6.6.5 Test Well

A test well construction was conducted in the area where there is no log data available to explore the geological formation and the hydrogeological conditions in the premise of planned city hall in the Pampang area (see FIGURE 6.6.2). The ground elevation of the area is about 30 m higher than that of the service area. The difference of the ground elevation may be advantageous in consumption of electricity by the booster pumps. The following works were conducted to achieve the purpose:

- Drilling of 150 mm 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),
- Sanitary seal with concrete at the well head.

Sample cuttings were collected during the pilot hole construction. The data on the lithology and resistivity are presented in FIGURE 6.6.3.

Findings on the lithology and georesistivity at the test well site is summarized as follows:

- The lithologic composition at the depth between 90 and 103 m and below 185 m is mainly fine to coarse sand with a little trace of pebbles and cobbles, partly cemented with adobe/clay. Rest of the layer is composed of a granular material.

- An apparent georesistivity value related to the electrode spacing of 1.0 m coincides with the lithology. Rather poor permeable layer is exhibited with the apparent resistivity value of less than 20 ohm-m which is related to the sand with adobe/clay.

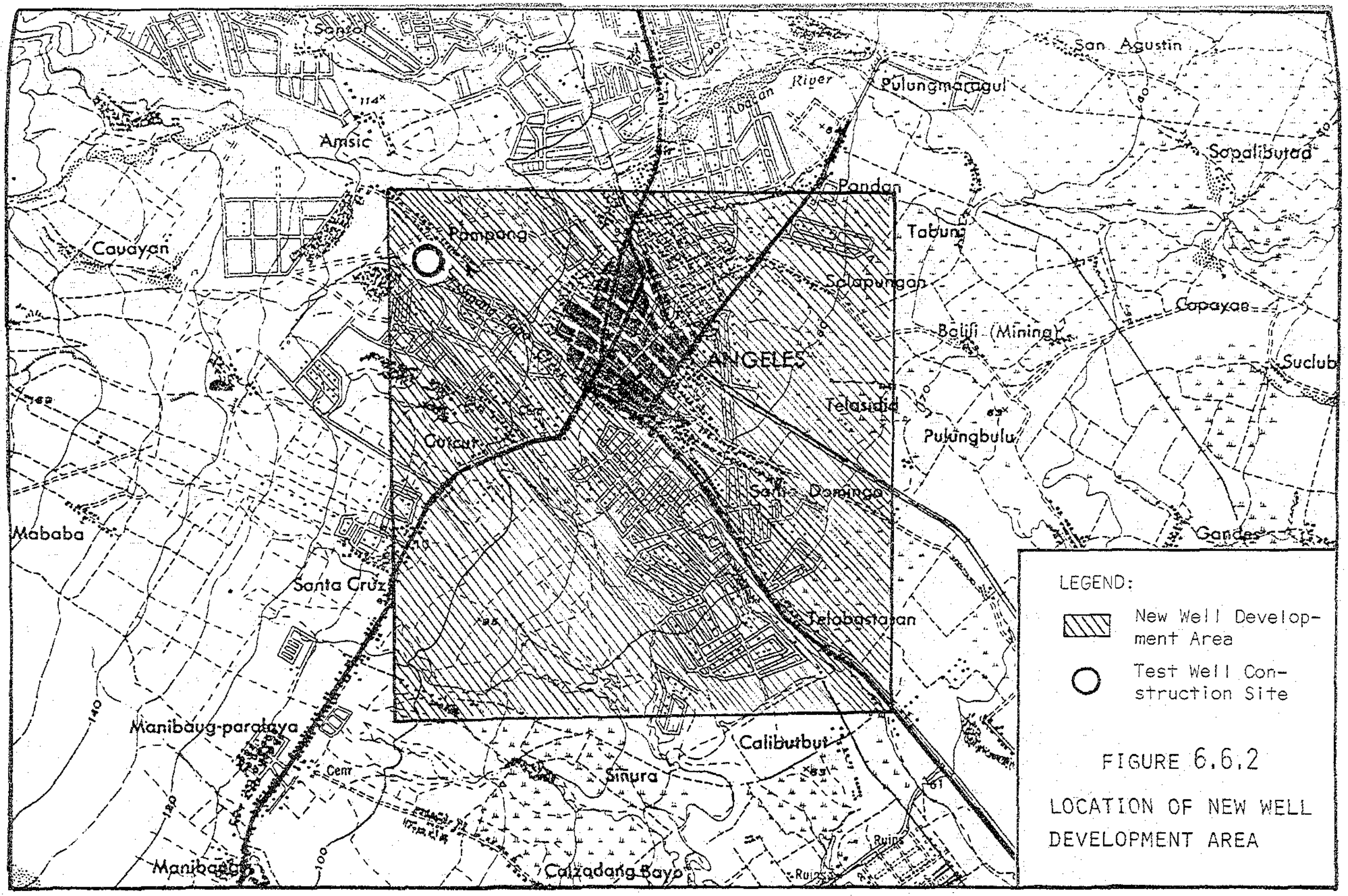

FIGURE 6.6.2

LOCATION OF NEW WELL DEVELOPMENT AREA

LOCALITY	PAMPANG ANGELES CITY	DATE OF COMPLETION	SEPT. 1986
DEPTH DRILLED	200 (m)	BOREHOLE DIAMETER	350 (mm)
CASING DIAMETER	250 (mm)	CASING MATERIAL	STEEL
TYPE OF SCREEN	SLOTTED & JOHNSON TYPE	SCREEN SCHEDULE	SLOTTED 90 m JOHNSON 30 m
STATIC WATER LEVEL	GL-3.96m	YIELD	1,800 cu.m/day
MAXIMUM DRAW DOWN	16.0 (m)	SPECIFIC CAPACITY	113 cu.m/day/m

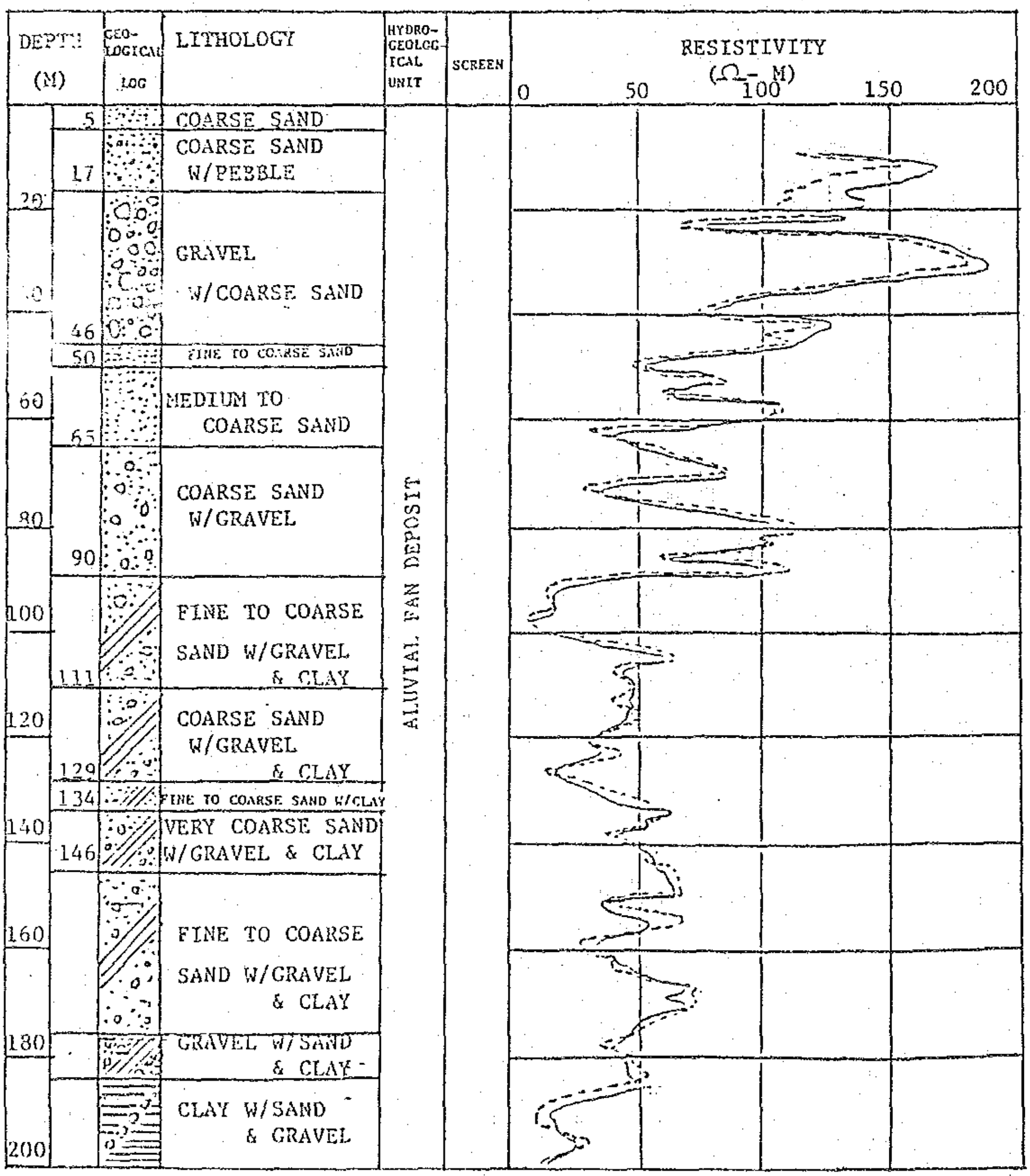

FIGURE 6.6.3 EXPLORATORY WELL LOG

According to the electric and stratigraphic logs, the final well design was prepared (See FIGURE 6.6.4).

A pumping test was conducted from October 7 to 11, 1986. The well was equipped with turbine pump at a setting depth of 51.28 m. The test included a constant rate drawdown and recovery test carried out for 72 hours and 25 hours, respectively. The coefficient of the transmissivity and permeability is T=24.17 sq.cm/sec and $K=3.02 \times 10^{-3}$ cm/sec by the recovery method, while T=20.85 sq.cm/sec and $K=2.61 \times 10^{-3}$ cm/sec by the drawdown method, respectively. The pumping test results are given in FIGUREs 6.6.5 and 6.6.6.

The actual discharge measured is approximately 1,800 cu.m/day and the drawdown is 16.63 m. However, the average well yield discussed in Section 6.6.6 may be expected in consideration of the limited pump capacity used for the pumping test.

6.6.6 Groundwater Availability

Well yield was evaluated using the specific capacity discussed in the previous section. Actual well yield will be realized if proper drawdown is attained. The average specific capacity of 136 l/min/m obtained as an average figure of the selected wells (see TABLE 6.6.3) may be used for water supply purposes. Proper design and construction of wells are requisites to ensure the amount.

Design drawdown for the confined aquifer would be about 15 m from the data on the existing well.

Total well yield was calculated as follows:

136 l/min/m x 15 m = 2,040 l/min = 2,900 cu.m/day

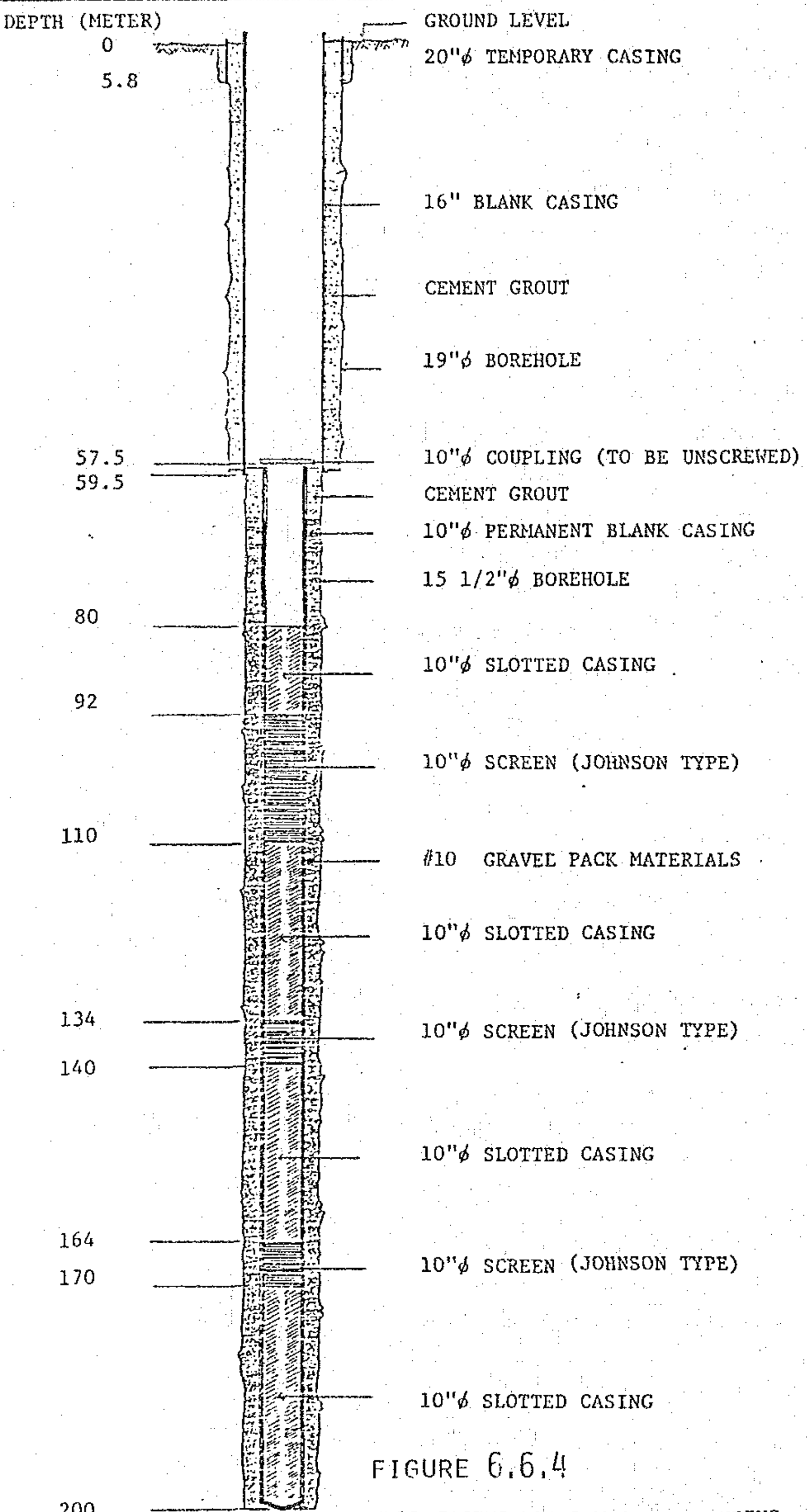

FIGURE 6.6.4

WELL CASING PROGRAM CORRESPONDING TO THE LITHOLOGIC AND ELECTRIC LOGGING RESULTS AT ANGELES EXPLORATORY WELL

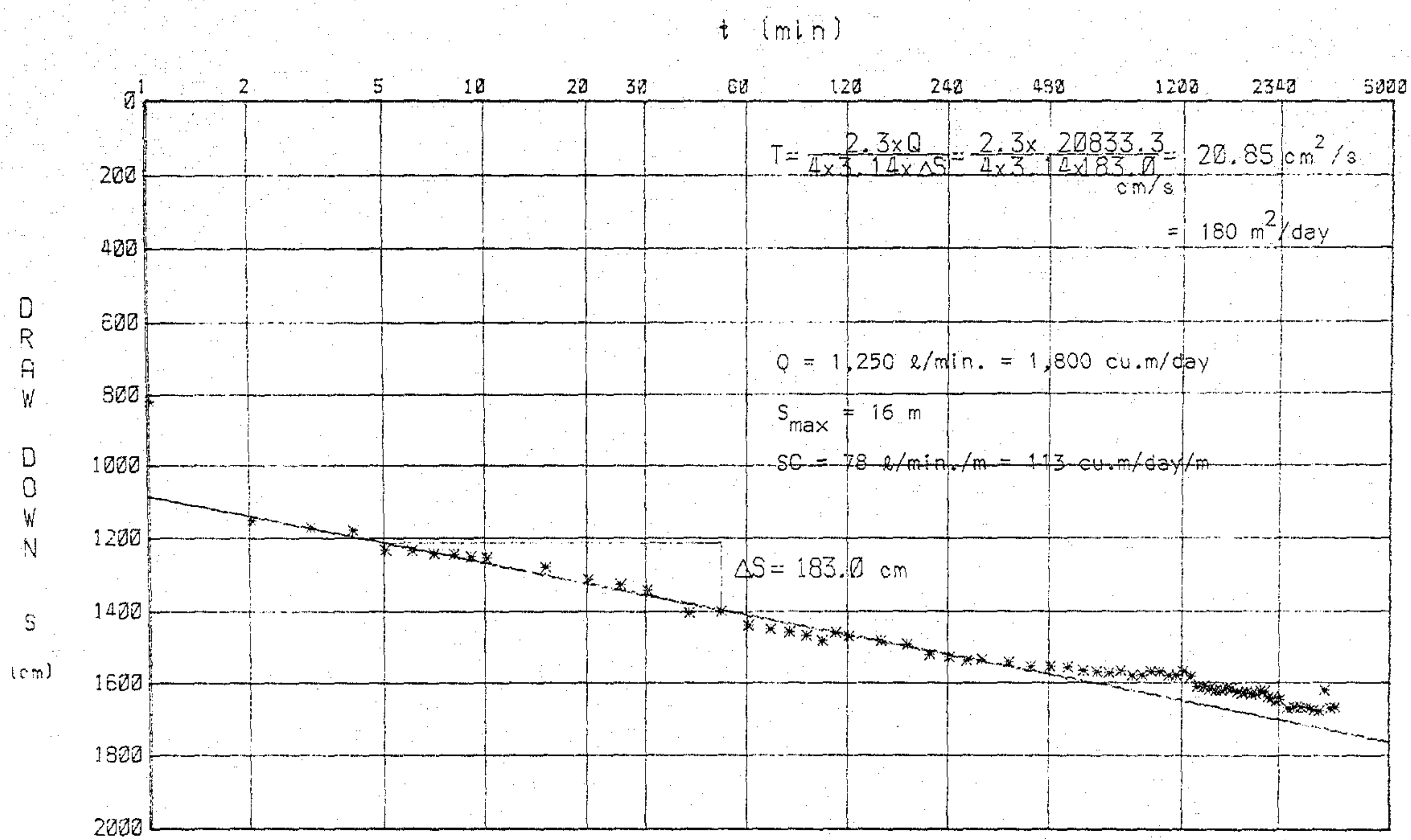

FIGURE 6.6.5 JACOB'S METHOD

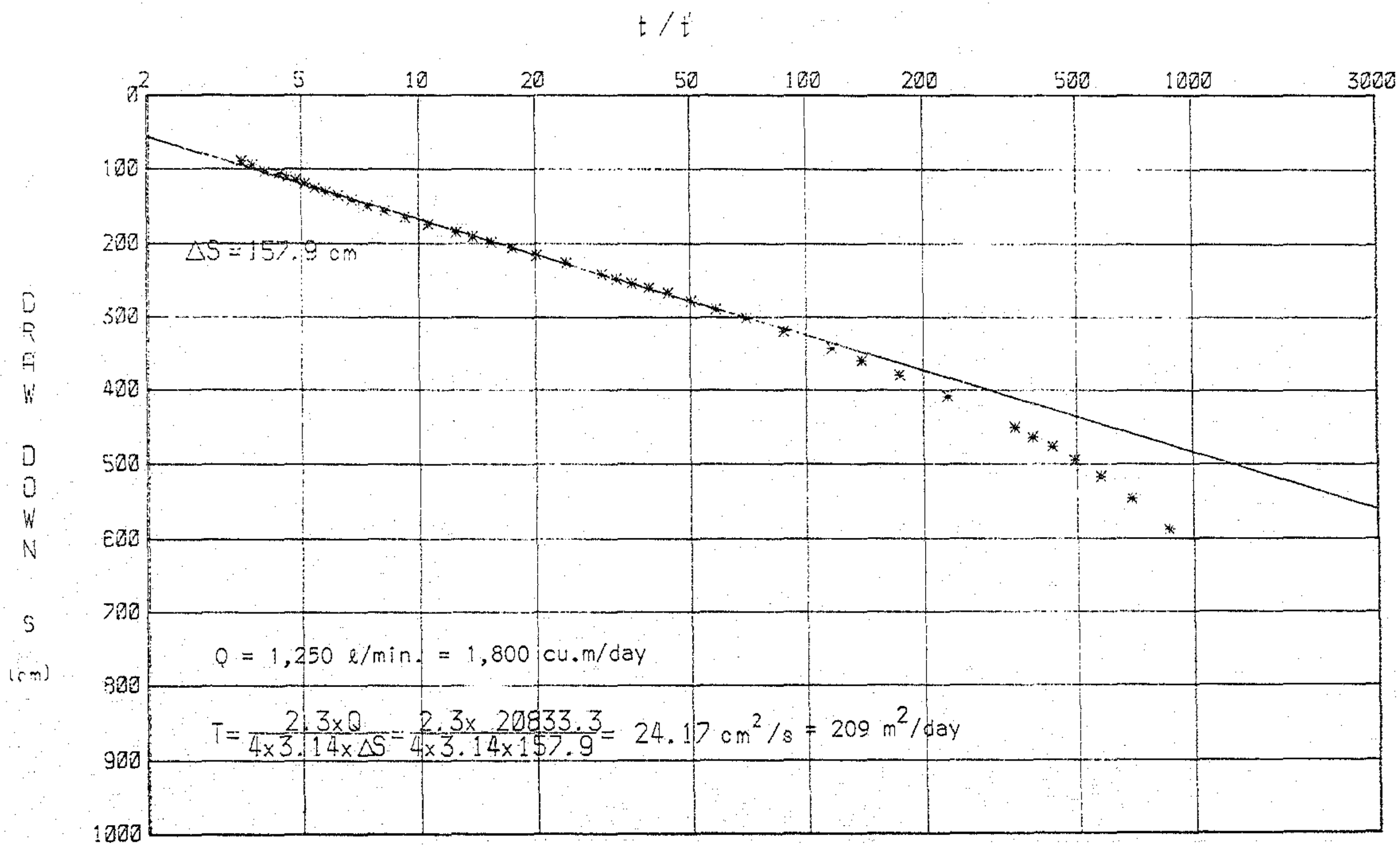

FIGURE 6.6.6 RECOVERY METHOD

Production wells should be arranged with adequate spaces between them for management of groundwater. The spacing should be determined based on the hydrogeological conditions ensuring safe yield. The following safe yield concepts were recommended for development of groundwater sources.

a) Safe yield should not exceed the long-term recharge to the basin.
b) Safe yield should not bring heavy depression in the vicinity of the pumping sites.

Regarding item a), the total extraction amount of 50,000 cu.m/day (50,000 cu.m/day ÷ 90.0 sq.km = 0.6 mm/day) for the year of 1995 would not exceed recharge rate of 1.37 mm/day.

As for item b), heavy depression cone could occur, if proposed wells would be located near the existing well fields. A tentative estimate of groundwater level in the future was made with reference to required amount using the finite difference equations. The southern portion of the City was identified as the favorable well sites as shown in FIGURE 6.6.2. It was also concluded that the average yield discussed above may be expected throughout the city area based on the test well survey.

With regard to the above discussions, existing wells which have comparatively low yield should be rehabilitated or re-drilled to attain reasonable well yield of the aquifer concerned.

6.7 WATER QUALITY

A series of water quality test was conducted in terms of physical/chemical and bacteriological indices to check potability of the present water source.

Sampling was conducted on July 14, 1986 (see APPENDIX 6.7.1). Physical/chemical examination included the indices of water temperature, pH and EC in the field and turbidity, total dry solids, alkalinity, acidity, hardness, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, SO_4^{2-}, CO_3^{2-}, HCO_3^{-}, Cl^{-}, Fe^{T}, Mn, NH_3-N and NO_3-N at the laboratory. Bacteriological examination was conducted regarding coliform group bacteria as MPN.

The summary of results, both from field investigation and laboratory analysis, is presented in APPENDIX 6.7.2. Other than turbidity and color which were exceeded in some wells and the positive bacteriological result in one deep well, all were found to be within the permissible limits led by the National Standards for Drinking Water (NSDW).

Physical/Chemical Test

(1) Deep Wells

The first batch of deep well samples included eleven ACWS wells. The results of the test on these samples were very satisfactory. In the other five private/public deep wells, all the tested parameters were within the limits except for sample No. 21 where turbidity and color were high.

(2) Shallow Wells

Samples in this group were collected form wells with depths ranging from 5.2 to 37 m. The results were also reasonable except for turbidity and color which were excessive in Sample No. 15 and 19. According to the respective owners of the two wells, water from these sources are not being used for drinking since these are visibly turbid.

(3) Abacan River

As in the above, Abacan River water is also within the acceptable standards except for very high turbidity at 382 FTU which is a general characteristic expected from any surface water source.

Bacteriological Analysis

Of the four samples tested for bacterial contamination, well water from Sample No. 23 yielded positively to E. coli bacteria.

Complimentary to the sampling for laboratory analysis, a preliminary water quality survey was also conducted. Very notable of the results was the generally low pH values which were below 7 with some samples yielding even lower the standard range of 6.5 to 8.5.

As a whole, groundwater in the area maybe classified to be within acceptable quality. In those wells where turbidity and color tests failed, the condition appears to be local as surrounding wells were reported to be good. Similarly, the other undesirable parameters are still within manageable range. For these reasons, treatment other than disinfection may not be required.

A number of test wells for the Barangay Waterworks Program were reported to have excessive iron concentration. Although the outcome of the recent water quality survey was convincing, further study to verify such in the corresponding areas maybe necessary.

6.8 RECOMMENDED WATER SOURCES

Groundwater seems to be the only potential source for the water supply in Angeles city

As discussed in the previous Section 6.6.4, groundwater is replenished by both the direction of recharges, vertical and horizontal, however these recharges volume have seasonal fluctuation.

Although the surface water of the Porac and Abacan River can be considered as a potential alternative source of water, those are only sources of horizontal recharge for groundwater in Angeles City and neighboring area. It is clear that groundwater potential would be decreased if the surface water is stored at the upper stream of groundwater basin.

Furthermore, groundwater storage would not be heavily affected by the seasonal fluctuation in contrast with the surface discharge because of huge storage capacity in the basin. On the basis of these assumptions, groundwater resource is the most recommendable source for the water supply in Angeles City, if adequate layout and productive scheme is taken into consideration. Groundwater potential in the area can be calculated based on the recharge rate of the surface river inflow and precipitation as described in the previous chapter. These are 15% of annual rainfall and 0.1 mm/day from drainage areas concerned. The total recharge to the study area was calculated to be approximately 80,000 cu.m/day.

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 long term development toward the target year of 2010. Each alternative was developed and evaluated based on the findings and results of foregoing studies.

The city water supply system may be determined based on the capacity of available water sources and their locations. The study of the alternative water sources was primarily conducted using the recommendations in Chapter 6 - Water Resources.

In the analysis and evaluation of alternatives, the major concerns were the low cost of construction, operation and maintenance of the 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 particular approaches are taken up:

- Alternative study of water sources was first carried out including necessary transmission facility for three cases that the future water source will depend fully on the groundwater from the deep wells, the surface water from the Porac River, or the combination of these two water sources.

- Alternative distribution system was studied for four cases considering pressure zones and reservoir locations based on the selected plan of water source development. The study on the required storage capacity of the reservoir was also carried out for these four alternatives and the project costs are compared including distribution network of respective alternatives.

- The study of phased distribution network development was performed for the plan of distribution system as selected in the foregoing study.

7.2 FACTORS TO BE CONSIDERED FOR ALTERNATIVE STUDY

In evaluating alternatives, considered were; water demand for each design year, recommended water sources, design criteria for distribution system, storage requirements and locations, and other parameters relevant to the existing and proposed systems.

7.2.1 Planning Stages

In studying alternatives, planning stages are considered both for the long term and short term development of water supply system as shown below:

Construction Phase	Design Period
Phase I	1986 - 1995
Phase II	1996 - 2010

The long term development shall be completed during the Phase II period, while the short term development by the year 1995.

The Phase I project is further divided into two stages; Stage 1 for 1990 and Stage 2 for 1995 taking into account of practical construction period for the required facilities, especially for internal network and service connections.

7.2.2 Water Demand in Each Design Year

The future water demand, as projected in Chapter 5 covering barangays to be served in the respective target years, is presented in TABLE 7.2.1.

TABLE 7.2.1 DAILY AVERAGE AND MAXIMUM DEMAND

Unit: cu.m/day

Barangay	1990	1995	2010
A. del Rosario	300	800	1,200
Claro M. Recto	500	1,200	1,900
Cut Cut	900	3,000	6,500
Lourdes Northwest	800	1,700	2,200
Lourdes Sur	700	1,300	2,300
Lourdes Sur East	400	1,200	1,900
Malabañas	200	300	700
Pampang	100	500	1,200
Pandan	1,300	2,700	5,600
Pulung Bulu	600	1,300	2,400
Salapungan	400	1,500	3,300
San Jose	400	1,300	2,700
San Nicolas	300	600	1,000
Sta. Teresita	700	2,100	4,100
Sta. Trinidad	300	1,000	2,000
Sto. Cristo	400	500	700
Sto. Domingo	800	2,600	5,400
Sta. Rosario	300	1,000	2,100
Virgen de los Remedios	100	300	600
Daily Average Demand	9,500	24,900	47,800
Daily Maximum Demand	12,000	31,000	59,800

7.2.3 Water Sources Considered

Water demand of the proposed service area in 2010 was estimated to be about 60,000 cu.m/day on a daily maximum basis. Aside from this, additional demand from the Clark Air Base and Balibago Waterworks will be approximately 20,000 to 30,000 cu.m/day.

To cope with this water demand, the following water sources are considered for development based on the studies performed in Chapter 6.

(1) Realignment of Existing Deep Wells

A study of the maximum utilization of the existing wells was made with the following criteria used to evaluate the wells.

a) The well capacity should be more than 1,000 cu.m/day.

b) Required space between neighboring wells should be more than 500 m.

c) The well site with a high possibility to yield sufficient water should be utilized, even if the present production amount is small.

TABLE 7.2.2 shows the required data for selection of wells to be utilized for future system.

TABLE 7.2.2 EVALUATION OF EXISTING WELLS FOR FUTURE UTILIZATION

No. of Pump Station	Well Capacity (cu.m/day)	Distance Between Neighbor-ing wells (m)	Well Const. Year	JICA Measured Produc-tion (cu.m/day)	Selected Wells and Expected Production (cu.m/day)	Remarks
1	2,725	No. 3;190	1970	3,968	2,700	Replacement of the pump
2	1,363	No. 1;400	1950	-		
3	654	No. 1;190	1953	709		
4	654	No.14;380	1955	320		
5	1,635	No.10;450	1955	978	1,600	Replacement of the pump
6	1,635	No.10;350	-	1,013	1,600	"
7	1,363	No.14;920	1958	814	1,400	"
8	1,254	No.12;150	1963	-	1,300	"
9	300	No. 4;350	-	-	(2,900)*	Candidate site for new well construction
10	1,080	No. 6;350	-	1,283		
11	813	No.13;600	1950	-		
12	818	No. 8;150	1975	588		
13	-	-	-	-		
14	1,000	No. 4;380	-	-	(2,900)*	Candidate site for new well construction
Total					11,500	

Note: * Either one of two sites may be used for new well construction.

The wells at pumping station Nos. 1, 5, 6, 7 and 8 are recommended to be utilized replacing existing pumps to adequate ones. It is recommended that well No. 14 be abandoned and a new well be constructed at either No. 9 or No. 14 well site since a yield of more than 2,900 cu.m/day is expected in the two sites. The total production from the existing wells and from a new well either at No. 9 or No. 14 well site is expected to be 11,500 cu.m/day. However, the total amount of 8,600 cu.m/day for 18-hour pump operation a day will be useful under the direct distribution of the water from the pumps.

(2) Surface Water

It was confirmed that there is a big stream of the Abacan River approximately 5 to 6 km from the center of Barangay Sapangbato in the mountainous area. The river water in the valley was previously utilized for the water supply of the Clark Air Base, however, it was abandoned due to unstable conditions in the area during rainy season.

Because of the topography (relationship between water level of the stream and ground level of surrounding area with more than 200 m difference), a pumping station will be required to transmit water to the City. In addition, it will be costly to construct a dam in the valley due to soil conditions (sand). The water observed at the point naturally infiltrates into the ground downstream of the river before the Barangay Sapang Bato. Therefore, even during rainy season, flow rate downstream of the Abacan River is quite low.

The Porac River is located about 10 km from the city proper. Based on the hydrological data of the Gumain River in the JICA Report, yearly average flow rate of the Porac River downstream of the Porac Municipality was calculated to be 5.35 cu.m/sec (462,000 cu.m/day), while monthly minimum approximately 1 cu.m/sec. The water from the Porac River may be utilized for the city water supply within a limited amount.

(3) Groundwater

The maximum production amount of groundwater was concluded to be approximately 80,000 cu.m/day in the city area based on the hydrogeological study. However, when the total water demand in the study area is taken into account, groundwater exploitation within the city area will not be sufficient. The groundwater development of Porac Municipality to supplement water production will be needed.

Groundwater production from deep wells is expected to be about 2,900 cu.m/day per well throughout the proposed service area. As studied in Chapter 6, the area with the highest groundwater potential is identified in the southeastern part of the City, followed by the hilly area in the northern part of the City.

A test well constructed during the field survey is considered to be utilized as a production well.

A proposed design parameter of deep wells to be constructed in the above-mentioned area at this planning stage is as follows:

Proposed Deep Well	Design Parameter
Well depth	200 m
Casing diameter	250 mm
Estimated discharge	2,900 cu.m/day
Influence area	250 m (radius)

7.2.4 Distribution System

The alternative study of the distribution system includes the various alternative pipeline configurations and routing to arrive at the cheapest possible distribution system that can provide adequate water pressure in the proposed service area.

(1) Pressure Zone

The ground elevation of the proposed service area for the year 2010 varies from about 70 m to 120 m. In this regard, studies were made for one or more pressure zones for water supply system.

(2) System Pressure

In accordance with the LWUA Methodology Manual, the design water pressure in the main pipes with a diameter of more than 150 mm as indicated below will be achieved in the year 2010 (Phase II) for the hourly maximum flow:

- Max. static water pressure : 7.0 kg/sq.cm

- Min. dynamic water pressure : 0.7 kg/sq.cm for the residential area; 1.4 kg/sq.cm for the commercial/industrial area.

During the Phase I period, a minor modification to the above-mentioned requirements may be adopted considering the cost constraints as the intermediate measure of system improvement.

"C" value (Hazen Williams' Formula) being adopted in the said manual is also given below:

ø100 mm to ø200 mm : C = 110
ø250 mm to ø500 mm : C = 120
ø600 mm and over : C = 130

(3) Fire Protection

Full fire protection with adequate water pressure will be insured during the Phase II period. During the Phase I period, the existing fire hydrants will be utilized. The criteria on the to location of fire hydrants as set forth in the LWUA Methodology Manual is summarized as follows:

	Residential Area	Commercial/ Industrial Area
Diameter of Fire Hydrants	100 mm	150 mm
Spacing	180 m	135 m
Hydrant Density	0.3 pc/ha	0.6 pc/ha

The number of fire hydrants can be determined either by spacing or by hydrant density criteria.

To verify the appropriateness of distribution system, a 22 l/sec of fire fighting water from each of two adjacent fire hydrants in the residential area, as required in the LWUA Methodology Manual, will be checked by the computer-aided network analysis.

(4) Storage Facilities

In coming up with the most cost-effective storage facilities, water demand and storage volume will have to be ascertained. In compliance with the LWUA Methodology Manual, the optimum configuration of the storage facilities will be selected from among the following three alternative schemes:

- Daily maximum supply and maximum storage,
- Intermediate supply and storage (150% of the daily maximum supply), and
- Peak hour supply and minimum storage.

The location of storage facilities will also be studied in relation to the location of major demand areas and necessary diameter of distribution pipes, as well as topographic conditions and land availability for the facilities.

(5) Distribution Network

The most optimum distribution network will be determined from the view point of the least construction cost by means of the computer-aided network analysis by taking into account the afore-mentioned criteria of distribution system.

(6) Equipment/Materials and Unit Costs

The unit costs of water supply equipment and materials were inquired both in Manila and respective study area during the field survey.

The survey results revealed that almost all the equipment and materials are imported or partially manufactured in Manila area and distributed to local areas. These market prices which were mainly pipes and fittings, were compared with the LWUA Methodology Manual at the 1986 price level and it is concluded that the said Manual be referred to estimate the project cost.

With regard to pipe materials, PVC pipe for diameters up to 150 mm and steel pipe for diameters of 200 mm and above are utilized in this study based on the cost comparison. (See APPENDIX 7.2.1 for details)

7.3 ALTERNATIVE STUDY OF WATER SUPPLY SYSTEM

7.3.1 Water Source and Transmission

(1) Development of Alternatives

The identified water sources for the City's water supply are the groundwater and the river water. The surface water source is the Porac River, which is about 10 km from Angeles City.

The following water source alternatives toward the year 2010 were established not only within the city area, but also outside the city.

Alternative S-1 : Utilization of groundwater from the distributed deep wells both in Angeles City and Porac Municipality.

Alternative S-2 : Utilization of groundwater in the city area supplemented by the surface water of the Porac River.

Alternative S-3 : Utilization of surface water of the Porac River.

The location of water sources and expected intake amount by alternative sources are as follows:

<u>Alternative S-1</u>

- o It was assumed that approximately 80% of allowable groundwater amount (80,000 cu.m/day) in the city area could be used. Therefore, a total of approximately 40,000 cu.m/day may be utilized for the city water supply considering future water use by the other waterworks and the Air Base.

- o Ensuring 8,600 cu.m/day from the consolidated existing wells with an 18-hour pump operation (see TABLE 7.2.2 for the recommended plan on the existing wells), eleven additional wells are to be developed in Sto. Domingo-Mining and Pampang areas with an estimated total amount of 31,900 cu.m/day (2,900 cu.m/day per well).

- o Further development of groundwater source in the Municipality of Porac will be required to meet the estimated daily maximum water demand of 60,000 cu.m/day (daily average: 50,000 cu.m/day). A total of 19,500 cu.m/day should be exploited in the area by the construction of 7 wells with an average production of 2,900 cu.m/day per well.

Alternative S-2

- A total of 40,000 cu.m/day groundwater in the city area will be used, of which 8,600 cu.m/day will be from the consolidated existing wells and 31,900 cu.m/day from the new wells as described in Alternative S-1.

- An additional 19,500 cu.m/day will be supplied from the Porac River.

Alternative S-3

- The surface water in the Porac River will be utilized with a total of 51,000 cu.m/day supplementing the present production amount from the consolidated existing wells.

A schematic layout of these alternatives are shown in FIGURE 7.3.1 and a facility configuration is presented in TABLE 7.3.1.

As to the water conveyance and transmission pipelines, the shortest routing is identified considering the existing and planned roads.

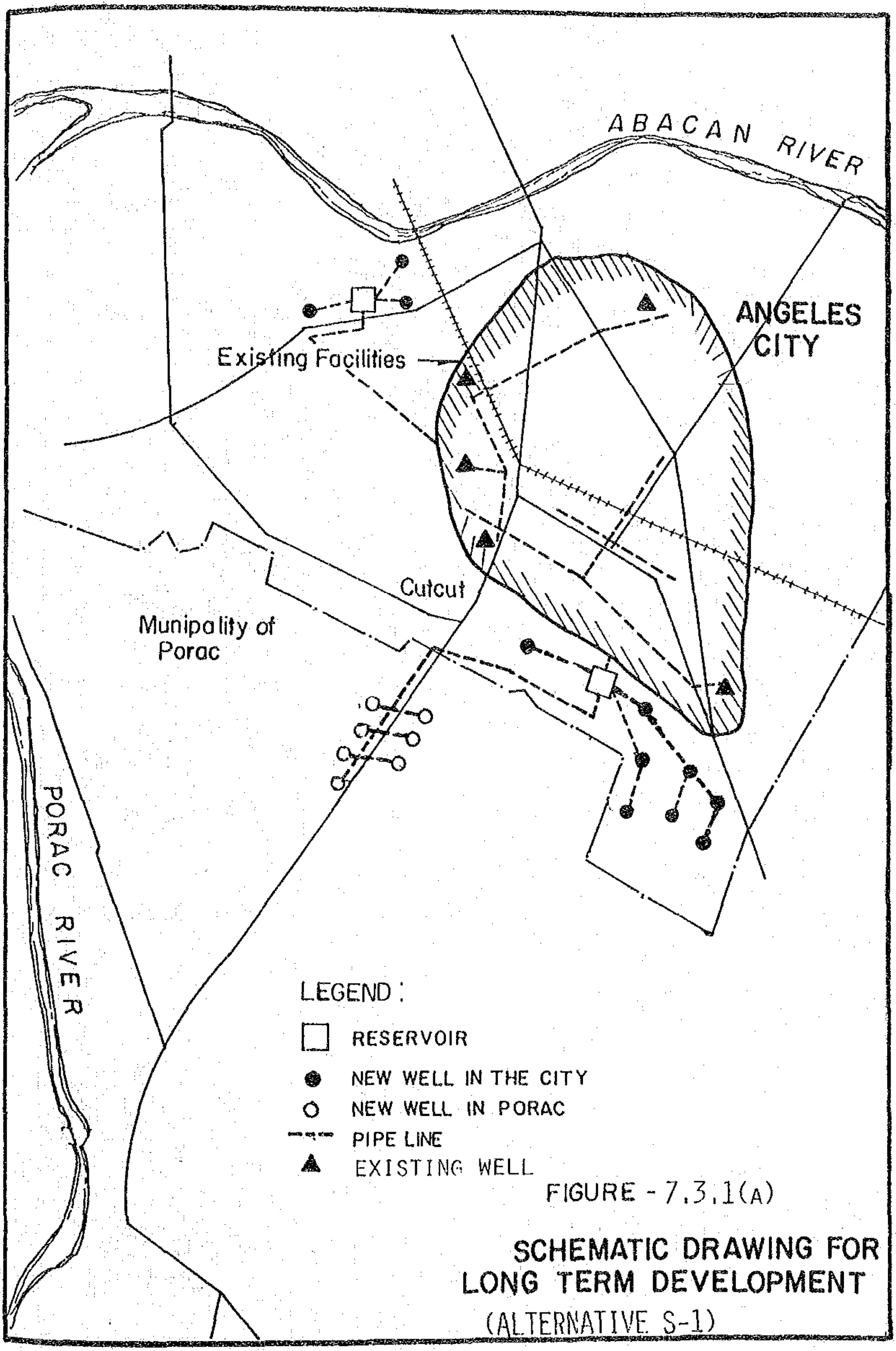

FIGURE - 7.3.1(A)

SCHEMATIC DRAWING FOR LONG TERM DEVELOPMENT

(ALTERNATIVE S-1)

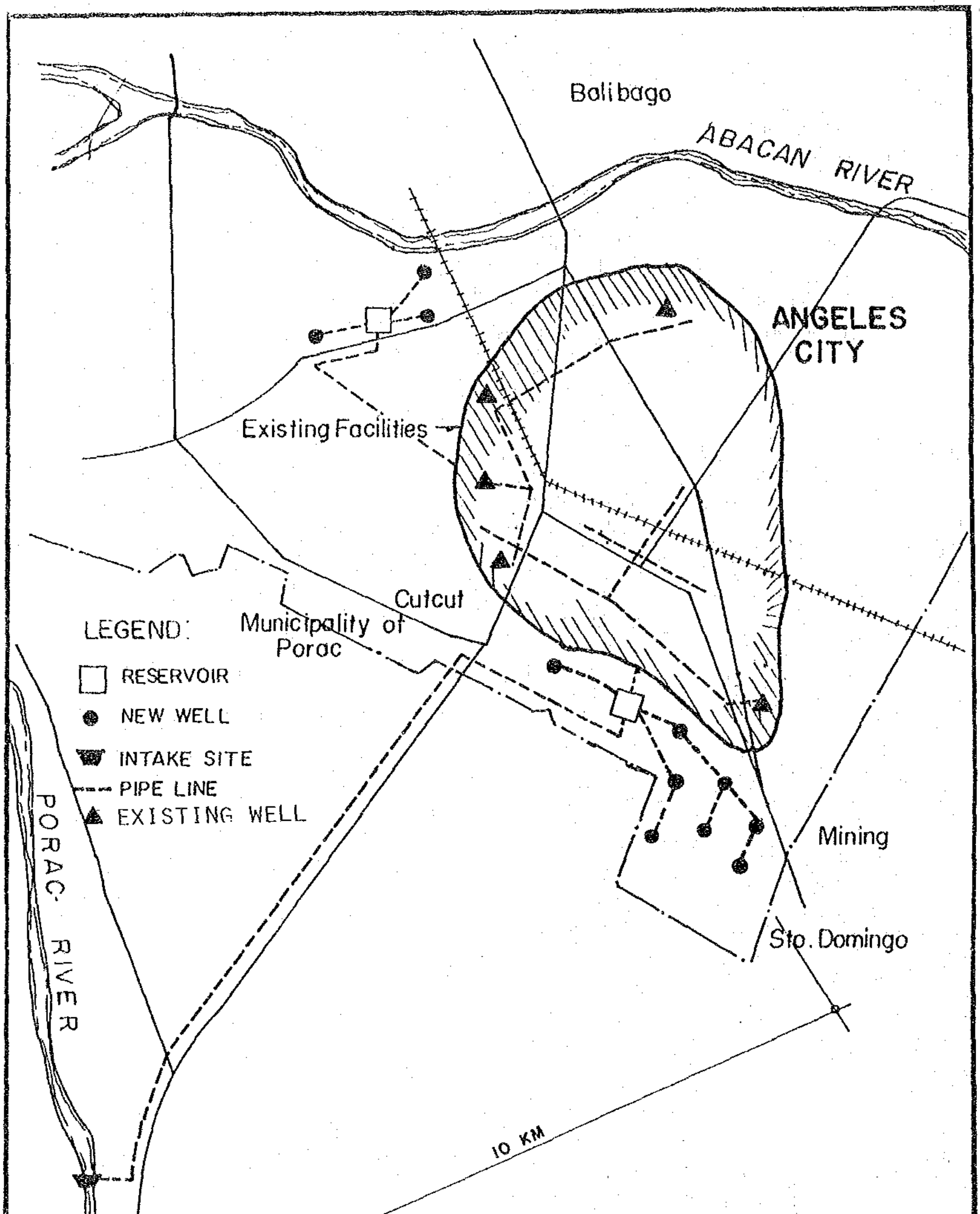

FIGURE - 7.3.1(B)

SCHEMATIC DRAWING FOR LONG TERM DEVELOPMENT

(ALTERNATIVE S-2)

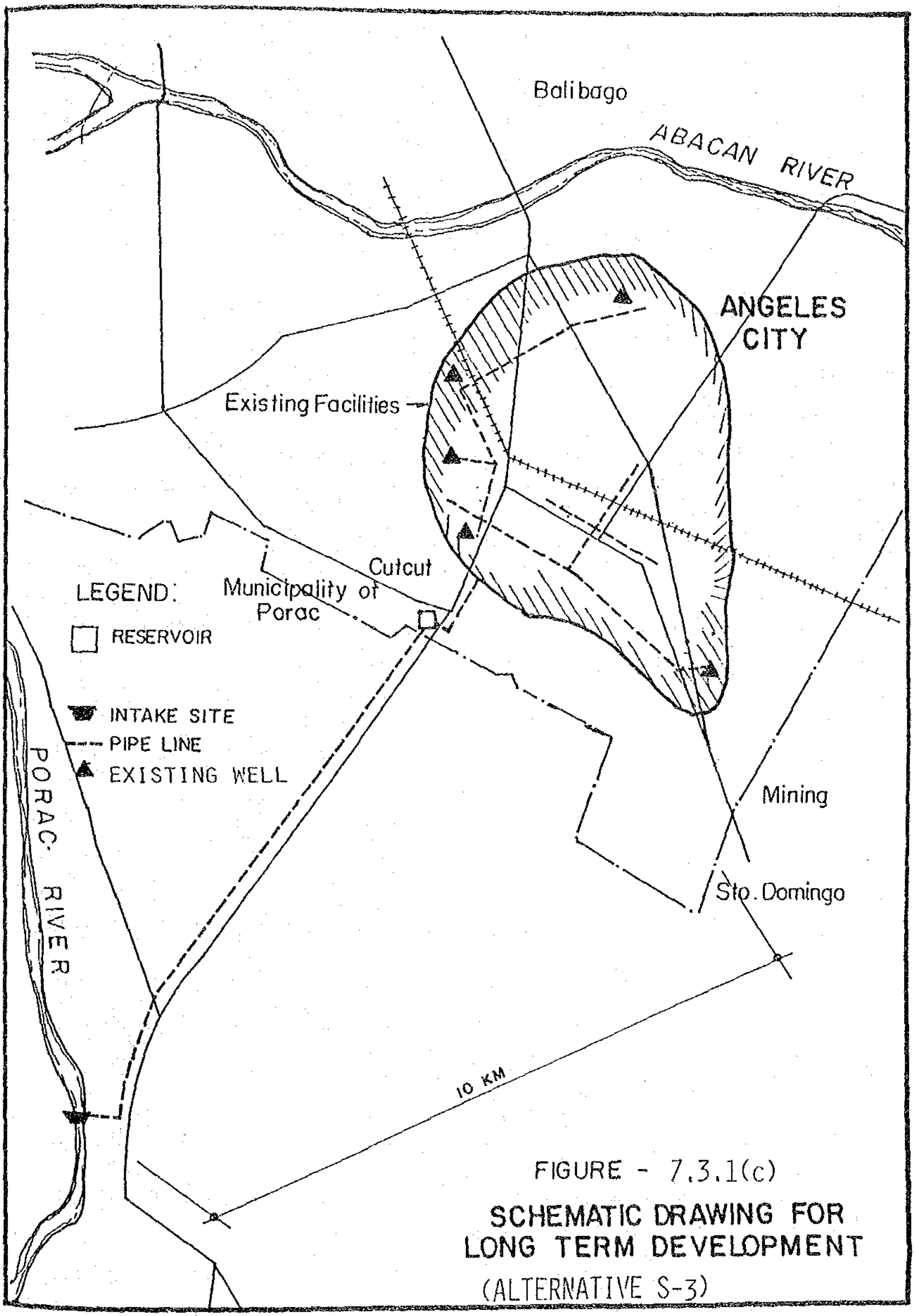

FIGURE - 7.3.1(c)

SCHEMATIC DRAWING FOR LONG TERM DEVELOPMENT

(ALTERNATIVE S-3)

TABLE 7.3.1 FACILITY CONFIGURATION OF WATER SOURCE ALTERNATIVES

Facilities	Alternative S-1	Alternative S-2	Alternative S-3
Water Source			
Existing Wells	5 wells (8,600 cu.m/day)	5 wells (8,600 cu.m/day)	5 wells (8,600 cu.m/day)
New Wells	18 wells (51,400 cu.m/day)	11 wells (31,900 cu.m/day)	-
Porac River	-	19,500 cu.m/day	51,400 cu.m/day
Transmission	ϕ200 - ϕ450 10,800 m	ϕ200 - ϕ600 15,000 m	ϕ700 10,000 m
Treatment			
Slow Sand Filter	-	3,900 sq.m	10,280 sq.m

(2) Cost Comparison

Construction costs for water source and transmission facilities including operation and maintenance costs are estimated as shown in TABLE 7.3.2. Details of cost estimate are contained in APPENDIX 7.3.1.

TABLE 7.3.2 COST COMPARISON OF WATER SOURCE ALTERNATIVES

Unit : ₱ x 1,000

Facilities	Alternative S-1	Alternative S-2	Alternative S-3
Water Source	28,440	21,074	8,414
Transmission	8,006	18,853	19,100
Treatment	-	8,190	18,504
Sub-Total	36,846	48,117	46,018
Operation	15,610	13,296	15,600
Maintenance	3,685	4,812	4,602
Sub-Total	19,295	18,108	20,202
TOTAL	56,141	66,225	66,220

Based on the above cost comparison, Alternative S-1 is the best plan of water source development.

7.3.2 Distribution System

(1) Development of Alternatives

Based on the selected plan of water source, the alternatives for distribution system were developed. The topography of the proposed service area and the location of additional new wells were considered in the study.

Groundwater from the consolidated 5 existing wells will be utilized by means of direct transmission to respective distribution pipelines after chlorination. A test well will also be utilized as one of water source.

The ground elevation of northwestern part of the proposed service area is about 120 m, while that of the southeastern part is about 70 m. Due to to this difference in topographic conditions, two principal alternative cases both for the service area composition and water source location were developed.

Alternatives of the service area composition are:

- The proposed service area will be covered by one integrated water supply system.
- The proposed service area will be covered by two water supply systems, of which one will be for the hilly area to be served during the Phase II period.

As to the water source location, the northern part and the southeastern part of the proposed service area are considered to be alternative well fields corresponding to the topographic conditions. The former has a potential advantage of high ground elevation for water distribution, while the latter has that of low ground elevation for water intake (pumping up of groundwater). Based on the study result in Chapter 6, the said southern part is given higher priority owing to its locational advantage in obtaining large amount of groundwater with comparatively lower cost in well construction. Thus, water source location alternatives are:

- One well field in the southeastern part of the proposed service area will be utilized to obtain the required amount of water.

- Two well fields (the northern part and southeastern part of the proposed service area) will be utilized to obtain the required amount of water.

Accordingly, the alternative plans for the distribution system are established as a combination of the above-mentioned alternatives as described below. A schematic layout of these alternatives is shown in FIGURE 7.3.2.

Alternative D-1

- o One integrated distribution system will be formed to cover the entire service area.

- o Water sources will be located at two well fields in the northern and southeastern parts of the service area.

- o Two distribution reservoirs will be located near the respective well fields and water from a test well will be transmitted to the reservoir in northern area.

Alternative D-2

- o One integrated distribution system will be formed to cover the entire service area.

- o Water sources will be located at the well field in the southeastern part of the service area.

- o One distribution reservoir will be located near the well field and water from a test well will be directly transmitted to distribution pipelines after chlorination.

Alternative D-3

- o Two separate distribution systems will be formed to cover the entire service area.

- o Water source will be located at two well fields in the northern and southeastern parts of the service area, of which northern well field will be further subdivided into two groups; one to serve for the northwestern part of the proposed service area and the other supplementing the southeastern well field to serve for the city proper area.

- o Three distribution reservoirs will be located at respective water source groups and water from a test well will be transmitted to the reservoir in the northern area to serve for the city proper area.

Alternative D-4

- o Two separate distribution systems will be formed to cover the entire service area.

- o Water sources will be located at two well fields in the northern and southeastern parts of the service area, of which the former is to serve for the northwestern part of the service area to be covered during the Phase II period, while the other is to serve the remaining major service area.

- o Two distribution reservoirs will be located at respective water source groups and water from a test well will be directly transmitted to distribution pipelines after chlorination to serve for the city proper area.

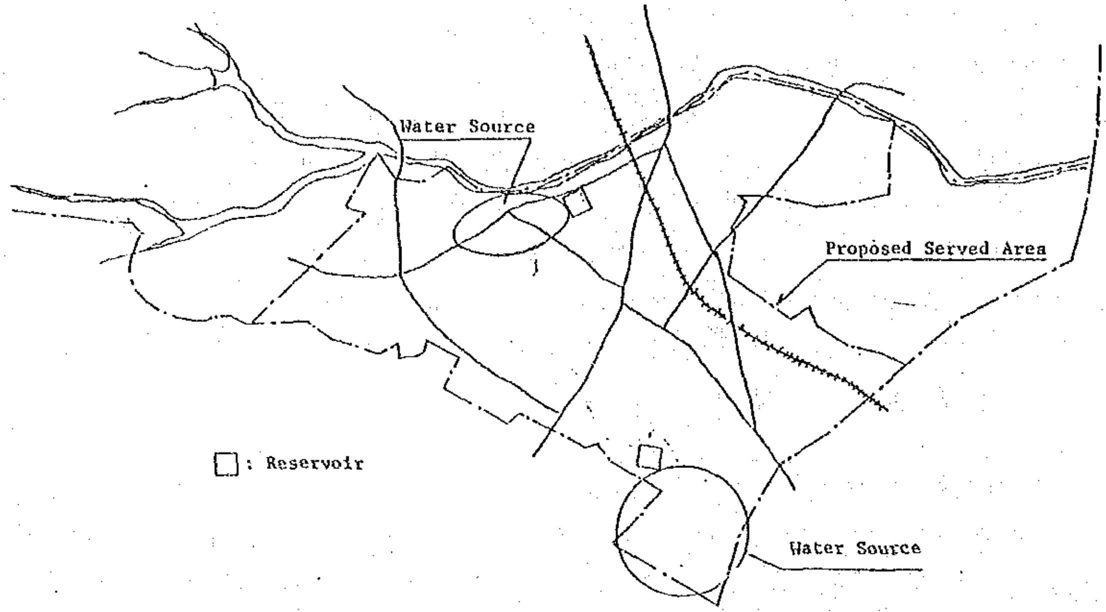

FIGURE 7.3.2(A)
SCHEMATIC LAYOUT OF ALTERNATIVE
DISTRIBUTION SYSTEM
(ALTERNATIVE D-1)

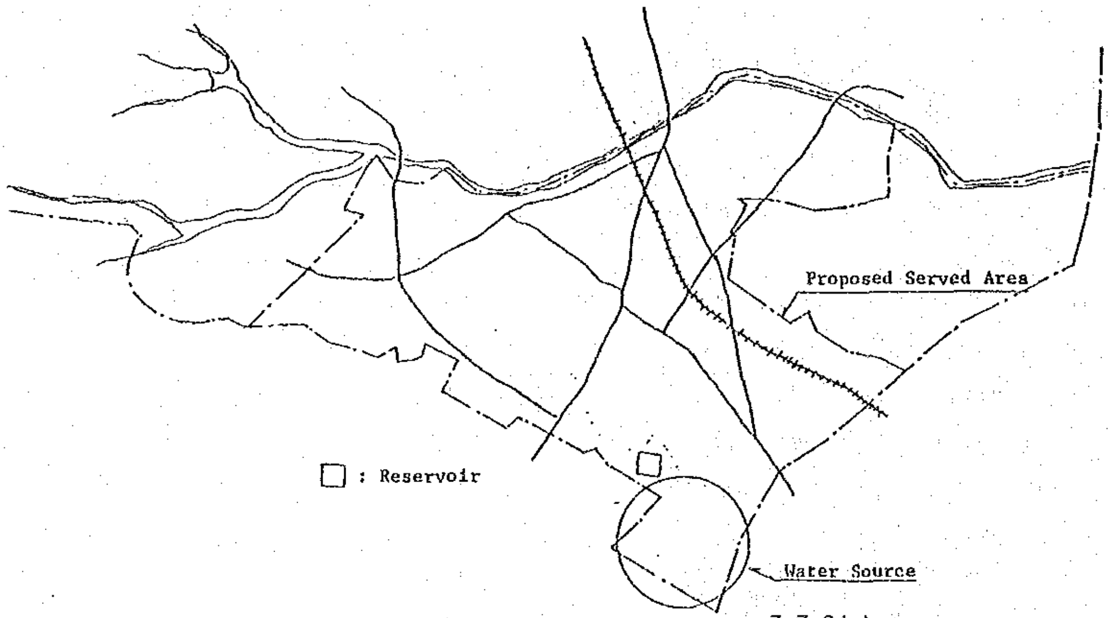

FIGURE 7.3.2(B)
SCHEMATIC LAYOUT OF ALTERNATIVE
DISTRIBUTION SYSTEM
(ALTERNATIVE D-2)

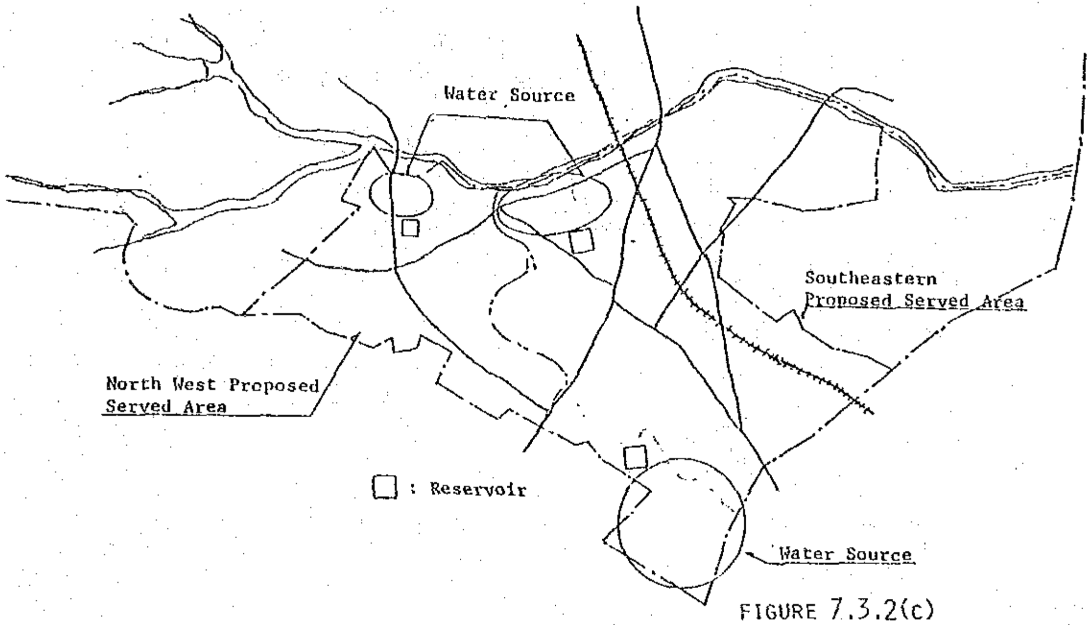

FIGURE 7.3.2(c)
SCHEMATIC LAYOUT OF ALTERNATIVE
DISTRIBUTION SYSTEM
(ALTERNATIVE D-3)

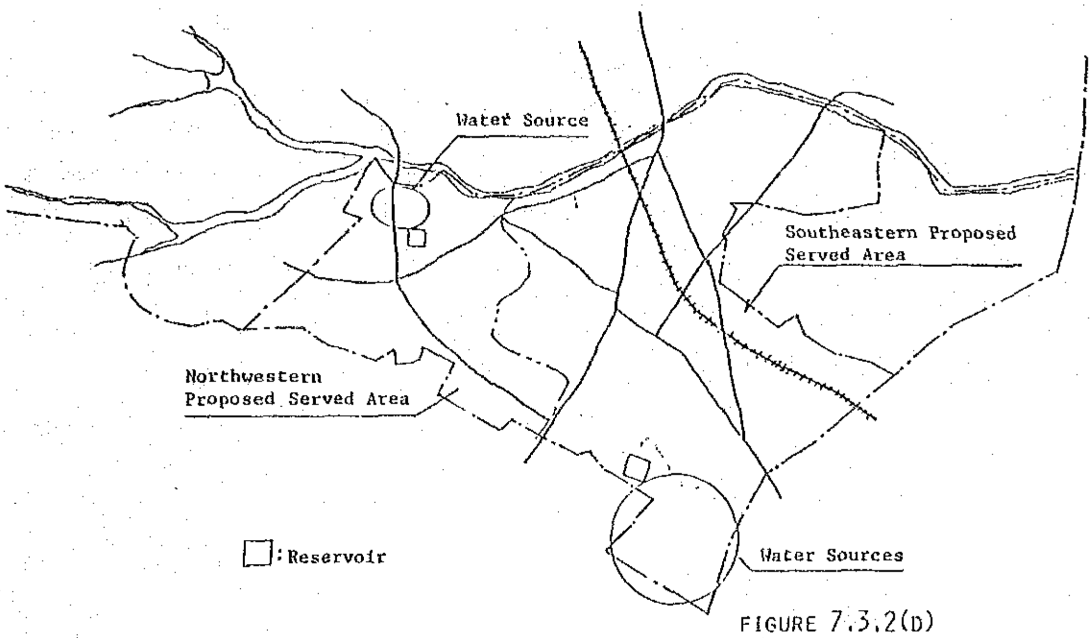

FIGURE 7.3.2(D)
SCHEMATIC LAYOUT OF ALTERNATIVE
DISTRIBUTION SYSTEM
(ALTERNATIVE D-4)

(2) Required Storage Capacity

Before studying each alternative for the distribution system, ways to optimize the storage capacity of the distribution reservoir were studied on three cases relative to the cost of water source development:

- o Maximum Storage Capacity
  = Emergency (2 hr) + Operational (100% in 24 hr)

- o Intermediate Storage Capacity
  = Emergency (2 hr) + Operational (100% in 16 hr)

- o Minimum Storage Capacity
  = Emergency (2 hr)

Required storage volume and additional water sources are shown in TABLE 7.3.3.

As shown in TABLE 7.3.3, both intermediate and minimum storage capacities of the reservoir in each alternative necessitate 11 additional deep wells with a total water production of about 31,900 cu.m/day. This is to cope with the peak hour water demand.

To supply the northwestern service area, the reservoirs required in Alternative D-3 and D-4 are compared on the ground reservoir and the elevated tank due to comparatively small storage requirement. The maximum storage capacity of the elevated tank is limited up to 500 cu.m per tank considering the strength of its structure. A cost comparison of these alternatives is shown in TABLE 7.3.4.

TABLE 7.3.3 REQUIRED STORAGE VOLUME AND ADDITIONAL WATER SOURCES

Alternative	Required Storage Volume (cu.m)						
		Maximum		Intermediate		Minimum	
	Emergency	Operat'l	Total	Operat'l	Total	Operat'l	Total
Alternative D-1							
Reservoir A	1,345	2,180	3,525	194	1,539	0	1,345
Reservoir B	3,638	5,893	9,531	524	4,162	0	3,638
Total	4,983	8,073	13,056	718	5,701	0	4,983
Alternative D-2							
Reservoir	4,983	8,073	13,056	718	5,701	0	4,983
Alternative D-3							
Northwestern Area							
Reservoir	283	632	915	163	446	0	283
Other Area							
Reservoir A	1,551	2,475	4,026	186	1,737	0	1,551
Reservoir B	3,149	5,026	8,175	378	3,527	0	3,149
Sub Total	4,700	7,501	12,201	564	5,264	0	4,700
Total	4,983	8,133	13,116	727	5,710	0	4,983
Alternative D-4							
Northwestern Area							
Reservoir	283	632	915	163	446	0	283
Other Area							
Reservoir	4,700	7,501	12,201	564	5,264	0	4,700
Total	4,983	8,133	13,116	727	5,710	0	4,983
Additional Water Source	(No. of Well)		0		11		11
	(cu.m/day)		0		31,900		31,900

TABLE 7.3.4 COST COMPARISON OF GROUND RESERVOIR AND ELEVATED TANK

Unit : ₱ x 1,000

Alternatives	Maximum	Intermediate	Minimum
<u>Ground Reservoir</u>			
Construction	1,565	989	739
Booster Pump at Reservoir with 35 mH	1,380	1,380	1,380
Additional Water Source with Pump	0	1,580	1,580
TOTAL	2,945	3,949	3,699
<u>Elevated Tank</u>			
Construction	2,678 (2 units)	1,313	1,917
Additional Water Source with Pump (35 mH)	0	1,580	1,580
TOTAL	2,678	2,893	3,497

Aside from the above comparison made on construction cost, the ground reservoir has a potential disadvantage that the booster pump requires a running cost for its operation and maintenance. Thus, it is concluded that the utilization of the elevated tank is needed only for this specific service area.

Based on the above conclusion, an overall cost comparison of reservoirs with different storage capacities is made as shown in TABLE 7.3.5, and concluded that the daily maximum supply with the maximum storage capacity is the most economical configuration of the reservoir location and distribution method.

TABLE 7.3.5 COST COMPARISON OF DIFFERENT STORAGE CAPACITIES

Unit : ₱ x 1,000

Alternative	Maximum	Intermediate	Minimum
Alternative D-1			
Reservoir A	3,705	2,182	2,002
Reservoir B	6,996	4,120	3,781
Sub Total	10,701	6,302	5,743
Additional Water Source	0	17,380	17,380
TOTAL	10,701	23,682	23,163
Alternative D-2			
Reservoir	8,554	5,038	4,622
Additional Water Source	0	17,380	17,380
TOTAL	8,554	22,418	22,002
Alternative D-3			
Northwestern Area			
Elevated Tank	2,678 (2 units)	1,313 (1 unit)	1,917 (1 unit)
Additional Water Source	0	1,580	1,580
Sub-Total	2,678	2,893	3,497
Other Area			
Reservoir A	4,034	2,357	2,193
Reservoir B	6,342	3,707	3,448
Additional Water Source	0	15,800	15,800
Sub-Total	10,376	21,864	21,441
TOTAL	13,054	24,757	24,938
Alternative D-4			
Northwestern Area (Same as Alternative D-3)	2,678	2,893	3,497
Other Area			
Reservoir	8,192	4,787	4,453
Additional Source	0	15,800	15,800
Sub-Total	8,192	20,587	20,253
TOTAL	10,870	23,480	23,750

(3) Distribution Network

In accordance with the result of foregoing studies, the most optimum configuration for the distribution network for each alternative distribution system is determined through the computer-aided hydraulic simulation. The network analysis is carried out to meet the peak hour water demand in the year 2010 (Phase II). Major distribution pipeline routes are selected considering the existing road conditions and the planned roads in the city development plan. The configuration for the distribution network is presented in TABLE 7.3.6 and the result of computer-aided hydraulic simulation is contained in APPENDIX 7.3.2.

TABLE 7.3.6 CONFIGURATION OF ALTERNATIVE DISTRIBUTION NETWORKS

	Alt. D-1	Alt. D-2	Alt. D-3	Alt. D-4
ϕ150 mm	4,290	7,030	6,180	7,930
ϕ200 mm	4,950	9,830	4,800	5,550
ϕ250 mm	8,670	4,710	6,970	4,860
ϕ300 mm	2,840	300	1,120	-
ϕ350 mm	4,720	4,520	5,220	3,210
ϕ400 mm	1,620	1,640	1,120	1,640
ϕ450 mm	2,240	1,630	2,240	2,240
ϕ500 mm	600	1,070	600	460
ϕ600 mm	200	-	200	-
ϕ700 mm	-	800	-	800
Total	30,130	29,530	28,450	26,690

The cost estimates of the above alternatives are subsequently performed as shown in TABLE 7.3.7.

TABLE 7.3.7 CONSTRUCTION COST OF ALTERNATIVE DISTRIBUTION NETWORKS

Unit : ₱x1,000

Cost	Alt. D-1	Alt. D-2	Alt. D-3	Alt. D-4
Distribution Pipes	21,488	20,650	19,772	18,841
Valves	3,975	4,368	3,728	3,915
TOTAL	25,463	25,018	23,500	22,756

7.3.3 Selection of Optimum Water Supply System

(1) Overall Composition of Alternatives

The following are the overall system configuration of alternative integrated from the results of forgoing studies.

TABLE 7.3.8 OVERALL CONFIGURATION OF ALTERNATIVE WATER SUPPLY SYSTEMS

Facilities	Alternative D-1	Alternative D-2	Alternative D-3	Alternative D-4
o Water Source	11 wells	11 wells	11 wells	11 wells
o Transmission (ø200 - ø500 mm)	700 m	750 m	750 m	750 m
o Distribution				
Reservoir	3,525 cu.m x 1 unit	13,056 cu.m x 1 unit	4,026 cu.m x 1 unit	12,201 cu.m x 1 unit
Reservoir	9,531 cu.m x 1 unit		8,175 cu.m x 1 unit	
Elevated Tank	-	-	458 cu.m x 15 m x 2 units	458 cu.m x 15 m x 2 units
Booster Pump	610 l/s x 50 m 230 l/s x 40 m	880 l/s x 50 m 70 l/s x 20 m	590 l/s x 50 m 290 l/s x 40 m	820 l/s x 50 m
Pipe (ø150 - ø700 mm)	30,130 m	29,530 m	28,450 m	26,690 m

(2) Cost Comparison of Alternatives

The overall cost comparison of four alternative water supply systems is conducted as shown in TABLE 7.3.9 and details are contained in APPENDIX 7.3.3.

TABLE 7.3.9 OVERALL COST COMPARISON OF ALTERNATIVE WATER SUPPLY SYSTEMS

Unit:₱x1,000

Facilities	Alternative D-1	Alternative D-2	Alternative D-3	Alternative D-4
Construction Cost				
Water Source	29,100	29,100	29,100	29,100
Transmission Line	4,740	5,470	4,775	5,020
Distribution Reservoir	10,701	8,554	13,054	10,870
Booster Pump Station	12,969	13,346	13,494	11,171
Distribution Pipe	21,488	20,650	19,772	18,841
Valve	3,975	4,368	3,728	3,915
TOTAL	82,973	81,488	82,923	78,917
O & M Cost (15 years)				
Energy Consumption	32,482	33,018	33,167	32,965
Labor	9,000	9,000	8,640	8,640
Maintenance (10% of construction cost)	8,297	8,149	8,530	7,892
TOTAL	49,779	50,167	50,337	49,497
GRAND TOTAL	132,752	131,655	134,260	128,414

Based on the above cost comparison, Alternative D-4 is the most optimum system configuration for the water supply system.

7.3.4 Phasing of Distribution Network Development

(1) Development of Alternatives

Further alternative studies on the distribution network of the previously selected overall water supply system was carried out to establish the most optimum implementation program both for the short term and the long term developments.

The computer-aided hydraulic simulation of the distribution network is therefore a key subject of this study. Two alternative approaches of the study are then considered; Alternative D-4-A consists of a single pipeline alignment, and Alternative D-4-B forms a parallel pipeline alignment. Particulars of these alternatives are as follows:

Alternative D-4-A

- o The most optimum network configuration to allow the peak hour water flow in the year 2010 as established in the foregoing alternative study is the basis of this particular alternative.

- o Major distribution pipes to be required in the Phase I period are identified from the above-mentioned network configuration.

- o Phase II distribution network will be completed by installing additional pipes in the area to be served in this period.

Alternative D-4-B

- o Based on the optimum route of major distribution pipelines as determined in the previous alternative study, the least cost network configuration, which is mainly pipe sizes, is determined to satisfy a minimum of 0.7 kg/sq.cm of water pressure under the peak hour water flow during the Phase I period.

- o For the Phase II water demand, additional pipes wherever necessary for augmenting the distribution capacity to cope with all the criteria set forth in the LWUA methodology manual are determined. Likewise, several pipeline routes will form a parallel pipe alignment.

The configuration of alternative distribution networks by construction phases is presented in TABLE 7.3.10 and the results of computer-aided hydraulic simulation are contained in APPENDIX 7.3.2.

TABLE 7.3.10 CONFIGURATION OF ALTERNATIVE PHASING FOR DISTRIBUTION NETWORK DEVELOPMENT

Materials	Alternative D-4-A			Alternative D-4-B		
	Phase I	Phase II	Total	Phase I	Phase II	Total
Pipe (m)						
ø150 mm	1,740	6,190	7,930	4,280	8,980	13,260
ø200 mm	3,750	1,800	5,550	4,730	3,700	8,430
ø250 mm	690	4,170	4,860	1,190	2,630	3,820
ø300 mm	0	0	0	2,420	3,230	5,650
ø350 mm	3,210	0	3,210	1,520	1,550	3,070
ø400 mm	1,640	0	1,640	1,070	0	1,070
ø450 mm	2,240	0	2,240	610	0	610
ø500 mm	460	0	0	600	0	600
ø600 mm	0	0	0	0	600	600
ø700 mm	700	100	800	100	100	200
TOTAL	14,430	12,260	26,690	16,520	20,790	37,310
Valve (pcs.)						
ø150 mm	6	21	27	14	30	44
ø200 mm	13	6	19	16	12	28
ø250 mm	2	14	16	4	9	13
ø300 mm	0	0	0	8	11	19
ø350 mm	11	0	11	5	5	10
ø400 mm	5	0	5	4	0	4
ø450 mm	7	0	7	2	0	2
ø500 mm	2	0	2	2	0	2
ø600 mm	0	0	0	0	2	2
ø700 mm	2	0	2	0	0	0
TOTAL	48	41	89	55	69	124

(2) Cost Comparison

Construction costs of each alternative were estimated. The costs of valves to be installed at every 300 m intervals were also included.

For this purpose, the year of construction is set in 1990 for Phase I and 1998 for Phase II pipelines. The discount rate applied to each phase is 12% per annum. For reference, 10% per annum and 15% per annum are also considered.

A summary of cost comparison is presented in TABLE 7.3.11.

TABLE 7.3.11 COST COMPARISON OF ALTERNATIVE DISTRIBUTION NETWORK FOR PHASED DEVELOPMENT

Distribution Network	Discount Rate 10%	Discount Rate 12%	Discount Rate 15%
Alternative D-4-A			
Phase I : (ϕ150 - ϕ700 mm)			
Pipeline : 14,430 m	7,543	7,226	6,678
Valve : 48 pcs.	2,048	1,962	1,813
Sub-Total	9,591	9,188	8,491
Phase II : (ϕ150 - ϕ700 mm)			
Pipeline : 12,260 mm	1,519	1,300	1,009
Valve : 41 pcs.	75	64	49
Sub-Total	1,594	1,364	1,058
TOTAL	11,185	10,552	9,549
Alternative D-4-B			
Phase I : (ϕ150 - ϕ700 mm)			
Pipeline : 16,520 m	6,784	6,500	6,007
Valve : 55 pcs.	1,155	1,107	1,023
Sub-Total	7,939	7,607	7,030
Phase II : (ϕ150 - ϕ700 mm)			
Pipeline : 20,790 m	2,962	2,534	1,966
Valve : 69 pcs.	382	327	254
Sub-Total	3,344	2,861	2,220
TOTAL	11,283	10,468	9,250

According to the above cost comparison, the difference of the net present worth of comparable costs is less than 6%. Therefore, further comparison is made by adopting the cost escalation rate; 12% per annum from 1986 to 1989 and 10% per annum for the later project period. The inflated net present worth of comparable cost is shown in TABLE 7.3.12.

TABLE 7.3.12 ESCALATED PROJECT COST OF ALTERNATIVE DISTRIBUTION NETWORK FOR PHASED DEVELOPMENT

	Discount Rate		
Distribution Network	10%	12%	15%
Alternative D-4-A			
Phase I	15,092	14,458	13,361
Phase II	5,377	4,601	3,569
TOTAL	20,469	19,059	16,930
Alternative D-4-B			
Phase I	12,492	11,970	11,062
Phase II	11,279	9,650	7,488
TOTAL	23,771	21,620	18,550

Based on the above cost comparison, it is concluded that Alternative D-4-A (single pipeline alignment) is the most optimum plan for phasing the development of distribution network.

CHAPTER 8
RECOMMENDED PLAN

CHAPTER 8 RECOMMENDED PLAN

8.1 GENERAL

This chapter presents the recommended plan for the short term and long term development of the Angeles City water supply system based on the results of fore-going alternative studies.

The recommended plan consists of two construction phases; Phase I (1986-1995) and Phase II (1996-2010). Phase I period is further divided into two stages; Stage 1 (1986-1990) and Stage 2 (1991-1995) considering the scope of immediate improvements and capital cost requirements.

The proposed implementation program includes the development of water sources and the construction of conveyance, transmission, treatment and disinfection, storage and distribution facilities. The repair and rehabilitation of existing water supply facilities are considered in the Phase I activities.

This chapter also presents capital and annual project costs of the recommended implementation schemes.

Some deviations from the technical standards being adopted in the LWUA Methodology Manual have been applied in the Phase I period due to cost considerations. These deviations are: staging of some waterworks facilities to provide lower initial construction costs; provision of lower system pressure, and the postponement of the construction of the administration building to Phase II. All costs presented in this chapter are based on 1986 price level.

8.2 RECOMMENDED WATER SUPPLY SYSTEM

8.2.1 Layout of the Water Supply System

The general layout of the recommended water supply system for Angeles City is shown in FIGURE 8.2.1 and its schematic layout is shown in FIGURE 8.2.2.

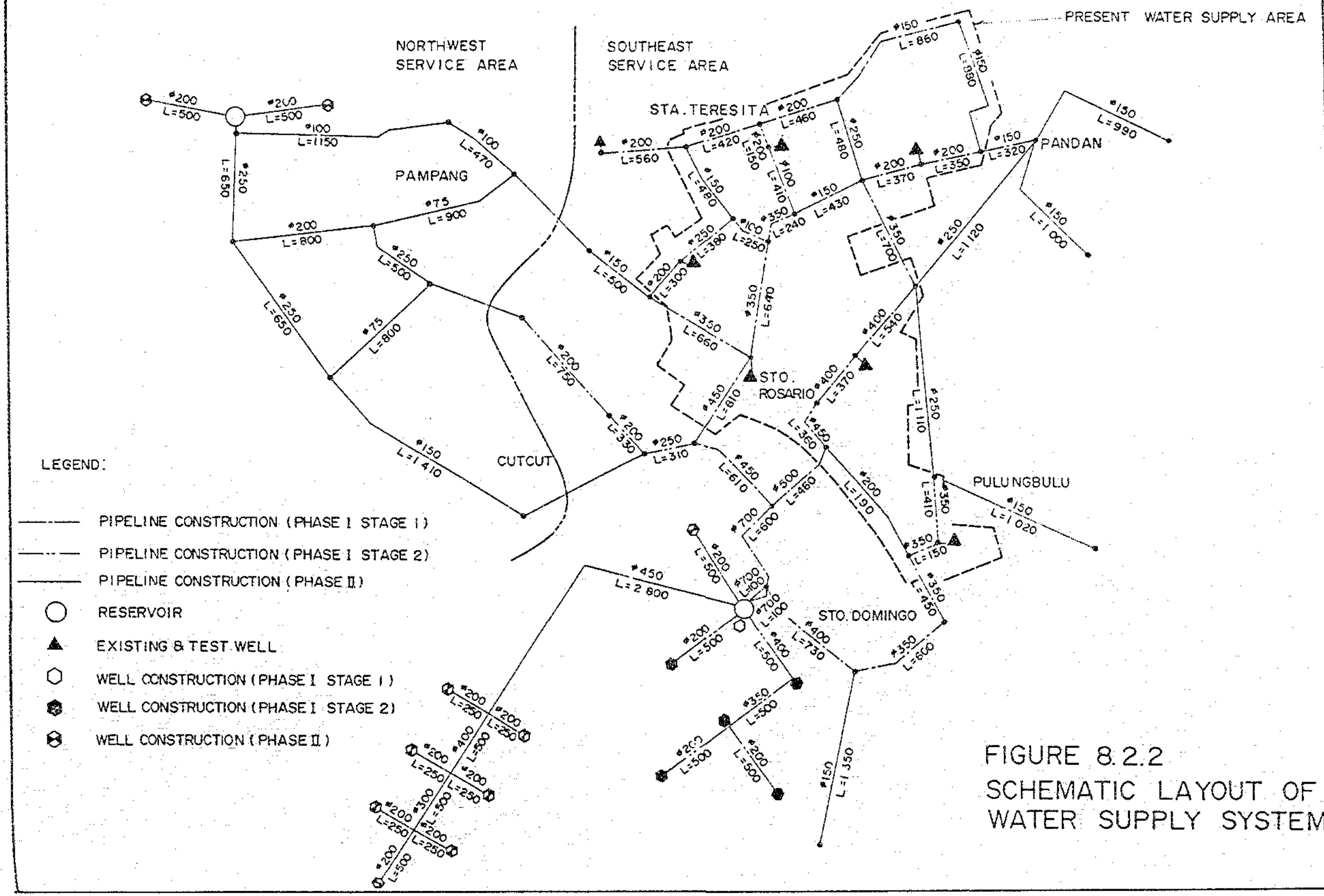

FIGURE 8.2.2
SCHEMATIC LAYOUT OF
WATER SUPPLY SYSTEM

The description of the required facilities by project phase is given in TABLE 8.2.1 and a summary of the major facilities is also given in TABLE 8.2.2.

(1) Source Facility

The existing 12 deep wells will be consolidated into 5 deep wells considering the yield and the distance to neighboring wells in relation to the influence area of drawdown of groundwater table. Existing pumps at these wells will be renewed during the Stage 1 of Phase I period.

The lack of water production will be managed by construction of new deep wells that will each have a planned discharge of 2,900 cu.m/day with a casing diameter of 250 mm and a total depth of 200 m. New deep wells will be constructed in Sto. Domingo area during Phase I period and in Pampang area (northwestern part of the City) and Porac area during Phase II period (See FIGURE 8.2.3).

The number of wells by area is determined based on the concept of distributing wells depending on the groundwater table.

(2) Transmission Facility

New transmission main will be constructed from wells to respective reservoirs corresponding to the plan of water source development.

(3) Treatment Facility

A constant flow chlorinator will be installed at the planned reservoir and the wells, from which water will be distributed directly to the service area.

(4) Distribution Facility

Storage capacity of reservoir is determined to be the maximum storage volume (100% distribution in 24-hour period) together with an emergency storage equivalent to 2-hour supply amount of the daily maximum water demand. The size of reservoir is determined in compliance with the water demand in each project phase and the emergency storage will be satisfied in the Phase II period.

The proposed service area will be divided into 2 sub-service areas (northern part with high ground elevation and southeastern part with low ground elevation) considering the topography and water demand.

The existing distribution lines will be utilized as a part of the proposed internal network, but subject to the leakage detection survey and repair/replacement, if necessary. All the proposed distribution mains will be, therefore, newly constructed.

(5) Service Connections

As it has been observed during the field survey of existing water supply facilities, there are considerable number of service connections with not-functioning water meters and unmetered service connections. Leakages from service connections were also confirmed.

Resultant from these situation, the implementation of leakage detection survey and repair/replacement of damaged water meters and service connections will be carried out in the early stage of the Project in order to increase the accounted-for water. The installation of water meters at new service connections and the provision of preventive maintenance program are another prerequisites for the sound operation of future water supply system.

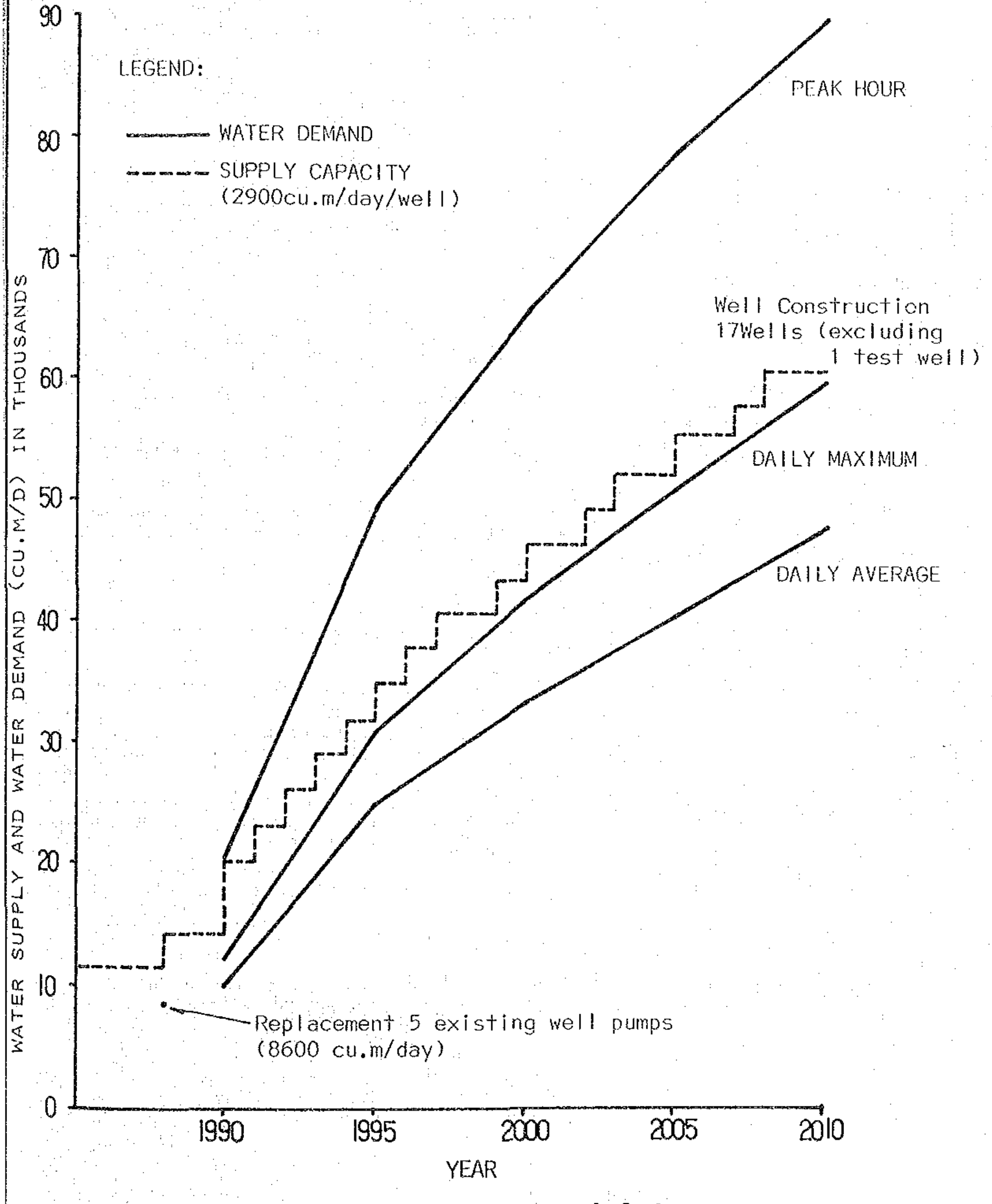

FIGURE 8.2.3

WATER SUPPLY VS. DEMAND CURVE
OF RECOMMENDED PLAN

TABLE 8.2.1 DESCRIPTION OF REQUIRED MAJOR FACILITIES BY PHASE

Phase	Facility	Major Facilities Required
Phase I Stage 1	Source	Existing 12 wells will be consolidated into 5 wells (8,600 cu.m/day) with replacement of pumps. One new well (2,900 cu.m/day) will be constructed in Sto. Domingo area. Total water production will be 14,400 cu.m/day.
	Treatment	Each one unit of constant flow chlorinator will be installed at 6 wells for direct distribution and at the reservoir.
	Transmission	No transmission main will be constructed, except from a new well to adjoining new reservoir.
	Distribution	A new reservoir (4,292 cu.m) equipped with booster pump (Q=70 l/sec, H=50 m) will be constructed at Sto. Domingo area. New distribution main (ϕ150-ϕ700 mm, 12,030 m) will be constructed to cover the existing service area. New internal network (ϕ100-ϕ150 mm, 11,190 m) will be constructed for the residential area. Leakage detection survey will be conducted throughout the existing service area and leakage repair will be carried out as necessary.
	Electricity	Substation will be constructed at the new reservoir in Sto. Domingo. (500 KVA)
Stage 2	Source	No. 14 existing well will be reconstructed. Five new wells with a total production of 14,500 cu.m/day will be constructed in Sto. Domingo area.
	Treatment	One unit of constant flow chlorinator will be installed at No. 14 well for direct distribution.
	Transmission	New transmission line (ϕ200-ϕ400 mm, 2,500 m) from new wells in Sto. Domingo area to the reservoir will be constructed.
	Distribution	Additional distribution pump will be installed at the reservoir. Additional distribution main (ϕ150-ϕ350 mm, 2,100 m) will be installed to cover the expanded service area. Additional internal network will be constructed in commercial area with ϕ100-ϕ150 mm for 4,140 m and residential area with ϕ75-ϕ100 mm for 36,270 m.

TABLE 8.2.1 DESCRIPTION OF REQUIRED MAJOR FACILITIES BY PHASE (Cont'd)

Phase	Facility	Major Facilities Required
Phase II	Source	A total of 10 deep wells (2,900 cu.m/day/well) will be constructed; 1 in Sto. Domingo area, 7 in Porac area and 2 in the northwestern (high ground elevation) area.
	Treatment	Each one unit of constant flow chlorinator will be installed at the reservoir and two new elevated tanks.
	Transmission	Additional transmission line (ϕ200-ϕ500 mm, 7,300 m) will be installed for Sto. Domingo area and the northwestern (high ground elevation) area.
	Distribution	The reservoir in Sto. Domingo area will be expanded to have additional 7,909 cu.m storage capacity. Two units of elevated tank (458 cu.m each with 15 mH) will be constructed in the northwestern (high ground elevation) area. Additional distribution main (ϕ150-ϕ250, ϕ700 mm, 12,560 m) will be constructed to cover the expanded service area. Additional internal network will be constructed in the northwestern (high ground elevation) area with ϕ100-ϕ150 mm for 6,000 m and in the south (low ground elevation) area with ϕ75-ϕ100 mm for 53,760 m. A total of 525 fire hydrants will be installed throughout the service area.
	Electricity	Substation in Sto. Domingo area will be renewed/augmented. (1,000KVA)
	Others	Equipment (pump, water meter, etc.) will be renewed corresponding to the respective service-life.

TABLE 8.2.2 SUMMARY OF MAJOR FACILITIES REQUIRED BY PHASE

Phase / Item	Phase I Stage 1	Phase I Stage 2	Phase II	Total	Remarks
1. Source Facility					
(1) Deep well (ϕ250mmx200mD)	1 unit	6 units	10 units	17 units	
(2) Pumping facility					
1) New pumping station(22kw)	2 sets	6 sets	10 units	18 units	
2) Existing pumping station (replacement of existing pumps)	5 sets	-	-	5 sets	(No. 1,5, 6,7 & 8)
3) Flow meter (ϕ150)	7 sets	6 sets	10 sets	23 sets	
2. Transmission Facility					
(1) Pipeline (ϕ200-ϕ500 mm)	-	2,500 m	7,300 m	9,800 m	
3. Distribution Facility					
(1) Reservoir (V=4,292 - 7,909 cu.m)	1 unit (4,292 cu.m)	-	1 unit (7,909 cu.m)	2 units	(Sto. Domingo)
(2) Elevated Tank (V=458 cu.m, 15 mH)	-	-	2 units	2 units	(Pampang)
(3) Pump facility	1 set	1 set	1 set	3 sets	
(4) Pump house	1 unit	-	1 unit	2 units	
(5) Chlorination facility (constant flow, 22kg/day)	7 sets	1 set	3 sets	11 sets	
(6) Electric Sub-station	1 unit	-	1 unit	2 units	
(7) Distribution pipes					
1) Main pipes (ϕ150-ϕ700 mm)	12,030 m	2,100 m	12,560 m	26,690 m	
2) Valve (ϕ150-ϕ700 mm)	38 sets	7 sets	42 sets	87 sets	
3) Internal network (ϕ 75-ϕ150 mm)	11,190 m	40,410 m	59,760 m	111,360 m	
4) Service Connection	3,960	14,400	17,570	35,930	ϕ1/2" - ϕ3/4"
5) Water meter	2,065	-	-	2,065	ϕ1/2" - ϕ3/4"
6) Fire hydrant	-	-	525 sets	525 sets	
7) Flow meter (ϕ400 mm)	1 set	-	1 set	2 sets	
(8) Administration & Operation building	1 unit	-	1 unit	2 units	
(9) Leakage Detection Service connection	4,128 sets	-	-	4,128 sets	

Note: Excluding replacement/renewal of equipment.

8.2.2 Implementation Program

In accordance with the facility requirements as described in the previous section, the project implementation program is developed as shown in FIGURE 8.2.4.

8.2.3 Project Cost

The project cost is estimated based on the implementation program using the current market price of equipment and materials and the LWUA Methodology Manual at the 1986 price level.

A summary of estimated project cost is shown in TABLE 8.2.3 and the detailed break down is given in APPENDIX 8.2.1.

Standby generator for stable supply and the chlorine neutralization equipment for safety measure are not considered in this planning stage, though these shall be determined prior to expand the water supply service.

FIGURE 8.2.4 IMPLEMENTATION PROGRAM

Descriptin		Phase I Stage 1			Phase 1 Stage 2					Phase II		
	'87	'88	'89	'90	'91	'92	'93	'94	'95	2000	2005	2010
Appraisal & Loan Procedure	——											
Engineering Service												
- Detailed Design		——								—		
- Construction Supervision					——	——	——	——	——	——	——	——
- Leakage Detection		1,376	1,376	1,376								
Source Facility												
- Deep Well (ø250x200m)			1		2	1	1	1	1	- - -	10	- - -
- Deep Well Pump Station			2		2	1	1	1	1	- - -	10	- - -
- Replacement of Existing Pump			5									
Transmission Facility												
- Main Pipe (ø200-ø400)					1,000	500	500	500			7,300	
- Main Pipe (ø200-ø450)										- - -	- - -	- - -
Distribution Facility												
- Reservoir (V= 4,290cu.m)			——									
- Reservoir (V= 7,910cu.m,)										—		
- Elevated Tank (V= 460cu.m, H=15m)										2		
- Booster Pump Station			- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
- Main Pipe ø150-ø700			7,260	4,770	2,100							
- Main Pipe ø150-ø700										- - -	12,560	
- Internal Network												
o Residential Area (ø75-ø100)			5,600	5,590	7,260	7,250	7,250	7,250	7,250		53,760	
o Commercial Area (ø100-ø150)					830	830	830	830	820		6,000	
- Fire Protection (ø100, ø150)										- - -	525	- - -
- Service Connection (ø1/2")			1,970	1,970	2,874	2,874	2,974	2,874	2,874		17,540	
(ø3/4")			10	10	6	6	6	6	6		30	
- Rehabilitation												
o Water Meter		——										
o Service Connection		——	——	——								
o Laterals			——	——								
- Disinfection (Chlorinator)			—	—	—					—		
- Electric Sub-Station			——							—		
Others												
- Operation Center			——							—		
- Administration Building												—
- Land Aquisition		——			——					—		
- Vehicle		2			1	1	1	1		1	1 1	1
- Replacement of equipments installed in Phase I		*			*	*	*	*		* - - -	* * - - -	* - - -

Legend: —— : Continuous Work; - - - : Intermittent Work; * : Procurement

TABLE 8.2.3 SUMMARY OF PROJECT COST

Unit: ₱x1,000

Facility	Phase I Stage 1	Phase I Stage 2	Phase II	Total
1) Source	4,254	9,852	16,420	30,526
2) Transmission	-	1,715	6,479	8,194
3) Distribution	31,357	26,553	56,775	114,685
4) Elec. Substation	2,757	0	5,131	7,888
5) Operation Center/ Adm. Bldg.	1,590	0	2,910	4,500
6) Material & Equip.	1,038	1,719	2,164	4,921
7) Land Acquisition	348	240	1,116	1,704
8) Replacement of Equipment	-	-	26,093	26,093
Sub Total	41,344	40,079	117,088	198,511
Physical Contingency (8%)	3,308	3,206	9,367	15,881
T O T A L	44,652	43,285	126,455	214,392
Leakage Detection	990	-	-	990
Engineering Charge				
Detailed Design (10% of TOTAL)	8,794	-	12,646	21,440
Construction Supervision (4% of TOTAL)	1,786	1,731	5,058	8,575
GRAND TOTAL	56,222	45,016	144,159	245,397
Operation & Maintenance Cost (per annum)	2,989	6,916	12,115	

CHAPTER 9
FINANCIAL FEASIBILITY ANALYSIS

CHAPTER 9 FINANCIAL FEASIBILITY ANALYSIS

9.1 GENERAL

The selected technical alternative for the realization of water supply for the Short Term Development Plan has been shown in Chapter 8. Such a plan must however be verified from a financial viewpoint. The financial feasibility of the project was analyzed and a financial plan to allocate available funds, based on LWUA's guideline, has been developed in this chapter.

The analysis of the financial viability of the project covers the revenues which mainly come from water sales, the development costs, the operating and maintenance costs, debt service on the loans, etc. during the first 10 years from the start of the construction of the water system. The Financial Internal Rate of Return (FIRR) is also calculated.

The proposed water rates should be fair, reasonable, and realistic based on the ability of the consumers to pay. In order to achieve this, a socialized rate structure will be adopted.

9.2 EXISTING SYSTEM

9.2.1 Rate Structure

As of July 1986, ACWS has 4,128 metered and unmetered connections. The following rate structure has been effective since 1978 in the waterworks system.

(1) Water Rates

There are two (2) types of water rates, i.e., flat rates and metered rates, as follows:

a) Flat Rates

Consumer Type	Size of Connection	Flat Rate
Domestic/Government	1/2"	₱ 18.00/month
	3/4"	40.00/month
Commercial/Industrial	1/2"	90.00/month
	3/4"	145.00/month
	1"	255.00/month

For each extra faucet, additional flat rate fee of P2.00/month shall be charged.

These rates are applicable to unmetered connections.

b) Metered Rates

Consumer Type	Size of Connection	Minimum Charge (₱/10cu.m/month)	Excess of 10 cu.m (₱/cu.m)
Domestic/Government	1/2"	14.00	0.80
	3/4"	32.00	0.80
Commercial/Industrial	1/2"	40.00	1.60
	3/4"	64.00	1.60
	1"	128.00	1.60

These rates are applicable to metered connections.

(2) Connection Service Fees

The applicant pays the following connection service fees.

a) For tapping work on the water mainline: ₱30.00

b) Pipe installation fee:

Unpaved road	₱10.00/meter
Paved road	20.00/meter

(3) Other Service Fees

In addition, the other service fees paid by the applicant are:

Reopening	:	₱15.00
Shutting off	:	15.00
Repair of water meter	:	15.00

9.2.2 Revenue and Expenditure

The annual revenue and expenditure of the waterworks system in the last three years are shown below:

Year	Revenue	Expenditure (Capital Outlay)	Deficit
1983	₱1,242,917	₱1,531,754 (84,526)	₱288,837
1984	1,429,935	1,979,144 (4,409)	549,209
1985	1,678,432	2,169,884 (0)	491,452

As shown above, the waterworks incurred a deficit on its annual operations.

In 1985, the waterworks revenue accounted for 3.5% of the City's total revenue while its expenditure amounted to 4.3% of the City's total expenditure.

The breakdown of the revenue of the waterworks is shown in TABLE 9.2.1.

TABLE 9.2.1 BREAKDOWN OF REVENUE OF ACWS

	1983	1984	1985
Water Bill	₱1,171,501.59	₱1,359,882.26	₱1,594,558.26
Water Penalties	71,415.06	70,052.30	83,873.26
Total	₱1,242,916.65	₱1,429,934.56	₱1,678,431.52

To increase the revenue of ACWS, priority should be given to the provision of meters covering all connections. Also the present water rate must be reviewed to provide a more socialized scheme such as that introduced by Balibago Waterworks System, Inc. (also located in Angeles City)

A breakdown of the expenditures is shown in TABLE 9.2.2. Also the corresponding breakdown in percentage is shown below:

	1983	1984	1985
Personal Services	23 %	23 %	36 %
Maintenance and Operating Expenses	68	72	60
Capital Outlay	6	0	0
Collection Services	3	5	4
Total Expenditure	100 %	100 %	100 %

Electricity cost which is included in the maintenance and operating expenses accounted for over 50% of the total expenditure from 1983 to 1985.

TABLE 9.2.2 EXPENDITURE OF ACWS

	1983	1984	1985
1. Personal Services			
Salaries and Wages	₱277,583	₱306,042	₱512,739
Insurance 1/	26,782	29,109	33,603
Living Allowance & Medicare	38,202	103,347	220,953
Home Development Fund & Terminal Leave	9,881	8,332	9,663
Sub-Total	₱352,448	₱446,830	₱776,958
2. Maintenance and Other Operating Expenses			
Traveling & Communication	₱ 3,717	₱ 1,923	₱ 1,090
Maintenance of Gov't Facility	231,708	247,586	49,656
Supplies and Materials	11,411	22,088	20,405
Electricity	760,000	1,117,300	1,219,967
Others 2/	35,892	40,335	11,853
Sub-Total	₱1,042,728	₱1,429,232	₱1,302,971
3. Capital Outlay			
Equipment	₱84,526	₱ 4,409	0
4. Collection Services	₱52,052	₱98,673	₱89,956
Total Expenditure	₱1,531,754	₱1,979,144	₱2,169,885

1/ Life insurance, Retirement insurance and State insurance

2/ Repair & spare parts for motor vehicle, gasoline & oil, etc.

9.2.3 Bill Rendering and Collection

Meter readers read all the metered connections every month, and bills are issued for each class of services. These are delivered to the customers by bill collectors of the waterworks. Normally 7 days elapse between bill issuance and delivery. Collections are done on the day the bill are delivered. About 75% of the bills delivered are paid at the first call of collectors. The average rate of bill collection is placed at 85%.

Generally, consumers who are delinquent in paying their water bills are notified 15 days after the deadline of payment as per the system's regulations. A final notice is issued after 30 days if a consumer still fails to pay the bill. Non-payment against this final notice would result in the service disconnection by the waterworks.

9.3 MARKET SURVEY

The market survey for the study area in Angeles City was conducted from June 19 to July 1, 1986 with LWUA using the simplified market survey method. The number of respondents totalled 6,556 and the estimated coverage ratio in the study area is 27%.

The details of the market survey results is shown in Appendix 9.3.1.

From the market survey, the income distribution of the respondents are determined as follows:

Income Bracket 3/	Ave.Pesos	Number
₱900 and below	722	903
₱901 to ₱1500	1,292	1,754
₱1,501 to ₱2,500	2,132	1,339
₱2,501 to ₱4,500	3,486	1,358
₱4,501 and above	8,256	945

3/ Residential, excluding no-income and no-answer

From the result of the market survey, the respondents' willingness to connect and the user's types are summarized as follows :

Answer		Residential	Commercial	Industrial	Total
Yes	:	59.4%	49.1%	46.1%	59.1%
No	:	15.2	19.3	19.2	15.3
Undecided	:	0.4	0.0	3.3	0.4
With Own Conn.	:	25.0	31.6	30.8	25.2

Residential users account for 97% of the total respondents. The respondents' willingness to connect is approximately 60% of the total, while unwillingness to connect is 15%. It was observed from the results of the survey that the majority of the respondents in all income brackets are willing to connect to the waterworks system.

Judging from the above, it is safe to conclude that the majority of the residents in the study area are willing to connect to the new system when the water supply system is expanded.

9.4 PROJECT COST AND FINANCING

9.4.1 Project Implementation Schedule and Project Period

As described in chapter 8, in the project schedule of this study, it is assumed that :

- Design will be completed in 1988
- Construction will be started in 1989 and completed by 1995.

The financial analysis covers a 10-year period which includes the construction period. However, a 20 year period is adopted for the calculation of FIRR.

9.4.2 Financial Conditions

The major potential sources of funds for the Water District are the operating sources and the non-operating sources.

The operating sources are the excess of revenue over expenses. The LWUA's guideline suggests that the District should make a contribution of 10% to the project cost as equity. However, when the waterworks cannot provide the said equity due to its current tight financial situation, it is suggested that the government will provide a grant to the District to make up for the equity. In this study, 5% of the project cost is set as the equity.

The non-operating sources include loans. In this study, to realize a reasonable water rate structure, it is recommended that the LWUA introduce a soft loan into the project in addition to the regular loan. The loan funds from LWUA will be utilized to finance the balance of the project cost plus capitalized interest. Presently, LWUA's terms include:

(1) Regular Loan

Interest	:	First ₱2 million : 10% per annum Next ₱5 million : 12% per annum Above ₱7 million : 14% per annum
Duration	:	Thirty-year loan; disbursements are assumed to be made at mid-year, and the maximum disbursement period is four years.
Principal	:	Principal repayment is thirty years with one year grace period.

(2) Soft loan

Interest	:	10% per annum Interest is not charged for the first 5 years, with the district to start paying interest on the 6th year. In cases where the project is not completed within 5 years, interest will be capitalized from the 5th year up to the time of completion.
Principal	:	Principal Repayment is 20 years starting on the 11th year after the start of disbursement.

9.4.3 Project Cost

On the basis of the cost estimate developed in Chapter 8, the project cost for the District in the Short Term Development Plan is estimated at ₱204.46 million and its breakdown is shown in TABLE 9.4.1.

The proposed financing scheme for the project is as follows :

Project Cost		₱204.46	million
Equity	5%	10.22	"
LWUA Regular Loan	50%	102.23	"
LWUA Soft Loan	45%	92.01	"
Capitalized Interest		₱24.41	"
Total Project Cost		₱228.87	million

The computation of capitalized interest and the subsequent debt service obligations of the District are presented in TABLE 9.4.2. The long term borrowing from 1988~95 amounts to ₱218.65 million.

9.4.4 Operating and Maintenance Cost

The operating and maintenance costs, shown in TABLE 9.4.3, described in detail in Chapter 8, include all annual expenses necessary in operating the system and maintaining its revenue producing capacity. In the financial projections, the operating and maintenance costs are assumed to increase according to the increase in the capacity of the system with expected inflationary effect as shown in TABLE 9.4.4.

9.4.5 Escalation of Costs

To account for the effects of inflation, the investment costs and the annual operating and maintenance costs are escalated by 15% compounded per annum.

TABLE 9.4.1 BREAKDOWN OF PROJECT COST

(Unit : 1,000 Pesos)

Year	1988	1989	1990	1991	1992	1993	1994	1995	Total
Construction Cost	2,543	27,454	11,347	11,406	7,320	7,320	7,298	6,735	81,423
Physical Contingencies	203	2,196	908	912	586	586	584	539	6,514
- Sub Total -	2,746	29,650	12,255	12,318	7,906	7,906	7,882	7,274	87,937
Price Contingencies	886	15,444	9,179	12,458	10,381	13,123	16,229	18,315	96,015
- Estimated Construction Cost -	3,632	45,094	21,434	24,777	18,286	21,029	24,111	25,588	183,951
Engineering Charge	11,630	0	0	0	0	0	0	0	11,630
Leakage Detection(L/D)	330	330	330	0	0	0	0	0	990
Price Escaration for L/D	106	172	247	0	0	0	0	0	525
Construction Supervision	145	1,804	857	991	731	841	964	1,024	7,358
Total Project Cost	15,844	47,400	22,868	25,768	19,018	21,870	25,075	26,612	204,455

Note) Construction Cost : Based on 1986 Price
Inflation Rate : 15% p.a.
Physical Contingencies : 8% of Construction Cost
Engineering Charge : (10% of Construction Cost & Physical Contingencies) + (Price Escalation)
Construction Supervision : 4% of Estimated Construction Cost

TABLE 9.4.2 PROJECTED DEBT SERVICE SCHEDULE

Disbursement Amount		₱194.24 million		
Regular Loan		102.23 "		
Soft Loan		92.01 "		
Capitalized Interest				
Regular Loan		24.41 "		
Soft Loan		0 "		
Total Loan		₱218.65 million		
Financed Interest				
Regular Loan	First	₱2 million	10% per annum	
	Next	₱5 million	12% "	
	Above	₱7 million	14% "	
Soft Loan			10% "	

(Unit : ₱ million)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1. Regular Loan										
Disbursement	15.84	47.40	22.87	16.12	-	-	-	-	-	-
Capitalized Interest	0	2.04	8.96	13.41	-	-	-	-	-	-
Operational Interest	-	-	-	-	17.55	17.55	17.50	17.44	17.38	17.30
Principal Repayment	-	-	-	-	0	0.37	0.42	0.48	0.54	0.62
Debt Services	0	0	0	0	17.55	17.92	17.92	17.92	17.92	17.92
2. Soft Loan										
Disbursement	-	-	-	9.65	17.02	19.87	22.08	23.39	-	-
Capitalized Interest	-	-	-	-	-	-	-	-	-	-
Operational Interest	-	-	-	-	-	-	-	-	9.20	9.20
Principal Repayment	-	-	-	-	-	-	-	-	-	-
Debt Services	0	0	0	0	0	0	0	0	9.20	9.20
Total Debt Services	0	0	0	0	17.55	17.92	17.92	17.92	27.12	27.12
Debt at End of Year	15.84	65.28	97.11	136.29	153.31	172.81	194.47	217.38	216.84	216.22

TABLE 9.4.3 PROJECTED OPERATION AND MAINTENANCE COST

(Unescalated)

(Unit : ₱1,000)

Year	Total O&M Cost	Administrative Expenses	Energy	Chemicals	Maintenance	Miscellaneous
1988	1,900	1,008	161	0	313	418
1989	2,465	1,056	242	71	470	626
1990	2,989	1,104	323	95	629	838
1991	3,775	1,234	456	125	848	1,112
1992	4,559	1,363	588	155	1,067	1,386
1993	5,346	1,493	721	186	1,287	1,659
1994	6,130	1,622	853	216	1,506	1,933
1995	6,916	1,752	986	246	1,725	2,207
1996	6,916	1,752	986	246	1,725	2,207
1997	6,916	1,752	986	246	1,725	2,207
1998	6,916	1,752	986	246	1,725	2,207

TABLE 9.4.4 PROJECTED OPERATION AND MAINTENANCE COST

(Escalated)

(Unit : ₱1,000)

Year	Total O&M Cost	Administrative Expenses	Energy	Chemicals	Maintenance	Miscellaneous
1988	2,513	1,333	213	0	414	553
1989	3,749	1,606	368	108	715	952
1990	5,228	1,931	565	166	1,100	1,466
1991	7,593	2,482	917	251	1,706	2,237
1992	10,546	3,153	1,360	359	2,468	3,206
1993	14,220	3,971	1,918	495	3,423	4,413
1994	18,752	4,962	2,609	661	4,607	5,913
1995	24,329	6,163	3,469	865	6,068	7,764
1996	27,978	7,087	3,989	995	6,978	8,929
1997	32,175	8,151	4,588	1,144	8,025	10,268
1998	37,001	9,373	5,276	1,316	9,229	11,808

9.4.6 Reserve Requirements

The reserve requirements are tied directly to the acquisition of development loans from LWUA. These are considered as funds necessary to support capital development. LWUA guidelines suggest that 10% of direct water sales be set aside as reserve funds. In this analysis, the allocation for reserves is assumed to be 5% from 1994 to 1995 and 10% from 1996 onward.

9.5 REVENUE ANALYSIS AND WATER RATES

9.5.1 Derivation of Revenue Units

LWUA recommends the adoption of the optional method which is a combination of the revenue unit and the quantity block methods.

The number of revenue units have been computed using the optional method. Under this method the minimum charge varies depending on the size of the connection.[4/] In addition, factors are applied to successive quantity blocks of water consumed per month.

These factors increase as the level of consumption increases since they are set to attain a socialized tariff structure where users with low consumption pay a low average rate while users with high level of consumption pay higher average rate. This scheme will also encourage the poor population to connect to the system.

The factors used for the minimum charge (Service Charge Revenue Units or SCRUs), and commodity charges for different sizes and types of service connections and total equivalent volume are shown in TABLE 9.5.1 and TABLE 9.5.2, respectively.

4/ The use factors for the first 10 cu.m which depend on the size of connections are as follows :

3/8" = 1.0	3/4" = 4.0
1/2" = 2.5	1" = 8.0

TABLE 9.5.1 SERVICE CONNECTIONS AND SERVICE CHARGE REVENUE UNITS

STRATIFICATION OF SERVICE CONNECTIONS (ANGELS CITY)

		Connection Size (inch)							
		Domestic/Government				Commercial/Industrial			
Year	Total Service Connections	1/2	3/4	1	Sub-TTL	1/2	3/4	1	Sub-TTL
1988	4,142	3.553	3		3.556	586	0		586
1989	6,115	5.341	12		5.353	762	0		762
1990	8,086	7.128	21		7.149	937	0		937
1991	10,965	9.638	27		9.665	1.300	0		1.300
1992	13,844	12.148	33		12.181	1,663	0		1.663
1993	16,724	14.658	39		14.697	2.027	0		2.027
1994	19.603	17.168	45		17.213	2.390	0		2.390
1995	22.482	19.678	51		19.729	2.753	0		2.753

COMPUTATION OF SERVICE CHARGE REVENUE UNITS (ANGELS CITY)

		Domestic/Government					Commercial/Industrial				
Year	Total SCRUS (1,000)	X 2.5	X 4.0	X 8.0	Sub-Total	X .12	X 5.0	X 8.0	X 16.0	Sub-Total	X .12
1988	1,419	8,883	12	0	8.895	1.067	2.930	0	0	2.930	352
1989	2.065	13.353	48	0	13.401	1.608	3.810	0	0	3.810	457
1990	2.711	17.820	84	0	17.904	2.148	4.685	0	0	4.685	562
1991	3,684	24.095	108	0	24.203	2.904	6.500	0	0	6.500	780
1992	4.658	30.370	132	0	30.502	3.660	8.315	0	0	8.315	998
1993	5.632	36.645	156	0	36.801	4.416	10.135	0	0	10.135	1.216
1994	6.606	42.920	180	0	43.100	5.172	11.950	0	0	11.950	1.434
1995	7.580	49.195	204	0	49.399	5.928	13.765	0	0	13.765	1.652

TABLE 9.5.2 EQUIVALENT VOLUME OF WATER SOLD

(Unit : X 1.000)

1988	SCRUS	Consumption (m3)	First 10 m3	11-20 m3 (1.25)	21-35 m3 (1.60)	Above 35 m3 (2.10)	Total Equivalent Volume
Domestic/Gov.		824	427	75	115	207	
Factor			0	1.25	1.60	2.10	
E.v.	1.067		-	94	184	434	1.780
Commercial/Ind.		224	70	29	45	80	
Factor			0	2.50	3.20	4.20	
E.v.	352		-	73	143	336	903
Total E.V.							2.683

1989	SCRUS	Consumption (m3)	First 10 m3	11-20 m3 (1.25)	21-35 m3 (1.60)	Above 35 m3 (2.10)	Total Equivalent Volume
Domestic/Gov.		1.274	642	120	183	328	
Factor			0	1.25	1.60	2.10	
E.v.	1.608		-	150	293	690	2.741
Commercial/Ind.		299	91	39	60	108	
Factor			0	2.50	3.20	4.20	
E.v.	457		-	99	193	453	1.202
Total E.V.							3.943

1990	SCRUS	Consumption (m3)	First 10 m3	11-20 m3 (1.25)	21-35 m3 (1.60)	Above 35 m3 (2.10)	Total Equivalent Volume
Domestic/Gov.		1.728	858	165	252	452	
Factor			0	1.25	1.60	2.10	
E.v.	2.148		-	207	404	950	3.709
Commercial/Ind.		376	112	50	76	137	
Factor			0	2.50	3.20	4.20	
E.v.	562		-	125	245	576	1.508
Total E.V.							5.217

TABLE 9.5.2 (Cont'd)

(Unit : X 1,000)

1991	SCRUS	Consumption (m3)	First 10 m3	11-20 m3 (1.25)	21-35 m3 (1.60)	Above 35 m3 (2.10)	Total Equivalent Volume
Domestic/Gov.		2.399	1.160	235	359	644	
Factor			0	1.25	1.60	2.10	
E.v.	2,904		-	294	575	1.353	5.127
Commercial/Ind.		562	156	77	118	211	
Factor			0	2.50	3.20	4.20	
E.v.	780		-	193	377	887	2.236
Total E.V.							7.363

1992	SCRUS	Consumption (m3)	First 10 m3	11-20 m3 (1.25)	21-35 m3 (1.60)	Above 35 m3 (2.10)	Total Equivalent Volume
Domestic/Gov.		3.071	1.462	306	467	837	
Factor			0	1.25	1.60	2.10	
E.v.	3.660		-	382	747	1.757	6.546
Commercial/Ind.		749	200	104	159	286	
Factor			0	2.50	3.20	4.20	
E.v.	998		-	261	510	1.200	2.969
Total E.V.							9.515

1993	SCRUS	Consumption (m3)	First 10 m3	11-20 m3 (1.25)	21-35 m3 (1.60)	Above 35 m3 (2.10)	Total Equivalent Volume
Domestic/Gov.		3.742	1.764	376	574	1.029	
Factor			0	1.25	1.60	2.10	
E.v.	4.416		-	470	918	2.160	7.964
Commercial/Ind.		934	243	131	200	359	
Factor			0	2.50	3.20	4.20	
E.v.	1.216		-	328	641	1,509	3.694
Total E.V.							11.658

TABLE 9.5.2 (Cont'd)

(Unit : X 1,000)

1994	SCRUS	Consumption (m3)	First 10 m3	11-20 m3 (1.25)	21-35 m3 (1.60)	Above 35 m3 (2.10)	Total Equivalent Volume
Domestic/Gov.		4,414	2,066	446	681	1,221	
Factor			0	1.25	1.60	2.10	
E.v.	5.172		-	558	1,090	2.564	9.384
Commercial/Ind.		1.121	287	158	242	434	
Factor			0	2.50	3.20	4.20	
E.v.	1.434		-	396	774	1.822	4.426
Total E.V.							13.810

1995	SCRUS	Consumption (m3)	First 10 m3	11-20 m3 (1.25)	21-35 m3 (1.60)	Above 35 m3 (2.10)	Total Equivalent Volume
Domestic/Gov.		5.086	2.367	517	788	1,414	
Factor			0	1.25	1.60	2.10	
E.v.	5.928		-	646	1,261	2.969	10.804
Commercial/Ind.		1.307	330	186	283	508	
Factor			0	2.50	3.20	4.20	
E.v.	1.652		-	464	906	2,133	5.155
Total E.V.							15.959

9.5.2 Water Rate Structure

It is assumed that the following socialized rate structure for domestic/institutional users with 1/2 inch connections is employed in this analysis :

Quantity Block	Factor
First 10 cu.m/month	1.00
11-20 cu.m/month	1.25
21-35 cu.m/month	1.60
Above 35 cu.m/month	2.10

For commercial/industrial users, the use factors are double.

9.5.3 Feasibility of Charges

The feasibility of charges can be determined by subjecting the required water rates for 1/2 inch connections to the following requirements:

1. Minimum charge (for the first 10 cu.m) must not exceed 5% of the average family income of the low income group.
2. Increase must be limited to 60% of the existing rates in the previous year.

The proposed water rates necessary to achieve financial viability are within the ability-to-pay of the customers. From the projected revenue forecast shown in TABLE 9.5.3, the following water charges for the initial 10 cu.m do not exceed 5% of the average income of the low income class, and anticipated increases are within the 60% limit throughout the study period.

However, when another LWUA's regular loan is applied to the project instead of the LWUA's soft loan which is employed here, the minimum charge should be increased in a few years before starting the debt services payment for this LWUA regular loan. This makes it difficult to satisfy the above reguirements in the year from 1991 to 1993.

TABLE 9.5.3 PROJECTED REVENUE FORECAST

(Unit : 1,000 Pesos)

Year	Total Expenses	Rate Unit	Total Equivalent Volume	Total Sales	Bad Debts (3%)	Net Sales	Surplus	Cumulative Surplus
1988	2,513	1.0	2.683	2,683	80	2.602	89	89
1989	3.749	1.2	3.943	4.731	142	4.589	840	929
1990	5.228	1.2	5.217	6.260	188	6.072	844	1,774
1991	7,593	1.8	7.303	13.254	398	12,856	5,263	7.037
1992	28,096	2.7	9.515	25.691	771	24.920	-3.176	3.861
1993	32,138	2.9	11.658	33.809	1.014	32.795	657	4.518
1994	36.370	3.1	13.810	42.812	1.284	41.527	5.157	9.675
1995	42.247	3.1	15.959	49.472	1.484	47.987	5.740	15.415

Period	Minimum Charge	Monthly Family Income	Percentage of Income Allocated to Water	Percentage Increase
1988	₱25.0	₱ 947	2.6	-
1989	30.0	1,084	2.8	20
1990	30.0	1,241	2.4	0
1991	45.0	1,415	3.2	50
1992	67.5	1,613	4.2	50
1993	72.5	1,839	3.9	7
1994	77.5	2,096	3.7	7
1995	77.5	2,389	3.2	0

9.6 FINANCIAL SUMMARY

The financial analysis was based on the forecasts of the following financial statements:

1. Income Statement (TABLE 9.6.1)
2. Cash Flow Statement (TABLE 9.6.2)
3. Balance Sheet (TABLE 9.6.3)

The following assumptions were used for the financial projections:

1. Revenue-Tariff levels were based on the following objectives:
   a) Revenue generation should be adequate to meet the minimum financial internal rate of return of 12-14%.
   b) The District should be able to meet its cash requirements and after project completion, to undertake a reasonable amount of investment to continue expansion and improvement of the system.

2. Reserve Fund ; 10% of direct water sales.

TABLE 9.6.1 PROJECTED INCOME STATEMENT

(Unit : 1,000 Pesos)

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No. of Service Connections	4,142	6,115	8,086	10,965	13,844	16,724	19,603	22,482	22,482	22,482	22,482
Production (m3 x 1,000)	2,090	2,860	3,507	4,776	5,969	7,085	8,287	9,132	9,132	9,132	9,132
Unaccounted for Water (%)	50	45	40	38	36	34	32	30	30	30	30
Consumption (m3 x 1,000)	1,048	1,573	2,104	2,961	3,820	4,676	5,535	6,393	6,393	6,393	6,393
Equivalent Volume (x 1,000)	2,683	3,943	5,217	7,363	9,515	11,658	13,810	15,959	15,959	15,959	15,959
Rate Unit	1.0	1.2	1.2	1.8	2.7	2.9	3.1	3.1	3.3	3.3	3.9
Water Sales	2,683	4,731	6,260	13,254	25,691	33,809	42,812	49,472	52,663	52,663	62,238
Other Revenues	80	142	188	398	771	1,014	1,284	1,484	1,580	1,580	1,867
- Total Revenues -	2,763	4,873	6,448	13,651	26,462	34,823	44,096	50,956	54,243	54,243	64,106
Direct Cost	2,513	3,749	5,228	7,593	10,546	14,220	18,752	24,329	27,978	32,175	37,001
Administrative Expenses	1,333	1,606	1,931	2,482	3,153	3,971	4,962	6,163	7,087	8,151	9,373
Power & Fuel	213	368	565	917	1,360	1,918	2,609	3,469	3,989	4,588	5,276
Chemicals	0	108	166	251	359	495	661	865	995	1,144	1,316
Maintenance & Repair	414	715	1,100	1,706	2,468	3,423	4,607	6,068	6,978	8,025	9,229
Miscellaneous	553	952	1,466	2,237	3,206	4,413	5,913	7,764	8,929	10,268	11,808
Bad Debts	80	142	188	398	771	1,014	1,284	1,484	1,580	1,580	1,867
- Total Costs -	2,593	3,891	5,416	7,991	11,317	15,234	20,036	25,813	29,558	33,755	38,869
Income Before Depreciation	170	982	1,032	5,661	15,145	19,589	24,060	25,143	24,685	20,488	25,237
Depreciation	396	1,632	2,428	3,407	3,883	4,430	5,056	5,722	5,722	5,722	5,722
Income Before Interest	-226	-650	-1,396	2,253	11,262	15,159	19,003	19,421	18,963	14,766	19,515
Interest	0	0	0	0	17,550	17,550	17,499	17,442	26,577	26,502	26,417
Net Income	-226	-650	-1,396	2,253	-6,288	-2,391	1,504	1,979	-7,614	-11,736	-6,902

TABLE 9.6.2 PROJECTED CASH FLOW STATEMENT

(Unit : 1,000 Pesos)

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Sources of Funds											
Income Before Depreciation	170	982	1.032	5.661	15.145	19.589	24.060	25.143	24.685	20.488	25,237
LWUA Loan	15,844	49.438	31.828	39,183	17.018	19.870	22.075	23.390	0	0	0
Equity	0	0	0	0	2.000	2.000	3,000	3.222	0	0	0
Grant	0	0	0	0	0	0	0	0	0	0	0
-Total Sources of Funds-	16.014	50.420	32.860	44.844	34.163	41.459	49.135	51.755	24.685	20.488	25.237
Applications of Funds											
Investment in Project	15.844	47.400	22.868	25.768	19.081	21,870	25.075	26.612	0	0	0
Capitalized Interest	0	2.038	8.960	13.415	0	0	0	0	0	0	0
[Total Investment]	15.844	49.438	31,828	39.183	19.018	21,870	25.075	26.612	0	0	0
Interest (Regular Loan)	0	0	0	0	17,550	17.550	17,499	17,442	17.376	17.301	17.216
Interest (Soft Loan)	0	0	0	0	0	0	0	0	9.201	9.201	9,201
< Total Operational Interest >	0	0	0	0	17.550	17.550	17.499	17.442	26.577	26.502	26.417
Principal (Regular Loan)	0	0	0	0	0	368	419	476	542	617	702
Principal (Soft Loan)	0	0	0	0	0	0	0	0	0	0	0
< Total Principal Repayment >	0	0	0	0	0	368	419	476	542	617	702
[Total Debt Services]	0	0	0	0	17,550	17,918	17.918	17,918	27.119	27.119	27.119
Working Capital Increase	-68	16	-73	330	773	275	2.382	201	2.590	-586	1.205
Cash & Other Current Assets	111	134	161	207	263	331	414	514	591	679	781
Accounts Receivable	447	789	1.043	2,209	4,282	5,635	7.135	8.245	8,777	8.777	10.373
Inventories	0	18	28	42	60	83	110	144	166	191	219
Reserves	0	0	0	0	0	0	2.141	2.474	5,266	5.266	6.224
Accounts Payable	419	625	871	1,266	1.758	2.370	3,125	4.055	4,663	5.363	6.167
Customers' Deposit	207	367	485	987	1,869	2.425	3,038	3,485	3,710	3.710	4,384
-Total Applications of funds-	15.776	49.454	31.755	39.513	37.341	40.003	45.375	44.731	29.709	26.533	28.324
Cash Surplus	237	966	1.105	5,331	-3,178	1,395	3.759	7.023	-5,024	-6.045	-3.087
Cumulative Cash Surplus	237	1.203	2.308	7.639	4,462	5.857	9.616	16.639	11.615	5.570	2.483
Cash Flow	237	966	1,105	5.331	-5.178	-605	759	3.801	-5.024	-6,045	-3.087

TABLE 9.6.3 PROJECTED BALANCE SHEET

(Unit : 1,000 Pesos)

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Fixed Asset	15.844	65.282	97,110	136.293	155.311	177.181	202,256	228.868	228.868	228.868	228.868
Depreciation	396	2,028	4,456	7.863	11.746	16.176	21.232	26.954	32.675	38.397	44.119
Net Fixed Asset	15.448	63.254	92.654	128,430	143.565	161.005	181,024	201.914	196.193	190.471	184.749
Current Asset	796	2.144	3,540	10,097	9.066	11,905	19.416	28.016	26.415	20.484	20.080
-Total Assets-	16,244	65,397	96,194	138.527	152,631	172.911	200,440	229.930	222,608	210.955	204.830
Capital Equity	0	0	0	0	2,000	4.000	7,000	10.222	10.222	10.222	10.222
Government Grant	0	0	0	0	0	0	0	0	0	0	0
Operational Surplus	-226	-876	-2.272	-19	-6.307	-8.697	-7,193	-5.214	-12.828	-24.564	-31.465
Total Equity	-226	-876	-2.272	-19	-4,307	-4,697	-193	5.008	-2.606	-14.342	-21.243
Long Term Debt	15.844	65.282	97.110	136,293	153,311	172.813	194.469	217.383	216.841	216.224	215.522
Current Liabilities	626	992	1,356	2,252	3.627	4,795	6.164	7.540	8.373	9.072	10.551
-Total Equity and Liabilities-	16.244	65,397	96.194	138.527	152,631	172.911	200.440	229.930	222.608	210.955	204.830

3. Cash ; 1 month of administrative expenses.

4. Accounts Receivable ; 2 months of direct water sales.

5. Bad Debts ; 3% of direct water sales.

6. Inventories ; 2 months of expenses of chemicals.

7. Depreciation ; 2.5% of average gross value of fixed assets.

8. Accounts Payable ; 2 months of direct operating and maintenance costs.

9. Customer's Deposits ; ₱50.00 per service connection.

10. Other Operating Revenues ; 3% of direct water sales.

9.7 FINANCIAL INTERNAL RATE OF RETURN (FIRR)

The Financial Internal Rate of Return is a major consideration affecting capital investment decisions. It measures the effective utilization of the total investment and also the equity employed in the project and shows the compounded growth of investments within the project period.

The rate of return was computed based on the present value of cash inflows and outflows. As shown in TABLE 9.7.1, the rate of return, with the assumptions made, is estimated to be 13.7%.

9.8 FINANCIAL RECOMMENDATION

The recommended project for the Short Term Development Plan is financially feasible. The proposed water rates for 1/2 inch connections of domestic users to achieve financial self-sufficiency are :

TABLE 9.7.1 FINANCIAL INTERNAL RATE OF RETURN

(Unit : ₱1,000)

Year	Rate/Unit (₱)	Income before Depreciation	LWUA Loan	Total Investment	Total Debt Services	Working Capital Increase	Net Cash Inflow	Present Value
1988	1.0	170	15,844	15,844	0	-68	237	237
1989	1.2	982	49,438	49,438	0	16	996	849
1990	1.2	1,032	31,828	31,828	0	-73	1,105	855
1991	1.8	5,661	39,183	39,183	0	330	5,331	3,626
1992	2.7	15,145	17,018	19,018	17,550	773	-5,178	-3,098
1993	2.9	19,589	19,870	21,870	17,918	275	-605	-318
1994	3.1	24,060	22,075	25,075	17,918	2,382	759	351
1995	3.1	25,143	23,390	26,612	17,918	201	3,801	1,547
1996	3.3	24,863	-	-	27,119	2,590	-5,024	-1,798
1997	3.3	20,488	-	-	27,119	-586	-6,045	-1,903
1998	3.9	25,237	-	-	27,119	1,205	-3,087	-855
1999	4.5	29,262	-	-	27,119	1,104	1,039	253
2000	5.0	30,858	-	-	27,119	675	3,065	656
2001	5.0	23,518	-	-	28,725	-1,025	-4,182	-788
2002	6.5	39,015	-	-	28,725	3,519	6,771	1,122
2003	6.5	29,308	-	-	28,725	-1,355	1,938	282
2004	7.5	34,103	-	-	28,725	1,573	3,805	487
2005	7.5	21,265	-	-	28,725	-1,793	-5,668	-639
2006	8.5	22,460	-	-	28,725	1,070	-7,335	-727
2007	10.0	29,419	-	-	28,725	2,327	-1,632	-142

FIRR = 13.7

Period	Rate/ Unit	First 10cu.m	11-20cu.m	21-35cu.m	Above 35cu.m
1988	₱1.0	₱25.0	₱3.1	₱4.0	₱5.3
1989	1.2	30.0	3.8	4.8	6.3
1990	1.2	30.0	3.8	4.8	6.3
1991	1.8	45.0	5.6	7.2	9.5
1992	2.7	67.5	8.4	10.8	14.2
1993	2.9	72.5	9.1	11.6	15.2
1994	3.1	77.5	9.7	12.4	16.3
1995	3.1	77.5	9.7	12.4	16.3
1996	3.3	82.5	10.3	13.2	17.3
1997	3.3	82.5	10.3	13.2	17.3

As shown above, increases of Rate/Unit are inevitable in this project, since the existing water rate structure is comparatively in a lower level. However, after 1992 a moderate increase in the percentage of the water rate is expected annually.

CHAPTER 10
ECONOMIC FEASIBILITY ANALYSIS

CHAPTER 10 ECONOMIC FEASIBILITY ANALYSIS

10.1 GENERAL

The objective of the project is to uplift the social welfare of the community. Therefore, an evaluation of the effectiveness of the project, in terms of socio-economic factors not considered in the financial analysis, is made in this economic analysis.

It may not be possible to evaluate all the costs and benefits of a project because some of them are not quantifiable or the technical methods to evaluate them quantitatively are not available. It is this reason that only quantifiable benefits and costs will be included in the analysis.

The comparison between the costs and benefits shall allow an assessment of the economic feasibility of the project.

10.2 METHOD OF ANALYSIS

To evaluate economic feasibility of the project, the Economic Internal Rate of Return (EIRR) should be assessed through the calculations on the economic benefits and costs anticipated from the implementation of the project.

The project is considered economically feasible if the EIRR is higher than the opportunity cost of capital, or the rate of return that can be obtained from the best alternative use of the available capital. For public investment programs such as water supply projects, the opportunity cost of capital is from 12% to 15%.

10.3 ECONOMIC BENEFITS OF THE PROJECT

The implementation of the project will provide the following direct and indirect benefits:

Direct Benefits:

- Increase in the area and population to be served
- Continuous supply of safe water

Indirect Benefit:

- Increase of employment opportunity
- Improvement of health condition
- Increase in consumer satisfaction
- Increase in land values
- Reduction in fire damage
- Increase in income in some productive sectors

The quantifiable benefits considered in the economic feasibility analysis are increased land value and the beneficial value of water (consumer's satisfaction).

Except for the beneficial value of water, all other benefits are held constant after completion of the project.

10.3.1 Increase in Land Values

The water supply improvement project will contribute to an increase in land value of the service area. However, this increased value could be the result of a general increase of productivity due to improved infrastructure which includes a water supply project.

The portion of land values attributable to the water supply system in the service area was determined by comparing the market values of land served and not served by the water system. The average market value of residential land served by the water system is ₱120/sq.m, and commercial land is ₱700/sq.m, while the average market value of residential land unserved by the water system is ₱50/sq.m, and commercial land is ₱120/sq.m, respectively.

Generally, it is assumed that 20% of the incremental value of land could be attributed to the water supply project.