	3070	20320	100	3703			
	RURAL												
	AGGUB	1334	10.64	240	1668	11.26	289	1769	10.79	331			
BAYOMBONG	BANGAR	558	4.45	100	562	3.80	94	552	3.37	96			
	BANGAAN	364	2.80	65	545	3.68	88	571	3.48	105			
	BASCARAN	2747	21.91	493	2727	18.41	469	3189	19.46	593			
	CURIFANG	1547	12.34	278	1618	10.93	282	1898	11.58	344			
	DADAP	601	4.79	108	728	4.92	143	803	4.90	153			
	LACTAWAN	645	5.14	116	725	4.90	130	834	5.09	155			
	SAN JUAN	703	5.61	127	950	6.42	157	986	6.02	173			
	SAN LUIS	801	6.39	144	1146	7.74	193	1464	8.93	273			
	TUCAL	570	4.55	102	675	4.56	115	720	4.39	135			
	UDDIAWAN	1776	14.16	319	2659	17.96	790	2748	16.77	635			
	WACAL	893	7.12	160	806	5.44	145	856	5.22	163			
	URBAN SUB TOTAL	12539	100	2252	14809	100	2895	16390	100	3156			
	TOTAL	27692		4989	33036		5965	36710		6859			
	GRAND TOTAL	52894		9419	61053		10987	68276		13063			

TABLE 5.2.4 POPULATION PROJECTION BY BARANGY

NAME OF MUNICIPAL. AREA	NAME OF BARANGAY	1980			1986			1990			1995			2000			2010		
		SHARE	POP'N	SHARE	POP'N	SHARE	POP'N	SHARE	POP'N	SHARE	POP'N	SHARE	POP'N	SHARE	POP'N	SHARE	POP'N	SHARE	POP'N
BAYOMBONG	URBAN	42.84	6393	40.14	7002	40.14	7605	40.14	8368	40.14	9141	40.14	10722						
	POB.DIST.#1	15.47	2308	18.77	3274	18.77	3556	18.77	3913	18.77	4275	18.77	5014						
	POB.DIST.#2	21.50	3208	21.13	3686	21.13	4003	21.13	4405	21.13	4812	21.13	5644						
	POB.DIST.#3	20.20	3014	19.96	3482	19.96	3782	19.96	4161	19.96	4546	19.96	5332						
	POB.DIST.#4																		
	URBAN SUB TOTAL	100	14923	100	17444	100	18946	100	20847	100	22774	100	26712						
	RURAL	9.70	1614	8.61	1622	7.94	1605	7.11	1558	6.27	1478	4.60	1234						
	BONFAL EAST	15.87	2641	15.39	2900	14.98	3028	13.29	2911	12.04	2838	11.82	3170						
	BONFAL PROPER	11.83	1968	11.90	2242	12.03	2432	12.21	2675	12.39	2920	12.69	3403						
	BONFAL WEST	6.60	1098	6.85	1291	6.95	1405	7.08	1551	7.21	1699	7.47	2003						
SOLANO	BUSILAC	9.18	1528	10.18	1918	10.78	2179	11.53	2526	12.28	2895	12.63	3387						
	CASAT	12.32	2051	11.79	2222	11.35	2294	10.78	2361	10.22	2409	9.09	2438						
	LA TORRE	2.51	418	2.15	405	1.96	396	1.71	375	1.47	346	0.98	263						
	MAGAPUY	8.82	1468	10.44	1967	10.92	2207	11.51	2521	11.10	2616	12.18	3266						
	MAGSAYSAY	6.82	1135	7.92	1492	8.61	1741	9.47	2074	10.33	2435	11.05	2963						
	MASOC	9.51	1583	11.69	2203	13.37	2703	14.31	3135	15.69	3698	16.49	4422						
	PAITAN	6.84	1139	3.08	580	1.11	224	1.00	219	1.00	236	1.00	268						
	VISTA HILLS																		
	URBAN SUB TOTAL	100	16643	100	18942	100	20214	100	21906	100	23570	100	26817						
	RURAL																		
SOLANO	TOTAL	31566		36286		39160		42753		46344		53529							
	URBAN	16.16	3284	16.36	3800	16.54	4195	16.76	4712	16.99	5262	17.44	6448						
	OSMENA	8.11	1648	8.04	1868	7.97	2021	7.88	2216	7.79	2413	7.61	2814						
	POB. NORTE	10.25	2082	9.79	2274	9.37	2376	8.85	2488	8.33	2580	7.29	2695						
	POB. SOUTH	15.91	3232	16.09	3737	16.26	4124	16.47	4631	16.68	5166	17.10	6323						
	QUEZON	27.25	5538	27.06	6285	26.89	6820	26.68	7501	26.46	8195	26.03	9625						
	QUIRINO	22.32	4536	22.66	5263	22.97	5826	23.36	6568	23.75	7356	24.53	9070						
	ROXAS																		
	URBAN SUB TOTAL	100	20320	100	23227	100	25362	100	28116	100	30972	100	36975						
	RURAL																		
BAYOMBONG	AGGUB	10.79	1769	11.06	1907	11.12	2002	11.20	2112	11.27	2210	11.42	2378						
	BANGAR	3.37	552	2.68	462	2.25	405	1.71	322	1.17	229	0.09	19						
	BANGAAN	3.48	571	3.99	688	4.22	760	4.51	850	4.80	941	5.38	1120						
	BASCARAN	19.46	3189	17.23	2971	16.25	2925	15.02	2832	13.80	2706	11.35	2364						
	CURIFANG	11.58	1898	10.78	1859	10.47	1885	10.09	1902	9.71	1904	8.95	1864						
	DADAP	4.90	803	4.99	861	5.04	907	5.09	960	5.15	1010	5.26	1095						
	LACTAWAN	5.09	834	5.00	862	4.99	898	4.97	937	4.95	971	4.91	1023						
	SAN JUAN	6.02	986	6.45	1112	6.60	1188	6.80	1282	6.99	1371	7.38	1537						
	SAN LUIS	8.93	1464	10.48	1807	11.50	2070	12.77	2408	14.04	2753	15.63	3255						
	TUCAL	4.39	720	4.33	747	4.27	769	4.20	792	4.12	808	3.97	827						
BAYOMBONG	UDDITAWAN	16.77	2748	19.17	3306	20.21	3638	21.52	4058	22.82	4475	24.48	5098						
	WACAL	5.22	856	3.84	662	3.08	554	2.12	400	1.18	231	1.18	246						
	URBAN SUB TOTAL	100	16390	100	17244	100	18001	100	18855	100	19609	100	20826						
	RURAL																		
	TOTAL	36710		40471		43363		46971		50581		57801							
	GRAND TOTAL	68276		76757		82523		89724		96925		111330							

TABLE 5.2.5 PROJECTION OF PERSONS PER HOUSEHOLD AND
NUMBER OF HOUSEHOLD

			1980	1986	1990	1995	2000	2010
Bayombong	Urban	Persons/HH	5.01	5.04	4.95	4.84	4.73	4.50
		No. of HH	2,977	3,461	3,827	4,307	4,815	5,936
	Rural		5.16	5.06	4.94	4.83	4.72	4.50
			3,227	3,746	4,092	4,535	4,994	5,959
	Total		5.09	5.04	4.95	4.84	4.72	4.50
			6,204	7,199	7,911	8,833	9,819	11,895
Solano	Urban		5.49	5.39	5.33	5.25	5.16	5.00
			3,703	4,309	4,758	5,355	6,002	7,395
	Rural		5.19	5.36	5.30	5.23	5.15	5.00
			3,156	3,217	3,396	3,605	3,808	4,165
	Total		5.35	5.38	5.31	5.24	5.16	5.00
			6,859	7,522	8,166	8,964	9,803	11,560
Grand Total		5.23	5.38	5.31	5.24	5.16	5.0	
		13,063	14,267	15,541	17,123	18,784	22,266	

5.3 POPULATION AND AREA TO BE SERVED BY THE PROPOSED WATER SUPPLY SYSTEM

The potential service area for the long term development plan was limited to a total of 15 barangays (9 barangays in Bayombong and 6 barangays in Solano), which are comprised of the poblacion area and its neighboring urban barangays of both municipalities. Some barangays along the present main pipeline route are also included in the potential service area, since they have been getting benefit from the existing water supply system.

One constraint for the expansion of the service area is the impracticality of including the areas situated on the right bank of the Magat River due to scattered low population and the absence of a bridge. Likewise, rural barangays have scattered habitation patterns and are not expected to form cluster-line urban barangays by the target year of 2010.

The potential service area identified for the long term development is shown in FIGURE 5.3.1.

The study area settled down for the short term development plan is the same as the present service area in consideration of population growth in the above mentioned potential service area and time constraints for improvement and expansion of the existing water supply system. The recommended service area for the immediate improvement is also shown in FIGURE 5.3.1.

To determine the percentage of the served population for the design years, the service area was classified into four (4) blocks considering the present water supply conditions, as follows:

- a. Masoc/La Torre area,
- b. Bayombong town proper,
- c. Bonfal area, and
- d. Solano town proper.

The present water supply status is summarized in TABLE 5.3.1.

As shown in TABLE 5.3.1 the served population percentage by barangay at present varies from 5% to 46%. However, the figure in the total system is only 20%. With respect to consumer status, the primary users occupies only 13% in the total system or two-thirds of the total number of domestic consumers.

The served population percentage for each design year is considered as follows:

Phase I - Stage 1 (1990)

- a) Main efforts in project implementation shall be focused on the improvement of major water supply facilities due to the limited time until the design year.

FIGURE 5.3.1

AREAS TO BE SERVED

LEGEND :

EXISTING SERVICE AREA

AREAS TO BE SERVED BY PHASE - I (1995)

AREAS TO BE SERVED BY PHASE - II (2010)

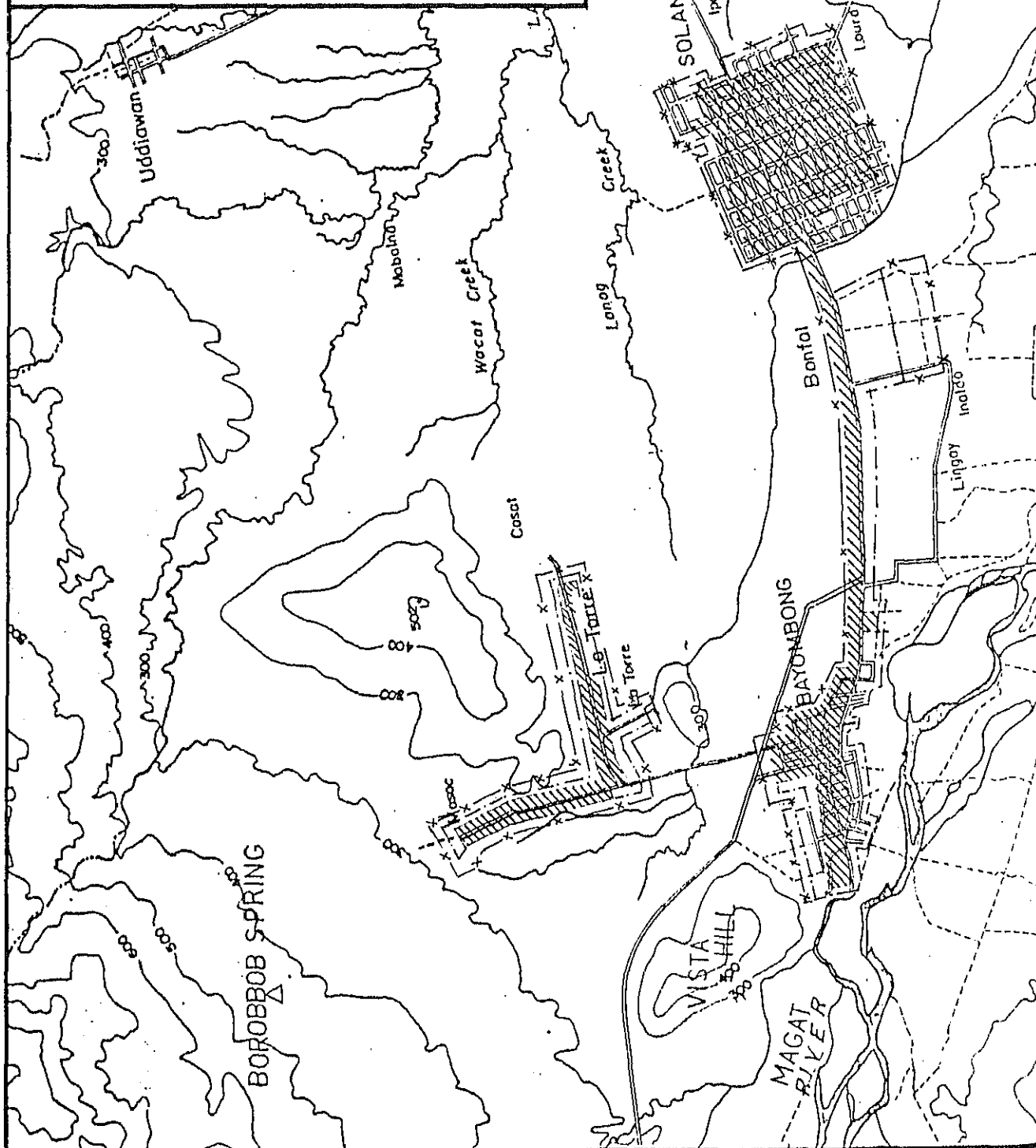


TABLE 5.3.1 PRESENT WATER SUPPLY STATUS

Service Area	Population	No. of Connection			P o p u l a t i o n S e r v e d				Served Population				
		House Public		Total	House Connections		Public	Faucet	TOTAL	Primary User	Borrower P.F.	Total	
		Conn.	Faucet		Primary	Borrower							
<u>Bayombong</u>													
District 1	7,002	140	0	140	706	318	1,024		1,024	3	2	5	15
District 2	3,274	22	0	22	11	50	161		161	31	15	46	
District 3	3,686	225	4	229	1,134	510	1,644	45	1,689	26	12	38	
District 4	3,482	183	0	183	923	415	1,338		1,338	16	8	24	
Sub Total	17,444	570	4	574	2,874	1,293	4,167	45	4,212	12	8	20	
La Torre	2,222	51	1	52	258	155	413	26	439	27	18	45	
Masoc	1,492	79	1	80	400	240	640	25	665	18	12	30	
Sub Total	3,714	130	2	132	658	395	1,053	51	1,104	0	0	0	
Bonfal East	1,622	-	-	-	-	-	-	-	-	7	3	10	
Bonfal Proper	2,900	40	0	40	202	91	293		293	7	3	10	
Bonfal West	2,242	31	0	31	157	71	228		228	5	2	8	
Sub Total	6,764	71	0	71	359	162	521		521	14	7	21	
TOTAL	27,922	771	6	777	3,891	1,850	5,741	96	5,837				
<u>Solano</u>													
Osmena	3,800	122	0	122	658	395	1,053	-	1,053	18	10	28	
Quezon	3,737	91	0	91	490	294	784		784	13	8	21	
Quirino	6,285	58	1	59	313	188	501	22	523	5	3	8	
Roxas	5,263	94	0	94	507	304	811		811	9	6	15	
Pob. North	1,868	82	0	82	442	265	707		707	24	14	38	
Pob. South	2,274	81	0	81	437	262	699		699	19	12	31	
TOTAL	23,224	528	1	529	2,847	1,708	4,555	22	4,577	13	7	20	
GRAND TOTAL	51,149	1,299	7	1,306	6,738	3,558	10,296	118	10,414	13	7	20	

- b) The expansion of served population shall be limited within the minimum level of service ratio given in TABLE 5.3.2 including borrowers in the respective service areas.
- c) Barangays, where the present served population percentage exceeds the minimum level given to respective service areas, will be kept at the same level, while lower barangay will be raised up to the target level.

Phase I - Stage 2 (1995)

- a) The served population percentage in the town proper service area is considered to be 60%. The population density by 1995 of the subject area is estimated at about 230 persons/ha in Bayombong and about 180 persons/ha in Solano. At present, there are about 192 persons/ha and about 120 persons/ha in Bayombong and Solano, respectively. The fact that these areas are the centers of communities with high economic activities was also taken into consideration.
- b) For Masoc/La Torre and Bonfal service areas, the served population percentage is considered to be 50% in respect to the habitation pattern and future land use plan established by the local government.

Phase II (2010)

- a) The town proper service area will be fully served by the water supply system.
- b) The Masoc/La Torre and Bonfal areas will be served at a ratio of 70% in respect to future land use and habitation pattern.

In addition to the above, all borrowers in the existing system will be provided with individual house connections and the existing public faucets will be changed to individual connections.

The Masoc/La Torre and Bonfal areas will have lower water supply service ratio due to their household distribution.

TABLE 5.3.2 MINIMUM LEVEL OF WATER SUPPLY SERVICE RATIO

Design Year Service Area	1986	1990	1995	2010
<u>Bayombong</u>				
Town proper	24	25	60	80
Masoc/La Torre	30	30	50	70
Bonfal area	8	10	50	70
<u>Solano</u>				
Town proper	20	20	60	80

The population to be served in respective design years is shown in TABLE 5.3.3.

TABLE 5.3.3 PLANNED SERVICE POPULATION

Design Year Population Service Area	1 9 8 6		1 9 9 0		1 9 9 5		2 0 0 0		2 0 0 5		2 0 1 0	
	Population	Served Population	Service %	Population	Served Population	Service %	Population	Served Population	Service %	Population	Served Population	Service %
Bayombong												
District 1	7,002	1,024	15	7,605	1,901	25	8,368	5,021	60	10,722	8,578	80
District 2	3,274	161	5	3,556	889	25	3,913	2,348	60	5,014	4,011	80
District 3	3,686	1,689	46	4,003	1,841	46	4,405	2,643	60	5,644	4,515	80
District 4	3,842	1,338	38	3,782	1,437	38	4,161	2,497	60	5,332	4,266	80
Sub Total	17,444	4,212	24	18,946	6,068	32	20,847	12,509	60	26,712	21,370	80
La Torre	2,222	439	20	2,539	762	30	2,778	1,389	50	3,497	2,448	70
Masco	1,492	665	45	1,740	783	45	2,074	1,037	50	2,963	2,074	
Sub Total	3,714	1,104	30	4,279	1,545	36	4,852	2,426	50	6,460	4,522	70
Bonfal East	1,622	-	-	2,011	201	10	2,206	1,103	50	2,800	1,960	70
Bonfal Proper	2,900	293	10	3,253	325	10	3,549	1,775	50	4,430	3,101	70
Bonfal West	2,242	228	10	2,432	243	10	2,674	1,337	50	3,403	2,382	70
Sub Total	6,764	521	8	7,696	769	10	8,429	4,215	50	10,633	7,443	70
TOTAL	27,922	5,837	21	30,921	8,382	27	34,128	19,150	56	43,805	33,335	76
Solano												
Osmeña	3,800	1,053	28	4,195	1,175	28	4,712	2,827	60	6,448	5,158	80
Quezon	3,737	784	21	4,124	866	21	4,631	2,779	60	6,323	5,058	80
Quirino	6,285	523	8	6,820	1,364	20	7,501	4,501	60	9,625	7,700	80
Roxas	5,263	811	15	5,826	1,165	20	6,568	3,941	60	9,070	7,256	80
Pob. North	1,868	707	38	2,021	768	38	2,216	1,330	60	2,814	2,156	80
Pob. South	2,274	699	31	2,376	737	31	2,488	1,493	60	2,695	2,156	80
TOTAL	23,227	4,577	20	25,362	6,075	24	28,116	16,871	60	36,975	29,579	80
GRAND TOTAL	51,149	10,414	20	56,283	14,457	26	62,244	36,021	58	80,780	62,914	78

5.4 WATER DEMAND PROJECTION IN THE PROPOSED SERVICE AREA

5.4.1 General

Based on the results of the various field surveys, the design unit water consumption by consumer type is established and the water demand in each design year is projected.

To determine the level of domestic unit water consumption, the present water supply conditions and water use, as well as the socio-economic conditions are taken into account. The domestic unit water consumption in each design year is then adjusted. For the commercial and institutional unit water consumptions, the LWUA Methodology Manual is adopted in principle. In planning the required capacity of water supply facilities, the factors to estimate the daily maximum and hourly maximum water demands are also determined.

5.4.2 Design Unit Water Consumption by Consumer Type

(1) Domestic Unit Water Consumption

The domestic unit water consumption at present was estimated by sub-area using the served population including borrowers as follows:

Bayombong	105	lpcd
Solano	90	"
Masoc/La Torre	350	"
Bonfal area	105	"

To determine the unit water consumption in the base year for domestic use, the following considerations are given:

- a) The Masoc/La Torre area shows high level of water consumption owing to the 24-hour continuous supply with high pressure, but a lot of leakage and wastage have been observed in the said area. When the proper improvement and water metering program are instituted, such consumption level may be reduced more or less to the same level as that in the town proper area.

- b) The socio-economic conditions and living standard of the above mentioned sub-areas are almost same.

Accordingly, a uniform unit water consumption for the base design year of 1986 is assumed to be 100 l/day.

The design unit water consumption for the short term development (1990/1995) and the long term development (2010) is estimated using an annual increase ratio in the LWUA Methodology Manual as shown in TABLE 5.4.1.

TABLE 5.4.1 DESIGN UNIT WATER CONSUMPTION FOR DOMESTIC USE

Design Year	Unit: lpcd			
	1986	1990	1995	2010
Bayombong & Solano	100	110	120	135

(2) Commercial and Institutional Unit Water Consumption

Although the field survey results were used as a basis for determining the unit water consumption for both commercial and institutional water use, they were based only on the limited number of existing service connections.

On the other hand, a number of potential users in these consumer groups are expected to appear when the existing water supply system is improved.

Considering the said conditions, it is deemed practical to adopt the unit consumption rates based on the LWUA Methodology Manual. A summary of estimation procedure is shown in TABLE 5.4.2.

TABLE 5.4.2 SUMMARY OF COMMERCIAL/INSTITUTIONAL
UNIT WATER CONSUMPTION

Connection	Year	Commercial Use	Institutional Use
Connection	1986	1.0/100 inhabitants	One connection per every
Density	1990	1.1/100 "	2,000 inhabitants in the
Ratio	1995	1.2/100 "	service area
	2010	1.7/100 "	
Unit Water	1986	1.0	3.4
Consumption	1990	1.3	4.5
(cu.m/conn.day)	1995	1.4	5.2
	2010	2.0	7.5

(3) Public Faucet

The total number of existing public faucets is only 7 against the total of 1,345 connections in the present service area. Two of these public faucets are in Masoc/La Torre area and the rest are located in the public market of Bayombong and Solano town proper. Considering the limited number of users (118 persons or 21 households based on the interview) and that the installation of public faucets has been limited by the Provincial Waterworks Office, it is deemed practical to replace these public faucets with individual service connections. Therefore, no unit water consumption is required for the target years of short/long term developments.

(4) Miscellaneous Agrofisbery Use

This special purpose of water, which is discussed in the section of the present water consumption, is considered to be unnecessary for future design years. When the water metering is introduced to all the service connections, this kind of water use will not be observed.

5.4.3 Water Demand Projection

(1) Unaccounted-for Water

In the existing water supply system, the unaccounted-for water/ not utilized water is estimated at 60% of the total distributed amount.

During the implementation of the short term development plan, it is planned to reduce the said percentage to 40% by 1990 and 30% by 1995.

By the year 2010, the ratio of unaccounted-for water is planned to be achieved at a level of 20%.

(2) Estimation of Future Water Consumption

The water consumption for each design year is estimated based on the afore-mentioned planned service population and design unit water consumption by consumer type.

A summary of the future water consumption is presented in TABLE 5.4.3 and the breakdown in each design year is shown in TABLES 5.4.4 to 5.4.6 on the daily average basis.

TABLE 5.4.3 SUMMARY OF FUTURE WATER CONSUMPTION (DAILY AVERAGE)

		Unit: cu.m/day		
Design Year	Consumer Type	Bayombong	Solano	Total
1990	Domestic	923	667	1,590
	Commercial	121	87	208
	Institutional	30	15	45
	Sub-Total	1,074	769	1,843
	Unaccounted-for Water	718	514	1,232
	TOTAL	1,792	1,283	3,075
1995	Domestic	2,298	2,024	4,323
	Commercial	320	283	603
	Institutional	56	40	96
	Sub-Total	2,674	2,347	5,021
	Unaccounted-for Water	1,146	1,006	2,152
	TOTAL	3,820	3,353	7,173
2010	Domestic	4,501	3,994	8,495
	Commercial	1,134	1,006	2,140
	Institutional	122	122	244
	Sub-Total	5,757	5,122	10,879
	Unaccounted-for Water	1,441	1,281	2,722
	TOTAL	7,198	6,403	13,601

5.4.4 Demand Variations

The ratio of the daily maximum water demand and the peak hour water demand is established as a function of the served population in respective design years.

(1) Daily Maximum Water Demand

The ratio of the daily maximum water demand to the daily average water demand is determined in relation to the planned service population as shown in TABLE 5.4.7.

TABLE 5.4.4 WATER CONSUMPTION IN 1990 (Daily Average)

Service Area	Served Population	No. of Connections			Water Consumption (cu.m/day)					Unaccounted for Water	Total
		Domestic	Commercial	Insti-tutional	Total	Domestic	Commercial	Insti-tutional	Total		
Bayombong											
District 1	1,901	384	21	1	406	209	27	5	241	161	402
District 2	889	180	10	0	190	98	13	0	111	74	185
District 3	1,841	372	20	1	393	203	26	5	234	156	390
District 4	1,437	290	16	1	307	158	21	5	184	123	307
Sub Total	6,068	1,226	67	3	1,296	668	87	15	770	514	1,284
La Torre Masco											
	762	154	8	1	163	84	10	5	99	66	165
	783	159	9	1	169	86	12	5	103	69	172
Sub Total	1,545	313	17	2	332	170	22	10	202	135	337
Bonfal East	201	41	2	0	43	22	3	0	25	17	42
Bonfal Proper	325	66	4	1	71	36	5	5	46	31	77
Bonfal West	243	49	3	0	52	27	4	0	31	21	52
Sub Total	769	156	9	1	166	85	12	5	102	69	171
TOTAL	8,382	1,695	93	6	1,794	923	121	30	1,074	718	1,792
Solano											
Osmeña	1,175	220	13	1	234	129	17	5	151	101	252
Quezon	866	162	10	0	172	95	13	0	108	72	180
Quirino	1,364	256	15	1	272	150	20	5	175	117	292
Roxas	1,165	219	13	1	233	128	17	5	150	100	250
Pob. North	768	144	8	0	152	84	10	0	94	63	157
Pob. South	737	138	8	0	146	81	10	0	91	61	152
TOTAL	6,075	1,139	67	3	1,209	667	87	15	769	514	1,283
GRAND TOTAL	14,457	2,834	160	9	3,003	1,590	208	45	1,843	1,232	3,075

TABLE 5.4.5 WATER CONSUMPTION IN 1995 (Daily Average)

Service Area	Served Population	No. of Connections			Water Consumption (cu.m/day)				Total	Unaccounted for Water.	Total	
		Domestic	Commercial	Insti-tutional	Total	Domestic	Commercial	Insti-tutional				
Bayombong												
District 1	5,021	1,037	60	3	1,100	603	84	16	703	301	1,004	
District 2	2,358	485	28	1	514	282	39	5	326	140	466	
District 3	2,643	546	32	1	579	317	45	5	367	157	524	
District 4	2,497	516	30	1	547	300	42	5	347	149	496	
Sub Total	12,509	2,584	150	6	2,740	1,502	210	31	1,743	747	2,490	
La Torre Masco												
La Torre	1,389	288	17	1	306	167	24	5	196	84	280	
Masco	1,037	215	12	1	228	124	17	5	146	63	209	
Sub Total	2,426	503	29	2	534	291	41	10	342	147	489	
Bonfal East												
Bonfal East	1,103	228	13	1	242	132	18	5	155	66	221	
Bonfal Proper	1,775	367	21	1	389	213	29	5	247	106	353	
Bonfal West	1,337	277	16	1	294	160	22	5	187	80	267	
Sub Total	4,215	872	50	3	925	505	69	15	589	252	841	
TOTAL												
	19,150	3,959	229	11	4,199	2,298	320	56	2,674	1,146	3,820	
Solano												
Osmeña	2,827	538	34	1	573	339	48	5	392	168	560	
Quezon	2,779	529	33	1	563	333	46	5	384	165	549	
Quirino	4,501	857	54	2	913	540	76	10	626	268	894	
Roxas	3,941	751	47	2	800	473	66	10	549	235	784	
Pob. North	1,330	253	16	1	270	160	22	5	187	80	267	
Pob. South	1,493	284	18	1	303	179	25	5	209	90	299	
TOTAL												
	16,871	3,212	202	8	3,422	2,024	283	40	2,347	1,006	3,353	
GRAND TOTAL												
	36,021	7,171	431	19	7,621	4,322	603	96	5,021	2,152	7,173	

TABLE 5.4.6 WATER CONSUMPTION IN 2010 (Daily Average)

Service Area	Served Population	No. of Connections			Water Consumption (cu.m/day)				Unaccounted for Water	Total
		Domestic	Commercial	Insti-tutional	Total	Domestic	Commercial	Insti-tutional		
Bayombong										
District 1	8,578	1,906	146	4	2,056	1,158	292	30	1,480	1,850
District 2	4,011	891	68	2	961	541	136	15	692	865
District 3	4,515	1,003	77	2	1,082	610	154	15	779	974
District 4	4,266	948	73	2	1,023	576	146	15	737	921
Sub Total	21,370	4,748	364	10	5,122	2,885	728	75	3,668	4,610
La Torre										
Masco	2,448	544	42	1	587	330	84	8	422	528
	2,074	461	35	1	497	280	70	8	358	448
Sub Total	4,522	1,005	77	2	1,084	610	154	16	780	976
Bonfal East										
Bonfal Proper	1,960	436	33	1	470	265	66	8	339	424
Bonfal West	3,101	689	53	2	744	419	106	15	540	675
	2,382	529	40	1	570	322	80	8	410	513
Sub Total	7,443	1,654	126	4	1,784	1,006	252	31	1,289	1,612
TOTAL	33,335	7,407	567	16	7,990	4,501	1,134	122	5,757	7,198
Solano										
Osmeña	5,158	1,032	88	3	1,123	696	176	23	895	1,119
Quezon	5,058	1,012	86	3	1,101	683	172	23	878	1,098
Quirino	7,700	1,540	131	4	1,675	1,040	262	30	1,332	1,665
Roxas	7,256	1,451	123	4	1,578	980	246	30	1,256	1,570
Pob. North	2,251	450	38	1	489	304	76	8	388	485
Pob. South	2,156	431	37	1	469	291	74	8	373	466
TOTAL	29,579	5,916	503	16	6,435	3,994	1,006	122	5,122	6,403
GRAND TOTAL	62,914	13,323	1,070	32	14,425	8,495	2,140	244	10,879	13,601

TABLE 5.4.7 DEMAND VARIATION FACTOR FOR DAILY
MAXIMUM WATER DEMAND

Service Population	Ratio (Daily Max./Daily Ave.)
Less than 30,000	1.30 : 1
30,000 to 200,000	1.25 : 1
Over 200,000	1.20 : 1

The estimated daily maximum water demand by respective service area is shown in TABLE 5.4.8.

TABLE 5.4.8 DAILY MAXIMUM WATER DEMAND

Municipality	Unit: cu.m/day		
	1990	1995	2010
Bayombong	2,330	4,780	9,000
Solano	1,670	4,190	8,000
Total	4,000	8,970	17,000

(2) Peak Hour Water Demand (Hourly Maximum Water Demand)

The peak hour water demand is estimated in proportionate to the daily maximum water demand and service population as show below:

$$C = (\text{Peak Hour Demand} \times 24) / (\text{Daily Maximum Demand})$$

$$= 2.2 - 0.3 \times \log (\text{Service Population} / 1,000)$$

The ratio of peak hour water demand for each design year is calculated as follows:

Phase I - Stage I (1990) : 1.85
 Stage II (1995) : 1.73
 Phase II (2010) : 1.66

TABLE 5.4.9 shows the peak hour water demand in each design year on the municipal level.

TABLE 5.4.9 PEAK HOUR WATER DEMAND

Municipality	Unit: cu.m/day		
	1990	1995	2010
Bayombong	4,310	8,270	14,940
Solano	3,090	7,250	13,280
Total	7,400	15,520	28,220

5.4.5 Number of Connections

Number of connections by consumer type were projected based on the previous study and presented in TABLE 5.4.4 to 5.4.6.

CHAPTER 6

WATER RESOURCES

CHAPTER 6 WATER RESOURCES

6.1 GENERAL

The BSWS obtains its water supply solely from the Borobbob Spring. The Borobbob Spring is situated approximately 6.6 km northwest of Bayombong Poblacion and is located some 435 m above the mean sea level (hereinafter referred to as MSL).

The rest of the barangays not served by the BSWS depend mainly on shallow wells for their daily water needs. These wells were drilled by the Ministry of Public Works and Highways (hereinafter referred to as MPWH). A number of municipal consumers have private shallow wells fitted with manual pumps or dugwells with "pulley rope and bucket."

6.2 METEOROLOGY

6.2.1 Rainfall and Temperature

The Municipalities of Bayombong and Solano are classified under the third type of climate characterized as relatively dry from November to April and wet during the rest of the year.

The average annual rainfall is 2,210.2 mm/year while peak monthly precipitation reaches an average of 407 mm. A fairly uniform temperature prevails over the study area with an annual average of 26°C.

The average rainfall and temperature is summarized in TABLE 6.1.1.

TABLE 6.1.1 CLIMATOLOGICAL DATA BAYOMBONG-SOLANO, NUEVA VIZCAYA

Month	Average Rainfall (mm) ^{1/}	Average Temperature (°C) ^{2/}
January	29.0	23.7
February	17.2	26.0
March	41.3	28.4
April	84.6	29.9
May	221.0	26.7
June	240.8	26.7
July	391.9	26.1
August	406.7	25.6
September	313.3	25.9
October	254.4	25.1
November	152.0	25.2
December	58.0	23.5
Yearly Average	2210.2	26.1

^{1/} Measurements done at Salinas Consuelo, Dupax, Bokod, and Itogon weather and hydrographic stations.

^{2/} Measurements done at Bagabag and Bambang stations.

6.2.2 Evapotranspiration

The value of the evapotranspiration was estimated using the Turc's formula as shown below:

$$E = \frac{P}{\sqrt{0.9 + P^2/L^2}}$$

where: E = Effective evapotranspiration in mm/year

P = Average yearly precipitation in mm

T = Average temperature in °C

L = $300 + 25T + 0.05 T^3$

The evapotranspiration value was calculated at 1,455 mm/year so that 765 mm/year is available for run-off and groundwater infiltration.

6.3 GEOMORPHOLOGY

The topography of Bayombong and Solano is characterized by rugged terrains in the elevated uplands and rolling ones on the foothills. On the southeastern sector, lie an alluvial plain and a river valley. At the western and eastern sides of the study area, the terrain rises steeply from the plain area in a generally north-south direction.

There are several drainage channels that cut across the study area and generally originate on the eastern and western rolling hills. However, most of them are intermittent. Only the Magat and Matuno Rivers are perennial surface water bodies. The water flow of the perennial streams is diverted for irrigation purposes.

The alluvial plain deposits are commonly planted with rice, while the rolling and moderately sloping part underlain by relatively young formations are planted with fruit-bearing trees, forest trees, shrubs and other tropical grasses.

6.4 GEOLOGY

The Cretaceous to Paleogene formations dominate the basement complex of the northern part of the Luzon Island, while the Tertiary formation starts to develop in a north-northeast to north direction over the study area. The geological map and geological cross-section are shown in FIGURES 6.4.1 and 6.4.2, while the composition of the stratigraphic unit is outlined below.

- The Cretaceous to Paleogene sedimentary and metamorphic rocks (kpg) consist mostly of undifferentiated graywacke and metamorphosed shale with spilite, basic flows and pyroclastics. Essentially spilitic and basic flows are usually intercalated with graywackes and transgressive on basement rocks.
- The Cretaceous to Paleogene extrusives (UV) consist of metamorphosed submarine flows of largely spilite and basalt with some keratophyres and andesites. Locally, the rock unit is intercalated with chert and marble. Generally, these extrusive units cover most part of the mountain flank situated east of the Magat River and underlie in other side of the Magat River. The permeability of the rocks comprising these stratigraphic sequence is very poor, thus, deepwells drilled in this area can produce only small amount of water for limited consumption.
- The lower to Middle Miocene rocks (N1), consist of conglomerates, wackes, shales, and reef limestone associated with basic to intermediate flows and pyroclastics. These lithologic units can be observed on

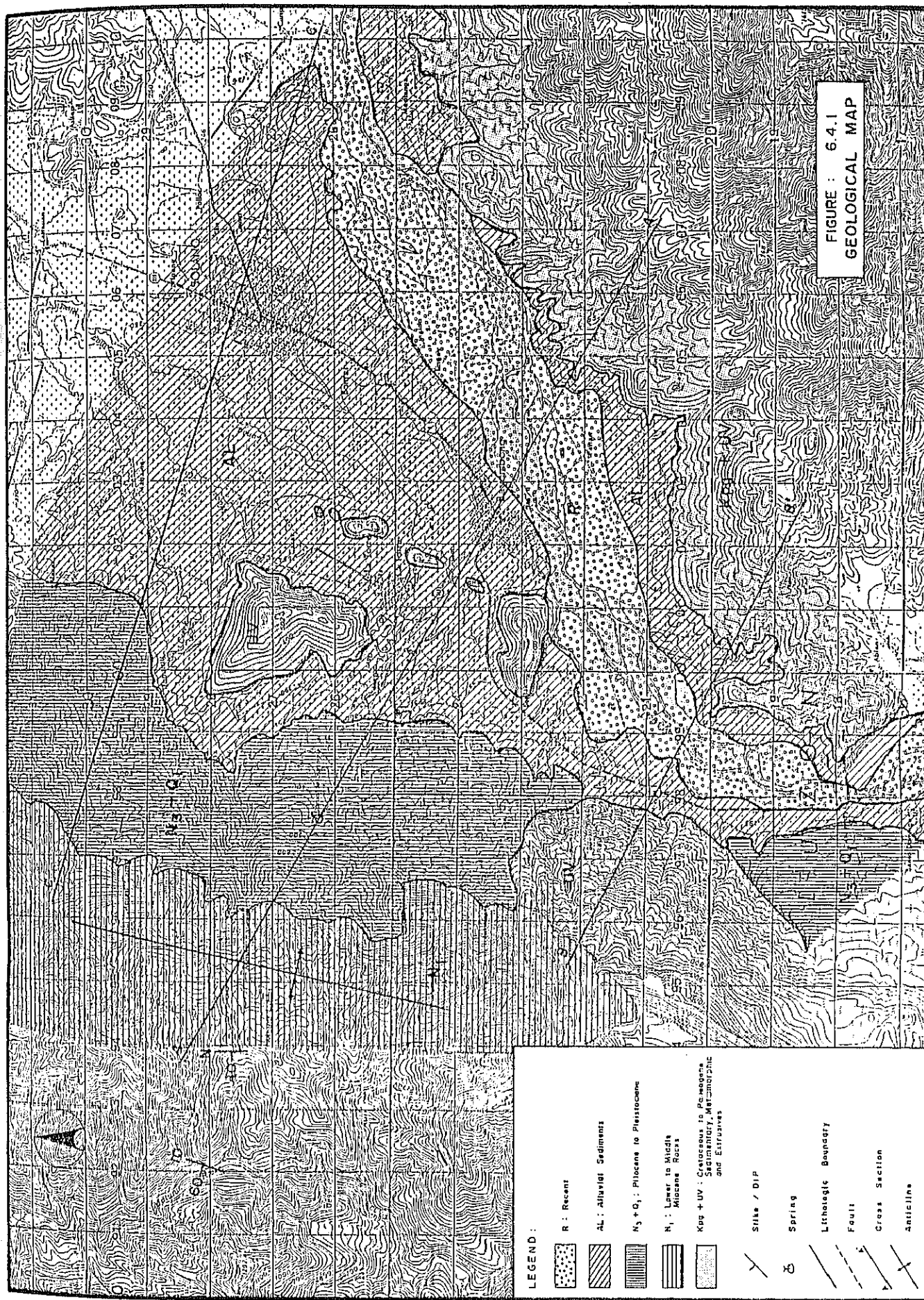
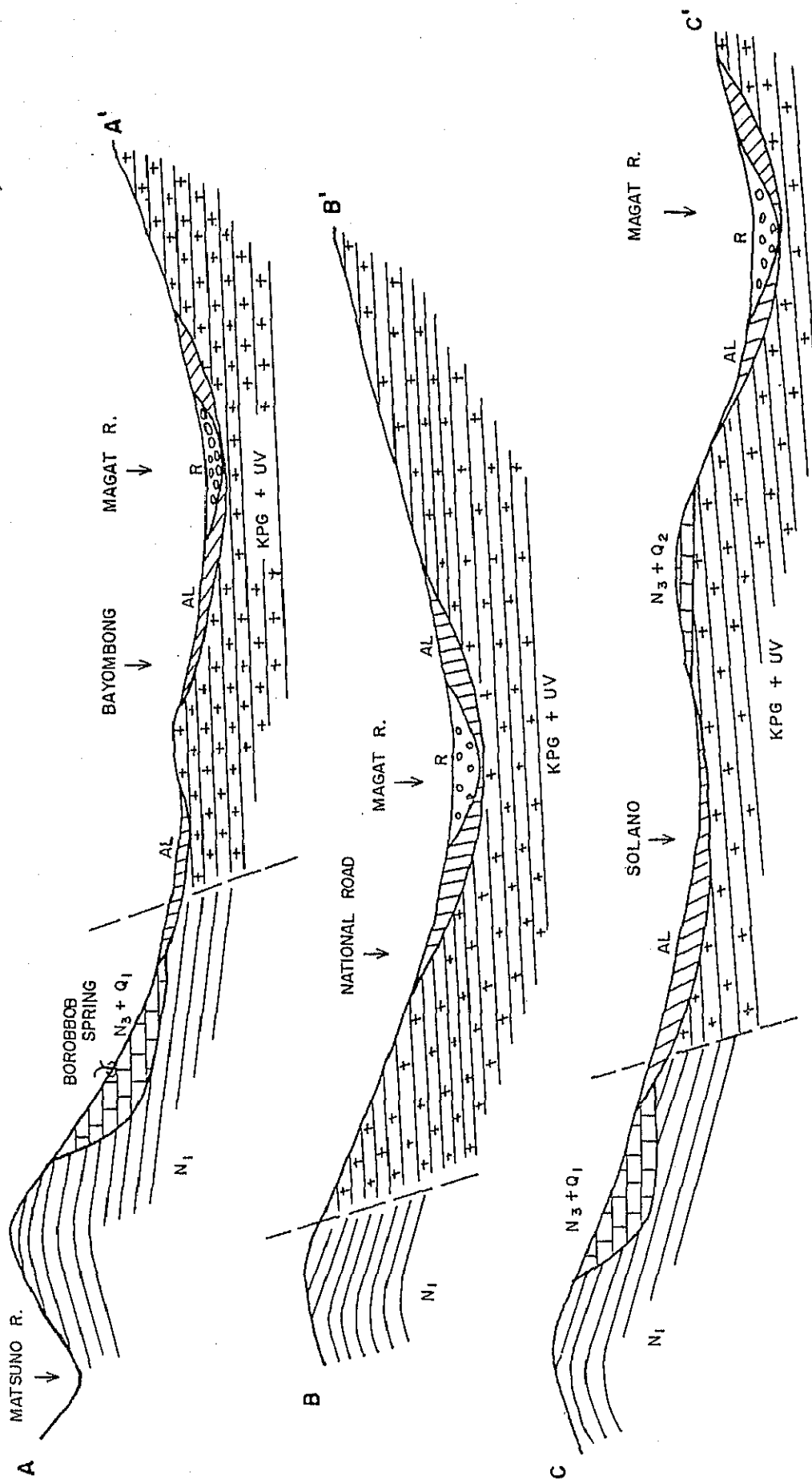


FIGURE 6.4.2 SCHEMATIC GEOLOGIC CROSS SECTION
 H = 1: 50,000
 SCALE APPROX.
 V = 1: 2,000



6.5 SURFACE WATER

Additional supply of water from surface water is necessary to meet the long term water demand of the BSWS.

The study area is traversed by small creeks and rivers with adequate flow but not being practicable for water supply purposes. The Matuno and Magat Rivers are the only surface water bodies passing close or within the boundaries of Bayombong-Solano study area.

6.5.1 Magat River

The National Irrigation Administration (hereinafter referred to as NIA) has initiated a water resource development study for the Magat River Basin covering the Magat and the Siffu Malig River Basins and numerous watersheds located in Isabela Province. The basin has a drainage area of 6,830 sq.km of which 32% is in Nueva Vizcaya.

The Magat River Basin originates from the Caraballo Mountain and flows a northeasterly direction for about 135 km and joins the Cagayan River at Naguillan, Isabela. The basin is characterized by Type III climate where the seasons are not very pronounced, i.e., respectively dry from November to April and rainy during the rest of the year.

The MPWH has established eight streamflow gauging stations, one of which is located alongside the Magat River at Barangay Bato, Bayombong. The drainage area at this point is 1,784 sq.km and discharge measurements were recorded from 1959-1970. Based on the available records, the minimum flow of the river ranges from 1.5 to 37.6 cu.m/sec as shown in TABLE 6.5.1.

The minimum flow of the Magat River can be expected to meet the 2010 long term water requirements of the BSWS.

TABLE 6.5.1 ANNUAL MINIMUM FLOW OF MAGAT RIVER,
BAYOMBONG, NUEVA VIZCAYA

<u>Year</u>	<u>Minimum Flow (cu.m/sec)</u>
1959	6.08
1960	16.6
1961	11.78
1962	0
1963	5.1
1964	8.72
1965	24.12
1966	4.5
1967	37.6
1968	11.1
1969	2.8
1970	1.5

6.5.2 Matuno River

The Matuno River, a major tributary of the Magat River, collects water from the mountain slopes in the west of the study area and traverses the southeastern portion of Bayombong and Solano. The MPWH has constructed a gauging station along the river at Barangay Bante, Bambang. It drains an area of approximately 558 sq.km and the recorded minimum flow of the river ranges from 3 to 18.54 cu.m/sec as listed in TABLE 6.5.2.

TABLE 6.5.2 ANNUAL MINIMUM FLOW OF MATUNO RIVER,
BAYOMBONG, NUEVA VIZCAYA

<u>Year</u>	<u>Minimum Flow (cu.m/sec)</u>
1957	16.5
1958	18.54
1959	13.35
1960	16.16
1961	11.30
1962	13.40
1963	16.0
1964	14.3
1969	3.6
1970	3.0

Likewise, the minimum flow of the Matuno River is also sufficient to meet the additional water requirements of the study area.

6.6 GROUNDWATER

6.6.1 Springs

Numerous springs exist along the flanks of the limestone hills extending northwest and southwest of the study area. The spring water are usually produced from fractures of rocks and most of them are seasonal and believed to be active only during rainy season.

Borobbob Spring

The Borobbob Spring is the only spring of major importance nearest the study area. It originates at the slopes of Mt. Pawac at an altitude of 435 m above the mean sea level. It presently supplies the water requirements of the the BSWS. The total yield of the spring as measured in last April, 1986, was 11,000 cu.m/day while measurement in July, 1986 revealed a flow of about 6,100 cu.m/day. Of the total amount, only about 4,900 cu.m/day is conveyed to the reservoir. The spring water maybe assumed to emanate from limestone fractures or from a natural cave.

During periods of heavy rains, water becomes moderately turbid probably due to the suspended silt and clay particles coming from the aquifer.

6.6.2 Water Point Inventory

A water point inventory was developed within the surrounding areas of Bayombong and Solano in order to assess the present groundwater conditions. The inventory included water level and temperature measurements of wells and conductivity surveys of both ground and surface water resources.

Wells

Majority of the wells in Bayombong-Solano area were drilled at shallow depths not exceeding 50 m below ground surface.

The data for the 46 wells drilled both by the MPWH and private well drillers are presented in TABLE 6.6.1 and their locations are shown in FIGURE 6.6.1. However, only 24 well lithologic logs are available and are presented in APPENDIX 6.6.2.

The low specific capacity values reflected on the results of test pumping data taken from the MPWH records indicate that these wells are capable of yielding only small amount of water for limited consumption. The thickness of the aquifer could not be determined since the MPWH has drilled only a certain depth where the alluvial sediments were partially tapped.

The MPWH wells range from 6 to 67 m in depth and have casing diameters of 32 to 150 mm. Based on the available lithologic logs, the well inventory maybe summarized as follows:

- a) LWUA-JICA well Nos. 1, 11, 14, 23, 29, 33, 35 and 43 obtain groundwater from the alluvial sediments. Some have penetrated into a thin weathered portion of the alluvial sequence overlying the Cretaceous to Paleogene extrusives.
- b) LWUA-JICA well Nos. 11 and 43 were drilled along the flood plains of the Magat River down to depths of 9.2 and 25 m, respectively. The borehole logs show that these wells encountered sand and gravel layers of unknown thickness.
- c) LWUA-JICA well Nos. 14, 23, 29, 33 and 35 were drilled within the urban centers of Bayombong and Solano to a depth not exceeding 15 m below ground surface encountering the alluvial sediments of sand and gravel.
- d) LWUA-JICA well No. 40 was drilled at the northwestern end of the alluvial formation down to a depth of 71.3 m below ground surface. The driller's lithologic description of brown clay may not mean the sediments belonging to alluvial formations but maybe interpreted as that comprising the extrusives of Cretaceous and Paleogene rock formations.
- e) The driller's classification of sandstone reported in some lithologic logs may correspond to cemented fine sandy tuff.

TABLE 6.6.1 WATER WELL DATA SUMMARY

Owner's Number	LWUA JICA Well Number	Location	Eleva- tion (m)	Comple- tion Date	Well Depth (m)	Casing Depth (m)	Casing Dia. (mm)	Static Water Level (mbgs)	Conductivity (micro- Siemens/cm)	Water Temperature (°C)
52-85-03	1	Uddiawan, Solano	280	1985	12	12	32	7.2	660	33
	2	Uddiawan, Solano	260	1965	6	6	32	5.0	700	29
	3	Uddiawan, Solano	250	1972	6	6	32	5.1	660	29
6766	4	Lattawan, E/S	278	8-13-54	40		112	4.6	590	29
9048	5	Solano	245	10-28-55	5.2	4.9	150	1.6	530	29
	6	Aggub, Solano	250	1978	6	6	32	2.1		
	7	Mapaina, Solano	246	1981	6	6	32	1.9	540	29
	8	San Luis, Solano	250		6	6	32	3.0	660	29
52-84-07	9	Polloc, Solano	320	2-8-84	31.2	25.2	125	12.0	160	27
6909	10	Concepcion Bliss	245	2-28-55	17.1	14.6	150	9.4	690	28
20973	11	Solano	230	7-4-58	9.2			1.8	470	27.5
52-76-20	12	Bangar, Solano	265	8-4-76			125	FF	450	30
52-76-30	13	Casat E/S, Rayombong	260	11-27-76	24.4	12.2	112	2.1	550	28
40601	14	Wacal E/S, Bayombong	250	2-19-60	13.7			0.9		
6761	15	Solano North E/S, Solano	250	6-1-57	23.2			0.9		
	16	Public Market	247		4.5	4.0	32	0.5	900	29
52-82-10	17	Solano	245	1-20-83	15.2	10.4	125	4.2		
52-85-03	18	Curipang, Solano	240	7-12-85	18.5	125	4.1			
	19	Bugnay, Quirino	260		15.0	14.0	1000	11.2	150	27.5
	20	Solano	295	1980			32	2.2	570	27
52-82-07	21	Curipang, Solano	280							
	22	Masoc, Bayombong	280	12-12-82	24.5	21.4	125	1.8	490	29
9042	23	La Torre E/S	265	12-13-82	23.0	21.9	125	2.9	610	28
		Bayombong								
		Luyang, Bayombong								
		Bonfal Sch.								
		Bayombong		10-15-55	7.6	7.0	150	2.8	410	29

TABLE 6.6.1 WATER WELL DATA SUMMARY (cont'd)

Owner's Number	LWUA JICA Well Number	Location	Eleva- tion (m)	Comple- tion Date	Well Depth (m)	Casing Depth (m)	Casing Dia. (mm)	Static Water Level (mbgs)	Conductivity (micro- Siemens/cm)	Water Temperature (°C)
44	24	Bonfal, Bayombong	264		20.1		112	2.0	420	29
	25	Inaldo, Bayombong	263				32	1.2	430	28.5
	26	Lingay, E/S Bayombong	272				112	1.3		
52-02-84	27	Inaldo, Bayombong	255				32	1.8	340	28
	28	Luyong North, Bayombong	270	6-29-84	29.6	22.0	125	1.7	530	30
52-76-31	29	Bayombong West, E/S Bayombong	265	11-30-76	12.8	12.8	112	1.2		
52-80-01	30	MPWH Off. Bayombong	270	1-31-80	15.2	14.6	125	2.2	610	33
53-83-02	31	MFEMVRH, Bayombong	290	9-1-83	30.0		150	2.6	520	29
52-76-25	32	MFEMVRH, Bayombong	290	8-21-84	18.6	16.8	125	2.7	520	29
	33	Bayombong Central Sch. Bayombong	270	8-6-76	15.2	12.2	112	1.7		
52-83-03	34	NVSIT, Bayombong	285	1983	30.5	16.5	125	1.8	580	30
52-76-06	35	Div. Off. Bayombong	270	9-3-76	10.7	10.7	38	1.6	210	28
	36	Bangan Hills, Bayombong	290				100	3.1	210	28
52-82-02	37	- do -	290				100	2.9	200	28
	38	- do -	290				100	2.9	200	28
52-82-25	39	Victa Alegre Bayombong	275	2-3-83	15.5	14.4	125	6.8		
6760	40	Busilac Sch. Bayombong	300					18.5	550	28
46	41	- do -	290				100	3.1	210	28
52-85-04	42	Busilac, Bayobmong	290	8-21-85	25.0	18.0	125	2.6	350	28.5
	43	Latuyot, Magapuy Bayombong	290					4.5	1000	26
	44	Bayombong	290				32	2.6	1000	26
52-76-19	45	Vista Hills, Ibung, Solano	300	7-22-76	24.4	13.7	112	2.9	610	28
	46		230	12-2-55	47.3			7.9		

