4.4 WATER CONSUMPTION

4.4.1 General

The available data on water consumption in the service area were those for the month of June, 1986. The total number of connections including the domestic, institutional and commercial connections by barangay is shown in TABLE 4.2.4. The water consumption by barangay during the month of June was also provided by the Provincial Office.

The per capita consumption was estimated based on the daily water consumption and estimated population served in consideration of secondary users/borrowers. The total water consumption is the amount of the metered consumption plus the estimated amount of the unmetered consumption.

4.4.2 Cabuyao-Sta. Rosa-Biñan Waterworks

The water consumption by metered connections and by consumer type for the month of June, 1986 is summarized below (water consumption by barangay is given in APPENDIX 4.4.1).

Consumer Type	Water Consumption (metered)
Domestic	2,942 cu.m/day
Commercial	65 "
Institutional	10 "
Industrial	134 "
Total	3,151 cu.m/day

(1) Unit Water Consumption

The unit water consumption by consumer type was estimated using the data on the water consumption by metered users.

a) Domestic Connection

An interview with concessionaires, covering all the existing service areas was conducted to get information on the served population, which included the primary users/borrowers. The interview results revealed that there are a considerable number of secondary users/borrowers. (Details are given in APPENDIX 4.5.1)

The average percentage of the secondary users/borrowers against the primary users for each Municipality is given below:

Cabuyao Area	:	20%
Sta. Rosa Area	:	40%
Biñan Area	:	50%

The average unit water consumption by municipality was estimated based on the daily consumption and the served population obtained from investigations. TABLE 4.4.1 shows the daily per capita/connection water consumption. The average figure in the total system is 151 lpcd or 1.231 cu.m/conn.day. This figure is larger than the common figure in other municipalities. The per capita consumption by barangay ranges from 90 to 175 lpcd. The following are the average figures in the three municipalities:

Cabuyao	:	173.6 lpcd, 1.250 cu.m/conn.day
Sta. Rosa	:	151.7 lpcd, 1.274 cu.m/conn.day
Biñan	:	121.7 lpcd, 1.094 cu.m/conn.day
Total	:	150.8 lpcd, 1.231 cu.m/conn.day

Although the overall average figure is calculated at 151 lpcd, the average figure of majority of metered domestic connections is about 120 lpcd. The calculation basis is given in TABLE 4.4.2. TABLE 4.4.3 shows the basic data on the water consumption by the range of water consumption.

TABLE 4.4.1 DAILY PER CAPITA/CONNECTION WATER CONSUMPTION : METERED CONNECTIONS

Municipality	Barangay	Daily Water Consumption (cu.m/day)	No. of Connections	Served Population			Unit Consumption		Remarks
				Primary	Secondary	Total	lpcd	cu.m/conn.day	
Cabuyao	1 Barangay I	252.4	203	1,218	244	1,462	172.6	1.243	Secondary user = 20% of primary user
	2 Barangay II	221.4	178	1,608	214	1,282	172.7	1.244	
	3 Barangay III	165.3	130	780	156	936	176.6	1.272	
	4 Bigaa	124.7	99	594	119	713	174.9	1.260	
	5 Sala	135.0	109	654	131	785	172.0	1.239	
	Sub-Total	898.8	719	4,314	864	5,187	173.6	1.250	
Sta. Rosa	1 Aplaya	38.5	32	192	77	269	143.1	1.203	Secondary user = 40% of primary user
	2 Balibago	392.0	278	1,668	667	2,335	167.9	1.410	
	3 Barangay I	149.1	126	756	302	1,058	140.9	1.183	
	4 Barangay II	243.0	191	1,146	458	1,604	151.5	1.272	
	5 Barangay III	40.4	32	192	77	269	150.2	1.263	
	6 Dila	17.9	19	114	46	160	111.9	0.942	
	7 Dita	253.7	202	1,212	485	1,697	149.5	1.256	
	8 Ibaba	76.1	64	384	154	538	141.4	1.189	
	9 Labas	75.0	52	312	125	437	171.6	1.442	
	10 Macabling	13.4	13	78	31	109	122.9	1.031	
	11 Tagapo	214.6	179	1,074	430	1,504	142.7	1.199	
	Sub-Total	1,513.7	1,188	7,128	2,852	9,980	151.7	1.274	
Biñan	1 De La Paz	13.2	14	84	42	126	104.8	0.943	Secondary user = 50% of primary user
	2 Malaban	7.9	8	48	24	72	109.7	1.228	
	3 Platero	70.0	57	342	171	513	136.5	1.228	
	4 Poblacion	62.3	64	384	192	576	108.2	0.973	
	5 San Antonio	309.4	263	1,578	789	2,367	91.0	1.176	
	6 San Jose	25.4	31	186	93	279	91.0	0.819	
	7 San Vicente	33.2	38	228	114	342	97.1	0.874	
	8 Sto. Domingo	7.8	8	48	24	72	108.3	0.975	
	Sub-Total	529.2	483	2,898	1,449	4,347	121.7	1.096	
TOTAL		2,941.7	2,390	14,340	5,165	19,505	150.8	1.231	

TABLE 4.4.2 WATER CONSUMPTION BY RANGE IN THE TOTAL SYSTEM

Range of Water Consumption	No. of Conn. (Domestic)	Monthly Consumption (cu.m/conn.)	Percentage conn.	Percentage consump.	Remarks
0-10 cu.m/month	292	1.916	12.2	2.2	
11-30	930	18.998	39.0 51.2	21.5 23.7	
31-50	624	24.580	26.1 77.3	27.9 51.6	2.138 connection (0-10 cu.m /month to 51-70 cu.m /month)
51-70	292	17.355	12.2 89.5	19.7 71.3	62.849 cu.m/month; 2.095 cu.m /day
71-100	175	14.593	7.3 96.8	16.5 87.8	
100 over	77	10.811	3.2 100	12.2 100	
Total	2,390	88.253			

Conditions:

Water consumption	: 2.095 cu.m/day
Number of connections	: 2,139
Ave. no. of persons per connection	: 6
Ave. % of secondary users to primary users	: 40% (average of Sta. Rosa)

Average per capita consumption

2.095 / (2,138 x 6 x 1.4) = 0.117 cu.m/cap.day
= 120 lpcd

TABLE 4.4.3 NUMBER OF CONNECTIONS AND MONTHLY CONSUMPTION BY WATER CONSUMER TYPE (METERED CONNECTIONS)

Municipality	Range of Consumption (cu.m/month)	Domestic No. of Connection	Domestic Monthly Consumption (cu.m/month)	Commercial No. of Connection	Commercial Monthly Consumption (cu.m/month)	Institutional No. of Connection	Institutional Monthly Consumption (cu.m/month)	Industrial No. of Connection	Industrial Monthly Consumption (cu.m/month)	TOTAL No. of Connection	TOTAL Monthly Consumption (cu.m/month)	TOTAL Daily Consumption (cu.m/day)
Cabuyao	0-10	90	635	1	1	1	6	-	-	92	642	21.4
	11-30	273	5,548	1	23	-	-	-	-	274	5,571	185.7
	31-50	187	7,436	2	96	1	39	-	-	190	7,551	251.7
	51-70	92	5,436	-	-	1	65	-	-	93	5,501	183.4
	71-100	53	4,464	-	-	-	-	-	-	53	4,464	148.8
	100 over	24	3,448	-	-	-	-	-	-	24	3,448	114.8
	Sub-Total	719	26,967	4	120	3	110	-	-	726	27,197	905.8
Santa Rosa	0-10	126	787	1	10	2	7	-	-	129	804	26.8
	11-30	456	9,292	1	19	-	-	-	-	457	9,311	310.4
	31-50	320	12,521	-	-	-	-	-	-	320	12,521	417.4
	51-70	148	8,756	-	-	1	59	-	-	149	8,815	293.8
	71-100	93	7,701	-	-	-	-	-	-	93	7,701	256.7
	100 over	45	6,351	1	1,507	1	109	5	4,026	52	11,993	399.7
	Sub-Total	1,188	45,408	3	1,536	4	175	5	4,026	1,200	51,145	1,704.8
Biñan	0-10	76	494	-	-	-	-	-	-	76	494	16.5
	11-30	201	4,158	1	24	-	-	-	-	202	4,182	139.4
	31-50	117	4,623	5	209	-	-	-	-	122	4,832	161.1
	51-70	52	3,163	-	-	-	-	-	-	52	3,163	105.4
	71-100	29	2,428	1	76	-	-	-	-	30	2,504	83.5
	100 over	8	1,012	-	-	-	-	-	-	8	1,012	33.6
	Sub-Total	483	15,878	7	309	-	-	-	-	490	16,187	539.5
TOTAL	0-10	292	1,916	2	11	3	13	-	-	297	1,940	64.7
	11-30	930	18,998	3	61	-	-	-	-	933	19,064	635.5
	31-50	624	24,580	7	275	1	39	-	-	632	24,904	830.1
	51-70	292	17,355	-	-	2	124	-	-	294	17,497	583.2
	71-100	175	14,593	1	76	-	-	-	-	176	14,669	489.0
	100 over	77	10,811	1	1,507	1	109	5	4,026	84	16,453	548.4
	Grand Total	2,390	88,253	14	1,945	7	285	5	4,026	2,416	94,509	3,150.1

Note : Data for the month of June, 1986.

b) Commercial, Institutional and Industrial Connections

There are 14, 7 and 5 metered connections for commercial, institutional and industrial uses, respectively. The average unit water consumption by the user type was estimated as shown in TABLE 4.4.4. The following is the overall average of unit water consumption.

Commercial : 1.115 cu.m/conn.day (average of 13 connections excluding one big establishment)
Institutional : 1.357 cu.m/conn.day
Industrial : 26.840 cu.m/conn.day

(2) Total Water Consumption

The total water consumption by municipality was estimated as the sum of the consumptions obtained from metered and unmetered connections, including those from the not-functioning metered connections. The consumption of the not-functioning metered and unmetered connections was calculated based on the number of each connection type and the average unit water consumption of the metered connections. TABLE 4.4.5 presents the calculation results. The water consumption by municipality is given below in rounded off figures.

Cabuyao	:	1,050 cu.m/day
St. Rosa	:	1,850 "
Biñan	:	850 "
Total	:	3,750 cu.m/day

Generally, water consumed per connection at flat rate connections is larger than that in the metered connections. A total of 214 additional faucets was calculated from collected charges and water rate (See TABLE 4.2.4 and APPENDIX 4.2.3). These are not considered as the registered connections in TABLE 4.2.4. The additional water consumption may be calculated using the average unit consumption (metered domestic) of 1.23 cu.m/day and number of additional faucets. A total of about 260 cu.m/day was estimated for the additional faucets.

TABLE 4.4.4 UNIT WATER CONSUMPTION FOR COMMERCIAL, INSTITUTIONAL AND INDUSTRIAL CONNECTIONS : METERED CONNECTIONS

Municipality	Barangay	Commercial			Institutional			Industrial		
		Daily Consump.	No. of Connect.	cu.m/conn. day	Daily Consump.	No. of Connect.	cu.m/conn. day	Daily Consump.	No. of Connect.	cu.m/conn. day
Cabuyao	1. Barangay I	-	-	-	-	-	-	-	-	-
	2. Barangay II	3.3	3	1,100	1.5	2	0.750	-	-	-
	3. Barangay III	-	-	-	-	-	-	-	-	-
	4. Bigaa	-	-	-	-	-	-	-	-	-
	5. Sala	0	1	0	2.2	1	2.167	-	-	-
	Sub-Total	3.3	4	1,100	3.7	3	1.223	-	-	-
Sta. Rosa	1. Aplaya	-	-	-	-	-	-	-	-	-
	2. Balibago	0.6	1	0.633	-	-	-	95.0	1	95.033
	3. Barangay I	0.3	1	0.333	-	-	-	-	-	-
	4. Barangay II	-	-	-	0.1	1	0.133	-	-	-
	5. Barangay III	-	-	-	-	-	-	-	-	-
	6. Dila	-	-	-	-	-	-	27.2	2	13.600
	7. Dita	50.2	1	*52.233	-	-	-	7.1	1	7.067
	8. Ibaba	-	-	-	-	-	-	-	-	-
	9. Labas	-	-	-	-	-	-	-	-	-
	10. Macabling	-	-	-	-	-	-	4.9	1	4.900
	11. Tagapo	-	-	-	5.7	3	1.900	-	-	-
	Sub-Total	51.1	3	17.033	5.8	4	1.450	134.2	5	26.840
Biñan	1. De La Paz	-	-	-	-	-	-	-	-	-
	2. Malaban	-	-	-	-	-	-	-	-	-
	3. Platero	-	-	-	-	-	-	-	-	-
	4. Poblacion	8.7	6	1.444	-	-	-	-	-	-
	5. San Antonio	1.6	1	1.633	-	-	-	-	-	-
	6. San Jose	-	-	-	-	-	-	-	-	-
	7. San Vicente	-	-	-	-	-	-	-	-	-
	8. Sto. Domingo	-	-	-	-	-	-	-	-	-
	Sub-Total	10.3	7	1.471	-	-	-	-	-	-
	TOTAL	64.7	14	4.621 (1.115)	9.5	7	1.357	134.2	5	26.840

Note: ( ): average figure excluding one big business establishment (*) in Sta. Rosa.

TABLE 4.4.5 WATER CONSUMPTION BY CONSUMER TYPE FOR NONFUNCTIONING METERED/WITHOUT METER AND TOTAL WATER CONSUMPTION

Municipality	Barangay	Nonfunctioning metered and without meter								Metered Consump.	Total Consump.	R.M.
		Domestic		Commercial		Institutional		Sub-Total				
		No. of Con.	m^3/d	No. of con.	m^3/d	No. of Con.	m^3/d	No. of Con	m^3/d	m^3/d	m^3/d	
Cabuyao	1 Barangay I	31	38.8	2	1.7	3	3.7	36	44.2	252.4	296.6	
	2 Barangay II	28	35.1	-	-	-	-	28	35.1	226.2	261.3	
	3 " III	14	17.5	-	-	-	-	14	17.5	165.3	182.8	
	4 Bigaa	8	10.0	-	-	-	-	8	10.0	124.7	134.7	
	5 Sala	8	10.0	-	-	-	41.2	9	51.2	137.2	188.4	Municipal bldg. consumption = $40m^3/d$
	Sub-Total	89	111.4	2	1.7	4	4.9	95	158.0	905.8	1063.8	
Sta. Rosa	1 Aplaya	5	6.4	-	-	-	-	5	6.4	38.5	44.9	
	2 Balibago	25	31.9	1	0.5	-	-	26	32.4	487.6	520.0	
	3 Barangay I	19	24.2	-	-	-	-	19	24.2	149.4	173.6	
	4 " II	16	20.3	-	-	-	-	16	20.3	243.1	263.4	
	5 " III	4	5.1	-	-	-	-	4	5.1	40.4	45.5	
	6 Dila	3	3.8	1	0.5	-	-	4	4.3	45.1	49.4	
	7 Dita	12	15.3	-	-	1	1.5	13	16.8	311.0	327.8	
	8 Ibaba	2	2.5	-	-	-	-	2	2.5	76.1	78.6	
	9 Labas	5	6.4	-	-	-	-	5	6.4	75.0	81.4	
	10 Macabling	1	1.3	-	-	-	-	1	1.3	18.3	19.6	
	11 Tagapo	6	7.6	-	-	-	-	6	7.6	220.3	227.9	
	Sub-Total	98	124.8	2	1.0	1	1.5	101	127.3	1704.8	1832.1	
Biñan	1 De la Paz	12	13.2	-	-	-	-	12	13.2	13.2	26.4	
	2 Malaban	27	29.6	-	-	1	1.5	28	31.1	7.9	39.0	
	3 Platero	3	3.3	-	-	-	-	3	3.3	70.0	73.3	
	4 Poblacion	72	78.9	5	7.4	3	4.4	80	90.7	71.0	161.7	
	5 San Antonio	120	131.5	-	-	-	-	120	131.5	311.0	442.5	
	6 San Jose	30	32.9	-	-	-	-	30	32.9	25.4	58.3	
	7 San Vicente	4	4.4	-	-	-	-	4	4.4	33.2	37.6	
	8 Sto. Domingo	14	15.3	-	-	-	-	14	15.3	7.8	23.1	
	Sub-Total	282	309.1	5	7.4	4	5.9	291	322.4	539.5	861.9	
Total		469	545.3	9	10.1	9	12.3	487	607.7	3150.1	3757.8	

TABLE 4.4.6 shows the revised water consumption by municipality.

TABLE 4.4.6 REVISED DAILY WATER CONSUMPTION BY MUNICIPALITY

Unit:cu.m/day

Municipality	Registered Connections	Additional Connections	Faucet Consumption	Total
Cabuyao	1,050	53	65	1,100
Sta. Rosa	1,850	7	9	1,850
Biñan	850	154	190	1,050
Total	3,750	214	264	4,000

Note: Total is rounded off figure.

Accordingly, the total of the daily average water consumptions is estimated at 4,000 cu.m/day. This comprises the volumes of 1,100, 1,850, and 1,050 cu.m/day for Cabuyao, Sta. Rosa and Biñan, respectively.

4.5 ANALYSIS ON WATER SUPPLY AND CONSUMPTION

4.5.1 Comparative Study on Intake Water Amount and Consumption

The relationship between the total production and the water consumption was evaluated using the data collected during the field survey.

The flow rates on a daily average basis along the major pipelines are shown in FIGURE 4.5.1 based on the field examination (Refer to APPENDIX 4.5.1).

The total production is 10,450 cu.m/day. Of this, 2,200, 5,900 and 2,000 cu.m/day are distributed to Cabuyao, Sta. Rosa and Biñan areas, respectively. FIGURE 4.5.2 presents the relationships between utilized and not-utilized water productions by municipality using the above water volume. The definitions of the unaccounted-for water and the not-utilized water are as follows:

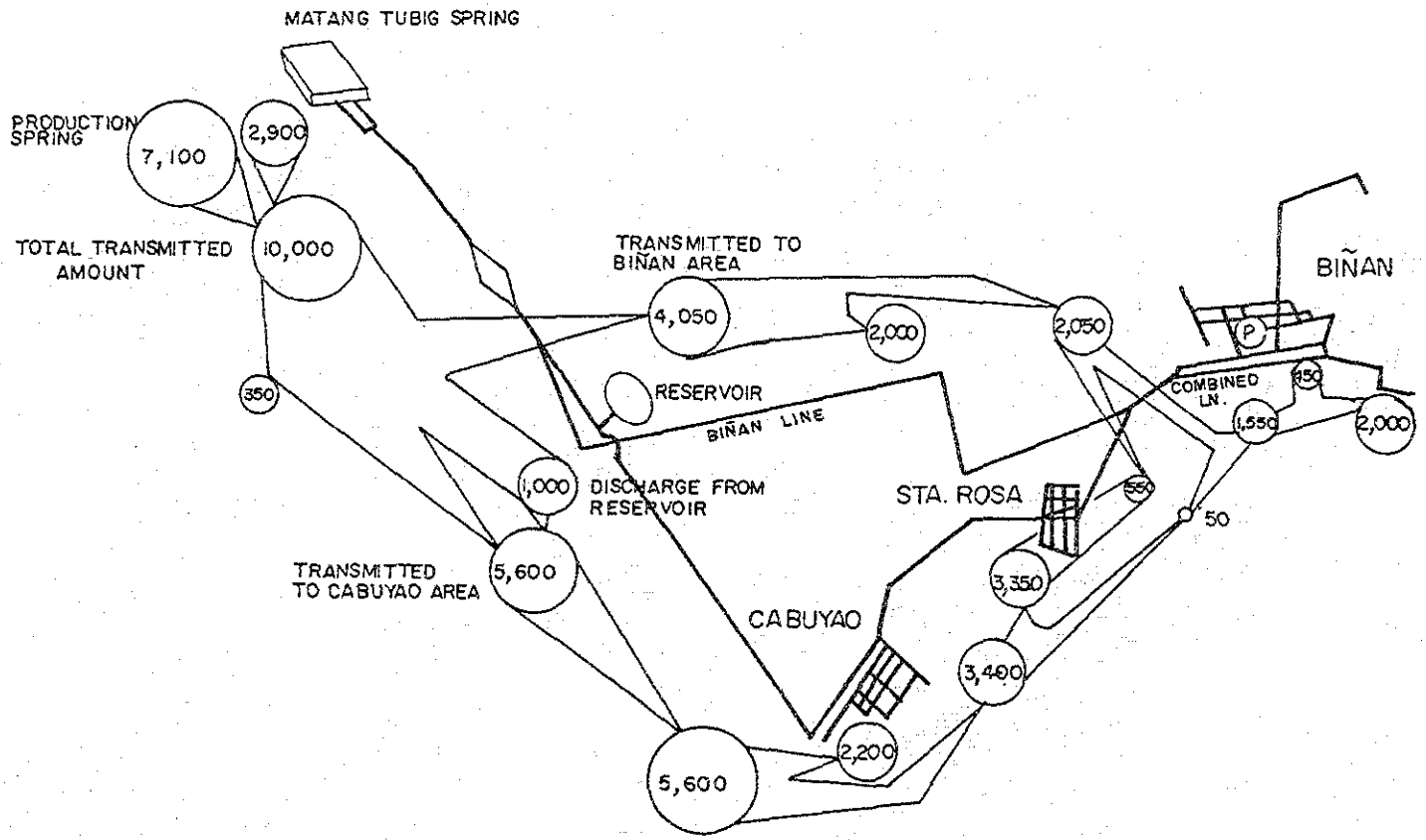


FIGURE 4.5.1

FLOW RATE ALONG MAIN PIPE LINES

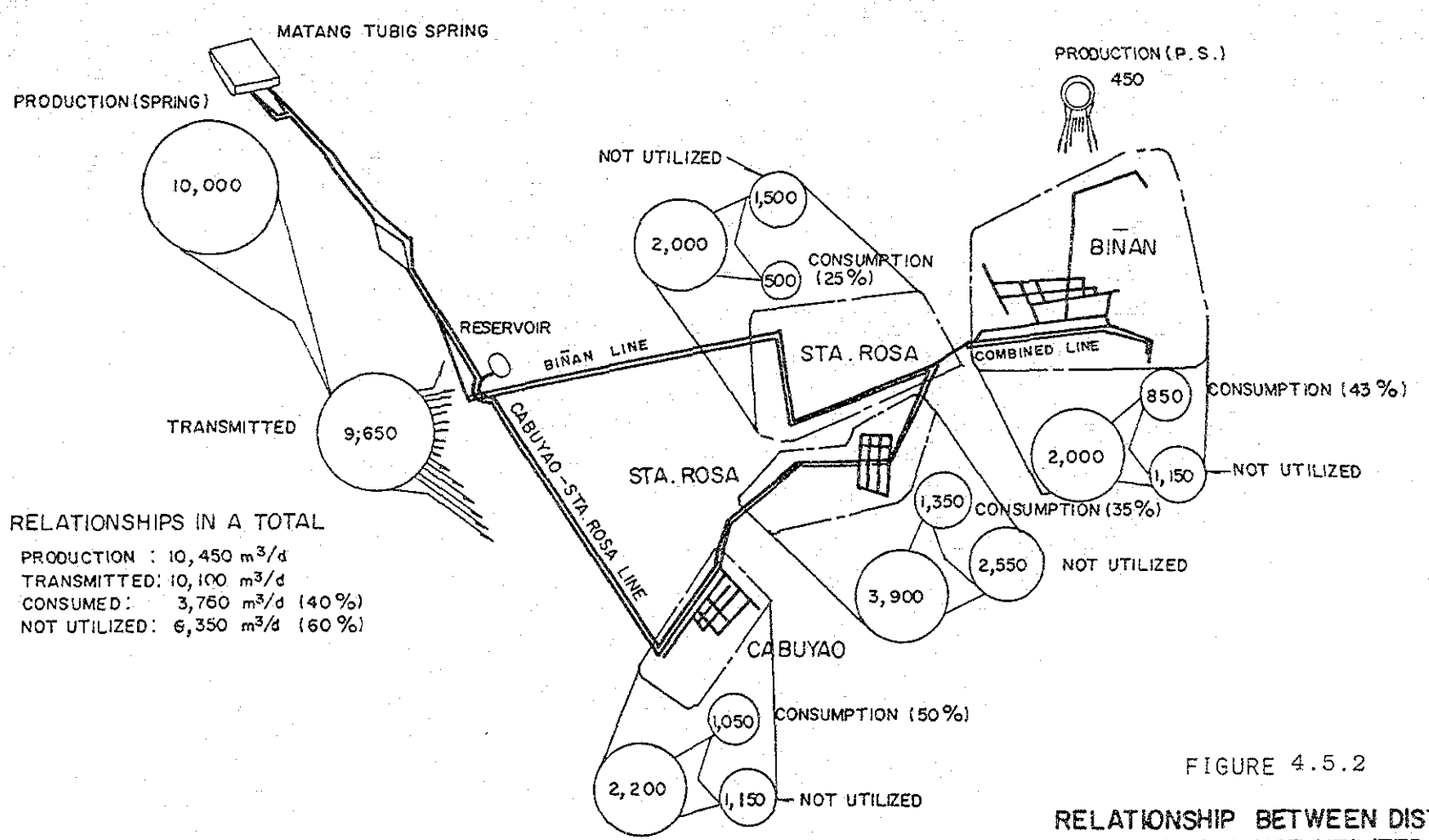


FIGURE 4.5.2

RELATIONSHIP BETWEEN DISTRIBUTED CONSUMED AND NOT UTILIZED WATER IN THE FOUR(4) AREAS

Unaccounted-for water: Water for which charges are not collected. Part of utilized water at the unmetered connections is regarded as the unaccounted-for water (exceeding water volume to that corresponding to the flat charge/connection with reference to the unit charges of metered connection).

Not-utilized water: Water which is not used at both metered and unmetered connections. Water used at the illegal connections is included in this category.

The percentage of not-utilized water to the distributed water from sources by municipality is given below:

Cabuyao	:	50%
Sta. Rosa	:	69%
Biñan	:	48%
Average	:	60%

At present, only 40% of transmitted/distributed water from water sources in the entire system is estimated as utilized water.

The percentage of utilized water in Sta. Rosa is quite low, especially in the area along Biñan line. There seem to be some special problems in the said area that a detailed investigation will be made immediately by the Provincial Office.

The average percentage of utilized water to the transmitted/distributed amount may be concluded to be approximately 50% at present based on the following:

a) Transmitted/distributed amount excluding the said area in Sta. Rosa: 8,100 cu.m/day
b) Utilized water (water consumption) in the same condition of item a) : 3,500 cu.m/day

c) Meter reading in the field during interview survey revealed a larger water consumption of about 20% than the average daily consumption calculated using water for the month of June, 1986. In addition, there is a high possibility that unmetered concessionaires (453 faucets in a total of flat rate connection) use water more than what is estimated which is 4,200 cu.m/day.

4.5.2 Unaccounted-for Water

The unaccounted-for water was estimated by municipality, and was discussed in the unaccounted-for water/not-utilized water facility survey.

The accounted-for water are those consumed by metered, unmetered and not-functioning metered concessionaires.

Of the total water consumption, water consumption associated with unmetered and not-functioning metered users was estimated using collected charges and present water rate as given below:

a) Unmetered connections : Due to present water rate for the flat charges, the connections with one faucet and those with additional faucets are taken into account.
   - Connections with one faucet : 18 cu.m/conn.month
   - Additional faucets : 1 cu.m/conn.month

b) Not-functioning meter : Average consumption per connection was estimated using average charges collected per connection and water rate structure for metered connections.

TABLE 4.5.1 shows the accounted-for water based on the aforementioned conditions. Approximately 90% of the total water consumption relevant to the accounted-for water corresponds to the metered connections. The accounted-for water in the entire system was estimated at about 3,600 cu.m/day, while about 6,850 cu.m/day or 65% of the total production are the unaccounted-for water (See TABLE 4.5.2).

TABLE 4.5.1 ACCOUNTED-FOR WATER

Municipality	Metered			Non-Metered				Not Functioning Metered			Total Consumption	
	No. of Connect.	Charge (₱)	Consump. m^3/m	No. of Connect.		Charge ₱	Consump. m^3/m	No. of Connect.	Charge ₱	Consump. m^3/m	Monthly m^3/m	Daily m^3/m
				Inst.	Addition							
Cabuyao	726	23,019.25	27,177	5	53	102.00	143	90	1,940.25	2,880	30,200	1,007
Sta. Rosa	1,200	45,008.50	51,145	13	7	186.80	241	88	2,485.25	3,608	54,994	1,833
Biñan	490	12,805.50	16,187	221	154	3,166.40	4,132	74	1,190.00	1,628	21,947	732
T o t a l	2,416	79,829.25	94,509	239	214	3,455.26	4,516	254	5,615.50	8,116	107,141	3,572

TABLE 4.5.2 ACCOUNTED-FOR WATER/UNACCOUNTED-FOR WATER

UNIT : m^3/day

		Transmission	Cabuyao	Sta. Rosa	Biñan	Total	R.M.
Accounted-for Water	Utilized Water	-	1,000	1,850	750	3,600	
Unaccounted-for Water	Not Utilized Water	350	1,100	4,050	950	6,450	
	Utilized Water	-	100	-	300	400	
	Sub-Total	350	1,200	4,050	1,250	6,850	
T O T A L		350	2,200	5,900	2,000	10,450	
Percentage of Unaccounted-for water to the total		100	55	70	65	65	Round Figure

4.6 EXISTING SANITATION CONDITIONS

4.6.1 Drainage and Sewage Disposal

Open canals or ditches constitute the drainage system of the three Municipalities. Some of the canals have been grouted with the riprap lining on both sides. In Sta. Rosa, about 70% of the poblacion and nearby barangays are served by the drainage system.

Sta. Rosa is naturally drained by three waterways. These are the Sta. Rosa River on the western boundary, the Diezmo River and the Cabuyao River on the eastern side, which all drain into the Laguna de Bay. The Sta. Rosa River which traverses the town proper serves as the main natural drainage outlet.

The present drainage system of Biñan is inadequate resulting in frequent flooding of some parts of the poblacion every time when there is a heavy rain. Only the built-up areas, especially those near the public market, are provided with drainage canals. Stormwater run-off is drained to the Biñan River which flows to the Laguna de Bay.

Cabuyao, Sta. Rosa and Biñan do not have a sewage collection system; instead, sanitary wastes are disposed through individual septic tanks. Household sewage are stored/treated in septic tanks and eventually disposed to the drainage canals and/or rivers.

Of the 5,188 households surveyed in Cabuyao in 1979, 53% use the water-sealed type and 22% use the open-pit type toilet facilities. The remaining 25% do not have their own toilet facilities.

Of the 3,580 households surveyed in Sta. Rosa in 1979, 56% use the water-sealed type, 15% the sanitary latrines, and 5% the Antipolo type. The remaining 24% do not have their own toilet facilities. In the 1983 survey, only 36.79 out of 11,650 households have sanitary toilets.

Result of the 1978 survey conducted in Biñan showed that 79% of the households have the water-sealed type of toilet. These consist of the automatic flush (16.72%), pour-flush (59.22%) and the communal type

CHAPTER 5
POPULATION AND WATER DEMAND PROJECTIONS

CHAPTER 5 POPULATION AND WATER DEMAND PROJECTIONS

5.1 GENERAL

The future water supply plans for the three Municipalities were studied based on the collected data and discussions with the city officials.

The target year for the Long Term Development is 2010, while the Short Term Development is designated for 1995. Furthermore, the period for the Short Term Development Plan is divided into two stages with 1990 and 1995 as design years. These design years are considered owing to the time constraints and complexity of pipe installation in the built-up area.

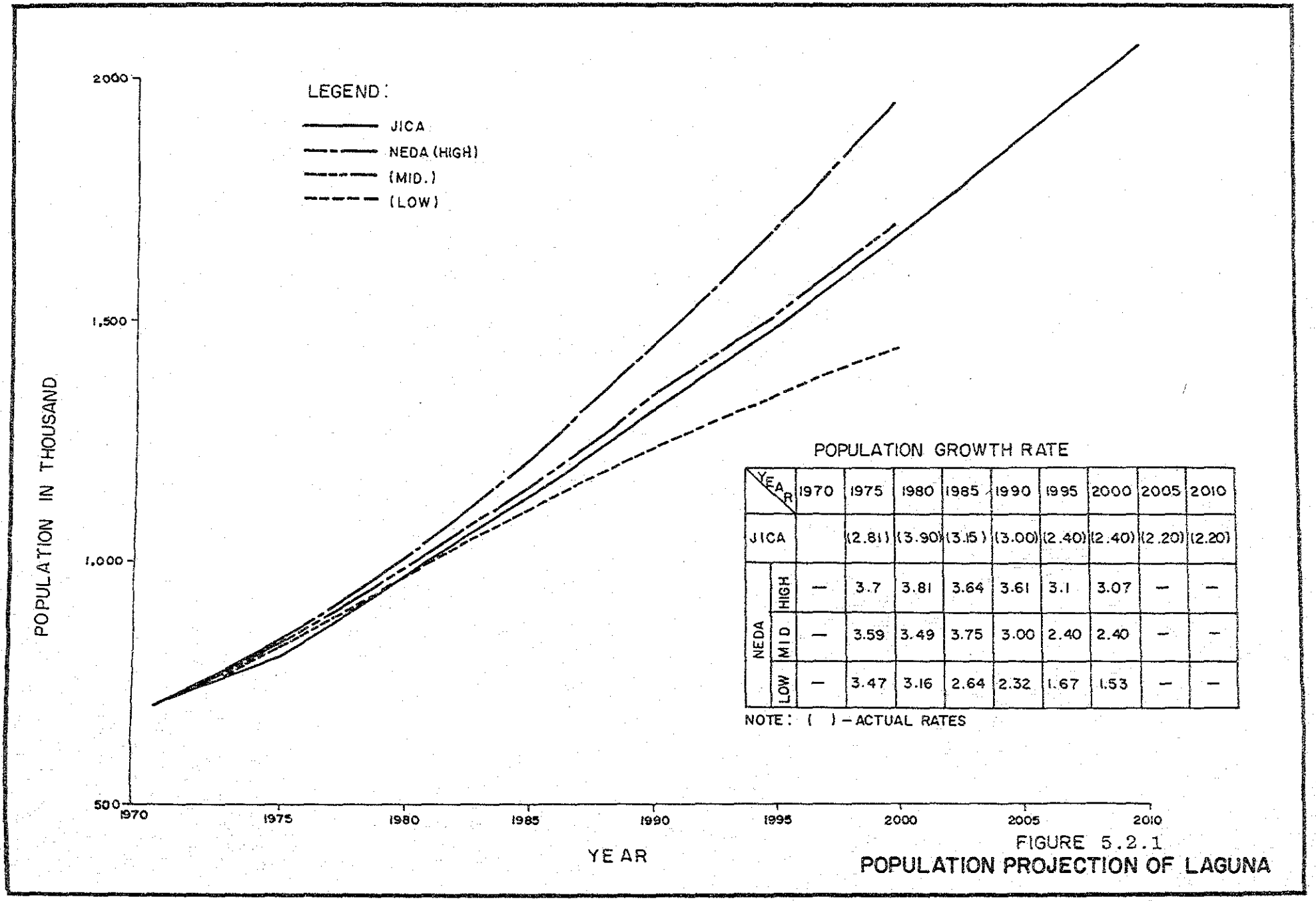
The potential service area was studied taking into account the technology and the economic aspects. The water demand, including consumptions and the unaccounted-for water was estimated.

5.2 POPULATION PROJECTION

The population projection was made using the breakdown method. The provincial population in the future was first projected with reference to the existing NEDA assumption. The projected provincial population based on the assumed growth rates was broken down and distributed among the Municipalities. Likewise, the population in the urban and rural areas was predicted. The population by barangay in the urban and rural areas was projected based on historical data.

5.2.1 Population Projection of the Province and Municipalities

The historical population trend of the three Municipalities is the major basis for the population projection of the study area. The NEDA-POPCOM projection was also considered for comparison purposes (See FIGURE 5.2.1). The historical population trend of the three Municipalities and the Laguna Province is shown in TABLE 5.2.1. From 1960 to 1980 the growth rates registered in the Laguna Province went up considerably. However, during the same period, the growth rates registered in the three Municipalities showed higher values than the Laguna rates. This could be attributed to the influx of people due to the industrialization of the three areas.



POPULATION GROWTH RATE

YEAR		1970	1975	1980	1985	1990	1995	2000	2005	2010
JICA			(2.81)	(3.90)	(3.15)	(3.00)	(2.40)	(2.40)	(2.20)	(2.20)
NEDA	HIGH	—	3.7	3.81	3.64	3.61	3.1	3.07	—	—
	MID	—	3.59	3.49	3.75	3.00	2.40	2.40	—	—
	LOW	—	3.47	3.16	2.64	2.32	1.67	1.53	—	—

NOTE: ( ) – ACTUAL RATES

FIGURE 5.2.1
POPULATION PROJECTION OF LAGUNA

TABLE 5.2.1
HISTORICAL POPULATION BY MUNICIPALITY
CABUYAO-STA. ROSA-BINAN

Municipality	1903	1918	1939	1948	1960	1970	1975	1980
Cabuyao (Pop.)	6,439	8,536	11,660	15,206	20,618	32,117	36,505	46,286
Growth Rate		1.90	1.50	2.99	2.57	4.53	2.59	4.86
% to Total	4.33	4.37	4.17	4.73	4.37	4.59	4.54	4.76
Sta. Rosa (Pop.)	7,339	10,557	15,069	17,259	26,583	41,335	47,639	64,325
Growth Rate		2.45	1.71	1.52	3.67	4.51	2.88	6.19
% to Total	4.94	5.40	5.39	5.37	5.63	5.91	5.93	6.61
Binan (Pop.)	9,563	10,692	16,238	20,794	33,309	58,290	67,444	83,684
Growth Rate		0.75	2.01	2.79	4.00	5.76	2.96	4.41
% to Total	6.44	5.47	5.81	6.47	7.06	8.33	8.39	8.60
Laguna (Pop.)	148,606	195,546	279,505	321,247	472,064	699,736	803,750	973,104
Growth Rate		1.85	1.72	1.56	3.26	4.01	2.81	3.90
% 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 Pop. / Laguna Prov. Pop.

Source: National Census

Comparison of the actual population of Laguna Province and the projected population made by the NEDA shows that from 1970 to 1975 the actual growth rate of Laguna Province was lower than the assumption of the NEDA. However, from 1975 to 1980 the actual growth rate was higher than the assumption of the NEDA. Therefore, to be conservative, the medium assumption growth rates used by the NEDA were used for the projection of Laguna Province.

The population projections of Cabuyao, Sta. Rosa and Biñan were based on the projected ratio of the municipal population to the provincial population. The historical ratio trend and growth rates of the three Municipalities and Laguna Province from 1903 to 1980 are shown in TABLE 5.2.1 while TABLE 5.2.2 shows the projected ratio, growth rates and population from 1980 to 2010. Based on the ratio trend of the three Municipalities, their ratio will all still go up which means that their growth rates will be higher than the provincial rates.

TABLE 5.2.3 summarizes the population projections of the two sources. FIGURE 5.2.2 shows the graph of the historical and projected population of the three Municipalities in comparison with the NEDA and municipal projections.

TABLE 5.2.2
POPULATION PROJECTION OF THE MUNICIPALITY
CABUYAO-STA.ROSA-BINAN

Municipality	Item	1980	1986	1990	1995	2000	2010	Remark
Cabuyao	Population	46,286	56,320	63,820	72,460	82,260	103,940	
	Growth Rate	4.86	3.32	3.17	2.57	2.57	2.37	
	Percent	4.76	4.81	4.84	4.88	4.92	5.00	
Sta. Rosa	Population	64,325	79,330	90,680	104,050	119,350	153,840	
	Growth Rate	6.19	3.56	3.40	2.79	2.78	2.57	
	Percent	6.61	6.77	6.87	7.01	7.14	7.40	
Binan	Population	83,684	102,210	116,090	132,190	150,510	191,260	
	Growth Rate	4.41	3.39	3.23	2.63	2.63	2.42	
	Percent	8.60	8.72	8.80	8.90	9.00	9.20	
Laguna	Population	973,104	1,172,130	1,319,240	1,485,330	1,672,330	2,078,890	
	Growth Rate	3.90	3.15	3.00	2.40	2.40	2.20	
	Percent	100.00	100.00	100.00	100.00	100.00	100.00	

TABLE 5.2.3
Comparison of Population Projection between Jica and Municipality

Municipality	Plan	1975	1980	1985	1986	1990	1992	1995	2000	2010	Mun./JICA	Base - Target
Cabuyao	JICA	36,505	46,286		56,323	63,821		72,458	82,260	103,945	1.00	1980 - 2010
	Public Market & Slaughterhouse	36,505	46,286	55,506		66,564		79,823	95,725		1.10	1980 - 2000
	Municipal Development	36,505	43,343	53,096		61,568		69,487	78,111		0.96	1979 - 2000
Sta. Rosa	JICA	47,639	64,325		79,332	90,678		104,050	119,351	153,838	1.00	1980 - 2010
	An Updated Town Plan	47,639	64,325	81,011	84,348	97,697	104,371				(1.08)	1980 - 1992
	Municipal Development	47,639	64,536	73,653		83,344		92,756	101,679		0.89	1975 - 2000
Binan	JICA	67,444	83,684		102,207	116,090		132,192	150,508	191,258	1.00	1980 - 2010
	Municipal Development	67,444	78,036	90,291		104,470		120,877	139,899		0.91	1975 - 2000

Note : Percentage of Municipal plan to JICA projection in 1995 (Phase I)
( ) : Comparison in 1990

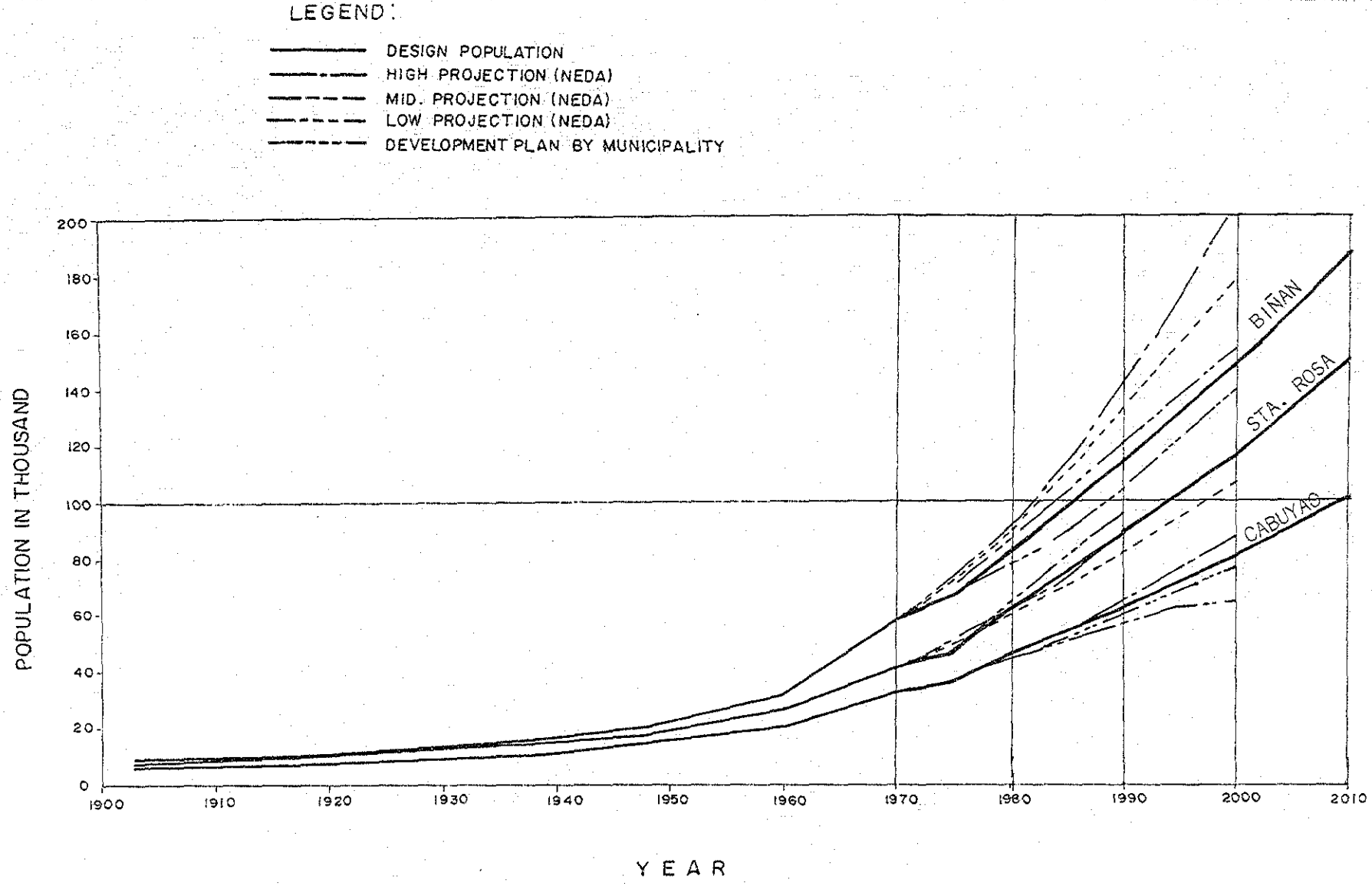


FIGURE 5.2.2

HISTORICAL AND PROJECTED POPULATION
CABUYAO – STA. ROSA – BIÑAN

5.2.2 Population Projection by Barangay

The 1970 to 1980 historical population rates of the barangays, categorized into urban and rural areas of Cabuyao, Sta. Rosa and Biñan, are shown in TABLEs 5.2.4.A, 5.2.4.B and 5.2.4.C respectively. For those barangays without corresponding figures, it means that during the study period the barangays were still not independent but parts of other barangays.

The summary of the historical population and the ratio of urban or rural areas to their respective municipalities from 1970 to 1980 are shown in TABLE 5.2.5. The population of the urban and rural areas were also projected by the ratio method. Based on the ratio trend from 1970 to 1980 the ratio of the rural areas will go up while the ratio of the urban areas will go down, which means the rural areas will attain higher growth rates than the urban areas. The projected urban and rural populations and ratios of Cabuyao, St. Rosa and Biñan from 1980 to 2010 are shown in TABLE 5.2.6.

The barangay populations were projected by projecting the ratio of the barangays to their corresponding urban or rural population. TABLEs 5.2.7.A, 5.2.7.B and 5.2.7.C show the projected populations and ratios of the barangays of Cabuyao, Sta. Rosa and Biñan from 1980 to 2010.

5.2.3 Projection of Number of Households

The historical number of households from 1970 to 1980 in the three Municipalities is shown in TABLEs 5.2.4.A, 5.2.4.B and 5.2.4.C. From the 1970 to 1980 trend of the number of persons per household, if can be said that the number of persons per household in the future is likely to decrease. TABLE 5.2.8 shows the projected number of persons per household and the number of households in the three Municipalities from 1980 to 2010.

TABLE 5.2.4.A
POPULATION AND NUMBER OF HOUSEHOLDS BY BARANGAY
CABUYAO, LAGUNA

Area	Barangay	1970			1975			1980		
		Pop.	Percent	H.H.	Pop.	Percent	H.H.	Pop.	Percent	H.H.
Urban	1. Barangay I	4,330	100.00		1,872	42.87	312	2,090	40.73	383
	2. Barangay II				1,447	33.13	235	1,535	29.91	265
	3. Barangay III				1,048	24.00	172	1,507	29.36	283
	Sub-Total	4,330	100.00	717	4,367	100.00	719	5,132	100.00	931
Rural	4. Baclaran	1,588	5.72		1,080	3.36	172	1,372	3.33	220
	5. Banay-Banay	1,786	6.43		1,885	5.86	300	2,829	6.87	491
	6. Banlic	3,776	13.59		2,066	6.43	332	3,165	7.69	541
	7. Bigaa	1,203	4.33		3,017	9.39	469	3,939	9.57	659
	8. Butong	3,736	13.45		1,276	3.97	204	1,520	3.69	272
	9. Casile	4,404	15.85		941	2.93	145	649	1.58	108
	10. Diezmo	3,829	13.78		484	1.50	82	580	1.41	98
	11. Gulod	2,021	7.27		4,222	13.14	648	5,085	12.36	852
	12. Mamatid	429	1.54		3,974	12.37	629	4,719	11.47	799
	13. Marinig	1,902	6.84		4,493	13.98	696	5,530	13.44	896
	14. Niugan	1,684	6.06		2,503	7.79	403	3,532	8.58	598
	15. Pittland	1,429	5.14		543	1.69	81	455	1.11	75
	16. Pulo				2,106	6.55	312	2,912	7.08	482
	17. Sala				1,925	5.99	310	2,969	7.21	507
	18. San Isidro				1,623	5.05	265	1,898	4.61	333
	Sub-Total	27,787	100.00	4,381	32,138	100.00	5,048	41,154	100.00	6,931
	Total	32,117		5,098	36,505		5,767	46,286		7,862

TABLE 5.2.4.B
POPULATION AND NUMBER OF HOUSEHOLDS BY BARANGAY
STA. ROSA, LAGUNA

Area	Barangay	1970			1975			1980		
		Pop.	Percent	H.H.	Pop.	Percent	H.H.	Pop.	Percent	H.H.
Urban	1. Kanluran	7,024	100.00		3,866	49.76	654	4,231	49.21	799
	2. Malusak				2,328	29.97	482	2,396	27.86	533
	3. Market Area				1,575	20.27	258	1,972	22.93	357
	Sub-Total	7,024	100.00		7,769	100.00	1,394	8,599	100.00	1,689
Rural	4. Aplaya	4,890	14.25		5,443	13.65	904	6,663	11.96	1,189
	5. Balibago	2,853	8.32		3,519	8.82	606	5,234	9.39	956
	6. Caingin	2,719	7.92		3,204	8.03	523	4,325	7.76	786
	7. Dila	1,466	4.27		1,396	3.50	220	2,131	3.82	396
	8. Dita	2,816	8.21		3,587	9.00	623	4,740	8.51	862
	9. Don Jose	1,246	3.63		1,094	2.74	150	1,694	3.04	236
	10. Ibaba	1,076	3.14		1,055	2.65	170	1,411	2.53	271
	11. Labas	1,750	5.10		2,000	5.02	329	2,694	4.84	520
	12. Makabling	1,865	5.44		2,443	6.13	380	3,173	5.69	552
	13. Malitlit	1,827	5.32		2,001	5.02	325	2,891	5.19	494
	14. Pook	2,319	6.76		2,687	6.74	432	4,252	7.63	806
	15. Pulong Sta. Cruz	1,535	4.47		1,934	4.85	311	3,053	5.48	526
	16. Sto. Domingo	637	1.86		693	1.74	113	732	1.31	119
	17. Sinalhan	4,287	12.49		5,190	13.02	840	6,417	11.52	1,098
	18. Tagapo	3,025	8.82		3,624	9.09	616	6,316	11.33	1,150
	Sub-Total	34,311	100.00		39,870	100.00	6,542	55,726	100.00	9,961
	Total	41,335		6,661	47,639		7,936	64,325		11,650

TABLE 5.2.4.C
POPULATION AND NUMBER OF HOUSEHOLDS BY BARANGAY
BINAN, LAGUNA

Area	Barangay	1970			1975			1980		
		Pop.	Percent	H.H.	Pop.	Percent	H.H.	Pop.	Percent	H.H.
Urban	1. Canlalay	5,010	10.32		6,135	10.96	1,029	7,572	11.13	1373
	2. Casile	447	0.92		690	1.23	121	540	0.79	100
	3. De La Paz	9,418	19.39		10,942	19.56	1,730	14,013	20.60	2461
	4. Malaban	8,900	18.33		10,281	18.38	1,694	14,550	21.38	2,529
	5. Poblacion	3,950	8.13		3,874	6.92	581	3,975	5.84	674
	6. San Antonio	10,519	21.66		12,530	22.40	2,045	13,416	19.72	2,350
	7. San Jose	3,081	6.35		3,333	5.96	543	3,974	5.84	677
	8. San Vicente	5,230	10.77		5,737	10.25	943	7,384	10.85	1,275
	9. Sto. Domingo	2,008	4.13		2,426	4.34	426	2,619	3.85	476
	Sub-Total	48,563	100.00		55,948	100.00	9,112	68,043	100.00	11,915
Rural	10. Binan	348	3.58		230	2.00	34	261	1.67	38
	11. Bungahan	180	1.85		216	1.88	36	224	1.43	37
	12. Calabuso	675	6.94		1,048	9.12	166	1,373	8.78	220
	13. Ganado	182	1.87		203	1.77	35	487	3.11	61
	14. Halang	773	7.95		1,093	9.51	195	1,586	10.14	268
	15. Langkiwa	470	4.83		583	5.07	97	834	5.33	138
	16. Loma	835	8.58		615	5.35	93	783	5.01	127
	17. Malamig	95	0.98		96	0.83	18	105	0.67	15
	18. Mamplasan	658	6.76		845	7.35	146	1,065	6.81	176
	19. Platero	2,344	24.10		2,979	25.91	496	3,853	24.63	671
	20. San Anton	738	7.59		827	7.19	138	1,096	7.01	181
	21. Soro-Soro	714	7.34		800	6.96	129	1,009	6.45	166
	22. Timbao	462	4.75		455	3.96	72	628	4.02	104
	23. Tubigan	1,038	10.67		1,275	11.09	223	2,009	12.84	382
	24. Zapote	215	2.21		231	2.01	37	328	2.10	46
	Sub-Total	9,727	100.00		11,496	100.00	1,915	15,641	100.00	2,630
	Total	58,290		9,289	67,444		11,027	83,684		14,545

TABLE 5.2.5
POPULATION AND NUMBER OF HOUSEHOLDS BY URBAN AND RURAL AREA
CABUYAO-STA. ROSA-BINAN

Municipality	Area	Item	1970	1975	1980	Remark
Cabuyao	Urban	Pop.	4,330	4,367	5,132	
		Percent	13.48	11.96	11.09	
		H.H.	717	719	931	
	Rural	Pop.	27,787	32,138	41,154	
		Percent	86.52	88.04	88.91	
		H.H.	4,381	5,048	6,931	
	Total	Pop.	32,117	36,505	46,286	
		Percent	100.00	100.00	100.00	
		H.H.	5,098	5,767	7,862	
Sta. Rosa	Urban	Pop.	7,024	7,769	8,599	
		Percent	16.99	16.31	13.37	
		H.H.		1,394	1,689	
	Rural	Pop.	34,311	39,870	55,726	
		Percent	83.01	83.69	86.63	
		H.H.		6,542	9,961	
	Total	Pop.	41,335	47,639	64,325	
		Percent	100.00	100.00	100.00	
		H.H.	6,661	7,936	6,661	
Binan	Urban	Pop.	48,563	55,948	68,043	
		Percent	83.31	82.95	81.31	
		H.H.		9,112	11,915	
	Rural	Pop.	9,727	11,496	15,641	
		Percent	16.69	17.05	18.69	
		H.H.		1,915	2,630	
	Total	Pop.	58,290	67,444	83,684	
		Percent	100.00	100.00	100.00	
		H.H.	9,289	11,027	14,545	

Source : National Censuses

TABLE 5.2.6
POPULATION PROJECTION BY URBAN AND RURAL AREA
CABUYAO-STA. ROSA-BINAN

Municipality	Area	Item	1980	1986	1990	1995	2000	2010	Remark
Cabuyao	Urban	Percent	11.09	10.67	10.39	10.04	9.70	9.00	
		Pop.	5,132	6,010	6,630	7,280	7,980	9,350	
	Rural	Percent	88.91	89.33	89.61	89.96	90.30	91.00	
		Pop.	41,154	50,310	57,190	65,180	74,280	94,590	
	Total	Percent	100.00	100.00	100.00	100.00	100.00	100.00	
		Pop.	46,286	56,320	63,820	72,460	82,260	103,940	
Sta. Rosa	Urban	Percent	13.37	12.29	11.58	10.68	9.79	8.00	
		Pop.	8,599	9,750	10,500	11,120	11,680	12,310	
	Rural	Percent	86.63	87.71	88.42	89.32	90.21	92.00	
		Pop.	55,726	69,580	80,180	92,930	107,670	141,530	
	Total	Percent	100.00	100.00	100.00	100.00	100.00	100.00	
		Pop.	64,325	79,330	90,680	104,050	119,350	153,840	
Binan	Urban	Percent	81.31	80.85	80.54	80.15	79.77	79.00	
		Pop.	68,043	82,630	93,500	105,960	120,060	151,100	
	Rural	Percent	18.69	19.15	19.46	19.85	20.23	21.00	
		Pop.	15,641	19,580	22,590	26,230	30,450	40,160	
	Total	Percent	100.00	100.00	100.00	100.00	100.00	100.00	
		Pop.	83,684	102,210	116,090	132,190	150,510	191,260	

TABLE 5.2.7.A
POPULATION PROJECTION OF BARANGAYS
CABUYAO, LAGUNA

Area	Barangay	1980		1986		1990		1995		2010	
		Percent	Pop.	Percent	Pop.	Percent	Pop.	Percent	Pop.	Percent	Pop.
Urban	1. Barangay I	40.73	2,090	40.18	2,410	39.82	2,640	39.36	2,870	38.00	3,550
	2. Barangay II	29.91	1,535	29.43	1,770	29.11	1,930	28.71	2,090	27.50	2,570
	3. Barangay III	29.36	1,507	30.39	1,830	31.07	2,060	31.93	2,320	34.50	3,230
	Sub-Total	100.00	5,132	100.00	6,010	100.00	6,630	100.00	7,280	100.00	9,350
Rural	4. Baclaran	3.33	1,372	3.34	1,680	3.35	1,920	3.36	2,190	3.40	3,220
	5. Banay-Banay	6.87	2,829	7.18	3,610	7.38	4,220	7.64	4,980	8.40	7,950
	6. Banlic	7.69	3,165	7.98	4,010	8.18	4,680	8.42	5,490	9.15	8,640
	7. Bigaa	9.57	3,939	9.66	4,860	9.71	5,550	9.78	6,370	10.00	9,460
	8. Butong	3.69	1,520	3.59	1,810	3.53	2,020	3.45	2,250	3.20	3,030
	9. Casile	1.58	649	1.46	740	1.39	790	1.29	840	1.00	950
	10. Diezmo	1.41	580	1.32	660	1.26	720	1.18	770	0.95	900
	11. Gulod	12.36	5,085	11.83	5,950	11.47	6,560	11.03	7,190	9.70	9,170
	12. Mamatid	11.47	4,719	11.08	5,570	10.81	6,180	10.48	6,830	9.50	8,990
	13. Marinig	13.44	5,530	13.15	6,620	12.96	7,410	12.72	8,290	12.00	11,350
	14. Niugan	8.58	3,532	8.90	4,480	9.12	5,220	9.39	6,120	10.20	9,650
	15. Pittland	1.11	455	1.05	530	1.01	580	0.96	630	0.80	760
	16. Pulo	7.08	2,912	7.52	3,780	7.82	4,470	8.19	5,340	9.30	8,800
	17. Sala	7.21	2,969	7.53	3,790	7.74	4,430	8.00	5,210	8.80	8,320
	18. San Isidro	4.61	1,898	4.41	2,220	4.27	2,440	4.11	2,680	3.60	3,400
	Sub-Total	100.00	41,154	100.00	50,310	100.00	57,190	100.00	65,180	100.00	94,590
	Total		46,286		56,320		63,820		72,460		103,940

TABLE 5.2.7.B
POPULATION PROJECTION OF BARANGAYS
STA. ROSA, LAGUNA

Area	Barangay	1980		1986		1990		1995		2010	
		Percent	Pop.	Percent	Pop.	Percent	Pop.	Percent	Pop.	Percent	Pop.
Urban	1. Kanluran	49.20	4,231	49.16	4,790	49.13	5,160	49.10	5,460	49.00	6,030
	2. Malusak	27.87	2,396	27.60	2,690	27.41	2,880	27.18	3,020	26.50	3,260
	3. Market Area	22.93	1,972	23.24	2,270	23.46	2,460	23.72	2,640	24.50	3,020
	Sub-Total	100.00	8,599	100.00	9,750	100.00	10,500	100.00	11,120	100.00	12,310
Rural	4. Aplaya	11.96	6,663	11.53	8,020	11.24	9,010	10.88	10,110	9.80	13,870
	5. Balibago	9.39	5,234	9.61	6,690	9.76	7,830	9.94	9,240	10.50	14,860
	6. Caingin	7.76	4,325	7.77	5,410	7.77	6,230	7.78	7,230	7.80	11,040
	7. Dila	3.83	2,131	3.82	2,660	3.82	3,060	3.82	3,550	3.80	5,380
	8. Dita	8.51	4,740	8.41	5,850	8.34	6,690	8.26	7,680	8.00	11,320
	9. Don Jose	3.04	1,694	2.91	2,020	2.83	2,270	2.72	2,530	2.40	3,400
	10. Ibaba	2.53	1,411	2.38	1,660	2.29	1,840	2.16	2,010	1.80	2,550
	11. Labas	4.83	2,694	4.82	3,350	4.82	3,860	4.82	4,480	4.80	6,790
	12. Makabling	5.69	3,173	5.75	4,000	5.79	4,640	5.84	5,430	6.00	8,490
	13. Malitlit	5.19	2,891	5.19	3,610	5.20	4,170	5.2	4,830	5.20	7,360
	14. Pook	7.63	4,252	7.95	5,530	8.16	6,540	8.42	7,820	9.20	13,020
	15. Pulong Sta. Cruz	5.48	3,053	5.70	3,970	5.85	4,690	6.04	5,610	6.60	9,340
	16. Sto. Domingo	1.31	732	1.23	860	1.17	940	1.1	1,020	0.90	1,270
	17. Sinalhan	11.52	6,417	11.10	7,720	10.81	8,670	10.45	9,710	9.40	13,300
	18. Tagapo	11.33	6,316	11.83	8,230	12.15	9,740	12.57	11,680	13.80	19,530
	Sub-Total	100.00	55,726	100.00	69,580	100.00	80,180	100.00	92,930	100.00	141,530
	Total		64,325		79,330		90,680		104,050		153,840

TABLE 5.2.7.C
POPULATION PROJECTION OF BARANGAYS
BINAN, LAGUNA

Area	Barangay	1980		1986		1990		1995		2010	
		Percent	Pop.	Percent	Pop.	Percent	Pop.	Percent	Pop.	Percent	Pop.
Urban	1. Canlalay	11.13	7,572	11.25	9,300	11.32	10,580	11.42	12,100	11.70	17,680
	2. Casile	0.79	540	0.79	650	0.79	740	0.80	850	0.80	1,210
	3. De La Paz	20.59	14,013	21.07	17,410	21.39	20,000	21.80	23,100	23.00	34,750
	4. Malaban	21.38	14,550	22.10	18,260	22.59	21,120	23.19	24,570	25.00	37,780
	5. Poblacion	5.85	3,975	5.48	4,530	5.23	4,890	4.92	5,210	4.00	6,040
	6. San Antonio	19.72	13,416	19.08	15,760	18.65	17,440	18.10	19,180	16.50	24,930
	7. San Jose	5.84	3,974	5.77	4,770	5.73	5,360	5.66	6,000	5.50	8,310
	8. San Vicente	10.85	7,384	10.78	8,910	10.73	10,030	10.68	11,320	10.50	15,870
	9. Sto. Domingo	3.85	2,619	3.68	3,040	3.57	3,340	3.43	3,630	3.00	4,530
	Sub-Total	100.00	68,043	100.00	82,630	100.00	93,500	100.00	105,960	100.00	151,100
Rural	10. Binan	1.67	261	1.58	310	1.51	340	1.44	380	1.20	480
	11. Bungahan	1.43	224	1.32	260	1.25	280	1.17	310	0.90	360
	12. Calabuso	8.78	1,373	8.82	1,730	8.85	2,000	8.88	2,330	9.00	3,610
	13. Ganado	3.11	487	3.39	660	3.58	810	3.81	1,000	4.50	1,810
	14. Halang	10.14	1,586	10.23	2,000	10.30	2,330	10.36	2,710	10.60	4,260
	15. Langkiwa	5.33	834	5.40	1,060	5.45	1,230	5.52	1,450	5.70	2,290
	16. Loma	5.01	783	4.85	950	4.74	1,070	4.60	1,210	4.20	1,690
	17. Malamig	0.67	105	0.66	130	0.65	150	0.64	170	0.60	240
	18. Mamplasan	6.81	1,065	6.85	1,340	6.87	1,550	6.90	1,810	7.00	2,810
	19. Platero	24.63	3,853	24.46	4,790	24.35	5,500	24.22	6,350	23.80	9,560
	20. San Anton	7.01	1,096	7.01	1,370	7.01	1,580	7.01	1,840	7.00	2,810
	21. Soro-Soro	6.45	1,009	6.24	1,220	6.10	1,380	5.93	1,550	5.40	2,170
	22. Timbao	4.02	628	4.02	790	4.01	910	4.00	1,050	4.00	1,610
	23. Tubigan	12.84	2,009	13.07	2,560	13.23	2,990	13.42	3,520	14.00	5,620
	24. Zapote	2.10	328	2.10	410	2.10	470	2.10	550	2.10	840
	Sub-Total	100.00	15,641	100.00	19,580	100.00	22,590	100.00	26,230	100.00	40,160
	Total		83,684		102,210		116,090		132,190		191,260

TABLE 5.2.8
POPULATION OF AVERAGE NUMBER OF PERSONS/HOUSEHOLD AND TOTAL HOUSEHOLDS
CABUYAO-STA. ROSA-BINAN

Municipality	Area	Item	1980	1986	1990	1995	2000	2010	Remark
Cabuyao	Urban	Person/H.H.	5.51	5.41	5.34	5.26	5.17	5.00	
		No. of H.H.	931	1,111	1,242	1,385	1,543	1,871	
	Rural	Person/H.H.	5.94	5.79	5.69	5.57	5.45	5.20	
		No. of H.H.	6,931	8,689	10,048	11,704	13,640	18,190	
	Total	Person/H.H.	5.89	5.75	5.65	5.54	5.42	5.18	
		No. of H.H.	7,862	9,800	11,290	13,089	15,183	20,061	
Sta. Rosa	Urban	Person/H.H.	5.09	4.97	4.89	4.80	4.70	4.50	
		No. of H.H.	1,689	1,961	2,145	2,318	2,488	2,735	
	Rural	Person/H.H.	5.59	5.48	5.40	5.30	5.20	5.00	
		No. of H.H.	9,961	12,707	14,858	17,544	20,713	28,306	
	Total	Person/H.H.	5.52	5.41	5.33	5.24	5.14	4.96	
		No. of H.H.	11,650	14,668	17,003	19,862	23,201	31,041	
Binan	Urban	Person/H.H.	5.71	5.57	5.47	5.36	5.24	5.00	
		No. of H.H.	11,915	14,839	17,081	19,785	22,926	30,219	
	Rural	Person/H.H.	5.95	5.80	5.70	5.57	5.45	5.20	
		No. of H.H.	2,630	3,376	3,965	4,707	5,588	7,724	
	Total	Person/H.H.	5.75	5.61	5.52	5.40	5.28	5.04	
		No. of H.H.	14,545	18,215	21,046	24,492	28,514	37,943	

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

5.3.1 General

The potential service area to be covered by the water supply system in the future is established considering the following factors:

- Condition of the existing water supply system
- Barangays presently served by the existing water supply system
- Population size and density by barangay
- Future development potential
- Topographical characteristics of the area

The proposed service area of the year 2010 system is shown in FIGURE 5.3.1. The number of barangays and the corresponding land areas to be covered in the municipalities are as follows:

- Cabuyao : 15 (3,530 ha)
- Sta. Rosa : 15 (2,370 ha)
- Biñan : 13 (1,310 ha)

The barangays to be covered in the immediate project (Phase I Stage I, 1990 and Phase I Stage II, 1995) are shown in FIGURE 5.3.2 while the number of barangays and the corresponding land area by municipality are presented below:

- Cabuyao : 5 (105 ha)
- Sta. Rosa : 11 (230 ha)
- Biñan : 8 (265 ha)

It should be stressed that these barangays are being served by the existing water supply system. In the three Municipalities, the average population served is 8.5% of the total municipal populations, and 16.6% of the total population of barangays covered by the CSBWS.

1. BIÑAN

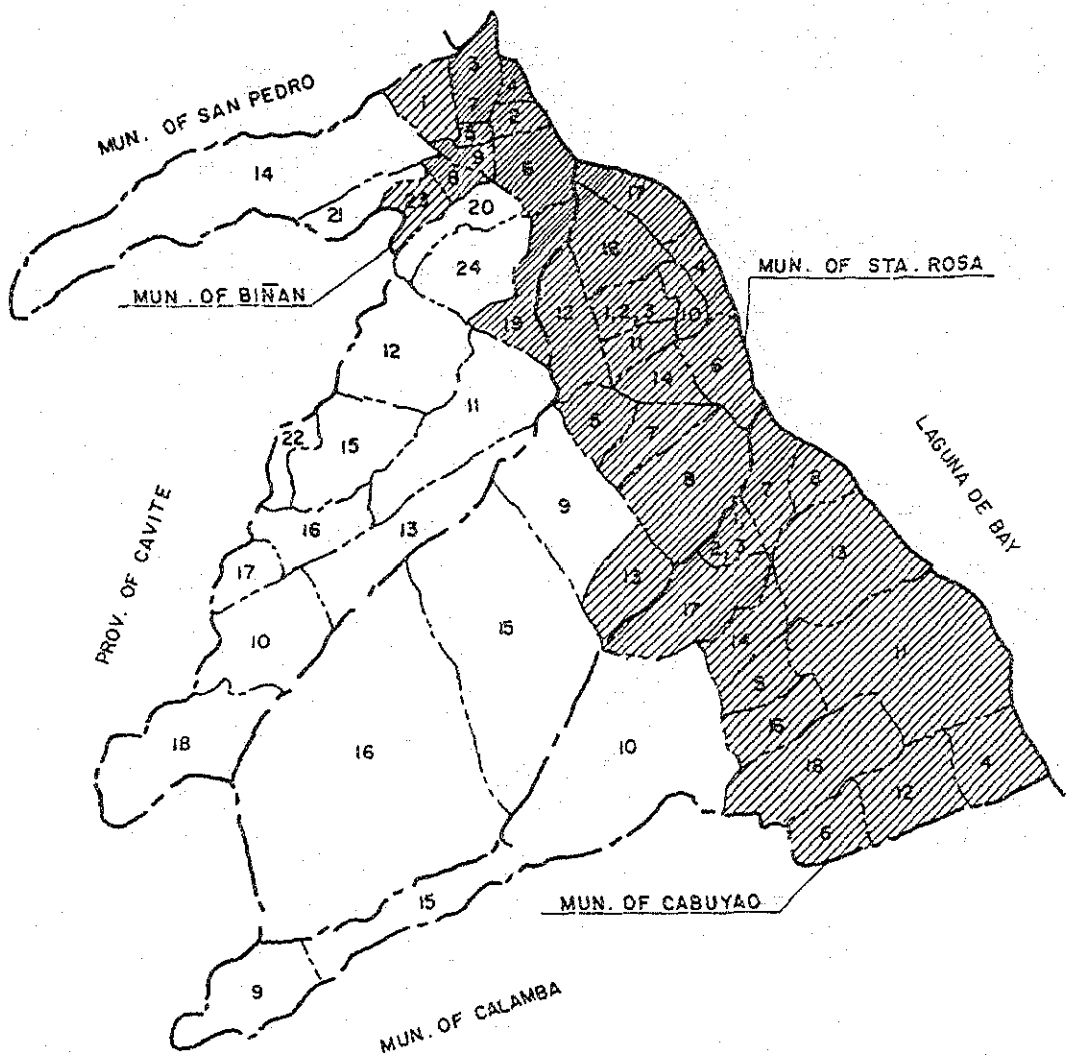
1. CANLALAY
2. CASILE
3. DE LA PAZ
4. MALABAN
5. POBLACION
6. SAN ANTONIO
7. SAN JOSE
8. SAN VICENTE
9. STO. DOMINGO
10. BIÑAN
11. BUNGAHAN
12. CALABUSO
13. GANADO
14. HALANG
15. LANGKIWA
16. LOMA
17. MALAMIG
18. MAMPLASAN
19. PLATERO
20. SAN ANTON
21. SORO-SORO
22. TIMBAO
23. TUBIGAN
24. ZAPOTE

2. STA. ROSA

1. KANLURAN
2. MALUSAK
3. MARKET AREA
4. APLAYA
5. BALIBAGO
6. CAINGIN
7. DILA
8. DITA
9. DON JOSE
10. IBABA
11. LABAS
12. MAKABLING
13. MALITLIT
14. POOK
15. PULONG STA. CRUZ
16. STO. DOMINGO
17. SINALHAN
18. TAGAPO

3. CABUYAO

1. BARANGAY I
2. BARANGAY II
3. BARANGAY III
4. BACLARAN
5. BANAY-BANAY
6. BANLIC
7. BIGAA
8. BUTONG
9. CASILE
10. DIEZMO
11. GULOD
12. MAMATID
13. MARINIG
14. NIUGAN
15. PITTLAND
16. PULO
17. SALA
18. SAN ISIDRO



NOTE: SUBJECT BARANGAYS OF THE BASIC DEVELOPMENT PLAN – ○

FIGURE - 5.3.1

SUBJECT BARANGAY OF THE
BASIC DEVELOPMENT PLAN
BINAN - STA. ROSA - CABUYAO

1. BINAN

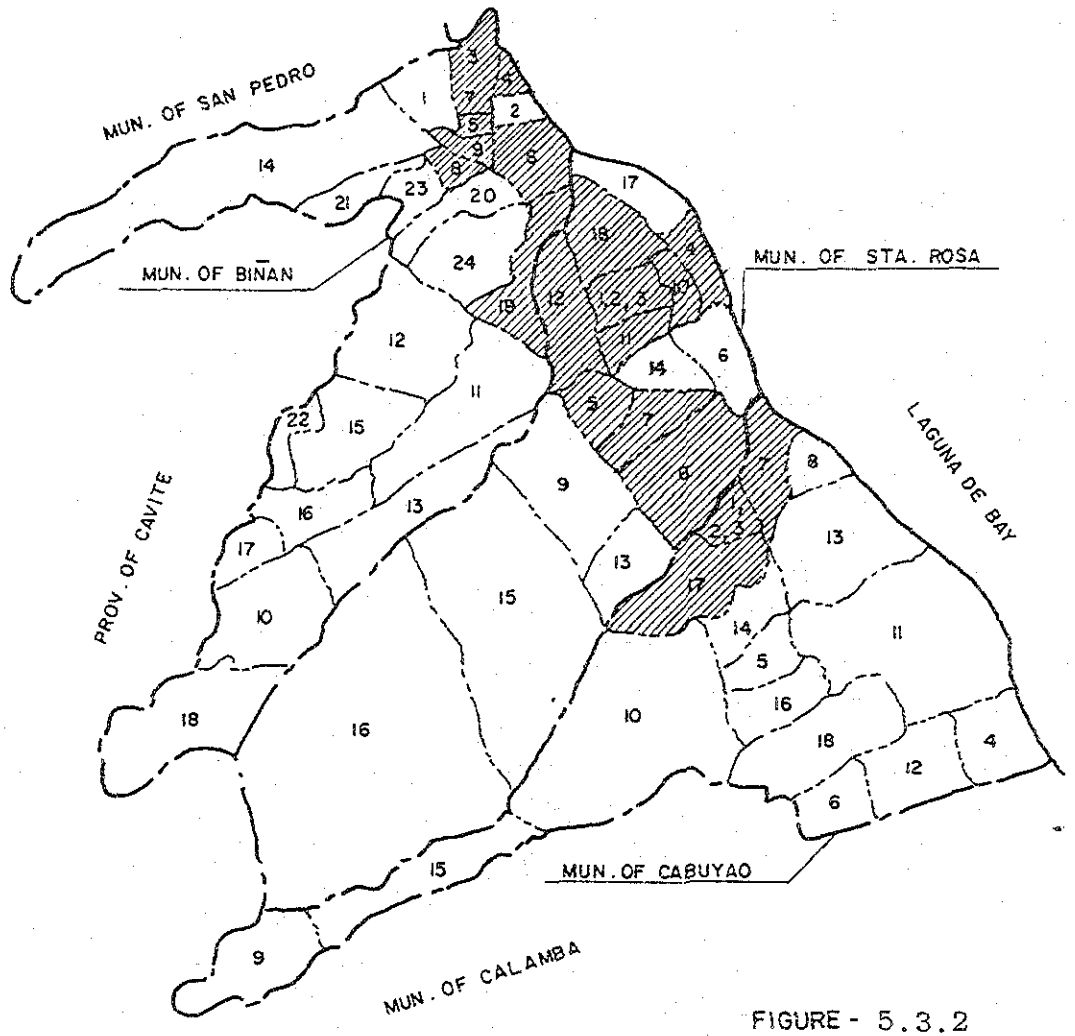
1. CANLALAY
2. CASILE
3. DE LA PAZ
4. MALABAN
5. POBLACION
6. SAN ANTONIO
7. SAN JOSE
8. SAN VICENTE
9. STO. DOMINGO
10. BINAN
11. BUNGAHAN
12. CALABUSO
13. GANADO
14. HALANG
15. LANGKIWA
16. LOMA
17. MALAMIG
18. MAMPLASAN
19. PLATERO
20. SAN ANTON
21. SORO-SORO
22. TIMBAO
23. TUBIGAN
24. ZAPOTE

2. STA. ROSA

1. KANLURAN
2. MALUSAK
3. MARKET AREA
4. APLAYA
5. BALIBAGO
6. CAINGIN
7. DILA
8. DITA
9. DON JOSE
10. IBABA
11. LABAS
12. MAKABLING
13. MALITLIT
14. POOK
15. PULONG STA. CRUZ
16. STO. DOMINGO
17. SINALHAN
18. TAGAPO

3. CABUYAO

1. BARANGAY I
2. BARANGAY II
3. BARANGAY III
4. BACLARAN
5. BANAY-BANAY
6. BANLIC
7. BIGAA
8. BUTONG
9. CASILE
10. DIEZMO
11. GULOD
12. MAMATID
13. MARINIG
14. NIUGAN
15. PITTLAND
16. PULO
17. SALA
18. SAN ISIDRO



NOTE :

Subject Barangay of the Feasibility Study :— ◯

FIGURE - 5.3.2

SUBJECT BARANGAY OF THE FEASIBILITY STUDY

BIÑAN — STA. ROSA — CABUYAO

5.3.2 Population and Area to be Served

The population being served at present (1986) in each barangay was calculated based on the assumed percentage of secondary users/borrowers to primary users by municipality obtained from the field survey. The following are the percentages for the three municipalities.

Cabuyao	=	20%
Sta. Rosa	=	40%
Biñan	=	50%

The populations to be served for the years 1990, 1995 and 2010 are summarized in TABLEs 5.3.1.A to 5.3.1.C. The percentage to be served in each target year is based on the following assumptions.

1990 : The percentage to be served in each barangay is assumed to be 20. But if the population being served at present in each barangay is more than 20% of the 1990 population, then the served population at present is used.

1995 : The percentage to be served in each barangay is assumed to be 60. However, since the present population being served is more than 60% of the 1995 population, the present figure is used.

2010 : The planned percentage to be served in each barangay for the year 2010 is 70%.

The recommended service area by design year is shown in FIGURE 5.3.3. The boundary of the service area by design year (1995 and 2010) was decided considering the following:

1995 : Present and future land use and existing service area.

2010 : Boundary of the related barangays.

TABLE 5.3.1.A POPULATION TO BE SERVED BY BARANGAY FOR THE DESIGN YEARS : CABUYAO

Barangay	1990 Barangay Pop.	1990 Percent	1990 Served Pop.	1995 Barangay Pop.	1995 Percent	1995 Served Pop.	2010 Barangay Pop.	2010 Percent	2010 Served Pop.
1. Barangay I	2,640	64	1,690	2,870	60	1,720	3,550	70	2,490
2. Barangay II	1,930	77	1,480	2,090	71	1,480	2,570	70	1,800
3. Barangay III	2,060	50	1,040	2,320	60	1,390	3,230	70	2,260
4. Baclaran	-	-	-	-	-	-	3,220	70	2,250
5. Banay-Banay	-	-	-	-	-	-	7,950	70	5,570
6. Banlic	-	-	-	-	-	-	8,640	70	6,050
7. Bigaa	5,550	20	1,100	6,370	60	3,820	9,460	70	6,620
8. Butong	-	-	-	-	-	-	3,030	70	2,120
9. Gulod	-	-	-	-	-	-	9,170	70	6,420
10. Mamatid	-	-	-	-	-	-	8,990	70	6,290
11. Marinig	-	-	-	-	-	-	11,650	70	7,950
12. Niugan	-	-	-	-	-	-	8,850	70	6,760
13. Pulo	-	-	-	-	-	-	8,800	70	6,160
14. Sala	4,430	20	890	5,210	60	3,130	8,320	70	5,820
15. San Isidro	-	-	-	-	-	-	3,400	70	2,380
Sub-Total	16,610	37	6,200	18,860	61	11,540	100,830	70	70,940
Municipality Total	63,820	9.7	6,200	72,460	15.9	11,540	103,940	68.3	70,940

TABLE 5.3.1.B POPULATION TO BE SERVED BY BARANGAY FOR THE DESIGN YEARS : STA. ROSA

Barangay	1990			1995			2010		
	Barangay Pop.	Percent	Served Pop.	Barangay Pop.	Percent	Served Pop.	Barangay Pop.	Percent	Served Pop.
1. Apalaya	9,010	20	1,800	10,110	60	6,070	13,870	70	9,710
2. Balibago	7,830	33	2,550	9,240	60	5,540	14,860	70	10,400
3. Barangay I	2,880	42	1,220	3,020	60	1,810	3,260	70	2,280
4. Barangay II	5,160	34	1,740	5,460	60	3,280	6,030	70	4,220
5. Barangay III	2,460	20	490	2,640	60	1,580	3,020	70	2,100
6. Caiñgin	-	-	-	-	-	-	11,040	70	7,730
7. Dila	3,060	20	610	3,550	60	2,130	5,380	70	3,770
8. Dita	6,690	27	1,800	7,680	60	4,610	11,320	70	7,920
9. Ibaba	1,840	30	550	2,010	60	1,210	2,550	70	1,790
10. Labas	3,860	20	770	4,480	60	2,690	6,790	70	4,750
11. Macabling	4,640	20	930	5,430	60	3,260	8,490	70	5,940
12. Malitlit	-	-	-	-	-	-	7,360	70	5,150
13. Pook	-	-	-	-	-	-	13,020	70	9,110
14. Sinalhan	-	-	-	-	-	-	13,300	70	9,310
15. Tagopo	9,740	20	1,950	11,680	60	7,010	19,540	70	13,680
Sub-Total	57,170	25	14,410	65,300	60	39,190	139,830	70	97,860
Municipality Total	90,680	15.9	14,410	104,050	37.7	39,190	153,840	63.6	97,860

TABLE 5.3.1.C POPULATION TO BE SERVED BY BARANGAY FOR THE DESIGN YEARS : BINAN

Barangay	1990 Barangay Pop.	1990 Percent	1990 Served Pop.	1995 Barangay Pop.	1995 Percent	1995 Served Pop.	2010 Barangay Pop.	2010 Percent	2010 Served Pop.
1. Canlalay	-	-	-	-	-	-	17,680	70	12,380
2. Casile	-	-	-	-	-	-	1,210	70	850
3. De La Paz	20,000	20	4,000	23,100	60	13,860	34,750	70	24,330
4. Malaban	21,120	20	4,220	24,570	60	14,740	37,780	70	26,450
5. Platero	5,500	20	1,100	6,350	60	3,810	9,560	70	6,690
6. Poblacion	4,890	25	1,220	5,210	60	3,130	6,040	70	4,230
7. San Antonio	17,440	20	3,490	19,180	60	11,510	24,930	70	17,450
8. San Anton	-	-	-	-	-	-	2,810	70	1,970
9. San Jose	5,360	20	1,070	6,000	60	3,600	8,310	70	5,820
10. San Vicente	10,030	20	2,010	11,320	60	6,390	15,870	70	11,110
11. Sto. Domingo	3,340	20	670	3,630	60	2,180	4,530	70	3,170
12. Tubigan	-	-	-	-	-	-	5,620	70	3,930
13. Zapote	-	-	-	-	-	-	840	70	590
Sub-Total	87,680	20.2	17,780	99,360	60	59,620	169,930	70	118,970
Municipality Total	116,090	15.3	17,780	132,190	45.1	59,620	191,260	62.2	118,970
Served Barangay Total	161,460	23.8	38,390	183,520	60	110,350	410,590	70	287,780
Three Municipality Total	270,590	14.2	38,390	308,700	35.7	110,350	449,040	64.1	287,780

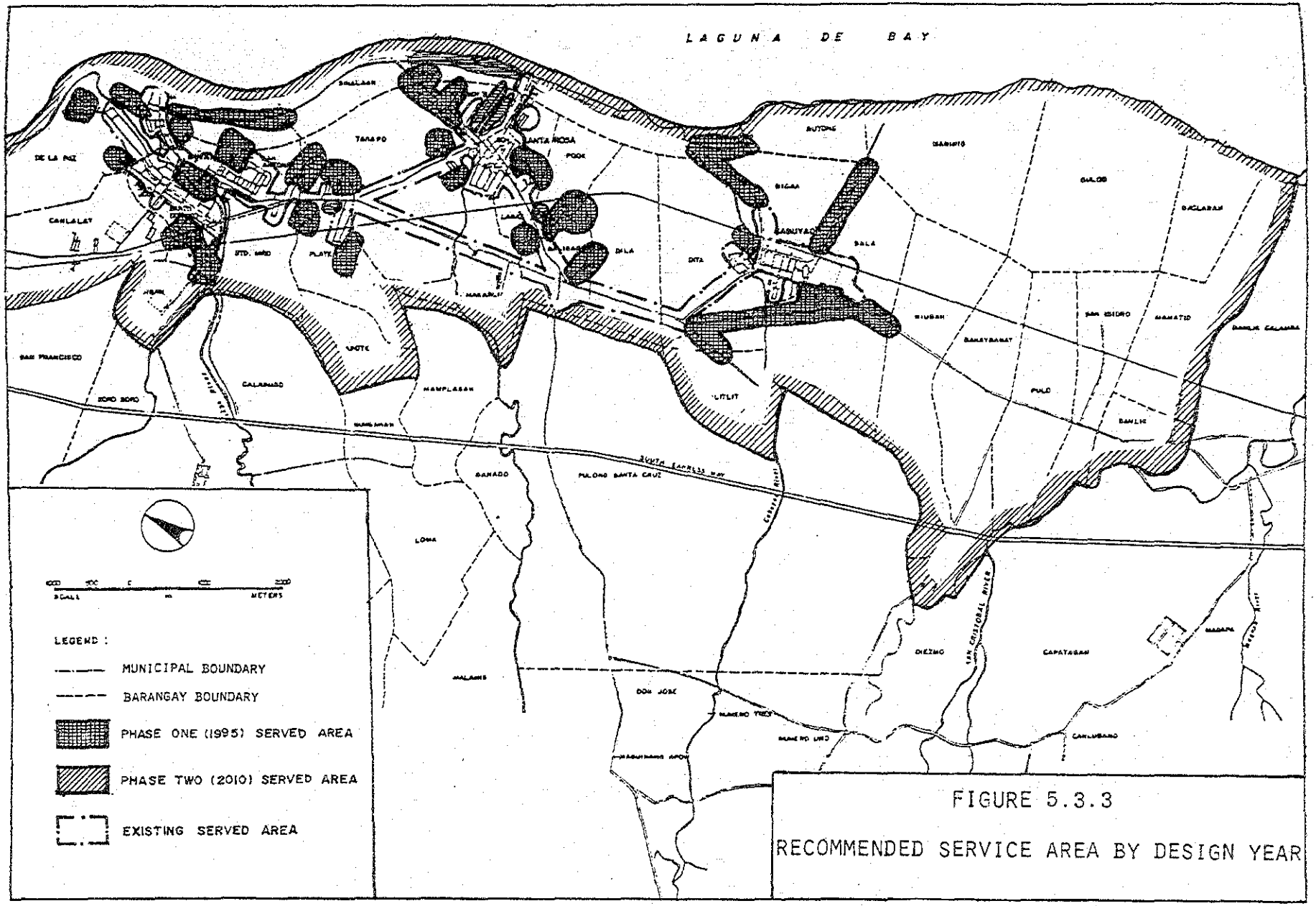


FIGURE 5.3.3

RECOMMENDED SERVICE AREA BY DESIGN YEAR

5.4 WATER DEMAND PROJECTION FOR THE PROPOSED SERVICE AREA

5.4.1 General

The future unit water consumption by consumer type was studied using the data obtained in May, 1986 and the results of field measurements. The served population and the number of connections by consumer type for the prospective service area were also studied. The water demand projection for the proposed area was finally made as a total of the water consumption and the assumed ratio of the unaccounted-for water to the total demand.

5.4.2 Design Unit Water Consumption by Consumer Type

(1) Domestic Unit Water Consumption

The average water consumption per capita in the CSBWS at present is estimated at 151 lpcd. For Cabuyao, Sta. Rosa and Biñan, it is 174, 152 and 122 lpcd, respectively. These figures reflect the present water service level in the locality as far as major water sources are concerned. These figures were based on some assumptions including the size of additional population served (secondary users/borrowers), as described in the previous CHAPTER.

The average per capita water consumption of the majority of the connections (90% of the total connections) with 70% of the total domestic consumption is calculated at 120 lpcd. (see TABLE 4.4.2, WATER CONSUMPTION)

The present per capita water consumption as a base figure for design purposes may be around 110 lpcd (10% reduction from 120 lpcd). This is due to reported cases of wastage and leakages in water meters in other municipalities.

The annual rate of increase for the unit water consumption is obtained from the LWUA Methodology Manual. TABLE 5.4.1 shows the future per capita water consumption using the base figure (1986) of 110 lpcd.

TABLE 5.4.1 ANNUAL RATE OF INCREASE AND PER CAPITA CONSUMPTION

Unit: Percent/lpcd

Item	1986	1990	1995	2000	2010
Increase Rate	-	2.0	1.5	1.5	1.0
Unit Consumption	110	119	128	138	152

(2) Commercial Unit Water Consumption

The daily average water consumption per commercial connection at present was calculated at 1.1 cu.m/conn.day. This figure is almost the same as the average figure for the domestic consumption. The unit water consumption for the future was calculated using the figure as the base year and the increase ratio from the LWUA Methodology Manual. TABLE 5.4.2 summarizes the consumption per connection in the future.

TABLE 5.4.2 DAILY AVERAGE COMMERCIAL UNIT WATER CONSUMPTION

Year	Increase Ratio	Unit Consumption (cu.m/con. day)
1986	1.0	1.1
1990	1.1	1.2
1995	1.3	1.4
2010	1.7	1.9

The number of commercial connections is calculated using the connection density increase ratio from the LWUA Methodology Manual. Although the present density ratio was calculated at 0.10 which is below 0.5% (Group I in the said Manual), the figure in Calamba was used to represent the average number of commercial connections, as shown in TABLE 5.4.3.

TABLE 5.4.3 CONNECTION DENSITY RATIO

Year	Coefficient of Density Increase	No. of Connection per 100 served pop.
1986	1.0	0.10 (1.5)*
1990	1.3	2.0
1995	1.6	2.4
2010	2.1	3.2

* Calamba Water District
Total commercial connections : 332
Served population : 20730
No. of connections per 100 service population: 1.6

(3) Institutional Unit Water Consumption

The daily average water consumption per connection at present was calculated to be 1.4 cu.m/conn.day from the metered consumption and the number of connections. The figure was obtained from the limited data available and it was concluded that present water supply is insufficient. Therefore, for future figures for design purposes it is recommended that the guideline in the LWUA Methodology Manual will be used as follows:

1986 : 1.4 (3.8) cu.m/conn. day
1990 : 4.5
1995 : 5.3
2010 : 7.5

The number of institutional connections will be estimated using the standard in the LWUA Methodology Manual; that is, one connection per 2,000 inhabitants in the service area.

(4) Industrial Unit Water Consumption

Big factories in the study area have their own water supply system. Furthermore, industrial establishments will be located far from the built-up area according to land use plan prepared by the municipalities. The present industrial water consumption (138 ≒ 150 cu.m/day in a system total) may be maintained in the service area through the future.

5.4.3 Water Demand Projection

The daily average water consumption by consumer type was estimated using the study results in the previous section. The water consumption by consumer type for the design years is summarized in TABLE 5.4.4 covering the three municipalities.

TABLE 5.4.4 WATER CONSUMPTION BY DESIGN YEAR (DAILY AVERAGE)

Year	Municipality	No. of Connections					Water Consumption (cu.m/day)				
		Domestic	Commerce	Inst.	Ind.	Total	Domestic	Commerce	Inst.	Ind.	Total
1990	Cabuyao	1,098	125	8	-	1,231	738	150	38	-	926
	Sta. Rosa	2,702	288	29	5	3,024	1,714	345	134	150	2,343
	Biñan	3,220	354	45	-	3,619	2,115	425	205	-	2,745
	Total	7,020	767	82	5	7,874	4,567	920	377	150	6,014
1995	Cabuyao	2,083	277	9	-	2,369	1,477	387	47	-	1,911
	Sta. Rosa	7,478	941	34	5	8,458	5,016	1,316	182	150	6,664
	Biñan	11,042	1,430	51	-	12,523	7,632	2,001	272	-	9,905
	Total	20,603	2,648	94	5	23,350	14,125	3,704	501	150	18,480
2010	Cabuyao	13,693	2,269	34	-	15,996	10,784	4,311	262	-	15,357
	Sta. Rosa	19,733	3,133	50	5	22,921	14,877	5,954	380	150	21,361
	Biñan	23,604	3,806	84	-	27,494	18,083	7,230	634	-	25,947
	Total	57,030	9,208	168	5	60,411	43,744	17,495	1,276	150	62,665

The water consumption is projected from 4,000 cu.m/day in 1986 to 63,000 cu.m/day in 2010.

The percentage of the not-utilized water to the distributed water at amounts to approximately 50%. The future figures are assumed to be 40%, 30% and 20% in 1990, 1995 and 2010, respectively. TABLEs 5.4.5.A, B and C present the result of demand projection. Water demand in 1986 is approximately 10,500 cu.m/day, which is almost the same as that in 1990. However, approximately 8 times the present demand will be required in year 2010. The daily average water demand by design year is summarized as follows:

1990 : 10,000 cu.m/day
1995 : 26,000 "
2010 : 78,000 "

5.4.4 Demand Variations

The ratio of the daily maximum and peak hour demand is a function of the served population.

a) Daily maximum water demand

The ratio of the daily maximum water demand to the daily average water demand is determined in proportion to the service population, as follows:

Served Population	Ratio (Daily Max.:Daily Ave.)	Application
Less than 30,000	1.30 : 1	
30,000 to 200,000	1.25 : 1	Phase I (1990, 1995)
Over 200,000	1.20 : 1	Phase II (2010)

b) Peak hour demand (Hourly maximum demand)

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

C = (Peak hour demand x 24)/(Daily maximum demand)
= 2.2 - 0.3 x log(Service population/1,000)

Phase I, Stage 1 (1990) : 1.7
Stage 2 (1995) : 1.6
Phase II (2010) : 1.5

The demand variations by design year are calculated using the above mentioned ratio, as follows:

Water Demand	1990	1995	2010
Daily average	10,000	26,400	78,300
Daily maximum	12,500	33,000	94,000
Peak hour	21,300	52,800	141,000

5.4.5 Number of Connections

The service connections are classified into domestic, commercial and institutional categories. The total number of connections for each category is projected in accordance with the LWUA Methodology Manual. It is expected that the waterworks will have total connections of 7,874 in 1990; 23,350 in 1995; and 66,411 in 2010. The number of connections by consumer type, and by barangay for the design years, are referred to in TABLEs 5.4.5.A to 5.4.5.C.

TABLE 5.4.5.A WATER DEMAND PROJECTION (1990)

Municipality/ Barangay	Barangay Population	Served Population	Number of Connections					Consumption (cu.m/day)					Unaccounted -for Water (cu.m/day)	Total Demand (cu.m/day)
			Domestic	Commer- cial	Institu- tional	Indus- trial	Total	Domestic	Commer- cial	Institu- tional	Indus- trial	Total		
Cabuyao														
1. Barangay I	2,640	1,690	299	34	1	0	334	201	41	5	0	247	165	412
2. Barangay II	1,930	1,480	262	30	1	0	293	176	36	5	0	217	145	362
3. Barangay III	2,060	1,040	184	21	1	0	206	124	25	5	0	154	103	257
4. Bigaa	5,550	1,100	195	22	3	0	220	131	26	14	0	171	114	285
5. Sala	4,430	890	158	18	2	0	178	106	22	9	0	137	91	228
Sub-Total	16,610	6,200	1,098	125	8	0	1,231	738	150	38	0	926	618	1,544
Sta. Rosa														
1. Aplaya	9,010	1,800	338	36	5	0	379	214	43	23	0	280	187	467
2. Balibago	7,830	2,550	478	51	4	1	534	303	61	18	100	482	321	803
3. Barangay I	2,880	1,220	229	24	1	0	254	145	29	5	0	179	119	298
4. Barangay II	5,160	1,740	326	35	3	0	364	207	42	14	0	263	175	438
5. Barangay III	2,460	490	92	10	1	0	103	58	12	5	0	75	50	125
6. Dila	3,060	610	114	12	2	2	130	73	14	9	30	126	84	210
7. Dita	6,690	1,800	338	36	3	1	378	214	43	14	10	281	187	468
8. Ibaba	1,840	550	103	11	1	0	115	65	13	5	0	83	55	138
9. Labas	3,860	770	144	15	2	0	161	92	18	9	0	119	79	198
10. Macabling	4,640	930	174	19	2	1	196	111	23	9	10	153	102	255
11. Tagapo	9,740	1,950	366	39	5	0	410	232	47	23	0	302	201	503
Sub-Total	57,170	14,410	2,702	288	29	5	3,024	1,714	345	134	150	2,343	1,560	3,903
Biñan														
1. De La Paz	20,000	4,000	725	80	10	0	815	476	96	45	0	617	411	1,028
2. Malaban	21,120	4,220	764	84	11	0	859	502	101	50	0	653	435	1,088
3. Platero	5,500	1,100	199	22	3	0	224	131	26	14	0	171	114	285
4. Poblacion	4,890	1,220	221	24	2	0	247	145	29	9	0	183	122	305
5. San Antonio	17,440	3,490	632	70	9	0	711	415	84	41	0	540	360	900
6. San Jose	5,360	1,070	194	21	3	0	218	127	25	14	0	166	111	277
7. San Vicente	10,030	2,010	364	40	5	0	409	239	48	23	0	310	207	517
8. Sto. Domingo	3,340	670	121	13	2	0	136	80	16	9	0	105	70	175
Sub-Total	87,680	17,780	3,220	354	45	0	3,619	2,115	425	205	0	2,745	1,830	4,575
Total	161,460	38,390	7,020	767	82	5	7,874	4,567	920	377	150	6,014	4,008	10,022

TABLE 5.4.5.B WATER DEMAND PROJECTION (1995)

Municipality/ Barangay	Barangay Population	Served Population	Number of Connections					Consumption (cu.m/day)					Unaccounted -for Water (cu.m/day)	Total Demand (cu.m/day)
			Domestic	Commer- cial	Institu- tional	Indus- trial	Total	Domestic	Commer- cial	Institu- tional	Indus- trial	Total		
Cabuyao														
1. Barangay I	2,870	1,720	310	41	1	0	352	220	57	5	0	282	121	403
2. Barangay II	2,090	1,480	267	36	1	0	304	189	50	5	0	244	105	349
3. Barangay III	2,320	1,390	251	33	1	0	285	178	46	5	0	229	98	327
4. Bigaa	6,370	3,820	690	92	3	0	785	489	129	16	0	634	272	906
5. Sala	5,210	3,130	565	75	3	0	643	401	105	16	0	522	224	746
Sub-Total	18,860	11,540	2,083	277	9	0	2,369	1,477	387	47	0	1,911	820	2,731
Sta. Rosa														
1. Aplaya	10,110	6,070	1,158	146	5	0	1,309	777	204	27	0	1,008	432	1,440
2. Balibago	9,240	5,540	1,057	133	5	1	1,196	709	186	27	100	1,022	438	1,460
3. Barangay I	3,020	1,810	345	43	2	0	390	232	60	11	0	303	130	433
4. Barangay II	5,460	3,280	626	79	3	0	708	420	111	16	0	547	234	781
5. Barangay III	2,640	1,580	302	38	1	0	341	202	53	5	0	260	111	371
6. Dila	3,550	2,130	406	51	2	2	461	273	71	11	30	385	165	550
7. Dita	7,680	4,610	880	111	4	1	996	590	155	21	10	776	333	1,109
8. Ibaba	2,010	1,210	231	29	1	0	261	155	41	5	0	201	86	287
9. Labas	4,480	2,690	513	65	2	0	580	344	91	11	0	446	191	637
10. Macabling	5,430	3,260	622	78	3	1	704	417	109	16	10	552	237	789
11. Tagapo	11,680	7,010	1,338	168	6	0	1,512	897	235	32	0	1,164	499	1,663
Sub-Total	65,300	39,190	7,478	941	34	5	8,458	5,016	1,316	182	150	6,664	2,856	9,520
Biñan														
1. De La Paz	23,100	13,860	2,567	333	12	0	2,912	1,774	466	64	0	2,304	987	3,291
2. Malaban	24,570	14,740	2,730	354	12	0	3,096	1,887	496	64	0	2,447	1,049	3,496
3. Platero	6,350	3,810	706	91	3	0	800	488	127	16	0	631	270	901
4. Poblacion	5,210	3,130	580	75	3	0	658	401	105	16	0	522	224	746
5. San Antonio	19,100	11,510	2,131	276	10	0	2,417	1,473	386	53	0	1,912	819	2,731
6. San Jose	6,000	3,600	667	86	3	0	756	461	120	16	0	597	256	853
7. San Vicente	11,320	6,790	1,257	163	6	0	1,426	869	228	32	0	1,129	484	1,613
8. Sto. Domingo	3,630	2,180	404	52	2	0	458	279	73	11	0	363	156	519
Sub-Total	99,280	59,620	11,042	1,430	51	0	12,523	7,632	2,001	272	0	9,905	4,245	14,150
Total	183,440	110,350	20,603	2,648	94	5	23,350	14,125	3,704	501	150	18,480	7,921	26,401

TABLE 5.4.5.C WATER DEMAND PROJECTION (2010)

Municipality/ Barangay	Barangay Population	Served Population	Number of Connections					Consumption (cu.m/day)					Unaccounted -for Water (cu.m/day)	Total Demand (cu.m/day)
			Domestic	Commer- cial	Institu- tional	Indus- trial	Total	Domestic	Commer- cial	Institu- tional	Indus- trial	Total		
Cabuyao														
1. Barangay I	3,550	2,490	481	80	1	0	562	378	152	8	0	538	135	673
2. Barangay II	2,570	1,800	347	50	1	0	398	274	110	8	0	392	98	490
3. Barangay III	3,230	2,260	436	72	1	0	509	344	137	8	0	489	122	611
4. Baclaran	3,220	2,250	434	72	1	0	507	342	137	8	0	487	122	609
5. Banay-Banay	7,950	5,570	1,075	78	3	0	1,156	847	338	23	0	1,208	302	1,510
6. Banlic	8,640	6,050	1,168	194	3	0	1,365	920	369	23	0	1,312	328	1,640
7. Bigaa	9,460	6,620	1,278	212	3	0	1,493	1,006	403	23	0	1,432	358	1,790
8. Butong	3,030	2,120	409	68	1	0	478	322	129	8	0	459	115	574
9. Gulod	9,170	6,420	1,239	205	3	0	1,447	976	390	23	0	1,389	347	1,736
10. Mamatid	8,990	6,290	1,214	201	3	0	1,418	956	382	23	0	1,361	340	1,701
11. Marinig	11,650	7,950	1,535	254	4	0	1,793	1,203	483	30	0	1,716	430	2,146
12. Niugan	8,850	6,760	1,305	216	3	0	1,524	1,028	410	23	0	1,461	365	1,826
13. Pulo	8,800	6,160	1,189	197	3	0	1,389	936	374	23	0	1,333	333	1,666
14. Sala	8,320	5,820	1,124	186	3	0	1,313	885	353	23	0	1,261	315	1,576
15. San Isidro	3,400	2,380	459	76	1	0	536	362	144	8	0	514	129	643
Sub-Total	100,830	70,940	13,693	2,161	34	0	15,888	10,779	4,311	262	0	15,352	3,839	19,191
Sta. Rosa														
1. Aplaya	13,870	9,710	1,958	311	5	0	2,274	1,476	591	38	0	2,105	526	2,631
2. Balibago	14,860	10,400	2,097	333	5	1	2,436	1,581	633	38	100	2,352	588	2,940
3. Barangay I	3,260	2,280	460	73	1	0	534	347	139	8	0	494	124	618
4. Barangay II	6,030	4,220	851	135	2	0	988	641	257	15	0	913	228	1,141
5. Barangay III	3,020	2,110	425	68	1	0	494	321	129	8	0	458	115	573
6. Caiñgin	11,040	7,730	1,558	247	4	0	1,809	1,175	469	30	0	1,674	419	2,093
7. Dila	5,380	3,770	760	121	2	2	885	573	230	15	30	848	212	1,060
8. Dita	11,320	7,920	1,597	253	4	1	1,855	1,204	481	30	10	1,725	431	2,156
9. Ibaba	2,550	1,790	361	57	1	0	419	272	108	8	0	388	97	485
10. Labas	6,790	4,750	958	152	2	0	1,112	722	289	15	0	1,026	257	1,283
11. Macabling	8,490	5,940	1,198	190	3	1	1,392	903	361	23	10	1,297	324	1,621
12. Malitlit	7,360	5,150	1,038	165	3	0	1,206	783	314	23	0	1,120	280	1,400
13. Pook	13,020	9,110	1,837	292	5	0	2,134	1,385	555	38	0	1,978	495	2,473
14. Sinalhan	13,300	9,310	1,877	298	5	0	2,180	1,415	566	38	0	2,019	505	2,524
15. Tagapo	19,540	13,680	2,758	438	7	0	3,203	2,079	832	53	0	2,964	741	3,705
Sub-Total	139,830	97,870	19,733	3,133	50	5	22,921	14,877	5,954	380	150	21,361	5,342	26,703

TABLE 5.4.5.C WATER DEMAND PROJECTION(2010) (CONTINUED)

Municipality/ Barangay	Barangay Population	Served Population	Number of Connections					Consumption (cu.m/day)					Unaccounted -for Water (cu.m/day)	Total Demand (cu.m/day)
			Domestic	Commer- cial	Institu- tional	Indus- trial	Total	Domestic	Commer- cial	Institu- tional	Indus- trial	Total		
Biñan														
1. Canlalay	17,680	12,380	2,456	396	9	0	2,861	1,882	752	68	0	2,702	676	3,378
2. Casile	1,210	850	169	27	1	0	197	129	51	8	0	188	47	235
3. De La Paz	34,750	24,330	4,827	779	17	0	5,623	3,698	1,480	128	0	5,306	1,327	6,633
4. Malaban	37,780	26,450	5,248	846	19	0	6,113	4,020	1,607	143	0	5,770	1,443	7,213
5. Platero	9,560	6,690	1,327	214	5	0	1,546	1,017	407	38	0	1,462	366	1,828
6. Poblacion	6,040	4,230	839	135	3	0	977	643	257	23	0	923	231	1,154
7. San Antonio	24,930	17,450	3,462	558	12	0	4,032	2,652	1,060	90	0	3,802	951	4,753
8. San Anton	2,810	1,970	391	63	1	0	455	299	120	8	0	427	107	534
9. San Jose	8,310	5,620	1,155	186	4	0	1,345	885	353	30	0	1,268	317	1,585
10. San Vicente	15,870	11,110	2,204	356	8	0	2,568	1,689	676	60	0	2,425	606	3,031
11. Sto. Domingo	4,530	3,170	629	101	2	0	732	482	192	15	0	689	172	861
12. Tubigan	5,620	3,930	780	126	3	0	909	597	239	23	0	859	215	1,074
13. Zapote	840	590	117	19	0	0	136	90	36	0	0	126	32	158
Sub-Total	169,930	118,770	23,604	3,806	84	0	27,494	18,083	7,230	634	0	25,947	6,490	32,437
Total	410,590	287,580	57,030	9,100	168	5	66,303	43,739	17,495	1,276	150	62,660	15,671	78,331

CHAPTER 6
WATER RESOURCES

CHAPTER 6 WATER RESOURCES

6.1 GENERAL

The collected data and the field survey results are the bases for the study of water resources in the study area. The major concern in the area is groundwater for the water supply.

A well log and pumping test data from the National Water Resources Council (hereinafter referred to as NWRC), as well as existing reports of investigation and publications such as geologic investigations by the Bureau of Mines, etc., were collected.

An inventory of springs and other existing wells were prepared during the field survey. The survey included discharge measurement of springs and some free-flowing wells, chemical analysis of some water samples and verification of locations of these wells and springs. Supplemental to the initial data gathering mentioned above, additional data collection was likewise undertaken in local agencies like the municipal offices, the NIA field office.

6.2 PHYSIOGRAPHY

The Municipalities of Cabuyao, Sta. Rosa and Biñan have a generally flat topography (slope=2.5%). They occupy the northwestern portion of the Laguna Province along the coast of Laguna de Bay. The southwestern part of the study area is, however, hilly with elevation greater than 100 m above mean sea water level. The development of the physiographic feature is controlled to a large extent by the presence of volcanoes not far from the region.

This is highly proven by the existence of volcanic formations inland as shown by the well stratigraphic logs. Alluvium on the other hand, comprises the lowland nearer the coast. This area is reported to be flooded during heavy rains.

The main drainage branches in the area are the Biñan River in Biñan, the Sta. Rosa River in Sta. Rosa, and the Cabuyao and Diezmo Rivers

in Cabuyao, all of which originate from the mountains in the southwest, crossing the region and finally draining into the Laguna de Bay.

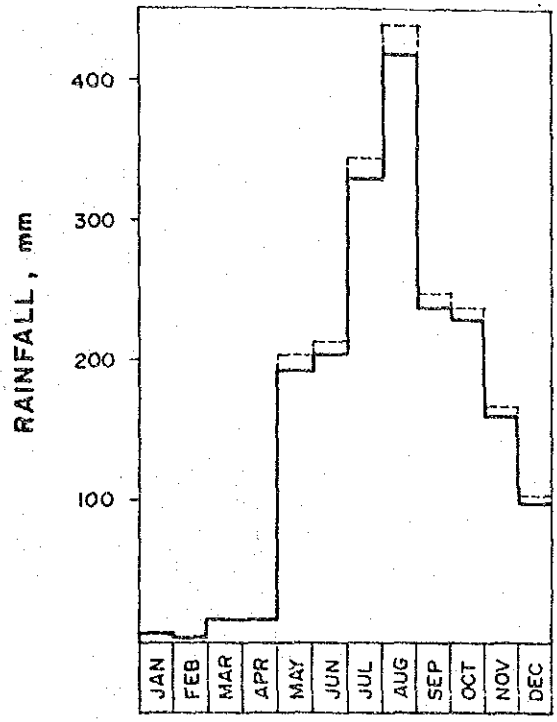
Sugarcane and rice compose the bulk of vegetal coverage in the three Municipalities. Nearer the coast, rice is predominant while inland, the presence of a sugar mill in Canlubang, makes sugarcane, which is common particularly in Sta. Rosa. During the seasonal change in climate, however, water melon and garlic are the major crops along the coast, especially in Cabuyao. The other parts are covered with coconut trees and other fruit-bearing trees, the remaining area being planted with other kinds of vegetables.

6.3 METEOROLOGY

A climate of the first type prevails over the three Municipalities. it includes two pronounced seasons: usually dry from November to April and wet during the rest of the year. Due to the absence of any climatological/synoptic station in any of the three (3) towns, rainfall and temperature data from adjacent stations, e.g., San Pedro Station and Manila International Airport Hydrometeorological Station, will be considered.

6.3.1 Rainfall

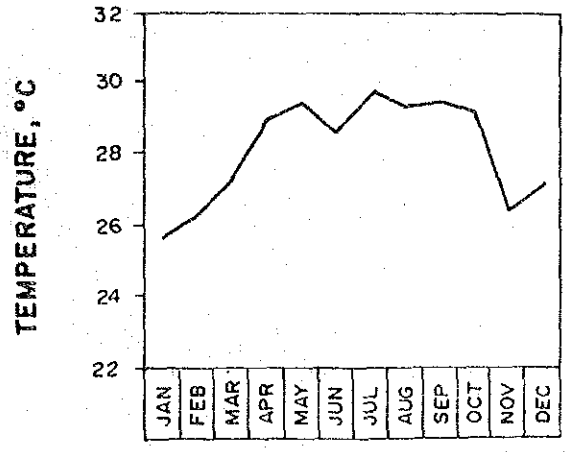
A summary of rainfall data based on a 11-year observation period (1971-1981) at San Pedro Station is shown in TABLE 6.3.1 and FIGURE 6.3.1. Both show that rainfall is low from December to April with the lowest registered in February with 1.5 mm. Maximum rainfall was observed in August with 415.1 mm while a total yearly average was computed to be 1897.1 mm.



AVERAGE RAINFALL
1971 - 1981
SAN PEDRO HYDROMET STATION

SAN PEDRO RAINFALL

ADJ. RAINFALL FOR STUDY AREA



AVERAGE TEMPERATURE
14 - YEAR RECORD
MIA HYDROMET STATION

LWUA - JICA
STUDY ON MUNICIPAL WATER SUPPLY PROJECT

FIGURE 6.3.1
CLIMATOLOGICAL DATA
CABUYAO - STA. ROSA - BIÑAN

TABLE 6.3.1 CLIMATOLOGICAL DATA

Month	Rainfall (mm)			Temperature (°C)
	San. Pedro	% Distribution	Study Area (Adjusted)	
Jan.	4.6	0.24	4.8	25.5
Feb.	1.5	0.08	1.6	26.1
Mar.	14.0	0.74	14.8	27.2
Apr.	14.2	0.75	15.0	28.9
May	191.1	10.07	201.4	29.4
Jun.	203.4	10.73	214.6	28.5
Jul.	327.5	17.27	345.4	27.7
Aug.	415.1	21.88	437.6	27.3
Sep.	236.8	12.48	249.6	77.4
Oct.	230.0	12.12	242.4	27.1
Nov.	160.0	8.43	168.6	26.2
Dec.	98.9	5.21	104.2	27.2
Total	1,897.1	100.00	2,000.0	Ave.27.4

Note: Rainfall; San Pedro Station
Temperature; Manila International Airport Hydromet. Station

In the "Comprehensive Development Plan of Cabuyao," however, the rainfall was reported to be 2,000 mm in consideration of the records in other adjacent municipalities. The isohyetal map of FIGURE 6.3.2 gives an approximate average of 2,000 mm. A 2,000 mm rainfall is adopted in this regard. The monthly rainfall distribution is then adjusted using the percentage distribution at San Pedro Station.

6.3.2 Temperature

The actual temperature in the study area is unknown. In this regard, data from the Manila International Airport (14-year record) station is assumed to represent the existing temperature in the region. From TABLE 6.3.1 and FIGURE 6.3.1, it could be observed that a fairly uniform temperature is prevalent with an annual mean of 27.4°C. This is comparable to municipal records of 27.5°C and 27.2°C for Cabuyao and Biñan, respectively. The hottest temperature is registered in May (29.4°C) and the coldest in January (25.5°C).

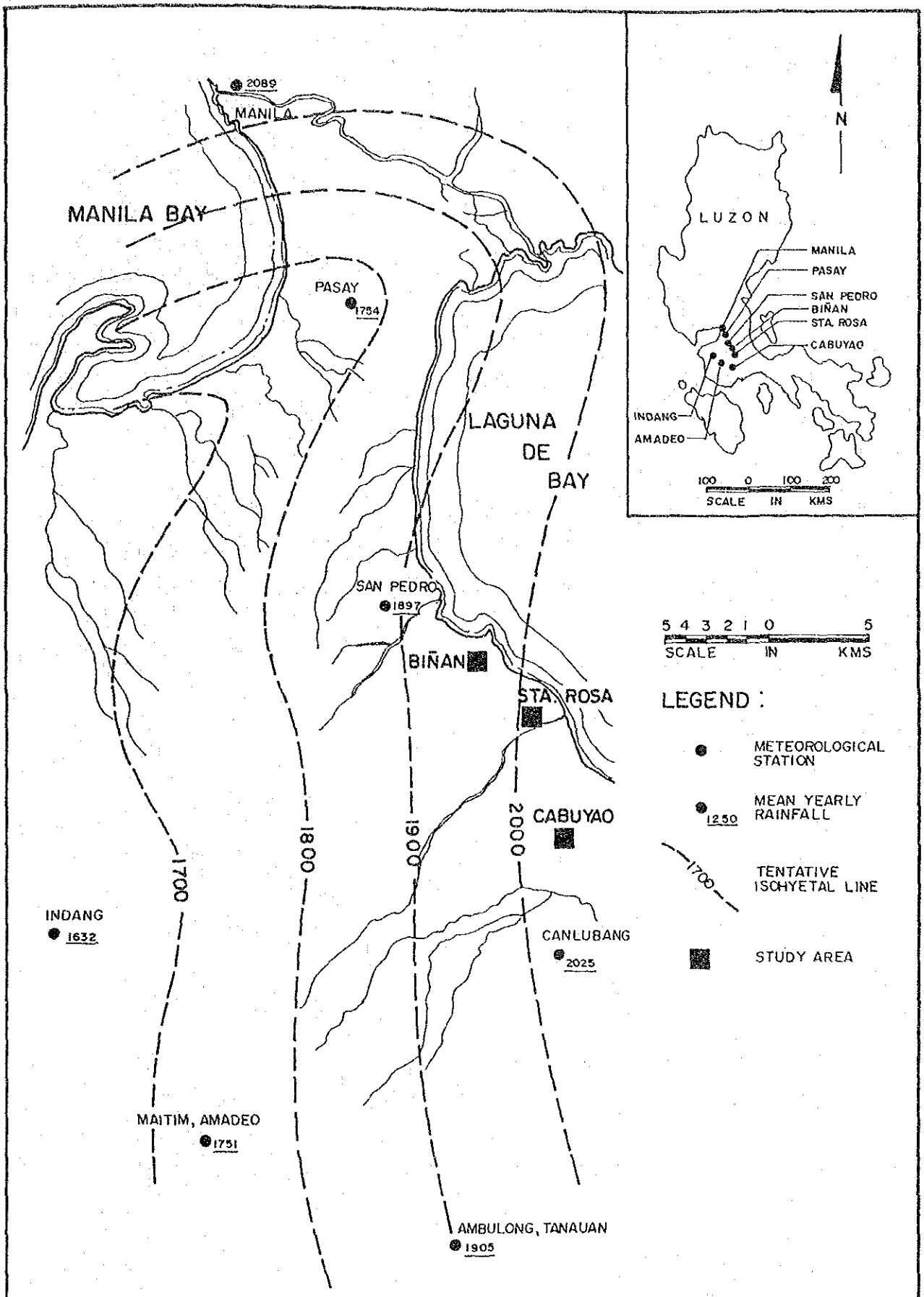


FIGURE 6.3.2

ISOHYETAL MAP

CABUYAO - STA. ROSA - BIÑAN

LWUA - JICA

STUDY ON MUNICIPAL WATER SUPPLY PROJECT

6.4 GEOLOGY

The study area is characterized by a plain and hilly section in the southwest. The hilly region is composed of clastic formation which extends into the major portion of the plain. In the lowland, along the shores of the Laguna de Bay, alluvial deposit takes place. A geological map covering the area is shown in FIGURE 6.4.1.

The main litho-stratigraphic units found in the project area as inferred from surface and subsurface data are as follows:

Pliocene - Pleistocene Sedimentary Rocks

Also known as "Laguna Formation," it can be mapped out almost entirely throughout the area, even beneath of the Laguna de Bay as confirmed by the borehole drilling of the NIA-UNDP study team through the bottom of the lake.

This rock formation constitutes the only sedimentary formation in the area. It consists of clastic debris and tuffaceous sedimentary rock which are of volcanic origin. The foothill and the portion covered by this formation are largely composed of fractured volcanic ash (tuff). Lithologic descriptions of well logs drilled in this region often describe layers of volcanic tuff, ash, pumice and other volcanic-derived strata (e.g., adobe) known to be tuffaceous and/or pumiceous.

Alluvial Formation

These are largely residual soil and reworked volcanics composed of sand, lenses of gravel and considerable silt and clay resulting from disintegration of volcanic and pyroclastic rocks caused by rapid weathering. It thickens to the north nearer Biñan.

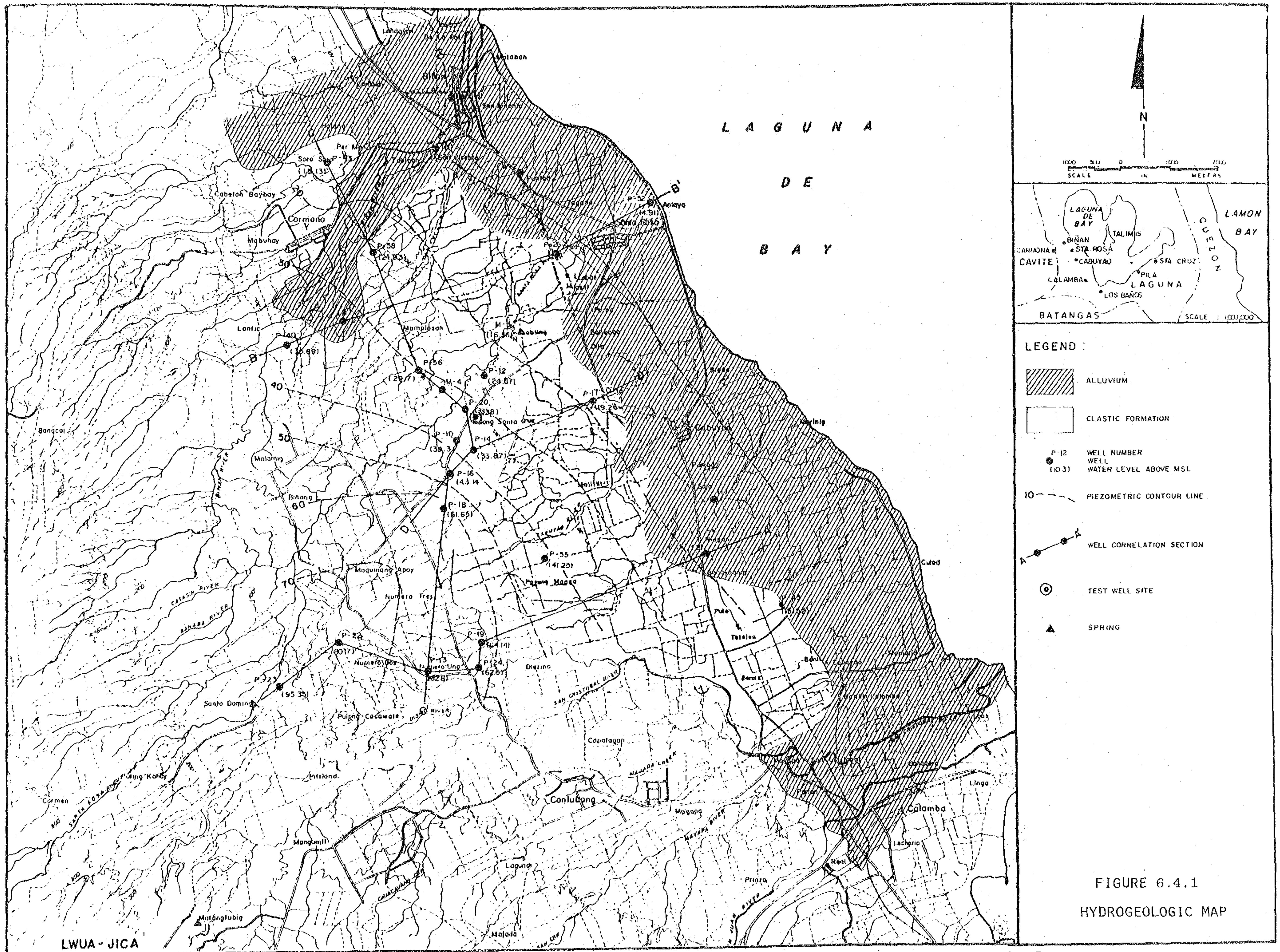


FIGURE 6.4.1

HYDROGEOLOGIC MAP

Geologic Structure

The structural feature is influenced to a greater extent by its location, being in the southern extensions of the Central Luzon intermontane basin. This region is strongly faulted, and the prominent one is the Marikina Fault which traverses the western section in a N-S direction. Disrupted by a number of minor steep faults, it reflects local land adjustment to the volcanic activity.

6.5 SURFACE WATER

The perennial surface water in the study area are the Biñan, Sta. Rosa, Diezmo and Cabuyao Rivers, and the Laguna de Bay. The rivers which pass inside the boundaries of the three Municipalities originate from the hills in the southwest and serve as the main drainage system in the area.

No stream flow records are available for these rivers and these were observed to be highly polluted.

The alternative surface water source to meet the future demand for the study area is the Laguna de Bay, a large body of fresh water which is at times salty due to backflow from the Manila Bay.

From previous studies conducted by T. Ingledow and Associates, Ltd. (hereinafter referred to as TIAL) in 1986 and the Laguna Lake Development Authority - Hydrotechnics Consulting Engineer (hereinafter referred to as LLDA-HCE) in 1973, the maximum and minimum recorded water levels are 4.15 m and -0.25 m above mean sea water level, respectively. Evaluation of median values gave Hmax=1.45 and Hmin=0.25 which correspond to a mean storage volume of 1,080 million cu.m of water (average lake surface area is 900 sq.km). From a water balance analysis (TIAL) considering all factors, eg. change in lake storage, outlet discharge (Napindan River), irrigation withdrawal, etc., a theoretical average annual volume of 3,000 million cu.m (95 cu.m/s flow) was estimated to be available for many uses in the surrounding areas and the Metropolitan Manila Area. Considering however the drought period which occurred in 1986-69 (100 year return period), the net available flow is 950 million cu.m.

This lake is totally polluted from industries and various livestock farms on its shores and doesn't seem to be a potential source for the system in the near feature since development of such would generally entail a large amount considering the prohibitive cost of treatment, intake facilities.

The most potential river in the area is the Diezmo River. It borders Cabuyao in the south and contributes to the flow of the San Cristobal River which empties into the Laguna de Bay at Calamba. From available intermittent records between 1912-1915 (LLDA-HCE), the approximate annual flow of this river is 6.2 cu.m/s. The maximum and minimum records gave monthly values of 1.2 (July) and 0.4 cu.m/s. almost half of the year. At present, this river is being utilized by the NIA to irrigate the inland planted to rice and sugarcane.

6.6 SPRINGS

Several springs located in the Matang-Tubig Spring area, Canlubang were investigated during the survey. Two of these springs are presently tapped: one is the major source of the CSBWS, while the other is being used by the Canlubang Sugar Estate for milling and irrigation. The remaining are four springs with outlets at the slope of the valley in the vicinity of the existing spring box.

These springs which are believed to be interconnected seep out from fractures on the bank of the Mangumit River and have an elevation of about 180 m above the mean sea level.

The discharge amount from the existing spring box is almost constant through the year (Approximately 8% increase in rainy season compared to the amount during dry season). The amount from the four potential water sources (springs) is also constant through the year. The figures measured in dry and rainy seasons are referred to APPENDIX 4.3.1.

6.7 GROUNDWATER

6.7.1 Water Point Inventory

Numerous wells exist in Cabuyao-Sta. Rosa-Biñan area. Most of these wells were drilled by the Ministry of Public Works and Highways (hereinafter referred to as MPWH) and were intended only for small scale water withdrawal (point sources with hand pumps). Hence, the design and construction are relatively poor, i.e., not fully penetrating the aquifer and the production is limited to open bottom holes (no screens/perforations).

The more important wells are those constructed by the NIA. Records of these wells included strata description and pumping test evaluation. A summary of all pumping test data collected during the field survey is given in TABLE 6.7.1 and well log data are shown in APPENDIX 6.7.1.

The most productive ones are those developed by the NIA. From available pumping test records, these wells (NIA), have varying discharges from 10 to 110 l/sec but most have above 50 l/sec production except for the smaller observation wells with a casing diameter of 100 mm.

Notable among the wells in the area is P-18. It is a NIA well which was used to irrigate several hectares of sugarcane and rice plantation. It was constructed in 1973 and is equipped with a 300/250 mm telescopic casing/screen. This well is a free-flowing one with a recorded water level of 12.35 m above ground surface (61.65 m above mean sea level). Pumping test records showed a specific capacity of 6.48 l/sec/m after pumping with a discharge of 118 l/sec and a drawdown of 18.23 m. Transmissivity of the aquifer penetrated by this well was evaluated to be very high at 4,669 sq.m/day.

Other wells in the area were also found to be free-flowing consisting of a series of volcanic tuff and ash interrelated with layers of clay.

TABLE 6.7.1. PUMPING TEST DATA SUMMARY (BIÑAN, STA. ROSA, CABUYAO)

Well No.	Location	Depth (m)	Water Level (m)	Discharge (l/s)	Drawdown (m)	Specific Capacity (l/s/m)	Trans-missivity
P-56	Mamplasan, Biñan	446	+0.46FF	93.49	23	4.14 *	'754
(B)	San Vicente, Biñan	161	GL	32.0	27	1.20	217
C-41	Biñan Elem. Sch.	152	0.94	8.69	27	0.33	463
C	Calabuso, Biñan	140	0.60	20.34	22.1	0.92	129
P-58	Calabuso, Biñan	170	1.06	15.30	4.34	3.53 *	605
P-43	Sorosoro, Biñan	169	0.59	12.30	5.08	2.42 *	512
P-40	Langking, Biñan	161	3.59	10.28	5.28	1.95 *	804
P-18	Paguyo, Sta. Rosa	200	+12.35FF	118.72	18.23	6.48 *	4669
P-13	Mangera, Sta. Rosa	200	+ 3.4FF	119.24	19.04	6.26 *	914
P-10	Sta. Cruz, Sta. Rosa	250	1.63	27.13	22.25	1.22 *	715
P-16	Pulong Sta. Cruz, Sta. Rosa	200	+ 1.91FF	99.68	26.49	3.76 *	737
P-19	Alasasan, Sta. Rosa	202	0.76	50.09			671
P-20	P. Sta. Cruz, Sta. Rosa	200	3.12	55.52	15.22	3.60 *	1021
P-23	Kawad, Sto. Domingo, Sta. Rosa	186	15.88	69.93	10.65	6.28 *	411
P-24	Alasasan, Sta. Rosa	200	1.83	106	16.47	6.43 *	520
P-52	Aplaya, Sta. Rosa	167	+ 3.39FF	13.73	12.50	1.10	426
P-55	Pasong Manga, Sta. Rosa	172	3.49	11.02	5.72	1.93 *	406
P-17	Dita, Sta. Rosa	235	15.27	41.64	39.98	1.04 *	421
P-12	P. Sta. Cruz, Sta. Rosa	200	1.70	114.03	18.44	6.18 *	764
P-14	P. Sta. Cruz, Sta. Rosa	200	3.63	105.84	17.30	6.12 *	797
P-26	Macabling, Sta. Rosa	204	-	67.13	26.33	2.55 *	332
M-3	Macabling, Sta. Rosa	240	1.44	54.07	27.24	1.98	566.1
(2)	Banaybanay, Cabuyao	91	-	15.60	8.55	1.82 *	429
(1)	Banaybanay, Cabuyao	91		17.60	2.75	6.40 *	390.13
P-45	San. Isidro, Cabuyao	172	0.73	10.46	9.38	1.11	134
P-22	Canlubang	200	19.33	30.87	11.90	2.59 *	569
(A)	Biñan	183	4.50	11.30	9.1	1.24 *	28

FF : Free-flowing well
* : Used data for estimation of the average specific capacity in each municipality.

6.7.2 Piezometric Conditions

An isopiezometric contour map is shown in FIGURE 6.4.1. This was made using the old water level records since no actual measurements were done during the survey. It must be noted that only the existing NIA well data were considered in making this map as they are likely to represent the true picture of the groundwater flow condition in the area.

The figure shows that the general hydraulic gradient is directed northeastward into the Laguna de Bay. Closer to the coast, the gradient ranges from 0.0036 to 0.005. In the vicinity of P-18, however, the slope is steeper at 0.04. In Barangay Balibago, Sta. Rosa and in areas covering the service areas (probable well sites), the gradient is from 0.004 to 0.005.

From the available records, a line of free flowing wells may be drawn in N-S direction from Numero Uno (Well No. SR-72) to Macabling. Similarly, along the stretch of the Laguna de Bay coast from Biñan to Cabuyao, several other wells with depth ranging from 38 to 100 m have water levels up to 0.91 m above ground surface.

At the present situation, the decline in water level in the area is increasing due to the relative increase in the number of industrial establishments in the area where they developed deep wells. An example of its effect is the lowering of the water level at NIA P-58 in Calabuso when a piggery 200 meters from the well started its operation using deep wells. In Pulong Sta. Cruz, Sta. Rosa, a decline of 0.14 m/year was observed at well No. SR-14 (NIA P-14). In any case, water level decline in the area is between 0.3 and 0.03 m/year.

In well Nos. P-19, P-20, P-23, and P-52, a water level monitoring program was implemented by the NIA from 1979 - 1983. It was observed from the records that very little seasonal fluctuations in water levels were recorded in the 8-year program. Relatively noticeable however, was the abrupt lowering of the level in P-20 in April 1979 (5 meters). In any case, water level decline was observed to be between 0.48 and 0.08 m/year. This may be assumed to occur inland. Along the coast however, the trend maybe different as reflected by the records in P-52 where instead of the expected

lowering of the water level, it appeared to increase slightly i.e., from 4.84 to 5.11 m above mean sea level. During the investigation, this well was found to be still free-flowing and residents nearby have expressed that only a very minor decrease in its discharge was observed since its construction in 1974.

6.7.3 Aquifers

Two types of aquifer maybe expected in the study area. Inland is the elastic formation while nearer the bay are the alluvial deposits.

Aquifer of the Elastic Formation

As maybe inferred from available well logs and pumping test data, the prominent aquifer in the area is the Laguna Formation. It underlies the greater part of the area forming a series of aquifers. The aquifer system is known to include clay and clayey tuff horizons, even at relatively shallow depths, and produces confine conditions and in some cases, free flowing wells. This confining bed maybe found within an average depth of 40 m.

This aquifer is generally composed of a series of volcanic (tuff/ash) layers interlayered with lenses of clay. From driller's log, it is also associated with layers of adobe, pumice, and other materials which are described to be either pumiceous or tuffaceous. Being volcanic in origin, this formation is considered to be generally nen-porous. Groundwater movement and storage in this material are rather confined to fissures (cave water).

The extent of this formation cannot fully be ascertained, but it is believed to span from about 1.5 to 3 km from the bay line going inland. In the Sta. Rosa area, this unit was seen to exist along the coast, underlying the alluvial deposits as shown by the log description of well No. P-52 which is located about 100 m from the shoreline. As mentioned in Section 6.4, this underlying clastic formation could be a reworked secondary deposit from erosion of the original formation.

The thickness of this aquifer is variable. As shown in the well correlation sections (FIGUREs 6.7.1 - 6.7.4), it appears to be greater than 100 m. A 446 m - well (P-56) showed that it could exist deeper than 500 m.

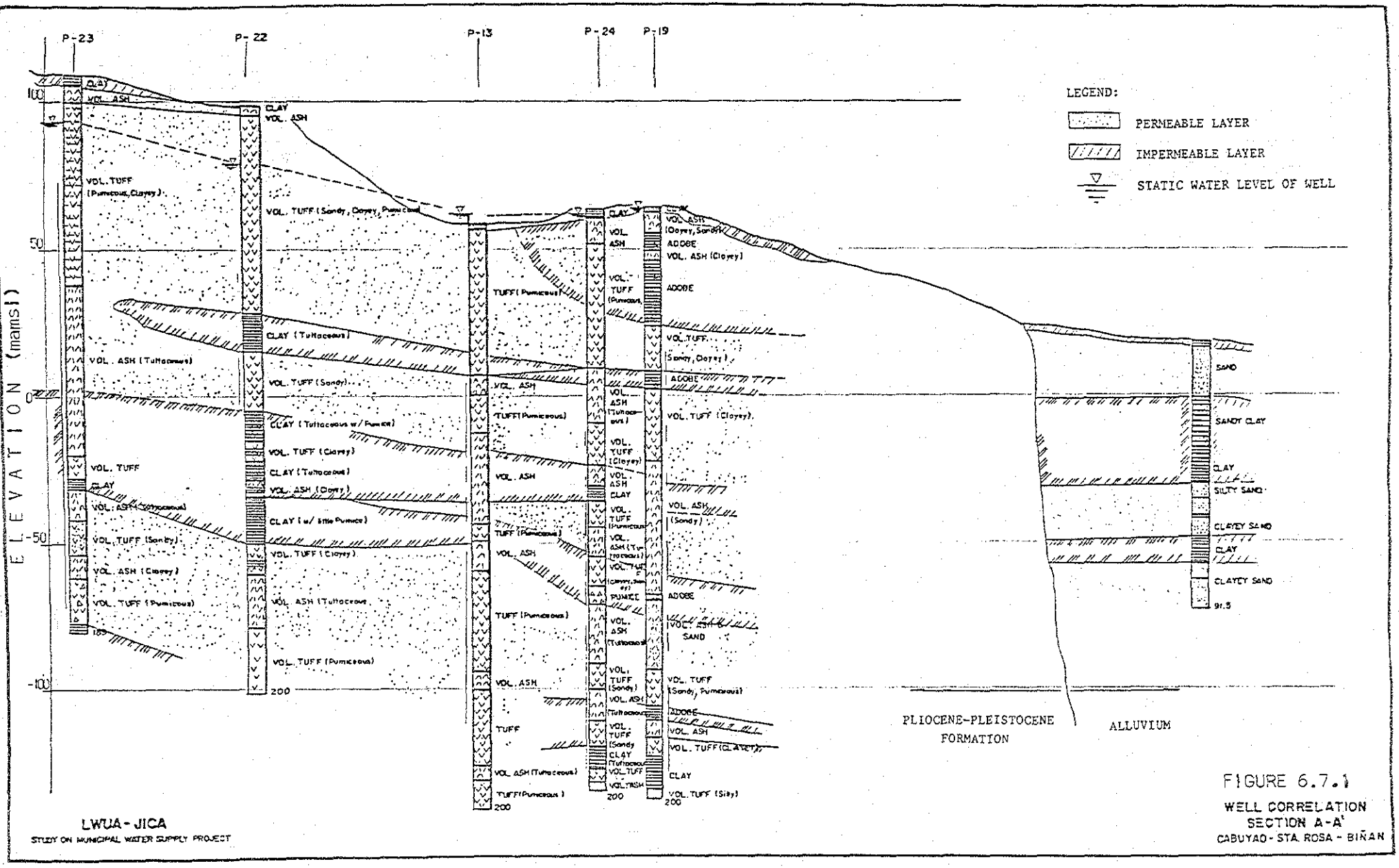


FIGURE 6.7.1
WELL CORRELATION SECTION A-A'
CABUYAO - STA. ROSA - BIÑAN

LWUA - JICA
STUDY ON MUNICIPAL WATER SUPPLY PROJECT

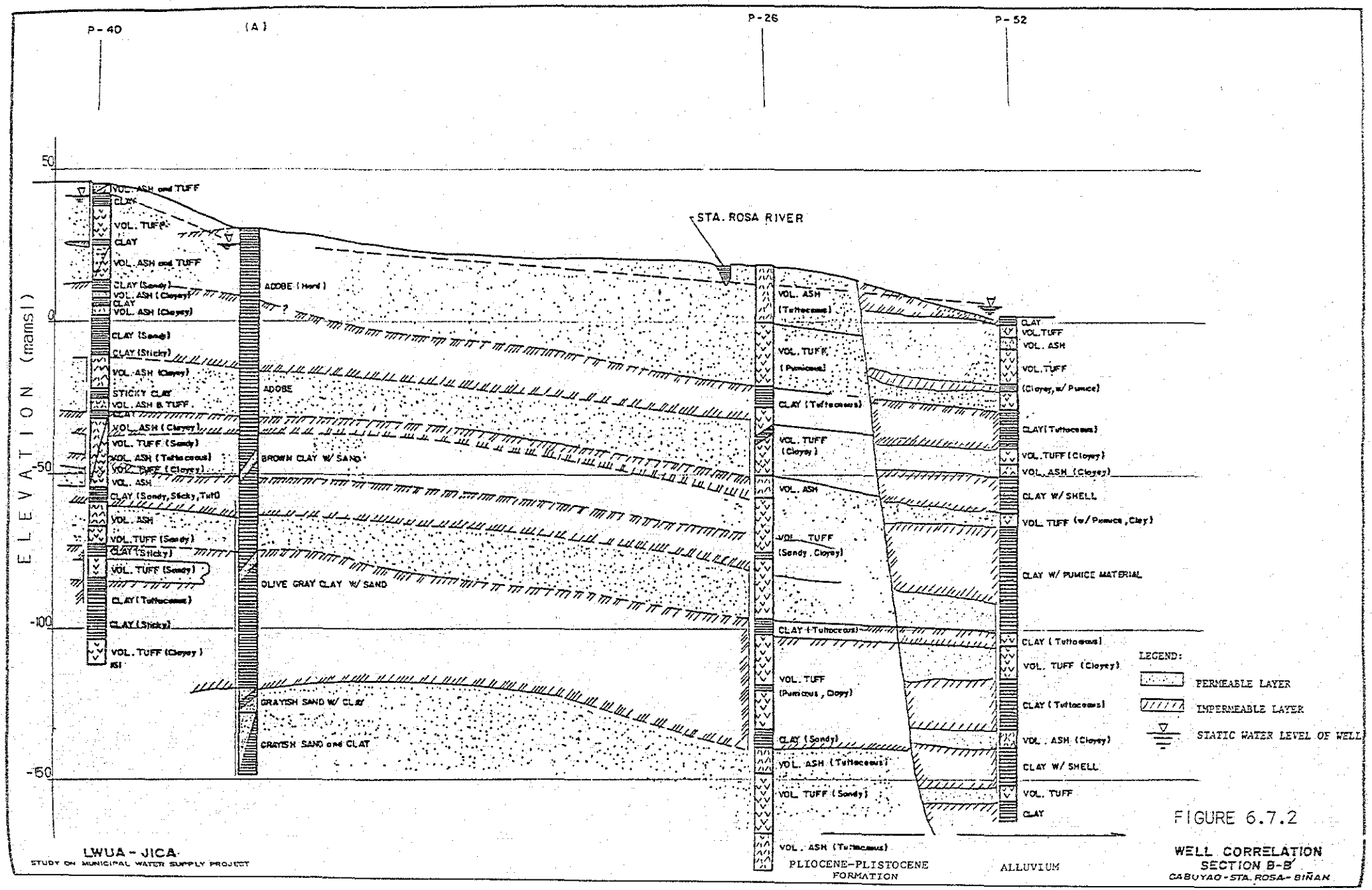


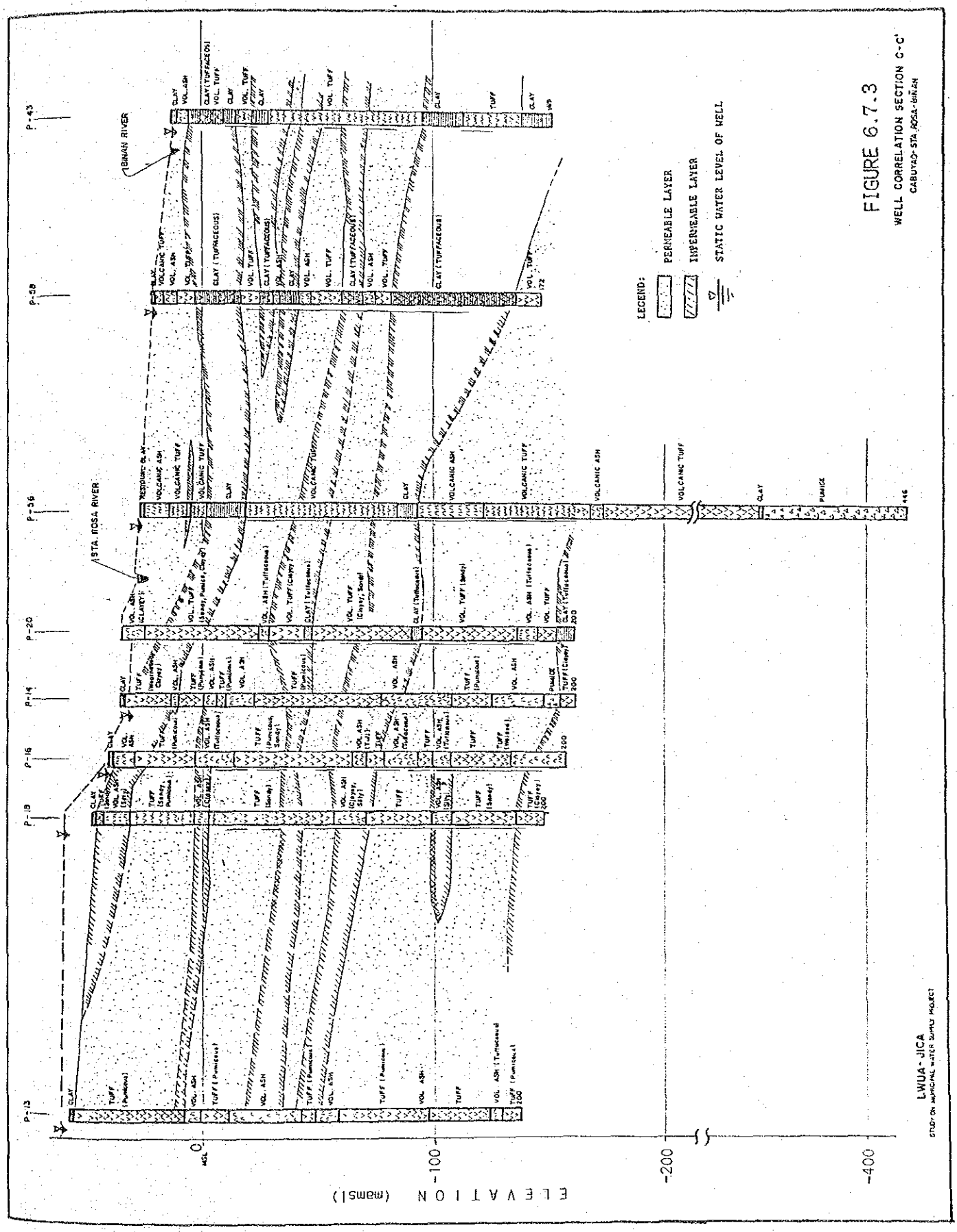
FIGURE 6.7.2

WELL CORRELATION SECTION B-B'

CABUYAO - STA. ROSA - BIÑAN

LWUA - JICA

STUDY ON MUNICIPAL WATER SUPPLY PROJECT


P-43
P-58
P-36
P-20
P-14
P-16
P-18
P-13
BINAHI RIVER
STA. ROSA RIVER
LEGEND:
PERMEABLE LAYER
IMPERMEABLE LAYER
STATIC WATER LEVEL OF WELL
0
-100
-200
-400
MSL
ELEVATION (mamsl)
FIGURE 6.7.3
WELL CORRELATION SECTION C-C'
CABUYAO-STA. ROSA-BINAN
LWUA - JICA
STUDY ON MUNICIPAL WATER SUPPLY PROJECT

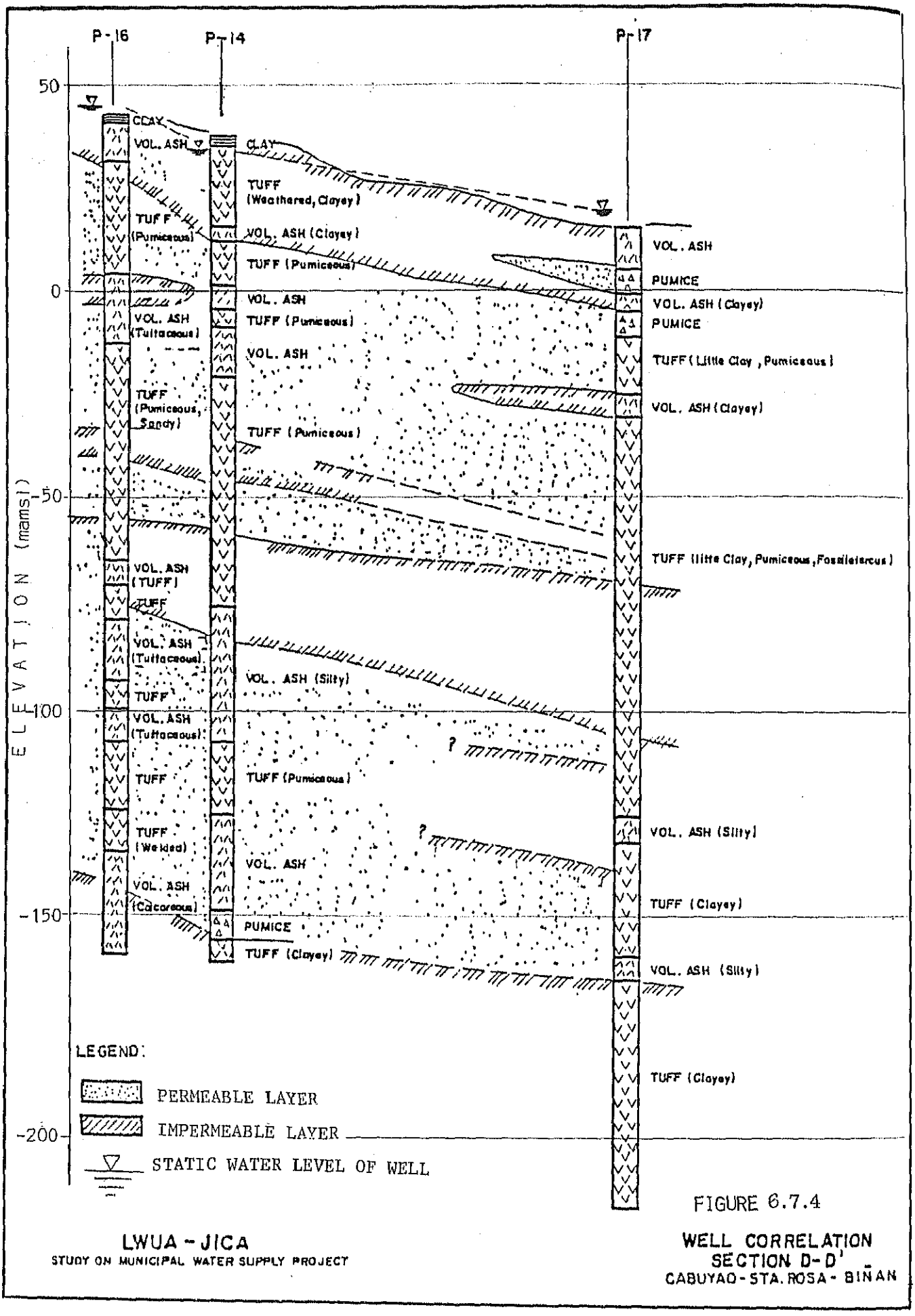


FIGURE 6.7.4

LWUA - JICA
STUDY ON MUNICIPAL WATER SUPPLY PROJECT

WELL CORRELATION
SECTION D-D'
CABUYAO - STA. ROSA - BINAN

Evaluation of the pumping test results in the NIA wells revealed that this aquifer is highly productive especially in Paguyo-Pulong Sta. Cruz region in Sta. Rosa. The computed transmissivities (TABLE 6.7.1) are high with an average of 600 sq.m/day even reaching a very high value of 4,669 sq.m/day in P-18. From the NIA-UNDP Report, the average storage coefficient is 0.007.

In the areas of San Vicente and Calaboso in Biñan and San Isidro in Cabuyao, the three wells were identified to have low transmissivities (160 sq.m/day). On the other hand, closely situated wells were also found to be productive.

Aquifer of the Alluvial Deposits

Closes to the shore of Laguna de Bay, an aquifer system composed of alluvial sediments takes place. Its thickness is relatively shallow and is tapped by hand pump wells for low scale water withdrawal.

This aquifer is often described to be composed of sandy and gravelly formation with lenses of silt and clay and is often associated with shells, layers of boulders, etc. In the study area, the Bureau of Public Works (now MPWH) wells were constructed in this formation but these wells are relatively shallow, hence, descriptions for the deeper sections could not be made. Four (4) NIA wells, however, with depths greater than 90 m also exist. Pumping test evaluations in these wells showed that this aquifer may also provide for good groundwater extraction. The average transmissivity of this aquifer was computed to be around 430 sq.m/day.

Pumping test evaluation in one well (A) in Biñan gave a very low value of 28 sq.m/day. The well is 183 m deep and has a specific capacity of 1.24 l/sec/m. A close review of the analysis (done by the NWRC) showed that the pumping water level was stable after only a few minutes of pumping. This condition implies high permeability of the aquifer. It could also be interpreted that the well is situated near a positive boundary where recharge is very high.

6.7.4 Hydrogeological Systems

Taking into consideration the geometrical structure of the above-described aquifer, the hydrogeological behavior of the two units maybe summarized as follows:

- In the recent alluvium, recharge occurs by direct infiltration from precipitation. Artificial recharge could likewise be attained through induced infiltration from Laguna de Bay.

- In the clastic formation, lateral recharge comes from the west and southwest portion of the study area where exposed permeable sections could receive the contribution of water from the hilly zone. Recharge may also come from direct infiltration in areas where the general clay cover is missing while additional recharge could be expected from seepages from constantly irrigated areas.

- Groundwater recharge may also occur along permeable river beds especially during heavy flood.

In a report made by Sandoval M.P., et al.[1/], the study area is classified as having a good recharge capacity.

In a water balance study by the NIA-UNDP team, the mean potential recharge in the area was concluded to be 0.22 million cu.m/sq.km or about 220 mm/year.

6.7.5 Test Well

The test well was constructed by means of an open hole drilling method to achieve better knowledge of the hydrogeological conditions which were defined in a broad way by the data from the NIA.

The test well site is located in Barangay Pulong Santa Cruz, Sta. Rosa. The works conducted for the purpose included the following:

1/ Hydrogeology of Central Luzon, M.P. Sandoval and F.B. Mamaril, Jr. 1970

- Drilling of 150 mm diameter of pilot hole to a depth of 200 m,
- Collection of sample cuttings,
- Electric logging,
- Reaming the pilot hole to 350 mm diameter to 200 m depth,
- Installation of 250 mm casing pipe and screen to 200 m depth,
- Gravel packing,
- Well development (bailing, swabbing, surging and pumping),
- Pumping test (constant rate drawdown and recovery test), and
- Sanitary seal with concrete at the well head.

Sample cuttings were collected during the drilling and the lithological data and the result of electric logging are shown in FIGURE 6.7.5.

According to the observation of the sample cuttings and the result of electric logging, the lithology of the well is described as follows:

- Tuffaceous clay with soft cemented lumps of gravel and sand shows a relatively high apparent resistivity value which is over 500 ohm-m and they are of impermeable layer accordingly.

- Fine to coarse gravel with sand shows a moderately high permeable layer which corresponds to the apparent resistivity value of 150 to 500 ohm-m.

- The layer showing the apparent resistivity value smaller than 40 ohm-m is considered to be a soft cemented chips of gravel and sand layer which is locally called as "Adobe".

The final design of the well is prepared based on the lithologic and electric logging results as shown in FIGURE 6.7.6.

A pumping test was conducted from October 1 to 5, 1986. The well was equipped with turbine pump at a setting depth of 39.08 m. The pumping test included a constant rate drawdown test and recovery test carried out for 72 hours and 25 hours, respectively. The results of the tests are shown in FIGUREs 6.7.7 and 6.7.8.

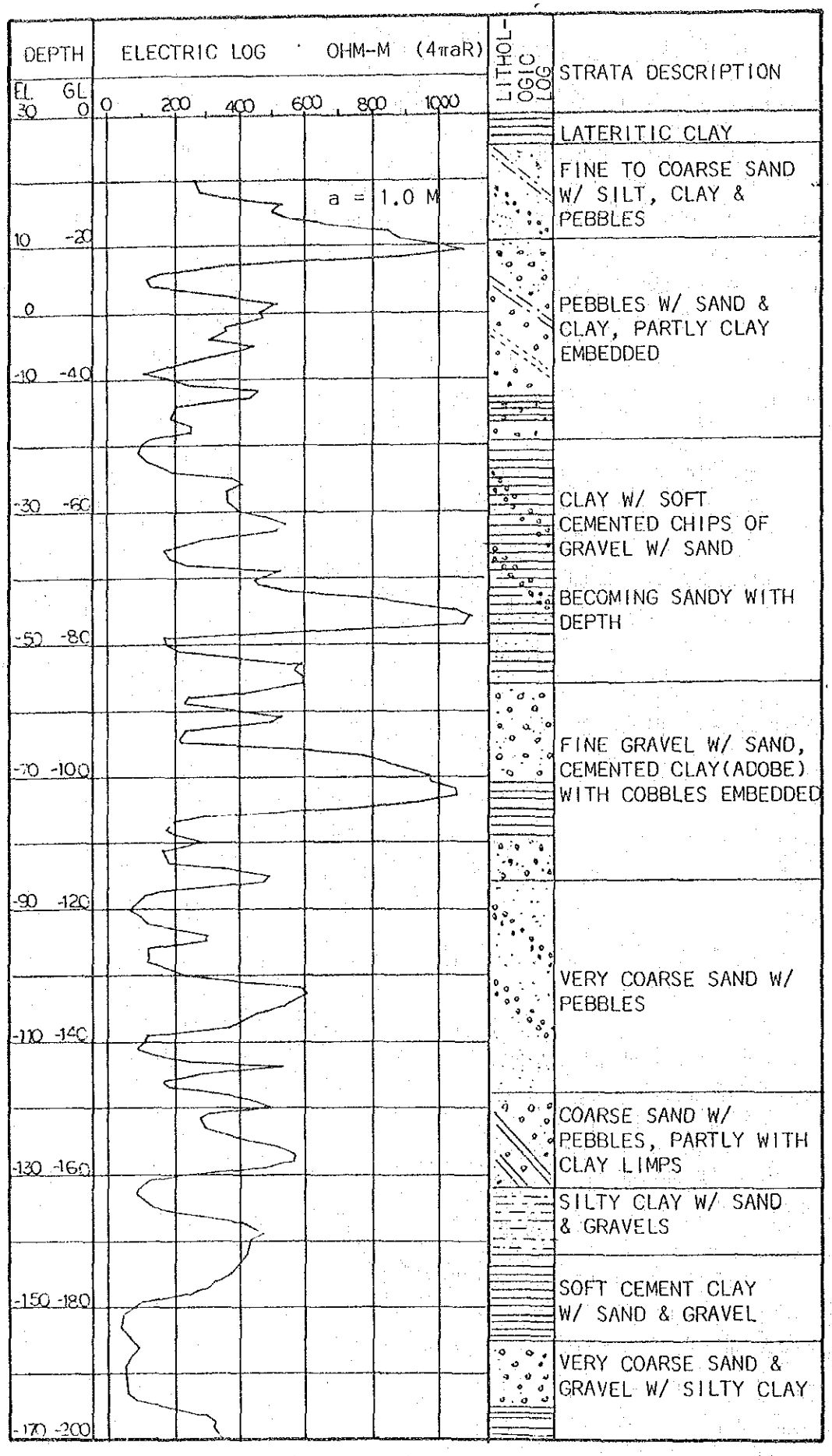


FIGURE 6.7.5 STA. ROSA TEST WELL LOG

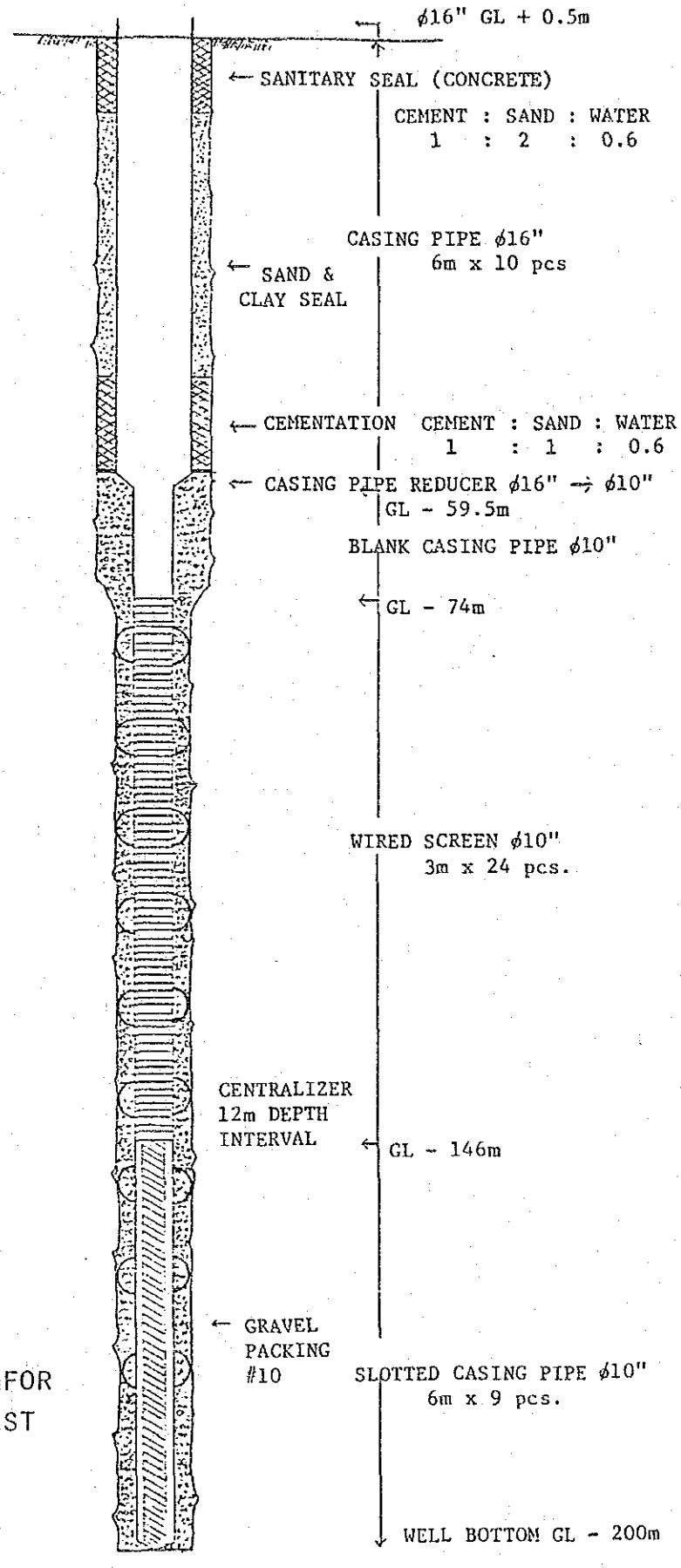


FIGURE 6.7.6

WELL DESIGN FOR STA. ROSA TEST WELL

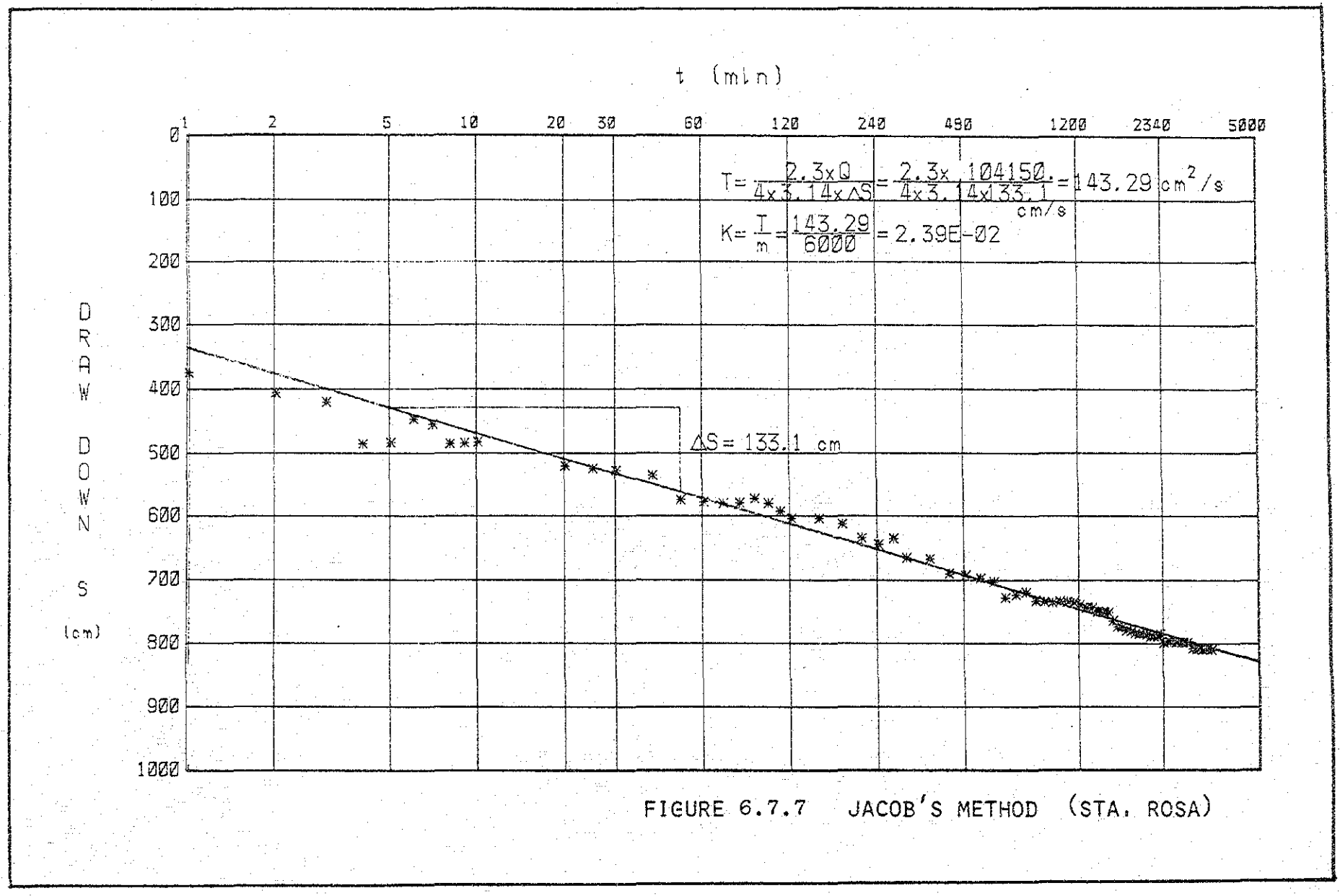


FIGURE 6.7.7 JACOB'S METHOD (STA. ROSA)

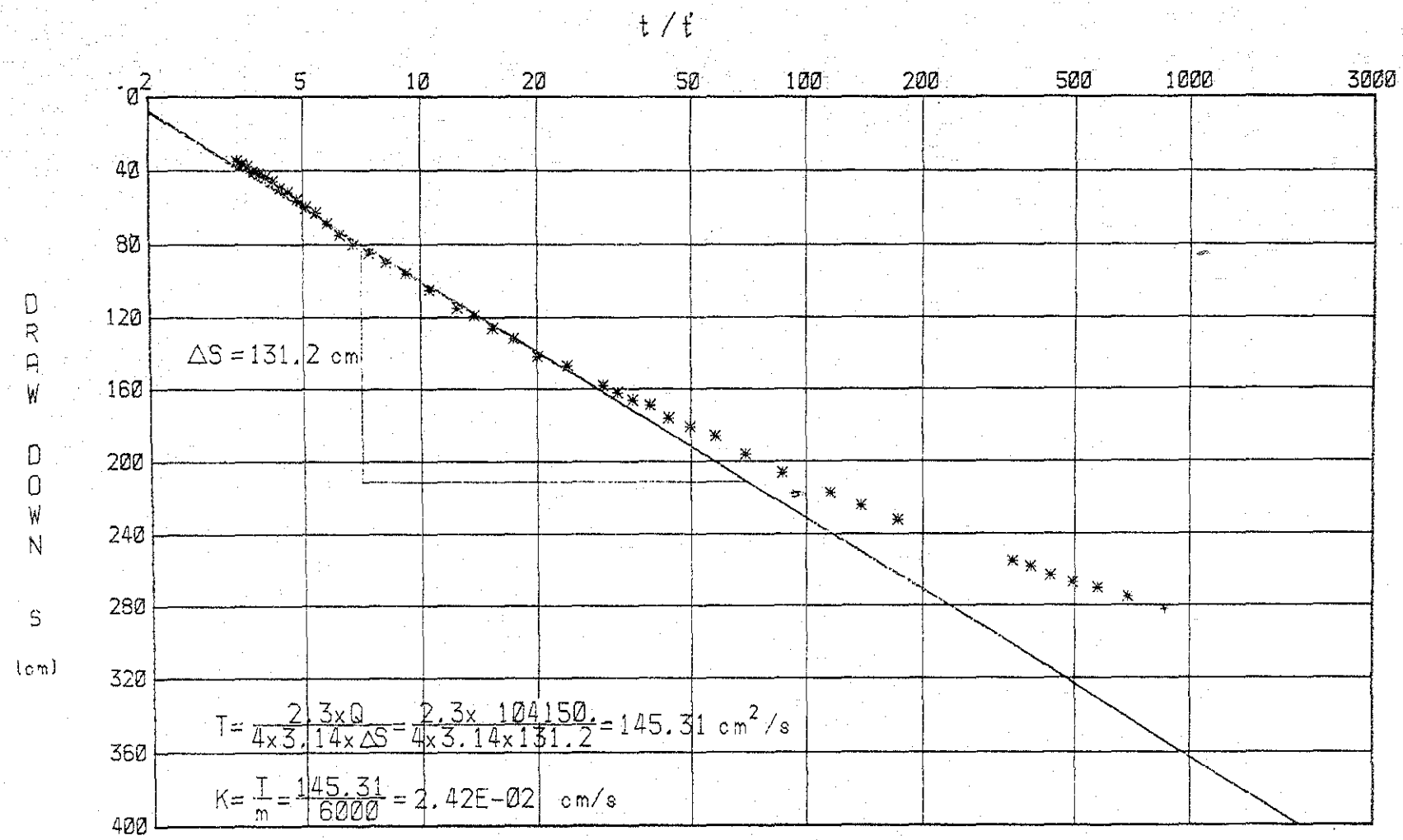


FIGURE 6.7.8 RECOVERY METHOD (STA. ROSA)

The coefficient of the transmissivity (T) and permeability (K) is 145.31 sq.cm/sec and 2.42×10^{-2}cm/sec by the recovery method, while 143.29 sq.cm/sec and 2.39×10^{-2}cm/sec by the drawdown method, respectively.

The actual discharge measured is approximately 3,000 cu.m/day and the drawdown is 8.09 m. The average amount of the exploitation discussed in Section 6.7.6 may be expected in consideration of the limited pump capacity used for the pumping test.

6.7.6 Groundwater Availability

The relatively high transmissivity and specific capacity values plus the existence of large capacity free-flowing wells imply a good to excellent groundwater condition in the study area. Quantifying this through water balance calculation is however impossible due to the absence of important factors which include data on basin-wide groundwater extraction, long-term well hydrograph and runoff.

In the area of Paguyo-Pulong Sta. Cruz, Sta. Rosa, the average transmissivity is about 1,400 sq.m/day. This area is where maximum groundwater is expected. Closer to the service area, the transmissivity ranges from 500 to 600 sq.m/day (See TABLE 6.7.1).

Safe Yield

The safe yield concept can be observed in terms of the annual groundwater withdrawal which is limited in the long term by natural recharge.

In most basins, where the quantity of water in storage is as many times the annual recharge of draft as that in any one year, the draft can exceed the recharge without carrying permanent depletion.

But on long term basis when series of wet and dry years tend to average out, the draft becomes an overdraft when the mean supply is exceeded. As known, perennial depletion in the area ranges from 0.03 to 0.3 m/year which is estimated to be between 0.2 to 2.0 mm/year in net water depth if storativity of 0.007 for the area applies.

This figure seems to be negligible compared to the 220 mm annual recharge. Consequently, the total amount of present extraction from the basin is still within the limit of the safe yield concept.

Well yield

A single well production can be evaluated by using specific capacity values from available pumping test records. Several wells in the area have specific capacities that are much lower than is expected from the observed values of transmissivity (See TABLE 6.7.1). This is considered due to well losses incurred either by inefficient well design or partial penetration of the aquifer or a combination of both. However, properly designed wells have specific capacities ranging from 3 to 6 l/sec/m.

The design specific capacities for Cabuyao, Sta. Rosa and Biñan were assessed using data with asterisk in TABLE 6.7.1 and the average figures were calculated at 3.0, 4.3 and 3.0 l/sec/m respectively. In this regard, actual well yield can be calculated by multiplying the specific capacity by the drawdown (15 m from the records).

Therefore, the expected yield of wells to be constructed for the future program is:

Sta. Rosa	: 64 l/sec (5,500 cu.m/day)
Cabuyao and Biñan	: 45 l/sec (3,900 cu.m/day)

6.8 WATER QUALITY

Water quality in terms of physical/chemical and bacteriological indices was examined covering existing and potential water sources. The location of points is shown in APPENDIX 6.8.1.

Sampling for field examination covering water temperature, pH and EC was conducted on July 31 and August 1, 1986 and that for laboratory analysis including turbidity, total dry solids, alkalinity, acidity, hardness, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, SO_4^{2-}, CO_3^{2-}, HCO_3^{-}, Cl^{-}, Mn, NH_3-N, NO_3-N and coliform group bacteria on August 4, 1986.

The summary of test results, both from field investigation and laboratory analysis is presented in APPENDIX 6.8.2.

Deep Wells

All samples from these sources passed both physical/chemical and bacteriological tests set by the National Standards for Drinking Water (hereinafter referred to as NSDW).

Shallow Wells

Except for the shallow well in San Antonio (Sample No. 6) which is positive for E-Coli bacteria and the shallow well in Malaban (Sample No. 4) which slightly failed the calcium test, all results are within the permissible limit set by the NSDW. This however is still within manageable limits at 76.5 mg/l (limit 75 mg/l). This condition which may be related to the area's proximity to Laguna de Bay similarly resulted in relatively high test results.

Springs

Both spring No. 1 (Sample No. 19) and the nearby potential spring No. 2 (Sample No. 20) passed the physical and chemical tests.

Laguna de Bay

The sample from this vast reservoir of fresh water was found to be within acceptable quality except for turbidity which is high at 25.8 FTU. Although the others are within the permissible limits, it maybe observed that these are the highest in all results obtained.

Bacteriological Analysis

In all 4 samples tested for bacterial contamination, 3 reacted positively. The faucets in Biñan and Sta. Rosa were found positive for E-Coli bacteria. The same was true for the shallow well in San Antonio (B-1) which is situated close to a drainage canal.

Overall, both groundwater (wells and springs) and surface water in the area are within desirable standards. In this regard, treatment other than chlorination may not be necessary. In utilizing the Laguna de Bay however, a more detailed monitoring of its quality may be required.

6.9 RECOMMENDED SOURCES

Utilization of deep wells appears to be the solution for the immediate and long term demand in the study area. These wells can be constructed in the Laguna Formation where records suggest good to excellent water potential. Preliminary well yield for each municipality is discussed in previous section.

For estimation purposes, the following well parameters are suggested:

Well Depth : 200 meters (minimum)
Casing Diameter: 350 mm
Design Drawdown: 15 m
Expected Yield : Biñan - 45 l/sec
Cabuyao - 45 l/sec
Sta. Rosa - 64 l/sec

Supplemental well sources in the region could be the NIA wells. Negotiation with the NIA in utilizing such wells is on-going. Additional sources for the area are the untapped springs which were measured two times to give an aggregate output of about 40 l/sec. Finally, the ultimate solution for the long term purpose may be the Laguna de Bay which at one time has been considered by the MWSS as a potential source for the Greater Manila Area.

In any case, chlorination is recommended. Moreover, water rights to the chosen sources should be maintained to avoid conflicts of ownership in the future.

CHAPTER 7
ANALYSIS AND EVALUATION OF ALTERNATIVES

CHAPTER 7 ANALYSIS AND EVALUATION OF ALTERNATIVES

7.1 GENERAL

This chapter identifies and evaluates the possible water supply alternatives for the development of the most optimum water supply system toward the year 2010. Each alternative was developed and evaluated based on the information collected through field surveys to the existing water supply sources/facilities and the potential water sources, and the hydrogeological studies.

The municipal water supply system may be determined based on its source capacity and location. The alternative study of water sources primarily utilized the recommendations in Chapter 6 - Water Resources.

Low cost construction, operation and maintenance of the facilities are the major concerns in the preparation of the plan of water supply facilities. The maximum utilization of existing facilities was then studied in this context.

Considering the above-mentioned principal concepts of the alternative study, the following approaches are particularly taken up:

- Alternative study of water sources is firstly carried out for two cases that whether or not the surface water from the Laguna de Bay is utilized.
- Transmission alternatives are subsequently studied with reference to the staged construction of pipelines corresponding to the selected water source development plan.
- Alternative study of distribution facilities are carried out for two cases of reservoir locations by two steps; the first step is to optimize the required storage capacity from three different distribution methods, and the second step is to determine the most optimum configuration of distribution network in compliance with the result of the first step study. The overall comparison of distribution facilities is performed among the said two alternative reservoir locations resultant from the above two step studies.