APPENDIX 4.2.1 shows the location, number of household served, casing and year of construction of the Level I facilities in Angeles City.

Aside form the above-mentioned publicly owned wells, there are also a number of privately-owned shallow/deep wells with jetmatic or pitcher pump. However, there is no inventory on these wells.

4.2.2 Level II System

At present, there are six piped water supply systems with public faucets (Level II) constructed by the MPWH through the Barangay Water Program since 1981. Population served by each system ranges from 240 to 1,200 persons. Basically, the system consists of a deepwell, an electric pump, steel elevated tank and the pipe system. Five of these systems are using the centrifugal pump type while only one uses the submersible type. The size of pipes ranges from 38 mm to 100 mm of either PVC or PE material.

APPENDIX 4.2.2 shows the location and description of these level II Systems.

4.2.3 Level III System

4.2.3.1 Angeles City Waterworks System

The ACWS was constructed by the Angeles Municipal Government in 1934 with a deep well as its source and an elevated storage tank. Since then, the system has been expanded/improved eight times already. Its first improvement/expansion program was undertaken by the defunct National Waterworks and Sewerage Authority (hereinafter referred to as NAWASA) in 1950. But by 1968, the system was transferred back to the City Government of Angeles.

Field surveys including measurements on the factors relevant to the existing water supply facilities were conducted from June 27 to July 14, 1986. Data and information collected are the basis of this Section.

(1) Water Source and Treatment

The ACWS derives its water source from fourteen deepwells, each equipped with either an electric driven turbine or submersible pump. Of these, eleven are presently in operation and the other three are already abandoned. A summary of data of these well and pumps are shown in TABLE 4.2.1.

Ten out of eleven existing pumping stations are operated continuously throughout the day. Pumping station No. 2 operates only from 6:00 A.M. to 10:00 P.M.

The discharge rates of eight pumping stations were examined. TABLE 4.2.2 shows the daily production of all the existing pumping stations as measured through this survey except for pumping stations No. 2, 8 and 14 whose figures are the result of measurements made in 1977.

The total production amount from the 11 pumping stations is calculated at 11,545 cu.m/day under the conditions previously stated. The existing figures of each pump; their rated capacity and records in 1977 are shown in TABLE 4.2.2 for the purpose of comparison. It may be worth noting that the difference in the total amount between that taken in 1977 and this survey is within 10%. It was also found that all the pumps were operated under the same conditions throughout the day with about a 5% hourly discharge rate difference between the minimum and maximum figures recorded.

TABLE 4.2.1 PUMPING STATION IN ANGELES CITY WATERWORKS

As of Dec. 31, 1985

Pumping Station	Location	Depth (m)	Casing Size (mm)	Static W.L. (m)	Draw-down (m)	Well Capacity (CMD)	Type of Pump	Pump Capa-city (CMD)	Total Dynamic Head (m)	Pumping W.L. (GL-m)	Horse-Power HP	Year of Construction/ Installation	Remarks
1	Mabini St.	152.5	300	4.6	18.3	2,725	Deepwell Turbine	2,725	61.0	22.9	50	Well; Pump 1970;1970	
2	Mabini St.	242.5	200	5.5	19.8	1,363	"	818	91.5	25.3	25	1950;1968	Operation time 6:00AM-22:00PM
3	Rizal St.	126.3	200	2.4	18.3	654	"	654	20.7	20.7	15	1953;1953	
4	Kuliat St.	79.9	150	2.4	25.9	654	"	545	65.6	28.4	7.5	1955;1955	
5	P. Balagtas	109.8	250	4.9	14.6	1,635	"	954	65.6	19.5	15	1955;1957	
6	Pandan	119.6	200	0.9	6.4	1,635	"	1,635	76.3	7.3	30	- ;1959	
7	San Joaquin	213.5	200	6.1	13.7	1,363	"	545	76.3	19.8	10	1958;1961	
8	Pampang Rd.	103.7	200	3.1	13.7	1,254	"	981	70.2	16.8	15	1963;1972	
9	Sto. Cristo	109.8	150	5.5	15.3	299.8	-	-	-	-	-	- ; -	Pump was abandoned in 1979
10	McArthur	91.5	200	5.5	18.3	1,090	Deepwell Turbine	981	82.4	22.3	15	- ; -	
11	8th St. Mirasol	97.6	200	6.1	15.3	818	-	-	-	-	-	1950; -	Well/pump was abandoned in 1979 for (Fe^{+})
12	Lourdes North East	122.0	150	4.6	-	818	Deepwell Turbine	545	-	-	15	1975; -	
13	Mayflow	-	-	-	-	-	-	-	-	-	-	- -	Well/pump was abandoned in 1973 (Fe^{++})
14	Angeles elementary school	145.7	100	5.6	3.7	999.6	Submer-sible	273	-	-	6	- -	

TABLE 4.2.2 DAILY WATER PRODUCTION

Unit : cu.m/day

Number of P.S.	Measurement : JICA (6/30-7/9)	Reference Records in 1977	Reference Rated Capacity	Remarks
1	3,968	3,570	2,725	
2	* 382	382	818	
3	709	568	654	
4	320	428	545	
5	987	1,015	954	
6	1,013	1,354	1,605	
7	814	439	545	
8	* 1,203	1,203	981	Temporary pump: 1565 cu.m/day
9	-	-	-	Abandoned in 1979
10	1,288	1,149	981	
11	-	-	-	Abandoned in 1973
12	588	390	545	
13	-	-	-	Abandoned in 1979
14	* 273	-	273	
Total	11,545	10,771	9,645	

Note : * Figures from the survey in 1977 or rated capacity

A pump efficiency test was carried out at No.1 pumping station. The measurement results revealed that the pump discharge rate is around 42 to 43 l/s with a dynamic water head between 31 to 38 m. The overall efficiencies of pump and motor, and solely pump are obtained with figures of 36% to 41% and 42% to 49%, respectively (Details are referred to in APPENDIX 4.2.3). These figures are common for the turbine pump. The existing pump seems to be operated within the range of its design capacity, although the pump itself as well as accessories are superannuated.

Groundwater is directly pumped to the main distribution pipelines without any water treatment. The pumping stations are located in strategic places, however, in some cases, the distance of one station to another is too near that there might be a possibility of interference in the functioning of well capacity. It has also been observed that many plumbing fixtures around the turbine pumps are found to be defective and leaking. FIGURE 4.2.1 shows the general lay-out of the existing ACWS facilities and FIGURE 4.2.2 shows a typical pump house connection.

There is only one stand-by generator installed, which is in pumping station No. 5; however, this has not been functioning since 1978.

(2) Transmission and Distribution

a) Storage Facility

The storage tank of ACWS is a reinforced concrete elevated tank located in Barangay San Nicolas, beside pump station No. 1. Tank capacity is 378 cu.m and its overflow elevation is about 30 m above ground. A schematic layout of the tank is shown in FIGURE 4.2.3. However, since 1966, the tank has not been in use because of leaks from the outer wall surface.

The said tank may be put to use provided appropriate measures, especially sealing, are made, since the structure itself is still useful. However, the storage capacity of the tank is too small to meet the water demand throughout the day, resulting to a minor contribution to the water supply in the system, at present.

There are also two steel elevated tanks used for fire protection located beside pump stations No. 6 and 12. Each tank has a capacity of 114 cu.m with a low water level of about 3.5 m above ground and is directly connected to the pump.

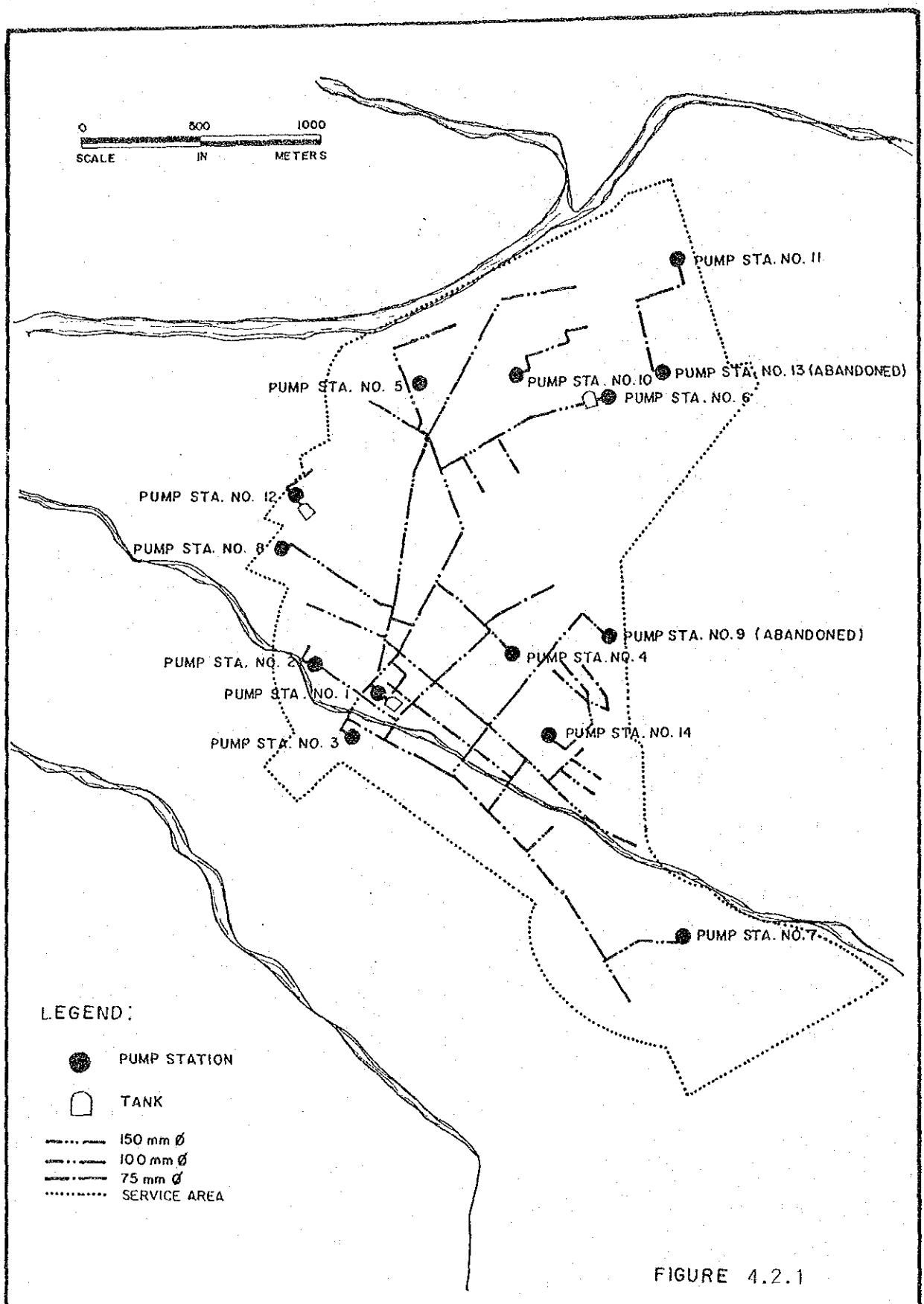


FIGURE 4.2.1

EXISTING DISTRIBUTION SYSTEM

ANGELES CITY WATERWORKS SYSTEM

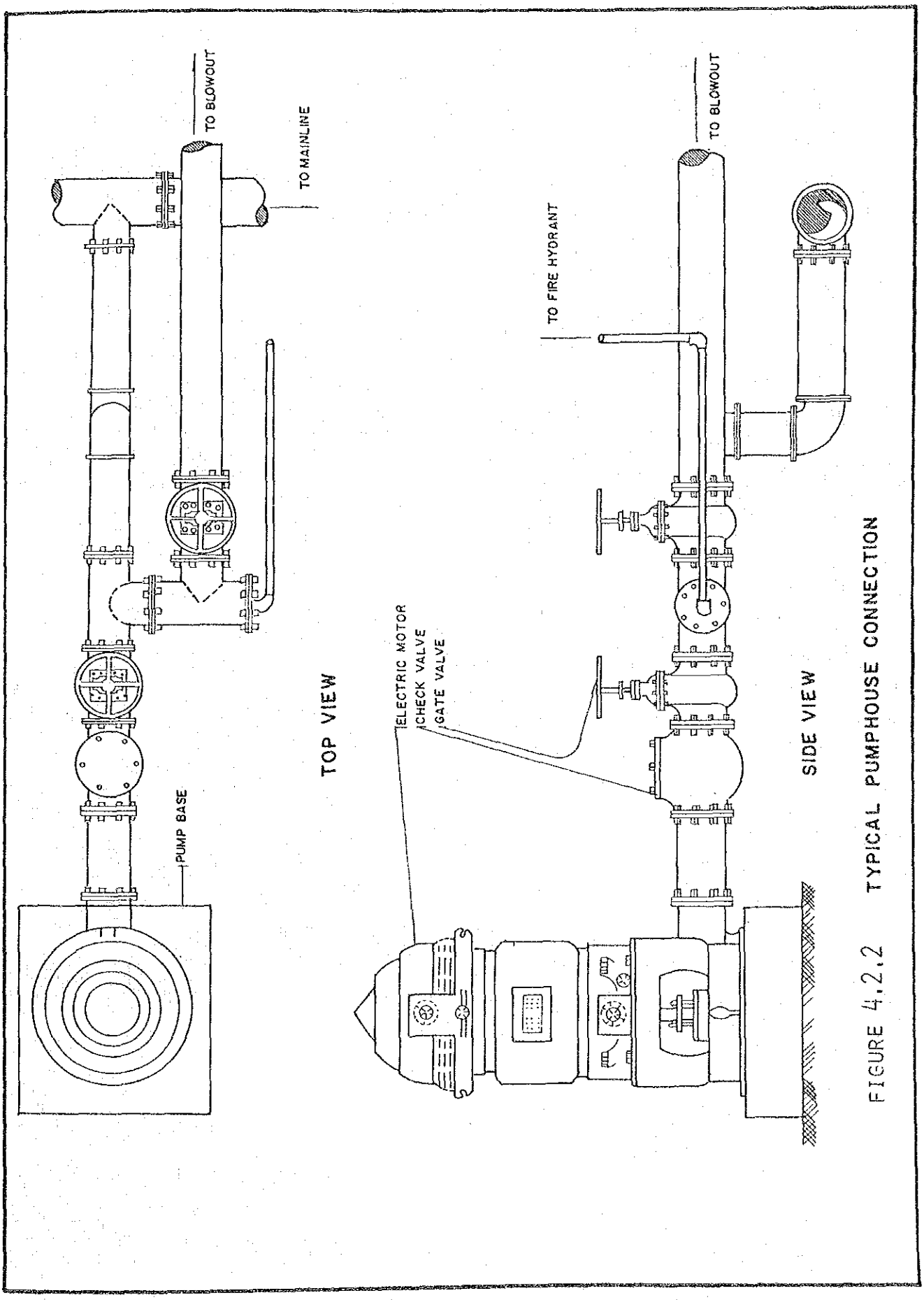


FIGURE 4.2.2 TYPICAL PUMPHOUSE CONNECTION

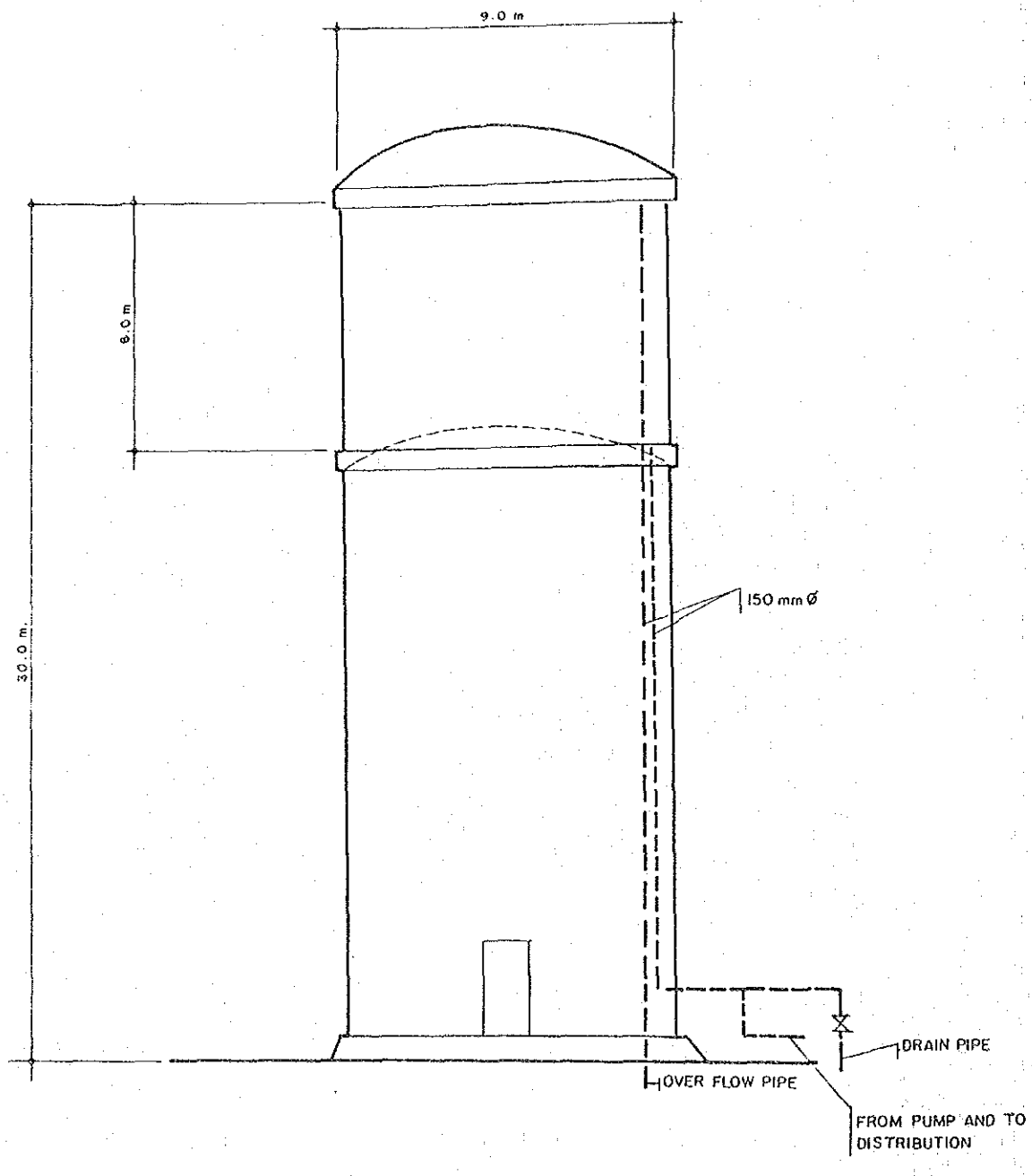


FIGURE 4.2.3

CONCRETE ELEVATED TANK

(378 m^3)

ANGELES CITY WATERWORKS SYSTEM

b) Distribution Facilities

The present service area of ACWS includes the core city and the six adjacent barangays. As previously stated, the distribution network has undergone repair and improvement eight times since its installation. Its last expansion was undertaken in 1970. Refer to FIGURE 4.2.1 for the existing distribution system. FIGURE 4.2.4 shows the service area covered by the zone boundaries.

Most of the main lines are dead-end and there exists no proper distribution network in the system except at the commercial area.

The main distribution pipes range from 75 mm to 150 mm in size with a total length of 16,610 m. TABLE 4.2.3 shows the system configuration of the distribution network.

TABLE 4.2.3 DISTRIBUTION NETWORK

Dia. (mm)	By Material				Total Length (m)
	CI (m)	GI (m)	AC (m)	PVC (m)	
150	990	-	480	-	1,470
100	11,100	-	1,370	730	13,200
75	-	1,040	400	500	1,940
Total	12,090	1,040	2,250	1,230	16,610

Note: CI = Cast Iron GI = Galvanized Iron
AC = Asbestos Cement PVC= Polyvinyl Chloride

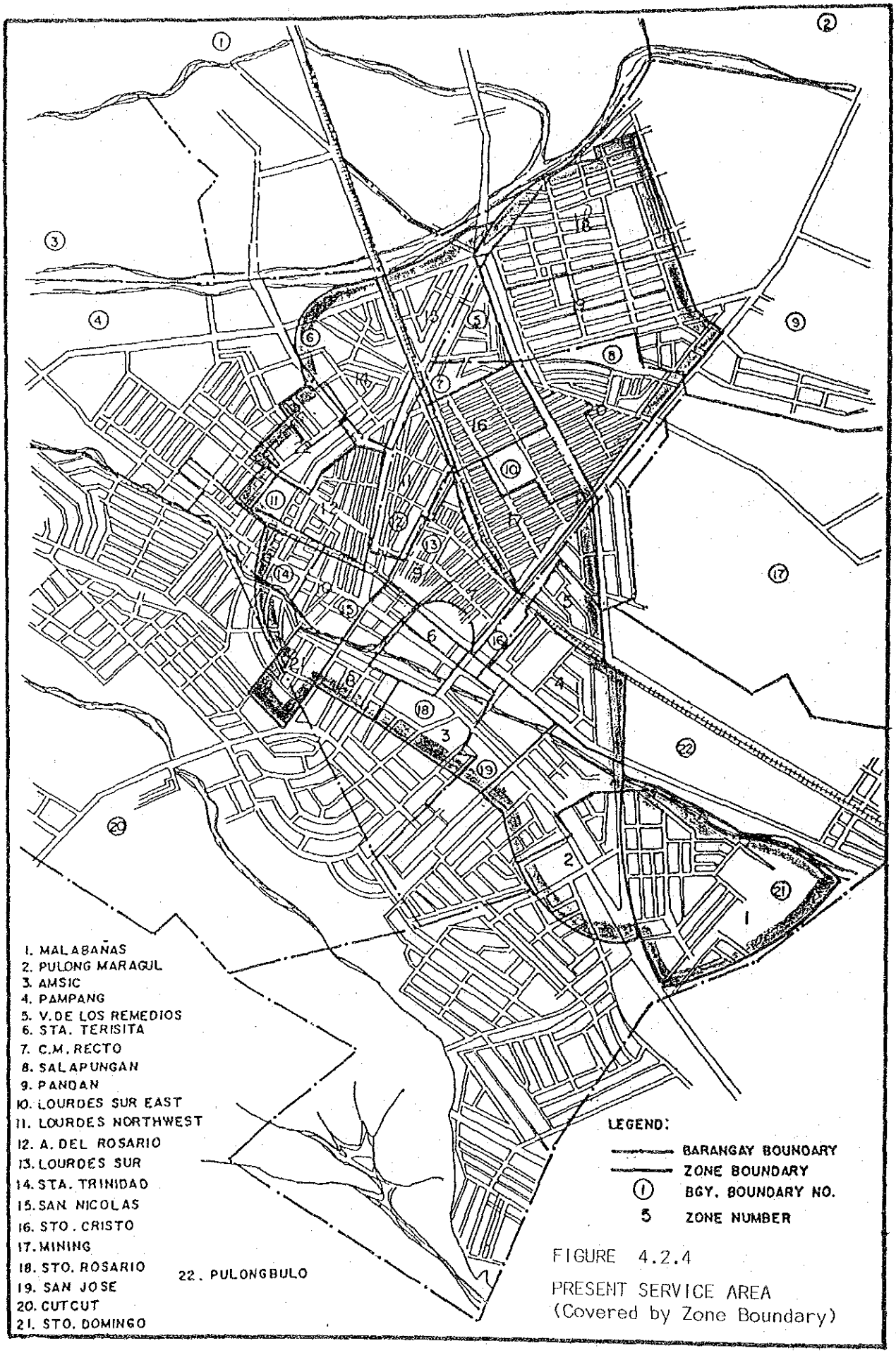


FIGURE 4.2.4

PRESENT SERVICE AREA
(Covered by Zone Boundary)

Major pipes are installed under the concrete road and exact location is uncertain since there are no drawings for the pipe laying. Some main pipelines were seen during field measurements on the pipeline system. The pipes made of Cast-Iron are comparatively in good condition, without any damage and leakage at joint portion, although the surface of pipes seems covered with rust.

A previous report prepared in 1977 to analyze existing pipe capacity associated with "C" value (Hazen Williams' Formula) concluded that the pipes were considerably deteriorated with a maximum "C" value of 50% compared with design figure for new pipes. The pipes at present may be at least lower than the above percentage in "C" value.

The distribution of water pressure in the existing service area was investigated at 25 strategic points together with the ranges of the pressure throughout the day (24 hours) from July 1 to July 10. The approximate contour line of the pressure is depicted in the map (details should be referred to in APPENDIX 4.2.4).

A topographic survey covering 60 points was also conducted to get the ground elevation. FIGURE 4.2.5 shows the survey result.

Water pressure in the service area is quite low throughout the day. Only a limited area in the vicinity of the pumping stations receive a certain level of favorable water supply throughout the day. FIGUREs 4.2.6 and 4.2.7 shown contour lines of water pressure in maximum and minimum figures through the day. Maximum contour lines are depicted corresponding to the location of pumping stations with a figure of 0.5 kg/sq.cm and 0.1 km/sq.cm. Those under minimum pressure represent a general feature of this water supply system with figures of 0.0 or 0.1 kg/sq.cm. These measurement results show the present practices in pump operation through the day.

It is realized that the low discharge or water pressure of the existing pumps is a major reason for insufficient water supply in system.

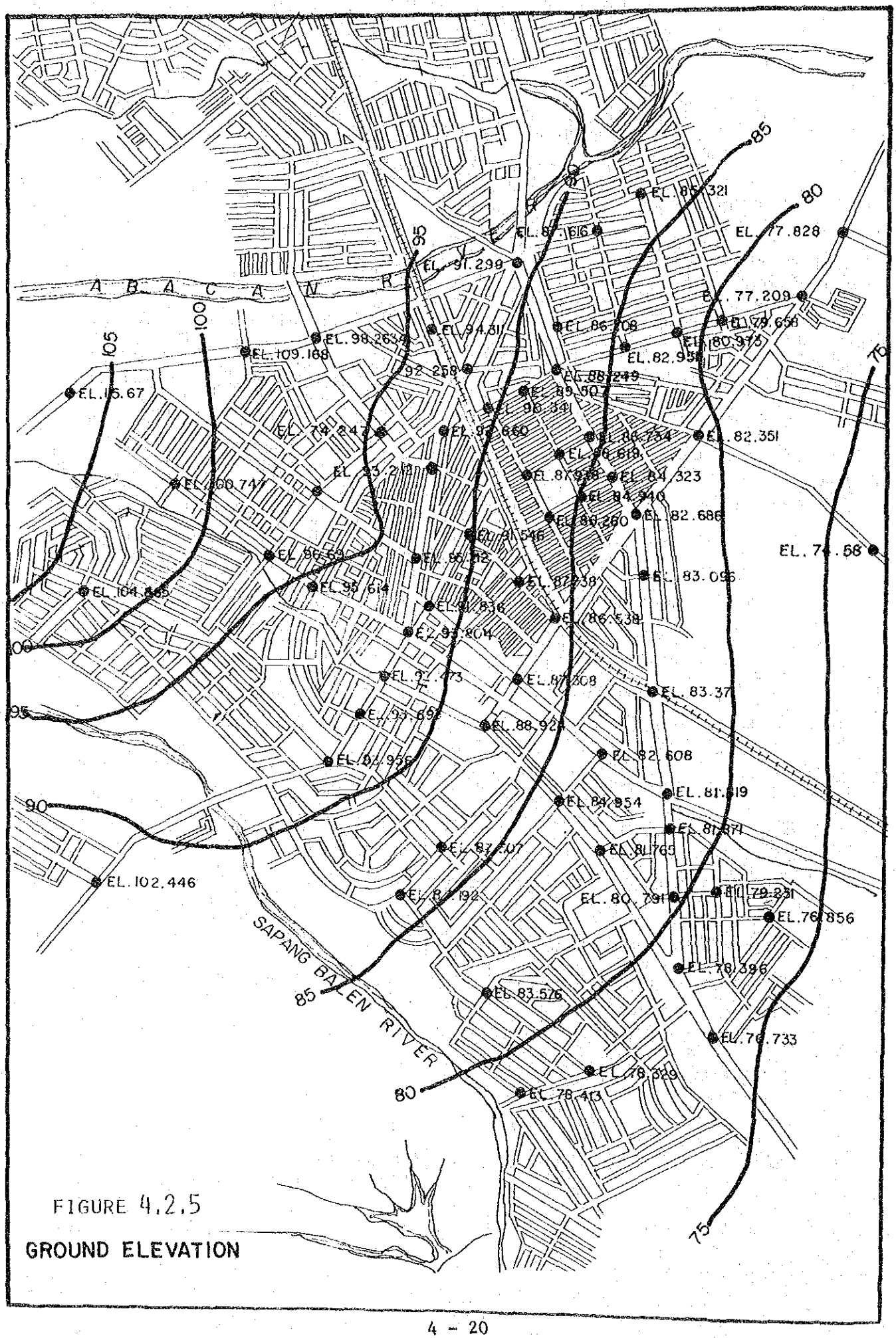


FIGURE 4.2.5

GROUND ELEVATION

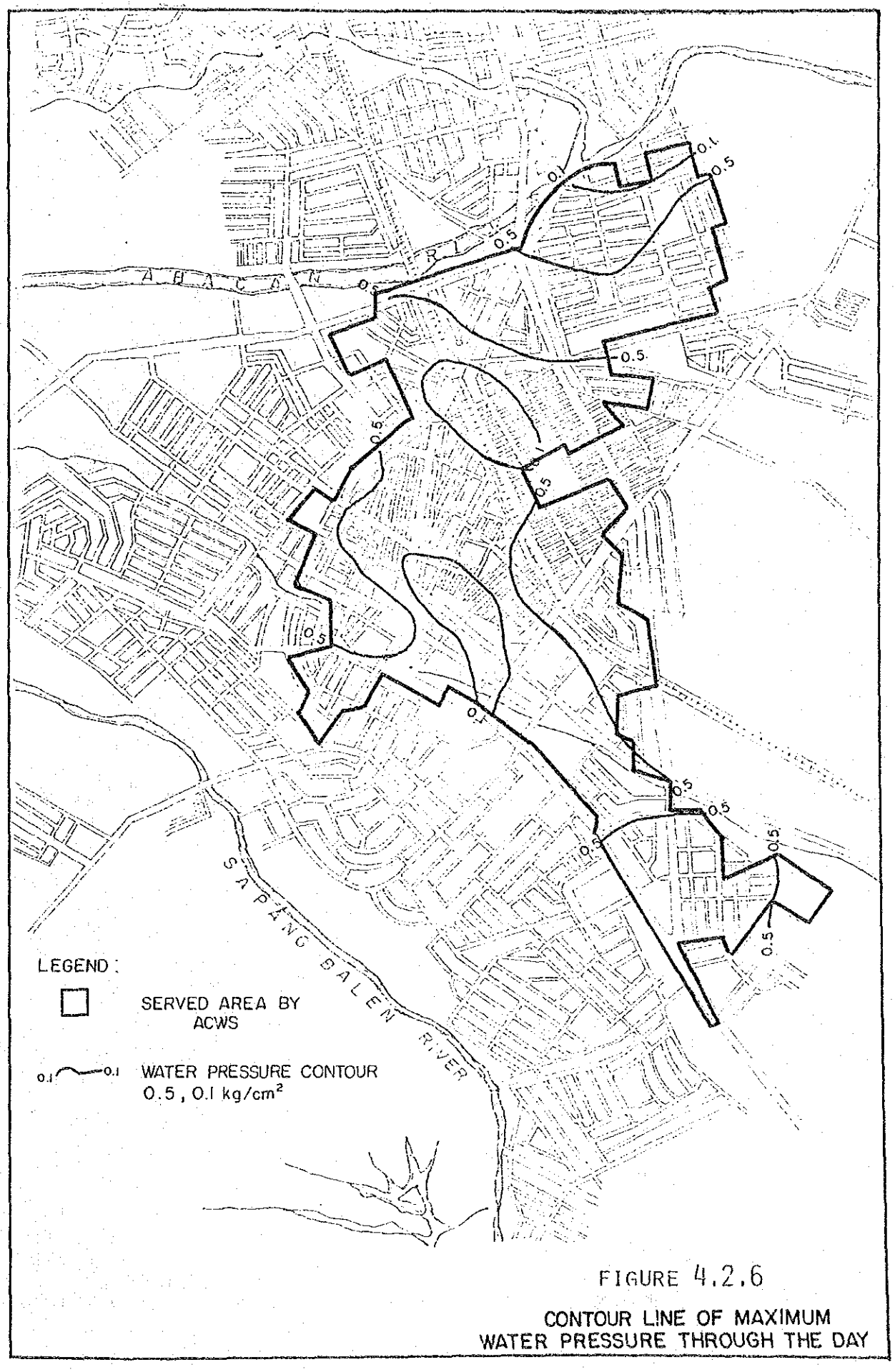


FIGURE 4.2.6

CONTOUR LINE OF MAXIMUM WATER PRESSURE THROUGH THE DAY

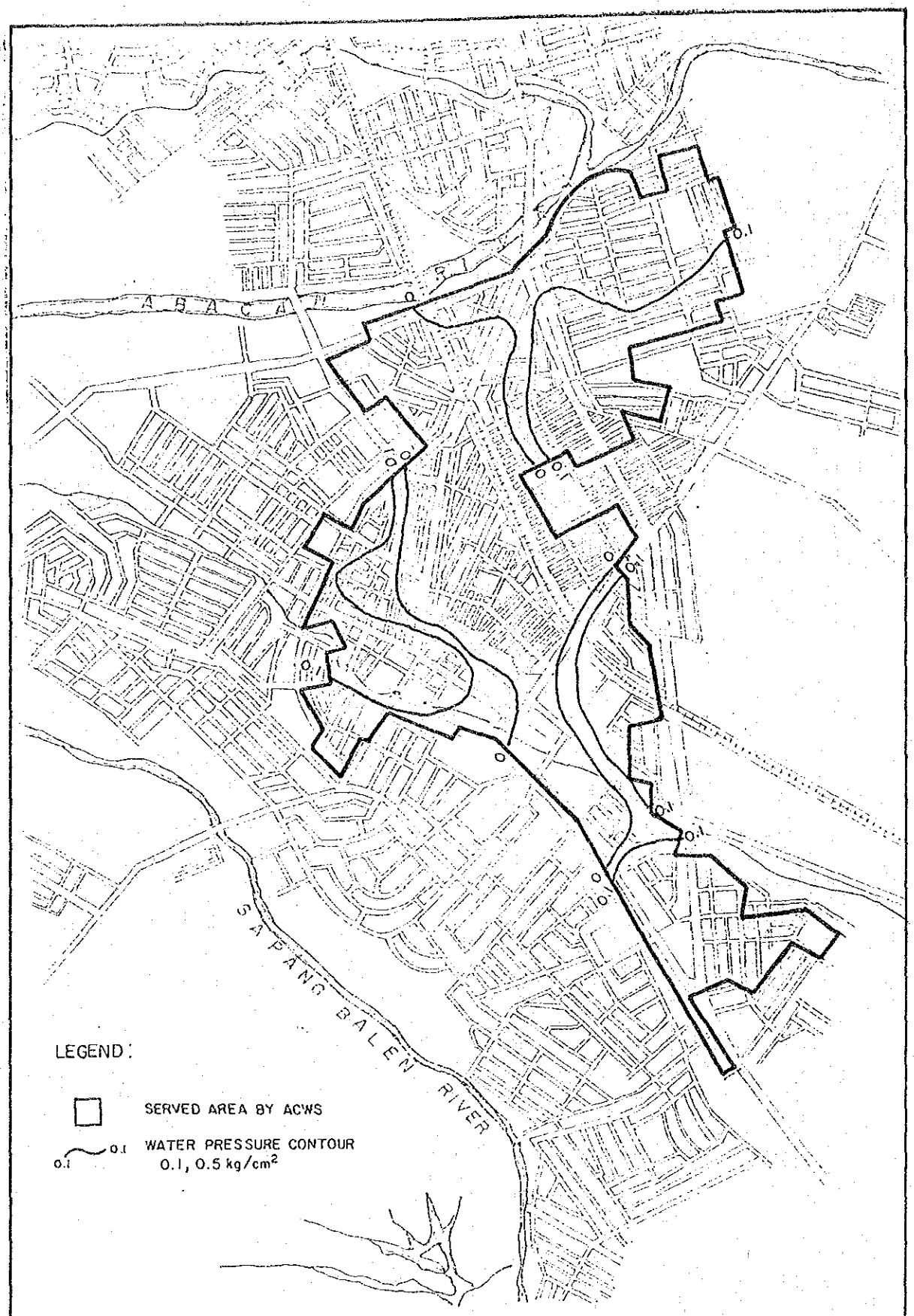


FIGURE 4.2.7
CONTOUR LINE OF MINIMUM WATER PRESSURE THROUGH THE DAY

c) Service Connections and Hydrants

The ACWS has a total of 4,128 registered service connections as of May 1986. The number of metered and unmetered connections by consumer type is given in TABLE 4.2.4. Consumers are categorized into domestic, commercial and institutional concessionaires. However, with regard to institutional users, most government office and public schools are charged free and are not included in the said TABLE. The three connections listed in the table (two government offices in Zone No. 1 and private hospital in Zone 5) are either charged as domestic or commercial by the ACWS, though categorized into institutional use in this study.

The service Connections by consumer type are as follows:

Type	Metered	Unmetered	Total
Domestic	971	2,568	3,539
Commercial	278	308	586
Institutional	1	2	3
Total	1,250	2,878	4,128

Approximately 70% of the total the number of connections is unmetered. APPENDIX 4.2.5 presents the number of metered and unmetered connections in terms of the size of service connections, in addition to the monthly consumption by metered concessionaires. The diameter of majority of connections is 1/2 inch, while 3/4 inch connection is used in the commercial connections.

There is a total of 24 fire hydrants located in various points in the distribution system with a size of 100 mm.

TABLE 4.2.4 NUMBER OF CONNECTION BY METERED AND UNMETERED

Consumer Type			Zone No. / HHs	1 351	2 670	3 241	4 270	5 442	6 212	7 349	8 413	9 574	10 696	11 184	12 751	13 342	14 630	15 527	16 581	17 715	18 475	19 442	20 158	21 172	22 276	Total 9471
Metered	Domestic	1/2	No. of Connect.	89	173	12	90	105	20	57	12	12	23	-	15	-	33	27	19	27	64	165	16	9	2	970
			m^3/month	2754	5687	276	2516	4519	878	1395	877	332	799	-	251	-	1386	1011	433	792	1900	7072	552	195	65	33690
		3/4	No. of Connect.	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
			m^3/month	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
		1	No. of Connect.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			m^3/month	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Commercial	1/2	No. of Connect.	1	3	-	-	1	22	2	134	17	11	1	2	-	1	-	-	1	-	7	-	5	55	263
			m^3/month	20	350	-	-	30	582	64	3395	430	513	68	13	-	50	-	-	15	-	275	-	107	1114	7026
		3/4	No. of Connect.	1	-	-	-	2	1	-	7	1	3	-	-	-	-	-	-	-	-	-	-	-	-	15
			m^3/month	14	-	-	-	29	15	-	553	294	152	-	-	-	-	-	-	-	-	-	-	-	-	1057
		1	No. of Connect.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			m^3/month	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Institutional		No. of Connect.	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
			m^3/day	-	-	-	-	414	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	414
Unmetered	Domestic	1/2	No. of Connect.	92	136	44	72	73	24	147	21	155	186	6	342	23	113	134	210	148	218	227	45	63	74	2553
		3/4	No. of Connect.	-	-	1	1	1	2	1	5	-	1	-	-	-	-	-	2	-	-	-	-	1	-	15
		1	No. of Connect.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Commercial	1/2	No. of Connect.	5	6	3	2	2	37	10	63	11	32	8	-	1	5	10	5	-	-	3	3	5	87	298
		3/4	No. of Connect.	-	-	1	-	-	-	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	5
		1	No. of Connect.	-	1	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	1	-	-	5
	Institutional	1/2	No. of Connect.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Note: Data in May 1986

4.2.3.2 Balibago Waterworks system

(1) Water Source

The existing water source of the Balibago Waterworks System are seven deep wells serving three barangays of the City located in the north side of the Abacan River. A description of the wells and pumps of the system is shown in TABLE 4.2.5. The system has two standby diesel motor located at pump stations No. 5 and 6.

(2) Transmission and Distribution

a) Storage Facilities

The system has two reinforced concrete elevated storage tanks located beside pump stations No. 5 and 6 in Bgy. Balibago. Both tanks have a capacity of 378 cu.m. with a low water level of about 30 m above ground level.

b) Treatment Facilities

Chlorination is the only treatment applied to the system. Chlorine is applied at the chlorination box in each pump station.

c) Distribution Facilities

The distribution network covers the three barangays in Angeles City and one barangay in Mabalacat with a total pipe length of 36 km. The sizes of the main distribution pipes range from 100 mm to 150 mm.

d) Service Connections

The system has a total registered connection of 5,063 as of January 1986. Approximately 10% of the total consumers is business establishments. The connections are classified by consumer type, as follows:

TABLE 4.2.5 PUMPING STATION IN BALIBAGO WATERWORKS

As of Dec. 31, 1985

Pumping Station	Location	Depth (m)	Casing Size (mm)	Drawdown (m)	Well Capacity (CMD)	Type of Pump	Pumping W.L. (GL-m)	Horse-power HP	Total Dynamic Head (m)	Pump Capacity (CMD)
1	McArthur Hi-way	152.5	350	-	-	Deepwell Horizontal	26.5	40	61.8	2,235
2	Josefa Subd.	85.4	300	20.4	2,453	"	25.9	25	75.3	1,085
3	Mt. View Subd.	183.0	200	-	-	"	43.0	25	85.3	703
4	Abacan	183.0	200	-	-	Deepwell Vertical	29.0	60	64.2	1,995
5	Diamond	134.2	200	-	-	Deepwell Horizontal	25.9	25	82.3	1,194
6	Lakandula	183.3	200	14.6	3,270	"	16.8	40	66.2	1,995
7	Don Bonifacio Subd.	91.5	300	8.5	2,998	"	18.6	40	60.9	1,194

Type	Metered	Unmetered	Total
Domestic	4,517	1	4,518
Commercial	545	-	545
Total	5,062	1	5,063

4.2.3.3 On-Going Project

An on-going project in the city is a Level III system under the Barangay Water Program to cover Barangay Cutcut. This project is expected to serve 690 households.

The system includes a deepwell, a submersible pump, an elevated steel tank and a distribution network. The total length of the distribution lines is 3,640 m of PVC material. Pipeline sizes range from 75 mm to 150 mm. As of April 1986, the project was 90% completed.

4.2.4 Operation and Maintenance

The operation and maintenance of Levels I and II facilities are undertaken by the association of the system's users.

For the ACWS, operation and maintenance are manned by a supervising mechanic, 12 pump operators, 3 mechanic, 3 plumbers and 2 pipefitters. The main functions of these O & M personnel are to operate and maintain the pumping units, inspect, install and repair the system's facilities, performs preventive maintenance and others.

Pump operation schedule for the ten pumps is on a 24-hour basis while one pump is only for a 16-hour operation due to pump vibrations.

The Balibago Waterworks System, Inc. operates and maintains the well source, distribution and chlorination facilities of the system in Balibago. The activities are mainly the operation of the pumping stations and two storage tanks.

As of January 1986, there were seven pumps in operation with each pump operating at an average of about 495 hours per month. Compared to the 1984 performance, this operation has been reduced. A summary of the pumping operation is shown below:

Item		Jan. 1986	1984
1.	Average output of each pumping station	22,028 cu.m/month	30,975 cu.m/month
2.	Average operating hours each pumping station	495.5 hr/month	524 hr/month
3.	Number of pumps operating	7	7
4.	Average capacity of each pump	1,090 cu.m/day	1,962 cu.m/day

A total of 24 personnel is assigned to the operation and maintenance of the system broken down into; 14 pump operators, 6 plumbers, 3 supervisors and 1 utility man.

4.2.5 Deficiencies of the Existing System

Of the 67 point source water supply facilities, four are in unsatisfactory condition due to poor water quality. Two wells in Barangay Capaya and another in Barangay Cutcut exhibited high iron concentration. On the other hand, the well in Barangay Pulung Cacutud has a musky taste. The depth of these wells ranges from 36.6 m to 42.7 m with a casing of 125mm.

Another deficiency noted is the casing sizes of some of the wells are too small in relation to their well depth of over 30 m.

Level II systems in the area are performing efficiently with no significant deficiency/problem seen.

With regard to the location of the ACWS facilities, the pumping stations are in different places. In some cases, the proximity of one deepwell site to another may result to an interference in the functioning of well capacity. For example, two well sources (pump stations No. 2 and 3) are located only about 190 m apart and are about 35 years old.

The mechanical efficiencies of the pumps were found to be within the allowable range, however, many plumbing fixtures around the turbine pumps were found to be defective and leaking. However, there is no stand-by generator available in case of a power failure, thus an interruption of service occurs.

There are no disinfection facilities in the system to safeguard the quality of the water supply. In fact, three deepwells have already been abandoned due to high iron concentration.

The storage facility of the system, a reinforced concrete elevated tank, is not in use due to leaks from the outer wall surface.

The existing water distribution system lacks an adequate grid system. Most of the pipes are dead-ended. The use of very old, small diameter pipes is a source of suspected extensive leakage. As a result, pressure distribution is very poor and some areas are without water during most of the day. Distribution valves are not known because it is buried under the concrete roadway.

In many instances, a number of service pipes are connected to the distribution main pipe at the same point. Likewise, only rubber straps around leaking service pipes are used for repairs.

Fire protection from available hydrants is almost non-existent due to low water pressure. The number of fire hydrants with a tee-stand pipe made of GI is very limited. The absence of hydrant valves, broken valves, stem and hydrant caps is very common.

4.3 WATER PRODUCTION

The water source of the ACWS is groundwater. Pump discharge rates through the day at nine out of eleven operating pump stations were measured in the field. Two pumping stations were either under repair (No. 8) or was quite small (No. 14). The total production amount from the eleven pumping stations was estimated at 11,545 cu.m/day. Compared with the rated capacity and records in 1977, the figure obtained through this survey is larger than said two reference figures by 10% to 20%. TABLE 4.3.1 presents measurement results and reference figures in the previous survey. The total amount of around 11,000 cu.m/day may be a conservative figure in discussing the present supply of the city waterworks.

TABLE 4.3.1 DAILY WATER PRODUCTION OF THE CITY WATERWORKS

Unit : cu.m/day

Number of P.S.	Measurement : JICA (6/30-7/9)	Reference		Remarks
		Records in 1977	Rated Capacity	
1	3,968	3,570	2,725	
2	382*	382	818	
3	709	568	654	
4	320	428	545	
5	987	1,015	954	
6	1,013	1,354	1,605	
7	814	439	545	
8	1,203*	1,203	981	Temporary pump: 1,565 cu.m/day
9	-	-	-	Abandoned in 1979
10	1,288	1,149	981	
11	-	-	-	Abandoned in 1973
12	588	390	545	
13	-	-	-	Abandoned in 1979
14	273*	-	273	
Total	11,545	10,771	9,645	

Note : * Figures from the survey in 1977 or rated capacity

The Balibago Waterworks likewise relies on groundwater for its source of supply. The average production in January 1986 is approximately 6,200 cu.m/day, the same as in 1984.

4.4 WATER CONSUMPTION

4.4.1 General

Present water consumption for the two waterworks was analyzed using the records in January and May 1986.

(1) Angeles City Waterworks

- Number of connections by metered and unmetered, and by consumer type (May, 1986)
- Water consumption by metered concessionaires and water charges collected both from metered and unmetered users (May, 1986)
- Water rate adopted by the city government
- Location of subarea (zone) with reference to barangays

(2) Balibago Waterworks

- Number of connections with meters and without meters (January 1986)
- Number of customers by range of water consumption, and by consumer type (January 1986 and 1984)
- Monthly water consumption by metered connections
- Present water rate

The water consumption study was made by water supply zones used in the collection of water charges by the City Engineers Office. However, the final figure was computed by barangay. The number of metered and unmetered connection by consumer type is given in the previous section.

The water consumption study for the Balibago Waterworks was made for comparison purposes with that of ACWS.

4.4.2 Angeles City Waterworks

Water consumption by the metered connections and collected charges by consumer type (metered and unmetered) for the month of May, 1986 are summarized below (Data by zone is given in APPENDIX 4.4.1).

TABLE 4.4.1 SUMMARY OF WATER CONSUMPTION AND CHARGES

Consumer Type	Water consumption (metered) (cu.m/day)	Collected Charges metered (₱)	Collected Charges unmetered (₱)	Total (₱)
Domestic	1,123	34,290.88	57,112.90	91,403.88
Commercial	269	20,681.30	28,134.00	48,815.30
Institutional	14	710.00	181.20	891.20
Total	1,406	55,682.28	85,428.10	141,110.38

(1) Unit Water Consumption

Unit water consumption by consumer type was estimated using the data on the water consumption by metered connections. The following is a description of the three consumer types.

a) Domestic connections

Interviews with concessionaires on the actual population served were conducted in the model study area to find out the unaccounted-for water/not utilized water. Approximately 35% of secondary users/borrowers were estimated in the model area (Zone No. 1). However, due to the fact that the zone is predominantly composed of apartment houses, a conservative figure of 30%, was concluded as the city average. This figure was confirmed at random in the field.

The actual population served was calculated taking into consideration the additional users and average persons per household (6 persons/HH). TABLE 4.4.2 shows per capita/connection consumption by size of service connection. Number of connections with 3/4" service connection is only one in Zone No. 3.

TABLE 4.4.2 UNIT WATER CONSUMPTION (METERED CONNECTONS)

DOMESTIC:

Zone Number	Metered Number	Connection (Dia.(in))	Served Population	Daily Consumption (cu.m/day)	Per Capita (lpcd)	Per Connection (cu.m/conn.day)
1	89	1/2	694	91.8	132	1.031
2	183	"	1,349	189.6	141	1.096
3	12	"	94	9.2	98	0.767
	1	3/4	8	0.3	38	0.333
4	90	1/2	702	83.9	120	0.932
5	105	"	819	150.6	184	1.435
6	20	"	156	29.3	188	1.463
7	57	"	445	46.5	104	0.816
8	12	"	94	29.2	311	2.436
9	12	"	94	11.1	118	0.922
10	23	"	179	26.6	149	1.158
11	-		-	-	-	-
12	15	1/2	117	8.4	71	0.558
13	-		-	-	-	-
14	33	1/2	257	46.2	180	1.400
15	27	"	211	33.7	160	1.248
16	19	"	148	14.4	97	0.960
17	27	"	211	26.4	125	0.978
18	64	"	499	63.3	127	0.990
19	165	"	1,287	235.7	183	1.429
20	16	"	125	18.4	147	1.150
21	9	"	70	6.5	93	0.722
22	2	"	16	2.2	138	1.083
TOTAL	971		7,575	1,123.3	148	1.157

Note: Majority of connections are those with a dia. of 1/2 inch.
Served population = No. of connections x 6 persons/HH x 1.3 (primary and secondary users)

Therefore, the average unit consumption was calculated using the entire data (1/2" and 3/4"). The average per capita and per connection consumption was calculated at 148 lpcd and 1.157 cu.m/conn.day, respectively.

b) Commercial connections

Approximately 5% of the total connection has 3/4" service connections, while majority have 1/2" ones. Consumption per connection was calculated at 0.890 and 2.349 cu.m/day for 1/2" and 3/4" connections, respectively. The overall average is 0.969 cu.m/day. TABLE 4.4.3 shows unit consumption by the different diameters of service connection.

c) Institutional connections

Only one connection is registered as an institutional connection with a diameter of 3/4". The daily consumption of the connection is 13.8 cu.m/day (See TABLE 4.4.3).

(2) Total Water Consumption

Prior to the calculation of the total consumption of the city, the composition of each barangay in the water supply zone was studied.

The relationship between barangay and water supply zone is given in APPENDIX 4.4.2. The percentage of served population in each zone in the barangays was calculated using the present population distribution.

The total water consumption of the city was estimated using the following conditions and assumptions.

a) Water consumption of metered connections by consumer type is the figure read from the meter for the month of May, 1986.

TABLE 4.4.3 UNIT WATER CONSUMPTION (METERED)

Commercial:

Zone Number	Metered Number	Connection Diameter (inch)	Daily Consumption (cu.m/day)	Per Connection (cu.m/conn.day)
1	1	1/2	0.667	0.667
	1	3/4	0.467	0.467
2	3	1/2	11.667	3.889
3	-	-	-	-
4	-	-	-	-
5	1	1/2	1.000	1.000
	2	3/4	0.967	0.483
6	22	1/2	19.400	0.882
	1	3/4	0.500	0.500
7	2	1/2	2.133	1.067
8	134	1/2	113.167	0.845
	7	3/4	18.433	2.633
9	17	1/2	14.333	0.843
	1	3/4	9.800	9.800
10	11	1/2	17.100	1.555
	3	3/4	5.067	1.689
11	1	1/2	2.267	2.267
12	2	1/2	0.433	0.217
13	-	-	-	-
14	1	1/2	1.667	1.667
15	-	-	-	-
16	-	-	-	-
17	1	1/2	0.500	0.500
18	-	-	-	-
19	7	1/2	9.167	1.310
20	-	-	-	-
21	5	1/2	3.567	0.713
22	55	1/2	37.133	0.675
Total	263	1/2	234.201	0.890
	15	3/4	35.234	2.349
	278		269.435	0.969

Institutional:

Zone Number	Metered Number	Connection Diameter (inch)	Daily Consumption (cu.m/day)	Per Connection (cu.m/conn.day)
5	1	3/4	13.800	13.800

b) Water consumption of the unmetered connections by consumer type is estimated using the following assumptions.

i) Domestic users

Generally, water consumed by the unmetered users is more than the metered users. However, in some areas of the city the opposite is true because of inadequate water supply or low water pressure. In such cases, the average per capita water consumption of the metered connections is used.

ii) Commercial users

Unit water consumption by the size of service connections whether 1/2" or 3/4" for the metered users is used as a basis of calculation.

iii) Institutional users

Since existing unmetered connections (1/2") are different from metered one (3/4") in diameter of service pipe, the figure for the commercial users with a size diameter of 1/2" is employed.

Served population and its percentage to related barangays are given in TABLE 4.4.4. The total of 27,600 persons was calculated as an actual population served and it is approximately 17% of the total population in the related barangays.

TABLE 4.4.5 shows water consumption by consumer type and the city total. The following is the summary of water consumption.

Domestic	:	4,085 cu.m/day
Commercial	:	588
Institutional	:	16
Total	:	4,659
	≒	4,700 cu.m/day

TABLE 4.4.4 NUMBER OF CONNECTIONS BY METERED AND UNMETERED BY CONSUMER TYPE

Barangay	Metered Connection				Unmetered Connection				Total	Pop. & Served Percent				
	Domest.	Comm'l.	Inst'l.	Sub-Total	Domest.	Comm'l.	Inst'l.	Sub-Total	Total Connect.	Brgy. Pop'n.	No. of Domest. Conn.	Prim. User	Served Pop'n	Served Percent
1. A. del Rosario	-	1		1	27	7		34	35	5,069	27	162	211	4.2
2. Claro M. Recto	22	-		22	217	6		223	245	7,660	239	1,434	1,864	24.3
3. Cutcut	5	3		8	33	2		35	43	16,227	38	228	296	1.8
4. Lourdes N.W.	17	29		46	379	44		423	869	11,201	396	2,376	3,089	27.6
5. Lourdes Sur	54	19		73	266	18		284	357	7,837	320	1,920	2,496	31.8
6. Lourdes Sur East	26	1		27	155	-		155	182	7,504	181	1,086	1,412	18.8
7. Malabañas *	18	-		18	78	6		84	102	16,293	96	576	749	4.6
8. Pampang	-	25		25	33	37		70	95	2,347	33	198	257	11.0
9. Pandan	225	11		236	434	3		437	673	15,075	659	3,954	5,140	34.1
10. Pulung Bulu	156	2		158	128	5		133	291	7,837	284	1,704	2,215	28.3
11. Salapungan	16	-		16	45	4		49	65	7,615	61	366	476	6.3
12. San Jose	92	2		94	81	6		87	181	7,394	173	1,038	1,349	18.2
13. San. Nicolas	21	116		137	132	69		201	338	4,184	153	918	1,193	28.5
14. Sta. Teresita	33	2		35	117	11		128	163	11,866	150	900	1,170	9.9
15. Sta. Trinidad	10	6		16	75	14		89	105	6,088	85	510	663	10.9
16. Sto. Cristo	72	9	1	82	102	22		124	206	2,811	174	1,044	1,357	48.3
17. Sto. Domingo	174	2		176	160	8	2	170	346	14,566	334	2,004	2,605	17.9
18. Sta. Rosario	22	50		72	65	43		108	180	5,269	87	522	679	12.9
19. Virgen de los Remedios	8	-		8	41	3		44	52	1,940	49	294	382	19.7
Total	971	278	1	1,250	2,568	308	2	2,878	4,128	158,783	3,539	21,234	27,603	17.3

Note : Total number of connections by consumer type

Domestic Connect.	3,539
Commercial Connect.	586
Institutional Connect.	3
Total	4,128

Served pop. includes secondary users/borrowers;
Number of secondary users is estimated in assumption of 30% to primary user.

* Most of the area in Malabañas is served by Balibago Waterworks

TABLE 4.4.5 ESTIMATION OF WATER CONSUMPTION

Connection Type	Conditions		Unit Consumption	Daily Water Consumption (cu.m/day)
Domestic	Served Population	27,603	148 lpcd	4,085
Commercial	Number of Connection	1/2" : 561	0.890 cu.m/conn.day	499
		3/4" & 1" : 25	2.349 cu.m/conn.day	59
	Sub-Total			588
Institutional	Number of Connection	1/2" : 2	0.890 cu.m/conn.day	2
		3/4" : 1	13.8 cu.m/conn.day	14
	Sub-Total			16
T o t a l	Served Population	: 27,603		
	No. of Connection	: 4,128		4,659

Although a total of 4,700 cu.m/day was obtained based on the same assumptions, special attention should be paid on the existence of a great number of additional faucets in the category of unmetered connections. Zone No. 1 (residential area) and No. 6 (commercial area) were selected as model areas to estimate the number of additional faucets using the same water charges.

The following is the summary of the result.

No. of Unmetered Connection		Additional Faucet	Total
Zone No. 1:	87	182	269
Zone No. 6:	26	31	57

The number of additional faucets may be 100 - 200% of registered connections (unmetered). If these faucets are used by the secondary users, the water consumption increases. The total number of unmetered connections is reported to be 2,878, which is approximately 70% of the total connections.

Assuming that an equal number of additional faucets, as to the registered connection are used by secondary users and that the consumption per connection is the same as those metered connections (1.157 cu.m/conn.day), then about 3,000 cu.m/day more is consumed. Under this assumption, more than 70% of the production amount is utilized. Under the present situation, it is highly possible that this is the case.

4.4.3 Balibago Waterworks

The daily average of water consumption in January 1986 is reported to be 4,108 cu.m/day (Refer to APPENDIX 4.4.3). Unit daily water consumption by water use was estimated in accordance with the flow chart as shown in FIGURE 4.4.1.

The daily average of water consumption per capita was calculated at 109 lpcd and 120 lpcd in 1986 and 1984, respectively (See TABLEs 4.4.6 & 4.4.7). These figures meet the design standards used in this country. Since the Balibago Waterworks is managed by the private sector and water rates are comparatively high, the consumption per capita seems to depend on present income levels. The ranges of consumption are from 56 lpcd to 250 lpcd. Average daily consumption per customer for business use was estimated at 2.18 cu.m/conn.day and 2.58 cu.m/conn.day in 1986 and 1984, respectively. These figures are common in most local major cities.

FIGURE 4.4.1 FLOW CHART FOR ESTIMATING UNIT WATER CONSUMPTION

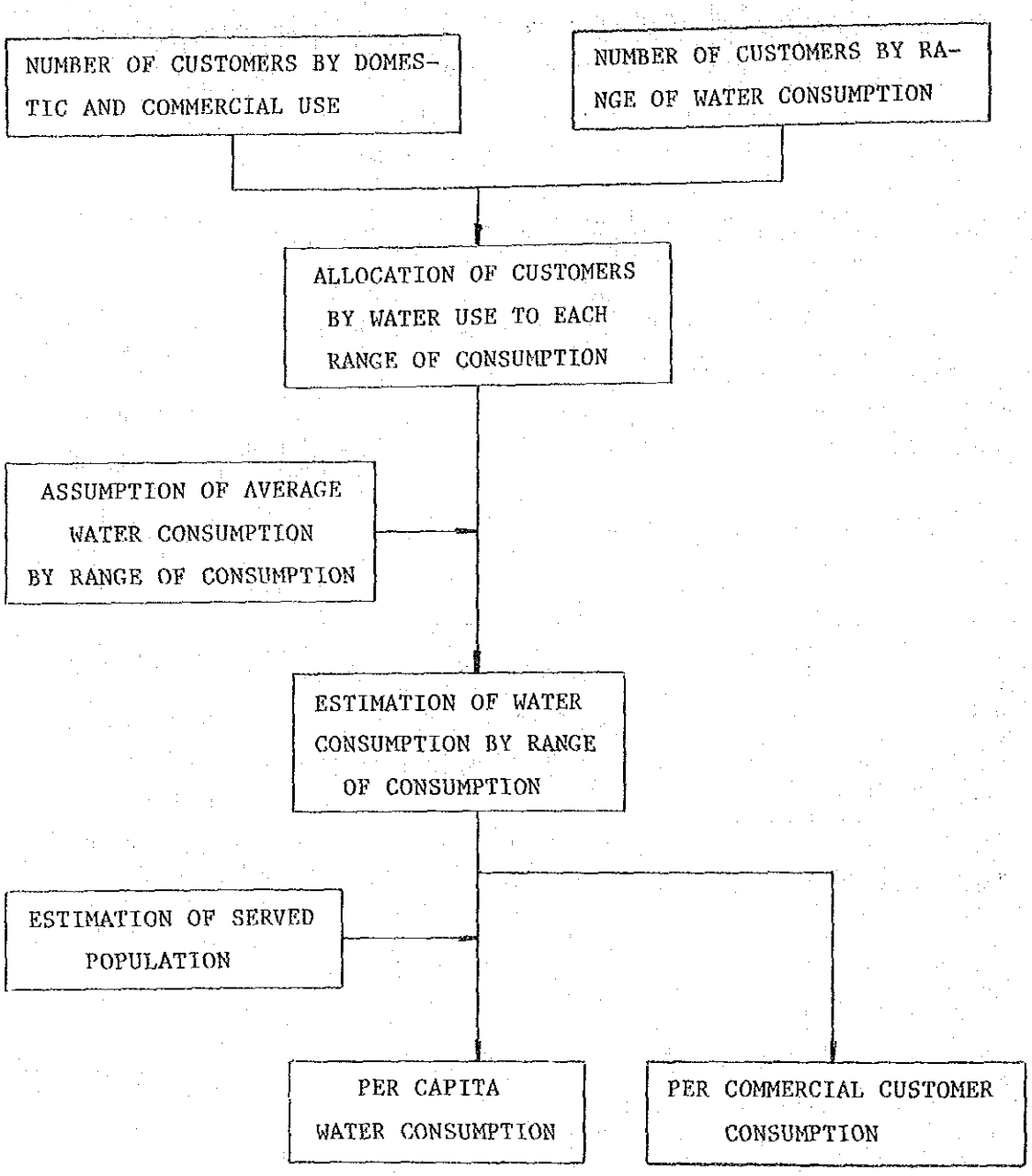


TABLE 4.4.6 UNIT WATER CONSUMPTION BY WATER USE

Item	Range of Consumption (cu.m/month)	No. of Connections	Average Consumption (cu.m/month)	Consumption (cu.m/month)	Served Pop.	Unit Consumption (lpcd)
		J A N U A R Y	1 9 8 6			
Domestic	1) Below 10	1,197	10	11,970	7,182	56
	2) 11-20	1,543	15	23,145	9,258	83
	3) 21-30	1,056	25	26,400	6,336	139
	4) 31-40	534	35	18,690	3,204	194
	5) 41-50	187	45	8,415	1,122	250
	Total	4,517		88,620	27,102	109
						(cu.m/conn.day)
Commercial	5) 41-50	109	45	4,905		
	6) 51-60	165	55	9,075		
	7) 61-70	93	65	6,045		
	8) 71-80	64	75	4,800		
	9) 81-90	29	85	2,465		
	10) 91-100	23	95	2,185		
	11) More than 100	62	100	6,200		
	Total	545		35,675		2.18
Grand Total		5,062		124,295	27,102	

Note: 1) Average number of persons per household: 6
2) Estimated total consumption is almost same as those reported by the Authority.

TABLE 4.4.7 UNIT WATER CONSUMPTION BY WATER USE

Item	Range of Consumption (cu.m/month)	No. of Connections	Average Consumption (cu.m/month)	Consumption (cu.m/month)	Served Pop.	Unit Consumption (lpcd)
			1 9 8 4			
Domestic	1) Below 10	962	10	9,620	5,772	56
	2) 11-20	1,390	15	20,850	8,340	83
	3) 21-30	983	25	24,575	5,898	139
	4) 31-40	651	35	22,785	3,906	194
	5) 41-50	355	45	15,975	2,130	250
	Total	4,341		93,805	26,046	120
						(cu.m/conn.day)
Commercial	5) 41-50	30	45	1,350		
	6) 51-60	204	55	11,220		
	7) 61-70	111	65	7,215		
	8) 71-80	79	75	5,825		
	9) 81-90	43	85	3,655		
	10) 91-100	28	95	2,660		
	11) More than 100	87	100	13,050		
	Total	582		45,075		2.58
Grand Total		4,923		138,880	26,046	

Note: 1) Average number of persons per household:6
2) Estimated total consumption is almost same as those reported by the Authority.
3) Average per capita consumption of the two calculation result is equal to 115 lpcd.

4.5 ANALYSIS ON WATER SUPPLY AND CONSUMPTION

4.5.1 Angeles City Waterworks

(1) Comparative Study on Production Amount and Consumption

Total water intake amount in all operating wells and water consumption in the service area were estimated in the previous section. Intake amount is 11,000 cu.m/day, while the total water consumption was estimated at 4,700 cu.m/day. Therefore, approximately 45% of the intake amount appears to have been consumed. However as discussed under the item "Total Water Consumption," there is a high possibility that additional water are being used by a considerable number of faucets associated with unmetered connections. In this instance, 70% of the intake amount was estimated as being consumed.

The survey for estimation of unaccounted-for water/not utilized water was conducted in the model study area (Refer to APPENDIX 4.5.1). The terms are defined as follows:

Unaccounted-for water :

Water for which charges are not collected. Part of utilized water at unmetered connections is regarded as 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 survey result revealed that 15 and 20% of distributed amount correspond to unutilized water and unaccounted-for water, respectively. These percentages seem to be above the City's average due to the characteristics of the model area associated with water use pattern and present practices of water supply.

(2) Unaccounted-for Water

Accounted-for water in the service area was calculated to include water consumption for connections adopting flat rates. The average unit quantity of water use at unmetered/not functioning meter was assumed as follows:

a) Domestic Connection

1/2" connection : ((₱18-₱14)÷0.8 + 10)÷30 = 0.5 cu.m/conn.day
3/4" connection : ((₱40-₱32)÷0.8 + 10)÷30 = 0.67

b) Commercial/institutional connection

1/2" connection : ((₱90-₱40)÷1.6 + 10)÷30 = 1.38 cu.m/conn.day
3/4" connection : ((₱145-₱64)÷1.6 + 10)÷30 = 2.02
1" connection : ((₱255-₱128)÷1.6 + 10)÷30 = 2.98

Accounted-for water for the unmetered/not functioning meter was estimated using the above average unit quantity and number of connections by the size of service connections (See APPENDIX 4.2.5). TABLE 4.5.1 shows the total of accounted-for water. Accounted-for water which is 3,100 cu.m/day resulted in approximately 30% of produced amount. Accordingly, unaccounted-for water was estimated at 7,900 cu.m/day which is 70% of the produced amount.

4.5.2 Balibago Waterworks

(1) Comparative Study on Production Amount and Consumption

Total water production of Balibago Waterworks is reported to be about 6,200 cu.m/day. On the other hand, the average water consumption is approximately 4,400 cu.m/day in January 1986 and 1984.

Approximately, 70% of produced water appears as being utilized in this system.

TABLE 4.5.1 ACCOUNTED-FOR WATER FOR THE WATERWORKS

Consumer Type	Item	No. of Connections	Unit Quantity (cu.m/conn.day)	Quantity (cu.m/day)
Domestic	Metered	971	-	1,123
	Unmetered 1/2"	2,553	0.50	1,277
	3/4"	15	0.67	10
	Sub-Total	3,539		2,410
Commercial	Metered	278	-	269
	Unmetered 1/2"	298	1.38	411
	3/4"	5	2.02	10
	1"	5	2.98	15
	Sub-Total	586		705
Institutional	Metered	1	-	14
	Unmetered 1/2"	2	1.38	3
	Sub-Total	3		17
	TOTAL	4,128	≒3,100	3,132

(2) Unaccounted-for Water

There is only one unmetered connection in the service area. Therefore, the total water consumption reported may be regarded as accounted-for water.

Unaccounted-for water corresponds to that discussed in the former comparative study between production and consumption. Approximately 30% of the total production is considered wastage.

4.6 EXISTING SANITATION CONDITIONS

4.6.1 Drainage and Sewage Disposal

The city has no layout plans for its drainage system. Surface runoff flows into the drainage pipes and into the rivers crossing the city. Domestic and commercial wastewater is usually disposed of at private septic tanks or pit privies.

In some cases, wastewater is discharged directly into the rivers.

4.6.2 Solid Waste Disposal

Daily collection of garbage and street sweeping is implemented in the city. There are six (6) dump trucks used in collecting garbage in the city and are disposed into a 10 ha area in Barangay Cauayan, 5 km west of the poblacion.

An average of 100 tons of garbage is collected and disposed of daily.

Other residents in the area dispose their refuse by burning and dumping in garbage pits and sometimes in vacant lots.

CHAPTER 5
POPULATION AND WATER DEMAND PROJECTIONS

CHAPTER 5 POPULATION AND WATER DEMAND PROJECTIONS

5.1 GENERAL

Future water supply plan for Angeles City was studied based on collected data and discussions with the city officials.

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

Potential service area was studied taking into account technology and economic aspects. Water demand to include consumptions and unaccounted-for water was estimated.

5.2 POPULATION PROJECTION

Population projection was made using break-down method. Provincial population in the future was first projected with reference to the existing NEDA projection. Projected provincial population in assumption of growth rates were broken-down in Angeles City using the sharing method. Likewise, population in urban and rural areas were predicted. Finally, population by barangay in the urban and rural areas was projected based on historical data.

5.2.1 Population Projection of the Province and City

Assuming the growth rate trend to decrease, the growth rate trend of NEDA projection was compared with the historical growth rate of the province. The 1980-1985 growth rate (2.59%) is approximately equal to the actual growth rate (2.54%) of the province in the year 1975-1980. The (1985-1990) growth rate (2.26%) of NEDA was applied for 1980-1986 population projection of the province. The 1990-1995 and 1995-2000 growth rates of NEDA were applied in the projection up to year 1995. The NEDA growth rate which was projected up to year 2020 was used in the projection for the year 2010.

As a result of the study, the provincial and city population were projected to be 1,894,460 and 363,740, respectively for the year 2010. The projected population is summarized in the following Table:

TABLE 5.2.1 POPULATION PROJECTION IN THE PROVINCE AND CITY

Year	Province		City		Provincial Population (%)
	Growth Rate	Population	Growth Rate	Population	
	(1980-1986)		(1980-1986)		
1986	2.26	1,351,140	2.91	224,290	16.60
1990	1.76	1,448,810	2.52	247,750	17.10
1995	1.59	1,560,040	2.27	274,570	17.60
2000	1.49	1,679,780	2.20	304,040	18.10
2010	1.21	1,894,460	2.04	363,740	19.20

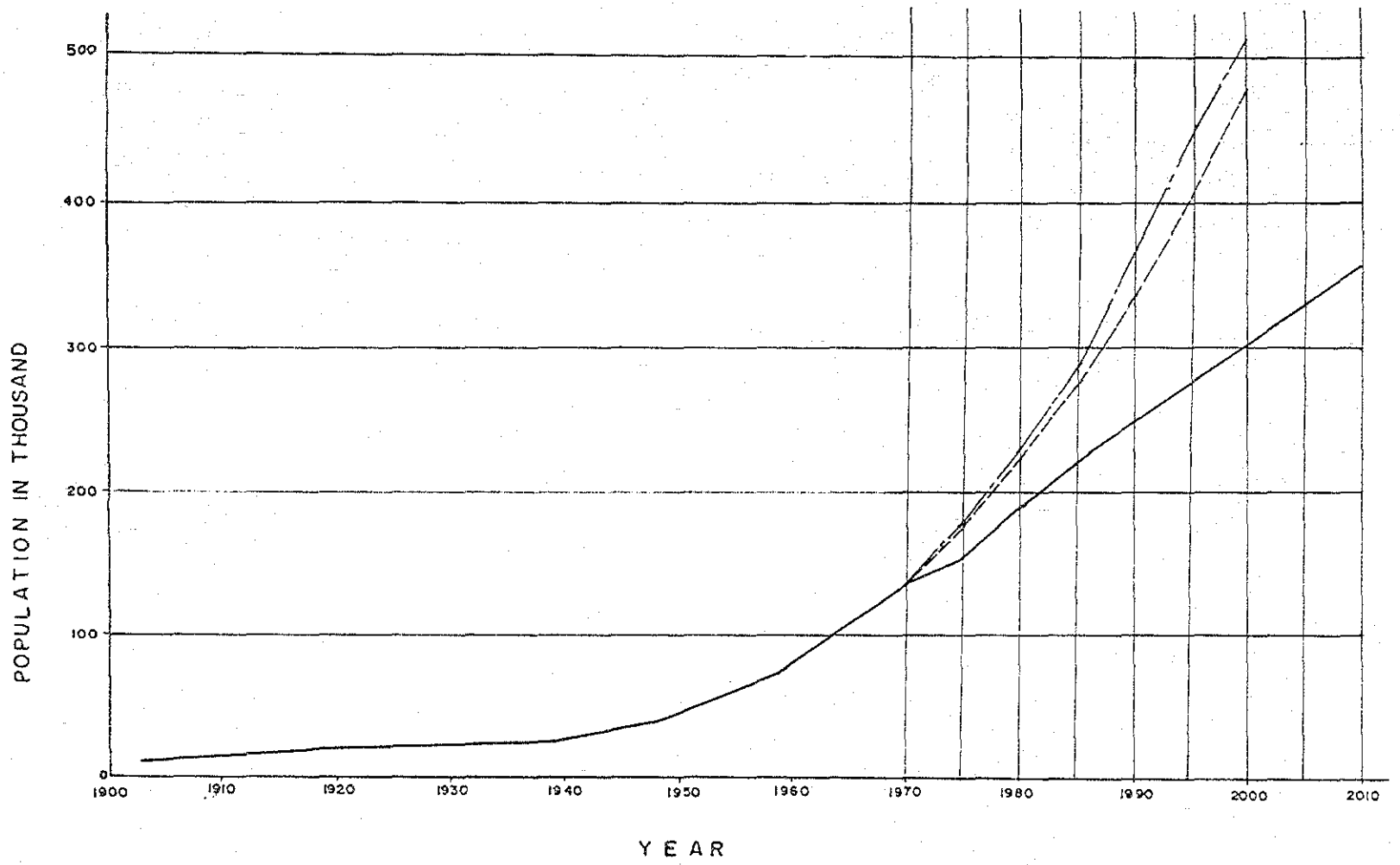
FIGURE 5.2.1 shows the population projection of the city in comparison with NEDA projections.

5.2.2 Population Projection by Barangay

The population of the urban area and the rural area were projected by their population percentage trend in relation to the City. Each barangay population was projected by their percentage trend to the urban or rural area population (See TABLEs 5.2.2 to 5.2.4). TABLE 5.2.5 shows the projected population for each barangay.

5.2.3 Projection of Number of Households

The total number of households in Angeles City increased from 22,025 in 1970 to 41,521 in 1983. From this total number of households, 41,095 are situated in the urban area while 426 are located in the rural area (See TABLEs 5.2.2 and 5.2.3). The number of households in the city was projected to be 72,650 in 2010, based on the projected number of persons per household (See TABLE 5.2.6).



LEGEND:

——— Design Population

—·— High Projection (NEDA)

– – – – Mid. Projection (NEDA)

FIGURE 5.2.1 HISTORICAL AND PROJECTED POPULATION

ANGELES CITY

TABLE 5.2.2 POPULATION AND NUMBER OF HOUSEHOLDS IN URBAN AND RURAL AREAS, ANGELES CITY

	Area	Item	1970	1975	1980	1983
Angeles City	Urban	Population	132,917	148,948	186,214	218,354
		Percent to Total	98.79	98.53	98.61	98.70
		Household	21,759	23,860	33,260	41,095
	Rural	Population	1,627	2,216	2,620	2,881
		Percent to Total	1.21	1.47	1.39	1.30
		Household	226	318	385	426
	Total	Population	134,544	151,164	188,834	221,235
		Percent	100.00	100.00	100.00	100.00
		Household	22,025	24,178	33,645	41,521

Source: National Census

TABLE 5.2.3 POPULATION AND NUMBER OF HOUSEHOLDS PROJECTION IN URBAN AND RURAL AREAS
ANGELES CITY

Area	Item	1980	1983	1986	1990	1995	2000	2010
Urban	Population	186,214	218,354	221,370	244,780	271,270	300,390	359 370
	Percent	98.61	98.70	98.70	98.8	98.8	98.8	98.9
	Household	33,260	41,095	41,930	46,800	52,470	58,780	71,870
Rural	Population	2,620	2,881	2,920	2,970	3,300	3,650	4,370
	Percent	1.39	1.30	1.20	1.20	1.20	1.20	1.20
	Household	385	426	440	460	530	610	780
Total	Population	188,834	221,235	224,290	247,750	274,570	304,040	363,740
	Percent	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Household	33,645	41,521	42,370	47,260	53,000	59,390	72,650

TABLE 5.2.4 POPULATION BY BARANGAY - ANGELES CITY

AREA	BARANGAY	1970 POPULATION	1970 PER-CENT	1970 HOUSEHOLD	1975 POPULATION	1975 PER-CENT	1975 HOUSEHOLD	1980 POPULATION	1980 PER-CENT	1980 HOUSEHOLD	1983 POPULATION	1983 PER-CENT	1983 HOUSEHOLD
URBAN	1. A. del Rosario	4,589	3.45		4,901	3.29	795	4,687	2.52	825	5,213	2.39	791
	2. Amsik	-			894	0.60	131	1,116	0.60	179	1,308	0.60	221
	3. Anunas	1,265	0.95		2,098	1.41	389	3,424	1.84	724	5,191	2.38	1,218
	4. Balibago	14,616	11.00		14,571	9.79	2,855	24,328	13.06	5,382	32,520	14.80	7,708
	5. Capaya	480	0.36		11,552	1.04	251	2,475	1.33	394	3,224	1.48	509
	6. Claro M. Recto	7,880	5.93		7,446	5.00	1,205	7,204	4.14	1,395	7,854	3.60	1,516
	7. Cutcut	7,170	5.39		8,648	5.80	1,257	12,710	6.82	2,113	15,808	7.24	2,836
	8. Lourdes Northwest	10,118	7.61		10,824	7.27	1,732	11,361	6.10	1,888	11,677	5.35	1,983
	9. Lourdes Sur	6,709	5.05		7,027	4.27	1,103	7,589	4.08	1,283	7,927	3.63	1,383
	10. Lourdes Sur East	8,169	6.15		7,120	4.78	1,054	7,494	4.02	1,181	7,715	3.53	1,260
	11. Malabañas	5,347	4.02		4,513	3.03	788	9,972	5.36	2,086	15,628	7.16	3,622
	12. Margot	996	0.75		1,376	0.92	215	1,653	0.89	261	1,834	0.84	291
	13. Pampang	1,596	1.20		1,083	0.73	158	1,732	0.93	278	2,194	1.00	372
	14. Pandan	5,981	4.50		10,915	7.33	1,601	13,301	7.14	2,104	14,878	6.81	2,456
	15. Pulungbulu	6,494	4.89		6,790	4.56	1,027	7,463	4.01	1,229	7,874	3.61	1,361
	16. Pulung Cacutud	761	0.57		977	0.65	136	1,070	0.58	160	1,127	0.52	175
	17. Pulung Maragul	1,369	1.03		3,200	2.15	507	4,103	2.20	705	4,724	2.16	850
	18. Salapungan	3,991	3.00		4,377	2.94	690	6,104	3.28	1,074	7,370	3.37	1,380
	19. San Jose	5,214	3.92		5,040	3.38	753	6,398	3.44	1,066	7,324	3.35	1,298
	20. San Nicolas	4,551	3.42		4,452	2.99	718	4,370	2.34	789	4,319	1.98	411
	21. Sapalibutad	1,692	1.27		1,972	1.32	285	2,131	1.14	344	2,227	1.02	383
	22. Sapangbato	6,346	4.78		6,286	4.22	942	7,430	3.99	1,229	8,168	3.74	1,429
	23. Sta. Teresita	8,642	6.50		9,239	6.20	1,487	10,795	5.80	1,865	11,790	5.40	2,120
	24. Sta. Trinidad (TIBAGUIN)	5,363	4.04		4,715	3.16	726	5,552	2.48	928	6,091	2.79	1,066
	25. Sto. Cristo	2,016	1.52		2,654	1.78	422	2,793	1.50	482	2,875	1.32	520
	26. Sto. Domingo	5,514	4.15		9,997	6.71	1,513	12,595	6.76	2,165	14,373	6.58	2,652
	27. Sto. Rosario (Poblacion)	3,837	2.89		4,463	3.00	712	3,930	2.11	705	5,138	2.35	830
	28. Virgen de los Remedios	2,211	1.66		1,828	1.23	408	1,925	1.03	426	1,982	0.91	437
	Sub-Total	132,917	100.00	21,759	148,948	100.00	23,860	186,214	100.00	33,260	218,354	100.00	41,095
RURAL	29. Cuayan				276	12.45	43	315	12.02	46	339	11.77	46
	30. Cutud	589	36.20		698	31.50	99	838	31.99	114	929	32.24	123
	31. Mining	497	30.55		638	28.79	86	779	29.73	118	872	30.27	139
	32. Tabun	541	33.25		604	27.26	90	688	26.26	107	741	25.72	118
	Sub-Total	1,627	100.00	266	2,216	100.00	318	2,620	100.00	385	2,881	100.00	426
	Total	134,544		22,025	151,164		24,178	188,835		33,645	221,235		41,521

TABLE 5.2.5 PROJECTED POPULATION OF BARANGAYS
ANGELES CITY

Area	Barangay	1980		1986		1990		1995		2010	
		Percent	Population	Percent	Population	Percent	Population	Percent	Population	Percent	Population
Urban	1. A. del Rosario	2.52	4,687	2.29	5,070	2.18	5,340	2.03	5,510	1.60	5,750
	2. Amsic	0.60	1,116	0.60	1,330	0.60	1,470	0.60	1,630	0.60	2,160
	3. Anunas	1.84	3,424	2.60	5,760	2.90	7,100	3.28	8,900	4.40	15,810
	4 Balibago	13.06	24,328	15.12	33,470	15.44	37,790	15.82	42,910	17.00	61,090
	5. Capaya	1.33	2,475	1.70	3,760	2.00	4,900	2.38	6,460	3.50	12,580
	6. Claro M. Recto	4.14	7,704	3.46	7,660	3.26	7,980	3.02	8,190	2.30	8,270
	7. Cutent	6.82	12,710	7.33	16,230	7.44	18,210	7.58	20,560	8.00	28,750
	8. Lourdes Northwest	6.10	11,361	5.06	11,200	4.78	11,700	4.44	12,040	3.40	12,220
	9. Lourdes Sur	4.08	7,589	3.54	7,840	3.41	8,350	3.26	8,840	2.80	10,060
	10. Lourdes Sur East	4.02	7,494	3.39	7,500	3.21	7,860	2.98	8,080	2.30	8,270
	11. Malabañas	5.36	9,972	7.36	16,290	7.48	18,310	7.64	20,730	8.10	29,110
	12. Margot	0.89	1,653	0.86	1,900	0.88	2,150	0.91	2,470	1.00	3,590
	13. Pampang	0.93	1,732	1.06	2,350	1.13	2,770	1.22	3,310	1.50	5,390
	14. Pandan	7.14	13,301	6.81	15,080	6.81	16,670	6.81	18,470	6.80	24,440
	15. Pulungbulu	4.01	7,463	3.54	7,840	3.45	8,440	3.34	9,060	3.00	10,780
	16. Pulung Cacutud	0.58	1,070	0.52	1,150	0.51	1,250	0.51	1,380	0.50	1,800
	17. Pulung Maragul	2.20	4,103	2.15	4,760	2.14	5,240	2.13	5,780	2.10	7,550
	18. Salapungan	3.28	6,104	3.44	7,620	3.53	8,640	3.65	9,900	4.00	14,370
	19. San Jose	3.44	6,398	3.34	7,390	3.34	8,180	3.32	9,010	3.30	11,860
	20. San Nicolas	2.35	4,379	1.89	4,190	1.80	4,410	1.67	4,530	1.30	4,670
	21. Sapalibutad	1.14	2,131	1.00	2,220	0.96	2,350	0.93	2,520	0.80	2,870
	22. Sapangbato	3.99	7,430	3.71	8,210	3.68	9,010	3.63	9,850	3.50	12,580
	23. Sta. Teresita	5.80	10,795	5.36	11,870	5.30	12,970	5.23	14,200	5.00	17,970
	24. Sta. Trinidad	2.98	5,552	2.75	6,090	2.64	6,580	2.62	7,110	2.40	8,620
	25. Sto. Cristo	1.50	2,793	1.27	2,810	1.21	2,960	1.13	3,070	0.90	3,230
	26. Sto. Domingo	6.76	12,595	6.58	14,570	6.59	16,130	6.59	17,880	6.60	23,720
	27. Sto. Rosario (Pob)	2.11	3,930	2.38	5,270	2.42	5,920	2.46	6,670	2.60	9,340
	28. Virgen de los Remedios	1.03	1,925	0.89	1,940	0.86	2,100	0.82	2,220	0.70	2,520
	Sub-Total	100.00	186,214	100.00	221,370	100.00	244,780	100.00	271,270	100.00	359,370
Rural	29. Cuayan	12.02	315	11.72	340	11.64	350	11.56	380	11.30	490
	30. Cutud	31.99	838	32.32	940	32.44	960	32.57	1,070	33.00	1,440
	31. Mining	29.73	779	30.33	890	30.41	900	30.51	1,010	30.80	1,350
	32. Tabun	26.26	688	25.63	750	25.51	760	25.36	840	24.90	1,090
	Sub-Total	100.00	2,620	100.00	2,920	100.00	2,970	100.00	3,300	100.00	4,370
	T o t a l		188,834		224,290		247,750		274,570		363,740

TABLE 5.2.6 PROJECTION OF PERSONS PER HOUSEHOLD AND NUMBER OF HOUSEHOLDS BY URBAN AND RURAL AREAS, ANGELES CITY

Area	Item	1980	1983	1986	1990	1995	2000	2010
Urban	Persons per household	5.60	5.31	5.28	5.23	5.17	5.11	5.00
	Number of Households	33,260	41,095	41,930	46,800	52,470	58,780	71,870
Rural	Persons per household	6.80	6.76	6.63	6.46	6.24	6.03	5.60
	Number of Households	385	426	440	460	530	610	780
Total	Persons per household	5.61	5.33	5.29	5.24	5.18	5.12	5.01
	Number of Households	33,645	41,521	42,370	47,260	53,000	59,390	72,650

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

Potential service area for the long term development plan was established covering 19 barangays with a total land area of 1,990 ha (See FIGURE 5.3.1). These barangays will enjoy the water supply in the target year. The following conditions have been analyzed in selecting barangays.

- o Existing water supply system
- o Location, especially existing built-up area and future development plan

Remote areas like Sapang Bato and Pulong Cacutud are excluded since Level II systems are already provided or are proposed by the City. The area served by the existing Balibago Waterworks is excluded from the ACWS as it is comparatively soundly managed. Also, there is no advantage to consolidate it into the ACWS due to limited groundwater resources available in Angeles City. The left bank area of the Abacan River is likewise excluded from the study area.

The study area recommended for the Short Term Development Plan is located within the existing service area. It covers 19 barangays with a land area of 750 ha as shown in FIGURE 5.3.2.

With regard to the subdivisions, most of them located at the outskirts of the City have their own private water supply system managed by the private sector. Some have an immediate water supply plan, though they use jetmatic/pitcher pumps at present.

Inclusion of these subdivisions into the ACWS would be favorable because of their proximity to the City's core. Such would also encourage the effective use and conservation of ground water in the Angeles City area. This idea should be explored further particularly between the ACWS and the subdivisions before the implementation of the City's water supply project, especially on the question of water charges.

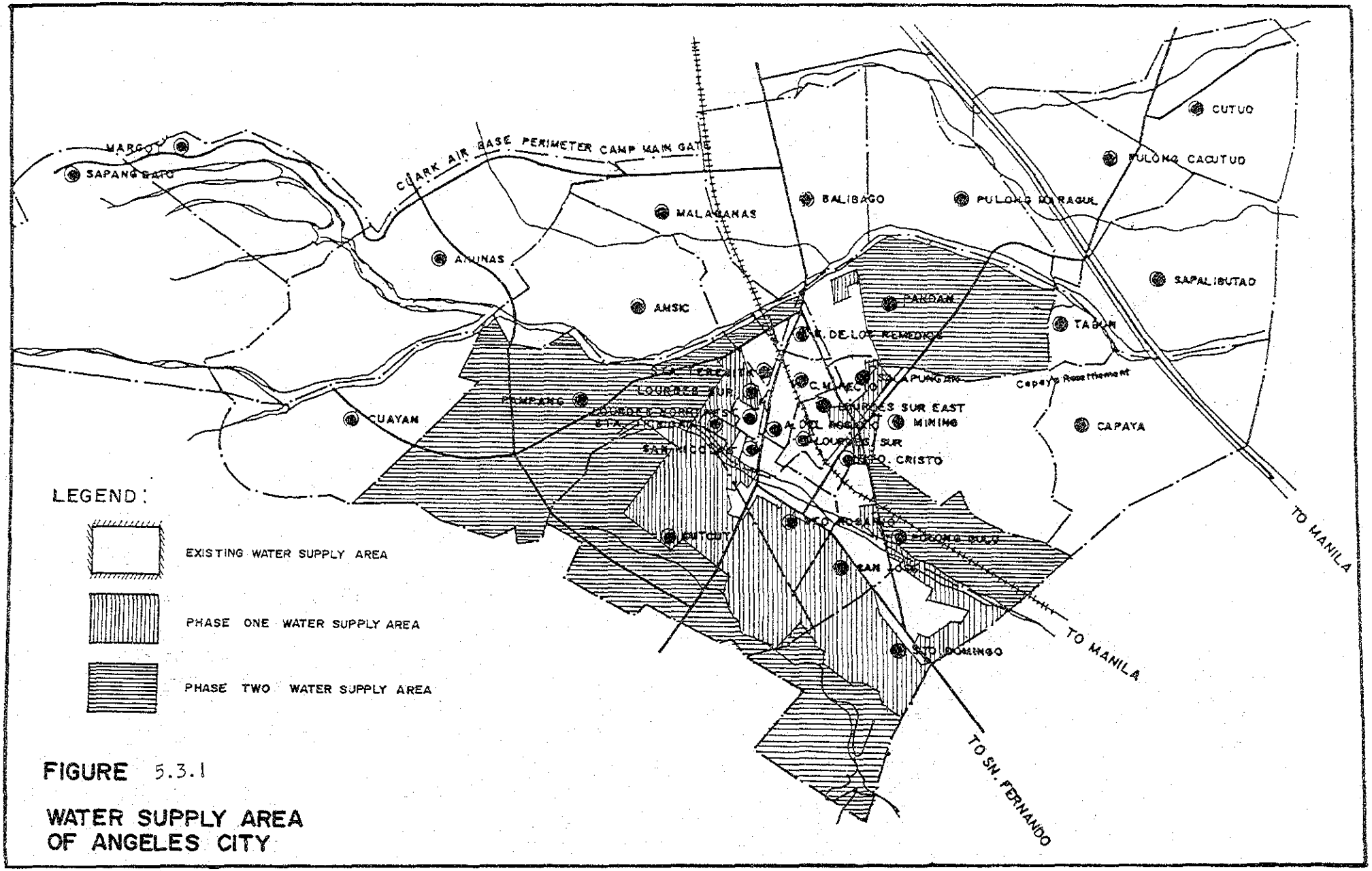


FIGURE 5.3.1

WATER SUPPLY AREA
OF ANGELES CITY

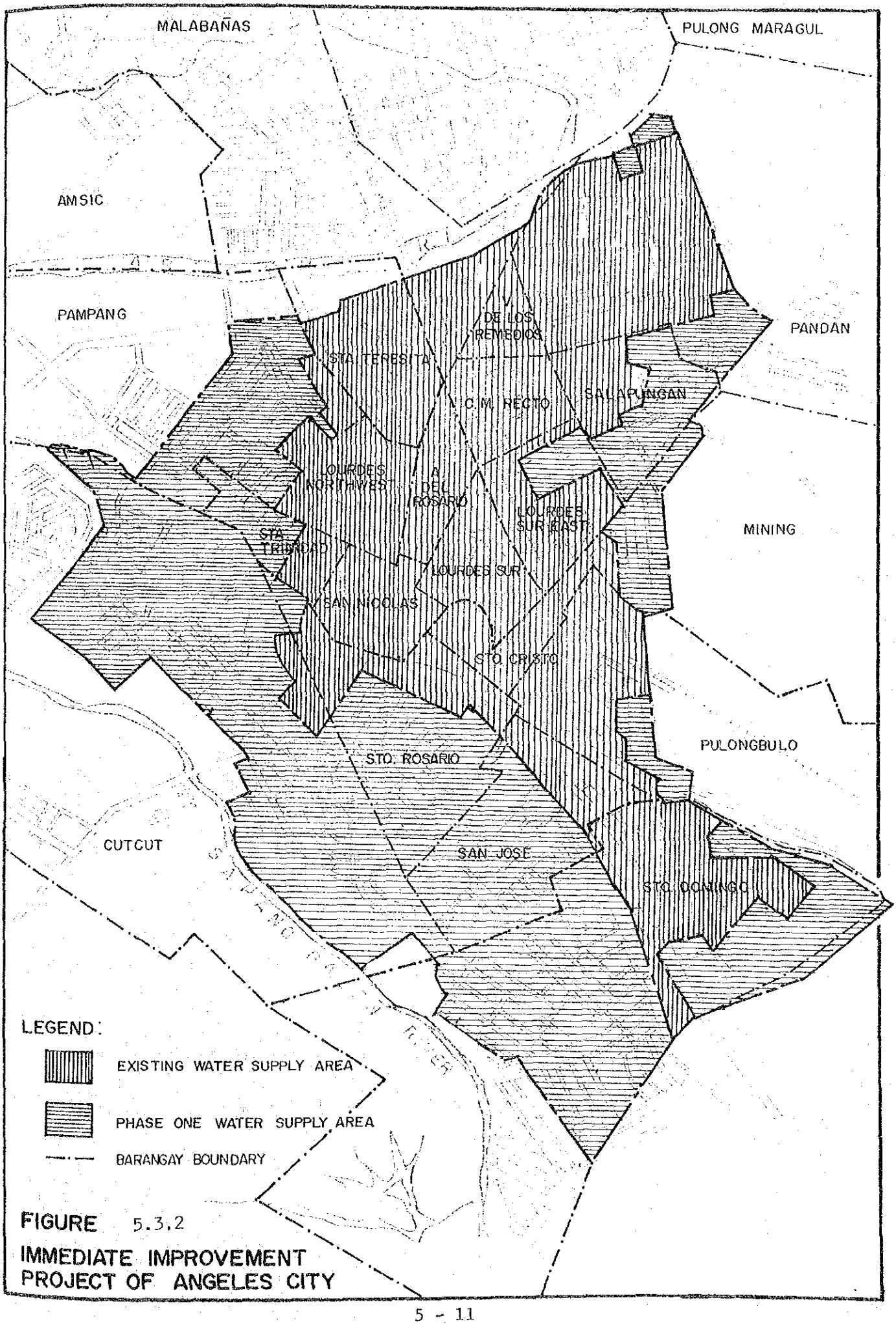


FIGURE 5.3.2

IMMEDIATE IMPROVEMENT PROJECT OF ANGELES CITY

Served population at present was investigated through interviews with the concessionaires. Approximately 1.3 times of primary users was estimated as the actual population served. Served percentage by barangay and city total in 1986, is shown in TABLE 5.3.1. The served percentages for the nineteen barangays range from 1.8 (Cutcut) to 48.4 (Sto. Cristo), while the average of the related barangays is 17.3%.

The served percentage for each barangay for the design years was established in consideration of the result of market survey as follows:

1990: Minimum served percentage was placed at 20 for each respective barangay population. However, if present served population is larger than the estimate for the year 1990, the present was used. The percentage for Barangay Malabañas was calculated considering the maximum area to be served in the right bank of the Abacan River (10% of the barangay total). Twenty percent was decided on the assumption that limited improvement/expansion of service connections may be more practical for the target year based on the present situation, though main pipe line will be replaced/augmented.

1995: Sixty percent (60%) of the respective barangay population was used excluding Brgy. Malabañas, which may be satisfactory and practical level for the Phase I work.

2010: Eighty percent (80%) of the total population in the related barangays is recommended.

TABLE 5.3.1 summarizes served percentage and served population by barangay at present and in the design years.

The service area to be covered for each design year was recommended in accordance with the following concept:

TABLE 5.3.1 POPULATION TO BE SERVED BY BARANGAY FOR THE DESIGN YEARS

Barangay	1986 Barangay Pop.	1986 Served Pop. Primary	1986 Served Pop. Total	1986 Percent Primary	1986 Percent Total	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. A. Del Rosario	5,070	162	210	3.2	4.1	5,340	20	1,070	5,400	60	3,240	5,390	80	4,310
2. Claro M. Recto	7,660	1,434	1,860	18.7	24.3	7,980	23	1,860	8,190	60	4,910	8,270	80	6,620
3. Cutcut	16,230	228	300	1.4	1.8	18,210	20	3,640	20,560	60	12,340	28,750	80	23,000
4. Lourdes North-west	11,200	2,376	3,090	21.2	27.6	11,700	26	3,090	11,340	60	6,800	9,700	80	7,760
5. Lourdes Sur	7,840	1,920	2,500	24.5	31.9	8,350	30	2,500	8,840	60	5,300	10,060	80	8,050
6. Lourdes Sur East	7,500	1,086	1,410	14.5	18.8	7,860	20	1,570	8,080	60	4,850	8,270	80	6,620
7. Malabañas	16,290	576	750	3.5	4.6	18,310	*4.1	750	21,650	*6	1,300	32,340	* 8	2,590
8. Pampang	2,350	198	260	8.4	11.1	2,770	20	550	3,310	60	1,990	5,390	80	4,310
9. Pandan	15,080	3,954	5,140	26.2	34.1	16,670	31	5,140	18,470	60	11,080	24,440	80	19,550
10. Pulung Bulu	7,840	1,704	2,220	21.7	28.3	8,440	26	2,220	9,060	60	5,440	10,780	80	8,620
11. Salapungan	7,620	366	480	4.8	6.3	8,640	20	1,730	9,900	60	5,940	14,370	80	11,500
12. San Jose	7,390	1,038	1,350	14.0	18.3	8,180	20	1,640	9,010	60	5,410	11,860	80	9,490
13. San Nicholas	4,180	918	1,190	22.0	28.5	4,410	27	1,190	4,420	60	2,650	4,310	80	3,450
14. Sta. Teresita	11,870	900	1,170	7.6	9.9	12,970	20	2,590	14,200	60	8,520	17,970	80	14,380
15. Sta. Trinidad	6,090	570	660	8.4	10.8	6,580	20	1,320	7,110	60	4,270	8,620	80	6,900
16. Sto. Cristo	2,810	1,044	1,360	37.2	48.4	2,960	46	1,360	3,070	60	1,840	3,230	80	2,580
17. Sto. Domingo	14,570	2,004	2,610	13.8	17.9	16,130	20	3,230	17,880	60	10,730	23,720	80	18,980
18. Sta. Rosario	5,270	522	680	9.9	12.9	5,920	20	1,180	6,670	60	4,000	9,340	80	7,470
19. Virgen de los Remedios	1,940	294	380	15.2	19.6	2,100	20	420	2,220	60	1,330	2,520	80	2,020
Sub-Total	158,800	21,234	27,600	13.4	17.3	173,520	21.4	37,050	189,380	53.8	101,940	239,330	70.3	168,200
City Total	224,290	21,234	27,600	9.5	12.3	247,750	15.0	37,050	274,570	37.1	101,940	363,740	46.2	168,200

Note: *; 10% of the Barangay Total

a) Phase I, Stage 1 (1990)

The area to be covered is the same as the existing service area, since most of the work would include improvement/replacement of main pipes. In addition, time constraint will only afford a slight increase of served percentage from the present one.

b) Phase I, Stage 2 (1995)

The area covered is highly populated extending from the existing service area. Sixteen subdivisions in the related barangays associated with existing service area (See TABLE 4.1.1) were considered to be given priority.

c) Phase II (2010)

All built-up areas in the recommended barangays will be covered. In addition, the residential areas out of the recommended barangays located near the fringe of the former service area will also be included.

5.4 WATER DEMAND PROJECTION FOR THE PROPOSED SERVICE AREA

5.4.1 General

Future unit water consumption by consumer type was studied using data of May, 1986 and the results of fields measurements. Served population and number of connections by consumer type for the prospective service area were also studied. Water demand projection for the proposed area was finally made based on the total of water consumption and assumed ratio of unaccounted-for water to the total demand.

5.4.2 Design Unit Water Consumption by Consumer Type

(1) Domestic Unit Water Consumption

Average per capita consumption at present in the ACWS was estimated at 148 lpcd, while 115 lpcd in the Balibago Waterworks. The city average figure was estimated based on the assumption that served population include secondary users/borrowers (30% of primary users). The figure was deemed too high, which may be attributed to the low water rates imposed in the area. The average consumption of the Balibago Waterworks may be taken as the basis for future unit water consumption. The annual rate of increase was taken from the LWUA Methodology Manual. TABLE 5.4.1 shows the projected per capita consumption from 1990 to 2010.

TABLE 5.4.1 ANNUAL RATE OF INCREASE AND PER CAPITA CONSUMPTION

Year	Rate of Increase (%)	Unit of Consumption (lpcd)
1986	-	115
1990	2.0	124
1995	1.5	134
2000	1.5	144
2010	1.0	159

(2) Commercial Unit Water Consumption

The daily average water consumption of commercial connections in the City was calculated at 1.0 cu.m/connection from the metered consumption and number of connections. This will be taken as the basis for the future commercial unit consumption. The unit consumption was assumed to increase in the future and the annual rate of increase was taken from the LWUA Methodology Manual. TABLE 5.4.2 shows the projection of commercial unit consumption.

TABLE 5.4.2 DAILY AVERAGE COMMERCIAL UNIT WATER CONSUMPTION

Year	Coefficient of Density Increase	Unit Consumption (cu.m/conn.day)
1986	1.0	1.0
1990	1.1	1.1
1995	1.3	1.3
2000	1.4	1.4
2010	1.7	1.7

The number of commercial connection was calculated using the connection density increase ratio from the LWUA Methodology Manual. Present density ratio was calculated at 2.1 (no. of commercial connections = 586/served population = 27,600). The projected number of commercial connections per 100 served populations from 1986 to 2010 is 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	2.1
1990	1.2	2.5
1995	1.3	2.7
2000	1.4	2.9
2010	1.8	3.8

Note: Figures in the LWUA Methodology Manual were modified according to change of base year.

(3) Institutional Unit Water Consumption

There are only three institutional connections in the City Waterworks while there is none in the Balibago Waterworks. The only institutional metered connection (a hospital) in the City Waterworks had a metered consumption of 13.8 cu.m/day. Since there is only one metered consumption, it cannot be assumed as the representative institutional

consumption in the area. Therefore, the figures in the LWUA Methodology Manual will be used. TABLE 5.4.4 shows the projected institutional consumption.

TABLE 5.4.4 FUTURE COMMERCIAL UNIT WATER CONSUMPTION AND CONNECTION RATIO

Year	Unit Water Consumption (cu.m/conn.day)	Connection Ratio (conn./population)
1986	3.8	1/2,000
1990	4.5	1/2,000
1995	5.3	1/2,000
2000	6.0	1/2,000
2010	7.5	1/2,000

Note: The future unit consumption and projected connections was based on the LWUA Methodology Manual.

5.4.3 Water Demand Projection

Daily average water consumption by consumer type was estimated based on the study results on the unit water consumption and projected number of connections/served population in the proposed service area. The City total water consumption by consumer type for the design years was summarized below.

TABLE 5.4.5 WATER CONSUMPTION BY DESIGN YEAR (DAILY AVERAGE)

	No. of Connections				Water Consumption (cu.m/day)			
Year	Domestic	Commerc.	Inst.	Total	Domestic	Commerc.	Inst.	Total
1990	7,128	937	21	8,086	4,632	1,031	101	5,764
1995	19,678	2,753	51	22,482	13,661	3,580	272	17,513
2010	33,571	6,393	83	40,047	26,745	10,870	627	38,242

The water consumption was projected from 4,700 cu.m/day in 1986 to 38,200 cu.m/day in 2010.

The percentage of current wastage which was analyzed in the previous section, amounted to approximately 55%. However, provision of

meters to the unmetered connections which have considerable number of additional faucets could reduce the above percentage. The future figures were assumed to be 40%, 30% and 20% in 1990, 1995 and 2010, respectively.

The same barangays were recommended both for short and long term development plans. TABLE 5.4.6 A, B and C present the result of demand projection.

Water demand (water supply amount) in 1986 is approximately 11,000 cu.m/day, which is almost the same as that in 1990. However, approximately 5 times the present demand will be required in the year 2010. Daily average water demand by design year is summarized as follows.

TABLE 5.4.7 DAILY AVERAGE WATER DEMAND BY DESIGN YEAR

Unit: cu.m/day

Year / Consumer Type	1990	1995	2010
Domestic	4,600	13,600	26,700
Commercial	1,000	3,600	10,900
Institutional	100	300	600
Sub Total	5,700	17,500	38,200
Unaccounted-for Water	3,800	7,500	9,600
Total	9,600	25,000	47,800

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 was determined in proportion to the service population as follows:

TABLE 5.4.6.A WATER DEMAND PROJECTION (1990)

Barangay	Barangay Population	Served Population	Number of Connections : Domestic	Commercial	Institutional	Total	Consumption (cu.m/day) : Domestic	Commercial	Institutional	Total	Unaccounted-for water (cu.m/day)	Total Demand (cu.m/day)
1. A. Del Rosario	5,340	1,070	204	27	1	232	133	30	5	168	112	280
2. Claro M. Recto	7,980	1,860	355	47	1	403	231	52	5	288	192	480
3. Cutcut	18,210	3,640	695	91	2	787	451	100	9	560	373	933
4. Lourdes Northwest	11,700	3,090	590	77	2	669	383	85	9	477	318	795
5. Lourdes Sur	8,350	2,500	534	70	1	605	347	77	5	429	286	715
6. Lourdes Sur East	7,860	1,570	300	39	1	340	195	43	5	243	162	405
7. Malabañas	18,310	750	143	19	0	162	93	21	0	114	76	190
8. Pampang	2,770	550	105	14	0	119	68	15	0	83	55	138
9. Pandan	16,670	5,140	981	129	3	1,113	637	142	14	793	529	1,322
10. Pulung Bulu	8,440	2,220	424	56	1	481	275	62	5	342	228	570
11. Salapungan	8,640	1,730	330	43	1	374	215	47	5	267	178	445
12. San Jose	8,180	1,640	313	41	1	355	203	45	5	253	169	422
13. San Nicholas	4,410	1,190	227	30	1	258	148	33	5	186	124	310
14. Sta. Teresita	12,970	2,590	494	65	1	560	321	72	5	398	265	663
15. Sta. Trinidad	6,580	1,320	252	33	1	286	164	36	5	205	137	342
16. Sto. Cristo	2,960	1,360	260	34	1	295	169	37	5	211	141	352
17. Sto. Domingo	16,130	3,230	616	81	2	699	401	89	9	499	333	832
18. Sta. Rosario	5,920	1,180	225	30	1	256	146	33	5	184	123	307
19. Virgen de los Remedios	2,100	420	80	11	0	91	52	12	0	64	43	107
Total	173,520	37,050	7,128	937	21	8,085	4,632	1,031	101	5,764	3,844	9,608

TABLE 5.4.6.B WATER DEMAND PROJECTION (1995)

Barangay	Barangay Population	Served Population	Number of Connections : Domestic	Commercial	Institutional	Total	Consumption (cu.m/day) : Domestic	Commercial	Institutional	Total	Unaccounted-for water (cu.m/day)	Total Demand (cu.m/day)
1. A. Del Rosario	5,400	3,240	625	87	2	714	434	113	11	558	239	797
2. Claro M. Recto	8,190	4,910	948	133	2	1,083	658	173	11	842	361	1,203
3. Cutcut	20,560	12,340	2,382	333	6	2,721	1,654	433	32	2,119	908	3,027
4. Lourdes Northwest	11,340	6,800	1,313	184	3	1,500	911	239	16	1,166	500	1,666
5. Lourdes Sur	8,840	5,300	1,023	143	3	1,169	710	186	16	912	391	1,303
6. Lourdes Sur East	8,080	4,850	936	131	2	1,069	650	170	11	831	356	1,187
7. Malabañas	21,650	1,300	251	35	1	287	174	46	5	225	96	321
8. Pampang	3,310	1,990	384	54	1	439	267	70	5	342	147	489
9. Pandan	18,470	11,080	2,139	299	6	2,444	1,485	389	32	1,906	817	2,723
10. Pulung Bulu	9,060	5,440	1,050	147	3	1,200	729	191	16	936	401	1,337
11. Salapungan	9,900	5,940	1,147	160	3	1,310	796	208	16	1,020	437	1,457
12. San Jose	9,010	5,410	1,044	146	3	1,193	725	190	16	931	399	1,330
13. San Nicholas	4,420	2,650	512	72	1	585	355	94	5	454	195	649
14. Sta. Teresita	14,200	8,520	1,645	230	4	1,879	1,142	299	21	1,462	627	2,089
15. Sta. Trinidad	7,110	4,270	824	115	2	941	572	150	11	733	314	1,047
16. Sto. Cristo	3,070	1,840	355	50	1	406	247	65	5	317	136	453
17. Sto. Domingo	17,880	10,730	2,071	290	5	2,366	1,438	377	27	1,842	789	2,631
18. Sta. Rosario	6,670	4,000	772	108	2	882	536	140	11	687	294	981
19. Virgen de los Remedios	2,220	1,330	257	36	1	294	178	47	5	230	99	329
Total	189,380	101,940	19,678	2,753	51	22,482	13,661	3,580	272	17,513	7,506	25,019

TABLE 5.4.6.C WATER DEMAND PROJECTION (2010)

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	Total	Domestic	Commer- cial	Institu- tional	Total		
1. A. Del Rosario	5,390	4,310	860	164	2	1,026	685	279	15	979	255	1,234
2. Claro M. Recto	8,270	6,620	1,321	252	3	1,576	1,053	428	23	1,504	376	1,880
3. Cutcut	28,750	23,000	4,591	874	12	5,477	3,657	1,486	90	5,233	1,308	6,541
4. Lourdes Northwest	9,700	7,760	1,549	295	4	1,848	1,234	502	30	1,766	442	2,208
5. Lourdes Sur	10,060	8,050	1,607	306	4	1,917	1,280	520	30	1,830	458	2,288
6. Lourdes Sur East	8,270	6,620	1,321	252	3	1,576	1,053	428	23	1,504	376	1,880
7. Malabañas	32,340	2,590	517	98	1	616	412	167	8	587	147	734
8. Pampang	5,390	4,310	860	164	2	1,026	685	279	15	979	245	1,224
9. Pandan	24,440	19,550	3,902	743	10	4,655	3,108	1,263	75	4,446	1,112	5,558
10. Pulung Bulu	10,780	8,620	1,721	328	4	2,053	1,371	558	30	1,959	490	2,449
11. Salapungan	14,370	11,500	2,295	437	6	2,738	1,829	743	45	2,617	654	3,271
12. San Jose	11,860	9,490	1,894	361	5	2,260	1,509	614	38	2,161	540	2,701
13. San Nicholas	4,310	3,450	689	131	2	822	549	223	15	787	197	984
14. Sta. Teresita	17,970	14,380	2,870	546	7	3,423	2,286	928	53	3,267	817	4,084
15. Sta. Trinidad	8,620	6,900	1,377	262	3	1,642	1,097	445	23	1,565	391	1,956
16. Sto. Cristo	3,230	2,580	515	98	1	614	410	167	8	585	146	731
17. Sto. Domingo	23,720	18,980	3,788	721	9	4,518	3,018	1,226	68	4,312	1,078	5,390
18. Sta. Rosario	9,340	7,470	1,491	284	4	1,779	1,188	483	30	1,701	425	2,126
19. Virgen de los Remedios	2,520	2,020	403	77	1	481	321	131	8	460	115	575
Total	239,330	168,200	33,571	6,393	83	40,047	26,745	10,870	627	38,242	9,572	47,814

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) Phase II (2010)
Over 200,000	1.20 : 1	

b) Peak hour demand (Hourly maximum demand)

Peak hour demand was estimated in proportion 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 (Served Population/1,000)

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

Demand variations by design year were calculated using the above mentioned ratio as follows:

Unit:cu.m/day

Demand	1990	1995	2010
Daily average	9,600	25,000	47,800
Daily maximum	12,000	31,300	59,800
Peak hour	20,400	50,100	89,700

5.4.5 Number of Connections

Service connections were classified into domestic, commercial and institutional. The total number of connections for each category was projected in accordance with the LWUA Methodology Manual. It is expected that the waterworks will have total connections of 8,086 in 1990; 22,482 in 1995; and 40,047 in 2010. The number of connections by consumer type, and by barangay for the design years, were referred to in TABLE 5.4.6 A to 5.4.6 C.

CHAPTER 6
WATER RESOURCES

CHAPTER 6 WATER RESOURCES

6.1 GENERAL

The study of water resources for the City was made with a great emphasis on groundwater which may be the immediate and future solution to meet the increasing water demand. Obtained data were used for evaluation of the groundwater to be utilized as water supply source.

An analysis of surface water resource using long term discharge records of the Gumain River was also made to seek for alternative resources for long term development.

6.2 PHYSIOGRAPHY

The geomorphological coverage of the study area includes the hilly to mountainous flanks on the west and the wide plain crossed by numerous creeks and other minor surface water bodies which generally compose the drainage network of the municipality.

The mountainous area which characterizes an elevation reaching about 200 m above mean sea level was found only in a limited area in the west (major portion of this feature is part of Porac, another municipality). The plain which has an average slope of about 7.7% has a well defined barangay i.e., almost covering the entire region and is generally composed of alluvial deposit.

The City is highly urbanized but a percentage is covered with a non productive commercial forest and almost half is cultivated for growing crops.

6.3 METEOROLOGY[1/]

6.3.1 Rainfall

A climate of the first type, dry from November to April and wet during the rest of the year, prevails in the area. A summary of rainfall data of Angeles City is given in FIGURE 6.3.1.

The annual mean rainfall was recorded to be 2014 mm with maximum and minimum values observed in August (460 mm) and January and February (13 mm), respectively.

6.3.2 Temperature

The annual mean temperature in the area is 27.7°C. The coldest was registered in the month of January to February (26°C) and the hottest in April to May (29°C) as shown in FIGURE 6.3.2.

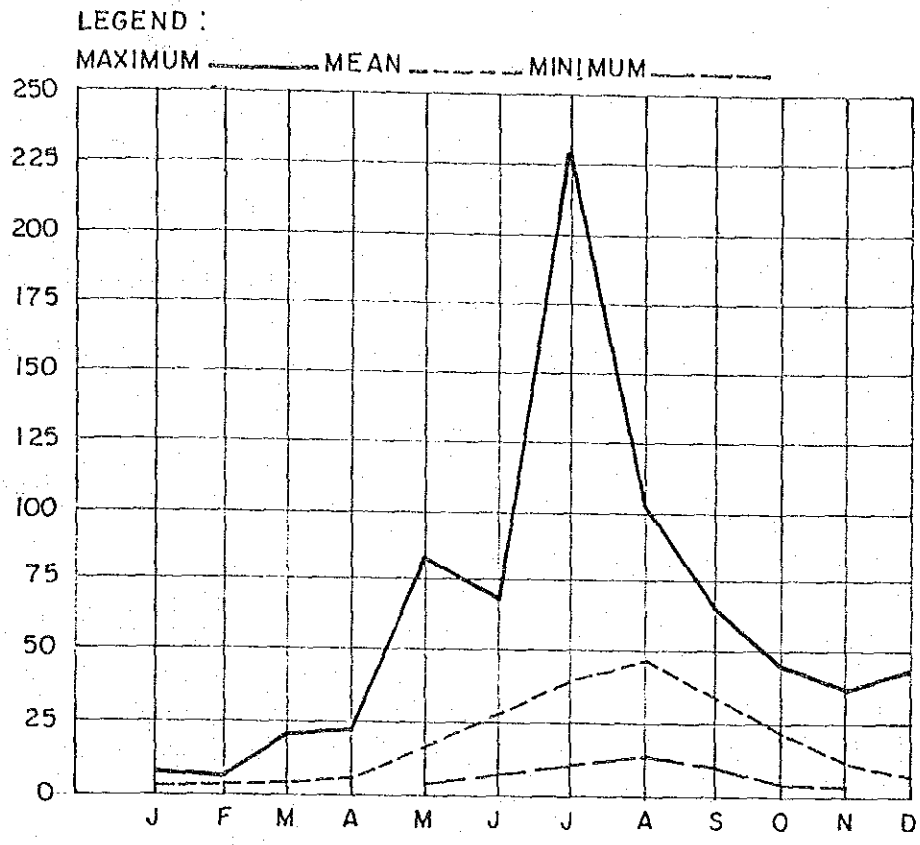
6.4 GEOLOGY

The alluvial fan formation is the erosional products of the volcano in the western mountain ranges and comprises the dominant geologic unit in the area, which consists of sand to gravelly beds associated with clay and volcano materials. The alluvial fan formation was replaced by the deltaic formation with inter-fingering relation on the east. The alluvial formation was estimated to be more than 200 m thick.

The plio-pleistocene formation underlies the alluvial fan in the area but it was difficult to clarify the Boundary of the both formations.

The western part of the study area lies on the hills and mountainous region, which was identified to be of pre-pliocene age (basement rock).

1/ Source: Socio-Economic and Physical Profile of Angeles City, 1980



MONTH	RAINFALL (c.m)		
	MAXIMUM	MINIMUM	MEAN
JANUARY	7.4		1.3
FEBRUARY	6.9		1.3
MARCH	8.3		2.5
APRIL	19.6		4.3
MAY	82.6	2.5	18.0
JUNE	67.3	6.1	26.4
JULY	227.6	9.4	37.1
AUGUST	100.3	12.2	46.0
SEPTEMBER	65.3	9.7	32.0
OCTOBER	47.2	1.8	17.5
NOVEMBER	36.3	0.3	9.9
DECEMBER	42.9		5.1

SOURCE : SOCIO-ECONOMIC AND PHYSICAL PROFILE OF ANGELES CITY, 1983

FIGURE 6.3.1
RAINFALL DATA
ANGELES CITY, PAMPANGA

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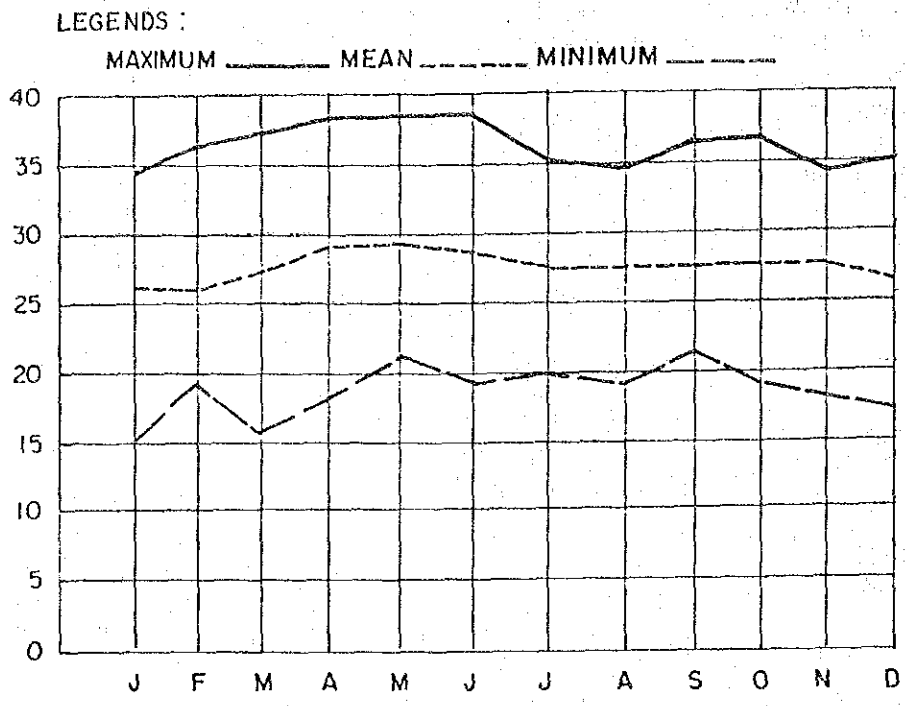


MONTH	TEMPERATURE °C		
	EXTREME MAXIMUM	EXTREME MINIMUM	MEAN
JANUARY	34	15	26
FEBRUARY	36	19	26
MARCH	37	16	27
APRIL	38	18	29
MAY	38	21	29
JUNE	38	19	28
JULY	35	20	27
AUGUST	34	19	27
SEPTEMBER	36	21	27
OCTOBER	36	19	27
NOVEMBER	34	18	27
DECEMBER	35	17	28

SOURCE : SOCIO-ECONOMIC AND PHYSICAL PROFILE OF ANGELES CITY, 1983

LWUA - JICA
STUDY ON MUNICIPAL WATER SUPPLY PROJECT

FIGURE 6.3.2
TEMPERATURE DATA
ANGELES CITY, PAMPANGA

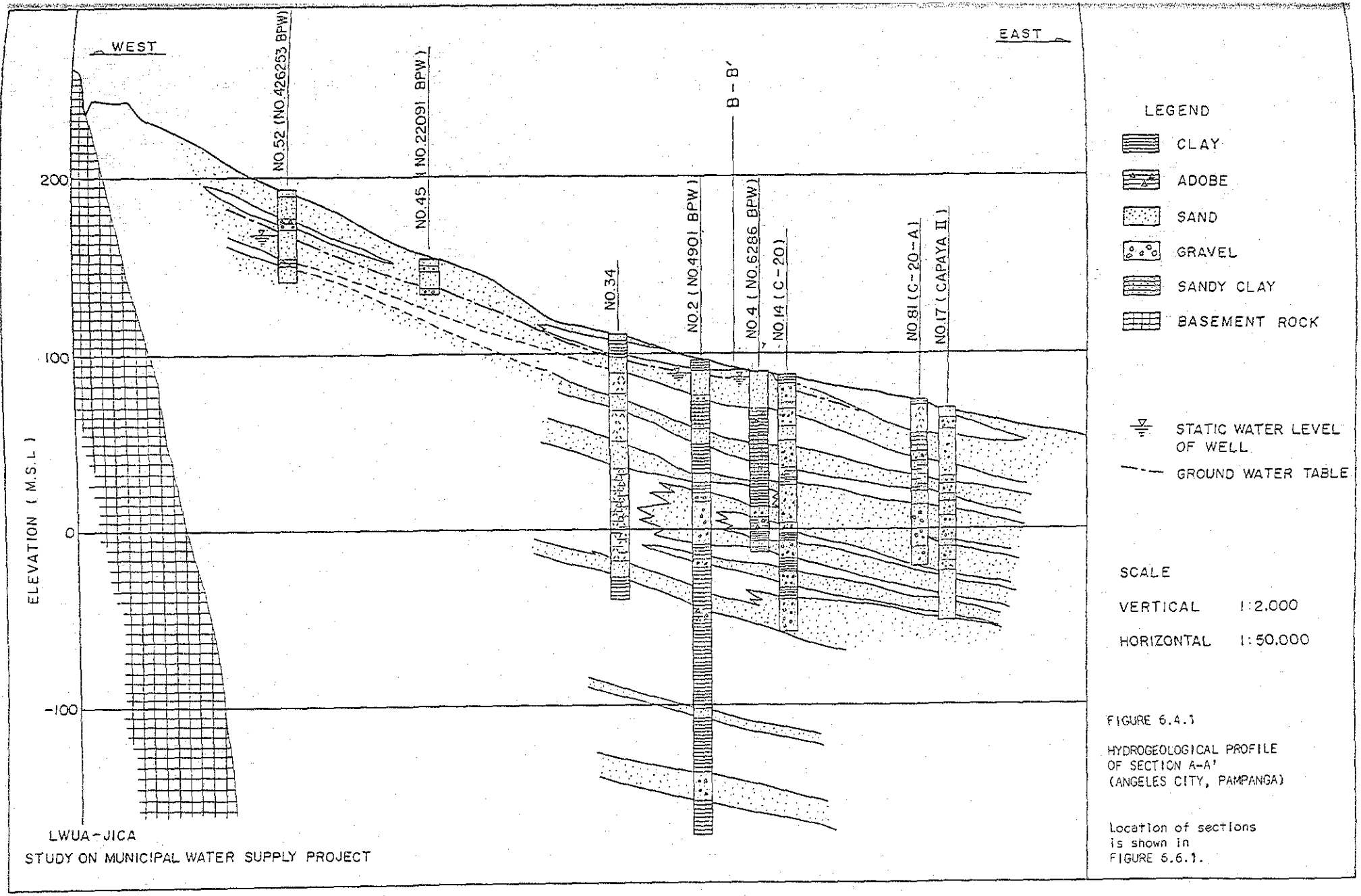


FIGURE 6.4.1

HYDROGEOLOGICAL PROFILE OF SECTION A-A' (ANGELES CITY, PAMPANGA)

Location of sections is shown in FIGURE 6.6.1.

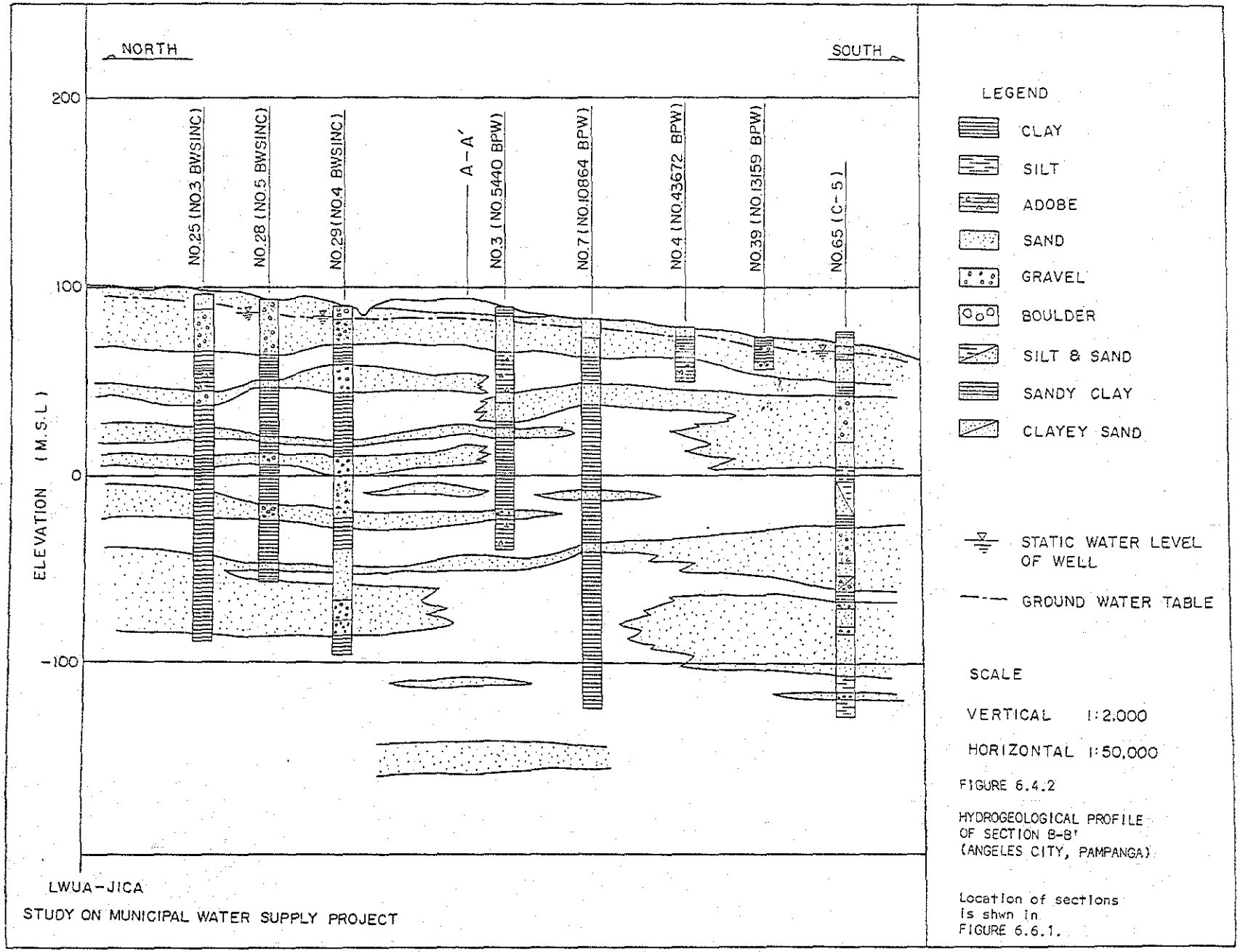


FIGURE 6.4.2

HYDROGEOLOGICAL PROFILE OF SECTION B-B' (ANGELES CITY, PAMPANGA)

Location of sections is shwn in FIGURE 6.6.1.

Geological profiles across the study area are shown in FIGURES 6.4.1 and 6.4.2, which were prepared on the basis of the geological logs of existing wells taking stratigraphical knowledges into consideration. In Section A-A' (Refer to FIGURE 6.6.1), the extent of alluvial deposit is shown to reach a basement rock formation in the west. In the plain, continuity of the upper layer was defined. In Section B-B', i.e., N-S lineament in calculation of some Balibago Waterworks System, Inc. wells (section) was not established due to different descriptions of the penetrated layers, hence, suppositional faults were believed to exist in their region.

As easily visualized from geologic profiles, most of the beds gently dip east in proportion to the gradient of ground surface. Each bed trends from west to east continuously, while beds are complex with a horizontal change in lithology.

6.5 SURFACE WATER

There are two principal streams; Abacan and Porac River, in the study area and surrounding area flowing from north to south.

The Abacan River has no flow rate record, but during field inspection conducted in June 1986 (start of wet season), a very small flow rate (estimated amount of 5 to 20 l/sec) was observed in the downstream of the Abacan River. Some of the surface water in the area convert to underflows because the river bed comprises permeable materials in the downstream of the river.

The discharge records of the Porac River for the past sixteen years (1946-1961) were analyzed to assess the probable discharge of the study area since the characteristics of the Porac River basin is similar to the study area. Analyzed probable minimum baseflow discharge for 10 year return period is 17.9 cu.m/sec or 1.31 mm/day. But the other study done by the JICA for the Gumain River Irrigation Development Project in February 1985 gave little reliability on these records due to the fact that no modification had been made to the conversion curve from water level to flow rate of the river notwithstanding the change in the river section by frequent flood and predicted the monthly average runoff as shown below using the following equation.

$$Q_P = 0.7 \times Q_G \times (A_P/A_G)$$

Where, Q_P : Runoff in the Porac River
Q_G : Runoff in the Gumain River
A_P : Basin area of the Porac River (111 sq.km)
A_G : Basin area of the Gumain River (114 sq.km)

Month	Average Runoff (cu.m/sec)
January	1.23
February	1.12
March	1.08
May	3.20
June	6.20
July	10.96
August	15.30
September	12.09
October	6.54
November	3.34
December	1.71
Average	5.35

Accordingly, available water amount of the Porac River can be expected to be approximately 1 cu.m/sec in the month with a minimum flowrate.

6.6 GROUNDWATER

6.6.1 Water Point Inventory

Many wells have penetrated the fan formation in the study area as listed in APPENDIX 6.6.1. There is no geological information on a significant number of shallow wells with depths ranging from 5 to 30 m.

There are some well log data with geological and groundwater information as shown in APPENDIX 6.6.2. Most of these well were constructed by the BPW, while the others were by the City Engineer's Office or some other private firms like the Balibago Water Works Inc. The lithological interpretation of the data may be considered reliable. However, there are not enough data on the aquifer test. The general idea of hydrogeological profiles is presented in FIGUREs 6.4.1 and 6.4.2, although geological information is not enough.

6.6.2 Groundwater Flow Conditions

A groundwater level counter map is shown in FIGURE 6.6.1. It was drawn using the result of water level measurement conducted during the study. The general direction of groundwater flow is from west to east and the average hydraulic gradient is 14/1,000.

Groundwater level shows a seasonal fluctuation depending on the balance between the quantity of water recharged and discharged from the basin concerned. Groundwater table trends were examined using data at present and in the year when the wells were constructed. The results are summarized in TABLE 6.6.1. Most of wells except for Porac (No. 42) showed a decline of water table, although the rate of decline is negligible ranging from 0.03 to 0.11 m/year. This result suggests that average annual draft is nearly equal to annual recharge on the basin. However, it is questionable whether obtained data on the water level in different years represent or not the long term trends under the similar meteorological conditions or accidental water levels. Further assessment for the groundwater trend may be required using long term well-hydrographs.

TABLE 6.6.1 RATE OF GROUNDWATER DECLINE IN THE AREA

JICA-LWUA Well NO.	Location	Depth (m)	Water Level (mbgs)		Decline (m/year)
			Initial	1986	
16	Mining	26.5	1.22 ('58)	3.54	0.08
20	Sapalibutad	48.8	1.22 ('58)	3.34	0.08
22	Pulung Cacutud	13.7	3.66 ('60)	4.51	0.03
31	Pampang	25.0	4.88 ('58)	6.07	0.04
34	Cutcut	152.0	3.66 ('84)	3.87	0.11
42	Macantian, Porac	14.9	10.47 ('56)	10.17	0.01

6.6.3 Aquifers

Pre-Pliocene formations and volcanic rocks which form the western mountain ranges are hydrogeologically functioned to impermeable layers.

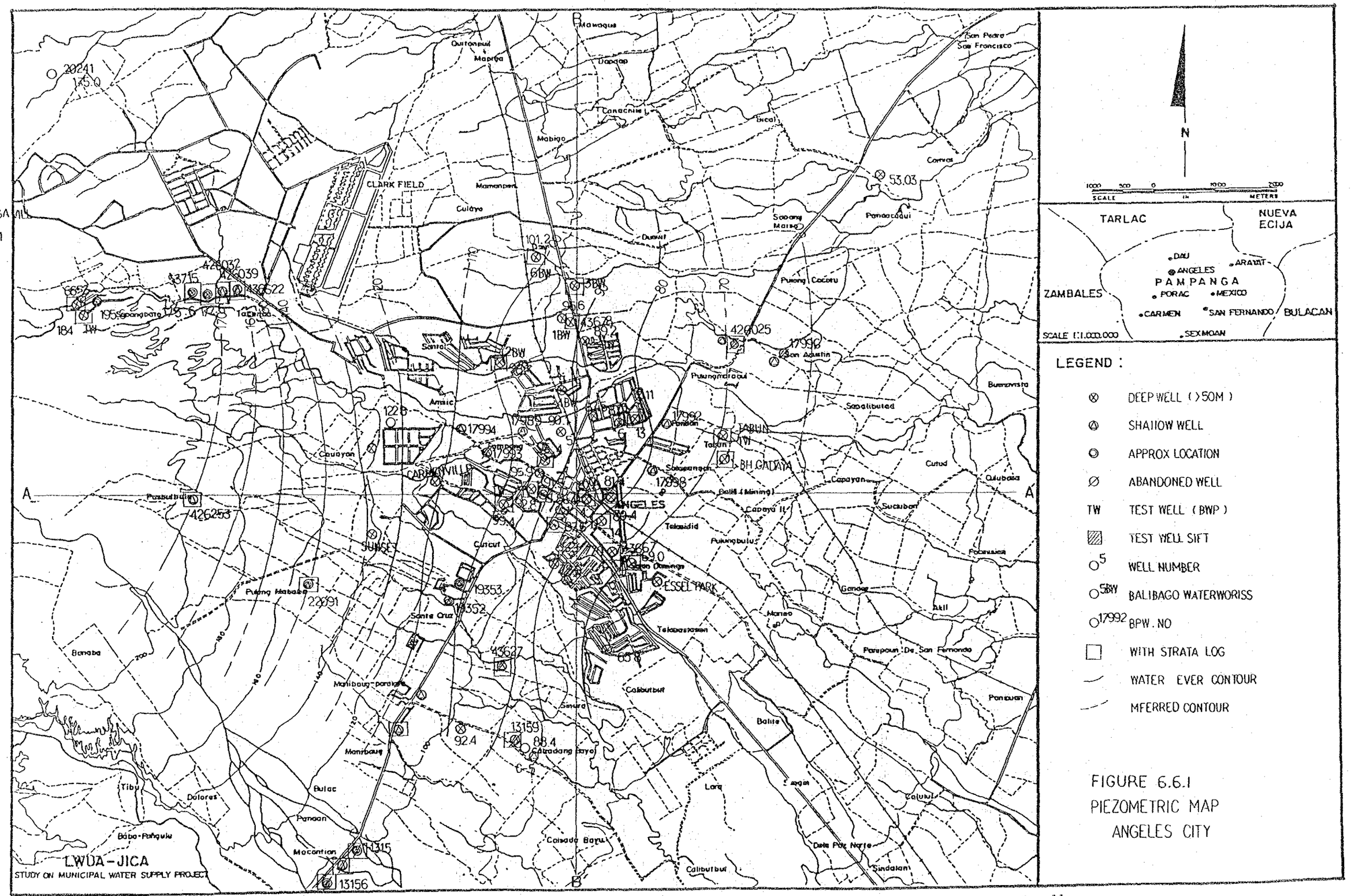
Within the study area, the alluvial fan formation contains aquifer system. The total thickness of the aquifer system is not clear but may infer more than 200 m.

The aquifer system mainly consists of clastic formation including fine impermeable clay, coarse permeable sand, gravel, and "adobe" (local name of a sort of tuff). Semi-permeable beds, usually a clayey sand and gravel compose considerable part of the system. It is difficult to clarify the strata whether they are impermeable or semi-permeable from the well log data.

Shallow Aquifer

Shallow aquifer under unconfined condition, which consists of sand and gravel, has an extensive distribution ranging from 10 to 40 m in thickness. In the study area, utilization of the shallow aquifer is limited to Level I water supply. The depth of shallow wells is about 6 m and the well equipped with pitcher pump is being used for domestic purpose.

The BPW constructed shallow wells from 1956 to 1967 for potable water supply in Angeles City and nearby municipalities (Porac, San Fernando). The depth of these wells ranges from 11 to 48 m with 100 to 112 mm diameter casing. No perforation was provided to the casings owing to open bottom holes. The characteristics of the aquifer of the selected shallow wells are summarized in TABLE 6.6.2.



BAWGA WELL
20771

FIGURE 6.6.1
PIEZOMETRIC MAP
ANGELES CITY

TABLE 6.6.2 SUMMARY OF SELECTED SHALLOW WELLS

Well No. JICA	Original (m)	Depth Well (m)	Tested Yield (l/min)	Draw-down (m)	Specific Capacity (l/min/m)	Trans-missivity (sq.m/day)	Location Barangay/ Municipality
19	17992	34	76	0.6	127	150	Pandan Angeles
32	17993	25	133	0.9	148	180	Pampang Angeles
42	13155	15	140	0.6	229	350	Macantian Porac
44	13158	12	49	0.3	164	220	Manibaug Porac
62	20771	26	38	0.3	126	150	Baluga Vill. Angeles
63	17989	25	66	0.6	105	110	Malabañas Angeles
71	13162	21	38	0.3	126	150	Sepungbulaon Porac

The data in the table reveal that specific capacity of the properly designed shallow wells ranges from 105 to 229 l/min/m with an average of 145 l/min/m. Inferred transmissivity ranges from 110 to 350 sq.m/day with an average of 180 sq.m/day.

Accordingly, shallow aquifer may be expected for the production wells, if perennial groundwater table could be kept within 10 m below ground surface.

Deep Aquifer

As described before, thickness of the alluvial fan formation in the study area was estimated to be not less than 200 m. The maximum depth among existing wells in the area was reported to be 243 m, while the average depth about 120 m. Based on the collected geological logs, the thickness of the permeable beds was concluded to be 70 to 100 m. However, the thickness of aquifer varies locally, as shown in the geological profiles. The aquifer in Porac (No. 65) is much thicker than that in Angeles City. The characteristics of the aquifer for the selected wells are summarized in TABLE 6.6.3.

Aquifers seem to exist under semi-confined or confined conditions. The specific capacity ranges from 60 to 212 l/min/m with an

average of 136 l/min/m which is slightly less than the figure of shallow aquifer.

Transmissivity of the deep aquifer calculated using above formula ranges from 50 to 370 sq.m/day with an average of 200 sq.m/day. The figure is slightly higher than the figure of shallow aquifer.

TABLE 6.6.3 SUMMARY OF SELECTED DEEP WELLS

Well No. JICA	Original	Depth well (m)	Tested Yield (l/min)	Draw-down (m)	Specific Capacity (l/min/m)	* Trans-missivity (sq.m/day)	Location (Barangay/ Municipality)
	CL-36	237	2,543	25.4	100	(180)	Porac
6	PS-6	120	985	6.4	154	200	Pandan Angeles
7	PS-7	214	821	13.7	60	50	San Joaquin Angeles
14	PS-14	148	602	3.7	163	(370)	Elem. School Angeles
24	BWS-6	183	1,970	14.6	135	160	Lakandula Angeles
66	BWS-7	92	1,806	8.5	212	310	Dau Angeles
67	BWS-8	92	2,496	15.9	157	200	Henson Vill. Angeles
68	EPZA	92	869	8.3	104	(150)	Export Proc. Angeles
					136(Average)		

* Transmissivity in ( ) are obtained from the existing well inventory shown in APPENDIX. 6.6.1.

It is difficult to define particular beds or portions as the potential aquifers due to lack of detail screen schedules in the collected well log data.

The aquifers located in depths of 50 to 100 m may be useful for groundwater production. The variation of specific capacity is not so conspicuous from the data on the selected wells, but it can be delineated using all collected data. Aquifer potential associated with specific capacity in the western portion of the highway up to Mabalacat may be slightly higher than that in the eastern part of the highway.

In general, the variation of the aquifer potential with reference to the location (horizontally and vertically) may be comparatively small.

However, the actual yield of the well may be different from each other depending on the well design and the manner of construction.

6.6.4 Groundwater Recharge

Groundwater recharge to the study area is provided vertically and horizontally. Vertical recharge by rainfall was analyzed by means of the relationship between rainfall and well-hydrographs. The result of analysis on the recharge by the NIA for Tarlac area adjacent to the Province of Pampanga may be applicable for the study area. Fifteen (15)% of rainfall or 323 mm/year was calculated for the Tarlac area. Recharge rate in the study area was calculated at 302 mm in the year 1983 using the study result. Rate of horizontal recharge was also analyzed using data on baseflow runoff. As mentioned before, rate of baseflow runoff in the month with a minimum flow at the Porac River (drainage area of 1180 sq.km) is 1.0 cu.m/sec (0.1 mm/day). Accordingly, it may be inferred that recharge contributed by the Abacan River is 0.54 mm/day based on the following assumptions.

Drainage area of the Abacan River	:	37.5 sq.km
Area of influence by the draft	:	90.0 sq.km
Baseflow runoff to the area	:	0.1 mm/day x 37.5 sq.km
		= 3.750 cu.m/day
Recharge to be contributed to the area:		3.750 cu.m/day ÷ 90 sq.km
		= 0.04 mm/day

Statistic data on rainfall in 1983 was taken into account and the rate of total recharge to the study area was roughly calculated as follows:

Recharge by rainfall	:	302 mm/year = 0.83 mm/day
Recharge by baseflow	:	0.04 mm/day

Total recharge to the area = 0.83 + 0.04 = 0.87 mm/day